



SERVICE MANUAL

Number 24

MARINE ENGINES

GM V-8

305 CID (5.0L) / 350 CID (5.7L)

**MerCruiser #24 GM V-8
305 CID (5.0L) / 350 CID (5.7L)**

90-861327--1

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Notice

Throughout this publication, “Dangers”, “Warnings” and “Cautions” (accompanied by the International HAZARD Symbol ) are used to alert the mechanic to special instructions concerning a particular service or operation that may be hazardous if performed incorrectly or carelessly. **OBSERVE THEM CAREFULLY!**

These “Safety Alerts” alone cannot eliminate the hazards that they signal. Strict compliance to these special instructions when performing the service, plus “Common Sense” operation, are major accident prevention measures.

DANGER

DANGER - Immediate hazards which WILL result in severe personal injury or death.

WARNING

WARNING - Hazards or unsafe practices which COULD result in severe personal injury or death.

CAUTION

Hazards or unsafe practices which could result in minor personal injury or product or property damage.

Notice to Users of This Manual

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

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

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

All information, illustrations and specifications contained in this manual are based on the latest product information available at the time of publication. As required, revisions to this manual will be sent to all dealers contracted by us to sell and/or service these products.

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

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

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

Cleanliness and Care of Outboard Motor

A marine power product is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in the ten thousands of an inch/mm. When any product component is serviced, care and cleanliness are important. Throughout this manual, it should be understood that proper cleaning, and protection of machined surfaces and friction areas is a part of the repair procedure. This is considered standard shop practice even if not specifically stated.

Whenever components are removed for service, they should be retained in order. At the time of installation, they should be installed in the same locations and with the same mating surfaces as when removed.

Personnel should not work on or under an outboard which is suspended. Outboards should be attached to work stands, or lowered to ground as soon as possible.

We reserve the right to make changes to this manual without prior notification.

Refer to dealer service bulletins for other pertinent information concerning the products described in this manual.

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POWER STEERING SYSTEM

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IMPORTANT INFORMATION
Section 1A - General Information



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Introduction

This comprehensive overhaul and repair manual is designed as a service guide for the models previously listed. It provides specific information, including procedures for disassembly, inspection, assembly and adjustment to enable dealers and service mechanics to repair and tune these engines.

Before attempting repairs or tune-up, it is suggested that the procedure first be read through to gain knowledge of the methods and tools used and the cautions and warnings required for safety.

How to Use This Manual

This manual is divided into sections which represent major components and systems.

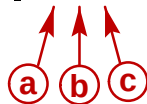
Some sections are further divided into parts which more fully describe the component.

Sections and section parts are listed on the "Service Manual Outline" page following "V-8 Models Covered in This Manual" page.

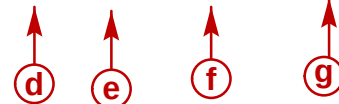
Page Numbering

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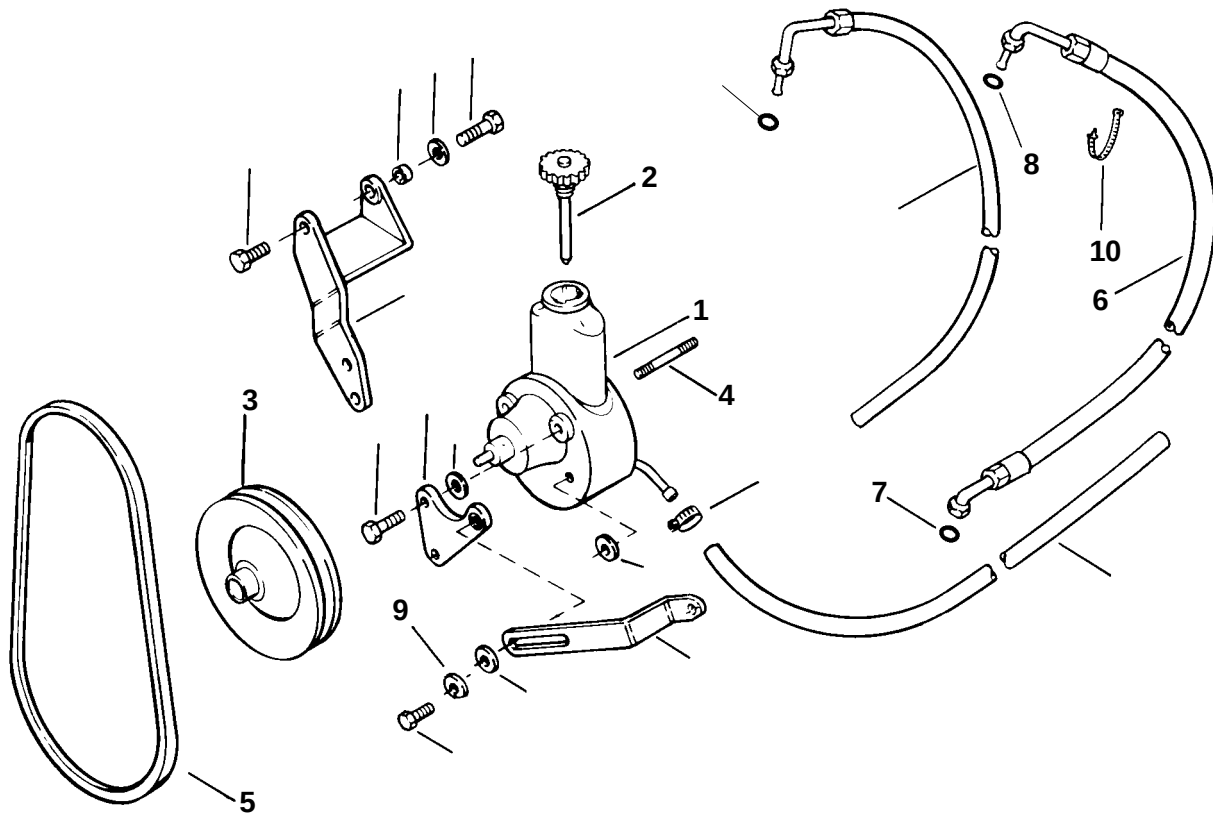
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- a** - Section Number
- b** - Section Part
- c** - Page Number
- d** - Manual Part Number
- e** - Revision Number
- f** - Month Printed
- g** - Year Printed

How to Read a Parts Manual

Power Steering Pump Assembly



REF. NO.	PART NO.	SYM.	QTY.	DESCRIPTION
1	90507A12		1	PUMP ASSEMBLY—Power Steering
2	36- 95805		1	CAP
3	73873A1		1	PULLEY
4	16- 41877		1	STUD
5	57- 65607T		1	V-BELT
6	32- 806684		1	HOSE—Pressure (FITTINGS ON BOTH ENDS)
7	25- 89879		1	O-RING
8	25- 806232		1	O-RING
9	13- 35048		1	LOCKWASHER (3/8 in.)
10	61990		1	CABLE TIE

REF. NO. : Number shown next to part on exploded view

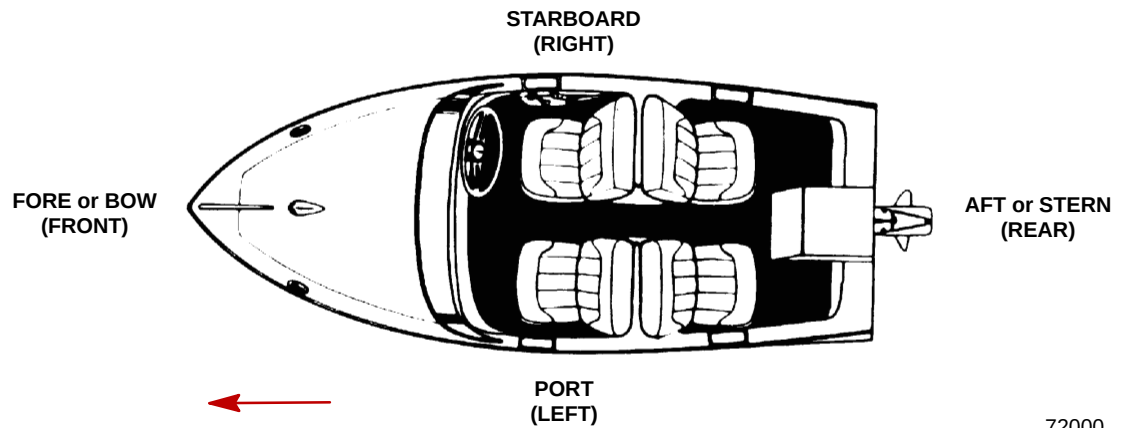
PART NO. : Mercury Part Number for ordering. If NSS (not sold separately) sometimes GM part number will be given in description column.

QTY. : The quantity that must be ordered.

DESCRIPTION : Description of part, what parts are included with a part (all indented items come with the main item above the indented parts), serial number information, and special information.

Directional References

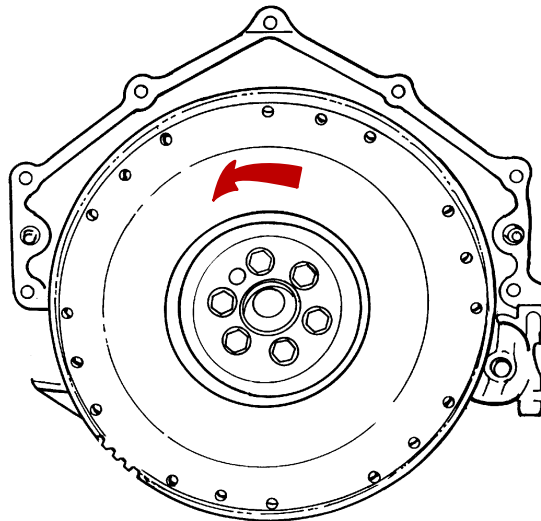
Front of boat is bow; rear is stern. Starboard side is right side; port side is left side. In this maintenance manual, all directional references are given as they appear when viewing boat from stern looking toward bow.



72000

Engine Rotation

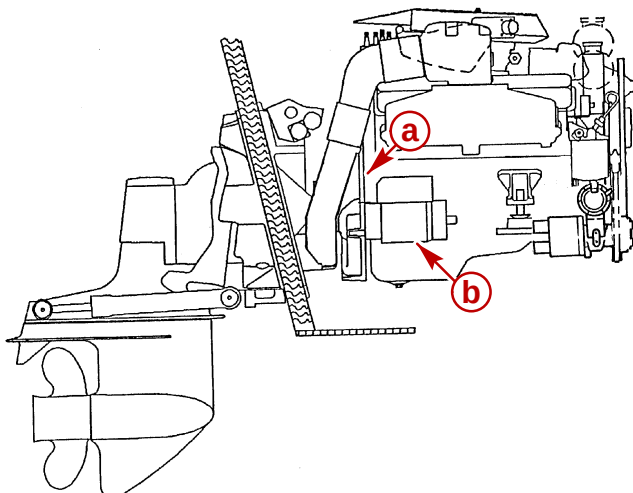
Engine rotation is determined by observing flywheel rotation from the rear (stern end) of the engine looking forward (toward water pump end). Propeller rotation is not necessarily the same as engine rotation. When ordering replacement engine, short blocks or parts for engine, be certain to check engine rotation. Do not rely on propeller rotation in determining engine rotation.



72001

Standard Left Hand Rotation

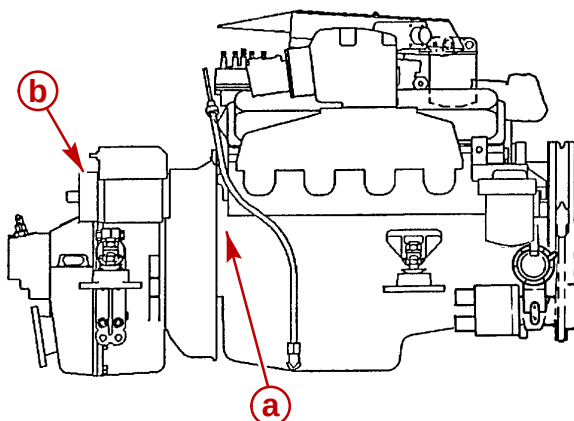
Engine Serial Number Locations



72923

Sterndrive (MCM)

- a** - Serial Number Plate
- b** - Starter Motor



72924

Inboard (MIE)

- a** - Serial Number Plate
- b** - Starter Motor

Propeller Information

Refer to the "Propeller" section in appropriate Mercury MerCruiser Sterndrive Service Manual, or order publication 90-86144-92, "Everything you need to know about propellers."

Changing diameter, pitch or coupling of a propeller will affect engine rpm and boat performance. The blade configuration also will affect performance. Two like propellers, same pitch and diameter, from two different manufacturers will perform differently.

1. It is the responsibility of the boat manufacturer and/or selling dealer to equip the boat with the correct propeller to allow the engine to operate within its specified rpm range at wide-open-throttle (WOT).

Because of the many variables of boat design and operation, only testing will determine the best propeller for the particular application.

To test for correct propeller, operate boat (with an average load onboard) at WOT and check rpm with an accurate tachometer. Engine rpm should be near top of the specified range so that, under heavy load, engine speed will not fall below specifications.

If engine exceeds the specified rpm, an increase in pitch and/or diameter is required.

If engine is below rated rpm, a decrease in pitch and/or diameter is required.

Normally, a change of approximately 150 rpm will be achieved for each single inch of pitch change of a propeller.

⚠ CAUTION

If a propeller is installed that does not allow engine rpm to reach the specified full-throttle rpm range, the engine will "labor" and will not produce full power. Operation under this condition will cause excessive fuel consumption, engine overheating and possible piston damage (due to detonation). Conversely, installing a propeller, allowing engine to run above the specified rpm limit, will cause excessive wear on internal engine parts which will lead to premature engine failure.

Water Testing New Engines

Use care during the first 20 hours of operation on new Mercury MerCruiser engines or possible engine failure may occur. If a new engine has to be water-tested at full throttle before the break-in period is complete, follow this procedure.

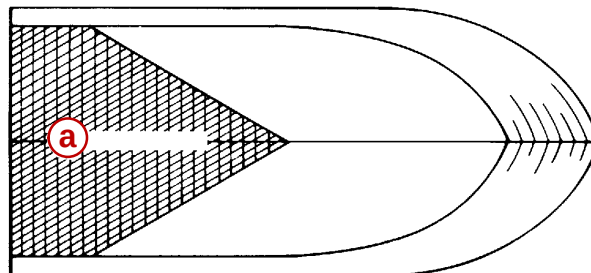
1. Start engine and run at idle rpm until normal operating temperature is reached.
2. Run boat up on plane.
3. Advance engine rpm (in 200 rpm increments) until engine reaches its maximum rated rpm.

IMPORTANT: Do not run at maximum rpm for more than 2 minutes.

Boat and Engine Performance

Boat Bottom

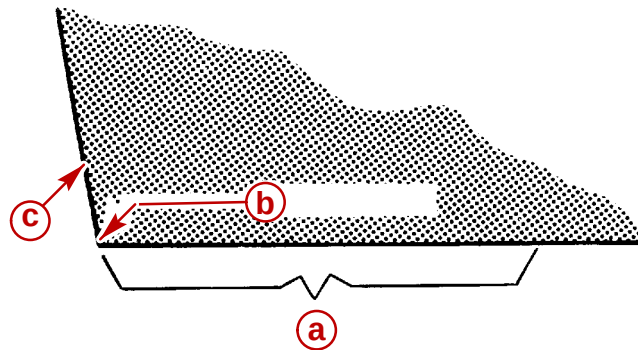
For maximum speed, a boat bottom should be as flat as possible in a fore-aft direction (longitudinally) for approximately the last 5 ft (1.5 m).



72002

a - Critical Bottom Area

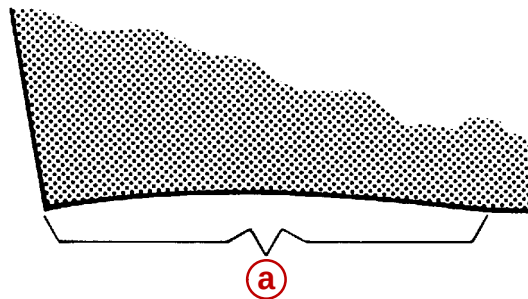
For best speed and minimum spray, the corner between the bottom and the transom should be sharp.



72003

- a** - Bottom
- b** - Corner
- c** - Transom

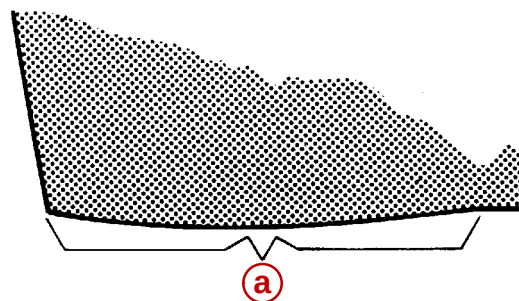
The bottom is referred to as having a “hook” if it is concave in the fore-and-aft direction. A hook causes more lift on the bottom near the transom and forces the bow to drop. This increases wetted surface and reduces boat speed. A hook, however, aids in planing and reduces any porpoising (rhythmical bouncing) tendency. A slight hook is often built in by the manufacturer. A hook also can be caused by incorrect trailering or storing the boat with support directly under the transom.



72004

- a** - Hook

A “rocker” is the reverse of a hook. The bottom is convex or bulged in the fore-and-aft direction. It can cause the boat to porpoise.



72005

- a** - Rocker

Any hook, rocker or surface roughness on the bottom, particularly in the critical center-aft portion will have a negative effect on speed, often several miles per hour on a fast boat.

Marine Fouling

Fouling is an unwanted build-up (usually animal-vegetable-derived) occurring on the boat's bottom and drive unit. Fouling adds up to drag, which reduces boat performance. In fresh water, fouling results from dirt, vegetable matter, algae or slime, chemicals, minerals and other pollutants. In salt water, barnacles, moss and other marine growth often produce dramatic build-up of material quickly. Therefore, it is important to keep the hull as clean as possible in all water conditions to maximize boat performance.

Antifouling paint, if required, may be applied to boat hull observing the following precautions.

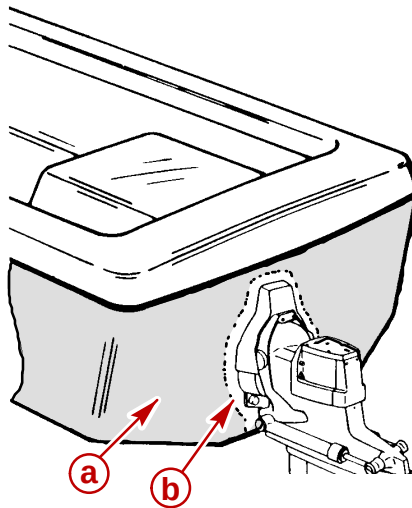
IMPORTANT: DO NOT paint anodes or MerCathode System reference electrode and anode, as this will render them ineffective as galvanic corrosion inhibitors.

⚠ CAUTION

Avoid corrosion damage. Do not apply antifouling paint to Mercury MerCruiser drive unit or transom assembly.

IMPORTANT: If antifouling protection is required, Tri-Butyl-Tin-Adipate (TBTA) base antifouling paints are recommended on Mercury MerCruiser boating applications. In areas where Tri-Butyl-Tin-Adipate base paints are prohibited by law, copper base paints can be used on boat hull and boat transom. Corrosion damage that results from the improper application of antifouling paint will not be covered by the limited warranty. Observe the following:

Avoid an electrical interconnection between the Mercury MerCruiser Product, Anodic Blocks, or MerCathode System and the paint by allowing a minimum of 1 in. (26mm) UNPAINTED area on transom of the boat around these items.



71176

- a** - Antifouling Paint
- b** - MINIMUM 1 inch (26 mm) Unpainted Area.

Weight Distribution

Weight distribution is extremely important; it affects a boat's running angle or attitude. For best top speed, all movable weight - cargo and passengers - should be as far aft as possible to allow the bow to come up to a more efficient angle (3 to 5 degrees). On the negative side of this approach is the problem that, as weight is moved aft, some boats will begin an unacceptable porpoise.

Secondly, as weight is moved aft, getting on plane becomes more difficult.

Finally, the ride in choppy water becomes more uncomfortable as the weight goes aft. With these factors in mind, each boater should seek out what weight locations best suit his/her needs.

Weight and passenger loading placed well forward increases the "wetted area" of the boat bottom and, in some cases, virtually destroys the good performance and handling characteristics of the boat. Operation in this configuration can produce an extremely wet ride, from wind-blown spray, and could even be unsafe in certain weather conditions or where bow steering may occur.

Weight distribution is not confined strictly to fore and aft locations, but also applies to lateral weight distribution. Uneven weight concentration to port or starboard of the longitudinal centerline can produce a severe listing attitude that can adversely affect the boat's performance, handling ability and riding comfort. In extreme rough water conditions, the safety of the boat and passengers may be in jeopardy.

Water in Boat

When a boat loses performance, check bilge for water. Water can add considerable weight to the boat, thereby decreasing the performance and handling.

Make certain that all drain passages are open for complete draining.

Elevation and Climate

Elevation has a very noticeable effect on the wide-open-throttle power of an engine. Since air (containing oxygen) gets thinner as elevation increases, the engine begins to starve for air. Humidity, barometric pressure and temperature do have a noticeable effect on the density of air. Heat and humidity thin the air. This phenomenon can become particularly apparent when an engine is propped out on a cool dry day in spring and later, on a hot, humid day in August, does not have the same performance.

Although some performance can be regained by dropping to a lower pitch propeller, the basic problem still exists. The propeller is too large in diameter for the reduced power output. A Quicksilver Propeller Repair Station or experienced marine dealer can determine how much diameter to remove from a lower-pitch propeller for specific high-elevation locations. In some cases, installing high altitude gears in the drive unit is possible and very beneficial. Weather conditions may effect the power output of internal combustion engines. Therefore, established horsepower ratings refer to the power that the engine will produce at its rated rpm under a specific combination of weather conditions.

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IMPORTANT INFORMATION

Section 1B - Maintenance

**1
B**

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Tools

Description	Part Number
Timing Light	91-99379
Quicksilver Scan Tool	91-823686A2

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Liquid Neoprene	92-25711--3
Quicksilver 2-4-C Marine Lubricant With Teflon	92-825407A3
Loctite Pipe Sealant With Teflon	Obtain Locally
Quicksilver U-Joint and Gimbal Bearing Grease	92-828052A2

Maintenance Schedules

Maintenance Intervals

Maintenance intervals and the tasks to be performed, as shown in this current schedule, or as found in a previously printed schedules, are generally based on an average boating application and environment. However, individual operating habits and personal maintenance preferences can have an impact on the suggested intervals. In consideration of these factors, Mercury MerCruiser has adjusted some maintenance intervals and corresponding tasks to be performed. In some cases, this may allow for more individual tasks to be performed in a single visit to the serving dealer, rather than multiple visits. Therefore, it is very important that the boat owner and servicing dealer discuss the current Maintenance Schedule and develop appropriate maintenance intervals to coincide with the individual operating habits, environment, and maintenance requirements.

Always disconnect battery cables from battery BEFORE working around electrical systems components to prevent injury to yourself and damage to electrical system should a wire be accidentally shorted.

Gas Sterndrive

Routine Maintenance *				
	Each Day Start	Each Day End	Weekly	Every Two Months
Check crankcase oil (interval can be extended based on experience).	●★			
If operating in salt, brackish or polluted waters, flush cooling system after each use.		●★		
Check drive unit oil level, trim pump oil level and power steering pump fluid level.			●★	
Check water pickups for debris or marine growth. Check water strainer and clean. Check coolant level.			●★	
Inspect drive unit anodes and replace if 50 percent eroded.			●★	
Inspect fuel pump sight tube and have pump replaced if fuel is present.			●★	
Check battery connections and fluid level.				●★
Lubricate propeller shaft and the retorque nut (if operating in only freshwater, this maintenance may be extended to every four months).				●★
Operating in Saltwater Only: treat engine surface with corrosion guard.				●★
Clean air filter every 50 hours of operation.				●★

* Only perform maintenance which applies to your particular power package

- Standard Models
- ★ Horizon Models

Gas Sterndrive(Continued)

Scheduled Maintenance *

	Annu- ally	Every 100 hours or Annually	Every 200 hours or 3 years	Every 300 hours or 3 years	Every 2 years	Every 5 years
Touch-up paint power package and spray with corrosion guard.	●★					
Change crankcase oil and filter.		●★				
Change drive unit oil and retorque connection of gimbal ring to steering shaft.		●★				
Replace fuel filter(s).		●★				
Check steering system and remote control for loose, missing or damaged parts. Lubricate cables and linkages.		●★				
Inspect U-joints, splines and bellows. Check clamps. Check engine alignment. Lubricate U-joints splines.		●	★			
Lubricate gimbal bearing and engine coupler.		● ⁸	★			
Check continuity circuit for loose or damaged connections. Test MerCathode® unit output on Bravo Models.		●	★			
Retorque engine mounts.		●		★		
Check spark plugs, wires, distributor cap and ignition timing. Check and adjust idle speed.		●		★		
Clean flame arrestor and crankcase ventilation hoses. Replace PCV valve.		●		★		
Check electrical system for loose, damaged or corroded fasteners.		●		★		
Inspect condition and tension of belts.		●		★		
Check cooling system and exhaust system hose clamps for tightness. Inspect both systems for damage or leaks.		●		★		
Disassemble and inspect seawater pump and replace worn components.		●		★		
Clean seawater section of closed cooling system. Clean, inspect and test pressure cap.		●		★		
Replace coolant.					♠	●★

* Only perform maintenance which applies to your particular power package

● Standard Models

★ Horizon Models

◆ Whichever Occurs First

♠ Interval will be reduced if not using extended life coolant.

⁸ Lubricate engine coupler every 50 hour if operated at idle for prolonged periods of time.

Gas Inboard

Routine Maintenance *

	Each Day Start	Each Day End	Weekly	Every Two Months
Check crankcase oil (interval can be extended based on experience).	●★			
If operating in salt, brackish or polluted waters, flush cooling system after each use.		●★		
Check transmission fluid.			●★	
Check water pickups for debris or marine growth. Check water strainer and clean. Check coolant level.			●★	

* Only perform maintenance which applies to your particular power package

- Standard Models
- ★ Horizon Models

Gas Inboard(Continued)

Scheduled Maintenance *

	Annually	Every 100 hours or Annually ◆	Every 200 hours or 3 years ◆	Every 300 hours or 3 years ◆	Every 2 years	Every 5 years	Per OEM
Touch-up paint power package and spray with corrosion guard.	●★						
Change crankcase oil and filter.		●★					
Change transmission fluid.		●★					
Replace fuel filter(s).		●★					
Check steering system and remote control for loose, missing or damaged parts. Lubricate cables and linkages.		●★					
Retorque engine mounts.		●		★			
Check spark plugs, wires, distributor cap and ignition timing. Check and adjust idle speed.		●		★			
Clean flame arrestor and crankcase ventilation hoses. Replace PCV valve.		●		★			
Check electrical system for loose, damaged or corroded fasteners.		●		★			
Inspect condition and tension of belts.		●		★			
Check cooling system and exhaust system hose clamps for tightness. Inspect both systems for damage or leaks.		●		★			
Disassemble and inspect seawater pump and replace worn components.		●		★			
Clean seawater section of closed cooling system. Clean, inspect and test pressure cap.		●		★			
Replace coolant.					●	★♠	
Check engine-to-propeller shaft alignment.							●★

* Only perform maintenance which applies to your particular power package

● Standard Models

★ Horizon Models

◆ Whichever Occurs First

♠ Interval will be reduced if not using extended life coolant.

Engine and Tune-Up Specifications

MCM (Sterndrive)

Model	MCM 5.0L ALPHA BRAVO	MCM 5.7L ALPHA BRAVO
Propshaft Horsepower (SAV1 Rating)	220 ¹	250 ¹
Propshaft Kilowatts (SAV1 Rating)	164 ¹	186 ¹
Number of Cylinders	V-8	
Displacement	305 cid (5.0 l)	350 cid (5.7 l)
Bore / Stroke - in. (mm)	3.74 x 3.48 (95 x 88.4)	4.0 x 3.48 (101.6 x 88.4)
Compression Ratio	9.4:1	
Compression Pressure	Minimum 100 psi (690 kPa) ⁷	
Idle rpm In Neutral ³	650 rpm ⁵	
Maximum rpm (at WOT) ³	4400-4800 rpm	
Oil Pressure (at 2000 rpm)	Minimum 30 psi (207 kPa)	
Minimum Oil Pressure (at Idle)	Minimum 4 psi (28 kPa)	
Fuel Pressure (1800 rpm)	3-7 psi (21-48 kPa)	
Electrical System	12 V Negative (-) Ground	
Alternator Rating	55 or 65 amp ⁸	
Minimum Battery Requirements	375 cca / 475 mca / 90 Ah	
Firing Order	1-8-4-3-6-5-7-2	
Spark Plug Type	AC - MR43LTS Champion - RS12YC NGK - BPR6EFS	
Spark Plug Gap	.045 in. (1.1 mm)	
Timing (at idle rpm) ⁴	10° BTDC	
Preliminary Idle Mixture	1 1/4 Turns	
Thermostat	160° F (71° C)	

¹ Power Rated in Accordance with NMMA (National Marine Manufacturers' Association) rating procedures.

² Power Rated in Accordance with SAV1 rating procedures. This rating procedure is used to certify that the engine complies with "Stage 1" Bodensee and Swiss Regulations. Horsepower differences shown result from differences in test rpm, allowable test tolerances, and/or installation of special kit components.

³ Measured using an accurate service tachometer with engine at normal operating temperature.

⁴ Timing must be set using a special procedure as outlined in the appropriate section of this manual. Timing cannot be properly set using the conventional method.

⁵ A special procedure must be followed to adjust idle rpm. Consult your Authorized Mercury MerCruiser Dealer before attempting this procedure.

⁶ Idle speed on EFI models is not adjustable.

⁷ Minimum recorded compression in any one cylinder should not be less than 70 percent of the highest recorded cylinder.

⁸ Serial Number Break 65Amp starts at OL619000 and up.

Engine and Tune-Up Specifications (Continued)

MCM (Sterndrive) (continued)

Model	MCM 5.0L EFI ALPHA BRAVO	MCM 5.7L EFI ALPHA BRAVO	MCM 350 MAG MPI ALPHA BRAVO
Propshaft Horsepower (SAV1 Rating)	230 ¹	260 ¹	300 ¹ (275 ²)
Propshaft Kilowatts (SAV1 Rating)	172 ¹	194 ¹	224 ¹ (205 ²)
Number of Cylinders	V-8		
Displacement	305 cid (5.0 l)	350 cid (5.7 l)	
Bore / Stroke - in. (mm)	3.74 x 3.48 (95 x 88.4)	4.0 x 3.48 (101.6 x 88.4)	
Compression Ratio	9.4:1		
Compression Pressure	Minimum 100 psi (690 kPa) ⁷		
Idle rpm In Neutral ³	600 rpm ⁶		
Maximum rpm (at WOT) ³	4400-4800 rpm		
Oil Pressure (at 2000 rpm)	Minimum 30 psi (207 kPa)		
Minimum Oil Pressure (at Idle)	Minimum 4 psi (28 kPa)		
Fuel Pressure (1800 rpm)	30 psi (207 kPa)		
Electrical System	12 V Negative (–) Ground		
Alternator Rating	55 or 65 amp ⁸		
Minimum Battery Requirements	550 cca / 700 mca / 120 Ah		
Firing Order	1-8-4-3-6-5-7-2		
Spark Plug Type	AC - MR43LTS Champion - RS12YC NGK - BPR6EFS		
Spark Plug Gap	.045 in (1.1 mm)		
Timing (at idle rpm) ⁵	8° BTDC		
Thermostat	160° F (71° C)		

¹ Power Rated in Accordance with NMMA (National Marine Manufacturers' Association) rating procedures.

² Power Rated in Accordance with SAV1 rating procedures. This rating procedure is used to certify that the engine complies with "Stage 1" Bodensee and Swiss Regulations. Horsepower differences shown result from differences in test rpm, allowable test tolerances, and/or installation of special kit components.

³ Measured using an accurate service tachometer with engine at normal operating temperature.

⁴ Timing must be set using a special procedure as outlined in the appropriate section of this manual. Timing cannot be properly set using the conventional method.

⁵ A special procedure must be followed to check or adjust idle rpm. Consult your Authorized Mercury MerCruiser Dealer before attempting this procedure.

⁶ Idle speed on EFI models is not adjustable.

⁷ Minimum recorded compression in any one cylinder should not be less than 70 percent of the highest recorded cylinder.

⁸ Serial Number Break 65Amp starts at OL619000 and up.

Engine and Tune-Up Specifications (Continued)

MIE (Inboard and Ski)

Model	MIE 5.7L	MIE 350 MAG MPI
Propshaft Horsepower (SAV1 Rating)	260 ¹	300 ¹ (290 ²)
Propshaft Kilowatts (SAV1 Rating)	194 ¹	224 ¹ (216 ²)
Number of Cylinders	V-8	
Displacement	350 cid (5.7 l)	
Bore / Stroke - in. (mm)	4.00 x 3.48 in. (101.6 x 88.4)	
Compression Ratio	9.4:1	
Compression Pressure	100 psi (690 kPa) ⁷	
Idle rpm In Neutral ³	650 rpm ⁵	600 rpm ⁶
Maximum rpm (at WOT)	4200-4600 rpm ³	4400-4800 rpm ³
Oil Pressure (at 2000 rpm)	Minimum 30 psi (207 kPa)	
Minimum Oil Pressure (at Idle)	4 psi (28 kPa)	
Fuel Pressure (1800 rpm)	3-7 psi (21-48 kPa)	30 psi (207 kPa)
Electrical System	12 V Negative (–) Ground	
Alternator Rating	55 or 65 amp ⁸	
Minimum Battery Requirements	375 cca/475 mca/90 Ah	550 cca/700 mca/120 Ah
Firing Order	1-8-4-3-6-5-7-2	1-8-4-3-6-5-7-2
Spark Plug Type	AC - MR43LTS Champion - RSY9C NGK - BPR6EFS	
Spark Plug Gap	.045 in. (1.1 mm)	
Timing (at idle rpm) ³	10° BTDC ⁴	8° BTDC ⁴
Preliminary Idle Mixture	1 1/4 Turns	Does Not Apply
Thermostat	160° F (71°C)	

¹ Power Rated in Accordance with NMMA (National Marine Manufacturers' Association) rating procedures.

² Power Rated in Accordance with SAV1 rating procedures. This rating procedure is used to certify that the engine complies with "Stage 1" Bodensee and Swiss Regulations. Horsepower differences shown result from differences in test rpm, allowable test tolerances, and/or installation of special kit components.

³ Measured using an accurate service tachometer with engine at normal operating temperature.

⁴ Timing must be set using a special procedure as outlined in the appropriate section of this manual. Timing cannot be properly set using the conventional method.

⁵ A special procedure must be followed to adjust idle rpm. Consult your Authorized Mercury MerCruiser Dealer before attempting this procedure.

⁶ Idle speed on EFI models is not adjustable.

⁷ Minimum recorded compression in any one cylinder should not be less than 70 percent of the highest recorded cylinder.

⁸ Serial Number Break 65Amp starts at OL619000 and up.

Engine and Tune-Up Specifications (Continued)

SKI (Inboard)

Model	5.7L SKI	350 MAG MPI SKI	BLACK SCORPION SKI
Propshaft HorsePower (SAV1 Rating)	260 ¹	300 ¹	315 ¹
Propshaft Kilowatts (SAV1 Rating)	194 ¹	224 ¹	235 ¹
Number of Cylinders	V-8		
Displacement	350 cid (5.7 l)		
Bore / Stroke - in. (mm)	4.00 x 3.48 in. (101.6 x 88.4 mm)		
Compression Ratio	9.4:1		
Compression Pressure	Minimum100 psi (690 kPa) ⁷		
Idle rpm In Neutral ³	650 rpm ⁵	600 rpm ⁶	
Maximum rpm (at WOT) ³	4400 - 4800	4600 - 5000	4800 - 5200
Oil Pressure (at 2000 rpm)	Minimum 30 psi (207 kPa)		
Minimum Oil Pressure (at Idle)	4 psi (28 kPa)		
Fuel Pressure (1800 rpm)	3-7 psi (21-48 kPa)	30 psi (207 kPa)	
Electrical System	12 V Negative (–) Ground		
Minimum Battery Require- ments	375 cca / 475 mca / 90 Ah	550 cca / 700 mca / 120 Ah	
Firing Order	1-8-4-3-6-5-7-2		
Spark Plug Type	AC - MR43LTS NGK - BPR6EFS Champion - RS12YC		
Spark Plug Gap	.045 in. (1.1 mm)		
Timing (at idle rpm)	10° BTDC ⁴	8° BTDC ⁴	
Preliminary Idle Mixture	1 1/4 Turns	Does Not Apply	
Thermostat	160° F (71°C)		

¹ Power Rated in Accordance with NMMA (National Marine Manufacturers' Association) rating procedures.

² Power Rated in Accordance with SAV1 rating procedures. This rating procedure is used to certify that the engine complies with "Stage 1" Bodensee and Swiss Regulations. Horsepower differences shown result from differences in test rpm, allowable test tolerances, and/or installation of special kit components.

³ Measured using an accurate service tachometer with engine at normal operating temperature.

⁴ Timing must be set using a special procedure as outlined in the appropriate section of this manual. Timing cannot be properly set using the conventional method.

⁵ A special procedure must be followed to adjust idle rpm. Consult your Authorized Mercury MerCruiser Dealer before attempting this procedure.

⁶ Idle speed on EFI models is not adjustable.

⁷ Minimum recorded compression in any one cylinder should not be less than 70 percent of the highest recorded cylinder.

⁸ Serial Number Break 65Amp starts at OL619000 and up.

Fluid Capacities

NOTICE	
Unit Of Measurement: U.S. Quarts (Liters)	
All capacities are approximate fluid measures.	

Sterndrive Engines

Model	MCM 305 cid / 5.0L and 350 cid / 5.7L
Crankcase Oil (With Filter) ¹	5.5 (5.25)
Seawater Cooling System ²	15 (14.1)
Closed Cooling System	20 (19)

¹ Always use dipstick to determine exact quantity of oil or fluid required.

² Seawater Cooling System capacity information is for winterization use only.

Inboard and Ski Engines

IMPORTANT: It may be necessary to adjust oil levels depending on installation angle and cooling systems (heat exchanger and fluid lines).

Model	350 cid / 5.7L
Crankcase Oil (With Filter) ¹	5.5 (5.25)
Seawater Cooling System ²	15 (14.1)
Closed Cooling System	20 (19)

¹ Always use dipstick to determine exact quantity of oil or fluid required.

² Seawater Cooling System capacity information is for winterization use only.

Sterndrives

NOTICE	
Unit Of Measurement: U.S. Fluid Ounces (Milliliters)	
All capacities are approximate fluid measures.	

Model	ALPHA ONE
Drive Unit Oil Capacity (With Gear Lube Monitor)	64 (1892)

Model	BRAVO ONE	BRAVO TWO	BRAVO THREE	BLACK-HAWK
Drive Unit Oil Capacity (With Gear Lube Monitor)	88 (2603)	104 (3076)	96 (2839)	80 (2365)

Fluid Capacities (Continued)

Transmission

NOTICE		
Unit Of Measurement: U.S. Quarts (Liters)		
All capacities are approximate fluid measures.		

NOTE: Always use dipstick to determine exact quantity of fluid required.

Make and Model	Capacity	Fluid Type
Velvet Drive 71C In-Line	1-1/2 (1.33) ¹	Mobil 424 <u>or</u> Dexron III Automatic Transmission Fluid Do Not Mix!
Velvet Drive 72 Series V-Drive	3 (2.75) ¹	Mobil 424 <u>or</u> Dexron III Automatic Transmission Fluid Do Not Mix!
5000A	2-1/2 (2.4)	Dexron III Automatic Transmission Fluid
5000V	3 (2.75) ¹	
Walter V-Drive Model RV-36	3/4 (0.5) ¹	SAE 30 Heavy Duty Motor Exxon Spartan, EP-68 Gear Oil, APG-80 Gear Oil
ZF (Hurth) 630V 630A 800A	4-1/4 (4.0) 3-1/4 (3.0) 5-3/4 (5.5)	Dexron III Automatic Transmission Fluid

¹ Fluid should be circulated and then rechecked. Add additional fluid as necessary.

20-Hour Break-In Period

IMPORTANT: The first 20 hours of operation is the engine break-in period. Correct break-in is essential to obtain minimum oil consumption and maximum engine performance. During this break-in period, the following rules must be observed:

- Do not operate below 1500 rpm for extended periods of time for first 10 hours. Shift into gear as soon as possible after starting and advance throttle above 1500 rpm **if conditions permit safe operation.**
- Do not operate at one speed consistently for extended periods.
- Do not exceed 3/4 throttle during first 10 hours. During next 10 hours, occasional operation at full throttle is permissible (5 minutes at a time maximum).
- Avoid full throttle acceleration from IDLE speed.
- Do not operate at full throttle until engine reaches normal operating temperature.

After Break-in Period

To help extend the life of your Mercury MerCruiser power package, the following recommendations should be considered;

- Use a propeller that allows the engine to operate at or near the top of the maximum rpm range (refer to "Specifications" section) when at full throttle with a normal boat load.
- Operation at 3/4 throttle setting or lower is recommended. Refrain from prolonged operation at maximum (full throttle) rpm.

End of First Season Checkup

At the end of the first season of operation, an Authorized Mercury MerCruiser Dealer should be contacted to discuss and/or perform various scheduled maintenance items. If you are in an area where the product is operated continuously (year-round operation), you should contact your dealer at the end of the first 100 hours of operation, or once yearly, whichever occurs first.

CA261

Specifications

Fuel Recommendations

IMPORTANT: Use of improper gasoline can damage your engine seriously. Engine damage resulting from use of improper gasoline is considered misuse of engine, and damage caused thereby will not be covered under the limited warranty.

FUEL RATINGS

Mercury MerCruiser engines will operate satisfactorily when using a major brand of unleaded gasoline as follows:

USA and Canada - having a posted pump Octane Rating of 87 (R+M)/2 minimum. Premium gasoline [92 (R+M)/2 Octane] is also acceptable. DO NOT use leaded gasoline.

Outside USA and Canada - having a posted pump Octane Rating of 90 RON minimum. Premium gasoline (98 RON) is also acceptable. If unleaded gasoline is not available, use a major brand of leaded gasoline.

CA291

USING REFORMULATED (OXYGENATED) GASOLINES (USA ONLY)

This type of gasoline is required in certain areas of the USA. The two types of "oxygenates" used in these fuels is Alcohol (Ethanol) or Ether (MTBE or ETBE). If Ethanol is the "oxygenate" that is used in the gasoline in your area, refer to "Gasolines Containing Alcohol."

These "Reformulated Gasolines" are acceptable for use in your Mercury MerCruiser engine.

VAPOR LOCKING

Fuels containing alcohol and winter grade fuels will aggravate vapor lock problems. A vapor lock condition can be identified by the following problems:

- Engine starts and, upon advancing throttle, shuts off and will not restart.
- If engine does restart, it shuts off when advancing throttle.
- Engine is difficult to restart after operating the boat and then leaving the engine off for 1 to 3 hours.

Other factors may combine to increase vapor locking. These factors include but are not limited to:

- air temperature
- fuel tank location
- fuel supply system
- engine coolant temperature
- temperature and vacuum of fuel to engine
- engine compartment air temperature and ventilation

Other conditions should be ruled out before treating the problem as vapor locking.

CA618

GASOLINES CONTAINING ALCOHOL

If the gasoline in your area contains either “methanol” (methyl alcohol) or “ethanol” (ethyl alcohol), you should be aware of certain adverse effects that can occur. These adverse effects are more severe with “methanol.” Increasing the percentage of alcohol in the fuel can also worsen these adverse effects.

Some of these adverse effects are caused because the alcohol in the gasoline can absorb moisture from the air, resulting in a separation of the water/alcohol from the gasoline in the fuel tank.

The fuel system components on your Mercury MerCruiser engine will withstand up to 10% alcohol content in the gasoline. We do not know what percentage your boat's fuel system will withstand. Contact your boat manufacturer for specific recommendations on the boat's fuel system components (fuel tanks, fuel lines, and fittings). Be aware that gasolines containing alcohol may cause increased:

- Corrosion of metal parts.
- Deterioration of rubber or plastic parts.
- Fuel permeation through rubber fuel lines.
- Starting and operating difficulties.

WARNING

FIRE AND EXPLOSION HAZARD: Fuel leakage from any part of fuel system can be a fire and explosion hazard which can cause serious bodily injury or death. Careful periodic inspection of entire fuel system is mandatory, particularly after storage. All fuel components including fuel tanks, whether plastic metal or fiberglass, fuel lines, fittings, fuel filters and carburetors/fuel injection components should be inspected for leakage, softening, hardening, swelling or corrosion. Any sign of leakage or deterioration requires replacement before further engine operation.

Because of possible adverse effects of alcohol in gasoline, it is recommended that only alcohol-free gasoline be used where possible. If only fuel containing alcohol is available, or if the presence of alcohol is unknown, increased inspection frequency for leaks and abnormalities is required.

IMPORTANT: When operating a Mercury MerCruiser engine on gasoline containing alcohol, storage of gasoline in the fuel tank for long periods should be avoided. Long periods of storage, common to boats, create unique problems. In cars alcohol-blend fuels normally are consumed before they can absorb enough moisture to cause trouble, but boats often sit idle long enough for phase separation to take place. In addition, internal corrosion may take place during storage if alcohol has washed protective oil films from internal components.

Test For Alcohol Content In Gasoline

The following is an acceptable and widely used field procedure for the detection of alcohol in gasoline. Use any small transparent bottle or tube that can be capped and is, or can be, provided with graduations or a mark at about 1/3 full. A pencil mark on a piece of adhesive tape may be used.

PROCEDURE

1. Fill the container with water to the mark.
2. Add fuel almost to fill the container, leaving some air space, then cap the container. The proportions of fuel to water are not critical, but there should be 2 to 3 times as much fuel as water.
3. Shake container vigorously and allow it to sit **upright for 3 to 5 minutes**. If the volume of water appears to have increased, alcohol is present. If you are not sure, there is no need for concern. If the dividing line between water and fuel becomes cloudy, use the middle of the cloudy band.

Transmission Fluid

Velvet Drive - Dexron III

Walter V-Drive - SAE 30 Heavy Duty Motor, Exxon Spartan EP-68 Gear Oil or APG-80 Gear Oil.

Hurth - Dexron III

Power Steering Fluid

Use Quicksilver Power Trim and Steering Fluid, or automatic transmission Fluid (ATF) Dexron III.

Coolant for Closed Cooling System

CAUTION

Alcohol or Methanol base antifreeze or plain water, are not recommended for use in fresh water section of cooling system at any time.

We recommend that the coolant section of closed cooling system be filled with Extended Life Ethylene Glycol 5/100 Antifreeze/Coolant mixed 50/50 with purified water. In areas where the possibility of freezing does not exist, it is permissible to use a solution of rust inhibitor and water (mixed to manufacturer's recommendations).

If any non-compatible coolant is added to this coolant, coolant must be changed every 2 years or 400 hours, whichever occurs first. All coolants other than Extended Life 5/100 Ethylene Glycol Antifreeze/Coolant must be changed every 2 years or 400 hours, whichever occurs first.

Mercury MerCruiser V-8 engines can use any type of permanent antifreeze or any brand antifreeze solution that meets GM specification 1825M.

CA693

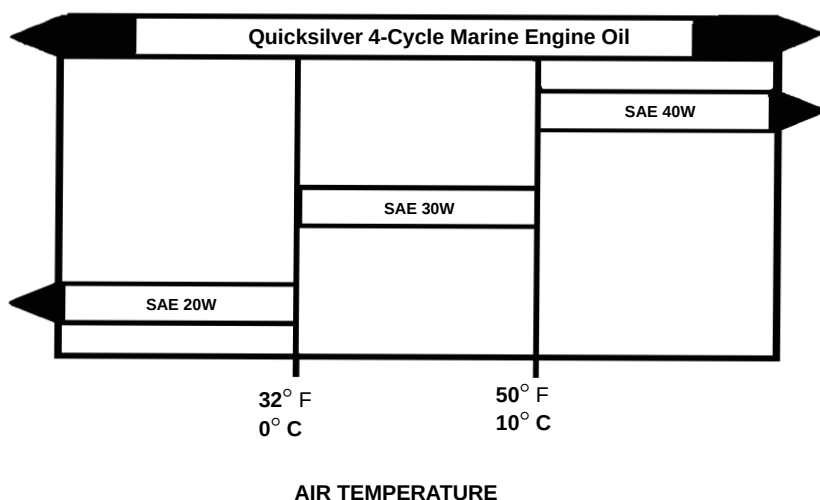
Crankcase Oil

To help obtain optimum engine performance and to provide maximum protection, we strongly recommend the use of Quicksilver 4-Cycle 25W-40 Marine Engine Oil. This oil is a special blend of 25-weight and 40-weight oils for marine engines. If not available, a good grade, straight weight, detergent automotive oil of correct viscosity, with an API classification of SH,CF/CF-2, may be used.

In those areas where Quicksilver 4-Cycle 25W-40 Marine Engine Oil or a recommended straight weight oil are not available, a multiviscosity 20W-40 (SH, CF/CF-2) or, as a second but less preferable choice, 20W-50, with API service ratings of SH, CF/CF-2 may be used.

IMPORTANT: The use of non-detergent oils, multi-viscosity oils (other than Quicksilver 25W-40 or a good quality 20W-40 or 20W-50), synthetic oils, low quality oils or oils that contain solid additives are specifically not recommended.

The chart below is a guide to crankcase oil selection. The oil filter should always be changed with oil.



70534

Overfilled Crankcase Oil

Overfilled crankcases (oil level being too high) can cause a fluctuation or drop in oil pressure and rocker arm "clatter" on Mercury MerCruiser engines. The over-full condition results in the engine crankshaft splashing and agitating the oil, causing it to foam (become aerated). The aerated oil causes the hydraulic valve lifters to "bleed down." This, in turn, results in rocker arm "clatter" and loss of engine performance, due to the valves not opening properly.

Care must be taken when checking engine oil level. Oil level must be maintained between the ADD mark and the FULL mark on the dipstick. To ensure that you are not getting a "false reading," make sure the following steps are done before checking the oil level.

- Boat "at rest" in the water, or
- If boat is on a trailer, raise or lower bow until the boat is setting at the approximate angle that it would be if setting "at rest" in the water.
- Allow sufficient time for oil to drain into the crankcase if engine has just been run or oil has just been added.

Checking Engine Oil Level / Filling

IMPORTANT: ENGINE CRANKCASE OIL MUST BE CHECKED AT INTERVALS SPECIFIED IN "MAINTENANCE SCHEDULE" CHART. It is normal for an engine to use a certain amount of oil in the process of lubrication and cooling of the engine. The amount of oil consumption is greatly dependent upon engine speed, with consumption being highest at wide-open-throttle and decreasing substantially as engine speed is reduced.

1. Stop engine and allow boat to come to a rest.
2. Allow oil to drain back into oil pan - approximately 5 minutes.
3. Remove dipstick.
4. Wipe clean and reinstall. Push dipstick all the way into dipstick tube.
5. Remove dipstick and note the oil level.
6. Oil level must be between the FULL or OP RANGE and ADD marks.
7. If oil level is below ADD mark, proceed to Steps 8. and 9.
8. Remove oil filler cap from valve rocker arm cover.
9. Add required amount of oil to bring level up to, but not over, the FULL mark on dipstick.

Changing Oil and Filter

1. Start engine and run until it reaches normal operating temperatures.

IMPORTANT: Change oil when engine is warm from operation, as it flows more freely, carrying away more impurities.

2. Stop engine.
3. Remove drain plug from oil pan or from oil drain hose.

NOTE: *If drain plug is not accessible because of boat construction, oil may be removed through dipstick tube, using a Quicksilver Crankcase Oil Pump. (See Quicksilver Accessory Guide.)*

4. After oil has drained completely, reinstall drain plug (if removed) and tighten securely.
5. Remove and discard oil filter and its sealing ring.
6. Coat sealing ring on new filter with engine oil, and install. Tighten filter securely (following filter manufacturer's instructions). Do not overtighten.
7. Fill crankcase with oil. See "Specifications" for type of oil and quantity.
8. Start engine and check for leaks.

Changing Water Separating Fuel Filter

⚠ WARNING

Be careful when changing water separating fuel filter. Gasoline is extremely flammable and highly explosive under certain conditions. Be sure ignition key is OFF. Do not smoke or allow spark or open flame in area when changing fuel filter. Wipe up any spilled fuel immediately.

⚠ WARNING

Make sure no fuel leaks exist before closing engine hatch.

⚠ CAUTION

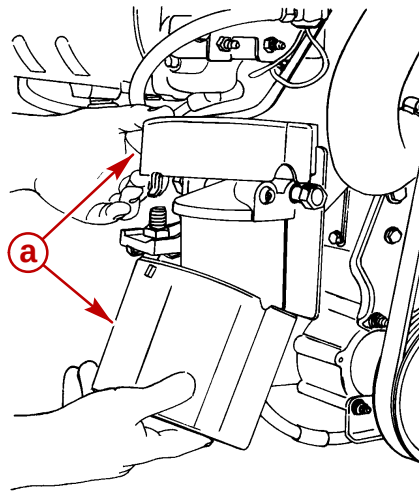
The electric fuel pump and factory installed water separating fuel filter have been carefully designed to function properly together. Do not install additional fuel filters and/or water separating fuel filters between fuel tank and engine.

The installation of additional filters may cause:

- Fuel Vapor Locking
- Difficult Warm-Starting
- Piston Detonation Due to Lean Fuel Mixture
- Poor Driveability

MCM (Sterndrive) Models

1. Unsnap latch and slide top and bottom cover pieces from around the water separating fuel filter and bracket.

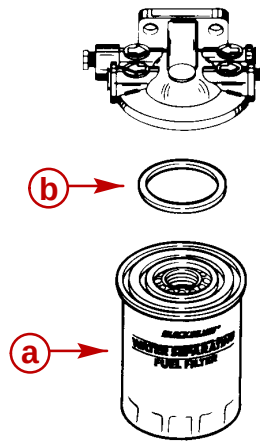


75034

a - Fuel Filter Cover

NOTE: Top and bottom cover pieces are formed with a groove on each side that slides around the brackets outer edges.

2. Remove water separating fuel filter and sealing ring from mounting bracket and discard.



70573

- a** - Fuel Filter
b - Sealing Ring

3. Coat sealing ring on new filter with motor oil.
4. Thread filter onto bracket and tighten securely by hand. Do not use a filter wrench.
5. Start and run engine.
6. Check filter connection for gasoline leaks. If leaks exist, recheck filter installation.
7. Install cover pieces around fuel filter. Be certain top part of cover latches to lower part.

MIE (Inboard and Ski) Models

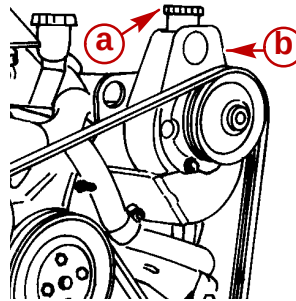
1. Remove water separating fuel filter and sealing ring from mounting bracket and discard.
2. Coat sealing ring on new filter with motor oil.
3. Thread filter onto bracket and tighten securely by hand. Do not use a filter wrench.
4. Start and run engine.
5. Check filter connection for gasoline leaks. If leaks exist, recheck filter installation.

Power Steering System

Checking Fluid Level

ENGINE WARM

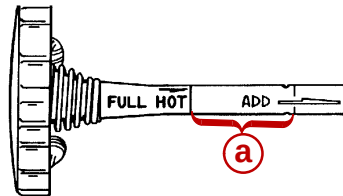
1. Stop engine. Position drive unit so that it is straight back.
2. Remove fill cap / dipstick from power steering pump and note fluid level.



74908

- c** - Fill Cap / Dipstick
d - Power Steering Pump

3. Level should be between the FULL HOT mark and ADD mark on dipstick.



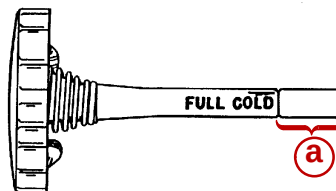
72518

- a** - Proper Fluid Level with Engine Warm

4. If level is below ADD mark, but fluid is still visible in pump reservoir, add required amount of Quicksilver Power Trim and Steering Fluid or automatic transmission fluid (ATF) Dexron III through fill cap opening, to bring level up to FULL HOT mark on dipstick. DO NOT OVERFILL.
5. If fluid is not visible in reservoir, a leak exists in the power steering system. Find cause and correct.

Engine Cold

1. With engine stopped, position drive unit so that it is straight back.
2. Remove fill cap / dipstick from power steering pump and note fluid level.
3. Level should be between FULL COLD mark and bottom of dipstick.



72519

- a** - Proper Fluid Level with Engine Cold

4. If level is below bottom of dipstick, but fluid is still visible in pump reservoir, add required amount of Quicksilver Power Trim and Steering Fluid or automatic Dexron III transmission fluid (ATF), through fill cap opening, to bring level up to FULL COLD mark on dipstick. DO NOT OVERFILL.

If fluid is not visible in reservoir, a leak exists in the power steering system. Find cause and correct.

Filling and Bleeding

IMPORTANT: Power steering system must be filled exactly as explained in the following to be sure that all air is bled from the system. All air must be removed, or fluid in pump may foam during operation and be discharged from pump reservoir. Foamy fluid also may cause power steering system to become spongy, which may result in poor boat control.

1. With engine stopped, position drive unit so that it is straight back.
2. Remove fill cap / dipstick from power steering pump.
3. Add Quicksilver Power Trim and Steering Fluid or Dexron III automatic transmission fluid (ATF), as required, to bring level up to FULL COLD mark on dipstick.

IMPORTANT: Use only Quicksilver Power Trim and Steering Fluid or Dexron III automatic transmission fluid (ATF), in power steering system.

4. Turn steering wheel back and forth to end of travel in each direction several times.
5. Recheck fluid level and add fluid, if necessary.
6. Install vented fill cap. Tighten securely.

CAUTION

DO NOT operate engine without water being supplied to seawater pickup pump, or pump impeller may be damaged and subsequent overheating damage to engine may result.

7. Start engine and run at fast idle (1000-1500 rpm) until engine reaches normal operating temperature. During this time, turn steering wheel back and forth to end of travel in each direction several times.
8. Position drive unit so that it is straight back and stop engine.
9. Remove fill cap from pump.
10. Allow any foam in pump reservoir to disperse.
11. Check fluid level and add fluid, as required, to bring level up to FULL HOT mark on dipstick. DO NOT OVERFILL.
12. Reinstall fill cap. Tighten securely.

IMPORTANT: Drive unit must be positioned straight back and power steering fluid must be hot to accurately check fluid level.

13. If fluid is still foamy (in Step 5), repeat Steps 7. through 12. until fluid does not foam and level remains constant.

Closed Cooling System

Checking Coolant Level

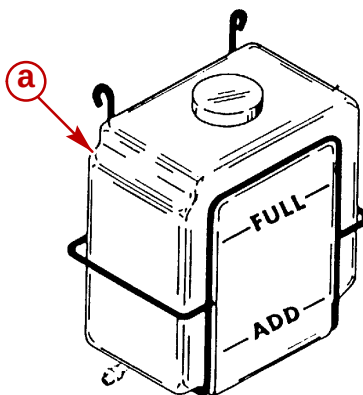
⚠ CAUTION

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

1. Coolant level in heat exchanger should be full (to bottom of filler neck).

IMPORTANT: When reinstalling pressure cap, be sure to tighten it until it contacts on filler neck.

2. Coolant level should be between the ADD and FULL marks on coolant recovery reservoir with the engine at normal operating temperature.



a - Coolant Recovery Reservoir

72520

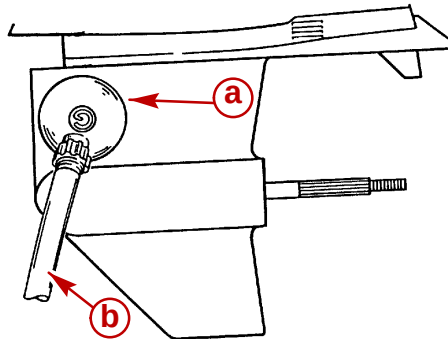
Flushing System MCM (Sterndrive)

If engine is operated in salty, polluted or mineral-laden water, flush seawater cooling system (preferably after each use) to reduce corrosion and prevent the accumulation of deposits in the system. Thoroughly flush the seawater cooling system prior to storage.

NOTE: For additional protection against freezing and rust to the exhaust manifolds and other components, a 50-50 mixture of antifreeze and water can be run through the engine during Power Package Layup.

BOAT OUT OF WATER

1. Install flushing attachment over water pickup holes in gear housing as shown.
2. Attach a water hose between the flushing attachment and a water tap.



a - Flushing Attachment
b - Hose

72693

⚠ WARNING

When flushing, be certain the area around propeller is clear, and no one is standing nearby. To avoid possible injury, remove propeller.

⚠ CAUTION

Do not run engine above 1500 rpm when flushing. Suction created by seawater pick-up pump may collapse flushing hose, causing engine to overheat.

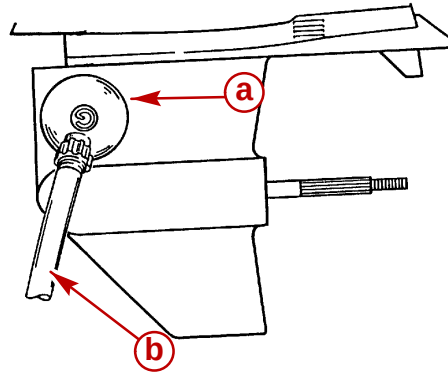
⚠ CAUTION

Watch temperature gauge on dash to ensure that engine does not overheat.

3. Partially open water tap (approximately 1/2 maximum capacity). DO NOT use full water pressure.
4. Place remote control in neutral, idle speed position, and start engine.
5. Operate engine at idle speed in neutral for 10 minutes, or until discharge water is clear, then stop engine.
6. Shut off water tap. Remove water hose and flushing attachment.

BOAT IN WATER

1. Raise drive unit to full UP position.
2. Install flushing attachment over water pickup holes in gear housing as shown.
3. Attach a water hose between the flushing attachment and a water tap.



72693

a - Flushing Attachment**b** - Hose

4. Lower drive unit to full IN position.

⚠ CAUTION

Do not run engine above 1500 rpm when flushing. Suction created by seawater pick-up pump may collapse flushing hose, causing engine to overheat.

⚠ CAUTION

Watch temperature gauge on dash to ensure that engine does not overheat.

5. Partially open water tap (approximately 1/2 maximum capacity). DO NOT use full water pressure.
6. Place remote control in neutral, idle speed position, and start engine.
7. Operate engine at idle speed in neutral for 10 minutes, then stop engine.
8. Shut off water tap.
9. Raise drive unit to full UP position.
10. Remove water hose and flushing attachment.

Flushing System MIE (Inboard and Ski)

CAUTION

If boat is in the water, seacock, if so equipped, must remain closed until engine is to be re-started, to prevent water from flowing back into cooling system and/or boat. If boat is not fitted with a seacock, water inlet hose must be left disconnected and plugged (to prevent water from flowing back into cooling system and/or boat). As a precautionary measure, attach a tag to the ignition switch or steering wheel of the boat with the warning: Open seacock or reconnect water inlet hose before starting engine.

IMPORTANT: If a seacock is to be installed for this purpose, valve used must have an internal cross-sectional area equal to or greater than water inlet hose to prevent restricting water flow during normal operation. A 1-1/4 in. (32 mm), or larger, brass ball valve or gate valve is recommended.

1. If boat is in water, close seacock, if so equipped, or disconnect and plug seawater inlet hose to prevent seawater from entering boat.
2. Remove inlet hose from seawater pickup pump.
3. Using an adaptor, connect a water hose from a water tap to seawater pump inlet.
4. Partially open water tap (approximately 1/3 maximum). Do not use full water pressure.
5. Place the remote control lever in neutral position and start engine.

WARNING

When flushing, be certain the area around propeller is clear, and no one is standing nearby. To avoid possible injury, remove propeller.

CAUTION

Do not run engine above 1500 rpm when flushing. Suction created by seawater pickup pump may collapse flushing hose, causing engine to overheat.

CAUTION

Watch temperature gauge on dash to ensure that engine does not overheat.

6. Operate engine at idle speed in neutral for 10 minutes, or until discharge water is clear. Stop engine.
7. Shut off water tap. Remove water hose and adaptor from pump inlet and reconnect water inlet hose. Be sure to tighten hose clamp securely.

IMPORTANT: If boat is in the water, do not open water inlet valve until engine is to be restarted to prevent contaminated water from flowing back into engine. If boat is not fitted with a valve, leave water inlet hose disconnected and plugged.

Transmission Fluid

NOTE: Due to the various installation angles and oil cooler set-ups, it may be necessary to adjust oil level.

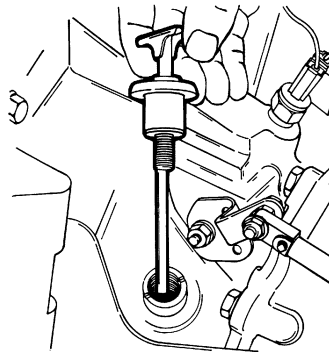
⚠ WARNING

Do not remove dipstick with engine running. Hot oil can cause burns.

⚠ CAUTION

Clean around the area of the dipstick before removing. Small particles of dirt can cause damage to internal components and cause valves to stick.

IMPORTANT: DO NOT allow fluid level to drop below the bottom line.



72526

TRANSMISSION WARM

The transmission should be at operating temperature (190° maximum) to get an accurate oil level reading. Oil will expand when heated. Oil will drain back from the cooler. Expansion and drain-back can significantly affect oil level.

1. When the transmission is at operating temperature, place selector lever in neutral.
2. Shut off engine.
3. Carefully remove dipstick and wipe clean.
4. Immediately insert clean dipstick and read oil level.

NOTE: Oil level must be checked immediately after engine shut-down to prevent an incorrect reading. Oil drains back into the transmission from the cooler and cooler lines.

5. Add or remove oil as necessary until the oil is at the required mark.

TRANSMISSION COLD

NOTE: For ease of checking the oil prior to engine start-up, a cold oil level mark can be made. To find the cold oil level mark, the oil level must first be set according to the warm oil level checking procedure.

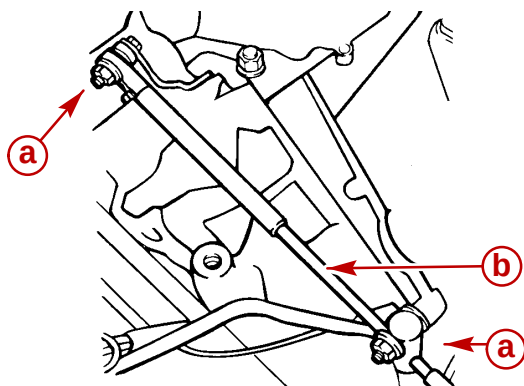
1. Let the boat sit overnight. Insert clean dipstick and read level.
2. Put a mark on the dipstick at the cold oil level.

NOTE: You can use the new mark to check the oil level when cold. If oil level adjustment is needed, add oil to the new mark. This procedure can be performed by the builder, dealer or owner to ease fluid checking procedure.

Lubrication

Throttle Cable

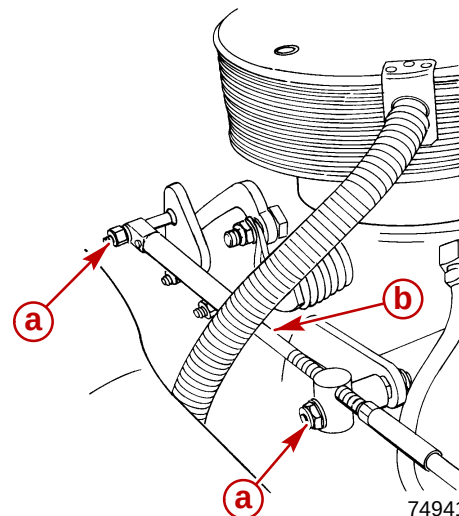
1. Lubricate pivot points and guide contact surfaces with SAE 30W motor oil.



71359

2 Barrel Carbureted Models

- a** - Pivot Points
- b** - Guide Contact Surface



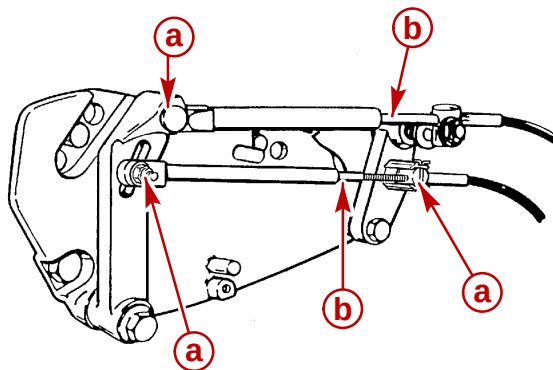
74941

EFI Models

Shift Cable and Transmission Linkage

MCM (STERNDRIVE) MODELS

1. Lubricate pivot points and guide contact surfaces with SAE 30W motor oil.



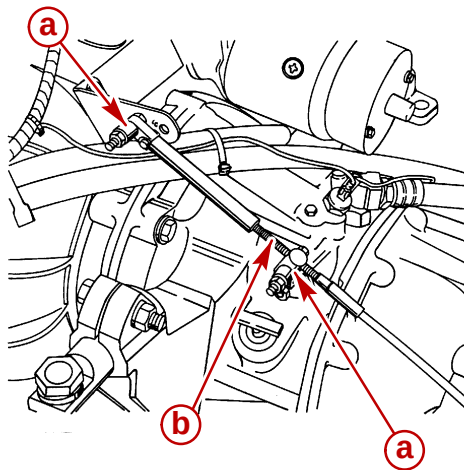
72016

Typical Shift Cable

- a** - Pivot Points
- b** - Guide Contact Surface

MIE (INBOARD AND SKI) MODELS

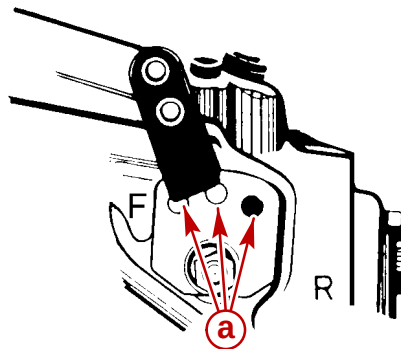
1. Lubricate pivot points and guide contact surfaces with SAE 30W motor oil.



72528

Typical Shift Cable**a** - Pivot Points**b** - Guide Contact Surface

2. Lubricate detent ball and holes in lever with SAE 30W motor oil.



71457

Typical In-Line Transmission**a** - Poppet Ball Locations

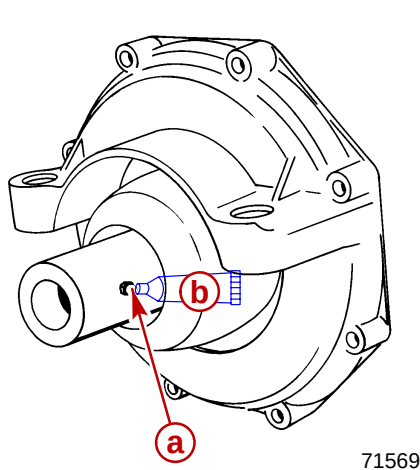
Engine Coupler/U-Joint Shaft Splines

NOTE: Engine coupler and shaft splines are greased with Quicksilver Engine Coupler Spline Grease, 92-816391A4; universal joints are greased with Quicksilver 2-4-C Marine Lubricant.

NOTE: Refer to Mercury MerCruiser Sterndrive Service Manual for sterndrive unit removal and installation, if necessary.

IMPORTANT: Sterndrive Unit does not have to be removed to grease coupler.

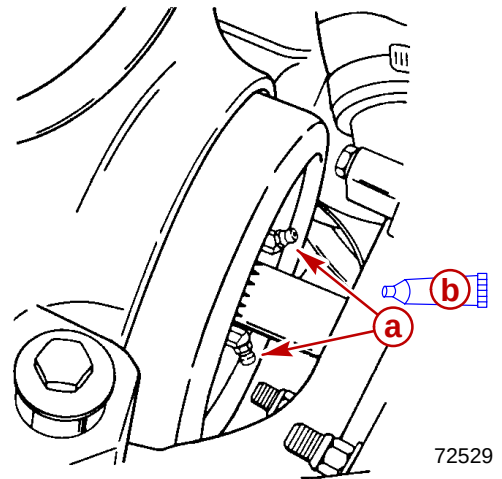
1. Lubricate engine coupler splines through grease fitting on coupler by applying approximately 8-10 pumps of grease from a typical hand-operated grease gun.



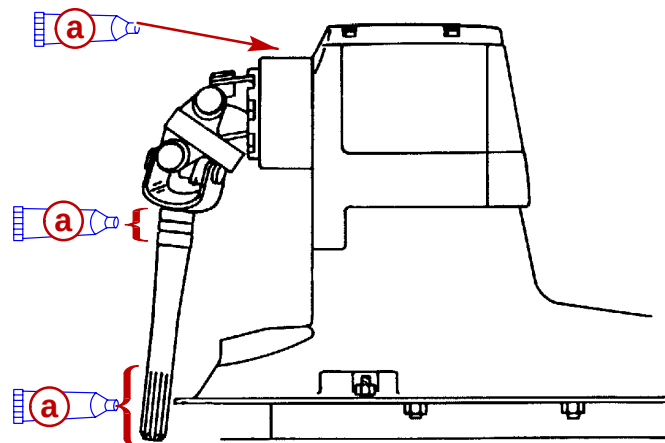
Alpha Drive Coupler

a- Grease Fitting

b- Quicksilver Engine Coupler Spline Grease



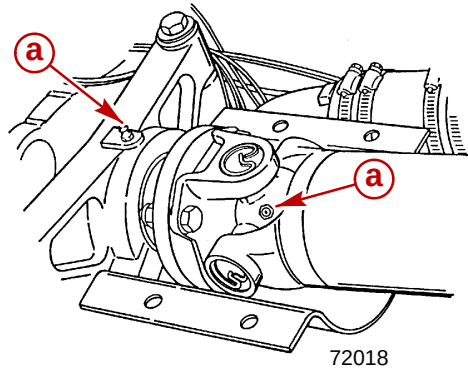
Bravo Drive Coupler



Typical Bravo Drive

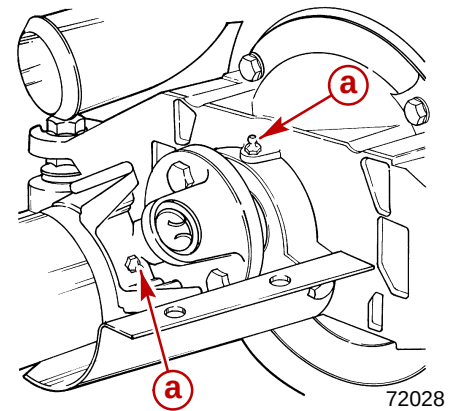
a- Quicksilver Engine Coupler Spline Grease

Sterndrive Drive Shaft Extension Models



Transom End

a - Grease Fitting



Engine End

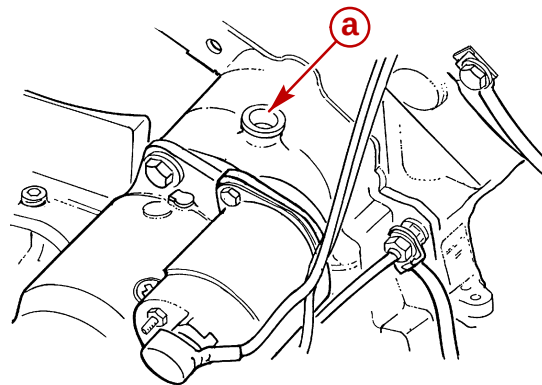
Starter Motor

MIE (INBOARD AND SKI) MODELS

⚠ WARNING

When performing the following procedure, be sure to observe the following:

- Be sure that engine compartment is well ventilated and that no gasoline vapors are present to avoid the possibility of a fire.
 - Be sure to ground coil high-tension wire to block. Failure to ground coil wire may cause damage to ignition coil in addition to being a safety hazard.
 - Stay clear of all moving parts.
1. Remove ignition coil high-tension wire from distributor cap tower and ground it to engine block with jumper wire. While cranking engine with starter motor, lubricate starter motor front bushing through oil cover with motor oil or its equivalent. Reinstall coil high-tension wire.
 2. Remove plastic plug from flywheel housing. Lubricate starter motor shaft with motor oil through hole in flywheel housing. Reinstall plastic plug.



a - Grease Fitting

Cleaning Flame Arrestor

⚠ WARNING

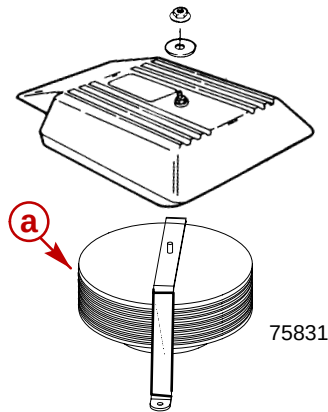
Avoid gasoline fire or explosion. Gasoline is extremely flammable and highly explosive under certain conditions. Be careful when cleaning flame arrestor and crankcase ventilation hoses. Be sure that ignition is OFF. DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hoses.

⚠ WARNING

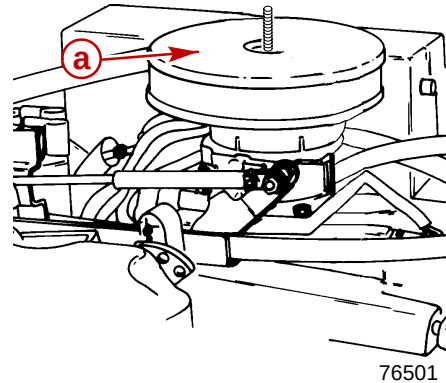
Avoid gasoline fire or explosion. Gasoline is extremely flammable and highly explosive under certain conditions. NEVER use gasoline as a cleaning solvent.

Top Mounted Flame Arrestor

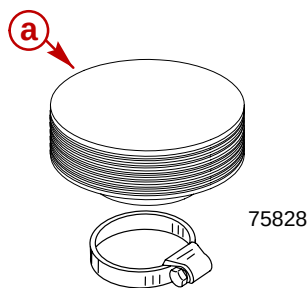
1. Remove crankcase ventilation hose from fitting on side of flame arrestor housing.
2. Remove flame arrestor.



Early Bracket Models

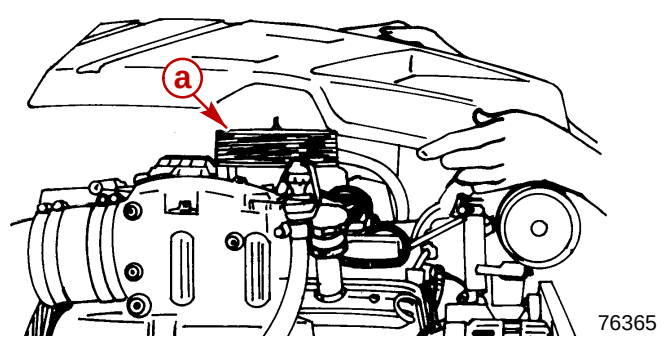


Later Throttle Body Stud Models



Early Clamp Models

a - Flame Arrestor

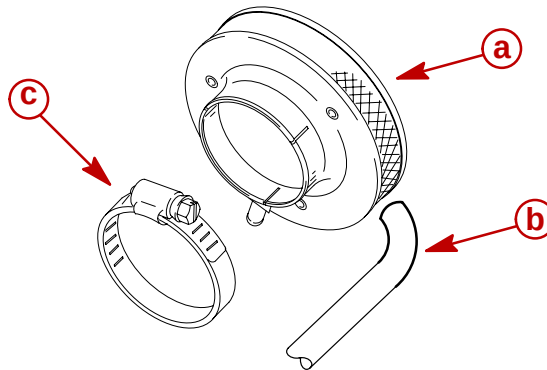


Horizon Models

3. Clean flame arrestor in solvent. Blow dry with compressed air.
4. Clean crankcase ventilation hose in solvent. Blow dry with compressed air.
5. Inspect crankcase ventilation hose for cracks or deterioration and replace if necessary.
6. Reinstall flame arrestor and crankcase ventilation hose.
7. Reinstall flame arrestor screws and tighten securely.

Black Scorpion Flame Arrestor

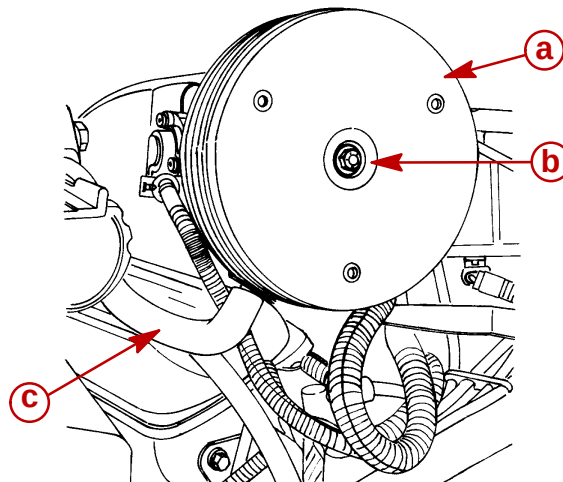
1. Remove clamp or nut, as applicable.
2. Remove crankcase ventilation hose.
3. Remove flame arrestor.



75046

Earlier Style Flame Arrestor

- a** - Flame Arrestor
- b** - Clamp
- c** - Vent Hose



75779

Later Style Flame Arrestor

- a** - Flame Arrestor
- b** - Nut
- c** - Vent Hose

4. Clean flame arrestor in solvent. Blow dry with compressed air.
5. Clean crankcase ventilation hoses in solvent. Blow dry with compressed air.
6. Inspect crankcase ventilation hoses for cracks or deterioration, and replace if necessary.
7. Install flame arrestor and related components.
8. Tighten clamp or nut securely.

Serpentine Drive Belt

Component Location

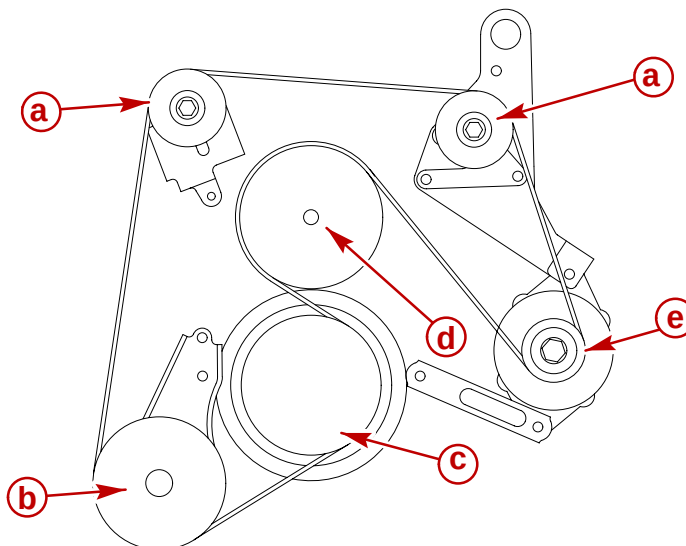
WARNING

Avoid possible serious injury. Make sure engine is shut off and ignition key is removed before inspecting belt.

IMPORTANT: MIE ENGINES ONLY: The brackets and washers on the 3 idler pulleys must be in a certain order or the belt will come off of the serpentine belt. All pulleys are referenced as though you were standing in front of the engine looking at the belt.

- Upper Right Idler Pulley Bracket Stud: Stud is threaded into the cylinder head. From the cylinder head is a nut, a flat washer, the lifting eye bracket, the oil cooler bracket, the idler pulley bracket and then a nut.
- Upper Left Idler Pulley Bracket Bolt: From the cylinder head is an idler pulley bracket, a flat washer, the heat exchanger bracket, a flat washer and the head of the bolt.
- Lower Idler Pulley Bracket Bolt: From the cylinder block is an idler pulley bracket and then the head of the bolt.

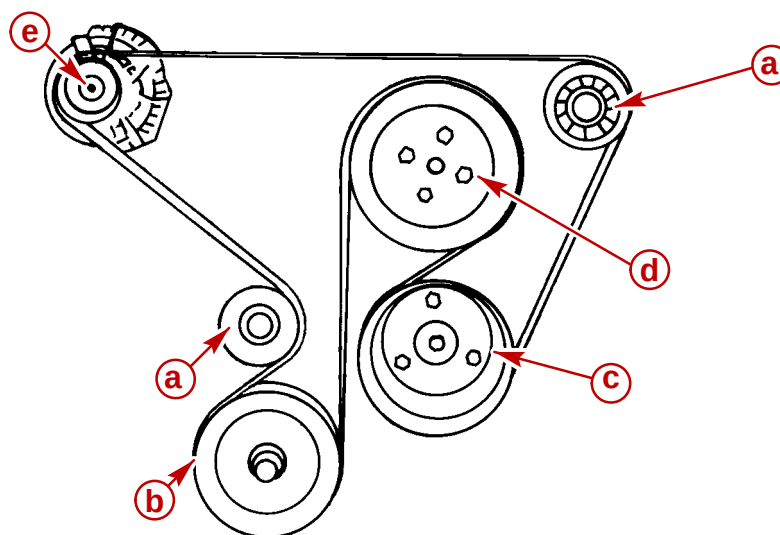
NOTE: Some models will have components arranged in a different order. All configurations are not shown. Checking, replacing and adjustment procedures are the same.



76389

Typical Inboard Model

- a** - Idler Pulley
- b** - Seawater Pump Pulley
- c** - Crankshaft Pulley
- d** - Circulating Pump Pulley
- e** - Alternator Pulley



76463

Typical Sterndrive Model

- a** - Idler Pulley
- b** - Seawater Pump Pulley
- c** - Crankshaft Pulley
- d** - Circulating Pump Pulley
- e** - Alternator Pulley

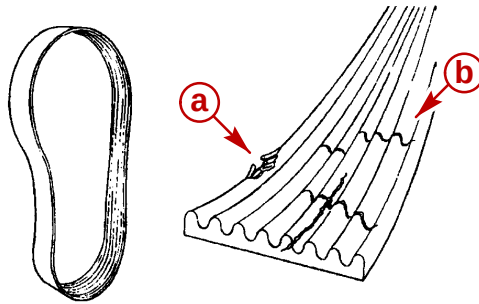
Inspection

1. Inspect drive belt for the following:

- Excessive wear
- Cracks

NOTE: Minor, transverse cracks (across the belt width) may be acceptable. Longitudinal cracks (in direction of belt length) that join transverse cracks are NOT acceptable.

- Fraying
- Glazed surfaces



75130

- a** - Fraying
b - Cracks

Replacing and/or Adjusting Tension

REMOVAL

1. Loosen 5/8 in. locking nut on adjustment stud.
2. Turn adjustment stud and loosen belt.
3. Remove drive belt.

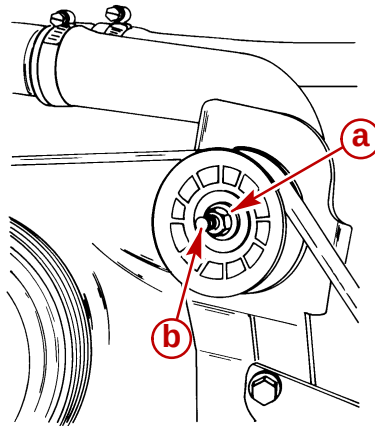
INSTALLATION AND ADJUSTMENT

4. Install drive belt on pulleys.
5. Adjust tension by loosening 5/8 in. locking nut on adjustment stud. Leave wrench on adjustment stud.

NOTE: Belt deflection is to be measured on the belt at the location that has the longest distance between two (2) pulleys. Proper tension is 1/4 in. (6 mm) deflection with moderate thumb pressure.

6. Use 5/16 in. socket and tighten adjusting stud until the correct deflection of the belt is obtained at location specified above.

7. While holding adjustment stud at the correct belt tension, tighten 5/8 in. locking nut.
8. Run engine for a short period of time and recheck belt adjustment.



- a** - 5/8 in. Locking Nut
b - 5/16 in Adjusting Stud

7490

Ignition Timing

Thunderbolt V Models

1. Connect timing light to number 1 spark plug wire.
2. Connect a shop tachometer to the engine.

IMPORTANT: Before starting the engine, connect a jumper wire from the ignition timing lead to a good ground. This has to be done before the ignition key is turned ON to lock the ignition module into Base Timing Mode.

3. Before starting the engine, connect jumper wire from timing lead to a good ground.

NOTE: The PUR/WHT timing lead is located towards the front of the engine near the fuel line or near the distributor, as equipped for your model.

4. Start engine and run at 1300 rpm until it reaches normal operating temperature.
5. Disconnect throttle cable from the carburetor.
6. With engine at idle rpm, adjust the carburetor idle rpm screw to the specified engine idle rpm.
7. With the engine still at idle rpm, check the ignition timing. If incorrect, rotate the distributor until timing is correct. Torque clamping screw to 18 lb-ft (25 Nm).
8. Adjust the idle mixture screw. Inward is LEAN, outward is RICH.
9. Recheck ignition timing.
10. Stop engine. Remove timing light, jumper wire and shop tachometer.

IMPORTANT: Timing jumper wire has to be removed or the ignition module will stay locked in the Base Timing Mode and it will not be able to advance the ignition timing correctly when the engine rpm is increased.

11. Adjust and reinstall throttle cable. Open and close remote control throttle lever to make sure that the carburetor's throttle lever returns against the rpm adjusting screw every time.

12. Restart the engine, increase rpm to 1300 then return to idle position slowly and shut the engine off. Ensure that the carburetor throttle lever came back against the idle rpm screw.
13. Shut engine off.

EFI/MPI Models

1. Connect timing light to number 1 spark plug wire.
2. Start engine and run at 1300 rpm until it reaches normal operating temperature.
3. Stop engine and connect the scan tool or timing tool to the DLC connector on the EFI/MPI wiring harness.
4. Start engine, allow rpm to stabilize.

NOTE: *MEFI-1 models only, manually adjust remote control throttle lever to get 1200 engine rpm.*

NOTE: *MEFI-2 and MEFI-3 models only, ECM will automatically adjust engine rpm to approximately 1200 rpm when put in the service mode on a scan tool or when using the timing tool.*

5. Check ignition timing. If incorrect, rotate the distributor until timing is correct. Torque clamping screw to 18 lb-ft (25 Nm).
6. Recheck ignition timing.
7. Disconnect scan tool or timing tool from DLC connector.
8. If required, return remote control throttle lever to idle position and shut off engine.
9. Restart engine, increase rpm to 1300 then return to idle position slowly. Ensure that engine returns to idle rpm. Readjust throttle cable, if required.
10. Shut engine off.

Cold Weather or Extended Storage

Precautions

WARNING

BE CAREFUL while working on fuel system; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF and do not smoke or allow sources of spark and/or open flames in the area.

WARNING

Avoid Fire or Explosion: To prevent a potential fire hazard, be sure that engine compartment is well ventilated and that there are no gasoline vapors present during starting or fogging of engine.

WARNING

Avoid Fire or Explosion: Fuel injection system is pressurized during operation. Use care when removing water separating fuel filter. Fuel could spray on hot engine causing fire or explosion. Allow engine to cool down before attempting to remove the water separating fuel filter in the following procedure. Also, hold a clean shop towel over the water separating fuel filter when removing it to help avoid fuel spraying on the engine.

CAUTION

If boat is in the water, seacock (water inlet valve), if equipped, must be closed until engine is to be restarted, to prevent water from flowing back into cooling system and/or boat. If boat is not fitted with a seacock, water inlet hose must be disconnected and plugged to prevent water from flowing back into cooling system and/or boat. As a precautionary measure attach a tag to the ignition switch or steering wheel of the boat with the warning that the seacock must be opened or the water inlet hose reconnected prior to starting engine.

CAUTION

DO NOT operate engine without water flowing through seawater pickup pump, as pump impeller may be damaged and subsequent overheating damage to engine or sterndrive unit may result.

CAUTION

If engine is equipped with Closed Cooling System, Closed Cooling section must be kept filled with a solution of ethylene glycol antifreeze and water (mix antifreeze to manufacturer's recommended proportions to protect engine to lowest temperature to which it will be exposed). DO NOT USE PROPYLENE GLYCOL antifreeze in closed cooling section. Seawater section, however, must be drained completely.

CAUTION

A discharged battery can be damaged by freezing.

⚠ CAUTION

Seawater section of cooling system **MUST BE COMPLETELY** drained for winter storage, or immediately after cold weather use, if the possibility of freezing temperatures exists. Failure to comply may result in trapped water causing freeze and/or corrosion damage to engine.

IMPORTANT: Observe the following information to ensure complete draining of cooling system.

- Engine must be as level as possible.
- A wire should be repeatedly inserted into all drain holes to ensure there are no obstructions in passages.

IMPORTANT: To prevent threads in manifolds, elbows and cylinder blocks from rusting during storage, reinstall drain plugs. Never leave drain plugs out during storage.

NOTE: If possible, place a container under drains and hoses to prevent water from draining into boat.

Power Package Layup

NOTICE

Refer to “Cold Weather or Extended Storage,” “Precautions,” in this section, **BEFORE** proceeding.

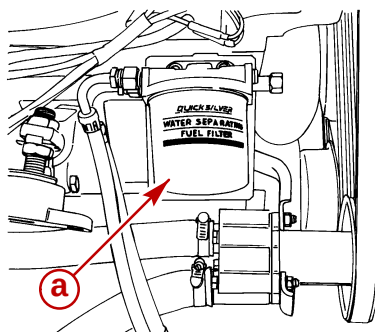
IMPORTANT: Mercury MerCruiser strongly recommends that this service be performed by an Authorized Mercury MerCruiser Dealer. Damage caused by freezing **IS NOT** covered by the MerCruiser Limited Warranty.

1. Fill fuel tank(s) with fresh gasoline that does not contain alcohol and a sufficient amount of Quicksilver Gasoline Stabilizer for Marine Engines to treat gasoline. Follow instructions on container.
2. **If boat is to be placed in storage with fuel containing alcohol in fuel tanks (if fuel without alcohol is not available):** Fuel tanks should be drained as low as possible and Quicksilver Gasoline Stabilizer for Marine Engines added to any fuel remaining in the tank. Refer to “Fuel Requirements” for additional information.

NOTE: If desired, a portable fuel tank can be used to perform the remainder of the power package layup procedures. Be sure to add an appropriate amount of Gasoline Stabilizer to the portable tank.

3. Run engine sufficiently to bring it up to normal operating temperature and allow fuel with Quicksilver Gasoline Stabilizer to circulate through fuel system.
4. Shut off engine.
5. Change oil and oil filter.
6. Flush cooling system. Refer to “Flushing Cooling System” procedure.
7. Close the fuel shutoff valve, if equipped. If no fuel shutoff valve is present, a suitable method must be employed to STOP the flow of fuel from the fuel tank to the engine before proceeding.

8. Prepare EFI fuel system for extended storage as follows:
 - a. Allow engine to cool down.
 - b. Remove the water separating fuel filter.
 - c. Pour out a small amount of fuel into a suitable container, then add approximately 2 fluid ounces (60 ml) of Quicksilver 2-Cycle Outboard Oil to fuel in the water separating fuel filter.
 - d. Reinstall water separating fuel filter.
 - e. Start and operate engine at idle speed until the water separating fuel filter and fuel injection system are empty and engine stops.
 - f. Remove and discard water separating fuel filter.
 - g. Install new filter.



75533

a - Water Separating Fuel Filter

9. Prepare carbureted fuel system for extended storage as follows:
 - a. Remove flame arrestor assembly and start engine.
 - b. While operating engine at fast idle (1000-1500 rpm), fog internal surfaces of induction system and combustion chambers by squirting approximately 8 ounces (227 grams) of Quicksilver Storage Seal or SAE 20W engine oil into carburetor bores.
 - c. Squirt the remaining 2 ounces (57 g) of Storage Seal (or oil) rapidly into carburetor, just as the engine begins to stall, due to lack of fuel. Allow engine to stop.
 - d. Turn ignition key to OFF position.
 - e. Refer to "Flushing Cooling System" and appropriately remove water supply to the seawater pickup pump.
10. Clean flame arrestor and crankcase ventilation hoses and reinstall.
11. Lubricate all items listed in "Lubrication" section.
12. Drain seawater section of cooling system as outlined in "Draining Instructions" section.
13. **On Models with Closed Cooling System:** Test coolant to ensure that it will withstand the lowest temperature expected during storage.
14. Service batteries per manufacturer's instructions.
15. Clean outside of engine and repaint any areas required with Quicksilver Primer and Spray Paint. After paint has dried, spray Quicksilver Corrosion and Rust Preventive Type II or wipe down with Quicksilver Storage Seal or SAE 20W engine oil.
16. For sterndrive unit layup, refer to appropriate sterndrive service manual.

NOTE: For additional protection against freezing and rust to the exhaust manifolds and other components, a 50-50 mixture of antifreeze and water can be run through the engine during Power Package Layup.

Draining Instructions

DRAINING SEAWATER (RAW-WATER) COOLED MODELS

NOTICE

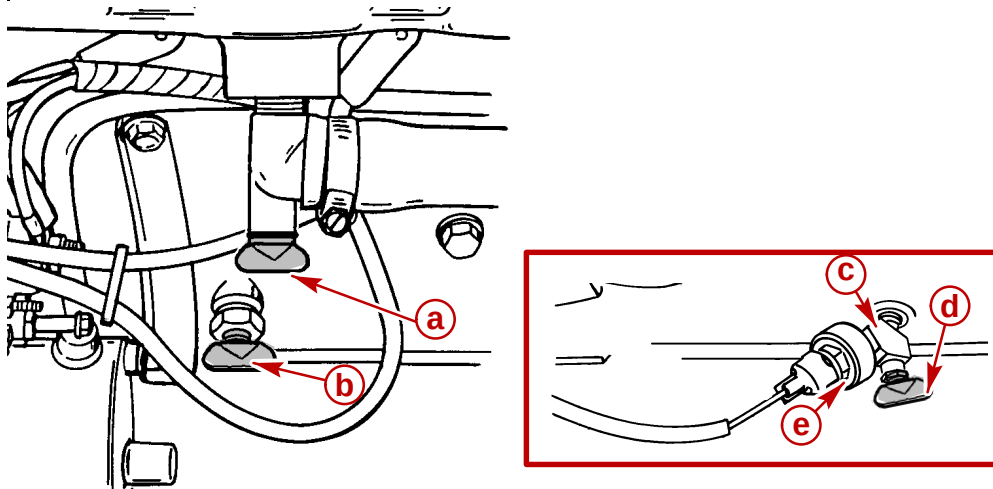
Refer to "Cold Weather or Extended Storage Precautions" in this section, **BEFORE** proceeding.

MCM (Sterndrive) Models:

1. Engine must be as level as possible to ensure complete draining of cooling system.
2. Remove drain plugs from bottom of port and starboard manifold fittings.
3. Remove drain plugs (port and starboard) from cylinder block, or cylinder block Y-fitting.

⚠ CAUTION

Avoid product damage. Do not disturb the Y-fitting when removing the drain plug. There is an ignition control "Knock Sensor" in the upper hole of the fitting. This sensor must not be loosened or removed. It is tightened to a critical specification at the factory.



74073

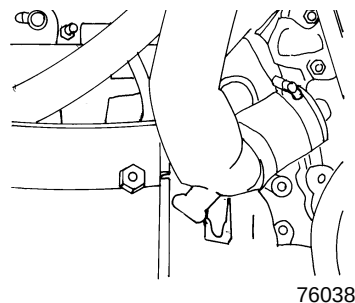
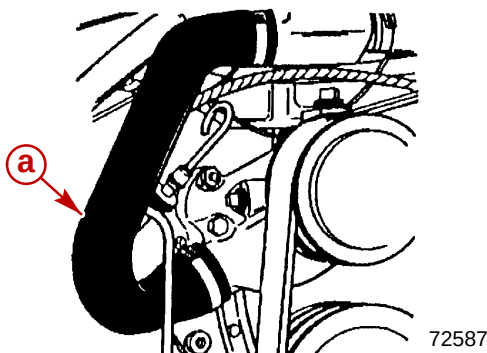
Starboard Side Shown (Port Similar)

- a** - Exhaust Elbow Drain Plug
- b** - Cylinder Block Drain Plug
- c** - Y-Fitting (Fuel Injected Only)
- d** - Cylinder Block Drain Plug (Fuel Injected Only)
- e** - Knock Sensor

4. Repeatedly clean out drain holes using a stiff piece of wire. Do this until entire system is drained.

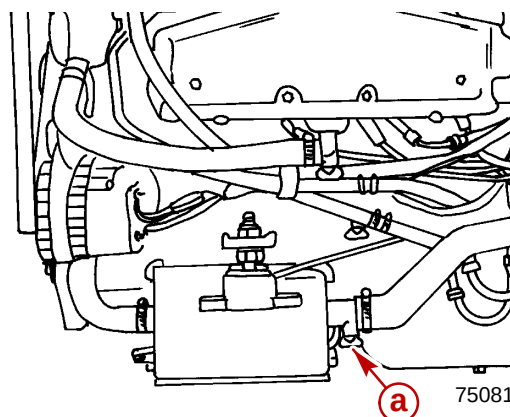
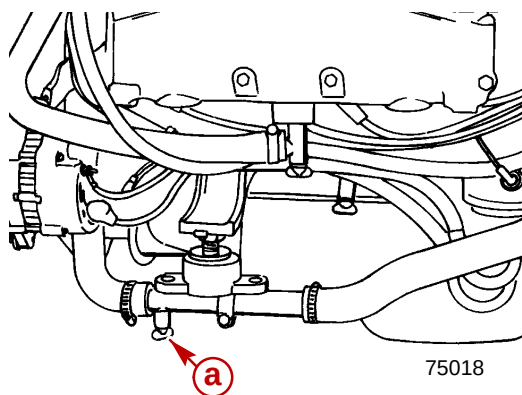
NOTE: It may be necessary to lift, bend, or lower hoses to allow water to drain completely when hoses are disconnected.

5. Remove the engine water circulating pump hose or drain plug if equipped as shown.



a- Hose, Water Circulating Pump To Thermostat Housing

6. Remove the drain plug from the water tube or Cool Fuel System cooler if equipped.

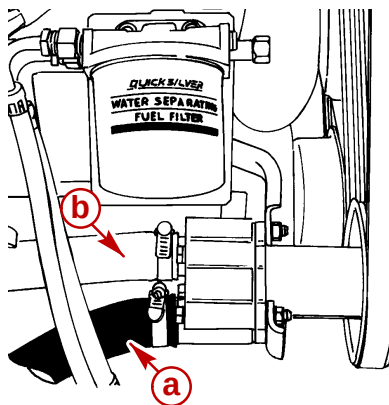


Some Carbureted Models

a- Drain Plug

Fuel Injected Models

7. Remove seawater pump inlet hose as shown.



a- Seawater Inlet Hose

b- Hose To Cooler

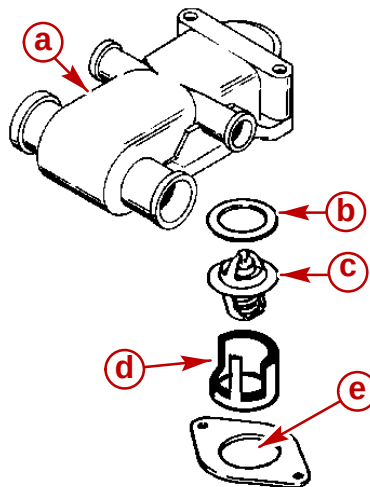
8. Crank engine over slightly with starter motor to purge any water trapped in seawater pickup pump. DO NOT ALLOW ENGINE TO START.

9. After seawater section of cooling system has been drained completely:
 - a. Install all drain plugs and tighten securely.
 - b. Reconnect hoses and tighten all hose clamps securely.
 - c. **If NOT equipped with seacock:** Seawater inlet hose must remain disconnected and plugged until engine is to be restarted.

IMPORTANT: Mercury MerCruiser recommends that propylene glycol antifreeze (nontoxic and biodegradable) be used in sea-water section of the cooling system for cold weather or extended storage. Make sure that the propylene glycol antifreeze contains a rust inhibitor and is recommended for use in marine engines. Be certain to follow the propylene glycol manufacturer's recommendations.

10. For additional assurance against freezing and corrosion in the internal water passages:
 - a. Remove the thermostat cover and thermostat.
 - b. Fill the engine seawater cooling system with a mixture of antifreeze and tap water mixed to manufacturer's recommendation to protect engine to the lowest temperature to which it will be exposed during cold weather or extended storage.
 - c. Using a new gasket, reinstall thermostat and cover. Tighten cover bolts to 30 lb-ft (41 Nm).

NOTE: Hoses shown removed for visual clarity. Do not remove hoses.



74493

- a** - Housing
- b** - Gasket
- c** - Thermostat
- d** - Spacer
- e** - Fill Here

DRAINING SEAWATER (RAW-WATER) COOLED

MIE (Inboard and Ski) Models:

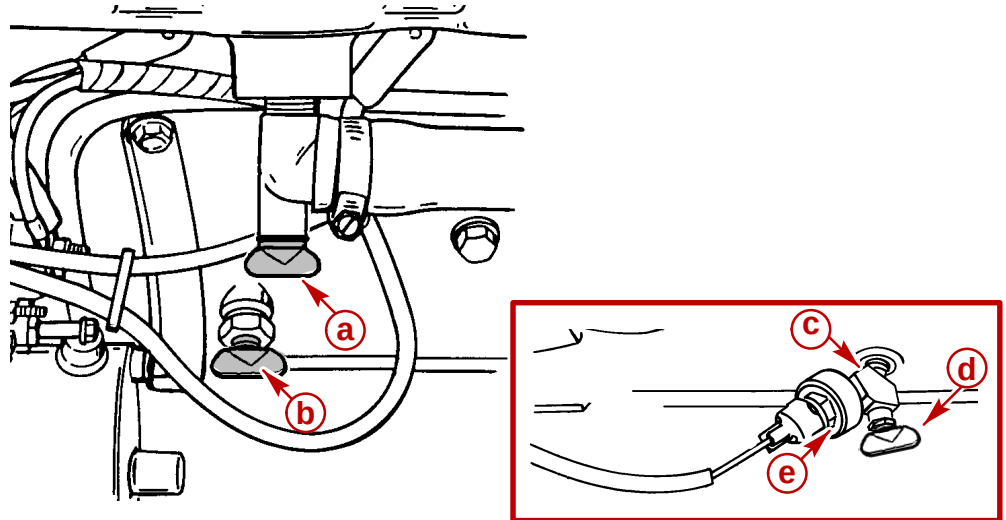
NOTICE

Refer to “Cold Weather or Extended Storage Precautions” in this section, **BEFORE** proceeding.

1. Engine must be as level as possible to ensure complete draining of cooling system.
2. Remove drain plugs from bottom of port and starboard manifold fittings.
3. Remove drain plugs (port and starboard) from cylinder block, or cylinder block Y-fitting.

⚠ CAUTION

Avoid product damage. Do not disturb the Y-fitting when removing the drain plug. There is an ignition control “Knock Sensor” in the upper hole of the fitting. This sensor must not be loosened or removed. It is tightened to a critical specification at the factory.



74073

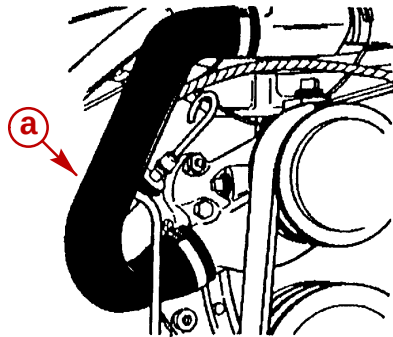
Starboard Side Shown (Port Similar)

- a** - Exhaust Elbow Drain Plug
- b** - Cylinder Block Drain Plug
- c** - Y-Fitting (Fuel Injected Only)
- d** - Cylinder Block Drain Plug (Fuel Injected Only)
- e** - Knock Sensor

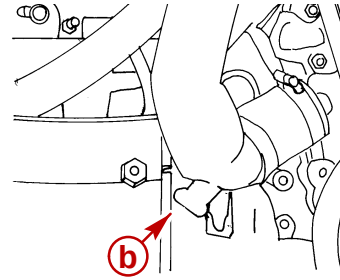
4. Repeatedly clean out drain holes using a stiff piece of wire. Do this until entire system is drained.

NOTE: It may be necessary to lift, bend, or lower hoses to allow water to drain completely when hoses are disconnected.

5. Remove the engine water circulating pump hose or drain plug if equipped as shown.



72587

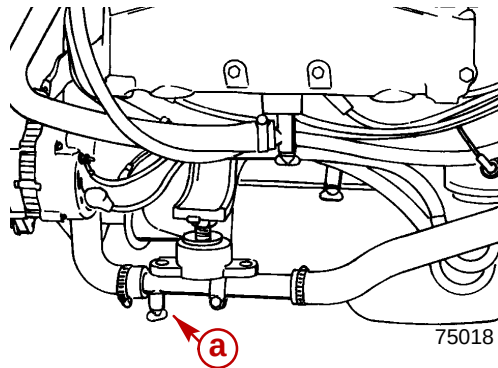


76038

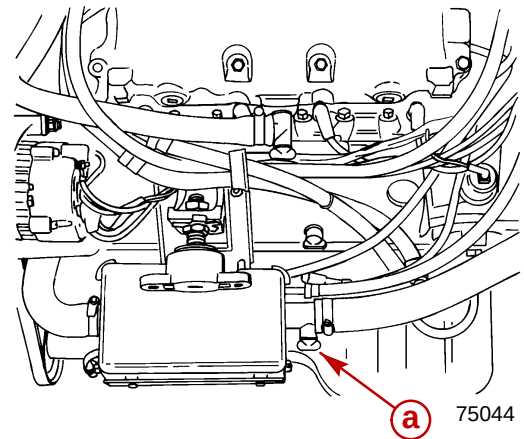
a- Hose, Water Circulating Pump To Thermostat Housing

b- Water Circulating Pump Hose Drain Plug

6. Remove the drain plug from the water tube (some carbureted models) or Cool Fuel System cooler (fuel injected models).



75018



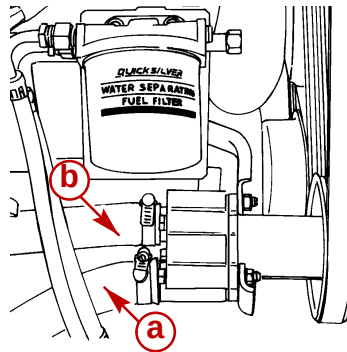
75044

Some Carbureted Models

a- Drain Plug

Fuel Injected Models

7. Remove both hoses from the seawater pump.



75533

a- Seawater Inlet Hose

b- Hose To Cooler

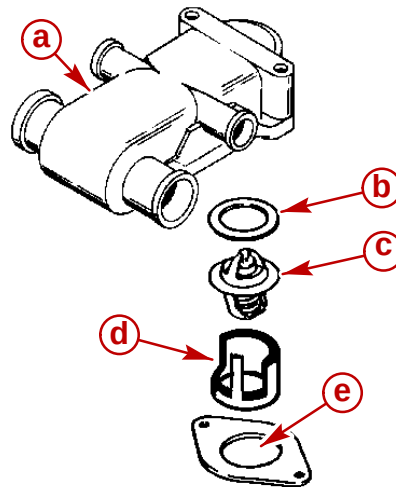
8. Crank engine over slightly with starter motor to purge any water trapped in seawater pickup pump. DO NOT ALLOW ENGINE TO START.

9. After seawater section of cooling system has been drained completely:
 - a. Install all drain plugs and tighten securely.
 - b. Reconnect hoses and tighten all hose clamps securely.
 - c. **If NOT equipped with seacock:** Seawater inlet hose must remain disconnected and plugged until engine is to be restarted.

IMPORTANT: Mercury MerCruiser recommends that propylene glycol antifreeze (nontoxic and biodegradable) be used in sea-water section of the cooling system for cold weather or extended storage. Make sure that the propylene glycol antifreeze contains a rust inhibitor and is recommended for use in marine engines. Be certain to follow the propylene glycol manufacturer's recommendations.

10. For additional assurance against freezing and corrosion in internal water passages:
 - a. Remove the thermostat cover and thermostat.
 - b. Fill the engine seawater cooling system with a mixture of antifreeze and tap water mixed to manufacturer's recommendation to protect engine to the lowest temperature to which it will be exposed during cold weather or extended storage.
 - c. Using a new gasket, reinstall thermostat and cover. Tighten cover bolts to 30 lb-ft (41 Nm).

NOTE: Hoses shown removed for visual clarity. Do not remove hoses.



- a** - Housing
- b** - Gasket
- c** - Thermostat
- d** - Spacer
- e** - Fill Here

74493

DRAINING SEAWATER SECTION OF CLOSED COOLED (COOLANT) MODELS

MCM (Sterndrive) Models

NOTICE

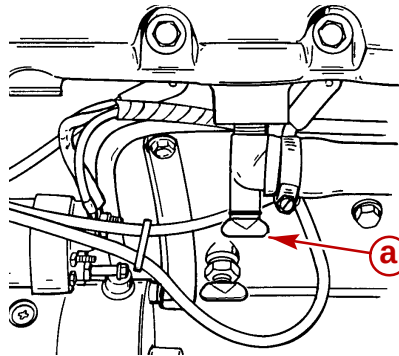
Refer to "Cold Weather or Extended Storage Precautions" in this section, **BEFORE** proceeding.

IMPORTANT: Drain seawater section of closed cooling system only.

1. Engine must be as level as possible to ensure complete draining of cooling system.

NOTE: Only if Extended Life 5/100 Ethylene Glycol Antifreeze/Coolant is used. If any non-compatible coolant is added to this coolant, coolant must be changed every 2 years or 400 hours, whichever occurs first. All coolants other than Extended Life 5/100 Ethylene Glycol Antifreeze/Coolant must be changed every 2 years or 400 hours, whichever occurs first.

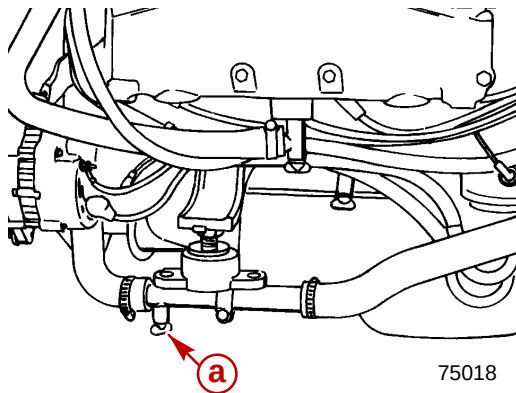
2. Remove drain plug from bottom of port and starboard exhaust manifolds.



74073

a - Drain Plug

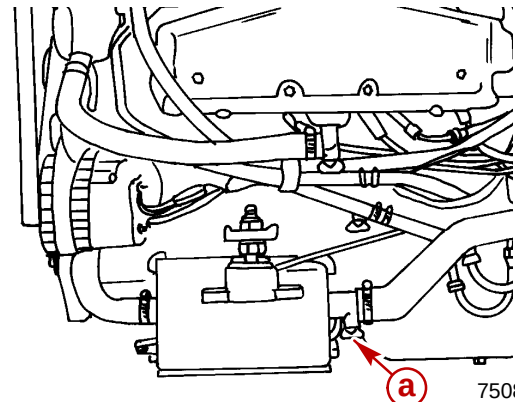
3. Remove the drain plug from the water tube or Cool Fuel System cooler if equipped.



75018

Some Carbureted Models

a - Drain Plug

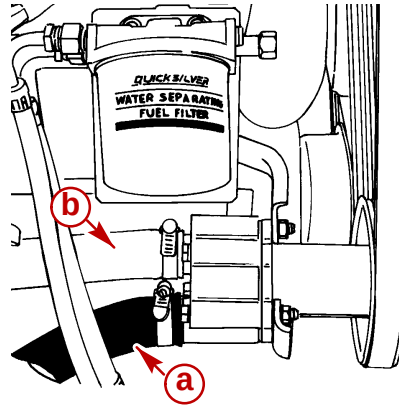


75081

Fuel Injected Models

NOTE: It may be necessary to lift, bend, or lower hoses to allow water to drain completely when hoses are disconnected.

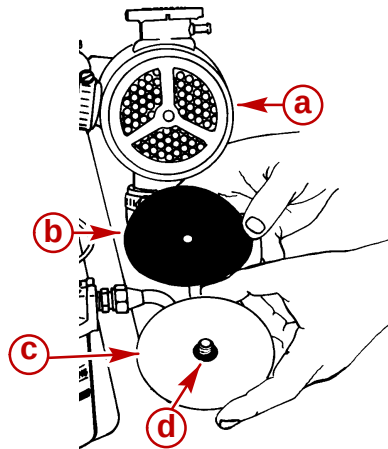
4. Remove seawater pump inlet hose.



75533

- a-** Seawater Inlet Hose
b- Hose To Cooler

5. Remove end caps, sealing washers and gaskets from the heat exchanger. Allow tubes to drain.



71515

- a-** Heat Exchanger
b- Sealing Washer
c- End Cap
d- Gasket

IMPORTANT: Use compressed air to blow any remaining water from the tubes in the heat exchanger.

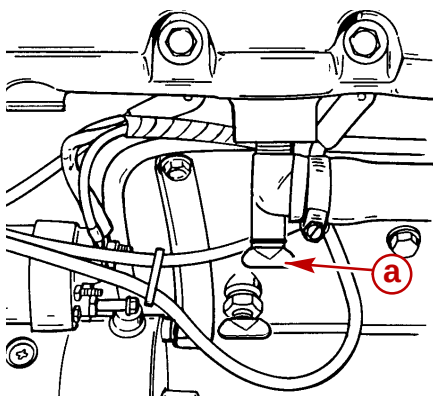
6. Repeatedly clean out drain holes using a stiff piece of wire. Do this until entire system is drained.
7. After seawater section of cooling system has been drained completely:
 - a. Install all drain plugs and tighten securely.
 - b. Reconnect hoses and tighten all hose clamps securely.
 - c. Apply Quicksilver Perfect Seal to both sides of new end plate gaskets.
 - d. Assemble new gaskets, new sealing washers and end plates onto heat exchanger. Torque end plate screws to 36-72 lb-in. (4-8 Nm).
 - e. **If NOT equipped with seacock:** Seawater inlet hose must remain disconnected and plugged until engine is to be restarted.

DRAINING SEAWATER SECTION OF CLOSED COOLED (COOLANT) MODELS

MIE (Inboard and Ski) Models**NOTICE**

Refer to "Cold Weather or Extended Storage Precautions" in this section, **BEFORE** proceeding.

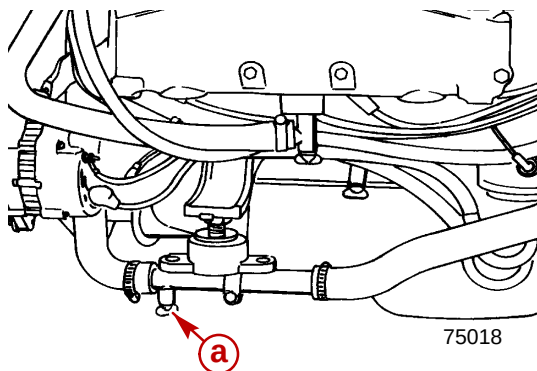
1. Ensure that the boat is as level as possible to ensure complete draining of cooling system.
2. Remove drain plugs (port and starboard) from bottom of exhaust manifolds.



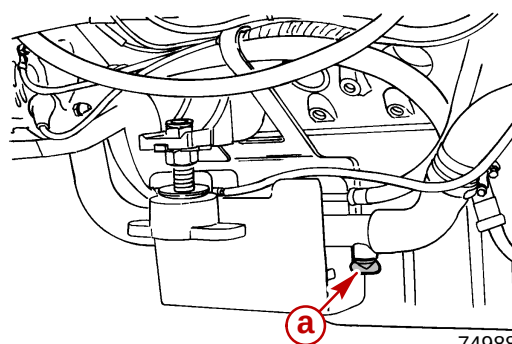
74073

a - Drain Plug

3. Remove the drain plug from the water tube or Cool Fuel System cooler if equipped.



75018

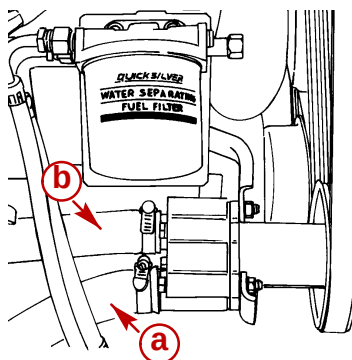


74988

Some Carbureted Models**Fuel Injected Models**

a - Drain Plug

4. Loosen hose clamps and remove both hoses from seawater pickup pump as shown.

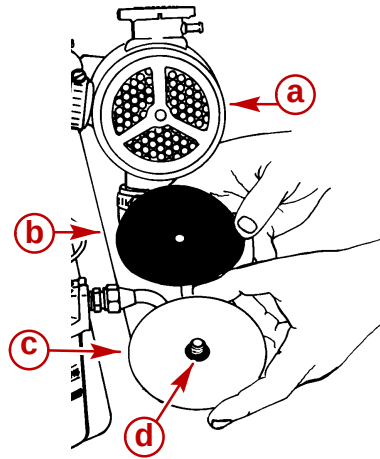


75533

a - Seawater Inlet Hose

b - Hose To Cooler

5. Remove end caps, sealing washers and gaskets from the heat exchanger. Allow tubes to drain.



71515

- a** - Heat Exchanger
- b** - Sealing Washer
- c** - End Cap
- d** - Gasket

IMPORTANT: Use compressed air to blow any remaining water from the tubes in the heat exchanger.

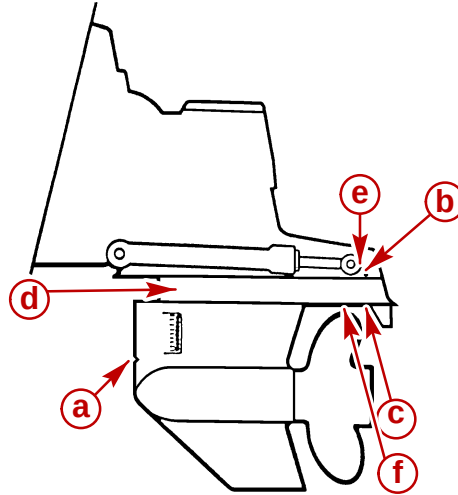
6. Repeatedly clean out drain holes using a stiff piece of wire. Do this until entire system is drained.
7. Crank engine over slightly with starter motor to purge any water trapped in seawater pickup pump. **DO NOT ALLOW ENGINE TO START.**
8. After seawater section of cooling system has been drained completely:
 - a. Except blue colored drain plugs with seals, coat threads of drain plugs with Quicksilver Perfect Seal. Install all drain plugs and tighten securely.
 - b. Apply Quicksilver Perfect Seal to both sides of new end plate gaskets. Assemble new gaskets, new sealing washers and end plates onto heat exchanger. Torque end plate screws to 36-72 lb-in. (4-8 Nm).
 - c. Reconnect all hoses and tighten hose clamps securely.
 - d. **If NOT equipped with seacock:** Seawater inlet hose must remain disconnected and plugged until engine is to be restarted.

Draining Sterndrive

NOTICE

Predelivery Preparation Instructions Must Be Performed Before Delivering Boat To The Product Owner.

1. **On Bravo Drive Equipped Models:** Insert a small wire (repeatedly) to make sure that speedometer pitot tube, anode cavity vent hole, and anode cavity drain passage are unobstructed and drained.

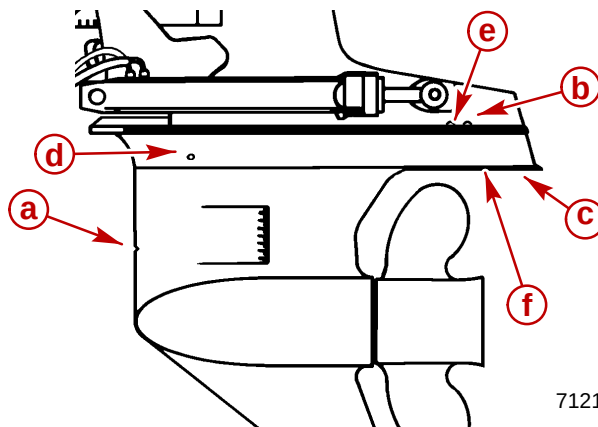


71217

Typical

- a** - Speedometer Pitot Tube
- b** - Anode Cavity Vent Hole
- c** - Anode Cavity Drain Passage
- d** - Gear Housing Water Drain Hole (One Each - Port and Starboard)
- e** - Gear Housing Cavity Vent Hole
- f** - Gear Housing Cavity Drain Hole

2. **On Alpha Drive Equipped Models:** Insert a small wire (repeatedly) to make sure that speedometer pitot tube, trim tab cavity vent hole, and trim tab cavity drain passage are unobstructed and drained.



71216

- a** - Speedometer Pitot Tube
- b** - Trim Tab Cavity Vent Hole
- c** - Trim Tab Cavity Drain Passage
- d** - Gear Housing Water Drain Hole (One Each - Port and Starboard)
- e** - Gear Housing Cavity Vent Hole
- f** - Gear Housing Cavity Drain Hole

Recommissioning

NOTICE

Refer to “Cold Weather or Extended Storage Precautions” in this section BEFORE proceeding.

1. Ensure that all cooling system hoses are connected and tight.
2. Ensure all petcocks and drain plugs are installed and tight.
3. Inspect serpentine drive belt for condition and proper tension.
4. Perform all lubrication and maintenance specified for completion “Annually” and “Every 100 hours or Annually” in maintenance schedule, except items which were performed at time of engine layup.
5. For sterndrive unit recommissioning, refer to appropriate Sterndrive Service Manual.

 CAUTION
--

When installing battery (in next step), be sure to connect positive battery cable to positive (+) terminal and negative (grounded) battery cable to negative (-) battery terminal. If battery cables are reversed, damage to electrical system WILL result.
--

6. Install fully charged battery. Clean battery cable clamps and terminals to help retard corrosion.

 CAUTION
--

DO NOT operate engine without cooling water being supplied to seawater pickup pump or water pump impeller will be damaged and subsequent overheating damage to engine may result.
--

7. Start engine and closely observe instrumentation to ensure that all systems are functioning properly.
8. Carefully inspect entire engine for fuel, oil, water and exhaust leaks.
9. Check steering system, shift and throttle controls for proper operation.

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IMPORTANT INFORMATION

Section 1C - Troubleshooting

**1
C**

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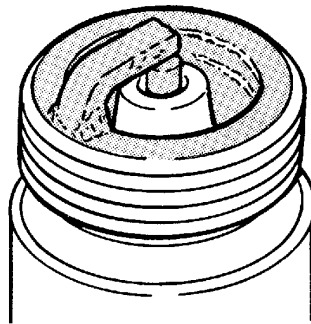
Used Spark Plug Analysis

Use the following illustrations for determining serviceability of spark plug. Spark plug condition also can suggest a variety of possible engine malfunctions and, therefore, can indicate needed engine repairs. When old plugs are replaced, replace entire set. Perform plug service only on those plugs suitable for additional service, using the following procedures:

1. Remove any oil deposits with solvent and dry plugs thoroughly.
2. Open electrode gap wide enough to permit cleaning and filing.
3. Remove combustion deposits from firing end of spark plug with a plug cleaner. Blow off with compressed air to remove abrasives.
4. File electrode surfaces to restore clean, sharp edges. Again remove filings with compressed air.
5. Reset gap to specifications by bending only side electrode with proper tool.

Normal Condition

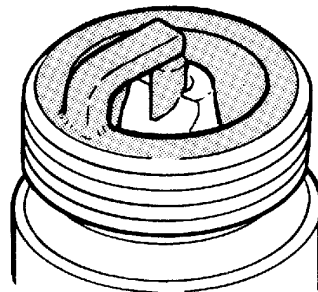
Few deposits are present and probably will be light tan or gray in color. This plug shows that plug heat range is compatible with engine, and engine is electrically and mechanically in good running condition. With proper plug servicing (clean, file and regap), this plug can be reinstalled with good results.



72420

Chipped Insulator

Chipped insulator usually results from careless plug regapping. Under certain conditions, severe detonation also can split insulator firing ends. Replace spark plugs.

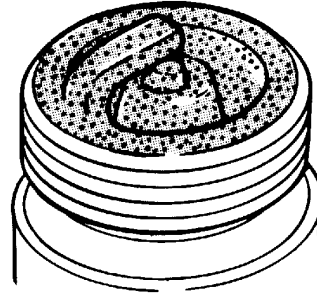


72420

Wet Fouling (Oil Deposits)

Plug becomes shorted by excessive oil entering combustion chamber, usually in engine with many hours of operation. Worn piston rings, cylinder walls, valve guides or valve stem seals are causes of oil entering combustion chamber. Only engine repairs will permanently relieve oil wet fouling.

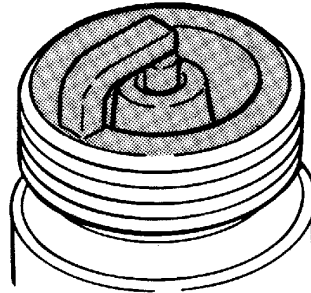
IMPORTANT: New engines or recently overhauled engines may wet foul plugs before normal oil control is achieved with proper break-in procedures. Such fouled plugs may be serviced (clean, file and regap) and reinstalled.



72420

Cold Fouling

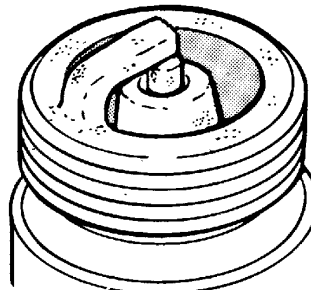
Dry, black deposits indicate rich fuel mixture or weak ignition. Clogged flame arrestor, flooding carburetor, sticky choke or weak ignition components all are probable causes. If, however, only one or two plugs in set are fouled, check for sticking valves or bad ignition leads. After correcting cause, service (clean, file and regap) plugs and reinstall.



72421

Overheating

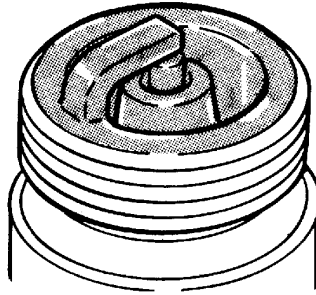
Insulator is dull white or gray and appears blistered. Electrodes are eroded and there is an absence of deposits. Check that correct plug heat range is being used. Also check for over-advanced ignition timing, cooling system malfunction, lean fuel/air mixtures, leaking intake manifold or sticking valves. Replace spark plugs.



72421

High Speed Glazing

Insulator has yellowish, varnish-like color, indicating that temperatures suddenly have risen, usually during hard, fast acceleration under heavy load. Normal deposits do not get a chance to blow off. Instead, they melt and form a conductive coating. Replace spark plugs. If condition recurs, use colder heat range plug and service plugs more frequently.



72421

Scavenger Deposits

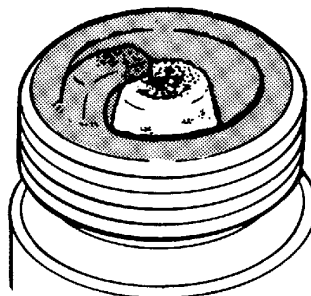
Powdery white or yellow deposits are built up on shell, insulator and electrodes. This is normal appearance with certain branded fuels. Accumulation on ground electrodes and shell areas may be unusually heavy, but may be easily chipped off. Plugs can be serviced (clean, file and regap) and reinstalled.



72422

Pre-Ignition Damage

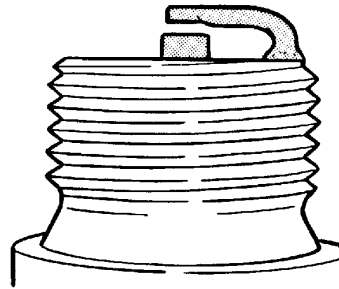
Pre-ignition damage is caused by excessive high temperatures. Center electrode melts first, followed by ground electrode. Normally, insulators are white but may be dirty if plug has been misfiring. Check for correct plug heat range, advanced ignition timing, lean fuel mixture, incorrect fuel used, malfunctioning cooling system, leaking intake manifold or lack of lubrication. Replace spark plugs.



72422

Reversed Coil Polarity

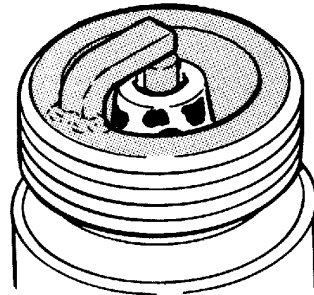
Concave erosion of ground electrode is an indication of reversed polarity. Center electrode will show only normal wear. Engine will misfire and idle rough. To correct, reverse primary coil leads. Replace spark plugs.



72422

Splashed Deposits

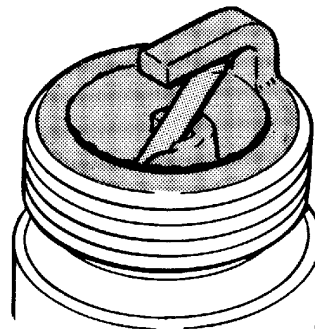
Spotted deposits, which sometimes occur after long delayed tune-up, accumulate after a long period of misfiring. When normal combustion temperatures are restored, upon installation of new plugs, deposits loosen from top of piston and head and are thrown against hot insulator. Plugs can be serviced (clean, file and regap) and reinstalled.



72423

Mechanical Damage

Mechanical damage to spark plug firing end is caused by foreign object in combustion chamber. Because of valve overlap, small objects can travel from one cylinder to another. Check all cylinders, intake manifold and exhaust material to prevent further damage. Replace spark plugs.



72423

IMPORTANT: When working on engine, spark plug holes, carburetor throat and throttle body should be kept covered to prevent foreign objects from entering combustion chamber.

Poor Boat Performance And/Or Poor Maneuverability

Symptom	Cause
Bow too low	A. Improper drive unit trim angle
	B. Improper weight distribution
	C. Boat is underpowered
	D. Permanent or power hook in boat bottom
	E. False bottom full of water
	F. Improperly adjusted trim tabs (after planes)
	G. Dirty boat bottom (marine growth)
Bow too high	A. Improper drive unit trim angle
	B. Propeller pitch too great
	C. Dirty boat bottom (marine growth)
	D. Poor running engine
	E. Improper weight distribution
	F. Rocker in boat bottom
	G. False bottom full of water
	H. Improperly adjusted anode (after planes)
Propeller ventilating	A. Drive unit installed too high on transom
	B. Dirty or rough boat bottom
	C. Damaged propeller; pitch too small; diameter too small
	D. Keel located too close to propeller or too deep in the water
	E. Water pickup or through hull fittings located too close to propeller
	F. Hook in boat bottom
	G. Propeller plugged up with weeds

Improper Full Throttle Engine RPM

RPM Too High

Cause	Special Information
Propeller	Damaged, pitch too low, diameter too small, propeller hub slipping
Boat	Water pickup or through hull fittings mounted too close to propeller (ventilation); keel located too close to propeller and/or too deep in the water (ventilation). Drive installed too high on transom; wrong gear ratio.
Operation	Unit trimmed out too far
Engine coupler slipping	

RPM Too Low

Cause	Special Information
Propeller	Damaged, pitch too great, diameter too great
Boat	Dirty or damaged bottom; permanent or power hook in bottom; false bottom full of water. Drive installed too low on transom; wrong gear ratio.
Operation	Unit trimmed in too far

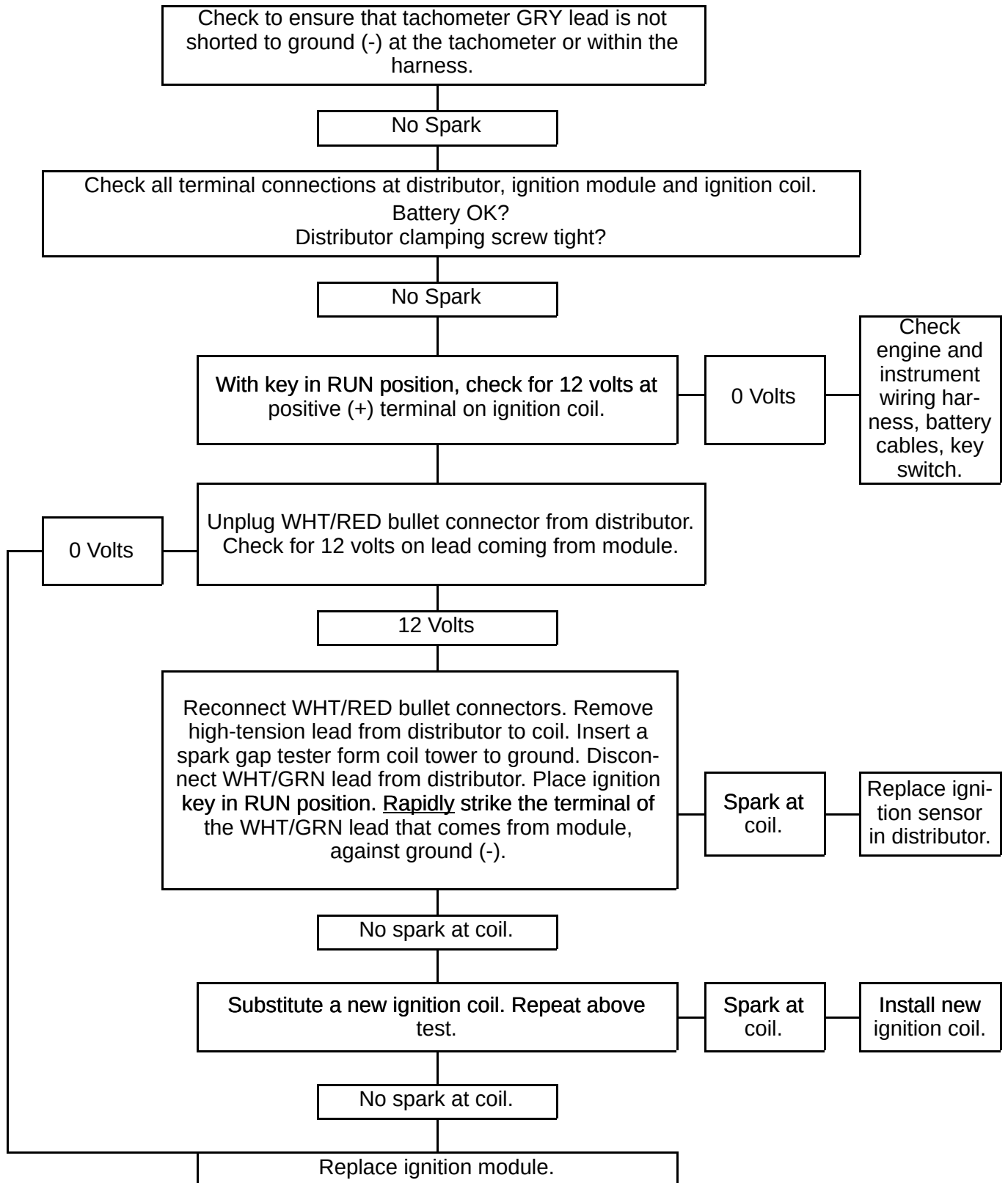
Engine Cranks Over But Will Not Start Or Starts Hard

NOTE: This troubleshooting chart applies to carbureted engines only. For EFI engines, refer to SECTION 5F-“Fuel Injection System Troubleshooting.”

Important Information

1. First, determine which engine system is causing the problem. To make an engine operate, basic components - fuel, spark (ignition), and compression - are required. If all three components are present, the engine should operate. If any one of the three are missing, weak or arriving at the wrong time, the engine will not operate.
2. Determine if there is fuel present by looking down the carburetor venturi while actuating throttle. There should be a stream of fuel coming out of the accelerator pump nozzles if the carburetor has fuel.
3. Check ignition system operation. Remove coil wire from tower on distributor cap. Hold coil wire near ground and check for spark while cranking engine over. Repeat procedure with spark plug wires. If there is spark at the spark plug wires, remove the spark plugs and make sure they are correct type and heat range, and not fouled or burned.
4. Run a compression check on engine to make sure the engine is mechanically OK.

Testing Thunderbolt V Ignition System



IMPORTANT: The WHT/GRN lead must be touched against ground (-) 2-3 times per second to simulate a running engine. Repeat this test several times to ensure that spark is present.

Fuel System Rich

Cause	Special Information
Warm engine carburetor percolation	Fuel boils out of float bowl when shut off and warm. Floods intake manifold.
Clogged flame arrestor	
Automatic choke not opening	
Float adjustment	
Float leaks or is saturated with fuel	
Needle and seat leaking	
Carburetor gaskets leaking	
Excessive fuel pump pressure	
Cracked or porous carburetor body	Unseats needle and seat

Fuel System Lean

Cause	Special Information
Empty fuel tank	
Fuel shut-off valve closed	
Vapor lock	Engine will not start after warm engine shut down
Automatic choke	Stuck open, wrong adjustment

Miscellaneous

Cause	Special Information
Low grade or stale fuel	
Water in fuel	

Engine Will Not Crank Over

Cause	Special Information
Remote control lever not in neutral position	
Battery charge low, damaged wiring, loose electrical connections	
Circuit breaker tripped	
Blown fuse	
Ignition switch	
Slave solenoid	
Faulty neutral start safety switch	Open circuit
Starter solenoid	
Starter motor	
Mechanical engine malfunction	

Charging System Inoperative

Cause	Special Information
Loose or broken drive belt	
Engine rpm too low on initial start	Rev engine to 1500 rpm
Loose or corroded electrical connections	
Faulty battery gauge	Best way to test is to replace gauge
Battery will not accept charge	Low electrolyte or failed battery
Faulty alternator or regulator	
Refer to SECTION 4C for complete "Charging System" diagnostic procedures	

Noisy Alternator

Cause	Special Information
Loose mounting bolts	
Drive belt	Worn, frayed, loose
Loose drive pulley	
Worn or dirty bearings	
Faulty diode trio or stator	

Instrumentation Malfunction

Cause	Special Information
Faulty wiring, loose or corroded terminals	
Faulty key switch	Test, as outlined in SECTION 4D
Faulty gauge	Test, as outlined in SECTION 4D
Faulty sender	Test , as outlined in SECTION 4D

Radio Noise

Cause	Special Information
A "popping" noise that will increase with engine rpm. Noise will stop as soon as engine is turned off.	Ignition System - wrong spark plugs, cracked distributor cap, cracked coil tower, leaking spark plug wires, moisture on ignition components
A "High pitched whine" in the radio	Alternator - poor brush contact on the slip rings
A "hissing or crackling" noise when instruments are jarred with ignition on	Instrumentation - loose connections or antennae wire routed too close to instruments
Varying unexplained noises	Accessories - bilge pump, bilge blower; fish finder, depth locator; cabin heater motor, etc. Disconnect one at a time until noise disappears.

Poor Fuel Economy

Cause	Special Information
Fuel leaks	
Operator habits	Prolonged idling, slow acceleration, failure to cut back on throttle once boat is on plane, boat overloaded, uneven weight distribution
Engine laboring	Bent, damaged or wrong propeller. Water test boat for proper operating rpm at wide-open-throttle
Clogged flame arrestor	
Engine compartment sealed too tight	Not enough air for engine to run properly
Boat bottom	Dirty (marine growth), hook, rocker
Carburetor	Idle mixture settings, accelerator pump adjustments, linkage binding, choke adjustment, carburetor flooding over, main fuel jets clogged or improperly sized
Improper fuel	
Crankcase ventilation system not working	
Engine needs tune-up	
Engine running too cold or too hot	
Plugged or restricted exhaust	
Engine	Low compression

Carburetor Malfunctions

Symptoms	Cause
Flooding	Needle and seat broken or damaged
	Float adjustment
	Saturated float
	Gaskets leaking
	Cracked fuel bowl
	Fuel percolation
	Automatic choke malfunctioning
Rough idle	Idle rpm too low
	Idle mixture screws improperly adjusted
	Idle passages dirty
	Throttle valves worn or damaged
	Engine flooding
	Vacuum leak
	Throttle body heat passages plugged
Hesitation or acceleration flatness	Accelerator pump damaged, malfunctioning or improperly adjusted
	Leaking gaskets
	Automatic choke malfunctioning
	Power valve broken or improperly adjusted
	Throttle valves worn or damaged
	Throttle body heat passages plugged
	Main metering jets clogged or improperly sized
	Float adjustment
	Secondary air valve wind-up

Engine Runs Poorly at Idle

Symptoms	Cause
Engine surges	Main metering jets clogged or improperly sized
	Leaking gaskets
	Float adjustment
	Saturated float
	Power valve broken or improperly adjusted
	Throttle valves worn or damaged
Low top speed or lack of power	Power valve broken or improperly adjusted
	Float adjustment
	Main metering jets clogged or improperly sized
	Leaking gaskets
Poor cold engine operation	Idle rpm too low
	Idle mixture screws improperly adjusted
	Throttle valves worn or damaged
	Automatic choke malfunctioning
	Engine flooding
Engine stalls	Idle rpm too low
	Idle mixture screws improperly adjusted
	Engine flooding
	Automatic choke malfunctioning
	Dirt in carburetor
	Accelerator pump damaged, malfunctioning or improperly adjusted
	Leaking gaskets
Hard starting	Refer to "Engine Starts Hard"

Engine Runs Poorly At High RPM

Cause	Special Information
Also refer to "Poor Boat Performance"	
Crankcase overfilled with oil	Check oil level with boat at rest in the water
Anti-siphon valve	Restricting fuel supply
Plugged fuel tank vent	
Improper fuel supply	Refer to "Carburetor Malfunctions"
Incorrect ignition timing	
Low grade of fuel or water in the fuel	
Spark plugs	Fouled, burned, cracked porcelain, incorrect heat range
Spark plug wires	Poor insulation, broken wires
Distributor cap or rotor	Dirty or cracked
Coil	Damaged or malfunctioning
Distributor	Excessive play in shaft
Engine overheating	Refer to "Engine Overheats"
Low compression	Worn valves, rings, cylinders, etc.
Restricted exhaust	

Engine Acceleration Is Poor

Cause	Special Information
Also refer to "Poor Boat Performance"	
Idle mixture screws improperly adjusted	
Incorrect ignition timing	
Incorrect distributor or amplifier advance curve	Refer to SECTION 4B
Accelerator pump	Check for stream of raw fuel from accelerator pump discharge nozzle, when opening throttle with engine shut off
Distributor cap or rotor	Dirty or cracked
Vacuum leak	Intake manifold or carburetor base
Spark plugs	Fouled, burned; wrong heat range; cracked porcelain
Float adjustment	
Dirty carburetor	
Low compression	

Troubleshooting with Vacuum Gauge

Reading	Cause
Steady reading between 15-21 inches at idle rpm	Normal
Extremely low reading, but steady at idle rpm	Vacuum leak, incorrect timing, underpowered boat, faulty boat bottom
Fluctuates between high and low at idle rpm	Blown head gasket between two adjacent cylinders
Fluctuates 4 or 5 inches very slowly at idle rpm	Carburetor needs adjustment, spark plug gap too narrow, valves are sticking
Fluctuates rapidly at idle, steadies as rpm is increased	Valve guides are worn
Continuously fluctuates between low and normal reading at regular intervals at idle rpm	Burned or leaking valve

Engine Noise

Important Information

No definite rule or test will positively determine source of engine noise. Use the following information only as a general guide to engine noise diagnosis.

1. Use a timing light to determine if noise is timed with engine speed or 1/2 engine speed. Noises timed with engine speed are related to crankshaft, rods, pistons, piston pins and flywheel. Noises timed to 1/2 engine speed are valve train related.
2. The use of a stethoscope can aid in locating a noise source; however, because noise will travel to other metal parts not involved in the problem, caution must be exercised.
3. If you believe noise is confined to one particular cylinder, ground spark plug leads, one at a time. If noise lessens noticeably or disappears, it is isolated to that particular cylinder.
4. Try to isolate the noise to location in engine: front to back, top to bottom. This can help determine which components are at fault.
5. Sometimes noises can be caused by moving parts coming in contact with other components. Examples are: flywheel or coupler; exhaust flappers rattling against exhaust pipe; crankshaft striking pan, pan baffle, or dipstick tube; rocker arm striking valve cover; and loose flywheel cover. In many cases if this is found to be the problem, a complete engine teardown is not necessary.
6. When noise is isolated to a certain area and component, removal and inspection will be required. Refer to proper sections of service manual for information required for service.
7. If noise cannot be distinguished between engine and drive unit, remove drive from boat. Run a water supply directly to engine. Run engine without the drive to determine if noise is still there.

Valve Cover Area

Noise Location	Possible Causes
Valve cover area, timed to 1/2 engine speed, noise could be confined to one cylinder or may be found in any multitude of cylinders	Rocker arm striking valve cover
	Rocker arm out of adjustment
	Worn rocker arm
	Bent push rod
	Collapsed filter

Cylinder Area

Noise Location	Possible Causes
Cylinder area, may be confined to one cylinder or found in more than one cylinder, timed to engine speed	Sticking valve
	Carbon build-up
	Connecting rod installed wrong
	Bent connecting rod
	Piston damaged or broken
	Piston rings damaged or broken
	Piston pin damaged or broken
	Worn cylinder

Camshaft Area

Noise Location	Possible Causes
Camshaft area, front of engine, timed to 1/2 engine speed	Crankshaft timing sprocket damaged
	Timing chain damaged
	Fuel pump damaged
	Valve lifter damaged
	Cam bearings damaged
Camshaft area, center of engine, timed to 1/2 engine speed	Fuel pump damaged
	Valve lifter damaged
	Cam bearing damaged
Camshaft area, rear of engine, timed to 1/2 engine speed	Distributor gear damaged
	Valve lifter damaged
	Cam bearings damaged
Camshaft area, throughout engine, timed to 1/2 engine speed	Loss of oil pressure
	Valve lifters damaged
	Cam bearings damaged

Crankshaft Area

Noise Location	Possible Causes
Crankshaft area, front of engine, timed to engine speed	Crankshaft timing sprocket damaged
	Timing chain damaged
	Main bearing damaged
	Rod bearing damaged
Crankshaft area, center of engine, timed to engine speed	Crankshaft striking pan or pan baffle
	Main bearing damaged
	Rod bearing damaged
Crankshaft area, rear of engine, timed to engine speed	Loose flywheel cover
	Loose coupler
	Loose flywheel
	Main bearing damaged
	Rod bearing damaged
Crankshaft area, throughout engine, timed to engine speed	Loss of oil pressure
	Main bearings damaged
	Rod bearings damaged

Miscellaneous

Noise	Possible Causes
Engine spark knock	Advanced timing
	Low octane fuel
	Engine running hot
	Carbon deposits in engine
Popping through carburetor	Wrong ignition timing
	Carburetor set too lean
	Faulty accelerator pump
	Vacuum leak
	Valve adjustment
	Valve timing
Hissing	Burned or stuck valve
	Vacuum leak
	Leaking exhaust (manifolds or pipes)
	Loose cylinder heads
Whistle	Blown head gasket
	Vacuum leak
Sparks jumping	Dry or tight bearing in an accessory
	Leaking high tension lead
	Cracked coil tower
Squeaks or squeals	Cracked distributor cap
	Drive belt slipping
	Dry or tight bearing in an accessory
Rattling in exhaust pipe area	Parts rubbing together
	Exhaust shutters

Oil Pressure

Cause	Special Information
Measuring oil pressure	Use a good automotive oil pressure test gauge. Do not rely on the oil pressure gauge in the boat.
Check engine oil level with boat at rest in the water	Oil level should be between the ADD and FULL marks
Oil level in crankcase above FULL mark	May cause loss of engine rpm, oil pressure gauge fluctuation, drop in oil pressure, and hydraulic valve lifter noise at high rpm
Oil level in crankcase below ADD mark	Low oil pressure; oil pressure gauge fluctuation; internal engine noise and/or damage
Change in oil pressure	This may be a normal condition. Oil pressure may read high in the cooler times of the day and when engine is not up to operating temperature. As the air temperature warms up and engine is operating at normal temperature, it is normal for oil pressure to drop.
Low engine oil pressure at idle	With modern engines and engine oils, low oil pressure readings at idle do not necessarily mean there is a problem. If valve lifters do not "clatter" (at idle), there is a sufficient volume of oil to lubricate all internal moving parts properly. The reason for the drop in oil pressure is that engine heat causes an expansion of the internal tolerances in the engine and the oil will thin out somewhat from heat.
Low engine oil pressure at idle after running at a high rpm	Refer to preceding.
Boats with dual engines	It is not uncommon to see different oil pressure readings between the two engines, as long as both engines fall within specifications. Differences in oil pressure can be attributed to differences in engine tolerances, gauges, wiring, senders, etc.
Boats with dual stations	Refer to Boats with Dual Engines, above.

Low Oil Pressure

Cause	Special Information
Low oil level in crankcase	
Defective oil pressure gauge and/or sender	Verify with an automotive test gauge. Refer to SECTION 4D for instrument testing.
Thin or diluted oil	Oil broken down, contains water or gas, wrong viscosity, engine running too hot or too cold, excessive idling in cold water (condensation)
Oil pump	Relief valve stuck open, pickup tube restricted, worn parts in oil pump, air leak on suction side of oil pump or pickup oil tube
Oil leak can be internal or external	Oil passage plugs leaking, cracked or porous cylinder block
Excessive bearing clearance	Cam bearings, main bearings, rod bearings

High Oil Pressure

Cause	Special Information
Oil too thick	Wrong viscosity, oil full of sludge or tar
Defective oil pressure gauge and/or sender	Verify with an automotive test gauge
Clogged or restricted oil passage	
Oil pump relief valve stuck closed	

Excessive Oil Consumption

Cause	Special Information
Normal consumption	One quart of oil consumed in 5-15 hours of operation at WOT (especially in a new or rebuilt engine) is normal
Oil leaks	Clean bilge, run engine with clean white paper on bilge floor, locate oil leak(s)
Oil too thin	Oil diluted or wrong viscosity
Oil level too high	
Drain holes in cylinder head plugged	Oil will flood valve guides
Defective valve seals	
Intake manifold gasket leaking	
Worn valve stems or valve guides	
Defective oil cooler	Crack in cooler tubes
Defective piston rings	Glazed, scuffed, worn, stuck, improperly installed; ring grooves worn; improper break-in; wrong end gap
Defective cylinders	Out of round, scored, tapered, glazed; excessive piston to cylinder clearance; cracked piston
Excessive bearing clearance	

NOTE: ENGINE CRANKCASE OIL MUST BE CHECKED AT INTERVALS SPECIFIED IN "MAINTENANCE SCHEDULE" in SECTION 1B. It is normal for an engine to use a certain amount of oil in the process of lubricating and cooling the engine. The amount of oil consumption is greatly dependent upon engine speed, with consumption being highest at wide-open-throttle and decreasing substantially as engine speed is reduced.

Water In Engine

Important Information

IMPORTANT: First determine location of water in engine. This information can be of great help when trying to determine where the water came from and how it got into the engine. The three most common problems are water on top of pistons, water in crankcase oil, water in crankcase oil and on top of pistons.

The first step, after locating water, is to remove all the water from the engine by removing all spark plugs and pumping cylinders out by cranking engine over. Change the oil and filter. Start engine and see if problem can be duplicated. If problem can be duplicated, a mechanical problem exists. If the problem cannot be duplicated, the problem is either an operator error or a problem that exists only under certain environmental conditions.

If water is contained to cylinder(s) only, it is usually entering through the intake system, exhaust system or head gasket.

If the water is contained to crankcase only, it is usually caused by a cracked or porous block, a flooded bilge or condensation.

If the water is located in both the cylinder(s) and the crankcase, it is usually caused by water in the cylinders getting past the rings and valves or complete submersion.

Checking for rust in the intake manifold or exhaust manifolds is a good idea. Rust in these areas will give clues if the water entered these areas.

Water on Top of Pistons

Cause	Special Information
Operator shut engine off at high rpm	
Engine “diesels” or tries to run backwards	Engine out of tune, poor fuel, high idle rpm, timing set too high
NOTE: The term “diesel” refers to an engine’s tendency to run on after the key has been turned to the OFF position.	
Rain water running into flame arrestor	Hatch cover
Spark plug misfiring	Improper combustion causes moisture in the air to accumulate in the cylinder
Backwash through the exhaust system	
Improper engine or exhaust hose installation	
Cracked exhaust manifold	
Improper manifold to elbow gasket installation	
Loose cylinder head bolts	
Blown cylinder head gasket	Check for warped cylinder head or cylinder block
Cracked valve seat	
Porous or cracked casting	Check cylinder heads, cylinder block, and intake manifold

Water in Crankcase Oil

Cause	Special Information
Water in boat bilge	Boat has been submerged or bilge water was high enough to run in through dipstick tube
Water seeping past piston rings or valves	Refer to “Water on Top of Pistons”
Engine running cold	Defective thermostat, missing thermostat; prolonged idling in cold water
Intake manifold leaking near a water passage	
Cracked or porous casting	Check cylinder head, cylinder block and intake manifold

Engine Overheats (Mechanical)

Cause	Special Information
Engine rpm below specifications at wide-open-throttle (engine laboring)	Damaged or wrong propeller, growth on boat bottom, false bottom full of water
Wrong ignition timing	Timing too far advanced or retarded
Sticking distributor advance weights	
Spark plug wires crossed (wrong firing order)	
Lean fuel mixture	Refer to "Carburetor Malfunctions"
Wrong heat range spark plugs	
Exhaust restriction	
Valve timing off	Jumped timing chain, or improperly installed
Blown head gasket(s)	A blown head gasket(s) normally cannot be detected by a compression check. Normally the engine will run at normal temperature at low rpm, but will overheat at speeds above 3000 rpm. Engines that are seawater cooled: Using a clear plastic hose, look for air bubbles between seawater pump and engine. If there are no bubbles present, install clear plastic hose between thermostat housing and manifold(s). If air bubbles are present at a higher rpm, it is a good indication there is a blown head gasket.
Insufficient lubrication to moving parts of engine	Defective oil pump, plugged oil passage, low oil level

Engine Overheats (Cooling System)

Cause	Special Information
IMPORTANT: The first step is to verify if the engine is actually overheating or the temperature gauge or sender is faulty. IMPORTANT: Best way to test gauge or sender is to replace them.	
Loose or faulty drive belt	
Seawater shutoff valve partially or fully closed (if equipped)	
Clogged or improperly installed sea strainer	
Loose hose connections between seawater pickup and seawater pump inlet (models with belt driven seawater pump only)	Pump will suck air. Pump may fail to prime or will force air bubbles into cooling system.
Seawater inlet hose kinked or collapsed	
Seawater pickup clogged	
Obstruction on boat bottom causing water turbulence	Obstruction will be in front of seawater pickup, causing air bubbles to be forced into cooling system
Defective thermostat	
Exhaust elbow water outlet holes plugged	
Insufficient seawater pump operation	Worn pump impeller
Obstruction in cooling system such as casting flash, sand, rust, salt, etc.	Refer to water flow diagram for engine type being serviced
Engine circulating pump defective	
Also refer to "Engine Overheats (Mechanical)"	
IMPORTANT: In addition to previous checks, make the following checks if engine is equipped with closed cooling.	
Low coolant level	
Antifreeze not mixed properly	Antifreeze should be mixed 50/50 or maximum 60/40 (60% antifreeze, 40% water)
Heat exchanger cores plugged	
Water hoses reversed at the water distribution block	Refer to water flow diagram in SECTION 6

Insufficient Water Flow from Belt Driven Seawater Pickup Pump

Cause	Special Information
Drive belt	Loose, worn or broken
Seawater shutoff valve partially or fully closed	
Clogged or improperly installed sea strainer	
Loose hose connections between seawater pickup and seawater pump inlet	Pump will suck air, pump may fail to prime or will force air bubbles into cooling system
Seawater inlet hose kinked or plugged	
Seawater pickup plugged	
Obstruction on boat bottom causing water turbulence.	Obstruction will be in front of seawater pickup, causing air bubbles to be forced into cooling system
Faulty seawater pump	

Power Steering

Poor, Erratic, or No Assist

Cause	Special Information
Drive belt	Worn, broken or out of adjustment
Fluid level	Low
Air in system	Air leak in lines, pump, or air from installation. Refer to SECTION 9A for bleeding procedure.
Leaking hoses	Refer to SECTION 9A for bleeding procedure.
Steering cables and/or steering helm	Cable or helm partially frozen from rust or corrosion, cable over-lubricated, improper cable installation.
Binding in stern drive unit	Refer to appropriate Sterndrive Service Manual
Restriction in hydraulic hoses	Causes a loss of pressure
Control valve	Not positioned properly, not balanced properly, or the mounting nut is loose
Mounting bracket adjusting screw loose or mounting tube is loose	
Faulty pump	Flow control valve may be sticking
Worn piston ring or scored housing bore in cylinder.	Causes loss of pressure
Leaking valve body or loose fitting spool	

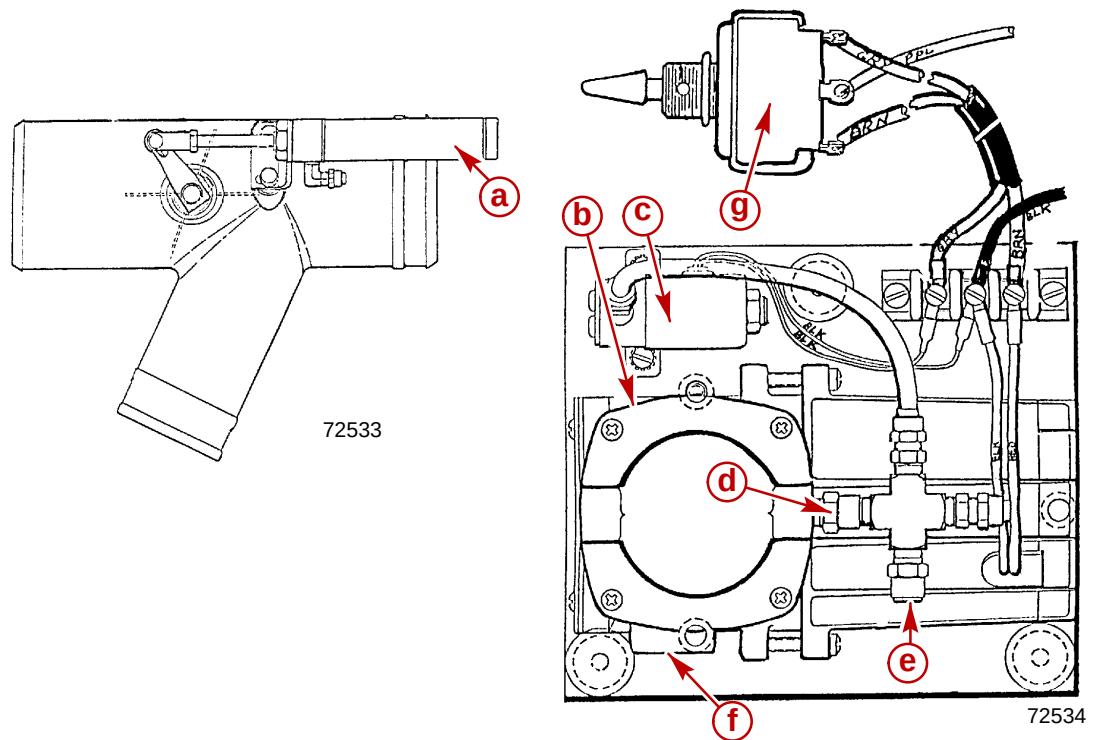
Noisy Pump

Cause	Special Information
Drive belt	Check belt tension
Low fluid level	
Air in fluid	Air leak in lines, pump, or air form installation
Faulty pump	Use stethoscope to listen for noise in pump
Restricted fluid passages	Kinks or debris in hoses or debris in passages
Stop nut adjusted improperly	Refer to appropriate Sterndrive Service Manual
Steering cables installed that do not meet BIA standards	Refer to appropriate Sterndrive Service Manual

Fluid Leaks

Cause	Special Information
Loose hose connections	Refer to SECTION 9A for bleeding instructions
Damaged hose	
Oil leaking from top of pump	System overfilled; fluid contains water; fluid contains air
Cylinder piston rod seal	
Faulty seals in valve	
Faulty seals in O-rings in pump	
Cracked or porous metal parts	

Troubleshooting Silent Choice Exhaust Silencer System



- a** - Air Cylinder Assembly
- b** - Air Pump
- c** - Solenoid
- d** - Check Valve
- e** - Relief Valve
- f** - Air Intake Valve
- g** - Mode Switch

NOTE: Perform the following tests with engine(s) not running.

Compressor Will Not Run - Testing Mode Switch

Cause	Special Information
PUR wire does not have battery voltage	Fuse is blown or wiring is faulty
BRN wire does not have battery voltage when mode switch is held in THRU-TRANSOM position	Switch is faulty
GRY wire does not have battery voltage when mode switch is held in THRU-PROP position.	Switch is faulty

Compressor Will Not Run - Testing Air Pump

Cause	Special Information
NOTE: Ensure that BLK wire, in terminal block, is grounded to engine.	
BRN wire, in terminal block, does not have battery voltage when mode switch is held in THRU-TRANSOM position.	Wiring is faulty. If voltage is present, air pump is faulty.

Air pump Runs - System Inoperative

With air pump running, check hoses, fittings, solenoid, and relief valve for air leakage. Replace parts as needed.

System operates but goes THRU-PROP after air pump stops running

1. Ensure that air pressure is not leaking past solenoid. If so, replace.
2. Ensure that air pressure is not leaking back through air pump. If so, replace check valve.
3. Ensure that air pressure is not leaking at air cylinder assemblies. If so, replace faulty ones.

System stays in THRU-TRANSOM mode, will not go back to THRU-PROP mode

GRY wire, in terminal block, must have battery voltage when mode switch is held in THRU-PROP position. If not, wiring is faulty. If voltage is present, solenoid is faulty.

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REMOVAL AND INSTALLATION

Section 2A - MCM Models

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**2
A**

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Not Disturbed During Service	2A-7		
Engine Mount Adjustment Was			
Disturbed During Service	2A-10		

Torque Specifications

Fastener Location		lb-in.	lb-ft	Nm
Drive Unit Shift Cable	Cable Barrel	Spread Cotter Key		
	Cable End Guide	See Note		
Hose Clamps		Securely		
Rear Engine Mounts			37	50
Power Steering Fluid Hose Fitting			23	31
Remote Control Shift Cables	Cable Barrel	Securely		
	Cable End Guide	See Note		
Remote Control Throttle Cable	Cable Barrel	Securely		
	Cable End Guide	See Note		
Drive Shaft			50	68
Extension Housing To Flywheel Housing			30	41
Flywheel Housing				
Front and Rear Engine Mounts		Securely		
Battery Cables				
Rear Engine Mount Bracket			50	68

NOTE: Tighten, then loosen 1/2 turn.

Tools

Description	Part Number
Engine Alignment Tool	91-805475A1
Universal Protractor	Obtain Locally

Lubricants / Sealants / Adhesives

Description	Part Number
Engine Coupler Spline Grease	91-816391A4
Quicksilver Liquid Neoprene	92-25711--3
Quicksilver 2-4-C Marine Lubricant With Teflon	92-825407A3
Loctite Pipe Sealant With Teflon	Obtain Locally
U-Joint and Gimbal Bearing Grease	92-828052A2
Loctite 27131	92-809820

Preparation

CAUTION

DO NOT use an alignment tool from another manufacturer. Alignment tools other than Quicksilver Alignment Tools (91-805475A1 or a properly modified 91-57797A3) may cause improper alignment and damage to gimbal bearing and/or engine coupler.

IMPORTANT: Sterndrive unit must be removed prior to engine removal. Refer to Sterndrive Service Manual.

Removal

1. Disconnect battery cables from battery.
2. Remove instrument harness connector plug from engine harness receptacle after loosening clamp.

WARNING

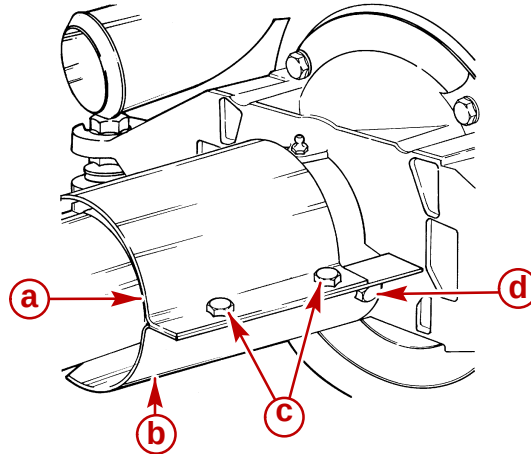
Be careful when working on fuel system. Gasoline is extremely flammable and highly explosive under certain conditions. Do not smoke or allow spark or open flame in area. Wipe up any spilled fuel immediately.

3. Using wrench to stabilize brass filter nut at fuel inlet, loosen fuel line fitting, disconnect and suitably plug fuel line to prevent fuel in tank from leaking into bilge.
4. Disconnect throttle cable from carburetor, or throttle body on fuel injection models, and retain locknuts and hardware.
5. Disconnect bullet connectors of trim sender wires (coming from transom assembly) from engine harness.

NOTE: After wires are disconnected be sure to loosen them from clamps or sta-straps retaining them to engine or hoses.

6. Disconnect MerCathode wires from MerCathode controller if mounted on engine (some models).
7. Disconnect seawater inlet hose from gimbal housing.
8. Disconnect exhaust elbow hoses (bellows).
9. Remove both shift cables from shift plate. Retain locknuts and hardware.
10. Disconnect any grounding wires and accessories that are connected to engine.
11. Disconnect (and suitably plug) fluid hoses from power steering control valve on transom.

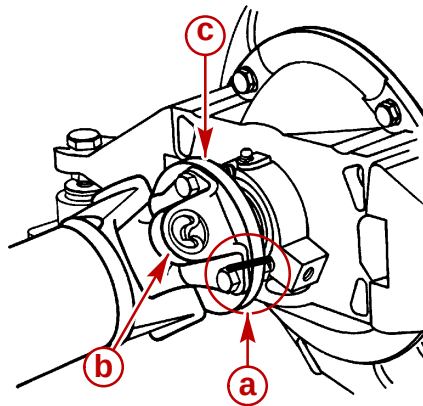
12. If equipped, remove top and then bottom drive shaft shields at engine end of extension drive shaft.



72033

- a**- Top Shield
- b**- Bottom Shield
- c**- 4 Bolts / Nuts (2 Hidden)
- d**- 3 Screws (Hidden)

13. Mark extension drive shaft U-joint yoke / output flange connections at engine end (to assist in exact same positioning during reassembly). Disconnect drive shaft from output flange.



70237

Engine End Shown

- a**- Matching Parts On Flange And Drive Shaft Connection
- b**- Extension Drive Shaft U-Joint Yoke
- c**- Output Flange

⚠ CAUTION

Center lifting eye (located on top of thermostat housing) is used for engine alignment only. DO NOT use to lift entire engine.

⚠ CAUTION

DO NOT allow lifting sling to hook or compress engine components or damage will occur.

⚠ CAUTION

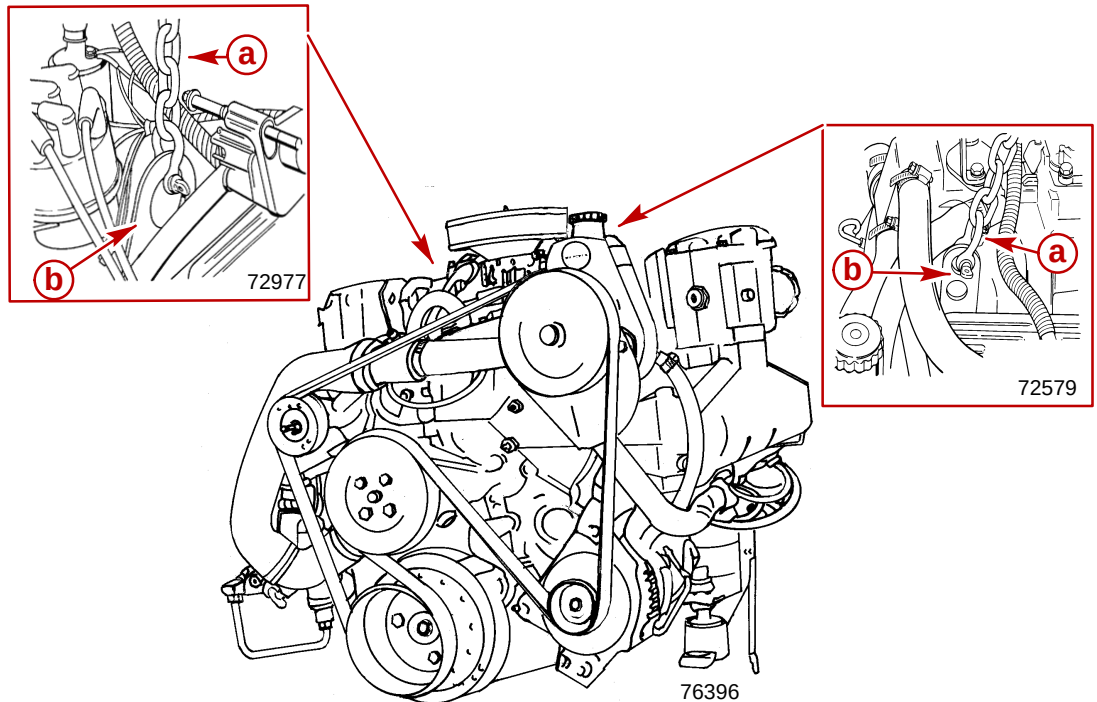
Multi-Port engines MUST be lifted with a lifting arm or damage to engine components will occur.

⚠ WARNING

Be careful when working on fuel system. Gasoline is extremely flammable and highly explosive under certain conditions. Do not smoke or allow spark or open flame in area. Wipe up any spilled fuel immediately.

IMPORTANT: To avoid the need for a complete realignment (after engine repair), **DO NOT CHANGE FRONT AND REAR MOUNT ADJUSTMENT.** Remove mounting bolts from boat stringers.

14. Support engine with suitable sling through lifting eyes on engine and remove front and rear engine mounting bolts. Retain hardware.



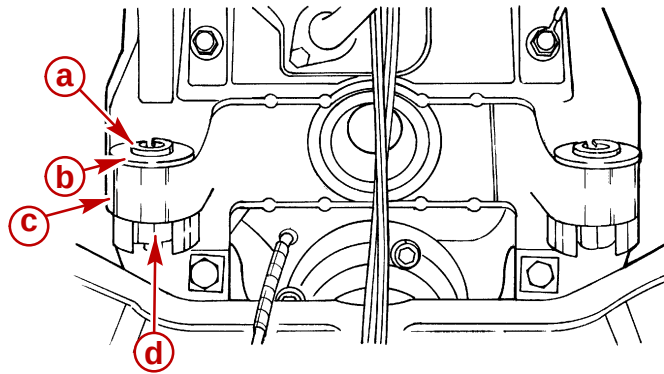
- a-** Suitable Sling
b- Engine Lifting Eyes

15. Carefully remove engine. **DO NOT** hit power steering control valve.

Installation

1. Be certain fiber washers (cemented in place) on inner transom plate are present. Inspect fiber washers. Replace if worn or damaged.
2. Install double wound lockwashers onto inner transom plate inside fiber washer.
3. Be certain rear engine mount locknuts are in position as shown.
4. Lubricate exhaust bellows with soap and water to ease installation.

5. Lubricate engine coupler splines with Quicksilver Engine Coupler Spline Grease.



72023

- a** - Double Wound Lockwasher
- b** - Fiber Wound Lockwasher (Cemented In Place)
- c** - Inner Transom Plate Mount (Engine Support)
- d** - Locknuts (Engine Mounting Bolts)

⚠ CAUTION

Center lifting eye (located on top of thermostat housing) is used for engine alignment only. **DO NOT** use to lift entire engine.

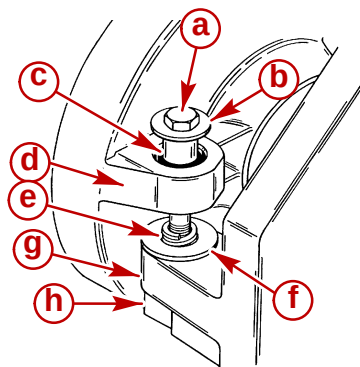
⚠ CAUTION

DO NOT allow lifting sling to hook or compress engine components or damage will occur.

6. Attach a suitable sling to lifting eyes on engine and adjust so that engine is level when suspended. **(Refer to "Removal" section for location of lifting eyes.)**
7. Lift engine into position (in boat) using an overhead hoist.
8. Align rear engine mounts with inner transom plate mounts while simultaneously aligning exhaust tubes with exhaust pipe hoses (bellows).

IMPORTANT: Engine attaching hardware must be installed in sequence shown.

9. Install both rear engine mounting bolts and hardware as shown. Torque to 37 lb-ft (50 Nm).



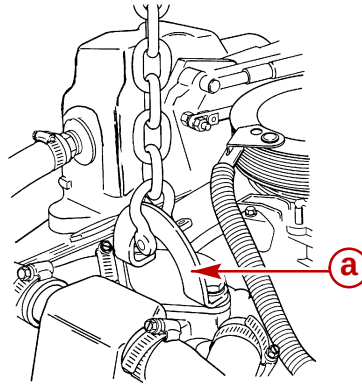
72535

- a** - Bolt, Rear Engine Mounting
- b** - Washer, Large Steel
- c** - Metal Spacer
- d** - Rear Engine Mount
- e** - Double Wound Lockwasher
- f** - Fiber Washer
- g** - Inner Transom Plate Mounts
- h** - Locknut (Hidden In This View)

⚠ CAUTION

When lowering engine into position **DO NOT** set engine on shift cable. Shift cable outer casing can be crushed causing difficult or improper shifting.

10. Set engine down on stringers and relieve hoist tension. Disconnect sling from engine lifting eyes and switch sling to center lifting eye.



72024

a - Center Lifting Eye

Drive Shaft Extension Models

ENGINE MOUNT ADJUSTMENT WAS NOT DISTURBED DURING SERVICE

⚠ CAUTION

Center lifting eye (located on top of thermostat housing) is used for engine alignment only. **DO NOT** use to lift entire engine.

⚠ CAUTION

Engine **MUST** be lifted with a lifting arm or damage to engine components will occur. **DO NOT** allow lifting sling to hook or compress engine components or damage will occur.

1. Attach a suitable sling to lifting eyes on engine and adjust so that engine is level when suspended. (**Refer to "Removal" section for location of lifting eyes.**)
2. Lift engine into approximate position in boat using an overhead hoist.
3. Set engine on stringers.
4. Grease drive shaft universal joints with Quicksilver U-Joint and Gimbal Bearing Grease.

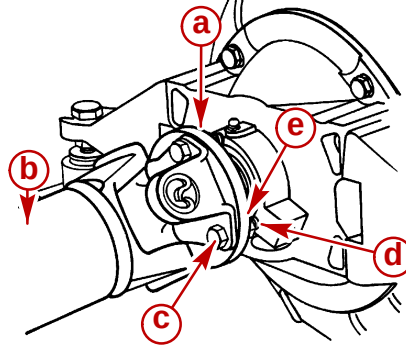
⚠ CAUTION

When attaching shaft in next step, **BE SURE** that the pilot on drive shaft flanges are engaged in input shaft and output shaft flanges. Flanges **MUST BE** flush to each other prior to tightening screws or screws may come loose during operation.

⚠ CAUTION

Failure to align shaft flanges with matching marks made on disassembly may cause improperly aligned drive unit and extension drive shaft U-joint centerlines resulting in a severe vibration problem.

5. As shown, align engine output flange to driveshaft flange exactly as marked during disassembly. Torque fasteners to 50 lb-ft (68 Nm).



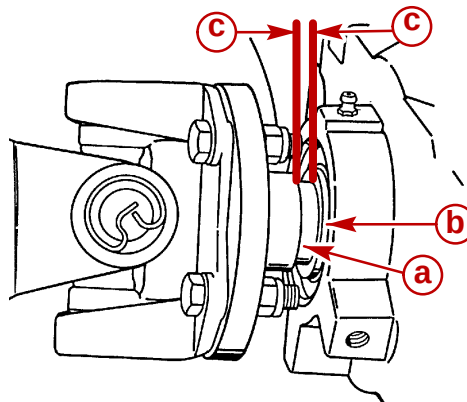
70237

Engine End Shown

- a** - Output Shaft Flange
- b** - Drive Shaft
- c** - 4 Bolt 7/16-20 x 1-1/2 In. (38 mm) Long
- d** - 4 Nut 7/16 In.-20
- e** - Matching Marks Made Upon Disassembly

IMPORTANT: Failure to properly position output shaft flange may result in bearing damage.

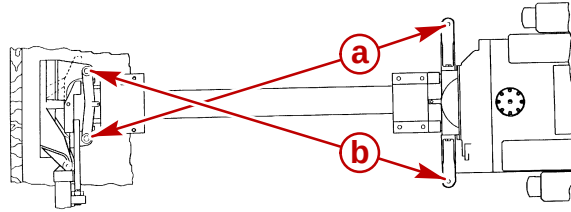
6. Relieve hoist tension from engine, then slide engine fore or aft as needed to obtain 1/4 in. (6 mm) clearance between flange shoulder and extension shaft housing bearing.



72591

- a** - Flange Shoulder
- b** - Bearing
- c** - 1/4 In. (6 mm)

7. Position engine for correct engine and drive shaft lateral alignment as follows:
 - a. Measure the length of "a" and "b" to the centers of bolt holes. They **MUST BE EQUAL**. If they are not equal, slide the aft and forward ends of the engine equal amounts in opposite directions to obtain equal lengths for "a" and "b."
 - b. Recheck Step 6. If Step 6. is not as specified, adjust and recheck Step 7. a. Continue this process until both Steps 6. and 7. a. are as specified.

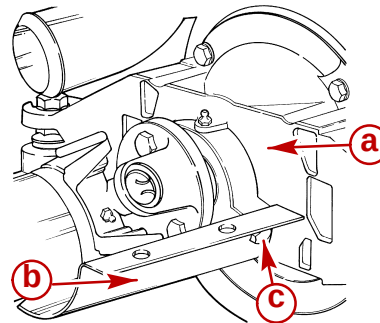


70246

Top View Shown
These Dimensions Must Be Equal

- a**- Must equal "b"
- b**- Must equal "a"

8. After engine has been aligned correctly, fasten front and rear engine mounts to stringers. Tighten mounting bolts securely.
9. Apply Loctite 27131 to threads of bottom drive shaft shield retaining screws and install bottom shield on engine end as shown. Torque screws to 30 lb-ft (41 Nm).

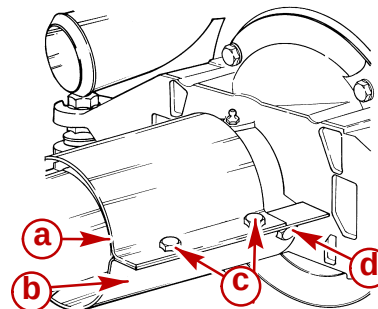


72028

Engine End Shown

- a**- Shaft Housing
- b**- Bottom Shield
- c**- 3 Screws (2 Hidden)

10. Then install top shield as shown. Torque bolts and nuts to 30 lb-ft (41 Nm).



72033

Engine End Shown

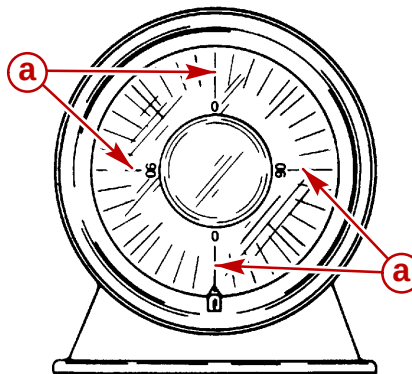
- a**- Top Shield
- b**- Bottom Shield
- c**- 4 Bolts/Nuts (2 Hidden)
- d**- 3 Screws (2 Hidden)

11. Proceed to "Engine Connections" section instructions following.

ENGINE MOUNT ADJUSTMENT WAS DISTURBED DURING SERVICE

NOTE: A Universal Protractor is recommended for measuring the angles in the following steps.

IMPORTANT: In the following steps, the protractor readings will be taken off of vertical and horizontal surfaces; therefore, both the 0 degree and the 90 degree marks will be used. It should be kept in mind that these are reference marks only and the assigned numbers should be ignored. It is only necessary to determine the number of degrees and to which side (left or right) of the reference marks the indicator needle rests. **PROTRACTOR MUST BE VIEWED FROM THE SAME SIDE OF POWER PACKAGE THROUGHOUT INSTALLATION.**



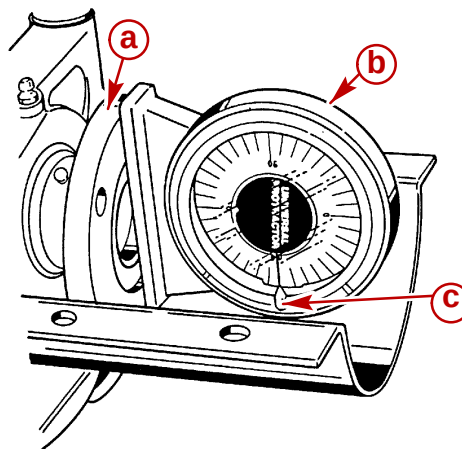
72429

a - Reference Marks

1. Refer to SECTION 8D - "Drive Shaft Models / Propeller Shaft," and remove drive shaft.
2. Position base of protractor against input shaft flange, as shown. NOTE and RECORD the number of degrees and to which side of the reference mark the indicator needle has moved in the following chart.

Reading from Step 1. _____ degrees to the _____ side of reference mark.

IMPORTANT: Be sure that boat does not move once reading has been taken from input shaft flange, as this reading establishes a reference point for aligning drive shaft and engine following. If boat is moved, reference point may be altered and subsequently, improper drive shaft and engine alignment may occur. Alignment tool **MUST BE** in place during entire alignment procedure if drive unit is not installed.



72592

- a -** Indicator Shaft Flange
- b -** Protractor
- c -** Indicator Needle

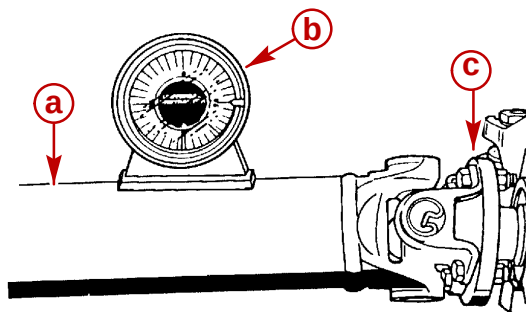
NOTE: For ease of installation we recommend the use of a chain leveler in the following steps.

3. Adjust engine mounts so that an equal amount of up and down adjustment exists.
4. Attach a suitable lifting chain to lifting eyes on engine and adjust so that engine will be level when suspended, then place engine into its approximate position (in boat) using an overhead hoist.
5. Refer to SECTION 8D - "Drive Shaft Models / Propeller Shaft," and install drive shaft while observing precautions in SECTION 8D, especially about aligning gimbal bearing U-joint centerlines with extension drive shaft U-joint centerlines at bearing support input shaft. DO NOT install shields at this time.

⚠ CAUTION

Engine MUST BE aligned correctly to achieve proper engine operation and to prevent damage to drive shaft. If drive shaft is run at an incorrect angle, damage to universal joint bearings may result.

6. Position base of protractor on drive shaft, then raise or lower engine (as boat construction permits) until indicator needle is 1° degree to 3° on either side of reading taken in Step 1. Record this reading in the following chart for later use.



70238

- a** - Drive Shaft
b - Protractor
c - Output Shaft Flange

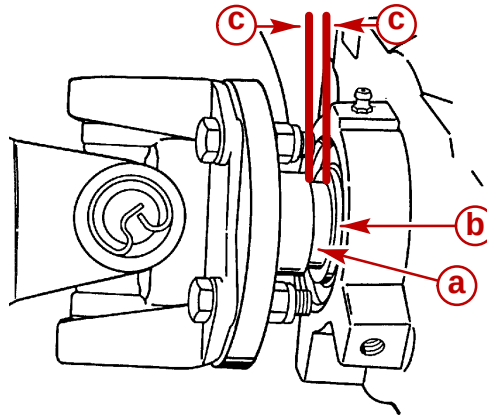
Reading from Step 6. _____ degrees to the _____ side of reference mark.

7. Adjust stringer height so that the stringers just contact the engine mount bases.

⚠ CAUTION

Failure to properly position output shaft flange (as described following) may result in bearing damage.

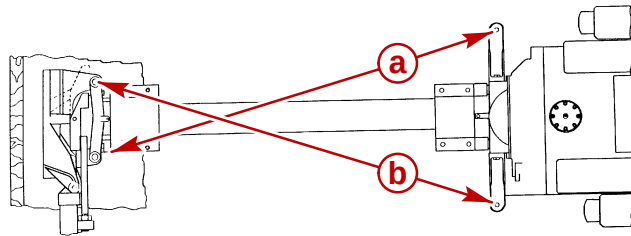
8. Relieve hoist tension from engine, then slide engine fore or aft as needed to obtain 1/4 in. (6 mm) between flange shoulder and extension shaft housing bearing, as shown.



72591

- a-** Flange Shoulder
b- Bearing
c- 1/4 in. (6 mm)

9. Position engine for correct engine and drive shaft lateral alignment as follows:
- Measure the length of "a" and "b" to the centers of bolt holes. They **MUST BE EQUAL**. If they are not equal, slide the aft and forward ends of the engine equal amounts in opposite directions to obtain equal lengths for "a" and "b."

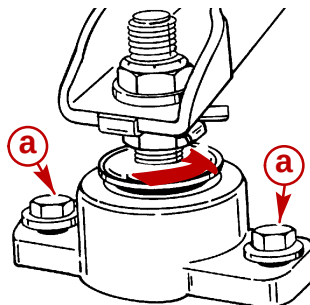


70246

Top View Shown

These Dimensions Must Be Equal

- a-** Must equal (b)
b- Must equal (a)
- Recheck Step 8. If Step 8 is not as specified, adjust and recheck Step 9a. Continue this process until both Steps 8 and 9a are as specified.
10. After engine has been aligned correctly, fasten front and rear engine mounts to stringers. Tighten securely.

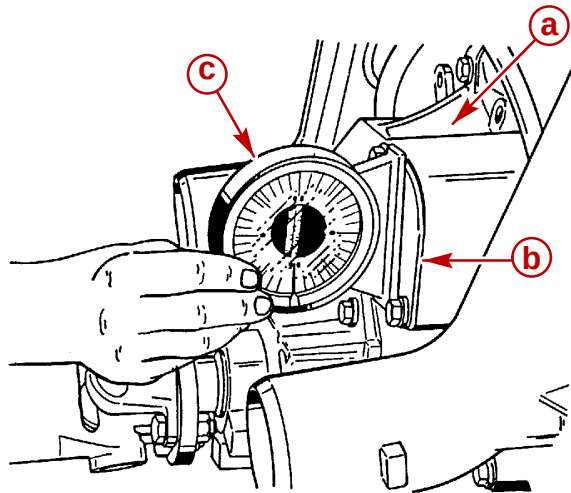


72536

Typical Mounting Shown

- a-** Mounting Bolts

11. Position protractor on starter housing cover plate, as shown. Now, raise or lower front engine mount adjusting nuts as required so that protractor needle reads exactly the same number of degrees as that recorded in Step 1.

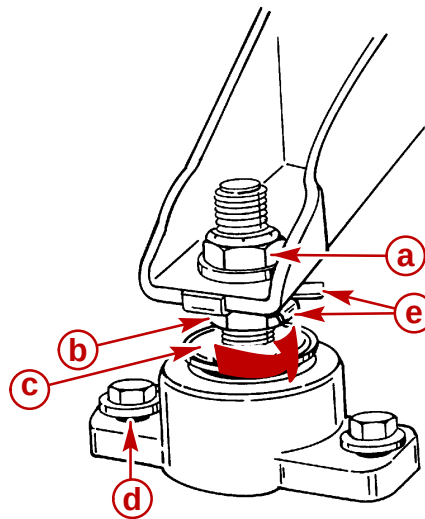


72593

Thru-Prop Exhaust Shown

- a-** Flywheel Housing
- b-** Starter Housing Cover Plate
- c-** Protractor

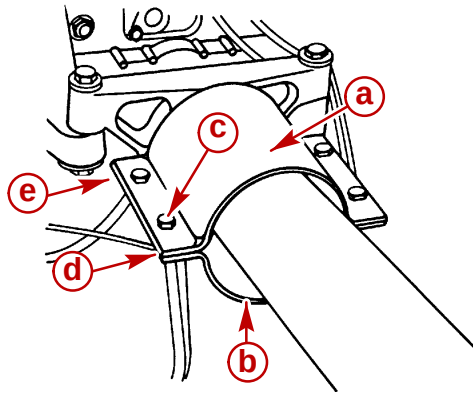
12. Position protractor on drive shaft and recheck angle. Angle should be the same as that recorded in Step 6. If not, raise or lower all four engine mount adjustment nuts an equal amount until correct angle is reached.
13. Tighten ALL engine mount nuts securely. Bend washer tab down on each adjustment nut.



72536

- a-** Nut and Lockwasher
- b-** Adjustment Nut
- c-** Turn Adjustment Nut In This Direction (Counterclockwise) To Raise Front Of Engine.
- d-** Slotted Hole Toward Front Of Engine
- e-** Tab Washer

14. Apply Loctite 27131 to threads of bottom drive shaft shield retaining screws and install bottom shields on engine and transom end as shown. Torque screws to 30 lb-ft (41 Nm). Then install both top shields as shown. Torque bolts and nuts to 30 lb-ft (41 Nm).



70245

Top Shield and Bottom Shield at Transom End (Engine End Similar)

- a-** Top Shield
- b-** Bottom Shield
- c-** 4 Bolt 3/8 x 16 x 7/8 In (22 mm Long)
- d-** 4 Nut 3/8-16
- e-** 3 Screws (Hidden)

Alignment

⚠ CAUTION

DO NOT use an alignment tool from another manufacturer. Alignment tools other than Quicksilver Alignment Tool 91-805475A1, may cause improper alignment and damage to gimbal bearing and/or engine coupler.

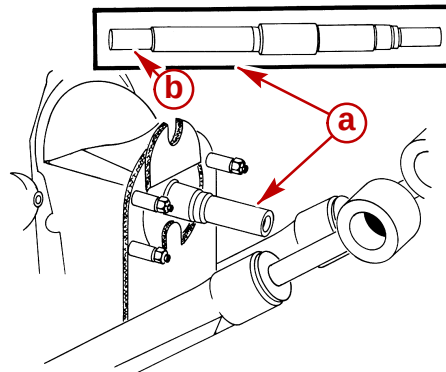
⚠ CAUTION

To avoid damage to gimbal bearing, engine coupler, or alignment tool:

- DO NOT attempt to force alignment tool!
- DO NOT raise or lower engine with alignment tool inserted (or partially inserted) in gimbal bearing or engine coupler.

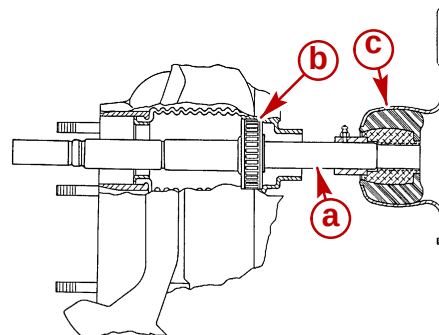
1. Align engine as follows:

- Attempt to insert solid end of Quicksilver Alignment Tool through gimbal bearing and into engine coupler splines. If it will not insert easily proceed to following.
- If the tool does not fit, remove it and carefully raise or lower the from end of the engine, as necessary, and attempt to insert the alignment tool.
- Repeat step "b" until the alignment tool installs easily (**SLIDES FREELY**) all the way into and out of engine coupler splines.



70013

- a-** Alignment Tool (Use Only Quicksilver Alignment Tool (91-805475A1))
b- Insert This End of Alignment Tool through Gimbal Housing Assembly

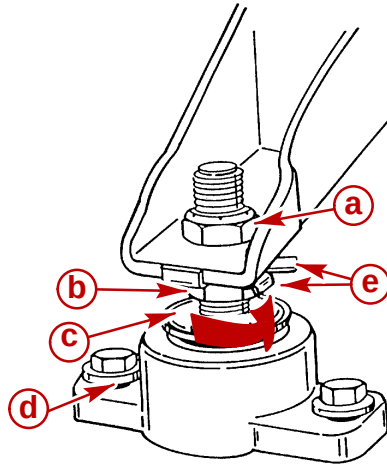


72585

- a-** Alignment Tool
b- Gimbal Bearing
c- Engine Coupler

IMPORTANT: Turn both front engine mount adjustment nuts an equal amount in direction required to align engine.

- d. Adjust front engine mounts until they rest on boat stringers.
- e. Relieve hoist tension entirely and fasten both front mounts to boat stringer using appropriate hardware (lag bolts or through-bolts, etc.).
- f. Recheck alignment with alignment tool. Tool must enter coupler splines freely. If not, readjust front mounts.
- g. When alignment is correct, tighten locknut or nut with lockwasher on each mount securely.
- h. Bend tab washer down against flat on adjusting nut.



72922

a - Locknut

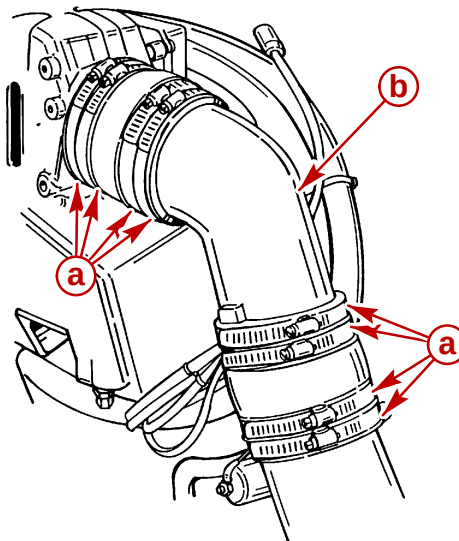
b - Adjustment Nut

c - Turn Adjustment Nut In This Direction (Counterclockwise) To Raise Front Of Engine

d - Slotted Hole To Front Of Engine

e - Tab Washer

- i. Remove alignment tool if not already removed.
2. Tighten all exhaust system hose clamps securely as follows (use two hose clamps on each connection):
 - a. **On Engines with Thru-Prop Exhaust:**



72537

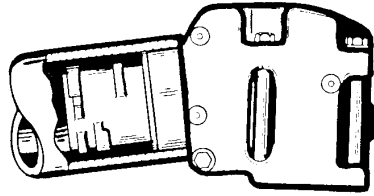
a - Hose Clamps

b - Exhaust Tube - Long Tube, Port Side - Short Tube, Starboard Side

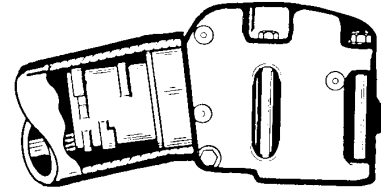
b. On Engines with Thru-Transom Exhaust:

NOTICE (THRU-TRANSOM EXHAUST)

Exhaust hoses must be connected to exhaust elbows so that they do not restrict the flow of discharge water from exhaust elbow. If hoses are connected incorrectly, discharge water from exhaust elbow will not flow around entire inside diameter of hose. This will cause a hot spot in the hose which may eventually burn through.



Correct



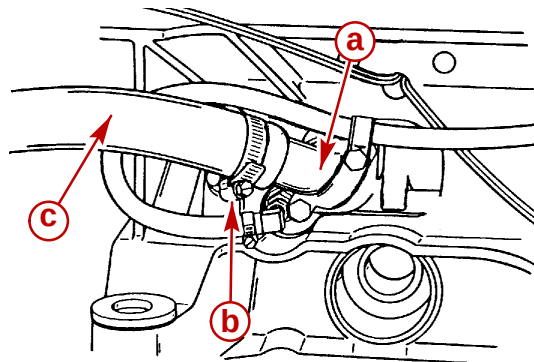
Incorrect

72538

WATER HOSE CONNECTIONS

IMPORTANT: When routing all wire harnesses and hoses, be sure they are routed and secured to avoid coming in contact with hot spots on engine and avoid contact with moving parts.

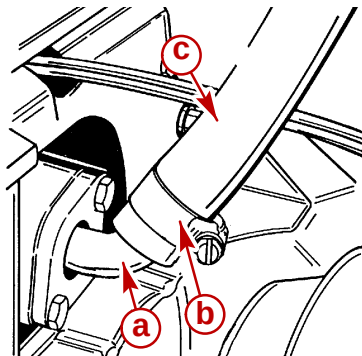
1. Connect seawater hose to water tube at gimbal housing with hose clamp. Tighten clamp securely.



72590

Alpha Drives

- a-** Water Inlet Tube
- b-** Hose Clamp (Tighten Securely)
- c-** Seawater Inlet



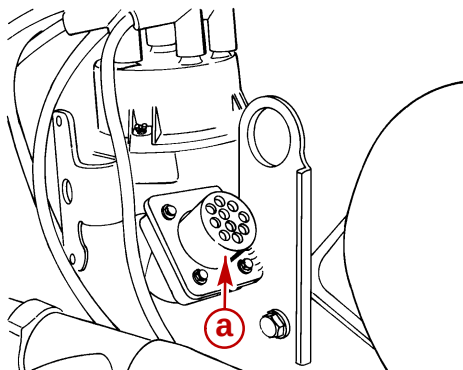
72614

Bravo Drives

- a-** Water Inlet Tube
- b-** Hose Clamp
- c-** Seawater Inlet

ELECTRICAL CONNECTIONS

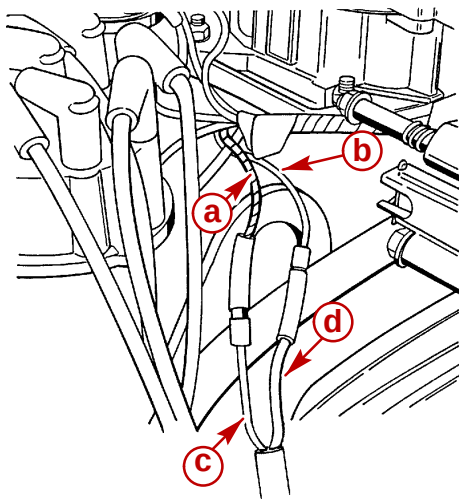
1. Connect instrument harness to engine harness with hose clamp. Tighten clamp securely.



74754

a - Engine Wiring Harness Receptacle Bracket

2. Connect trim position sender leads from gimbal housing to leads from engine harness.



72582

a - BROWN/WHITE (From Engine Harness)

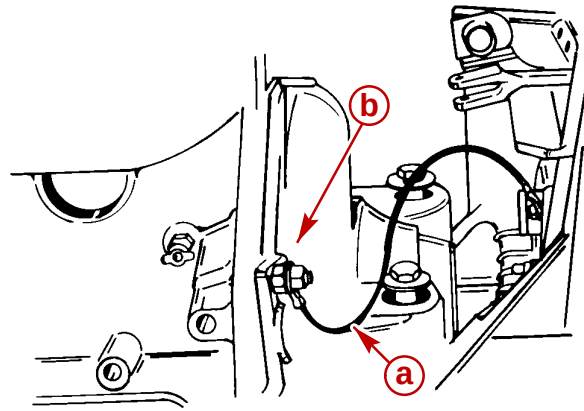
b - BLACK (From Engine Harness)

c - BLACK (From Transom)

d - BLACK (From Transom Assembly)

IMPORTANT: Do not attach any accessory ground (–) wires to transom plate ground point. Accessory ground wires should only be attached to ground stud on engine.

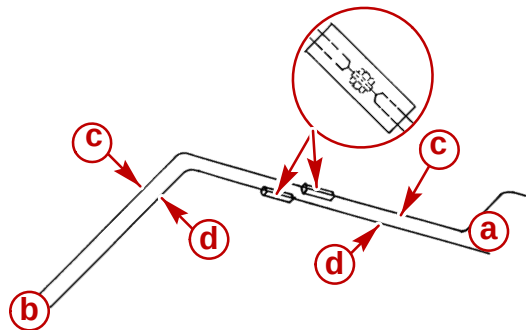
3. Connect continuity wire between transom plate and engine ground (-) stud.



71651

- a**- Continuity Wire
b- Engine Ground (-) Stud

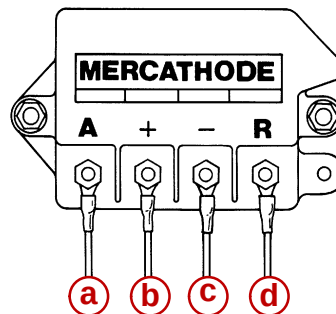
4. Reconnect shift cut-out switch harness to engine harness.



72034

- a**- Engine Harness
b- Switch Harness
c- BLACK
d- WHITE/GREEN (or GRAY)

5. Connect any grounding wires or accessories that may have been disconnected.
6. Connect wires to MerCathode controller assembly as shown. Apply a thin coat of Quick-silver Liquid Neoprene to all connections.



22232

- a**- ORANGE Wire - From Electrode On Transom Assembly
b- RED/PURPLE Wire - Connect (Other End) To Positive (+) Battery Terminal
c- BLACK Wire - From Engine Harness
d- BROWN Wire - From Electrode on Transom Assembly

7. Connect battery cables to battery by FIRST connecting positive (+) battery cable (usually RED) to positive (+) battery terminal. Tighten clamp securely. Then, connect negative (–) battery cable (usually BLACK) to negative (–) battery terminal. Tighten clamp securely.

NOTE: Spray terminals with a battery connection sealant to help retard corrosion.

FUEL SUPPLY CONNECTIONS

⚠ WARNING

Be careful when working on fuel system. Gasoline is extremely flammable and highly explosive under certain conditions. Do not smoke or allow spark or open flame in area. Wipe up any spilled fuel immediately.

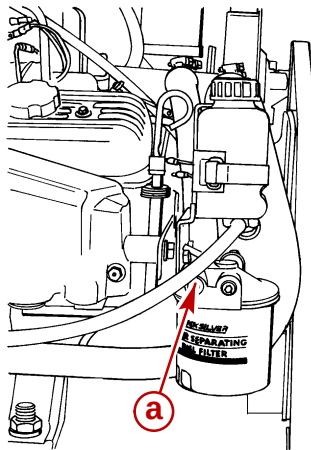
⚠ WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak.

1. Connect fuel line to appropriate location as shown. Refer to the following caution for proper tightening.

⚠ CAUTION

Remove plastic plug from fuel inlet hole. Apply #592 Loctite Pipe Sealant with Teflon to threads of fuel inlet line connector. DO NOT USE TEFLON TAPE. To prevent cracking the casting and/or fuel leaks, turn inlet connector in by hand until finger tight, then tighten connector to 1-3/4 to 2-1/4 turns with wrench. DO NOT OVERTIGHTEN. Inspect for fuel leaks when first starting engine.

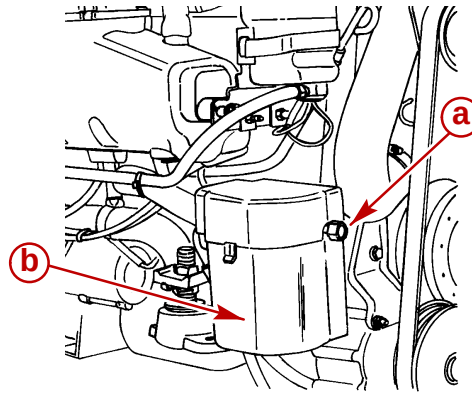


75429

Carbureted Models

a - Fuel Inlet Hose Connects Here

2. **On EFI Models**, connect the fuel line to fuel filter adapter as shown.



75036

EFI Models

a- Fuel Inlet Hose Connects Here

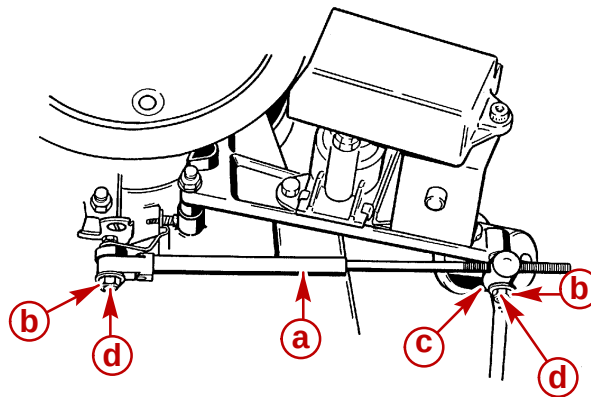
b- Fuel Filter Cover

THROTTLE CABLE INSTALLATION AND ADJUSTMENT

1. Connect throttle cable using hardware retained and adjust as follows:
 - a. Place remote control handle(s) in neutral, idle position.

IMPORTANT: Be sure that cable is routed in such a way as to avoid sharp bends and/or contact with moving parts. **DO NOT** fasten any items to throttle cable. Outer cable must be free to move when cable is actuated.

- b. Install cable end guide on throttle lever, then push cable barrel lightly toward throttle lever end. (This will place a slight preload on cable to avoid slack in cable when moving remote control lever.) Adjust barrel on throttle cable to align with anchor stud.
- c. Secure throttle cable with hardware (retained) as shown. Tighten cable end guide locknut until it contacts and then loosen one half turn. Tighten cable barrel securely. **DO NOT OVERTIGHTEN.** Cable must pivot freely.



72013

2 Barrel Carburetor Models

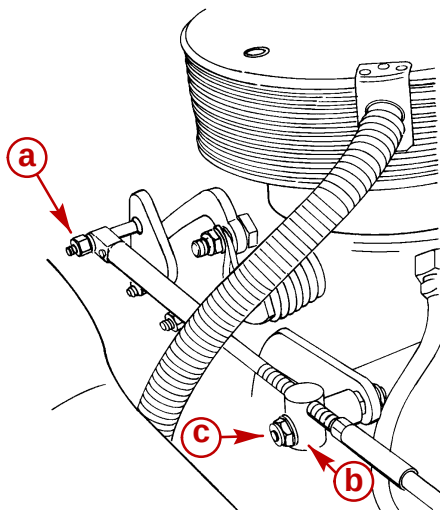
a- Cable End Guide

b- Attaching Hardware

c- Cable Barrel

d- Anchor Studs

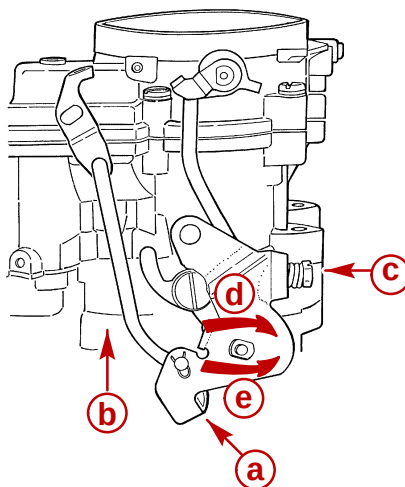
- d. Place remote control throttle lever in the WOT position. Ensure that throttle shutters (valves) are completely open and throttle shaft lever contacts carburetor body casting.



71711

Fuel Injection Models

- a-** Flat Washer and Locknut
 - b-** Cable Barrel
 - c-** Flat Washer And Locknut
- e. Return remote control throttle lever to idle position. Ensure that throttle lever contacts idle speed adjustment screw.



72283

2 Barrel Carburetor Models

- a-** Throttle Lever Tang
- b-** Carburetor Body
- c-** Idle rpm Adjustment Screw
- d-** Wide Open Throttle
- e-** Idle

POWER STEERING CONNECTIONS

IMPORTANT: After fluid hose installation in the following, bleed power steering system as outlined in SECTION 1B - "Maintenance" of this manual, or refer to the appropriate Sterndrive Service Manual.

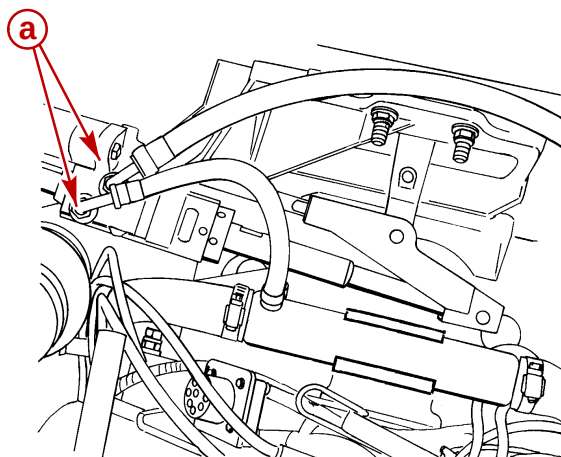
⚠ CAUTION

Route hoses exactly as shown below. This will help avoid stress on the hose fittings and will help avoid kinks in the hose.

IMPORTANT: Make hydraulic connections as quickly as possible to prevent fluid leakage.

IMPORTANT: Be careful not to cross-thread or overtighten fittings.

1. Connect front hose from the cooler. and rear hose from pump. Route hoses as shown.
2. Torque fittings to 23 lb-ft (31 Nm).



75720

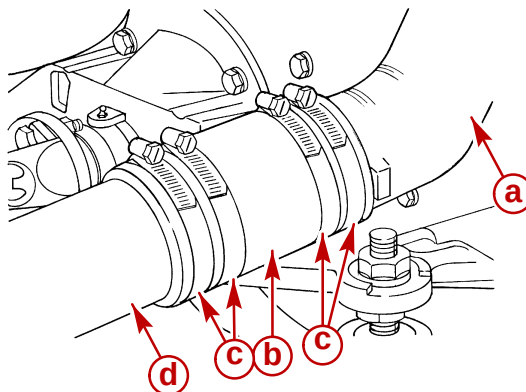
All Models

a - Hose Fittings

EXHAUST HOSE CONNECTIONS

1. Using double hose clamps on all connections, install exhaust hoses and exhaust tubes as shown in "a" or "b" following. Tighten all hose clamps securely.

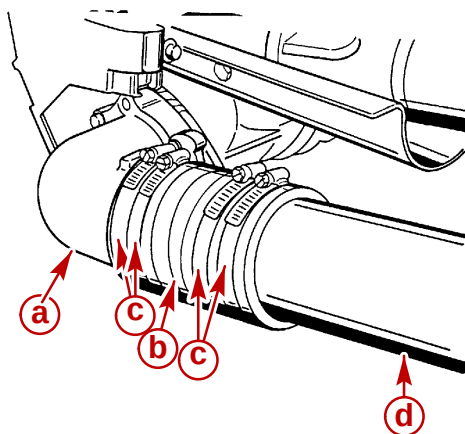
- a. **On Engines with Thru-Prop Exhaust:**



72027

Starboard Side Engine End Shown (Port Similar)

- a** - Exhaust Pipe
- b** - Exhaust Hose
- c** - Hose Clamps
- d** - Exhaust Tube



72584

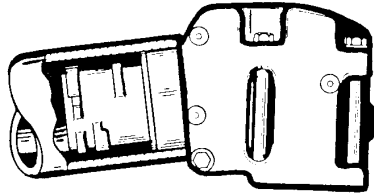
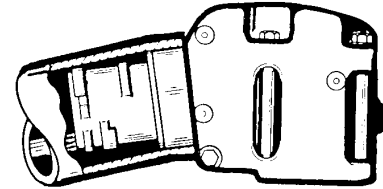
Starboard Side Transom End Shown (Port Similar)

- a** - Exhaust Separator Assembly
- b** - Exhaust Hose
- c** - Hose Clamps
- d** - Exhaust Tube

b. On Engines with Thru-Transom Exhaust:

NOTICE (Thru-TRANSOM EXHAUST)

Exhaust hoses must be connected to exhaust elbows so that they do not restrict the flow of discharge water from exhaust elbow. If hoses are connected incorrectly, discharge water from exhaust elbow will not flow around entire inside diameter of hose. This will cause a hot spot in the hose which may eventually burn through.

**Correct****Incorrect**

72538

2. Connect battery cables to battery by FIRST connecting positive (+) battery cable (usually red) to positive (+) battery terminal. Tighten clamp securely. Then, connect negative (–) battery cable (usually black) to negative (–) battery terminal. Tighten clamp securely.

NOTE: Spray terminals with a battery connection sealant to help retard corrosion.

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REMOVAL AND INSTALLATION

SECTION 2B - MIE Models

Table of Contents

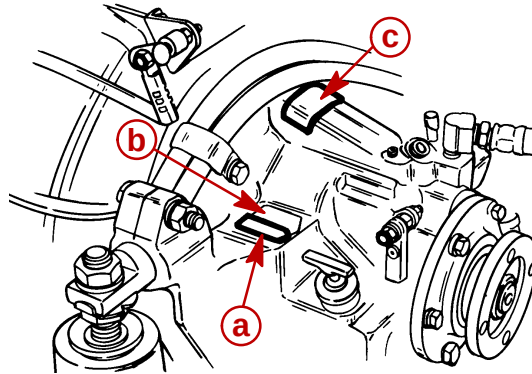


Identification	2B-2	Preparation	2B-4
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Torque Specifications	2B-3	Attachment Morse Shift Cables	2B-22
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Identification

Velvet Drive In-Line and V-Drive Transmissions

On Velvet Drive In-Line and V-Drive Transmissions (71C, 72C, 72C V-Drive, with or without Walter transmissions) the gear ratio (in forward gear) is marked on transmission identification plate. Transmission output shaft rotation and propeller rotation required (in forward gear) is indicated on a decal on transmission case. Transmission rotation is described when viewed from the rear of transmission.



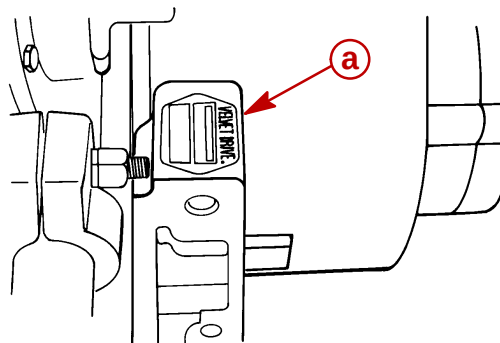
22556

In-Line Transmission Shown (Others Similarly Located)

- a** - Transmission Identification Plate
- b** - Gear Ratio (In Forward Gear)
- c** - Output Flange Rotation Decal (In Forward Gear)

Velvet Drive Down-Angle Transmission

On the Velvet Drive 5000A and 5000V Transmissions the transmission identification plate indicates gear ratio, serial number and model.



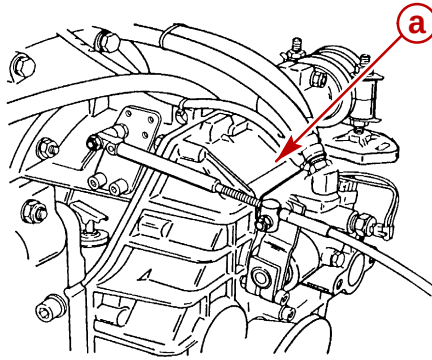
71778

Velvet Drive 5000A - 8° Down-Angle Transmission Shown (5000V - V-Drive Similar)

- a** - Transmission Identification Plate

Hurth Transmissions

On the Hurth 8° Down-Angle and V-Drive Transmissions the transmission identification plate indicates gear ratio, serial number and model.



73587

Typical Hurth Down-Angle Transmission Shown (V-Drive Identification Plate Similarly Located)

a - Transmission Identification Plate

On Velvet Drive In-Line and V-Drive Transmissions the gear ratio (in forward gear) is marked on transmission identification plate. Transmission output shaft rotation and propeller rotation required (in forward gear) is indicated on a decal on transmission case. Transmission rotation is described when viewed from the rear of transmission.

Torque Specifications

Fastener Location		lb-in.	lb-ft	Nm
Battery Cables			Securely	
Engine Mount Pads				
Hose Clamps				
Mount Locking Nut			Securely NOTE 2	
Propeller Shaft Coupler To Transmission Output Flange			50	68
Trunnion Clamping Screw / Nut				
Remote Control Shift Cable	Cable Barrel		Securely	
	Cable End Guide		NOTE 1	
Remote Control Throttle Cable	Cable Barrel		Securely	
	Cable End Guide		NOTE 1	

NOTE: ¹ Tighten, then loosen nut 1/2 turn.

NOTE: ² Bend tab against adjusting nut.

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver 2-4-C Marine Lubricant With Teflon	92-825407A3
Quicksilver Liquid Neoprene	92-25711--3

Preparation

1. Disconnect battery cables from battery.
2. Remove instrument panel harness connector plug from engine harness receptacle after loosening clamp.

WARNING

Be careful when working on fuel system. Gasoline is extremely flammable and highly explosive under certain conditions. Do not smoke or allow spark or open flame in area. Wipe up any spilled fuel immediately.

3. Using wrench to stabilize brass coupling at fuel inlet, loosen fuel line fitting, disconnect and suitably plug fuel line to prevent fuel in tank from leaking into bilge.
4. Disconnect throttle cable. Retain locknuts and hardware.
5. Disconnect shift cable from transmission.
6. Disconnect seawater inlet hose from engine.
7. Disconnect exhaust system hoses.
8. Disconnect any grounding wires and accessories that are connected to engine.
9. Disconnect propeller shaft coupler from transmission output flange.

Removal

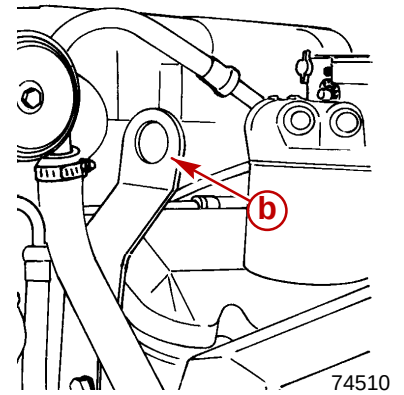
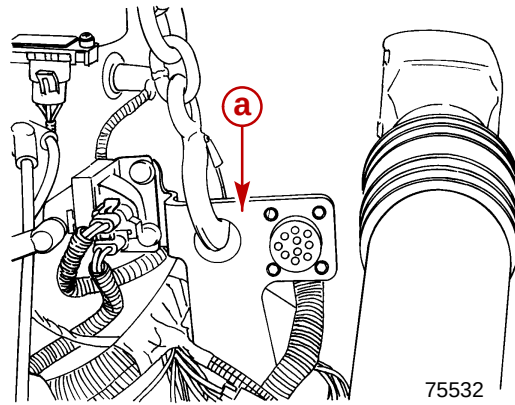
CAUTION

Center lifting eye (located on top of thermostat housing) is used for engine alignment only. DO NOT use to lift entire engine.

CAUTION

DO NOT allow lifting sling to hook or compress engine components or damage to them will occur.

1. Support engine with suitable sling through lifting eyes on engine.

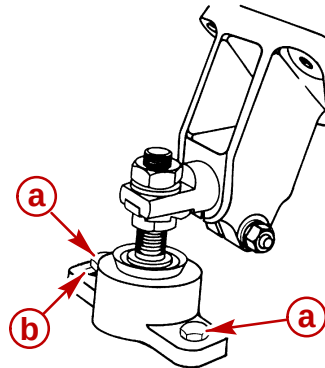


Typical

a- Rear Lifting Eye

b- Front Lifting Eye

2. Remove front and rear engine mounting bolts. Retain hardware.



Typical Mount

a- Bolts or Lag Screws (with Washers)

b- Slot Forward (If So Designed)

3. Carefully remove engine.

Installation and Alignment

1. Follow instructions "a" or "b":

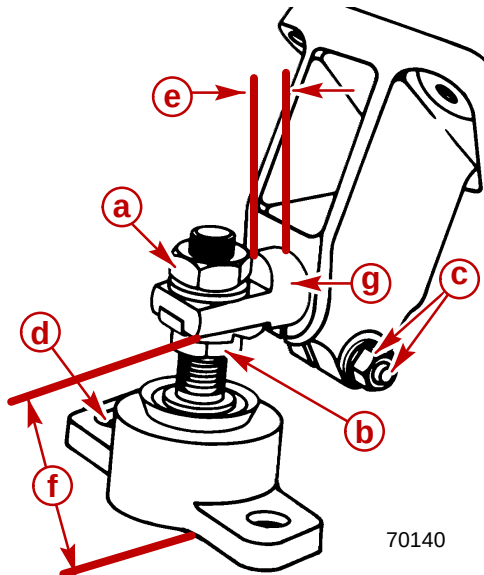
a. **Engine mount(s) or adjustment WAS NOT DISTURBED during engine service:**
Proceed to following Step 2.

b. **Engine mount(s) or adjustment WAS DISTURBED during engine service:**

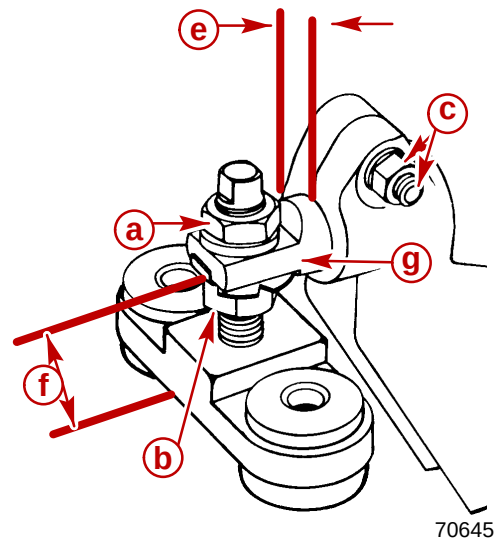
IMPORTANT: Engine mounts must be adjusted, as explained in the following, to center mount adjustment and establish a uniform height on all mounts.

Ensure that all mounts are:

- (1.) In the center of their up-and-down adjustment.
- (2.) Mounting hole, which is a slot, is forward (if so designed; 350 Magnum Tournament Ski rear mount does not have a slotted hole).
- (3.) Large diameter of mount trunnion extended as shown.
- (4.) Each mount base is downward. Tighten clamping screws and nuts slightly to prevent moving in or out. Mounts must be free to pivot when installing engine.



Front Mount



Rear Mount

- a-** Locking Nut
- b-** Adjusting Nut
- c-** Trunnion Clamp Screw(s) And Nut(s), With Lockwasher(s)
- d-** Slot Forward
- e-** 3/8 in. + 1/16 in. (10 mm + 2 mm)
- f-** 2-5/8 in. + 1/16 in. (67 mm + 2 mm)
- g-** Mount Trunnion

⚠ CAUTION

Center lifting eye (located on top of thermostat housing) is used for engine alignment only. DO NOT use to lift entire engine.

⚠ CAUTION

DO NOT allow lifting sling to hook or compress engine components or damage to them will occur.

2. Attach a suitable sling to lifting eyes on engine. Refer to "Removal" in this section for location of lifting eyes.

IMPORTANT: Engine bed must position engine so that a minimum of 1/4 in. (6 mm) up-and-down adjustment still exists on all four mounts after performing final alignment. This is necessary to allow for future engine alignment.

3. Lift engine into boat and position on engine bed so that transmission output flange and propeller shaft coupler are visibly aligned (no gap can be seen between coupling faces when butted together). **Adjust engine bed height**, if necessary, to obtain proper alignment. DO NOT use mount adjustments to adjust engine position at this time.
4. Check all four mounts to ensure that they are still positioned properly, then fasten mounts to engine bed with appropriate bolts or lag screws and hardware. Tighten securely.
5. Disconnect and remove sling. Proceed to "Engine Final Alignment" section following.

Engine Final Alignment

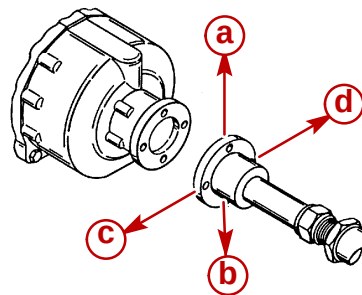
⚠ CAUTION

To avoid vibration, noise and damage to transmission output shaft oil seal and bearings, engine must be properly aligned.

IMPORTANT: Engine alignment MUST BE RECHECKED with boat in the water, fuel tanks filled and with a normal load on board.

Engine must be aligned so that transmission output flange and propeller shaft coupler centerlines are aligned and coupling faces are parallel within 0.003 in. (0.07 mm). This applies to installations with solid couplings, as well as flexible couplings.

1. Check mating surfaces on transmission output flange and propeller shaft coupler faces to make sure they are clean and flat.
2. Center propeller shaft in shaft log as follows:
 - a. Push down and then lift shaft as far as it will move. Then place shaft in the middle of the movement.
 - b. Move shaft to port and then to starboard as far as shaft will move. Then place shaft in the middle of the movement.
 - c. With shaft in center of shaft log, as determined by above procedures "a" and "b," align engine to shaft.

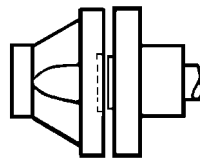
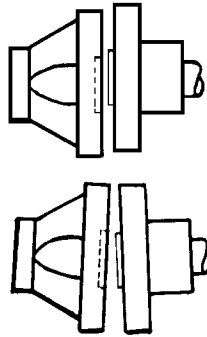


- a**- Up
- b**- Down
- c**- Port
- d**- Starboard

72595

3. Check that coupling centerlines align, by butting propeller shaft coupler against transmission output flange. Shoulder on propeller shaft coupler should engage recess on transmission output flange face with no resistance.

NOTE: Some propeller shaft couplers may not have a shoulder on mating face. On these installations, use a straight edge to check centerline alignment.



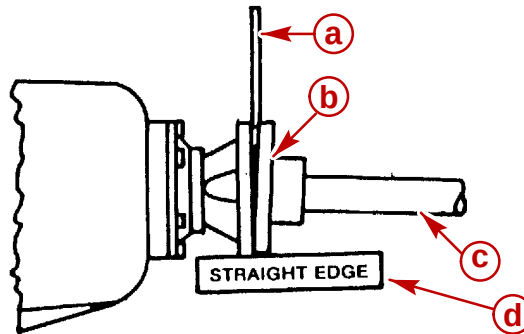
72597

Incorrect

Correct

IMPORTANT: Remote V-Drive Models: refer to remote V-drive manufacturer's instructions for drive shaft (between transmission and remote V-drive) alignment.

4. Check for angular misalignment, by hand holding coupling faces tightly together; check for a gap between faces with a .003 in. (0.07 mm) feeler gauge at 90° intervals.

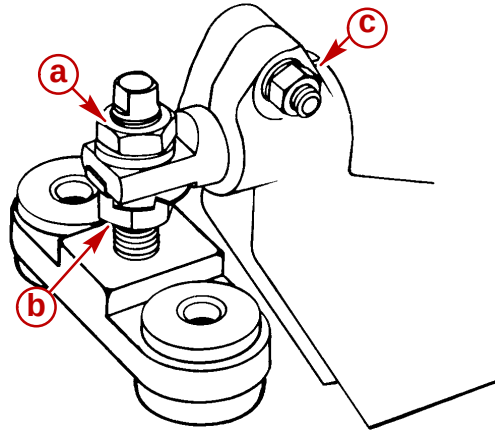


72598

- a-** Feeler Gauge
- b-** Transmission Coupling
- c-** Propeller Shaft
- d-** Straight Edge

5. If coupling centerlines are not aligned or if coupling faces are more than .003 in. (0.07 mm) out of parallel, adjust engine mounts as follows:
 - a. TO ADJUST ENGINE UP OR DOWN: Loosen locking nut on mounts requiring adjustment and turn both front mount or rear mount adjusting nuts equally.

IMPORTANT: Both front mount (or rear mount) adjusting nuts must be turned equally to keep engine level from side to side.



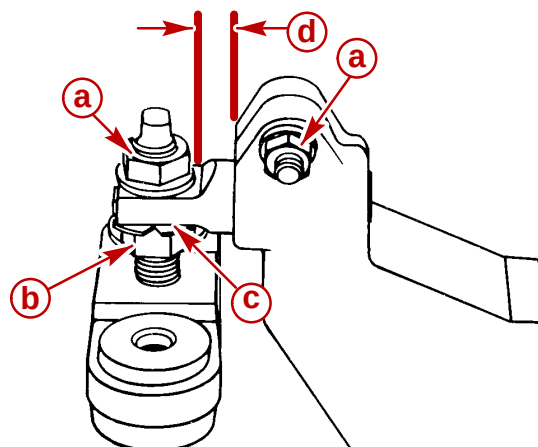
70645

- a-** Locking Nut
- b-** Adjusting Nut
- c-** Clamping Bolt(s) and Nut(s), with Lockwasher(s)

- b. TO MOVE ENGINE TO THE LEFT OR RIGHT: Loosen clamping screw and nut on all four mount brackets; move engine to the left or right as necessary to obtain proper alignment. On mounts which do have a slotted hole, a small amount of adjustment can be obtained with slot on front end of mounts. Loosen lag screws (which fasten mounts to engine bed) and move engine, as required. Tighten lag screws securely.

IMPORTANT: Large diameter of mount trunnion MUST NOT extend over 1 3/4 in. (45 mm) from mount brackets on any of the mounts.

6. After engine has been properly aligned, secure engine mounts as shown.
7. Torque clamping screws and nuts on all 4 mount brackets to 50 lb-ft (68 Nm).
8. Tighten locknuts on all 4 mounts securely.
9. Bend one of the tabs on tab washer down onto flat of adjusting nut.



70646

- a-** Clamping Bolts and Nuts
- b-** Locknut
- c-** Tab On Tab Washer
- d-** 1 3/4 in. (45 mm)

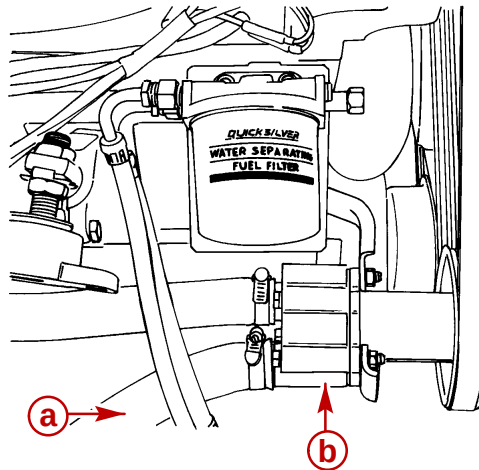
10. Connect propeller shaft coupler to transmission output flange. Attach couplers together with bolts, lockwashers and nuts. Torque to 50 lb-ft (68 Nm).

NOTE: If propeller shaft coupler has setscrews, the shaft should be dimpled at setscrew locations. Setscrews should be safety wired after being tightened securely.

Engine Connections

IMPORTANT: When routing all wire harnesses and hoses, be sure they are routed and secured to avoid coming in contact with hot spots on engine and avoid contact with moving parts.

1. Connect seawater inlet hose to seawater pump as shown. Tighten hose clamp securely.



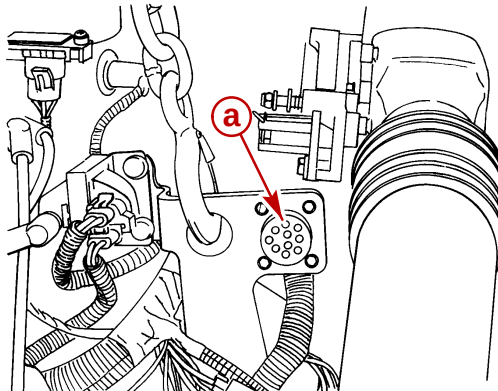
75533

Typical

a- Seawater Inlet Hose

b- Seawater Pump

2. Connect the instrumentation wiring harness to engine harness plug at location shown.



74938

Typical

a- Engine Harness Plug

⚠ WARNING

Be careful when working on fuel system. Gasoline is extremely flammable and highly explosive under certain conditions. Do not smoke or allow spark or open flame in area. Wipe up any spilled fuel immediately.

⚠ WARNING

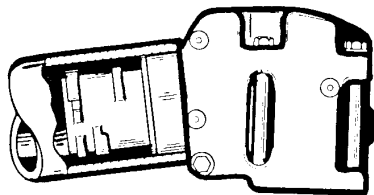
Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak.

- Apply #592 Loctite Pipe Sealant with Teflon to threads of brass fitting or plug. **DO NOT USE TEFLON TAPE.**
- Thread brass fitting or plug into fuel pump or fuel filter base until finger tight.
- Tighten fitting or plug an additional 1-3/4 to 2-1/4 turns using a wrench. **DO NOT OVERTIGHTEN.**
- Install fuel line. To prevent overtightening, hold brass fitting with suitable wrench and tighten fuel line connectors securely.
- Check for fuel leaks.

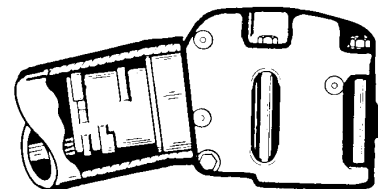
3. Connect fuel line from fuel tank(s) to engine. Make certain connection is secure. Check for leaks.
4. Connect exhaust system tubes and hoses using at least two hose clamps at each connection.

⚠ CAUTION

Avoid exhaust hose failure. Discharge water from exhaust elbow must flow around entire inside diameter of hose to avoid causing hot spots which could eventually result in burned-through exhaust hoses. Exhaust hoses and/or tubes must be correctly connected to exhaust elbows so that they do not restrict the flow of discharge water from exhaust elbow.



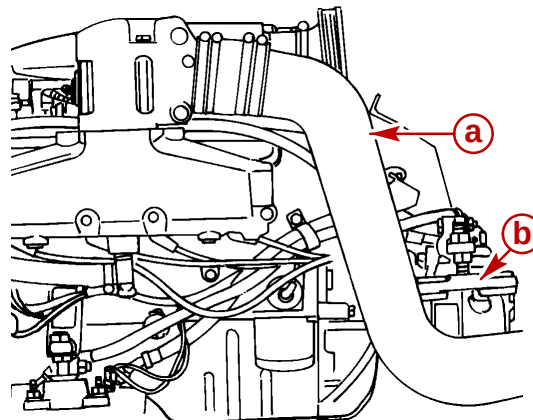
Correct



Incorrect

72538

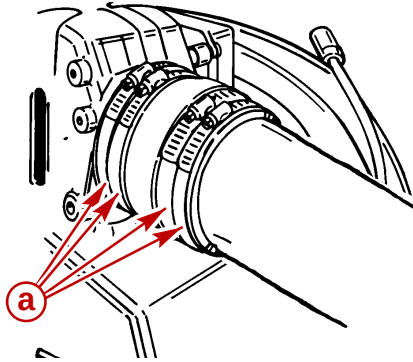
IMPORTANT: BLACK SCORPION S-pipes must be routed under the transmission mounts.



74832

- a-** S-Pipe
b- Transmission Mount

5. Tighten all exhaust hose and/or exhaust tube clamps securely.



73961

a - Hose Clamps

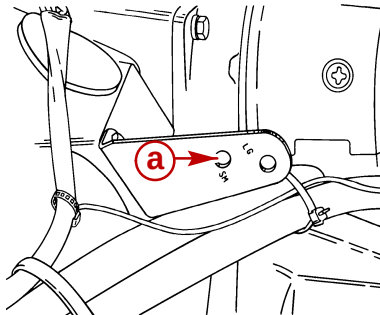
6. **On In-Line and Remote V-Drive:** Connect and adjust Quicksilver shift cable(s) as outlined following.

IMPORTANT: When installing shift cables, be sure that cables are routed in such a way as to avoid sharp bends and/or contact with moving parts. DO NOT fasten any items to shift cables.

NOTE: On models with other than Quicksilver shift cables refer to shift cable manufacturer's instructions.

IMPORTANT: Velvet Drive Transmission Warranty is jeopardized if the shift lever poppet ball or spring is permanently removed, if the shift lever is repositioned or changed in any manner or if remote control and cable do not position shift lever correctly.

- a. Verify shift cable stud is in appropriate stud hole as indicated. Tighten elastic stop nut securely.

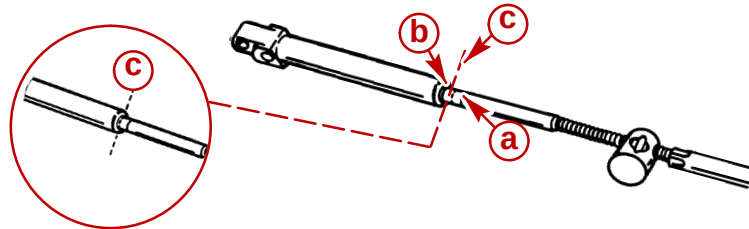


50947

a - 5.7L Shift Cable Anchor Stud Hole

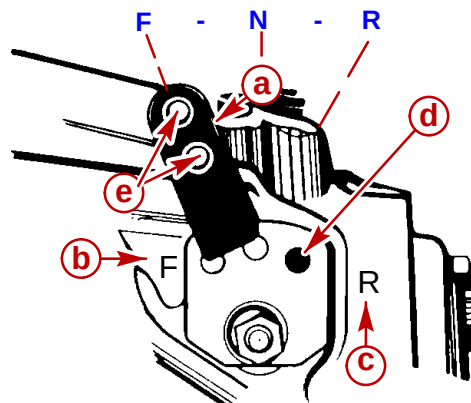
- b. Place remote control shift lever and transmission shift lever in neutral position.
- c. Remove nuts and washers from shift cable attaching studs.

- d. Locate center of remote control and control shift cable play (backlash), as follows:
 - (1.) Check that remote control is in neutral position.
 - (2.) Push in on control cable end with enough pressure to remove play and mark position "a" on tube.
 - (3.) Pull out on control cable end with enough pressure to remove play and mark position "b" on tube.
 - (4.) Measure distance between marks "a" and "b," and mark position "c," half-way between marks "a" and "b."



22024

- e. Center cable-end play, then adjust cable barrel to align holes in barrel and in cable end guide, with attaching points on transmission.
- f. Temporarily install shift cable. Do not secure at this time.
- g. Place remote control shift lever in forward gear position and check position of transmission shift lever. Shift lever must be positioned as previously indicated.
- h. Place remote control lever in reverse gear position and again check shift lever position. Lever must be positioned as previously indicated.
- i. If transmission shift lever will position properly in one gear, but not in the other, recheck shift cable adjustment. If transmission shift lever will not position properly in either gear, move transmission shift lever stud, from top hole in shift lever to bottom hole, and recheck for proper positioning. If proper positioning is still not obtained, remote control does not provide sufficient shift cable travel and must be replaced.

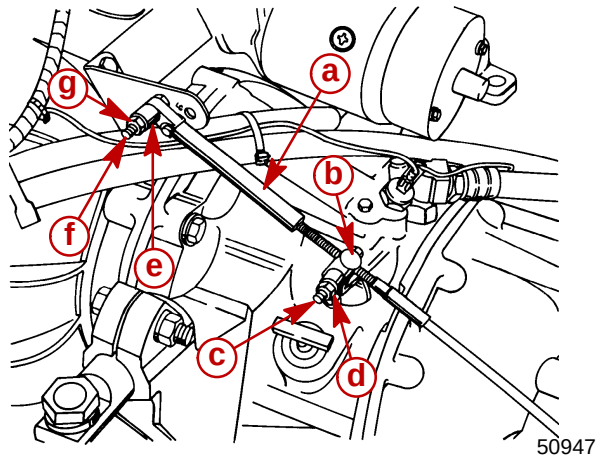


22457

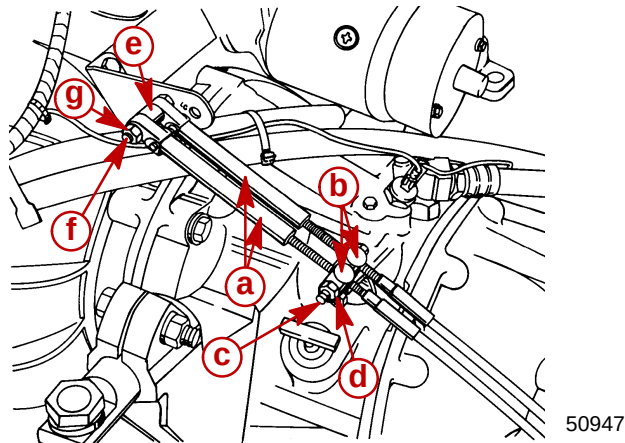
- a** - Transmission Shift Lever
- b** - Shift Lever MUST BE Over This Letter In FORWARD
- c** - Shift Lever MUST BE Over This Letter In REVERSE
- d** - Poppet Ball MUST BE Centered in Detent Hole for Each F-N-R Position (Forward Gear Shown)
- e** - Shift Lever Stud Holes

NOTE: Move shift lever stud to lower hole if necessary, to center poppet ball in forward and reverse detent holes.

- j. Reattach nut and washer to cable end guide stud. Tighten until contacts, then loosen one-half turn.
- k. Reattach nut and washer to cable barrel stud. Tighten until contacts. Tighten securely, but DO NOT OVERTIGHTEN.

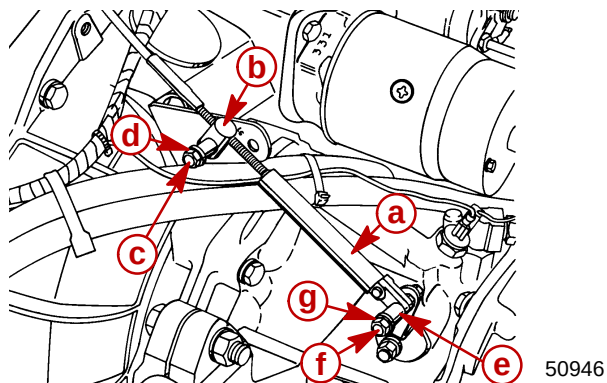


Rear Entry Single Station Installation In-Line And Remote V-Drive

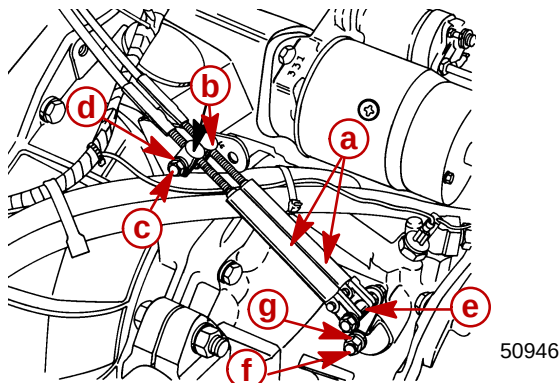


Rear Entry Dual Station Installation In-Line And V-Drive

- a** - Cable End Guide
- b** - Cable Barrel
- c** - Cable Barrel Stud
- d** - Elastic Stop Nut and Washer
- e** - Spacer
- f** - Cable End Guide Stud
- g** - Elastic Stop Nut and Washer



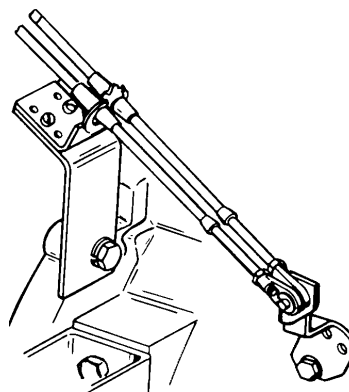
Front Entry Single Station Installation In-Line And V-Drive



Front Entry Dual Station Installation In-Line And V-Drive

- a** - Cable End Guide
- b** - Cable Barrel
- c** - Cable Barrel Stud
- d** - Elastic Stop Nut and Washer
- e** - Spacer
- f** - Cable End Guide Stud
- g** - Elastic Stop Nut and Washer

NOTE: For models equipped with a dual station shift bracket such as the one shown, refer to shift cable manufacturer's instructions for adjusting the cable. Shift lever must be positioned as stated in the preceding steps.



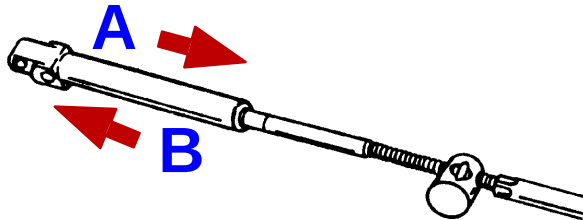
22457

Dual Station Shift Bracket (Not Quicksilver)

7. **On 5000 series (8° Down Angle and V-Drive):** Connect and adjust Quicksilver shift cable(s) as outlined following:

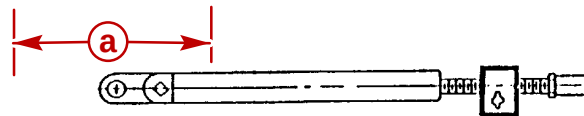
For Left-Hand Propeller Shaft Rotation: Shift cable hookup at remote control must result in shift cable end guide moving in direction "A" when remote control handle is placed in forward position.

For Right-Hand Propeller Shaft Rotation: Shift cable hookup at remote control must result in shift cable end guide moving in direction "B" when remote control handle is placed in forward position.



23242

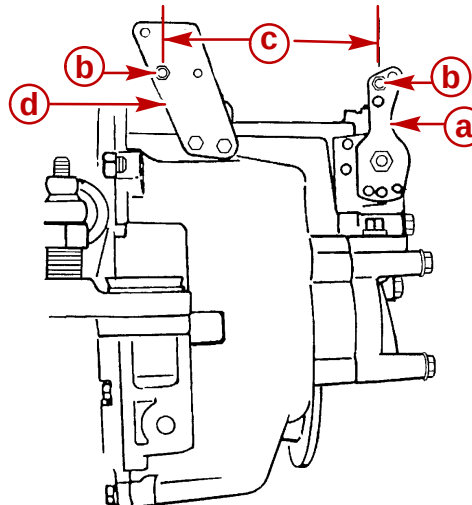
Remote control must provide a total shift cable travel (at transmission end) of at least 2-3/4 in. (70 mm). This is necessary to position transmission shift lever fully in the forward and reverse gear positions. Insufficient shift cable travel will cause transmission to slip and eventually fail.



72602

a - 2-3/4 In. (70 mm) Minimum

IMPORTANT: The distance between studs (Dimension "C") shown in the following illustration is set at 7-1/8 in. (181 mm).



73284

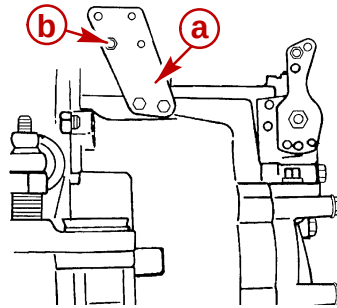
8° Down Angle Shown (V-Drive Similar)

- a** - Shift Lever
- b** - Anchor Stud
- c** - Dimension Between Studs 7-1/8 in. (181 mm)
- d** - Shift Cable Bracket

⚠ WARNING

Avoid serious injury or property damage caused by improper shifting. Anchor stud for shift cable must be installed in the correct hole.

- a. Be certain anchor stud is installed in the front hole as shown in the illustration following.

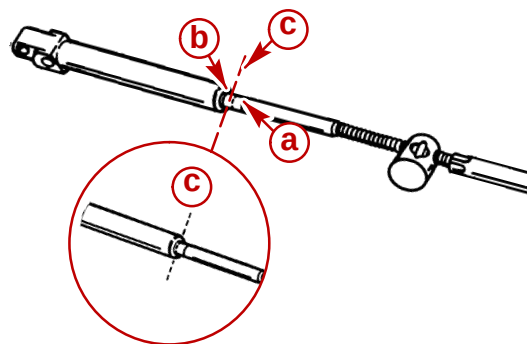


73284

a - Shift Cable Bracket

b - Anchor Stud in Front Hole

- b. Place remote control shift lever and transmission shift lever in neutral position.
- c. Remove nuts and washers from shift cable attaching studs.
- d. Locate center of remote control and control shift cable play (backlash) as follows:
 - (1.) Check that remote control is in neutral position.
 - (2.) Push in on control cable end with enough pressure to remove play; mark position "a" on tube
 - (3.) Pull out on control cable end with enough effort to remove play; mark position "b" on tube.
 - (4.) Measure distance between marks "a" and "b;" mark position "c," half-way between marks "a" and "b."



22024

- e. Center cable-end play, then adjust cable barrel to align holes in barrel and in cable end guide with attaching points on transmission.
- f. Temporarily install shift cable. Do not secure at this time.

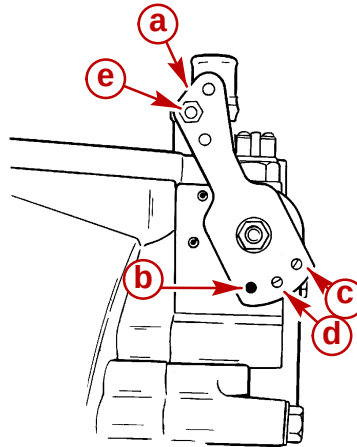
- g. Place remote control shift lever in gear and check position of transmission shift lever. Shift lever must be positioned in the desired detent hole.

IMPORTANT: Transmission is fully in gear when shift lever comes to a stop in either direction.

IMPORTANT: Velvet Drive Transmission Warranty is jeopardized if the shift lever poppet ball or spring is permanently removed, if the shift lever is repositioned or changed in any manner or if remote control and shift cable do not position shift lever exactly as shown.

⚠ CAUTION

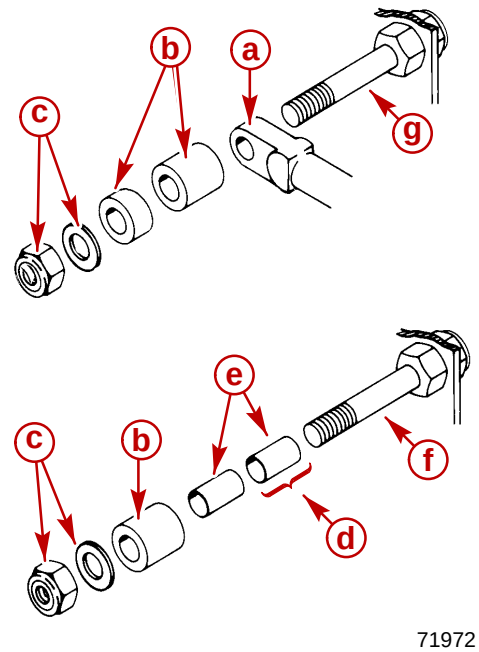
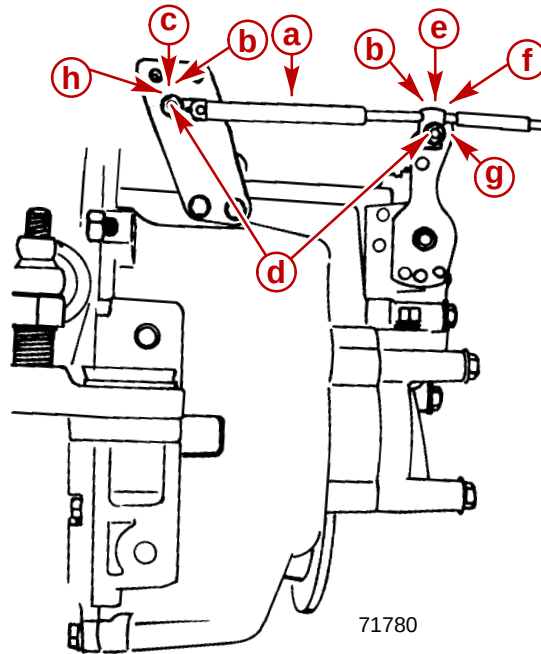
Remote control and shift cable must position transmission shift lever exactly as shown or transmission failure may occur. Do not remove poppet ball or spring.



73248

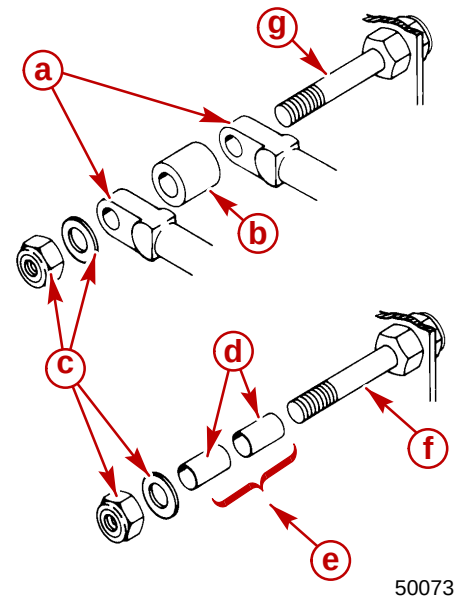
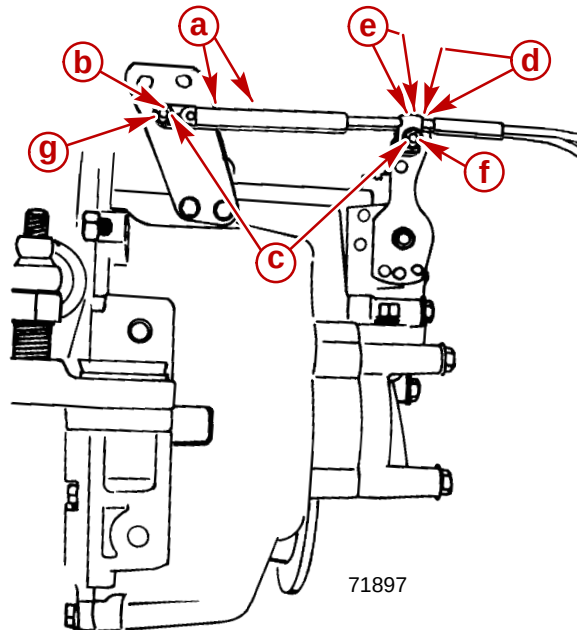
Velvet Drive 5000 Series (8° Down Angle Shown, V-Drive Similar)

- a-** Transmission Shift Lever
- b-** Poppet Ball MUST BE Centered in This Detent Hole when LEFT-HAND Propeller Shaft Rotation Is Desired
- c-** Poppet Ball MUST BE Centered in This Detent Hole when RIGHT-HAND Propeller Shaft Rotation Is Desired
- d-** Poppet Ball MUST BE Centered in This Detent Hole for NEUTRAL Position
- e-** Install Shift Lever Stud in This Hole when Using Quicksilver Shift Cables
- h. Place remote control shift lever in opposite gear position and again check transmission shift lever position. Lever must be positioned in the desired detent hole.
- i. If transmission shift lever will not position properly in one gear or both gears, recheck shift cable adjustment and travel as previously instructed in "a"-"h." If proper positioning is still not obtained, remote control does not provide sufficient shift cable travel and must be repaired or replaced.
- j. Install nut and washer to cable end guide stud. Tighten until contacts, then loosen one half turn.
- k. Install nut and washer to cable barrel stud. Tighten until contacts. Tighten securely, but DO NOT OVERTIGHTEN.



Typical Single Cable Installation - Rear Approach

- a**- Cable End Guide
- b**- Spacer (As Required)
- c**- Elastic Stop Nut and Washer
- d**- Bushing(s)
- e**- Cable Barrel Stud
- f**- Cable End Guide Stud

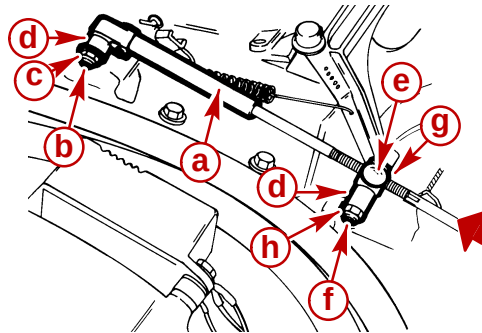


Typical Dual Cable Installation - Rear Approach

- a**- Cable End Guide
- b**- Spacer (As Required)
- c**- Elastic Stop Nut and Washer
- d**- Bushing(s)
- e**- Cable Barrel (s) [Position(s) Only Indicated In Lower Drawing]
- f**- Cable Barrel Stud
- g**- Cable End Guide Stud

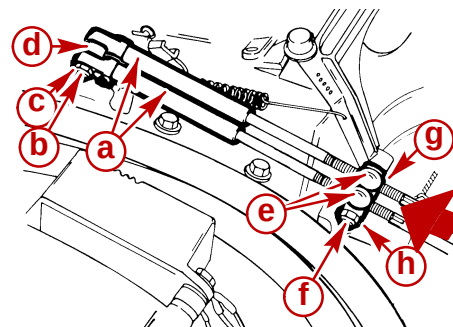
8. Install throttle cable, or cables, following instructions "a," "b" or "c":
- On Models Equipped with Other Than Quicksilver Throttle Cables:** Attach and adjust throttle cables referring to cable manufacturer's instructions.
 - On Carbureted Models Equipped with Quicksilver Throttle Cables:** Connect and adjust throttle cable(s) as outlined following:
 - (1.) Place remote control throttle lever(s) in idle position.
 - (2.) Install cable end guide on carburetor throttle lever stud as shown. Push cable barrel lightly toward throttle lever. (This will place a slight preload on cable to avoid slack in cable when moving remote control levers.) Then adjust cable barrel to align with anchor stud and slide barrel onto stud.
 - (3.) Secure throttle cable with hardware as shown. Tighten cable end guide locknut until it contacts and then loosen one full turn. Tighten barrel locknut until secure, but DO NOT Overtighten as cable(s) must be able to pivot.

NOTE: Refer to the first drawing of the following for installations where dual station length anchor studs are present but only a single station cable has been installed.



22552

- a** - Cable End Guide
- b** - Throttle Lever Stud
- c** - Elastic Stop Nut and Washer
- d** - Spacer
- e** - Cable Barrel
- f** - Anchor Stud
- g** - Washer
- h** - Elastic Stop Nut

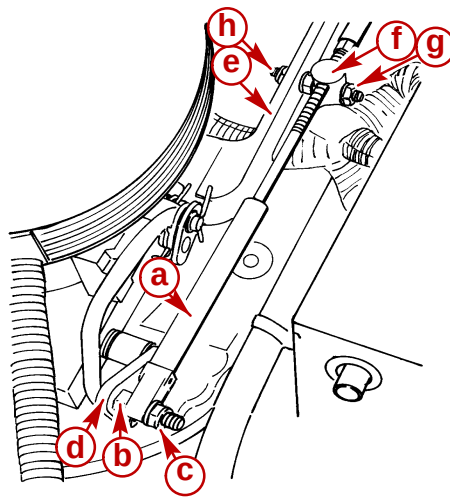


22553

Dual Station

- a** - Cable End Guide
- b** - Throttle Lever Stud
- c** - Washer and Locknut
- d** - Spacer
- e** - Cable Barrel
- f** - Anchor Stud
- g** - Washer
- h** - Washer and Locknut

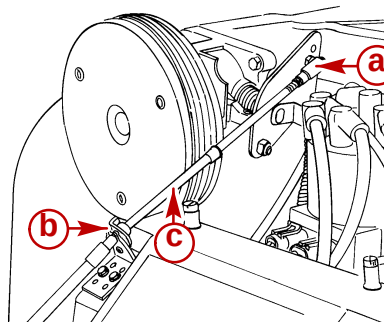
- c. **On EFI Models Equipped with Quicksilver Throttle Cables:** Connect and adjust throttle cable(s) as outlined following:
- (1.) Place remote control handle in neutral idle position.
 - (2.) Remove flame arrestor.
 - (3.) Attach cable to throttle body following cable manufacturer's instructions.
 - (4.) Install cable end guide on throttle lever, then push cable barrel end lightly toward throttle lever end. (This places a slight preload on shift cable to avoid slack in cable when moving remote control lever.)
 - (5.) Adjust barrel on throttle cable to align with hole in anchor plate.
 - (6.) Position cable as shown.
 - (7.) Secure throttle cable with hardware as shown. Tighten cable end guide locknut until it contacts and then loosen one half turn. Tighten barrel locknut until secure, but **DO NOT** Overtighten as cable(s) must be able to pivot.



74109

EFI (Throttle Body) Injection

- a-** Cable End Guide
- b-** Throttle Lever Stud
- c-** Locknut and Flat Washer
- d-** Throttle Lever
- e-** Throttle Bracket
- f-** Cable Barrel
- g-** Flat Washer and Locknut
- h-** Throttle Cable Anchor Stud



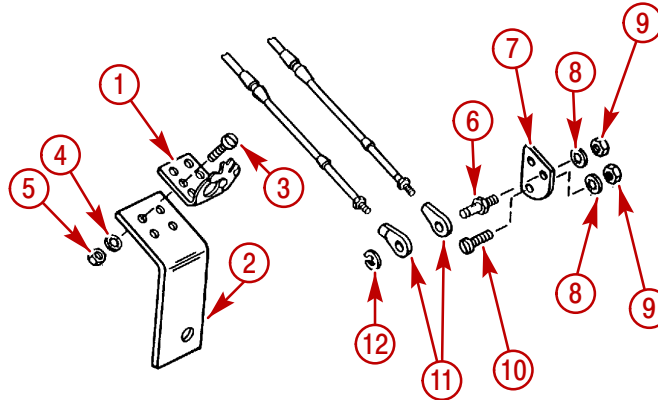
74838

Black Scorpion

- a-** Throttle Lever
- b-** Anchor Plate
- c-** Throttle Cable

Attaching / Adjusting Reversed Attachment Morse Shift Cables

1. Disconnect battery cables from battery.



72608

MORSE MARINE PRODUCTS PART NUMBER A35627

NOTE: Each item includes: description, number required and part number.

- 1** - Cable Clip - 1 - A35531
- 2** - Bracket -1 -B35762
- 3** - Screw, Mach., Fill. Hd. #10-32 x 1/2 In. Long - 2 - A50112-545
- 4** - Lockwasher, Internal Tooth, #10 - 2 -A50803-059
- 5** - Nut, Hex, #10-32 - 2 - A50900-076
- 6** - Pivot Pin - 1 - A300965
- 7** - Adaptor Plate - 1 - A47151
- 8** - Lockwasher, Internal Tooth, 1/4 - 2 - A50803-077
- 9** - Nut, Hex, 1/4-28 - 2 - A50901-016
- 10** - Screw, Mach., Flat Hd. 1/4-28 x 5/8 In Long - 1 - A50120-561
- 11** - Cable Terminal - 2 - A3000646
- 12** - E-Ring 5/16 In. - 1 - Obtain Locally

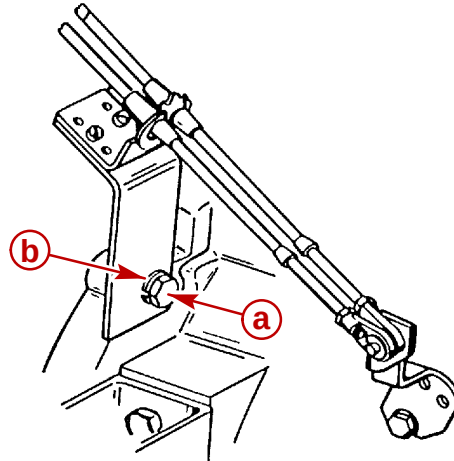
If your engine/transmission package is equipped with the above or is being equipped with the above Morse Marine cables observe the following:

2. Place remote control and transmission shift lever in neutral.

IMPORTANT: Remote control must provide a total shift cable travel (at transmission end) of at least 2-3/4 in. (70 mm). This is necessary to position transmission shift lever fully in the forward and reverse gear positions. Insufficient shift cable travel will cause transmission to slip and eventually fail.

3. Attach cable clip to bracket using screws, lockwashers and nuts. Use center holes in cable clip.

4. Remove top transmission mounting bolt and lockwasher from left (valve) side of transmission; position bracket, replace bolt and lockwasher.



22457

a - Bolt

b - Lock Washer

5. Fasten pivot pin securely through hole (not countersunk) in adaptor plate using lockwasher and nut.
6. Attach adaptor plate to transmission shift lever using screw, lockwasher and nut.
7. Fasten cable hubs in cable clip and screw terminals onto cable rods until holes in terminals line up with pivot pin. Hold each terminal securely to prevent from turning and tighten cable nut against terminal.

NOTE: Be sure control head hand lever and transmission shift lever are in neutral position during the above installation.

8. Place terminals on pivot pin and secure with E-ring.

NOTE: When using this kit with Models "S" or "SR" controls, adjust the stop screws in the control head to prevent cable from jamming the clutch arm against its stops at forward and reverse.

9. Refer to control head installation instructions for final check and adjustment procedures.
10. Connect battery cables to battery by FIRST connecting positive (+) battery cable end to positive (+) battery terminal. Tighten clamp securely. Then, connect negative (–) battery cable end to negative (–) battery terminal. Tighten clamp securely.

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ENGINE

Section 3A - 350 cid / 5.0L/ 305 cid / 5.7L Engines

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Torque Specifications

Description			lb-in.	lb-ft	Nm
Alternator Brace to Alternator			192		28
Alternator Brace to Engine				30	41
Alternator to Mounting Bracket				35	48
Alternator Mounting Bracket				30	41
Camshaft Sprocket Gear			216		24
Carburetor or Throttle Body			132		15
Connecting Rod Cap Nuts	First Pass			20	27
	Final Pass (Angle Torque)			+ 55 Degrees	+ 55 Degrees
Coupler-to-Flywheel (MCM)				35	48
Crankshaft Pulley				43	58
Crankcase Front Cover (Timing Chain/Gear Cover)			106		12
Cylinder Head Bolt 111	First Pass	Short Bolt Medium Bolt Long Bolt		22	30
	Final Pass (Angle Torque)	Short Bolt Medium Bolt Long Bolt	+ 55 Degrees + 65 Degrees + 75 Degrees		
Distributor Hold Down				18	25
Exhaust Manifold				20	27
Filter Adapter (5/16-18)					
Flywheel				75	100
Flywheel Drive Plate (MIE)				35	48
Flywheel Housing to Block				30	41
Flywheel Housing Cover			80		9
Front Mount Bracket				30	41
Fuel Pump				25	34
Intake Manifold				18	24
Main Bearing Cap	First Pass			15	20
	Final Pass (Angle Torque)			+ 73 Degrees	
Main Bearing Cap (Optional - Without Angular Torque)				77	105

Torque Specifications (Continued)

Description	lb-in.	lb-ft	Nm
Oil Baffle Nuts		25	34
Oil Filter Adapter Bolt		15	20
Oil Pan Drain Plug		15	20
Oil Pan Corner Nut		18	25
Oil Pan Nuts (5/16-18)	106		12
Oil Pump		65	88
Oil Pump Cover	80		9
Power Steering Pump Brace to Block		30	41
Power Steering Pump Bracket			
Rear Crankshaft Oil Seal Retainer Bolts and Nuts	106		12
Rear Mount (MCM)		40	54
Rear Mount (MIE)		50	68
Remote Oil Connector (1/2 in. x 13)		25	34
Remote Oil Filter Adapter Nut / Fitting		20	27
Rocker Arm Cover	106		12
Roller Lifter Restrictor Retainer Plate		18	25
Seawater Pump Brace		30	41
Seawater Pump Bracket			
Spark Plugs (New Cylinder Head)		22	30
Spark Plugs (All Others)		15	20
Starter Motor		50	50
Thermostat Housing		30	41
Torsional Damper		40	54
Transmission To Housing		50	68
Water Circulating Pump		33	45
Water Temperature Sender		20	27

Special Tools

KENT-MOORE SPECIAL TOOLS	
Kent-Moore Special Tools 29784 Little Mack Roseville, MI 48066 Phone: (313) 574-2332	
Description	Part Number
Valve Spring Compressor (Head on)	J5892
Valve Spring Compressor (Head off)	J8062
Valve Spring Tester	J8056
Valve Guide Cleaner	J8101
Valve Guide Reamer (Standard)	J7049
Valve Guide Reamer (.015 in. oversize)	J5830-02
Rocker Arm Stud Remover	J5802-01
Rocker Arm Stud Installer	J6880
Stud Bore Reamer (.003 in. oversize)	J5715
Stud Bore Reamer (.013 in. oversize)	J6036
Carbon Remover Brush	J8089
Piston Pin Tool	J24086-B
Piston Ring Groove Cleaner	J3936-03
Piston Ring Compressor	J8037
Connecting Rod Guide Tool (3/8 -24)	J5239
Oil Pump Suction Pipe Installer	J21882
Camshaft Bearing Installer/Remover Tool	J6098-01
Ball Socket Adapter	J8520-1
Torsional Damper Remover and Installer	J23523-E
Crankcase Front Cover Seal Installer	J35468
Crankshaft Gear and Sprocket Puller	J5825-A
Crankshaft Gear and Sprocket Installer	J5590
Air Adapter	J23590
Main Bearing Remover and Installer	J8080
Rear Main Seal Installer	J26817-A

Specifications

General Specifications

Engine Model	305 cid (5.0L)
Displacement	305 cid (5.0 L)
Bore	3.735 (94.89)
Stroke	3.479 in. (88.39 mm)
Firing Order	1-8-4-3-6-5-7-2
Compression Ratio	9.4:1
Heads	Cast Iron
Intake Manifold	Cast Iron
Block	Cast Iron (2 Bolt Main Bearing Caps)
Rods	Forged Steel
Crankshaft	Cast Iron
Pistons	Cast Aluminum
Camshaft	Cast Iron

Engine Model	350 cid (5.7L)
Displacement	350 cid (5.7 l)
Bore	4.00 (101.6)
Stroke	3.479 in. (88.39 mm)
Firing Order	1-8-4-3-6-5-7-2
Compression Ratio	9.3:1
Heads	Cast Iron
Intake Manifold	Cast Iron (Carbureted and EFI Models) Aluminum (MPI Models)
Block	Cast Iron (2 Bolt Main Bearing Caps)
Rods	Forged Steel
Crankshaft	Cast Iron
Pistons	Cast Aluminum
Camshaft	Steel

Engine Specifications

NOTICE	
Unit Of Measurement: Inches (Millimeters)	

CYLINDER BORE

Engine		305 cid (5.0L)	350 cid (5.7L)
Diameter		3.7350-3.7384 (94.881-94.958)	4.00-4.001 (101.618-101.643)
Out of Round	Production	0.001 (0.025) Max	
	Service	0.002 (0.05) Max	
Taper	Production	Thrust Side	0.0005 (0.012) Max
		Relief Side	0.001 (0.025) Max
	Service Limit		0.001 (0.025) Over Production

PISTON CLEARANCE

Production	0.0007-0.002 (0.018-0.053) Max
Service	0.0007-0.0026 (0.018-0.068) Max

PISTON RING: COMPRESSION

Groove Clearance	Production	Top	0.0012-0.0027 (0.030-0.070)
		2nd	0.0015-0.003 (0.040-0.080)
	Service	Top	0.0012-0.0035 (0.030-0.090)
		2nd	0.0015-0.004 (0.040-0.100)
Gap	Production	Top	0.009-0.020 (0.25-0.51)
		2nd	0.010-0.020 (0.46-0.66)
	Service	Top	0.010-0.025 (0.25-0.65)
		2nd	0.018-0.035 (0.46-0.90)

PISTON RING: OIL

Groove Clearance	Production	0.002-0.006 (0.051-0.17)	
	Service	0.002-0.008 (0.051-0.22)	0.002-0.0076 (0.051-0.195)
Gap	Production	0.009-0.029 (0.25-0.76)	
	Service Limit	0.009-0.035 (0.25-0.89)	0.009-0.030 (0.25-0.785)

PISTON PIN

Diameter		0.9269-0.9270 (23.545-23.548)
Clearance	Production	0.0005-0.0009 (0.013-0.023)
	Service Limit	0.0005-0.00098 (0.013-0.025) Max
Fit in Rod		0.00082-0.00157 (0.021-0.040) Interference

CRANKSHAFT

Engine			305 cid (5.0L)	350 cid (5.7L)
Main Journal	Diameter	No.1	2.4483-2.4492 (62.189-62.212)	
Main Journal	Diameter	No. 2, 3, 4	2.4480-2.4490 (62.181-62.207)	
		No.5	2.4479-2.4490 (62.177-62.207)	
	Taper	Production	0.00019 (0.005) Max	
		Service	0.001 (0.02) Max	
	Out of Round	Production	0.00019 (0.005) Max	
		Service	0.00098 (0.025) Max	
Main Bearing Clearance	Production	No.1	0.0007-0.0022 (0.018-0.053)	
		No. 2, 3, 4	0.00086-0.0024 (0.022-0.061)	
		No.5	0.00098-0.0027 (0.025-0.069)	
	Service	No.1	0.00098-0.002 (0.025-0.051)	
		No. 2, 3, 4	0.00098-0.0025 (0.025-0.064)	
		No.5	0.00149-0.0029 (0.038-0.076)	
Crankshaft End Play			0.0019-0.0078 (0.05-0.20)	
Connecting Rod Journal	Diameter		2.0977-2.0997 (53.284–53.334)	
	Taper	Production	0.00027 (0.007) Max	
		Service	0.00098 (0.025) Max	
	Out of Round	Production	0.00027 (0.007) Max	
		Service	0.00098 (0.025) Max	
Rod Bearing Clearance		Production	0.00129-0.00346 (0.033-0.088)	
		Service	0.00098-0.0029 (0.025-0.076)	
Rod Side Clearance			0.0059-0.0240 (0.15-0.61)	
Crankshaft Runout			0.0019-0.0078 (0.05-0.20)	

VALVE SYSTEM

Engine			305 cid (5.0L)	350 CID (5.7L)
Lifter Type			Roller Hydraulic	
Rocker Arm Ratio			1.50 to 1	
Valve Lift		Intake	0.2744-.2783 (6.97-7.07)	
		Exhaust	0.2834-.2874 (7.20-7.30)	
Valve Lash (Intake and Exhaust)			1 Turn Down from Zero Lash	
Face Angle		Intake	45°	
		Exhaust	45°	
Seat Angle (Intake & Exhaust)			46°	
Seat Runout (Intake & Exhaust)			0.0019 (0.05) Max	
Seat Width		Intake	0.03448-0.070 (1.14-1.78)	0.0401-0.0649 (1.02-1.65)
		Exhaust	0.0649-0.098 (1.65-2.49)	0.059-0.100 (1.50-2.56)
Stem Clearance	Production	Intake	0.00098-0.0027 (0.025-0.069)	
		Exhaust	0.00098-0.0027 (0.025-0.069)	
	Service	Intake	0.00098-0.0037 (0.025-0.094)	
		Exhaust	0.00098-0.0037 (0.025-0.094)	0.0010-0.0076 (0.025-0.194)
Stem Diameter		Intake	.341 (8.66)	
		Exhaust	.341 (8.66)	
Valve Diameter		Intake	1.84 (46.74)	1.94 (49.28)
		Exhaust	1.50 (38.1)	
Valve Margin After Surfacing - Intake and Exhaust			0.031 (0.79) Minimum	

VALVE SPRING

Engine			5.0l / 305 cid / 350 cid (5.7L)
Valve Spring	Free Length		2.019 (51.3)
	Pressure	Valve Closed	76-84 Lb. (338-374 N) at 1.7 (43.2)
		Valve Open	187-203 Lb. (832-903 N) at 1.27 (32.3)
	Installed Height	Intake	1.68-1.70 (42.92-43.43)
		Exhaust	1.68-1.70 (42.92-43.43)
	Free Length		2.019 (51.3)
	Approximate Number of Coils		4

CAMSHAFT AND DRIVE

Engine	305 cid (5.0L)	350 cid (5.7L)
Journal Diameter	1.8677-1.8661 (47.440-47.490)	
Journal Out Of Round	0.001 (0.025) Maximum	
Camshaft Runout	0.0026 (0.06) Maximum	
Timing Chain Deflection	0.43 (11) Maximum	

FLYWHEEL

Engine	305 cid (5.0L)	350 cid (5.7L)
Runout	0.008 (0.203) Maximum	

CYLINDER HEAD

Engine	305 cid (5.0L)	350 cid (5.7L)
Surface Flatness (At Exhaust Manifold Deck)	0.0019 (0.05)	
Surface Flatness (At Engine Block Deck)	0.0039 (0.10)	
Surface Flatness (At Intake Manifold Deck)	0.0039 (0.10)	

General Information

Repair Procedures

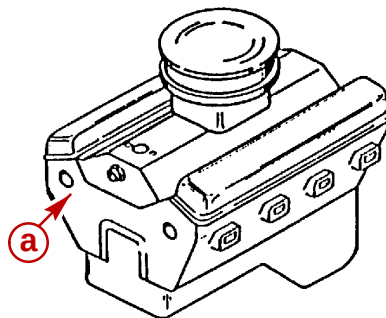
Some of the repairs in this section must be completed with engine removed from boat. Engine removal depends upon type of repair and boat design. Place engine on repair stand for major repairs.

Lubricate all moving parts (during reassembly) with engine oil. Apply Quicksilver Perfect Seal on threads of and under heads of cylinder head bolts, and on threads of all cylinder block external bolts, screws and studs.

Engine Identification

The Mercury MerCruiser Model can be determined by looking at the last two letters of the engine code stamped into the cylinder block. This code number is stamped on all Mercury MerCruiser power packages and replacement partial engines, but not replacement cylinder block assemblies.

If the engine serial number and/or model decals are missing, the engine code letters may help in determining the engine models.



72312

a - Location Of G.M. Engine Code

Following is a list of GM engines and their respective code letters.

MCM (Sterndrive)	Code
5.0L Alpha and Bravo	ZA
5.7L Alpha and Bravo	MH
5.0L EFI Alpha and Bravo	MH
5.7L EFI Alpha and Bravo	MH
350 Mag MPI Alpha and Bravo	MH
350 Mag MPI Alpha and Bravo Horizon	MH

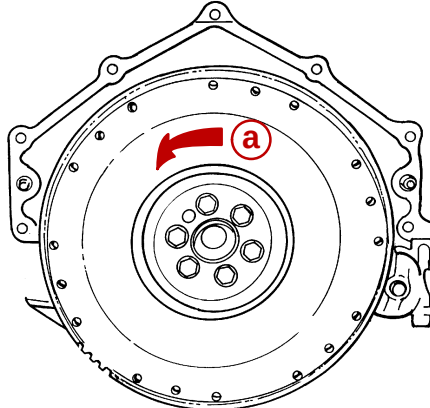
MIE (Ski and Inboard)	Code
5.7L Ski	MH
350 Mag MPI Ski	MH
Black Scorpion	MH
5.7L Inboard	MK
350 Mag MPI Inboard	MK
350 Mag MPI Horizon Inboard	MK

Engine Rotation

Engine rotation terminology at times has caused confusion. To clarify, engine rotation is determined by observing flywheel rotation from the rear (transmission or stern drive end) of the engine looking forward (water pump end).

PROPELLER ROTATION IS NOT NECESSARILY THE SAME as engine rotation.

When ordering replacement engines, short blocks or parts for engines, be certain to check engine rotation. Do not rely on propeller rotation in determining engine rotation.



72001

a - Left-Hand Rotation (CCW) - All Stern Drive Engines, MIE Inboard LH (Standard) Rotation

Description

Crankshaft

The crankshaft is supported in the block by five insert type bearings. Crankshaft end thrust is controlled by flanges on the No. 5 bearing. A torsional damper on the forward end of the crankshaft serves to help dampen any engine torsional vibration.

Piston and Connecting Rods

Piston pins are offset slightly toward the thrust side of the pistons to provide a gradual change in thrust pressure against the cylinder wall as the piston travels its path. Pins have a floating fit in the piston and a press fit in the connecting rod (to hold them in place).

Connecting rods are made of forged steel and are connected to the crankshaft through insert type bearings.

Camshaft and Drive

Camshafts are generally made of cast iron. However engines with roller lifters have camshafts made of steel. All camshafts are driven at one-half crankshaft speed by a timing chain and sprockets, or by timing gears. The camshafts are supported by five main bearings that are pressed into the block.

A helical gear on the aft end of the camshaft drives the distributor and oil pump. An eccentric cam on the front of the camshaft drives the fuel pump through a push rod. The fuel pump push rod is made of different material when used on engines with steel camshafts and roller lifters, than for engines with cast iron camshafts.

⚠ CAUTION

Avoid rapid and severe camshaft and fuel pump push rod wear that could result in engine damage. Always use the fuel pump push rod specified for use with the cast iron or steel camshaft in your engine.

Engines with cast iron camshaft and flat faced lifters, have a taper on the lobes and a spherical foot on the hydraulic valve lifters. This causes the valve lifters to rotate, thus reducing wear. Engines with steel camshaft and roller lifters, have eight restrictors held in place by a retaining plate to keep the hydraulic valve lifters from rotating so that they follow the cam lobes precisely.

Cylinder Head

The cylinder heads are made of cast iron and have individual intake and exhaust ports for each cylinder.

Stainless steel or graphite composition head gaskets are used to retard corrosion.

Valve Train

The valves and valve springs are heavy-duty to withstand the high engine speeds encountered. Valve tips have been hardened to extend valve life. Exhaust valve rotators are used on some engines to help extend valve life.

Hydraulic valve lifters ride directly on the camshaft lobes and transmit the thrust of the lobes to the push rods that actuate the valves through the rocker arm.

In addition to transmitting thrust of the cam lobes, the hydraulic lifters also serve to remove any clearance (lash) from the valve train to keep all parts in constant contact.

The valve lifters also are used to lubricate the valve train bearing surfaces.

Intake Manifold

The carbureted and throttle body fuel injection manifolds are a double level design for efficient fuel distribution. The upper level of passages feeds cylinders 2, 3, 5 and 8 while the lower level passages feed cylinders 1, 4, 6 and 7.

The multi-port injection manifold is a tunnel ram design with the injectors mounted directly above the intake ports in cylinder head.

Lubrication System

The engine lubrication system is a force-feed type. Oil is supplied under full pressure to the crankshaft, connecting rods, camshaft bearings and valve lifters, and is supplied under controlled volume to the push rods and rocker arms. All other moving parts are lubricated by gravity flow or splash.

A positive displacement gear-type oil pump is mounted on the rear main bearing cap and is driven by an extension shaft from the distributor (which is driven by the camshaft). Oil from the bottom of the pump in the rear of the oil pan is drawn into the oil pump through an oil pickup screen and pipe assembly.

If the screen should become clogged, a relief valve in the screen will open and continue to allow oil to be drawn into the system. Once the oil reaches the pump, the pump forces the oil through the lubrication system. A spring-loaded relief valve in the pump limits the maximum pump output pressure.

After leaving the pump, the pressurized oil flows through a full-flow oil filter. On engines with an engine oil cooler, the oil also flows through the cooler before returning to the block. A bypass valve allows oil to bypass the filter and oil cooler should they become restricted.

Some of the oil, after leaving the oil cooler and/or filter, is routed to the No. 5 crankshaft main bearing. The remainder of the oil is routed to the main oil gallery, which is located directly above the camshaft and runs the entire length of the block. From the main oil gallery, the oil is routed through individual oil passages to an annular groove in each camshaft bearing bore. Some of the oil is then used to lubricate camshaft bearings. The remainder of the oil is routed to the valve lifter oil galleries and No. 1, 2, 3, and 4 crankshaft main bearings by means of individual oil passages which intersect with the annular grooves.

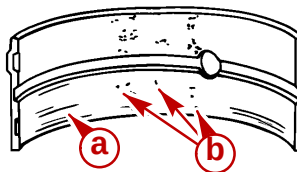
The camshaft bearings have holes which align with the oil passages or annular grooves in the block and allow oil to flow between the bearings and the camshaft journals. The oil that is forced out the front end of the No. 1 camshaft bearing drains down onto the camshaft drive and keeps it lubricated.

The oil that reaches the crankshaft main bearings is forced through a hole in the upper half of each bearing and flows between the bearings and the crankshaft journals. Some of the oil is then routed to the connecting rod bearings through grooves in the upper half of the crankshaft main bearings and oil passages in the crankshaft. Oil that is forced out the ends of the connecting rod bearings and crankshaft main bearings and splashes onto the camshaft, cylinder walls, pistons and piston pins, keeping them lubricated. Oil is forced out the front end of the No. 1 crankshaft main bearing to assist in lubricating the camshaft drive. A baffle plate, mounted on the bottom of the main bearings or in the oil pan, prevents oil thrown from the crankshaft and connecting rods from aerating the oil in the oil pan.

Oil that reaches the valve lifter oil galleries is forced into each hydraulic valve lifter through holes in the side of the lifter. From here, the oil is forced through the metering valve in each of the lifters (which controls the volume of oil flow) and then up through the push rods to the rocker arms. A hole in each rocker arm push rod seat allows the oil to pass through the rocker arm and lubricate the valve train bearing surfaces. After lubricating the valve train, oil drains back to the oil pan through oil return holes in the cylinder head and block.

The distributor shaft and gear is lubricated by the oil flowing through the right valve lifter oil gallery. The fuel pump push rod is lubricated by oil thrown off from the camshaft eccentric.

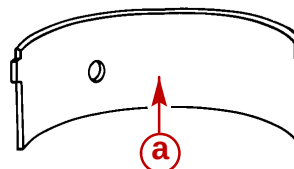
Bearing Failures



70436

Scratched By Dirt

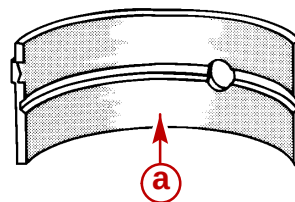
- a** - Scratches
- b** - Dirt Imbedded In Bearing Material



70436

Tapered Journal

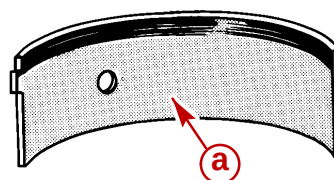
- a** - Overlay Gone From Entire Surface



70436

Lack Of Oil

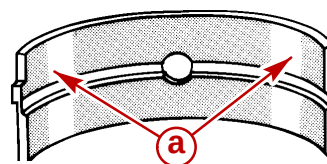
- a** - Overlay Worn Off



70436

Radius Ride

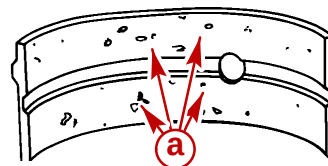
- a** - Worn Area



70436

Improper Seating

- a** - Bright Or Polished Sections



70436

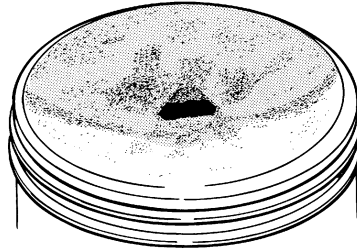
Fatigue Failure

- a** - Craters or Pockets

Piston Failures

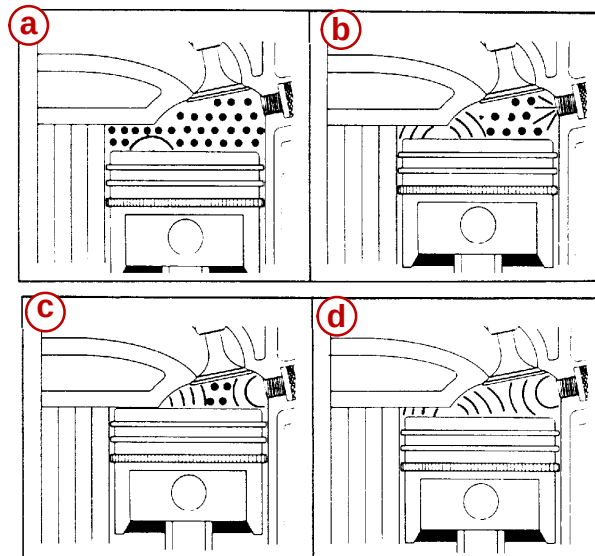
Pre-Ignition

Pre-ignition is abnormal fuel ignition caused by combustion chamber hot spots. Control of the start of ignition is lost, as combustion pressure rises too early, causing power loss and rough running. The upward motion on the piston is opposed by the pressure rise. This can result in extensive damage to the internal parts from the high increase in combustion chamber temperature.



72424

Pre-Ignition Damage



72314

- a** - Ignited By Hot Deposits
- b** - Regular Ignition Spark
- c** - Ignites Remaining Fuel
- d** - Flame Front Collide

PRE-IGNITION CAUSES

1. Hot spots in the combustion chamber from glowing deposits (due to the use of improper oils and/or fuels).
2. Overheated spark plug electrodes (improper heat range or defective plug).
3. Any other protuberance in the combustion chamber, such as an overhanging piece of gasket, an improperly seated valve or any other inadequately cooled section of material that could serve as a source for pre-ignition problems.

NOTE: Engine failures that result from the foregoing conditions are beyond the control of Mercury MerCruiser. No warranty will apply to failures that occur under these conditions.

Detonation

Detonation, commonly called “fuel knock,” “spark knock” or “carbon knock,” is abnormal combustion of the fuel causing the fuel to explode violently. The explosion causes overheating or damage to the spark plugs, pistons, valves and, in severe cases, results in pre-ignition.

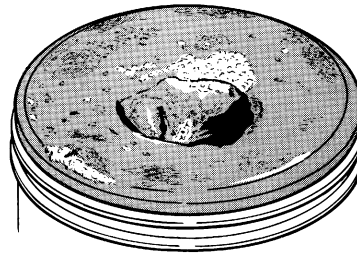
DETONATION CAUSES

1. Use of low octane gasoline or neglecting engine maintenance.

IMPORTANT: Use of improper fuels will cause engine damage and poor performance.

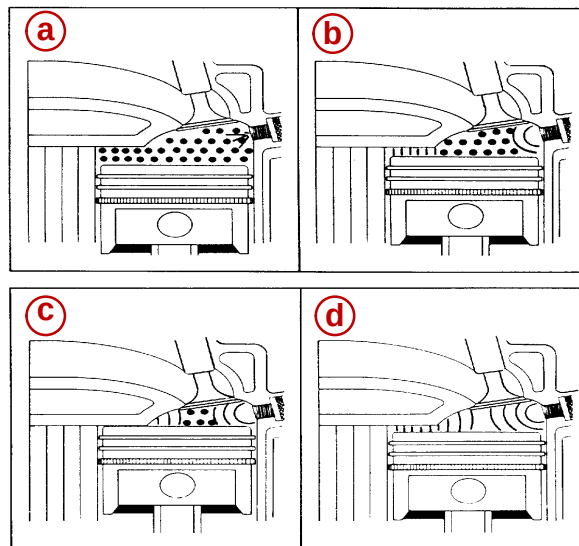
2. Over-advanced ignition timing.
3. Lean fuel mixture at or near full throttle (could be caused by carburetor or leaking intake manifold).
4. Cross-firing spark plugs.
5. Excess accumulation of deposits on piston and/or combustion chamber that result in higher compression ratio.
6. Inadequate cooling of engine due to deterioration of cooling system.

NOTE: Engine failures, that result from the foregoing conditions are beyond the control of Mercury MerCruiser. No warranty will apply to failures that occur under these conditions.



72425

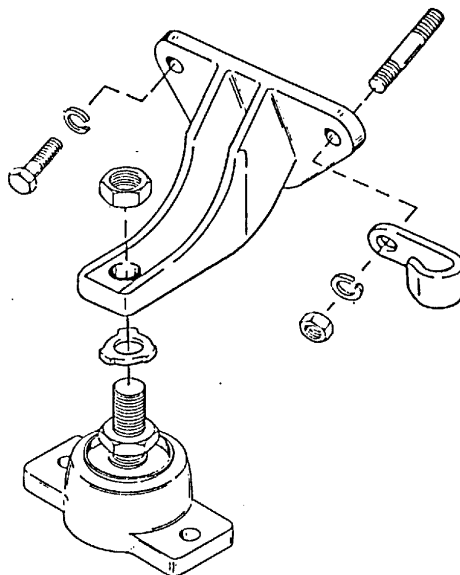
Detonation Damage



72315

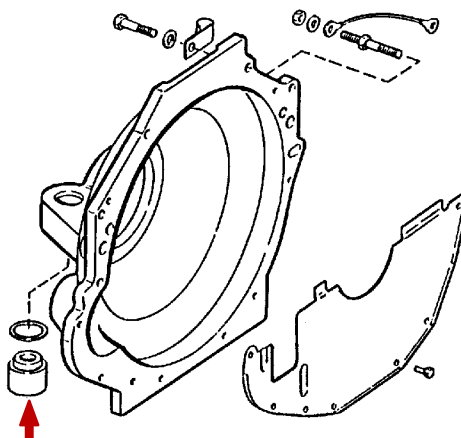
- a** - Spark Occurs
- b** - Combustion Begins
- c** - Combustion Continues
- d** - Detonation Occurs

Engine Mounts



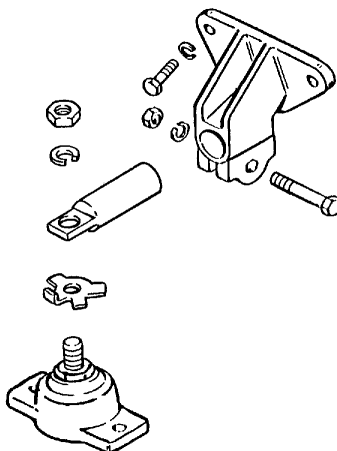
72317

Front Mount - All MCM (Sterndrive) Models



72318

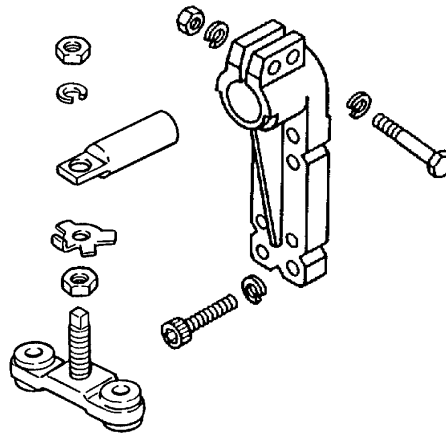
Rear Mount / Flywheel Housing - All MCM (Sterndrive) Models



72319

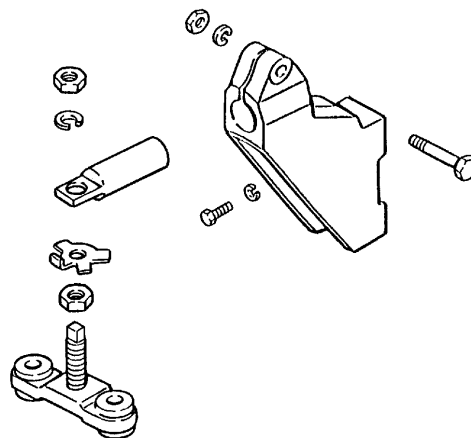
Front Mount Assembly - All MIE Models

Engine Mounts (Continued)



73055

Rear Mount Assembly - Most MIE Models



73056

Rear Mount Assembly - MIE Models with Velvet Drive In-Line Transmission

Rocker Arm Cover

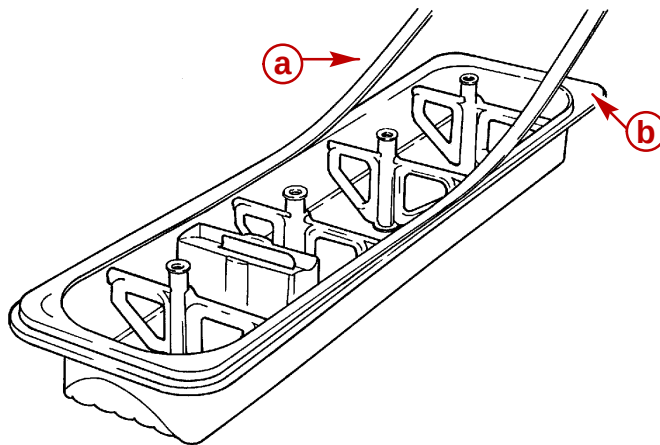
Removal

NOTE: It may be necessary to remove exhaust manifold before removing rocker arm cover. Refer to SECTION 7B for exhaust manifold removal.

1. Disconnect crankcase ventilation hoses.
2. Remove any items that interfere with the removal of rocker arm covers.
3. Remove rocker arm cover.

Installation

1. Clean sealing surfaces on cylinder head and rocker arm cover with degreaser.
2. Place new rocker arm cover gasket in position.



72324

- a** - Rocker Arm Cover Gasket
b - Sealing Surface

3. Install rocker arm cover. Torque screws to 90 lb-in. (10 Nm).
4. Reinstall any items that were removed.
5. Connect crankcase ventilation hoses.
6. Start engine and check for oil leaks.

Intake Manifold

Removal

1. Drain engine cooling system.
2. Disconnect hoses from thermostat housing.
3. Disconnect electrical leads interfering with removal.
4. Disconnect crankcase ventilation hoses from rocker arm covers.
5. Disconnect throttle cable.
6. Disconnect fuel line from carburetor or throttle body.
7. Remove distributor cap and mark position of rotor on distributor housing. Also mark position of distributor housing on intake manifold.
8. Remove distributor.

IMPORTANT: Do not crank engine over after distributor has been removed.

9. Remove other ignition components.
10. Remove oil pressure sending unit.
11. Disconnect any items that interfere with removal of manifold.

IMPORTANT: It may be necessary to pry intake manifold away from cylinder heads and block, in next step. Use extreme care to prevent damage to sealing surfaces.

12. Remove intake manifold bolts.
13. Remove intake manifold and carburetor or throttle body assembly.

NOTE: *If intake manifold requires replacement, transfer all remaining parts to new manifold.*

Cleaning and Inspection

1. Clean gasket material from all mating surfaces.

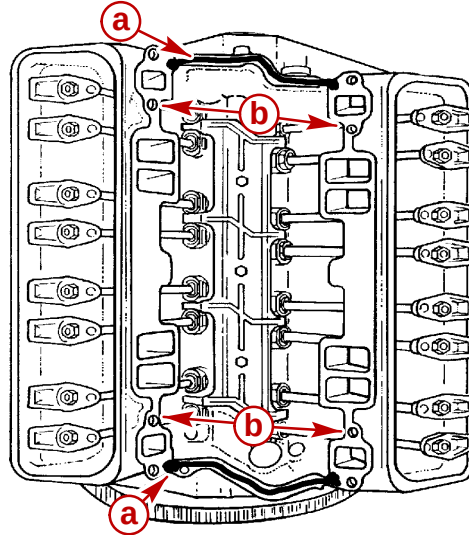
IMPORTANT: When cleaning cylinder head mating surface, do not allow gasket material to enter engine crankcase or intake ports.

2. Inspect manifold for cracks or scratches. Machined surfaces must be clean and free of all marks and deep scratches or leaks may result.
3. Inspect intake passages for varnish buildup and other foreign material. Clean as necessary.

Installation

IMPORTANT: DO NOT get Quicksilver RTV Sealer into oil sending unit hole at rear of engine.

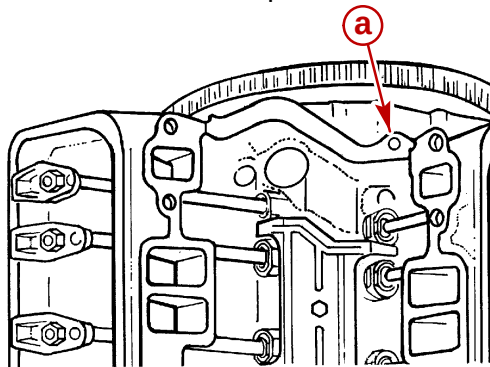
1. Apply a 3/16 in. (5 mm) wide bead of Quicksilver RTV Sealer to engine block as shown. Extend sealer 1/2 in. (13 mm) up on intake gaskets.
2. Apply Loctite Pipe Thread Sealant to the threads of the four inner manifold bolts.



72325

a - 3/16 Bead Of RTV Sealer

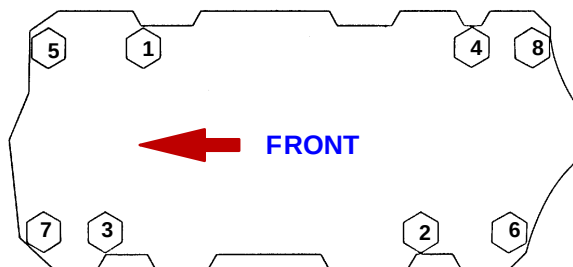
b - Inner Manifold Bolts With Loctite Pipe Thread Sealant



72326

a - Oil Sending Unit Hole

3. Carefully install manifold assembly and torque bolts to 18 lb-ft (24 Nm) in sequence as shown.



72878

4. Connect all electrical leads.
5. Connect hoses to thermostat housing.
6. Install fuel line.

7. Connect crankcase ventilation hose(s).
8. Install distributor. Position rotor and housing to align with marks made during removal, then install distributor cap.
9. Install other ignition components and reconnect wires.
10. Coat threads of oil pressure sending unit with Quicksilver Perfect Seal and install.
11. Connect any items that were disconnected.
12. Start engine.
13. Adjust ignition timing. Adjust carburetor, if equipped.
14. Check hose connections, gaskets and seals for leaks.
15. Inspect fuel line connections for fuel leaks.

Rocker Arm / Push Rod

Removal

NOTE: When servicing only one cylinder's rocker arms, bring that cylinder's piston up to TDC before removing rocker arms. When servicing all rocker arms, bring No. 1 piston up to TDC before removing rocker arms.

1. Remove rocker arm covers.
2. Remove rocker arm assemblies and push rods.

IMPORTANT: Place rocker arm assemblies and push rods in a rack for reassembly in their original locations.

Cleaning and Inspection

1. Clean parts with solvent and dry with compressed air.
2. Inspect all contact surfaces for wear. Replace all damaged parts.

Installation

IMPORTANT: When installing rocker arms and rocker arm balls, coat bearing surfaces of rocker arms and rocker arm balls with engine oil.

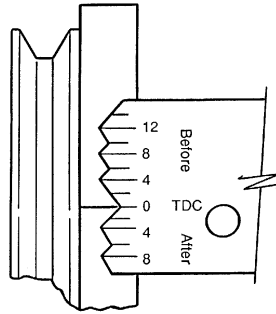
1. Install push rods in their original locations. Ensure push rods seat in lifter socket.
2. Install rocker arms, rocker arm balls and rocker arm nuts in their original locations.
3. Adjust valves.

Valve Adjustment

Engine Stopped

With valve cover removed, adjust valves when lifter is on low part of camshaft lobe.

1. Crank engine with starter or turn over in normal direction of rotation until mark on torsional damper lines up with center "0" mark on timing tab. Ensure engine is in No. 1 firing position by placing fingers on No. 1 valve as mark on torsional damper comes near "0" mark on timing mark. If valves move as mark comes up to timing tab, engine is in No. 6 firing position and should be turned over one more time to reach No. 1 position.



72328

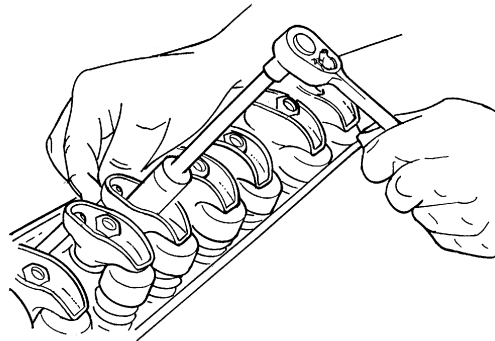
2. **Adjust the following valves:**

MCM and MIE Left-Hand (Standard) Rotation Engines

Exhaust - 1-3-4-8

Intake - 1-2-5-7

3. Loosen adjusting nut until lash is felt at push rod, and then tighten adjusting nut until all lash is removed. Lash can be checked by moving push rod up and down while tightening adjusting nut until all play is removed.



72300

4. Hydraulic lifters can be adjusted by tightening adjustment nut an additional one turn (360 degrees). No other adjustment is required.
5. Crank engine one revolution until pointer "0" mark and torsional damper mark are again in alignment. This is No.6 firing position. With engine in this position, the following valves may be adjusted as previously outlined.

MCM and MIE Left-hand (Standard) Rotation Engines

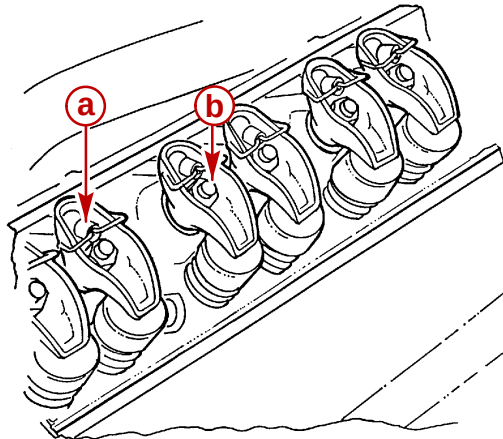
Exhaust - 2-5-6-7

Intake - 3-4-6-8

Engine Operating

Following procedure is performed with engine operating:

1. Check engine for normal operating temperature.
2. Remove rocker arm covers and install rocker stoppers as shown.



72301

a - Rocker Stoppers (91-66273)

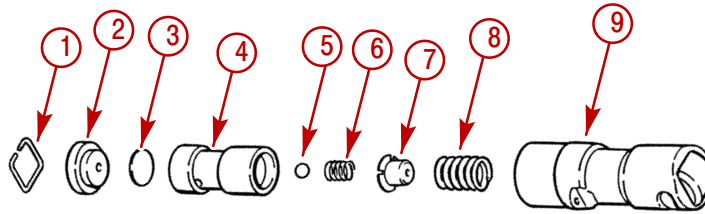
b - Rocker Arm Nuts

3. With engine operating at idle, loosen one rocker arm nut until rocker arm starts to clatter.
4. Turn rocker arm nut down until clatter just stops. This is zero lash position.

IMPORTANT: The following one-turn preload adjustment must be done slowly to allow the lifter to adjust itself. This will prevent the valves from hitting the pistons and causing internal damage and/or bent push rods.

5. Turn nut down 1/4 additional turn (90 degrees) and pause 10 seconds until engine runs smoothly. Repeat until nut has been turned down one turn (360 degrees) from the zero lash position.
6. Repeat Steps 2, 3, 4 to adjust other valves.
7. Remove rocker stoppers after all valves are adjusted.
8. Install rocker arm covers; torque screws to 106 lb-in. (12 Nm).
9. Adjust carburetor, if equipped, idle mixture and idle speed. Check for leaks.

Hydraulic Valve Lifters



72031

Roller Lifter

- 1** - Push Rod Seat Retainer
- 2** - Push Rod Seat
- 3** - Metering Valve
- 4** - Plunger
- 5** - Check Ball
- 6** - Check Ball Spring
- 7** - Check Ball Retainer
- 8** - Plunger Spring
- 9** - Lifter Body

Hydraulic valve lifters require little attention. Lifters are extremely simple in design. Normally, readjustments are not necessary and servicing requires only that care and cleanliness be exercised in the handling of parts.

Locating Noisy Lifters

Locate a noisy valve lifter by using a piece of garden hose approximately 4 ft. (1.2 m) in length. Place one end of hose near end of each intake and exhaust valve and other end of hose to the ear. In this manner, sound is localized making it easy to determine which lifter is at fault.

Another method is to place a finger on face of valve spring retainer. If lifter is not functioning properly, a distinct shock will be felt when valve returns to its seat.

General types of valve lifter noise are as follows:

1. Hard rapping noise - usually caused by plunger becoming tight in bore of lifter body so that return spring cannot push plunger back up to working position. Probable causes are:
 - a. Excessive varnish or carbon deposit causing abnormal stickiness.
 - b. Galling or "pickup" between plunger and bore of lifter body, usually caused by an abrasive piece of dirt or metal wedged between plunger and lifter body.
2. Moderate rapping noise. Probable causes are:
 - a. Excessively high leakdown rate.
 - b. Leaky check valve seat.
 - c. Improper adjustment.
3. General noise throughout valve train. Probable causes are:
 - a. Insufficient oil supply.
 - b. Improper adjustment.

4. Intermittent clicking. Probable causes are:
 - a. A microscopic piece of dirt momentarily caught between ball seat and check valve ball.
 - b. In rare cases, ball may be out of round or have a flat spot.
 - c. Improper adjustment.

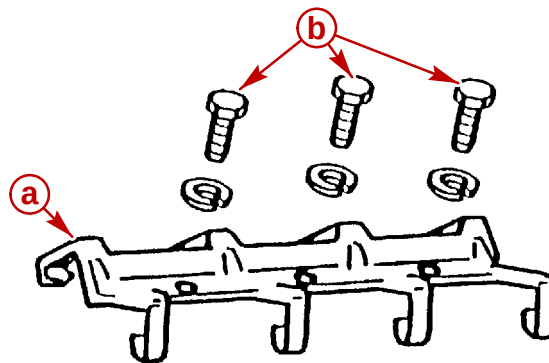
In most cases where noise exists in one or more lifters, all lifter units should be removed, disassembled, cleaned in solvent, reassembled and reinstalled in engine. If dirt, corrosion, carbon, etc., is shown to exist in one unit, it probably exists in all the units. Thus it would only be a matter of time before all lifters caused trouble.

Removal

IMPORTANT: Keep push rod and hydraulic valve lifter from each valve together as a matched set and mark them so they can be reinstalled in the same location later.

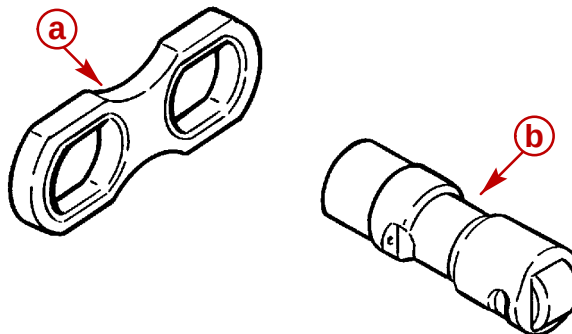
1. Remove rocker arm covers.
2. Remove intake manifold.
3. Remove lifter restrictor retainer on roller lifter models.
4. Remove rocker arm assemblies and push rods.

NOTE: Engines with roller lifters have additional valve train components shown below.



72329

- a** - Lifter Restrictor Retainer
b - Fasteners



72340

- a** - Roller Lifter Restrictor
b - Roller Lifter

5. Remove lifter restrictors and lifters.

Cleaning and Inspection

1. Thoroughly clean all parts in cleaning solvent and inspect them carefully. If any parts are damaged or worn, entire lifter assembly should be replaced.
2. If outer lifter body wall is scuffed or worn, inspect cylinder block lifter bore.
3. If roller of lifter is scuffed or worn, inspect camshaft lobe.
4. If push rod seat is scuffed or worn, inspect push rod.

Installation

IMPORTANT: It is recommended that the engine oil be changed and a new oil filter be installed whenever servicing valve lifters or camshaft.

IMPORTANT: Before installing lifters/rollers, coat the bottom of the lifter/roller with engine oil. If new lifters or a new camshaft have been installed, an additive containing EP lube (such as General Motors Cam and Lifter Prelube or equivalent) should be poured over camshaft lobes before installing lifters.

IMPORTANT: Before installation, coat entire valve lifter with engine oil.

IMPORTANT: DO NOT install used valve lifters if a new camshaft has been installed.

1. Install roller lifters and components.
2. Torque roller lifter restrictor retainer plate fasteners to 18 lb-ft (25 Nm).
3. Install intake manifold.
4. Install and adjust valve mechanism.
5. Install rocker arm cover.
6. Start engine and check for leaks.

Valve Stem Oil Seal / Valve Spring

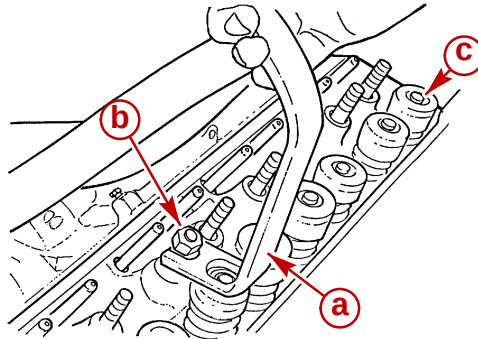
Removal - Head Installed

1. Remove rocker arm cover.
2. Remove spark plug of affected cylinder.
3. Remove rocker arm assembly.
4. Install air line adaptor tool (J-23590) in spark plug hole and apply compressed air to hold valves in place.

NOTE: If compressed air is not available, piston may be brought up to TDC and used to keep valves from falling out of valve guides.

IMPORTANT: Do not turn crankshaft while valve springs, retainers, and locks are removed or valves will fall into cylinder.

5. Using valve spring compressor as shown, compress valve spring and remove valve locks.



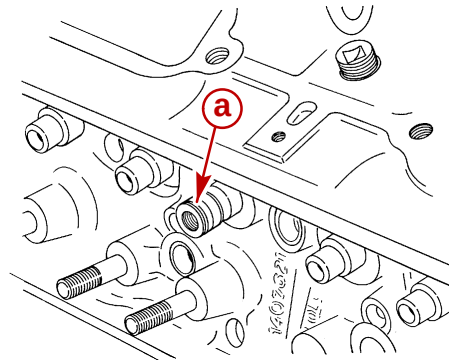
72306

- a - Valve Spring Compressor (J5892)
- b - Rocker Arm Nut
- c - Valve Locks

6. Slowly release valve spring compressor.
7. Remove cap, shield, and valve spring.

IMPORTANT: Keep air pressure in cylinder while springs, caps, and valve locks are removed or valves will fall into cylinder.

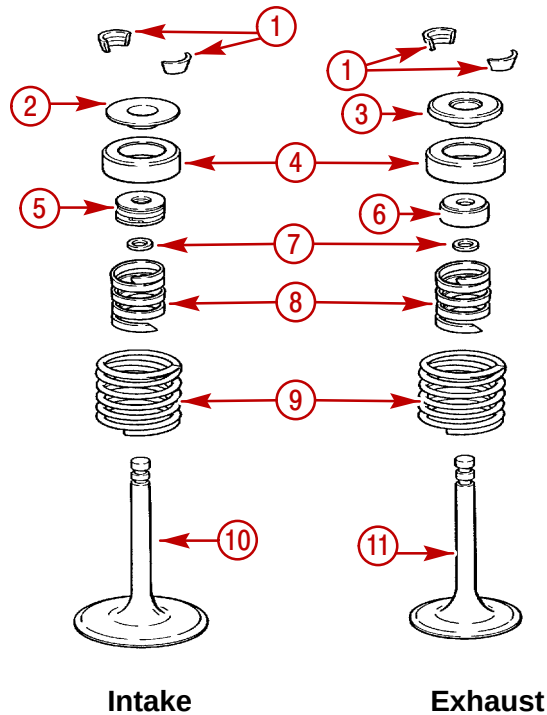
8. Remove seals from valve stems and valve guide.



72330

- a - Valve Guide Seal

Valve Assembly (Exploded View)



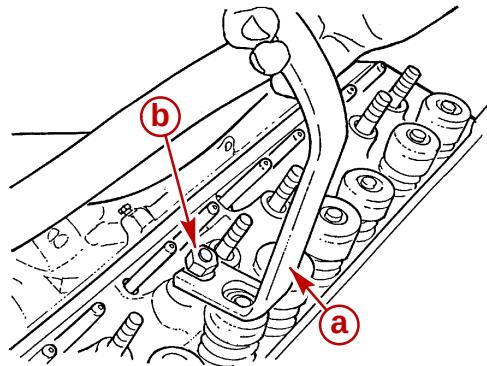
72331

- 1** - Valve Locks
- 2** - Retainer
- 3** - Rotator
- 4** - Cap
- 5** - Valve Guide Oil Seal
- 6** - Oil Shield
- 7** - Valve Stem Oil Seal
- 8** - Inner Spring
- 9** - Outer Spring
- 10** - Intake Valve
- 11** - Exhaust Valve

Installation - Head Installed

1. Install valve guide seal (intake valve only) over valve stem and push down until seated against head.
2. Set valve spring (with damper installed) and shield in place.
3. Place cap on intake valve and/or rotator on exhaust valve.
4. While compressing valve spring with valve spring compressor, install oil seal in lower groove of valve stem, making sure seal is not twisted. A light coating of oil will help prevent twisting.

5. Install valve locks (Quicksilver Needle Bearing Assembly Lubricant may be used to hold them in place) and slowly release tool, making sure locks seat properly in upper grooves of valve stem.



72306

a - Valve Spring Compressor (J-5892)

b - Rocker Arm Nut

6. Install push rods and rocker arm assemblies.
7. Adjust valves as outlined under "Valve Adjustment - Engine Stopped."
8. Install rocker arm cover [torque to 90 lb-in. (10 Nm)].
9. Install spark plug [torque to 15 lb-ft (20 Nm)].

Cylinder Head

Removal

1. Drain engine cooling system.
2. Remove exhaust manifolds.
3. Remove intake manifold.
4. Remove rocker arm covers.
5. Remove rocker arm assemblies and push rods (keep in order for reassembly in their original locations).
6. Remove any components attached to front or rear of cylinder head.
7. Remove spark plugs.
8. Remove head bolts.

⚠ CAUTION

The head gasket may be holding cylinder head to block. Use care when prying off cylinder heads. DO NOT damage gasket surfaces. DO NOT drop cylinder heads.

9. Place cylinder head on wooden blocks to prevent damage to gasket surfaces.

Cleaning and Inspection

1. Clean gasket material and sealer from engine block and cylinder heads.
2. Inspect sealing surfaces for deep nicks and scratches.
3. Inspect for corrosion around cooling passages.
4. Clean head bolt threads and engine block bolt hole threads, making sure no dirt, old oil or coolant remain.

Installation

⚠ CAUTION

When using ribbed stainless steel head gaskets, apply a thin coating of Quicksilver Perfect Seal to both sides of gasket. Too much sealer may hold gasket away from head or block causing leakage. DO NOT use sealer on graphite composition head gaskets.

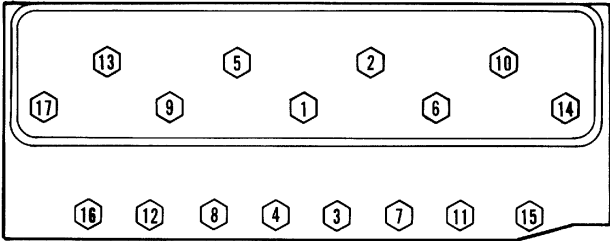
1. Place head gasket in position over dowel pins.

2. Carefully set cylinder head in place over dowel pins.

3. Coat threads of head bolts with Quicksilver Perfect Seal and install finger-tight.

4. Torque cylinder heads in two steps. First pass, torque all bolts to 22 lb-ft (30 Nm). Second pass is an angle torque sequence as follows:

First Pass	Short Bolt Medium Bolt Long Bolt	22 lb-ft (30 Nm)
Second Pass (Angle Torque)	Short Bolt	+ 55 Degrees
	Medium Bolt	+ 65 Degrees
	Long Bolt	+ 75 Degrees



72332

5. Install push rods and rocker arm assemblies in their original positions.

6. On roller cam engines, install lifter restrictors and retainer.

7. Adjust valves as outlined under "Valve Adjustment - Engine Stopped."

8. Install as outlined:

a. Intake manifold.

b. Rocker arm covers.

c. Exhaust manifolds.

d. Spark plugs.

e. Any components removed from front or rear of cylinder heads.

9. Follow procedures in SECTION 6A or 6B of this manual:

Seawater Cooled Models: Provide for adequate water supply to seawater pickup (see SECTION 6A).

Closed Cooled Models: Refill closed cooling section (see SECTION 6B), and provide adequate water supply to seawater pickup.

⚠ CAUTION

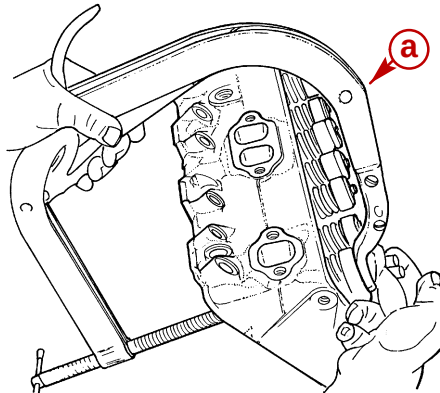
Ensure that cooling water supply is available before starting the engine.

10. Start engine.
11. Set timing.
12. Set idle speed.
13. Check for leaks.

Cylinder Head and Valve Conditioning

Disassembly

1. Using valve spring compressor, compress valve spring and remove valve locks. Slowly release tool.



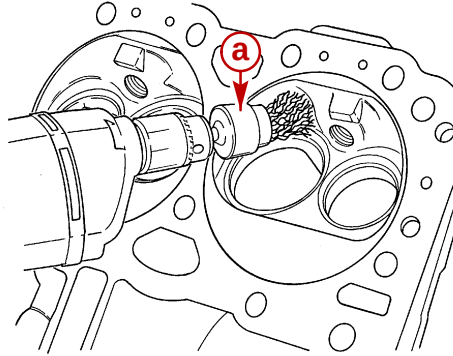
a - Valve Spring Compressor (J-8062)

2. Remove all valve components.
3. Remove valves from cylinder head and place in a rack, for reassembly in their original locations.

72333

Cleaning and Inspection

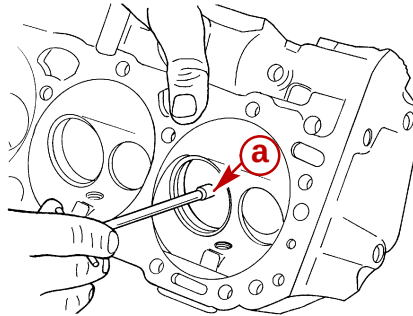
1. Clean push rods and rocker arm assemblies.
2. Clean carbon from valves using a wire wheel.
3. Clean gasket material from cylinder head mating surfaces.
4. Clean all carbon from combustion chambers and valve ports using carbon remover brush.



72334

a - Carbon Remover Brush (J-8089)

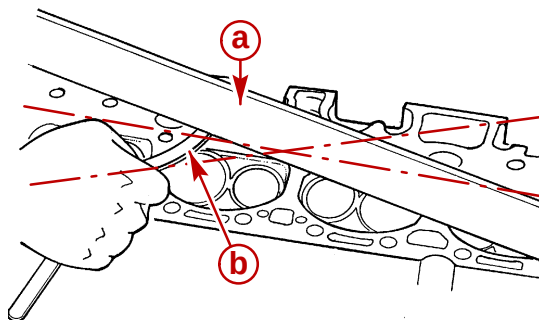
5. Thoroughly clean valve guides with valve guide cleaner.



72335

a - Valve Guide Cleaner (J-8101)

6. Inspect cylinder heads for cracks in exhaust ports, water jackets, and combustion chambers (especially around spark plug holes and valve seats). Replace heads if any cracks are found.
7. Inspect cylinder head gasket surface for burrs, nicks erosion or other damage.
8. Check flatness of cylinder head gasket surface, using a machinist's straight edge and feeler gauges as shown. Refer to "Specifications." Take measurements diagonally across head both ways) and straight down center of head.



72307

a - Straight Edge

b - Feeler Gauge

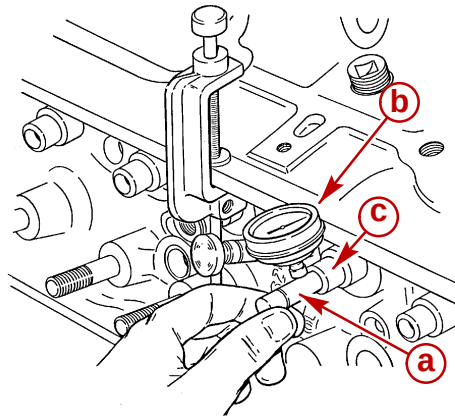
IMPORTANT: Cylinder head surfaces should be resurfaced if warped more than specified to provide proper alignment.

9. Inspect valves for burned heads, cracked faces or damaged stems.

IMPORTANT: Excessive valve stem to bore clearance will cause excessive oil consumption and possible valve breakage. Insufficient clearance will result in noisy and sticky valves.

10. Measure valve stem clearance as follows:

- a. Attach a dial indicator to cylinder head, positioning it against the valve stem and close to the valve guide.
- b. Holding valve head off seat about 1/16 in. (2 mm), move valve stem back and forth in direction shown. Compare stem clearance with specifications.
- c. If clearance exceeds specifications, it will be necessary to ream valve guides for oversized valves. Refer to "Valve Guide Bore Repair."



- a** - Valve Stem
b - Dial Indicator
c - Valve Guide

72336

Valve Guide Bore Repair

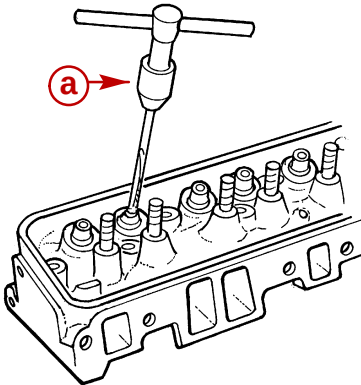
IMPORTANT: Measure valve stem diameter of both the intake and exhaust valve, as valve stem diameter may or may not be the same for both valves.

If .015 in. oversize valves are required, ream valve guide bores for oversize valves, as follows:

- 1. Measure valve stem diameter of old valve being replaced and select proper size valve guide reamer from chart below.

Standard Valve Stem Diameter	Reamer Required for .015 In. Oversize Valve
.341 in. (8.66)	J-5830-02

- 2. Ream valve guide bores.



72337

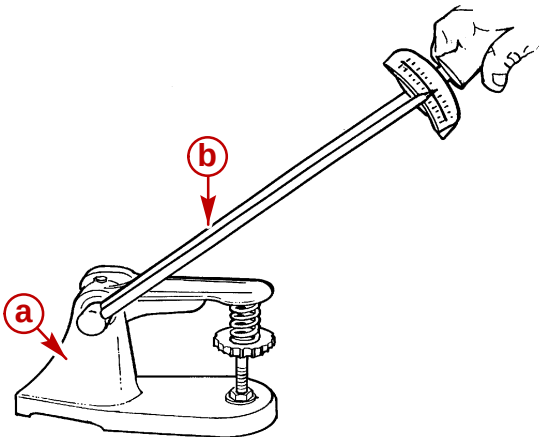
a - Valve Guide Reamer

- 3. Remove the sharp corner created by reamer at top of valve guide.

Valve Springs - Checking Tension

Use valve spring tester to check valve spring tension with dampers removed. Refer to "Specifications."

IMPORTANT: Replace the spring if the spring tension is less than 76 lb. (338 N) at 1.70 in (43.2 mm) length.



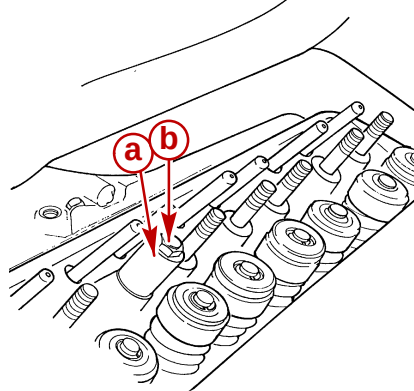
72308

a - Valve Spring Tester (P/N J-9666)

b - Torque Wrench

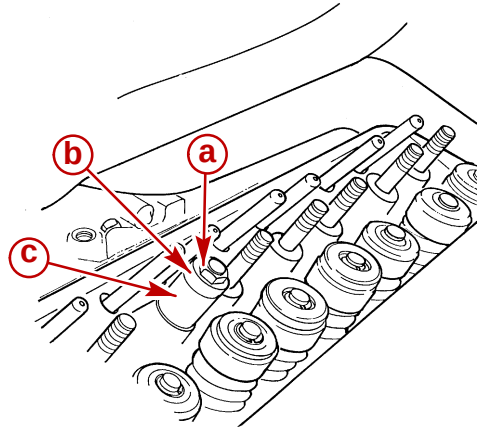
Rocker Arm Stud Replacement

1. Replace worn or loose rocker arm studs with oversize studs.
2. Use rocker arm stud remover to partially remove old stud as follows:
 - a. Place large sleeve, flat washer and nut over stud.
 - b. Turn nut until it contacts stud threads.
3. Remove nut and install small sleeve on stud.
4. Install nut on stud and turn nut to remove stud.



72309

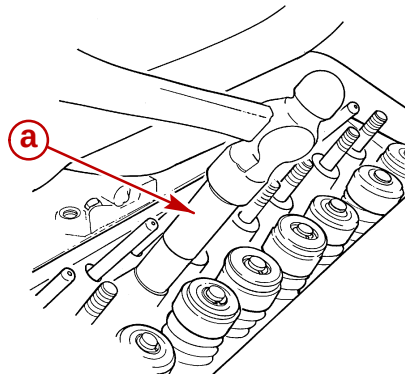
- a** - Large Sleeve
b - 3/8-24 Thd. Nut



72310

- a** - Nut
b - Small Sleeve
c - Large Sleeve

5. When installing an oversize stud ream stud hole using appropriate reaming tool.
6. Install new stud with rocker arm stud installer.



72311

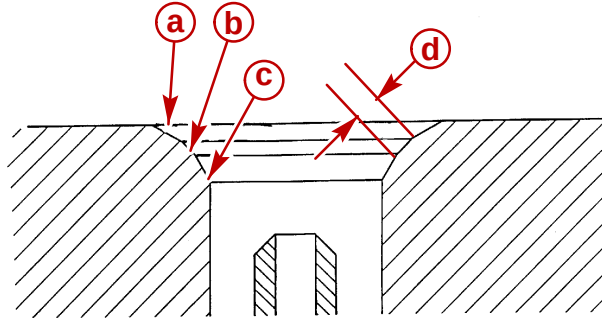
- a** - Rocker Arm Stud Installer (J-6880)

Valve Seat Repair

Valve seat reconditioning is very important, since seating of valves must be perfect for engine to deliver maximum power and performance.

Another important factor is valve head cooling. Good contact between each valve and its seat in valve head is important to ensure that heat will be properly dispersed.

Several different types of equipment are available for reconditioning valve seats. Equipment manufacturer's recommendations should be followed carefully to attain proper results.



50668

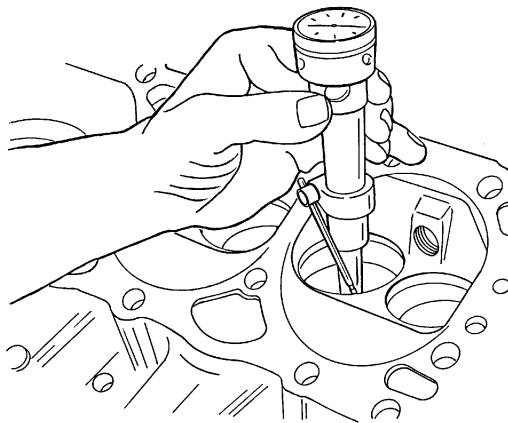
Typical "3 Angle" Valve Seat

- a** - Top Angle (30°)
- b** - Seat Angle (46°)
- c** - Bottom Angle (60°)
- d** - Seat Width

Intake 1/32-1/16 [.031-.063] In. (0.8-1.5 mm)

Exhaust 1/16-3/32 [.063-.094] In. (1.6-2.3 mm)

Regardless of type of equipment, it is essential that valve guide bores be free from carbon or dirt to achieve proper centering of pilot in valve guide, ensuring concentricity.



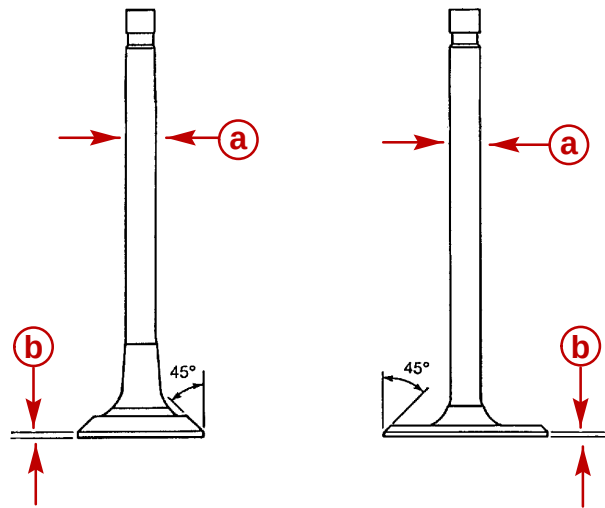
72338

Measuring Valve Seat Concentricity

Valve Grinding

Valves that are pitted must be refaced to the proper angle. Valve stems that show excessive warp or wear, must be replaced. When a warped valve head is refaced, a knife edge will be ground on part or all of the valve head due to the amount of metal that must be removed to completely reface. Heat will localize on this edge and lead to breakage, burning or pre-ignition. If the edge of the valve head (valve margin) is less than 0.031 in. (0.79 mm) after grinding, replace the valve.

Several different types of equipment are available for refacing valves. The manufacturer's recommendation should be carefully followed to attain proper results.



50695

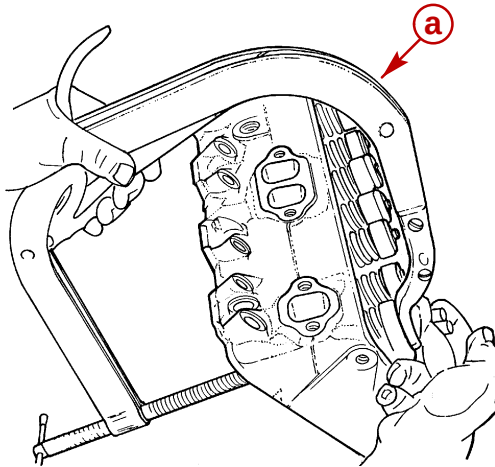
Exhaust**Intake**

- a** - .341 In. (8.16 mm)
b - 0.031 (0.79) Minimum

Reassembly

1. Lubricate valve guides and valve stems with engine oil.
2. Install each valve in the port from which it was removed or to which it was fitted.
3. Install valve guide seal (intake valve only) over valve stem and push down until seated against head.
4. Set valve spring (with damper installed) and shield in place.
5. Place cap on intake valve and/or rotator on exhaust valve.

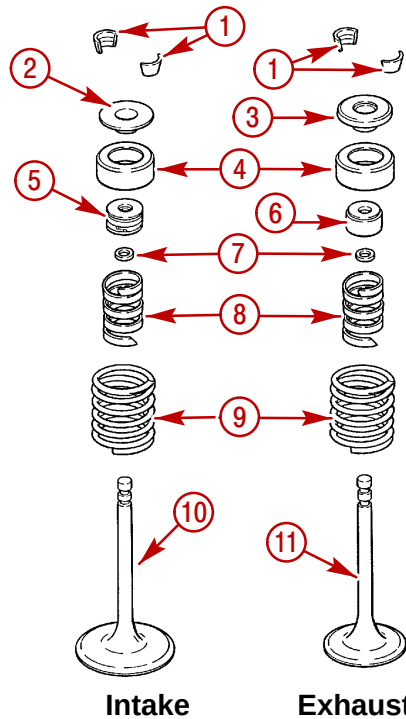
6. While compressing valve spring install oil seal in lower groove of valve stem. Ensure seal is not twisted. A light coating of oil will help prevent twisting.



72333

a - Valve Spring Compressor (J-8062)

7. Install valve locks (grease may be used to hold them in place) and slowly release tool. Ensure locks seat properly in upper grooves of valve stem.

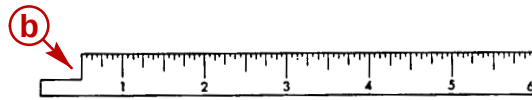


72331

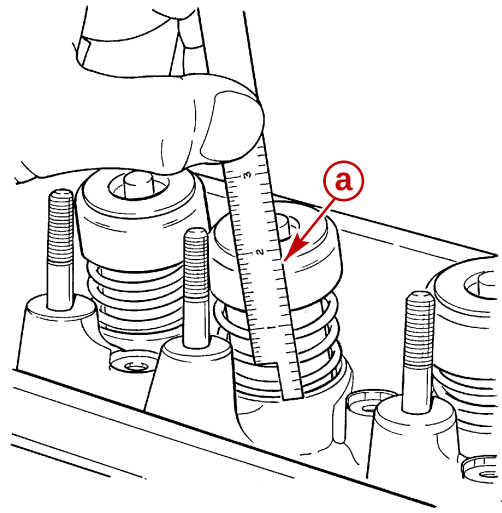
- 1** - Valve Locks
- 2** - Retainer
- 3** - Rotator
- 4** - Cap
- 5** - Valve Guide Oil Seal
- 6** - Oil Shield
- 7** - Valve Stem Oil Seal
- 8** - Inner Spring
- 9** - Outer Spring
- 10** - Intake Valve
- 11** - Exhaust Valve

8. Check installed height of valve springs using a narrow, thin scale. Measure from spring seat to top of valve spring, as shown.

IMPORTANT: If measurement exceeds specified height, install a valve spring shim and re-check. DO NOT shim valve springs to give an installed height less than the minimum specified.



05037

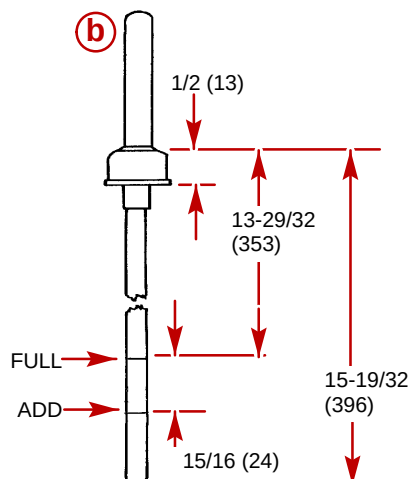
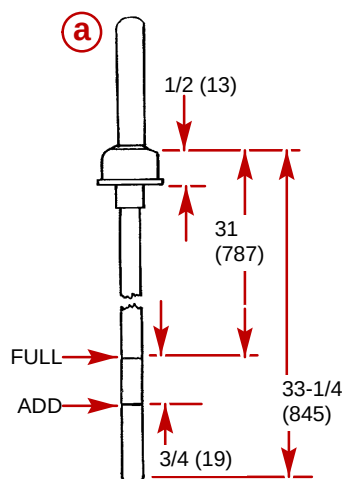


72339

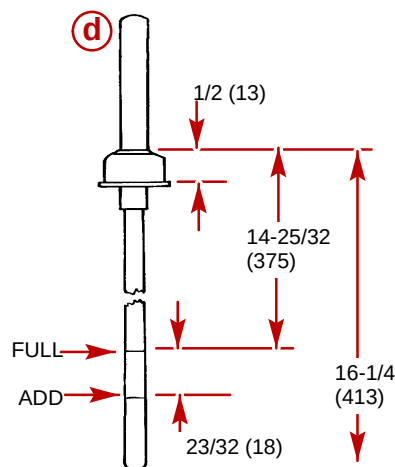
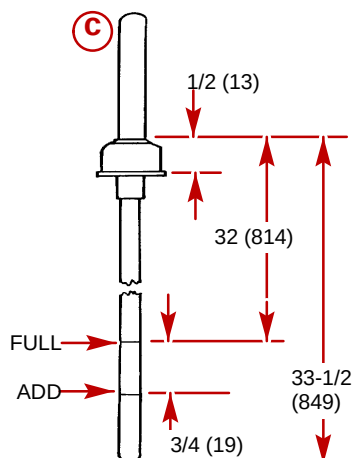
- a** - Valve Spring Installed Height
- b** - Cut Away Scale (Grind Out This Portion)

Crankcase Oil Dipstick Specifications

All Engines



72341



72341

Earlier Models

a - All MCM Engines (15297)

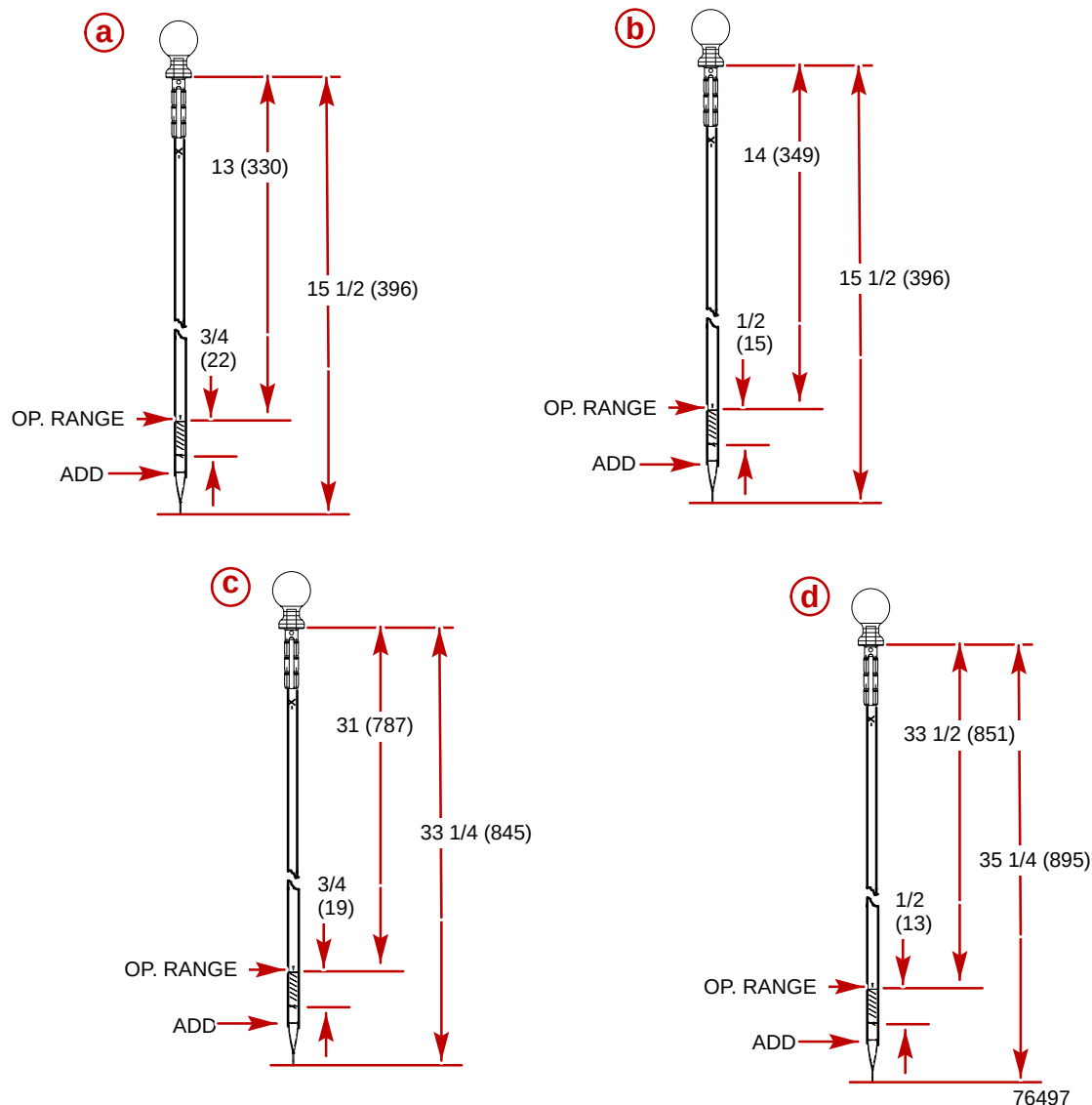
b - MIE Inboard Engines With In-Line or Down Angle Transmissions (805395) ¹

c - All MIE Ski Engines (16482)

d - MIE Inboard Engines With V-Drive Transmissions (805394) ¹

¹ Engines with Plastisol Coated Oil Pans

Crankcase Oil Dipstick Specifications (Continued)



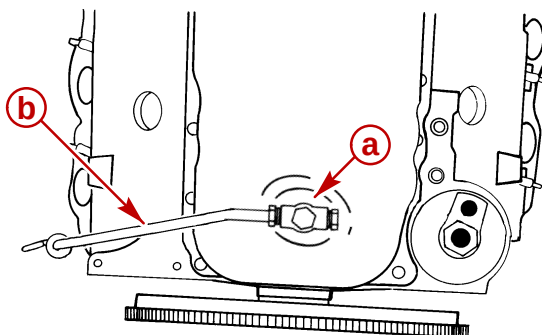
Later Models

- a** - All MIE Engines (861942-2)
- b** - All MIE Engines Remote Drive Transmissions(861942-3)
- c** - All MCM Service And Ski (861942-7)
- d** - All MCM Engines (861942-9)

Oil Pan

Removal

1. Drain crankcase oil.
2. If necessary, disconnect outlet hose from seawater pump.
3. Remove dipstick and tube. **On MIE models, be careful not to disturb orientation of banjo fitting on bottom of pan.**



71859

- a** - Banjo Fitting
b - Dipstick Tube

4. Remove oil pan.

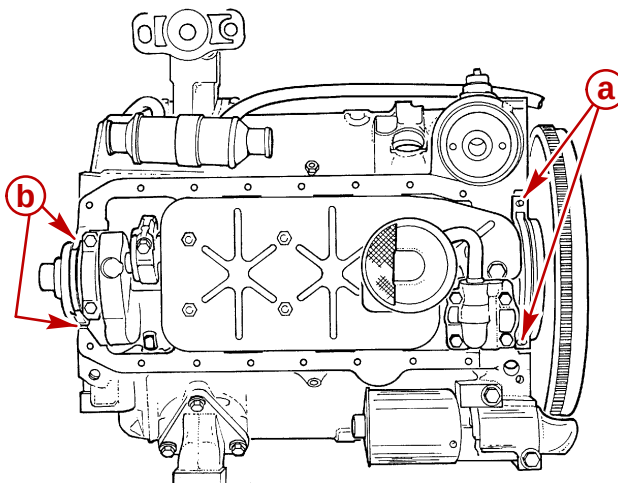
Cleaning and Inspection

1. Clean sealing surfaces of engine block and oil pan.

Installation

1. Apply a small amount of Quicksilver RTV Sealer to joints of rear seal retainer and joints of front cover.

IMPORTANT: Quicksilver RTV Sealer sets up in about 15 minutes. Be sure to complete assembly promptly.

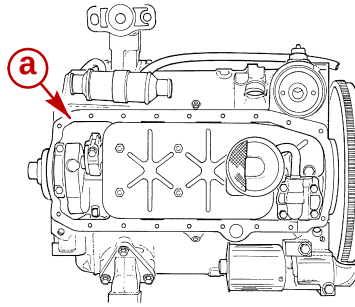


72343

- a** - Joints of Rear Seal Retainer
b - Joints of Front Cover

2. Install oil pan gasket in position as shown.

NOTE: A one-piece oil pan gasket may be re-used if it is still pliable and is not cracked, torn or otherwise damaged.



72344

a - Oil Pan Gasket

3. Install oil pan. Starting from the center and working outward in each direction, tighten oil pan stud nuts to 18 lb-ft (25 Nm) and oil pan reinforcement bolt or stud to 106 lb-in. (12 Nm).

4. Install dipstick tube and dipstick. **On MIE models, install dipstick tube as follows:**

a. Install banjo fitting as shown. Do not tighten banjo fitting bolt at this time.

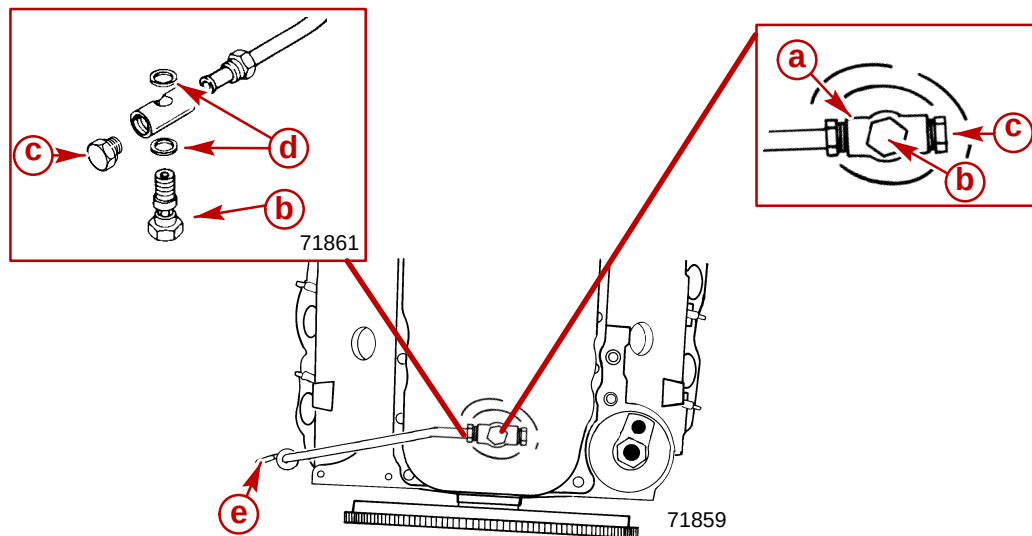
NOTE: Dipstick tube can be positioned on either side of engine.

b. Install dipstick tube and secure with hardware as shown. Do not tighten tube at banjo fitting.

c. Secure tube at manifold.

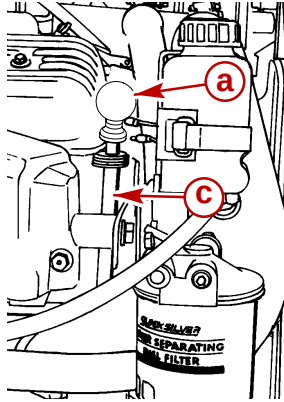
d. Tighten tube at banjo fitting.

e. Install plug in banjo fitting.

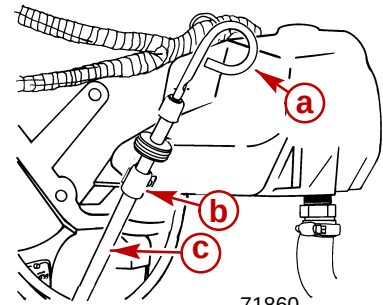


- a - Banjo Fitting**
- b - Banjo Fitting Bolt**
- c - Plug**
- d - Gaskets**
- e - Dipstick Tube**

- f. Tighten all connections on banjo fitting at this time. Torque banjo fitting bolt to 180 lb-in. (20 Nm). Tighten dipstick tube and plug securely.



76386



71860

Typical Dipstick Styles

- a** - Gage
- b** - Clamp (Secured by Manifold Screw)
- c** - Dipstick Tube

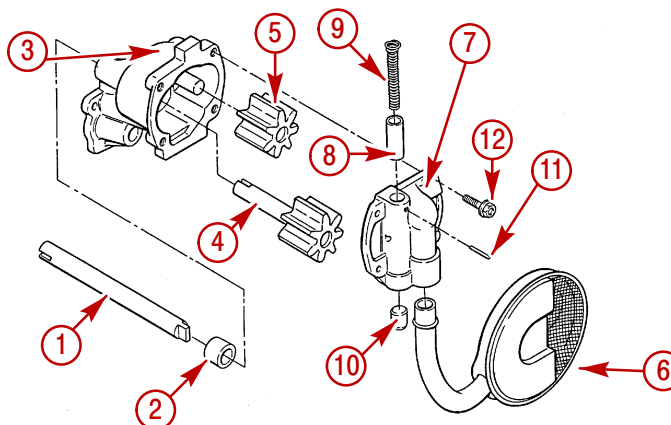
g. Install appropriate gage.

5. Fill crankcase with required quantity of oil of specified viscosity. See SECTION 1B - "Maintenance."

Oil Pump

The oil pump consists of two gears and a pressure regulator valve enclosed in a two-piece housing. It is only available as an assembly. The oil pump is driven by the distributor shaft, which is driven by a helical gear on camshaft.

Exploded View



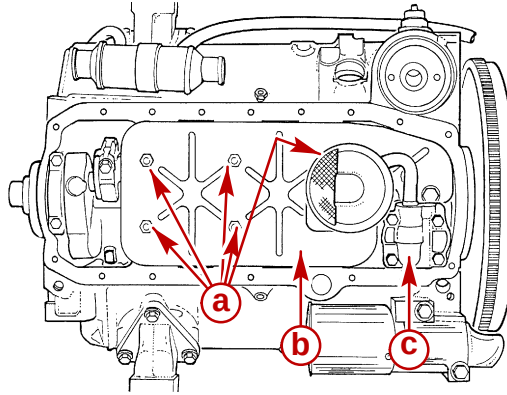
72146

Oil Pump Assembly

- 1** - Extension Shaft
- 2** - Shaft Coupling
- 3** - Pump Body
- 4** - Drive Gear and Shaft
- 5** - Idler Gear
- 6** - Pick Up Screen and Pipe
- 7** - Pump Cover
- 8** - Pressure Regulator Valve
- 9** - Pressure Regulator Spring
- 10** - Plug
- 11** - Pin
- 12** - Screws

Removal

1. Remove oil pan as outlined.
2. Remove gasket carefully as the one-piece gasket for the oil pan may be reused if still pliable and not cracked, torn or otherwise damaged.
3. Remove baffle.



72344

- a** - Nuts (5)
- b** - Baffle
- c** - Oil Pump

4. Remove oil pump.

Disassembly

Refer to "Exploded View" in this section.

1. Remove pump cover.

IMPORTANT: Mark gear teeth for reassembly with same teeth indexing.

2. Remove idler gear and drive gear from pump body.
3. Remove retaining pin, spring and pressure regulator valve from pump cover.

IMPORTANT: Do not remove pickup screen and pipe assembly unless replacement is necessary. Loss of press fit condition could result in an air leak and loss of oil pressure.

IMPORTANT: Do not disturb pickup screen on pipe. This is serviced as an assembly.

4. If pickup screen and pipe assembly requires replacement, mount pump in a soft-jawed vise and extract pipe from pump.

Cleaning and Inspection

1. Wash all parts in cleaning solvent and dry with compressed air.
2. Inspect pump body and cover for cracks or excessive wear.
3. Inspect pump gears for damage and excessive wear.
4. Check for loose drive gear shaft in pump body.
5. Inspect inside of pump cover for wear that would permit oil to leak past ends of gears.
6. Inspect pickup screen and pipe assembly for damage to screen and pipe.
7. Check pressure regulator valve for fit.

IMPORTANT: Pump gears and body are not serviced separately. If pump gears or body are damaged or worn, replacement of entire oil pump assembly is necessary.

Reassembly

⚠ CAUTION

Be careful of twisting, shearing or collapsing pipe while installing in pump. Pickup screen must be parallel to oil pan bottom when oil pump is installed.

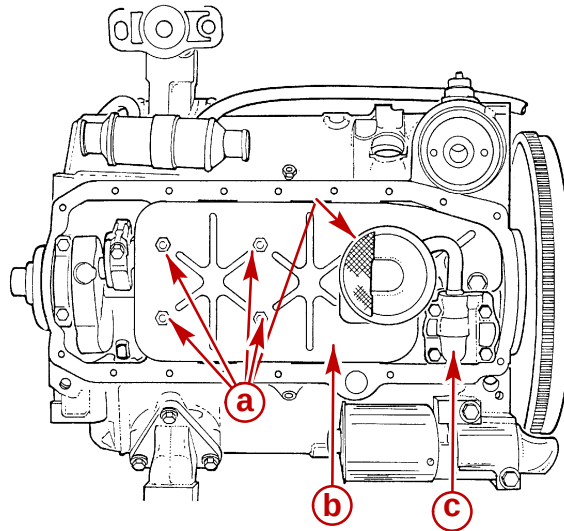
1. If pickup screen and pipe assembly was removed:
 - a. Mount pump in a soft-jawed vise.
 - b. Apply Quicksilver Perfect Seal to end of new pipe.
 - c. Using oil pump suction pipe installer (J-21882), tap the pipe in place with a hammer.

IMPORTANT: Oil internal parts liberally before installation.

1. Install pressure regulator valve and related parts.
2. Install drive gear in pump body.
3. Install idler gear in pump body with smooth side of gear toward pump cover opening.
4. Align marks made in disassembly.
5. Fill gear cavity with engine oil.
6. Install pump cover and torque attaching screws to 80 lb-in. (9 Nm).
7. Turn extension shaft by hand to check for smooth operation.

Installation

1. Install pump and extension shaft to rear main bearing, aligning extension shaft with distributor drive shaft.
2. Install baffle. Tighten baffle nuts to 25 lb-ft (34 Nm).
3. Tighten oil pump bolt to 65 lb-ft (88 Nm).



72344

- a** - 5 Nuts
- b** - Baffle
- c** - Oil Pump

4. Install oil pan as outlined. The one-piece gasket for the oil pan may be reused if still pliable and not cracked, torn or otherwise damaged.

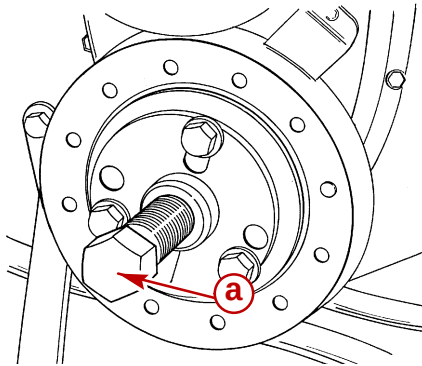
Torsional Damper

Removal

1. Remove drive belts.
2. Remove drive pulley,
3. Remove torsional damper retaining bolt.

IMPORTANT: Do not use a universal claw type puller to remove torsional damper (in next step) as outside ring of torsional damper is bonded in rubber to the hub and use of claw type puller may break the bond.

4. Remove torsional damper with torsional damper remover and installer. (J-23523-E)



72345

a - Torsional Damper Remover and Installer (J-23523-E)

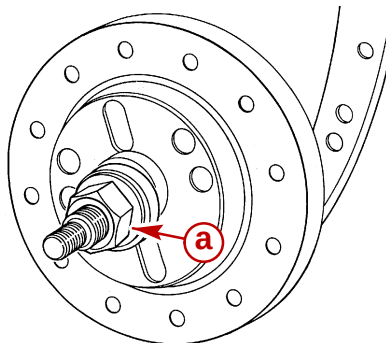
Installation

IMPORTANT: The inertia weight section of the torsional damper is assembled to the hub with a rubber type material. The installation procedure (with proper tool) must be followed or movement of the inertia weight on the hub will destroy the tuning of the torsional damper.

1. Replace key in crankshaft if it is damaged.
2. Coat seal surface of torsional damper with engine oil.
3. Install torsional damper on crankshaft, using torsional damper remover and installer as follows:
 - a. Install appropriate end of threaded rod into crankshaft.

IMPORTANT: Be sure to install threaded rod in crankshaft at least 1/2 in. (13 mm) to prevent damage to threads.

- b. Install plate, thrust bearing, washer and nut on rod.
- c. Install torsional damper on crankshaft by turning nut until it contacts.



72346

a - Torsional Damper Remover and Installer (J-23523-E)

- d. Remove tool from crankshaft.
 - e. To prevent oil leakage, apply Quicksilver RTV sealant to torsional damper keyway.
 - f. Install torsional damper bolt. Torque to 60 lb-ft (81 Nm).
- 4. Install drive pulley(s). Torque bolts to 35 lb-ft (48 Nm).
 - 5. Install and adjust drive belts.

Crankcase Front Cover Oil Seal

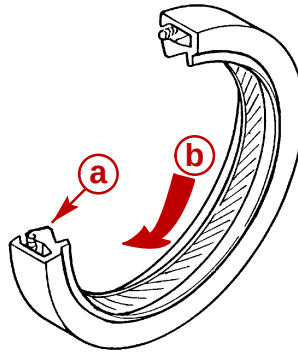
Oil Seal Replacement (Without Removing Front Cover)

REMOVAL

1. Remove torsional damper.
2. Pry seal out of cover from the front with a large screwdriver. Be careful not to distort front cover or damage crankshaft.

INSTALLATION

1. Apply Quicksilver Perfect Seal to seal retainer mating surface and apply grease to seal lips.



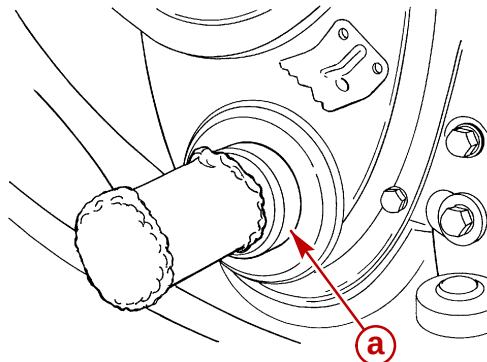
73124

a - Seal Lip Toward Inside of Engine

b - Rotation of Crankshaft as Viewed from Front End Looking Toward Flywheel End

2. Install new seal with open end of seal inward, using crankcase front cover seal installer. Drive seal in until it just contacts.

IMPORTANT: Do not use excessive force.



72347

a - Crankcase Front Cover Seal Installer (J-35468)

3. Reinstall torsional damper as outlined.

Crankcase Front Cover

Removal

1. Remove engine from boat if necessary to gain access to cover.
2. Remove torsional damper and oil pan.
3. Remove water circulating pump.

IMPORTANT: Crankcase front cover is not reusable per G.M. Specification. It must be replaced if removed.

4. Remove crankcase front cover.
5. If damaged, drive oil seal out of front cover (from the rear) using a punch.

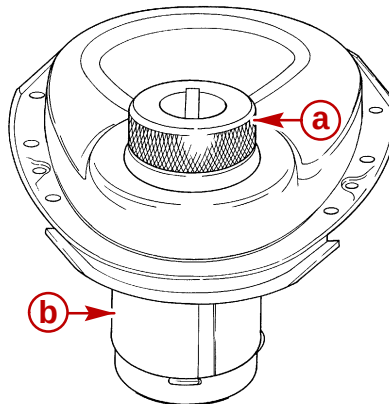
Cleaning and Inspection

1. Clean old gasket material and sealer from mating surfaces on cylinder block.

IMPORTANT: Surfaces must be clean and flat or oil leakage may result.

Installation

1. Install oil seal in new cover with lip of seal toward inside of engine, using crankcase front cover seal installer. Support cover around seal area with appropriate tool as shown.



72348

a - Crankcase Front Cover Seal Installer (J-35468)

b - Support (to Prevent Distorting Cover)

2. Coat both sides of front cover gasket with Quicksilver Perfect Seal and place in position on engine.
3. Install front cover, making sure holes in cover align with dowel pins in block. Torque front cover attaching screws to 106 lb-in. (12 Nm).

4. Install oil pan and torsional damper as outlined.
5. Install water circulating pump.
6. Reinstall engine in boat.
7. Fill crankcase with engine oil.
8. Follow procedures in SECTION 6A or 6B of this manual:

Seawater Cooled Models: Provide for adequate water supply to seawater pickup (see SECTION 6A).

Closed Cooled Models: Refill closed cooling section (see SECTION 6B), and provide adequate water supply to seawater pickup.

 CAUTION

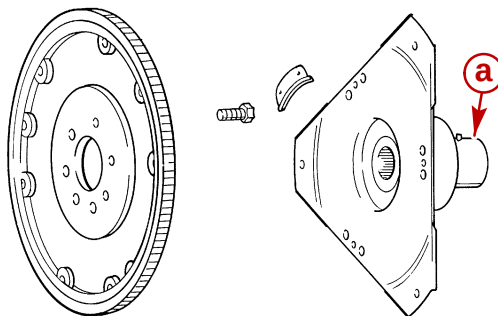
Ensure that cooling water supply is available before starting the engine.

9. Start engine and check for water and oil leaks.

Flywheel

Removal

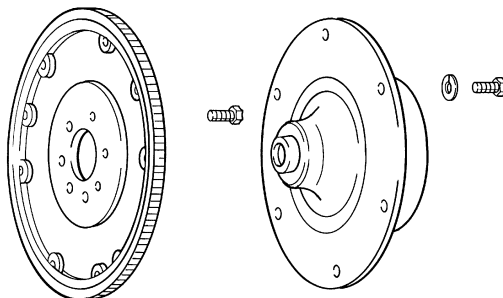
1. Remove engine from boat.
2. Remove transmission, if equipped.
3. Remove flywheel housing and related parts.
4. Remove MCM coupler or MIE drive plate.
5. Remove flywheel.



72349

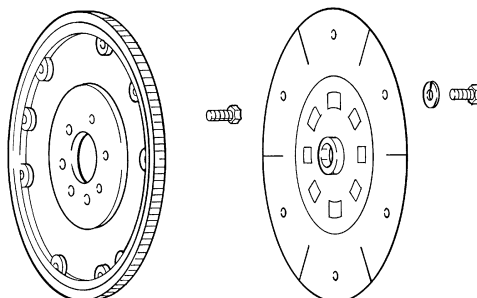
Alpha Coupler

a - Some earlier models did not have sealed, steel hub coupler.



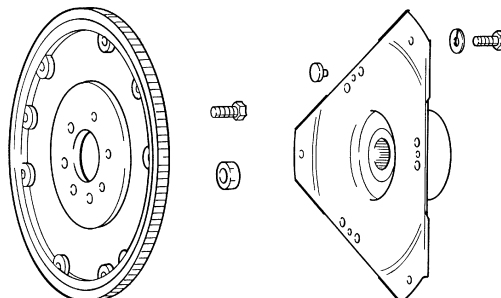
72350

Bravo Coupler



72351

MIE Drive Plate



72352

Drive Shaft Extension Coupler

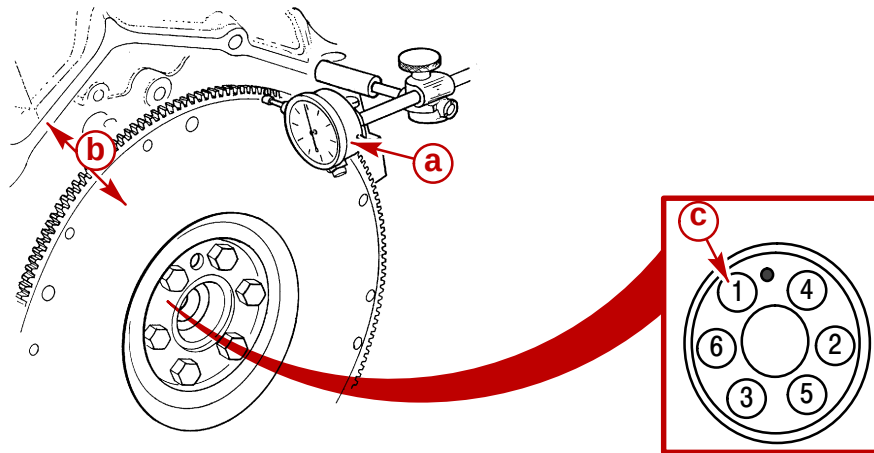
Cleaning and Inspection

1. Inspect splines in drive plate or coupler for wear.
2. Check flywheel ring gear for worn and missing teeth.
3. Clean mating surfaces of flywheel and crankshaft. Remove any burrs. Mating surfaces must be clean bare metal.

Installation

NOTE: Pilot bushing can be reused. The pilot bushing can be removed without damage by filling pilot bushing cavity with grease, then inserting an old transmission input shaft in bore of bushing and hitting it with a hammer. This will create hydraulic pressure in pilot bushing cavity that should force bushing out.

1. Install flywheel while aligning dowel hole in flywheel with dowel in crankshaft. Apply Loctite 27131 to threads of flywheel bolts. Torque bolts in sequence to 75 lb-ft (100 Nm).
2. Check flywheel runout as follows:
 - a. Attach a dial indicator to engine block.
 - b. Take readings around outer edge of flywheel. Push in on flywheel to remove crankshaft end play.
 - c. Maximum runout - .008 in. (0.203 mm).

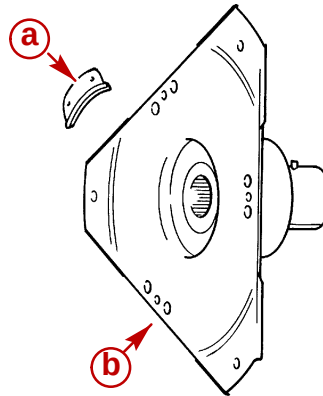


72353

- a** - Dial Indicator
b - Push Flywheel and Crankshaft Forward as Far as It Will Go When Taking Reading
c - Torque Sequence

IMPORTANT: Insert three rubber bumpers in Alpha coupler before installation on flywheel.

3. Insert three rubber bumpers in Alpha coupler before installation on flywheel.



72354

Typical

- a** - Rubber Bumper (Alpha Coupler Only)
- b** - Coupler

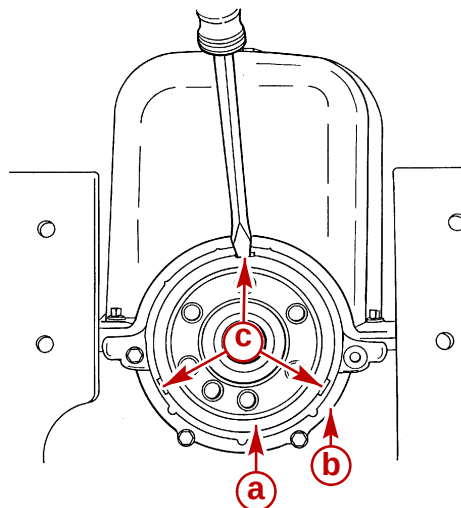
4. Install drive coupler or drive plate. Torque bolts to 35 lb-ft (48 Nm).
5. Install flywheel housing and related parts. Torque bolts to 30 lb-ft (41 Nm).
6. Install flywheel housing cover. Torque bolts to 80 lb-in. (9 Nm).
7. Install transmission (MIE). Torque bolts to 50 lb-ft (68 Nm).
8. Install engine.

Rear Main Oil Seal

The rear crankshaft oil seal can be replaced without removing the oil pan or rear main bearing cap from engine.

Removal

1. Remove the flywheel.
2. Remove seal by using a screwdriver to pry it out of the seal retainer as shown.



72355

- a** - Rear Seal
- b** - Seal Retainer
- c** - Slots (Three)

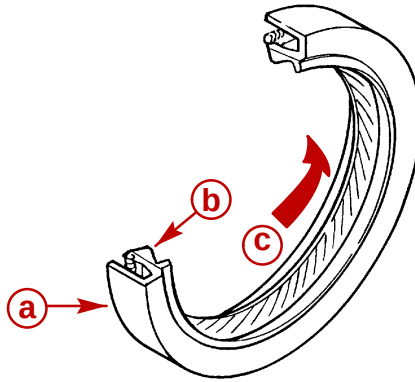
Cleaning and Inspection

1. Clean crankshaft seal running surface.
2. Clean the seal retainer bore.

Installation

1. Apply a thin coat of clean engine oil to the bore of the seal retainer.
2. Apply a thin coat of clean engine oil to the outer diameter of the seal.

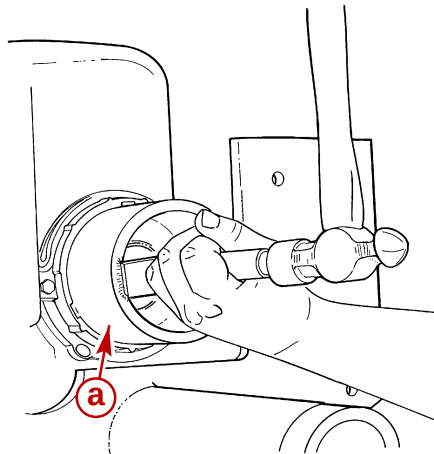
IMPORTANT: Do not allow oil or other lubricants to contact the seal surface of the rear oil main seal.



73127

- a** - Rear Main Oil Seal
- b** - Seal Lip Toward Inside of Engine
- c** - Rotation of Crankshaft as Viewed from Flywheel End Looking Forward

3. Install seal using rear main seal installer as shown.



72356

- a** - Rear Main Seal Installer (J-26817-A)

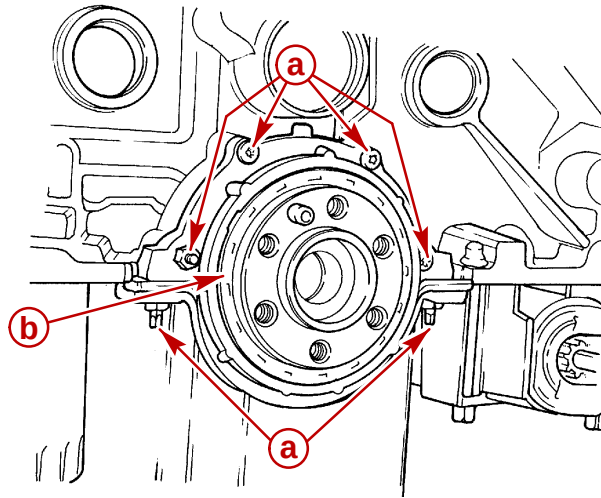
NOTE: Tool J35621-A (not shown) may also be used to install the seal. This tool holds the seal and attaches to the crankshaft. The seal is then pressed into the seal retainer by turning the large wing nut on the tool.

Rear Main Oil Seal Retainer

The rear main oil seal retainer can only be replaced with the oil pan removed.

Removal

1. Remove oil pan.
2. Remove oil seal retainer fasteners.
3. Remove oil seal retainer.



72464

- a** - Fasteners
b - Oil Seal Retainer

4. Remove old gasket.

Cleaning and Inspection

1. Clean gasket material from mating surfaces.
2. Inspect oil seal retainer for cracks or scored surface.
3. Inspect oil seal for worn, dry or torn rubber. Replace if necessary (refer to "Rear Main Oil Seal" as outlined).
4. Inspect alignment pin for damage. Replace if necessary.

Installation

IMPORTANT: Always use a new crankshaft rear main oil seal and new oil seal retainer gasket when installing the crankshaft rear main oil seal retainer.

1. Install new oil seal retainer gasket.

IMPORTANT: Do not allow oil or other lubricants to contact the seal surface of the rear main oil seal.

2. Install the crankshaft rear oil seal retainer on to the studs.
3. Install retainer nuts and bolts. Torque to 106 lb-in. (12 Nm).
4. If not already installed, install the Rear Main Oil Seal as outlined.
5. Install oil pan as outlined.

NOTE: A one-piece oil pan gasket may be re-used if it is still pliable and is not cracked, torn or otherwise damaged.

Main Bearings

IMPORTANT: Before removing main bearing caps or connecting rod caps, mark them for reassembly in their original locations.

Main bearings are of the precision insert type and do not use shims for adjustment. If clearances are found to be excessive, a new bearing, both upper and lower halves, will be required. Service bearings are available in standard size and .001 in., .010 in. and .020 in. undersize.

Selective fitting of both rod and main bearing inserts is necessary in production to obtain close tolerances. For this reason you may find one-half of a standard insert with one-half of a .001 in. undersize insert which will decrease the clearance .0005 in. from using a full standard bearing.

When a production crankshaft cannot be precision fitted by this method, it is then ground .009 in. undersize **ON ONLY THOSE MAIN JOURNALS THAT CANNOT BE PROPERLY FITTED. ALL JOURNALS WILL NOT NECESSARILY BE GROUND UNDERSIZE.** A .009 in. undersize bearing and .010 in. undersize bearing may be used for precision fitting in the same manner as previously described.

Inspection

In general, the lower half of the bearing (except No. 1 bearing) shows a greater wear and the most distress from fatigue. If upon inspection the lower half is suitable for use, it can be assumed that the upper half is also satisfactory. If the lower half shows evidence of wear or damage, both upper and lower halves should be replaced. Never replace one half without replacing the other half.

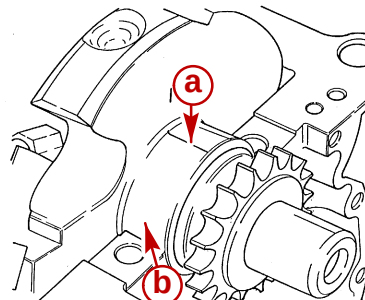
Checking Clearances

To obtain accurate measurements while using Plastigage, or its equivalent, engine must be out of the boat and upside down so crankshaft will rest on the upper bearings and total clearance can be measured between lower bearing and journal.

To assure the proper seating of the crankshaft, all bearing cap bolts should be at their specified torque. In addition, preparatory to checking fit of bearings, the surface of the crankshaft journal and bearing should be wiped clean of oil.

1. With the oil pan and oil pump removed, remove bearing cap and wipe oil from journal and bearing cap to be inspected.
2. Place a piece of gauging plastic the full width of the bearing (parallel to the crankshaft) on the journal as shown.

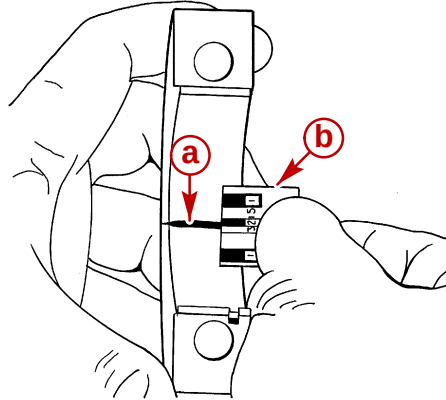
NOTICE
Do not rotate the crankshaft while the gauging plastic is between the bearing and journal.



72357

- a** - Gauging Plastic
b - Journal

3. Install the bearing cap and evenly torque the retaining bolts to specifications. Bearing cap **MUST** be torqued to specification to ensure proper reading. Variations in torque affect the compression of the plastic gauge.
4. Remove bearing cap. The flattened gauging plastic will be found adhering to either the bearing cap or journal.
5. On the edge of the gauging plastic envelope there is a graduated scale which is correlated in thousandths of an inch. Without removing the gauging plastic, measure its compressed width (at the widest point) with the graduations on the gauging plastic envelope as shown.



72358

a - Compressed Gauging Plastic

b - Graduated Scale

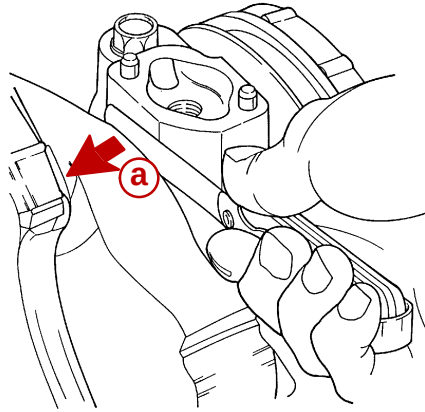
NOTE: Normally main bearing journals wear evenly and are not out of round.

- if a bearing is being fitted to an out-of-round journal (.001 in. max.), be sure to fit to the maximum diameter of the journal.
 - If the bearing is fitted to the minimum diameter, and the journal is out of round .001 in., interference between the bearing and journal will result in rapid bearing failure.
 - If the flattened gauging plastic tapers toward the middle or ends, there is a difference in clearance indicating taper, low spot or other irregularity of the bearing or journal.
 - Measure the journal with a micrometer if the flattened gauging plastic indicates more than .001 in. difference.
6. If the bearing clearance is within specifications, the bearing insert is satisfactory. If the clearance is not within specifications, replace the insert. Always replace both upper and lower inserts as a unit.
 7. A standard or .001 in. undersize bearing may produce the proper clearance. If not, it will be necessary to regrind the crankshaft journal for use with the next undersize bearing.

IMPORTANT: After selecting new bearing, recheck clearance.

8. Proceed to the next bearing. After all bearings have been checked, rotate the crankshaft to check for excessive drag. When checking No. 1 main bearing, loosen accessory drive belts to prevent tapered reading with plastic gauge.

9. Measure crankshaft end play (see "Specifications") by forcing the crankshaft to the extreme front position. Measure at the front end of the rear main bearing with a feeler gauge as shown.

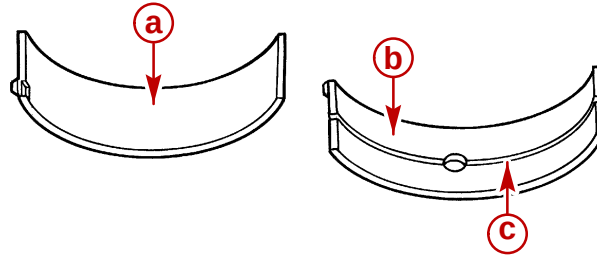


72360

a - Force Crankshaft to Extreme Forward Position

Replacement

NOTE: Main bearings may be replaced with or without removing crankshaft.



72359

Main Bearing Inserts

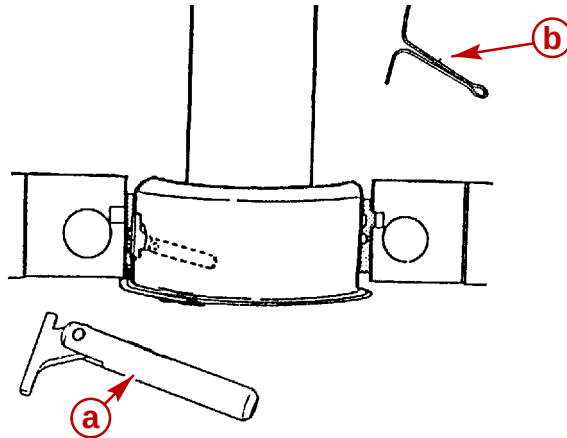
- a** - Lower Bearing Insert
- b** - Upper Bearing Insert
- c** - Oil Groove

WITH CRANKSHAFT REMOVED

1. Remove and inspect the crankshaft.
2. Remove the main bearings from the cylinder block and main bearing caps.
3. Coat bearing surfaces of new main bearings with oil.
4. Install the upper bearings in cylinder block.
5. Install the lower bearings in main bearing caps.
6. Install the crankshaft.

WITHOUT CRANKSHAFT REMOVED

1. Remove oil pan, oil pump and spark plugs.
2. Remove cap on main bearing requiring replacement.
3. Remove bearing from cap.
4. Install main bearing remover/installer in oil hole in crankshaft journal. If such a tool is not available, a cotter pin may be bent, as shown, and used.



72622

a - Main Bearing Remover/Installer (J-8080)

b - Cotter Pin

5. Rotate the crankshaft clockwise as viewed from the front of engine. This will roll upper bearing out of block.
6. Oil new upper bearing.
7. Insert plain (unnotched) end between crankshaft and indented or notched side of block.
8. Rotate the bearing into place and remove tool from oil hole in crankshaft journal.
9. Oil new lower bearing and install in bearing cap.
10. Install main bearing cap with arrows pointing toward front of engine.
11. Torque all main bearing caps, EXCEPT THE REAR MAIN CAP, to specifications.
12. Torque rear main bearing cap to 15 lb-ft (20 Nm); then tap end of crankshaft, first rearward then forward with a lead hammer. This will line up rear main bearing and crankshaft thrust surfaces.
13. Torque rear main bearing cap to specification.

Connecting Rod Bearings

Connecting rod bearings are of the precision insert type and do not use shims for adjustment. DO NOT FILE RODS OR ROD CAPS. If clearances are found to be excessive, a new bearing will be required. Service bearings are available in standard size and .001 in. and .002 in. undersize for use with new and used standard size crankshafts. They are also available in .010 in. and .020 in. undersize for use with reconditioned crankshafts.

When removing a connecting rod cap, you may find a .010 in. undersize bearing. These are used in manufacturing for selective fitting.

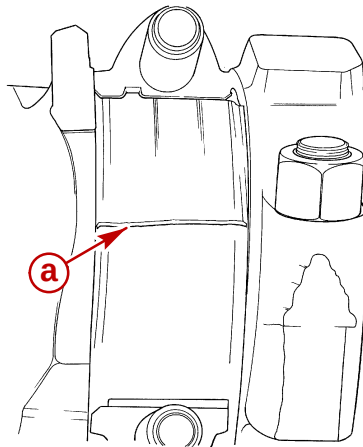
Inspection and Replacement

IMPORTANT: Before you remove the connecting rod cap, mark the side of the rod and cap with the cylinder number to assure matched reassembly of rod and cap.

1. Remove oil pan and oil pump.
2. Remove connecting rod cap and bearing.
3. Inspect bearing for evidence of wear and damage. Do not reinstall a worn or damaged bearing.
4. Wipe both upper and lower bearing shells and crankpin clean of oil.
5. Measure the crankpin for out-of-round or taper with a micrometer.
 - a. Not within specifications, replace or recondition the crankshaft.
 - b. Within specifications and a new bearing is to be installed, measure the maximum diameter of the crankpin to determine required bearing size.

NOTE: If within specifications, measure new or used bearing clearances with gauging plastic or its equivalent. If a bearing is being fitted to an out-of-round crankpin, be sure to fit to the maximum diameter of the crankpin. If the bearing is fitted to the minimum diameter, and the crankpin is out of round .001 in., interference between the bearing and crankpin will result in rapid bearing failure.

6. Measure bearing clearances.
 - a. Place a piece of gauging plastic, the length of the bearing (parallel to the crankshaft), on the crankpin or bearing surface as shown.
 - b. Position the gauging plastic in the middle of the bearing shell. Bearings are eccentric and false readings could occur if placed elsewhere.



72361

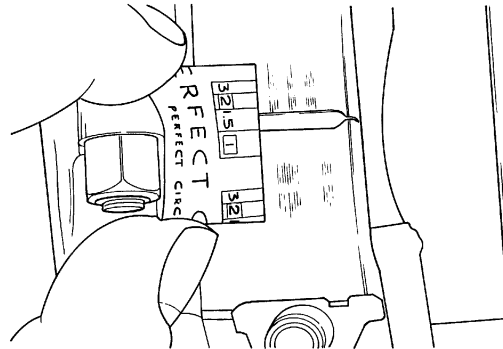
a - Gauging Plastic

- c. Install the bearing in the connecting rod and cap.
- d. Install the bearing cap. Bearing cap **MUST** be torqued to specification in order to ensure proper reading. Variations in torque affect the compression of the plastic gauge.
- e. Evenly, and in a two pass sequence, torque nuts to 20 lb-ft (27 Nm) on first pass. Then, torque nuts an additional 55 degrees angular torque.

NOTICE

Do not rotate the crankshaft while the gauging plastic is between the bearing and journal.
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- f. Remove the bearing cap and use the scale on the gauging plastic envelope to measure the gauging plastic width at the widest point.

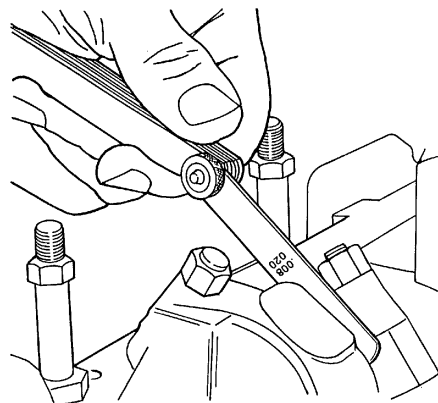


72362

7. If the clearance exceeds specifications, select a new, correct size bearing and remeasure the clearance.

NOTE: Be sure to check what size bearing is being removed in order to determine proper replacement size bearing. If clearance cannot be brought to within specifications, the crankpin will have to be ground undersize. If the crankpin is already at maximum undersize, replace crankshaft.

8. Coat the bearing surface with oil.
9. Install the rod cap.
10. Evenly, and in a two pass sequence, torque nuts to 20 lb-ft (27 Nm) on first pass. Then, torque nuts an additional 55 degrees angular torque.
11. When all connecting rod bearings have been installed, tap each rod lightly (parallel to the crankpin) to ensure clearance.
12. Measure all connecting rod side clearances (see "Specifications") between connecting rod caps as shown.



72363

Connecting Rod / Piston Assembly

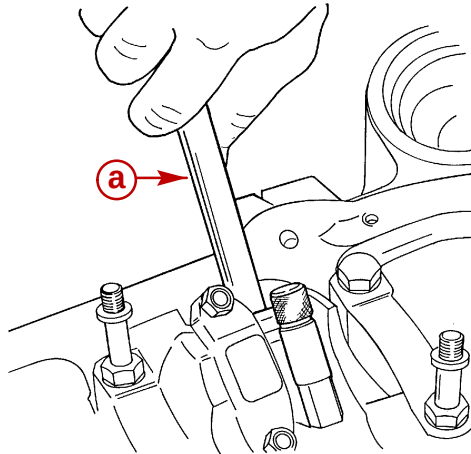
Removal

1. Remove oil pan and dipstick tube.
2. Remove baffle and oil pump.
3. Remove distributor and intake manifold.
4. Remove cylinder heads.

IMPORTANT: Before ridge and/or deposits are removed, turn crankshaft until piston is at bottom of stroke and place a cloth on top of piston to collect cuttings. After ridge and/or deposits are removed, turn crankshaft until piston is at top of stroke, then remove cloth and cuttings.

5. Use a ridge reamer to remove any ridge and/or deposits from upper end of cylinder bore.
6. Mark connecting rods and bearing caps (left bank 1, 3, 5 and 7; right bank 2, 4, 6 and 8 from front to rear on same side as piston thrust).
7. Remove connecting rod cap and install connecting rod bolt guide (3/8-24) on bolts. Push connecting rod and piston assembly out of top of cylinder block.

NOTE: Turn crankshaft slightly to disconnect and remove some connecting rod and piston assemblies.

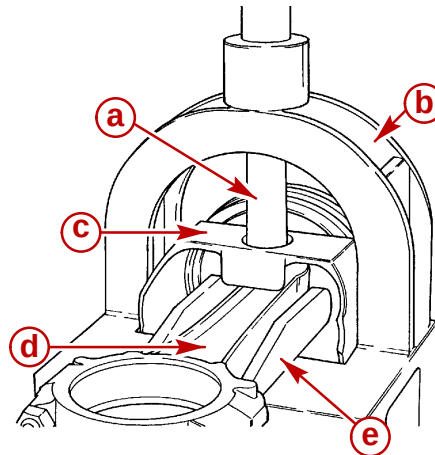


72364

a - Connecting Rod Bolt Guide 3/8-24 (J-5239)

Disassembly

Disassemble piston from connecting rod using piston pin remover as shown. Follow instructions supplied with kit.



72365

- a** - Piston Pin Remover (J-24086-B)
- b** - Arched Base
- c** - Piston
- d** - Connecting Rod
- e** - Rod Support

Cleaning and Inspection

CONNECTING RODS

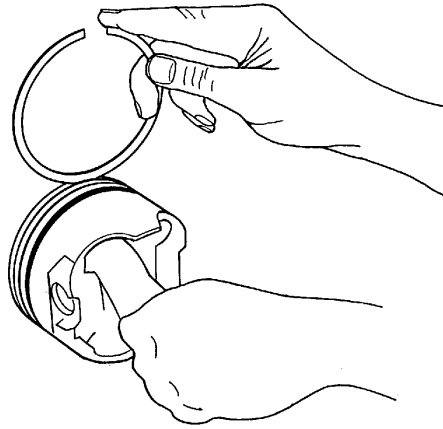
1. Wash connecting rods in cleaning solvent and dry with compressed air.
2. Check for twisted and bent rods and inspect for nicks and cracks. Replace damaged connecting rods.

PISTONS

NOTE: Cylinder bore and taper must be within specifications before pistons can be considered for re-use.

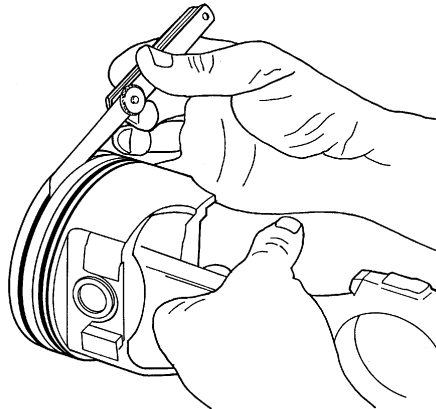
1. Clean varnish from piston skirts with a cleaning solvent. DO NOT WIRE BRUSH ANY PART OF PISTON. Clean ring grooves with a groove cleaner and make sure oil ring holes are clean.
2. Inspect piston for damaged ring lands, skirts and pin bosses, wavy or worn ring lands, scuffed or damaged skirts and eroded areas at top of piston.
3. Inspect grooves for nicks and burrs that might cause rings to hang up.
4. Measure piston skirt and check clearance as outlined under "Piston Selection."

5. Slip outer surface of a new top and second compression ring into respective piston ring-groove and roll ring entirely around the groove to make sure that ring is free as shown. If binding occurs at any point, determine cause. If caused by ring groove, remove by dressing with a fine cut file. If binding is caused by a distorted ring, recheck with another ring.



72366

6. Proper clearance of piston ring in its groove is very important to provide proper ring action and reduce wear. Therefore, when fitting new rings, clearances between ring and groove surfaces should be measured. See "Specifications."
7. Replace pistons that are damaged or show signs of excessive wear.



72367

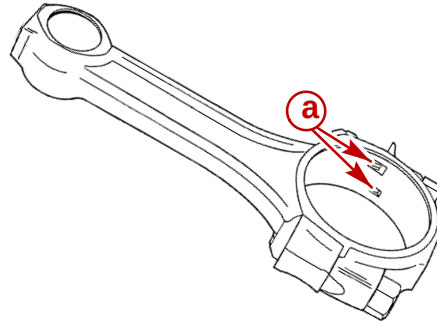
PISTON PINS

1. Piston pin clearance is designed to maintain adequate clearance under all engine operating conditions. Because of this, piston and piston pin are a matched set and not serviced separately.
2. Inspect piston pin bores and piston pins for wear. Piston pin bores and piston pins must be free of varnish and scuffing when measured. Measure piston pin with a micrometer and piston pin bore with a dial bore gauge or inside micrometer. If clearance is in excess of the .001 in. (0.025 mm) wear limit, replace piston and piston pin assembly.

Reassembly

IMPORTANT: When reassembling pistons and connecting rods, the following must be kept in mind.

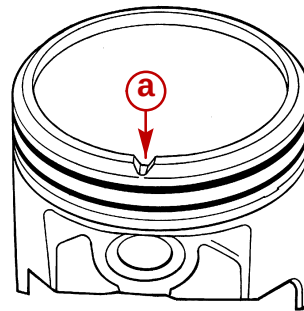
- Piston and pin are machine fitted to each other and must remain together as a matched set. Do not intermix pistons and pins.
- If original pistons and/or connecting rods are being used, be sure to assemble pistons and connecting rods so they can be reinstalled in same cylinder from which they were removed.
- Connecting rod bearing tangs are always toward outside of cylinder block.



72368

a - Rod Bearing Tangs

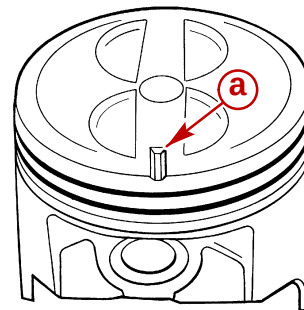
- To determine if engine is left-hand (standard) rotation or right-hand (opposite) rotation, inspect camshaft drive. If engine has a timing chain, engine is left-hand rotation. If engine has timing gears, engine is right-hand rotation. All MCM engines are left-hand rotation.
- Notch on piston must be positioned correctly for engine that is being repaired.



72369

305 cid / 5.0L Engines

a - Notch - Toward Front

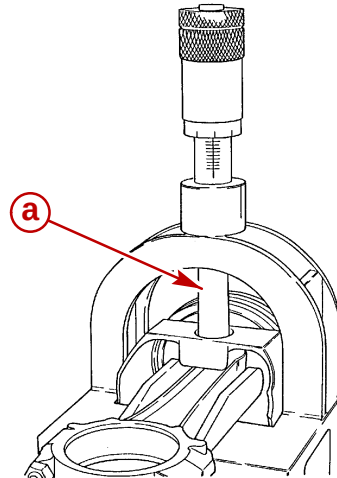


72370

350 cid / 5.7L Engines

a - Notch - Toward Front

1. Assemble piston to connecting rod using piston pin remover as shown. Follow instructions supplied with kit.



72371

a - Piston Pin Remover (J-24086-B)

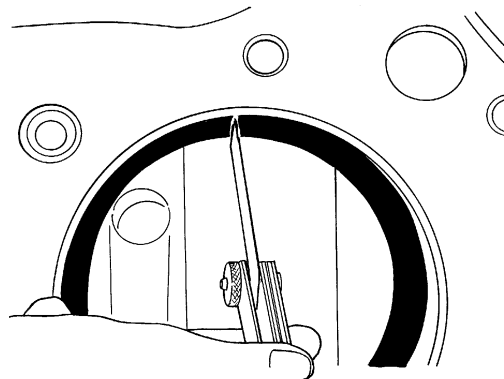
2. Once assembled, check piston for freedom of movement (back and forth and up and down) on connecting rod. Piston should move freely in all directions. If it does not, piston pin bore is tight and piston / pin assembly must be replaced.
3. If a new connecting rod has been installed, mark connecting rod and cap (on side of rod and cap with slots for connecting rod bearing tangs) with cylinder number in which it will be installed.

PISTON RINGS

All compression rings are marked on upper side of ring. When installing compression rings, make sure that marked side is toward top of piston.

Oil control rings are a three-piece type, consisting of two rings and a spacer.

1. Select rings comparable in size to cylinder bore and piston size.
2. Slip compression ring in cylinder bore, then press ring down into cylinder bore about 1/4 in. (6 mm) (below ring travel). Be sure that ring is square with cylinder wall.
3. Measure gap between ends of ring with a feeler gauge as shown.



72372

4. If gap between ends of ring is below specifications, remove ring and try another for fit.
5. Fit each compression ring to cylinder in which it is going to be used.
6. Clean and inspect pistons, if not previously done.
7. Install piston rings as follows:

- a. Install oil ring spacer in groove and insert anti-rotation tang in oil hole.
- b. Hold spacer ends butted and install lower steel oil ring rail with gap properly located.
- c. Install upper steel oil ring rail with gap properly located.
- d. Flex the oil ring assembly to make sure ring is free. If binding occurs at any point, the cause should be determined. If binding is caused by ring groove, remove by dressing groove with a fine cut file. If binding is caused by a distorted ring, use a new ring.

IMPORTANT: Use piston ring expander (91-24697) for compression ring installation.

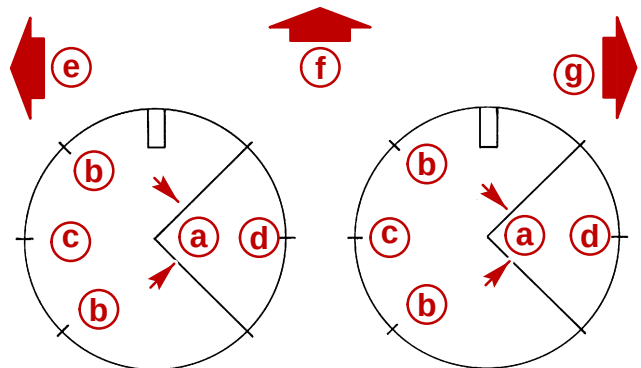
- e. Using ring expander, install lower compression ring with marked side up.
- f. Using ring expander, install top compression ring with marked side up.

Installation

IMPORTANT: Cylinder bores must be clean before piston installation. Clean with a light honing, as necessary. Then clean with hot water and detergent wash. After cleaning, swab bores several times with light engine oil and clean cloth, then wipe with a clean dry cloth.

1. Lubricate connecting rod bearings.
2. Install connecting rod bearings in rods and rod caps.
3. Lightly coat pistons, rings and cylinder walls with light engine oil.
4. With bearing caps removed, install connecting rod bolt guide 3/8-24 (J-5239) on connecting rod bolts.

IMPORTANT: Be sure ring gaps are properly positioned as shown.



1-3-5-7 Cylinders

2-4-6-8 Cylinders

72373

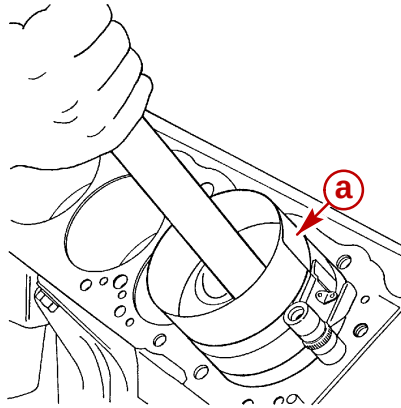
Ring Gap Location

- a** - Oil Ring Spacer Gap (Tang in Hole or Slot Within Arc)
- b** - Oil Ring Rail Gaps
- c** - 2nd Compression Ring Gap
- d** - Top Compression Ring Gap
- e** - Engine Left
- f** - Engine Front
- g** - Engine Right

5. Install each connecting rod and piston assembly in its respective bore with connecting rod bearing tangs toward outside of cylinder block.
6. Use piston ring compressor to compress rings.
7. Guide connecting rod into place on crankshaft journal with connecting rod bolt guide. Use a hammer handle with light blows to install piston into bore.

8. Hold ring compressor firmly against cylinder block until all piston rings have entered cylinder bore.

IMPORTANT: Be sure to install new pistons in same cylinders for which they were fitted, and used pistons in same cylinder from which they were removed. Each connecting rod and bearing cap should be marked, beginning at front of engine (1, 3, 5 and 7 in left bank and 2, 4, 6 and 8 in right bank). Numbers on connecting rod and bearing cap must be on same side when installed in cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and connecting rod should be numbered to correspond with new cylinder number.



72374

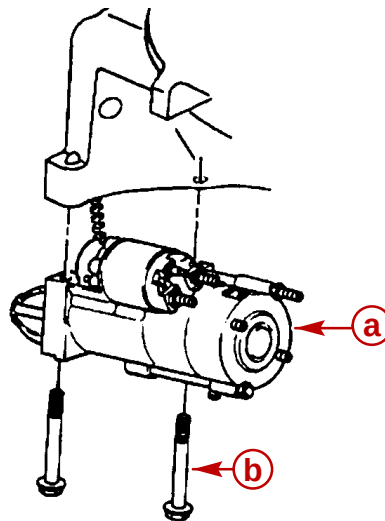
a - Piston Ring Compressor (J-8037)

9. Remove connecting rod bolt guide.
 10. Install bearing caps and torque nuts to 45 lb-ft (61 Nm).
 11. Check connecting rod side clearance as previously described.
- NOTE:** If bearing replacement is required, refer to "Connecting Rod Bearings."
12. Install oil pump and baffle.
 13. Install dipstick and oil pan.
 14. Install cylinder heads.
 15. Install intake manifold.
 16. Install distributor.
 17. Fill crankcase with oil. Refer to SECTION 1 - "Maintenance."
 18. Adjust valves as outlined under "Valve Adjustment - Engine Stopped."

Crankshaft

Removal

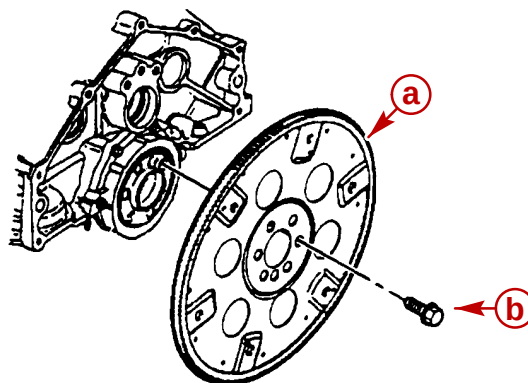
1. Remove engine from boat.
2. Drain crankcase oil.
3. Remove starter.



76489

- a** - Starter
b - Mounting Bolts

4. Remove flywheel housing.
5. Remove drive coupler/plate and flywheel.

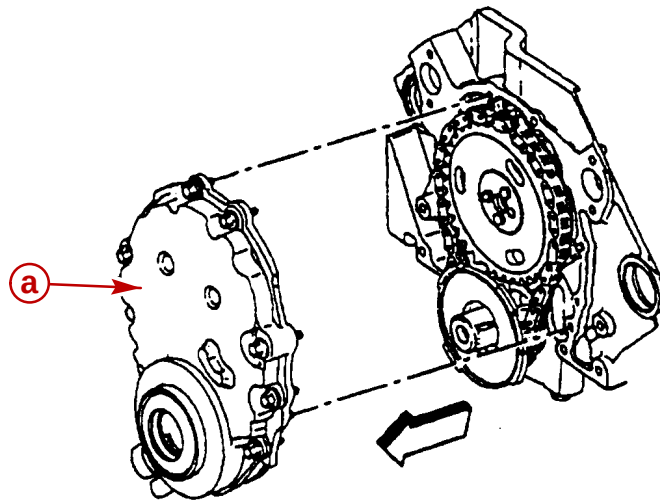


76490

- a** - Flywheel
b - Bolts

6. Remove belts.
7. Remove circulating pump.
8. Remove crankshaft pulley and torsional damper.
9. Remove spark plugs.
10. Remove oil pan and dipstick tube.
11. Remove baffle and oil pump.

12. Remove timing chain gear cover.



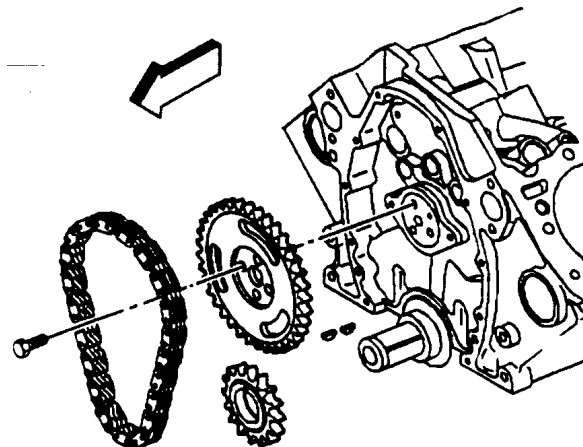
76491

a - Timing Chain Gear Cover

13. Remove timing chain.

14. Turn crankshaft to align timing mark with camshaft mark.

15. Remove camshaft sprocket or gear.



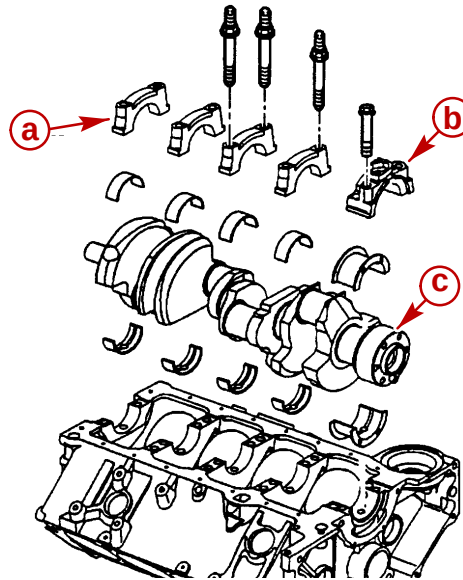
76488

16. Remove rear main seal and retainer.

17. Ensure all bearing caps (main and connecting rods) are marked so they can be reinstalled in their original locations.

18. Remove connecting rod bearing caps, then push piston and rod assemblies toward heads.

19. Remove main bearing caps and carefully lift crankshaft out of cylinder block.



76492

- a** - Connecting Rod Bearing Caps
- b** - Main Bearing Cap
- c** - Crankshaft

20. If new main and/or connecting rod bearings are to be installed, remove main bearing inserts from cylinder block and bearing caps, and/or connecting rod bearing inserts from connecting rod and caps. Install new bearings following procedures outlined.

Cleaning and Inspection

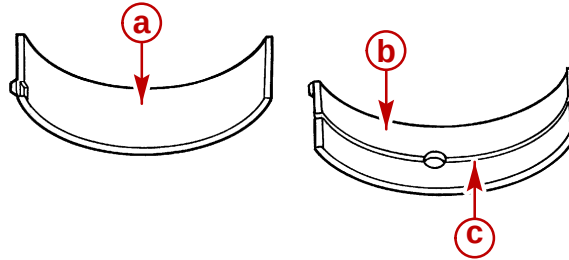
1. Wash crankshaft in solvent and dry with compressed air.
2. Measure main bearing journals and crankpin dimensions with a micrometer for out-of-round, taper or undersize (see "Specifications").
3. Check crankshaft for runout (by supporting at front and rear main bearings journals in V-blocks) and check at front and rear intermediate journals with a dial indicator (see "Specifications").
4. Replace or recondition crankshaft if not within specifications.

Installation

1. Remove timing sprocket or gear from old crankshaft and reinstall on new crankshaft as outlined.
2. On jackshaft models, if old pilot bushing is to be reused, bushing can be removed without damage. by
 - a. Fill pilot bushing cavity with grease, then insert an old transmission input shaft in bore of bushing and hit it with a hammer. This will create hydraulic pressure in pilot bushing cavity that should force bushing out.

IMPORTANT: Be sure that all bearings and crankshaft journals are clean.

3. Install main bearings in engine block.



72359

Main Bearing Inserts

- a** - Lower Bearing Insert (Install in Cap)
- b** - Upper Bearing Insert (Install in Block)
- c** - Oil Groove

4. Carefully lower crankshaft into place. Be careful not to damage bearing surface.
5. Check clearance of each main bearing, following procedure outlined under "Main Bearings." If bearing clearances are satisfactory, apply engine oil to journals and bearings.
6. Install main bearing caps.
7. Torque bolts to specifications. When tightening rear main bearing cap, follow procedure outlined under "Main Bearings."
8. Check crankshaft end play as outlined.
9. Install rear main seal retainer and seal.
10. Torque fasteners to 106 lb-in. (12 Nm).
11. Check clearance for each connecting rod bearing, following procedure under "Connecting Rod Bearings." If bearing clearances are satisfactory, apply engine oil to journals and bearings.
12. Coat the bearing surface with oil, install the rod cap.
13. Torque nuts to 20 lb-ft (27 Nm) on first pass. Then, torque nuts an additional 55 degrees angular torque.
14. Turn crankshaft so mark on timing sprocket or gear is facing camshaft.

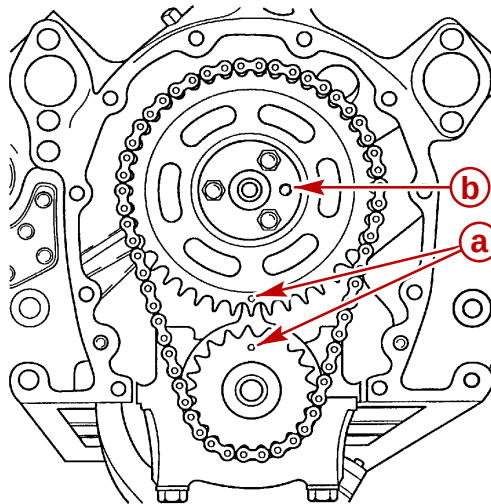
15. Install timing chain and sprocket or gear on camshaft -align marks with crankshaft.
16. Install timing chain/gear cover.
17. Install oil pump and baffle.
18. Install dipstick tube and oil pan.
19. Install spark plugs.
20. Install torsional damper and crankshaft pulley.
21. Install water pump.
22. Install belts.
23. Install flywheel and drive coupler / plate.
24. Install flywheel housing.
25. Install starter.
26. Install new oil filter.
27. Fill crankcase with oil.
28. Install engine in boat.

Timing Chain and Sprocket

Removal

1. Remove torsional damper, oil pan and crankcase front cover.
2. Turn crankshaft until timing marks on crankshaft and camshaft sprockets are in alignment.

NOTE: Flat lifter timing gear is shown. Roller lifter gears have similar timing marks.



72376

Standard (LH) Rotation Shown

- a** - Timing Marks Aligned
- b** - Locating Pin

3. Remove camshaft gear or sprocket and timing chain. If gear or sprocket does not come off easily, a light tap on the lower edge of the gear or sprocket with a plastic mallet should dislodge it.
4. Remove crankshaft sprocket or gear if either requires replacement.

Cleaning and Inspection

1. Clean all parts in solvent and dry with compressed air.
2. Inspect timing chain for wear and damage.
3. Inspect sprockets for wear and damage.
4. Inspect timing gears for worn and damaged teeth.
5. Inspect camshaft gear-to-cylinder block contact surfaces for damage.

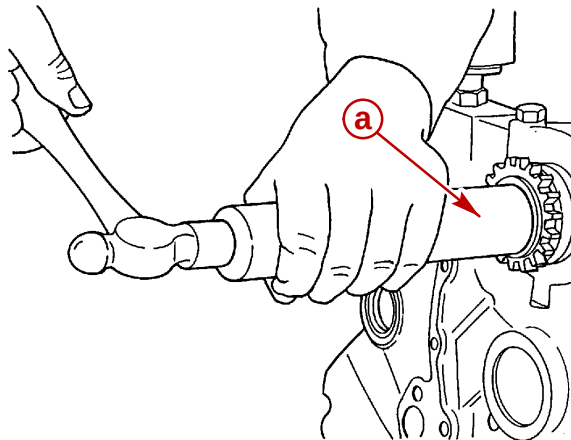
Crankshaft Sprocket/Gear

Removal

1. Remove torsional damper and crankcase front cove.
2. Remove camshaft timing chain/gear.
 - a. On left-hand rotation engines, remove crankshaft sprocket using crankshaft gear and sprocket puller (J-5825-A).
 - b. On right-hand rotation engines, remove crankshaft gear using a universal puller.

Installation

1. Using crankshaft gear and sprocket installer, as shown, install sprocket or gear on crankshaft.



72377

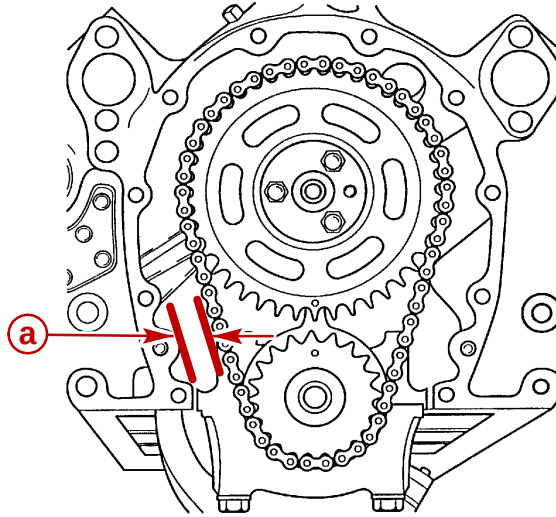
a - Crankshaft Gear and Sprocket Installer (J-5590)

2. Install timing chain or gear.
3. Install crankcase cover and torsional damper.

Checking Timing Chain Deflection

1. Install timing chain and sprockets.
2. Rotate camshaft (in either direction) to place tension on one side of the chain.
3. Establish a reference point on the block (on taut side of chain) and measure from this point to the chain.
4. Rotate camshaft in the opposite direction to slacken the chain, then force chain out with fingers and again measure the distance between reference point and timing chain.

5. The deflection is the difference between these two measurements. If the deflection exceeds 3/4 in. (19 mm), timing chain should be replaced.



72376

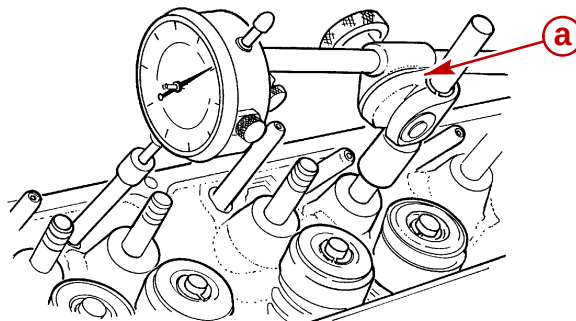
a - Reference Point

Camshaft

Measuring Lobe Lift

NOTE: Procedure is similar to checking valve timing. If improper valve operation is indicated, measure lift of each push rod in consecutive order and record readings.

1. Remove valve mechanism.
2. Position indicator with ball socket adaptor tool on push rod. Be sure that push rod is in lifter socket.



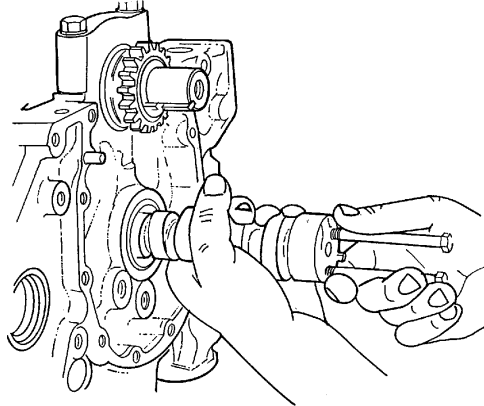
72380

a - Ball Socket Adapter Tool (J-8520-1)

3. Rotate crankshaft torsional damper slowly in direction of rotation until lifter is on heel of cam lobe. At this point, push rod will be in its lowest position.
4. Set dial indicator on zero, then rotate balancer slowly (or attach an auxiliary starter switch and "bump" engine over) until push rod is in fully raised position.
5. Compare total lift, recorded from dial indicator, with "Specifications."
6. Continue to rotate engine until indicator reads zero. This will check accuracy of original indicator reading.
7. If camshaft readings for all lobes are within specifications, remove dial indicator assembly.
8. Install and adjust valve mechanism.

Removal

1. Remove valve lifters.
2. Remove crankcase front cover.
3. Remove fuel pump and fuel pump push rod.
4. Remove camshaft as follows:
 - a. Remove timing chain and sprocket or timing gears as outlined. On the 5.7L engine only, remove camshaft thrust plate.
 - b. Install two 5/16-18 x 5 in. bolts in camshaft bolt holes and carefully remove camshaft as shown.



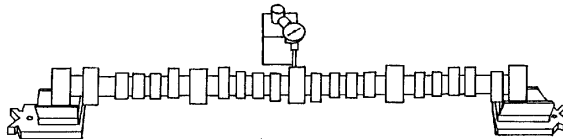
72381

Inspection

Measure camshaft bearing journals with a micrometer for out-of-round condition. If journals exceed .001 in. (0.025 mm) out-of-round, camshaft should be replaced.

Also check camshaft for alignment with V-blocks and dial indicator which indicates exact amount camshaft is out of true. If out of true more than .002 in. (0.051 mm) (dial indicator reading) camshaft should be replaced.

On engines with timing gears, inspect camshaft gear and thrust plate for wear and damage.



72382

Checking Camshaft Alignment

Installation

1. Install camshaft as follows:
 - a. Install two 5/16-18 x 5 in. bolts in camshaft bolt holes.
 - b. Lubricate camshaft journals with engine oil and install camshaft. Be careful not to damage bearings.
 - c. Lubricate camshaft lobes with General Motors Cam and Lifter Prelube or equivalent.
 - d. Install camshaft thrust plate (retainer) and bolts. Torque the bolts to 106 lb-in. (12 Nm).
 - e. Install timing chain or gears as outlined.
2. Install fuel pump push rod and fuel pump.
3. Install crankcase front cover and valve lifters as outlined.

Camshaft Bearings

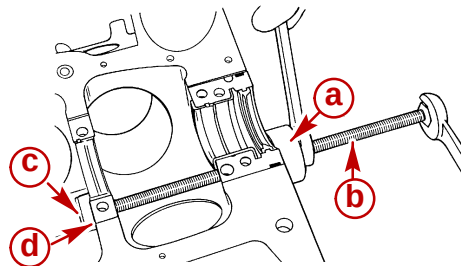
Removal

Camshaft bearings can be replaced while engine is disassembled for overhaul or without complete disassembly. To replace bearings without complete disassembly, fasten connecting rods against sides of engine so that they will not interfere while replacing camshaft bearings. Remove camshaft and crankshaft, leaving cylinder heads attached and pistons in place.

1. With camshaft and crankshaft removed, drive camshaft rear plug from cylinder block.

NOTE: This procedure is based on removal of bearings from center of engine first, thus requiring a minimum amount of turns to remove all bearings.

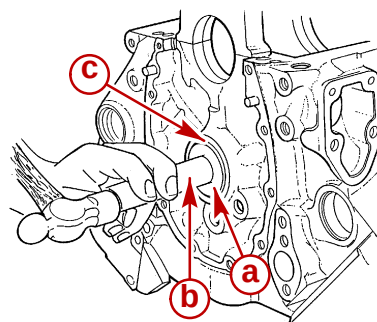
2. Using Install nut and thrust washer to end of threads on camshaft bearing remover and installer set (P/N J-6098-01).
3. Position pilot in front camshaft bearing.
4. Install puller screw through pilot.
5. Install tool with shoulder toward bearing. Be sure a sufficient amount of threads are engaged.
6. Using two wrenches, hold puller screw while turning nut.
7. Pull bearing bore.
8. Remove tool and bearing from puller screw.
9. Remove remaining bearings (except front and rear) in same manner.
10. Position pilot in rear camshaft bearing to remove rear intermediate bearing.



72383

- a** - Index Pilot
- b** - Puller Screw
- c** - Driver
- d** - Bearing

11. Assemble driver on driver handle and remove front and rear camshaft bearings by driving toward center of cylinder block.



72384

- a** - Driver
- b** - Driver Handle
- c** - Bearing

Cleaning and Inspection

Clean camshaft bearing bores in cylinder block with solvent and blow out with compressed air. Be sure grooves and drilled oil passages are clean.

Installation

Front and rear bearings must be installed last as pilot will not fit into bearing bores if bearings are installed.

Lubricate outer surface of new camshaft bearings with engine oil to ease installation.

INDEXING BEARING

IMPORTANT: All camshaft bearings are not the same. Be sure to install bearings in proper locations (Indicated by bearing manufacturer) and to position bearings as follows (directional references are in reference to engine in its normal operating position):

- Front bearing must be positioned so that oil holes are equal distance from 6 o'clock position in the block. Intermediate and center bearings must be positioned so that oil holes are at the 5 o'clock position (toward left side of block and at a position even with bottom of cylinder bore). Rear bearing must be positioned so that oil hole is at the 12 o'clock position.

INTERMEDIATE AND CENTER BEARINGS

1. Install nut and thrust washer onto puller screw.
2. Position pilot in front camshaft bearing bore and insert screw through pilot.
3. Index center camshaft bearing.
4. Position appropriate size removal and installation tool in bearing and thread puller screw into tool. Be sure at least 1/2 in. (13 mm) of threads are engaged.
5. Using two wrenches, hold puller screw and turn nut until bearing has been pulled into position.
6. Remove the removal and installation tool and ensure that oil hole(s) in bearing are positioned correctly.
7. Install intermediate bearings in same manner. Ensure bearings are indexed correctly. Position pilot in rear camshaft bearing bore to install rear intermediate bearing.

FRONT AND REAR BEARINGS

1. Install appropriate size removal and installation tool on drive handle.
2. Index front bearing and drive it into position with tool.
3. Ensure bearing is positioned correctly. Index rear bearing and drive it into position with tool.
4. Install a new camshaft rear plug.

IMPORTANT: Plug must be installed flush to 1/32 in. (0.8 mm) deep and must be parallel with rear surface of cylinder block.

5. Install crankshaft and camshaft.

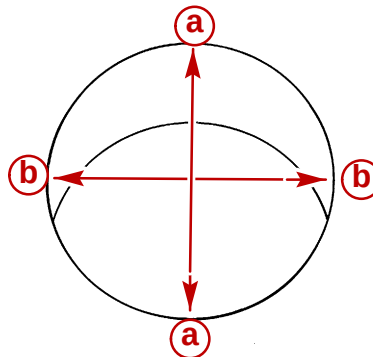
Cylinder Block

Cleaning and Inspection

1. Remove all engine components.
2. Wash cylinder block thoroughly in cleaning solvent.
3. Clean all gasket surfaces.
4. Remove oil gallery plugs.
5. Clean all oil passages.
6. Remove expansion plugs.

NOTE: These plugs may be removed with a sharp punch, or they may be drilled and pried out.

7. Clean and inspect water passages in cylinder block.
8. Inspect cylinder block for cracks in cylinder walls, water jacket valve lifter bores and main bearing webs.
9. Measure cylinder walls for taper, out-of-round or excessive ridge at top of ring travel. This should be done with a dial indicator or inside micrometer. Carefully work gauge up and down cylinder to determine taper and turn it to different points around cylinder wall to determine out-of-round condition. If cylinders exceed specifications, boring and/or honing will be necessary.



72385

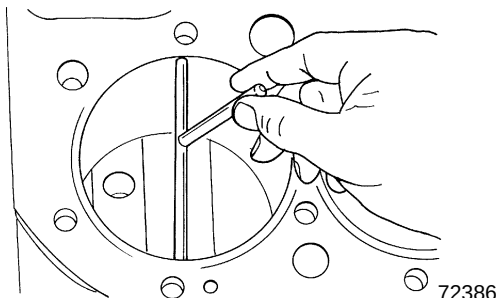
Cylinder Measurement

a - At right angle to centerline of engine

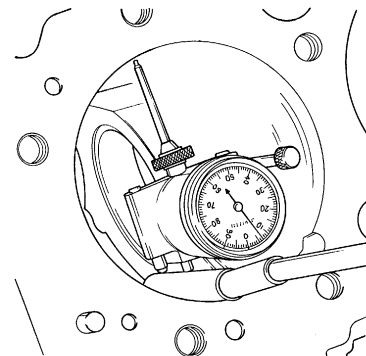
b - Parallel to centerline of engine

"Out-of-Round" = Difference between "a" and "b"

"Taper" = Difference between measurement "a" at top of cylinder bore and "a" measurement at bottom of cylinder bore



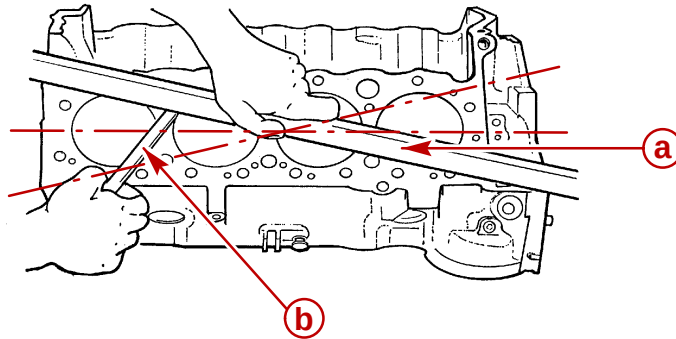
72386



72387

Measuring Cylinder Bore

10. Check cylinder head gasket surfaces for warp with a machinist's straight-edge and a feeler gauge. Take measurements diagonally across surfaces (both ways) and straight down center. If surfaces are warped more than .003 in. (0.07 mm) in a 6 in. area or .007 in. (0.2 mm) overall, block must be resurfaced by an automotive machine shop.



72388

- a** - Machinist's Straight-Edge
b - Feeler Gauge

CYLINDER CONDITIONING

NOTE: Performance of the following operation depends upon engine condition at time of repair.

NOTE: If cylinder block inspection indicates that block is suitable for continued use (except for out-of-round or tapered cylinders), they can be conditioned by honing or boring.

1. If cylinders have less than .005 in. (0.127 mm) taper or wear, they can be conditioned with a hone and fitted with high limit standard size piston. A cylinder bore of more than .005 in. wear or taper may not clean up entirely when fitted to a high limit piston. To entirely clean up the bore, it will be necessary to rebore for an oversize piston. If more than .005 in. taper or wear, bore and hone to smallest oversize that will permit complete resurfacing of all cylinders.
2. When pistons are being fitted and honing is not necessary, cylinder bores may be cleaned with a hot water and detergent wash. After cleaning, swab cylinder bores several times with light engine oil and a clean cloth, then wipe with a clean dry cloth.

CYLINDER BORING

IMPORTANT: Before using any type boring bar, file top of cylinder block to remove dirt or burrs. This prevents boring bar tilt, (the rebored cylinder wall is not at right angles to crankshaft.)

1. File top of cylinder block to remove dirt and burrs.
2. Measure piston to be fitted with a micrometer, measuring at center of piston skirt and at right angles to piston pin. Bore cylinder to same diameter as piston and hone to give specified clearance.

NOTE: Hone cylinders as outlined under "Cylinder Honing" and "Piston Selection," following.

3. Carefully observe instructions furnished by manufacturer of equipment being used.

CYLINDER HONING

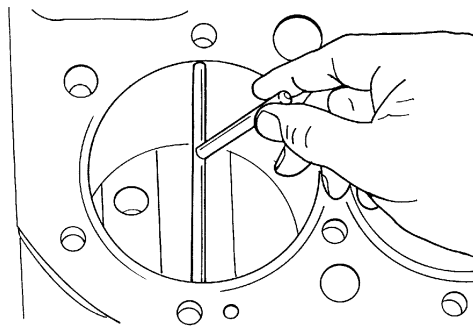
1. Follow hone manufacturer's recommendations for use of hone and cleaning and lubrication during honing.
2. Occasionally, during the honing operation, thoroughly clean cylinder bore and check piston for correct fit in cylinder.
3. When finish-honing a cylinder bore to fit a piston, move hone up and down at a sufficient speed to obtain very fine uniform surface finish marks in a crosshatch pattern of approximately 30 degrees to cylinder bore. Finish marks should be clean but not sharp, free from imbedded particles and torn or folded metal.
4. Permanently mark piston (for cylinder to which it has been fitted) and proceed to hone cylinders and fit remaining pistons.

IMPORTANT: Handle pistons with care and do not attempt to force them through cylinder until cylinder is honed to correct size, as this type piston can be distorted by careless handling.

5. Thoroughly clean cylinder bores with hot water and detergent. Scrub well with a stiff bristle brush and rinse thoroughly with hot water. It is extremely essential that a good cleaning operation be performed. If any abrasive material remains in cylinder bores, it will rapidly wear new rings, cylinder bores and bearings lubricated by the contaminated oil. Swab bores several times with light engine oil on a clean cloth, then wipe with a clean dry cloth. Cylinder should not be cleaned with kerosene or gasoline. Clean remainder of cylinder block to remove excess material spread during honing operation.

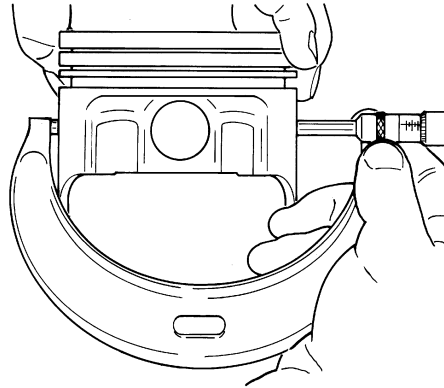
PISTON SELECTION

1. Check used piston to cylinder bore clearance as follows:
 - a. Measure cylinder bore diameter with a telescope gauge 2-1/2 in. (64 mm) from top of cylinder bore as follows.



72386

- b. Measure piston diameter at skirt across center line of piston pin as shown.



72624

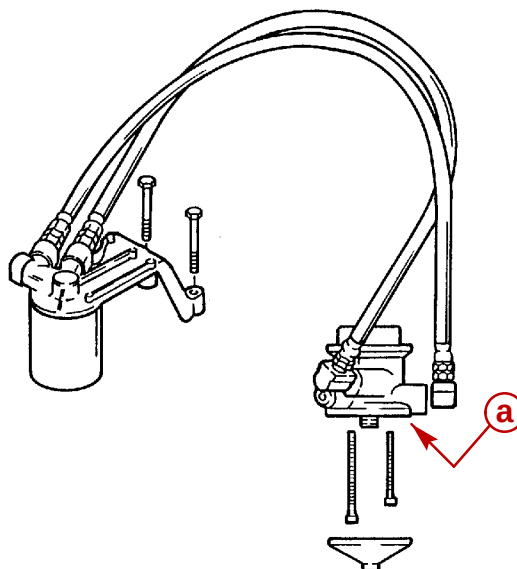
- c. Subtract piston diameter from cylinder bore diameter to determine piston-to-bore clearance.
 - d. Determine if piston-to-bore clearance is in acceptable range shown in "Specifications."
2. If used piston is not satisfactory, determine if a new piston can be selected to fit cylinder bore within acceptable range.
 3. If cylinder bore must be reconditioned, measure new piston diameter (across centerline of piston pin), then hone cylinder bore to correct clearance (acceptable range).
 4. Mark piston to identify cylinder for which it was fitted.

Oil Filter By-Pass Valve and Adaptor Assembly



72389

Without Remote Oil Filter



72390

With Remote Oil Filter

a - Fiber Valve

IMPORTANT: Oil by-pass valve and adaptor assembly should be inspected whenever engine is disassembled for major repair or whenever inadequate oil filtration is suspected.

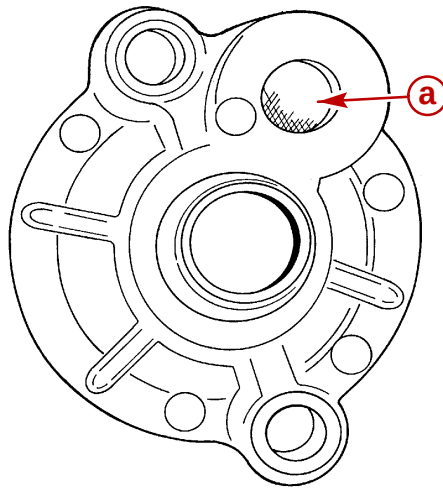
IMPORTANT: Refer to "Engine Parts List" when ordering parts for oil filter by-pass valve, adaptor assembly or remote oil filter parts.

Removal

1. Remove oil filter (on engines with block mounted filter) or cylinder block adaptor (on engines with remote oil filter).
2. Remove by-pass valve and adaptor assembly.

Cleaning and Inspection

1. Clean by-pass valve and adaptor assembly in solvent and blow dry with compressed air.
2. Inspect fiber valve for cracks or other damage.
3. Ensure that valve fits tightly against its seat.
4. Push valve down and release it. Valve should return freely to its seat. If valve operation is questionable, by-pass valve and adaptor assembly should be replaced. Bypass valve may be replaced separately on remote filter assembly.



72391

Typical By-Pass Valve and Adaptor Assembly

a - Fiber Valve

5. Wipe out valve chamber in cylinder block to remove any foreign material.

Installation

1. Install by-pass valve and adaptor assembly or cylinder block adaptor to engine block. Tighten bolts to 20 lb-ft (27 Nm).
2. Lubricate oil filter rubber seal and install hand-tight only.

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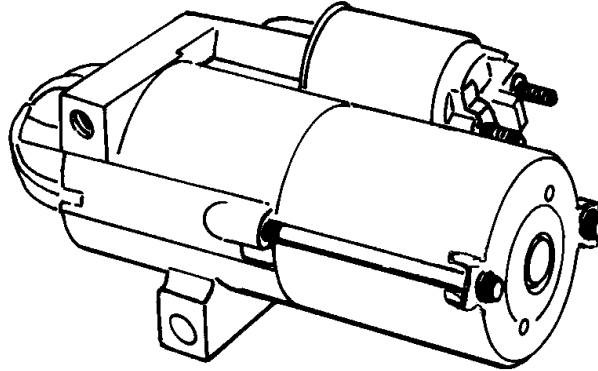
ELECTRICAL SYSTEMS

Section 4A - Starting System

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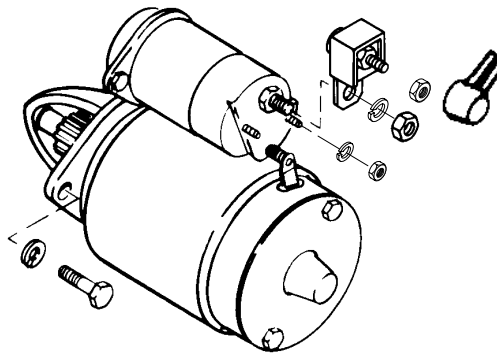
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Identification



75820

Permanent Magnet Gear Reduction (PG260F1) Starter



76505

Delco 14MT Direct Drive Starter

Replacement Parts Warning

⚠ WARNING

Electrical, ignition and fuel system components comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

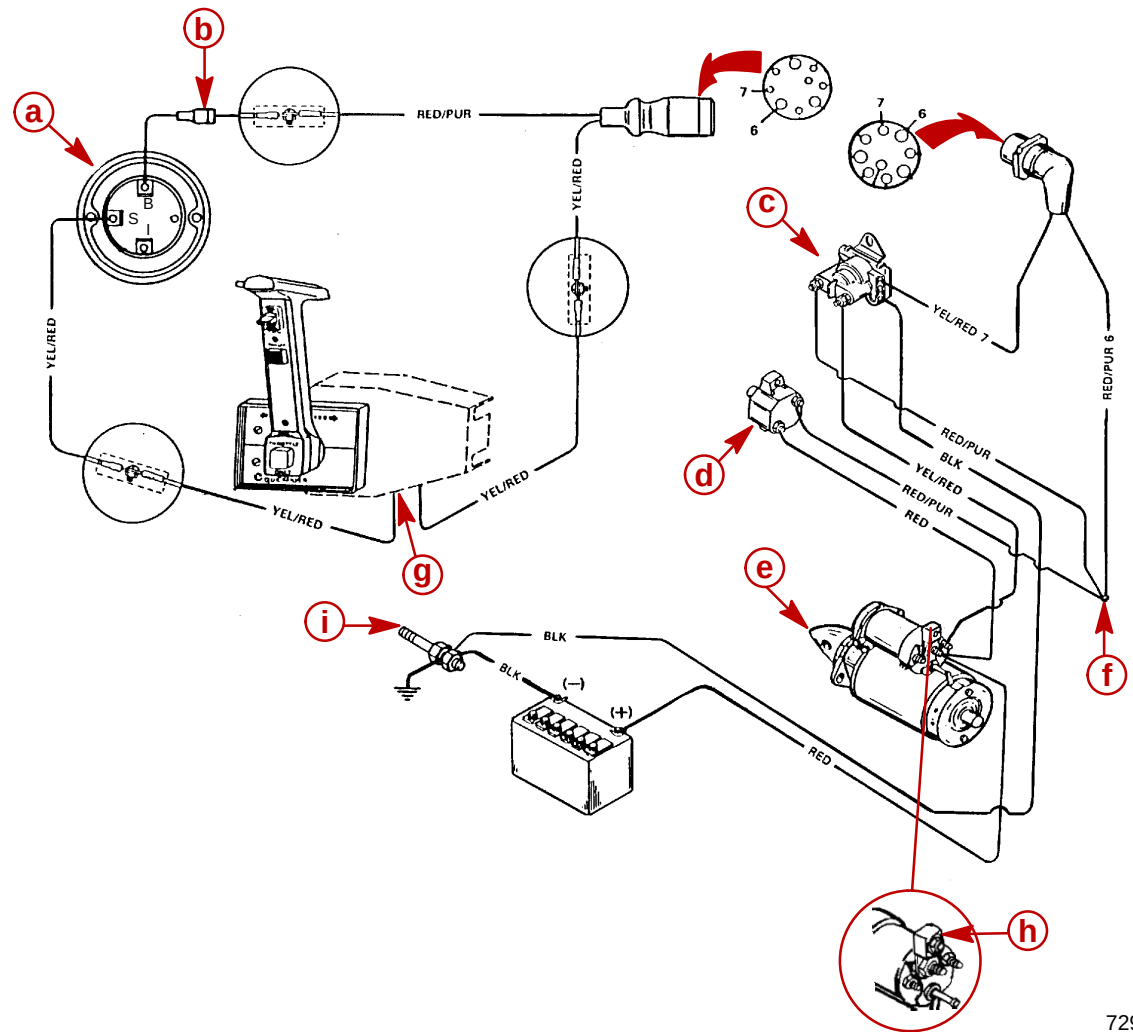
Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

General Precautions

⚠ CAUTION

The starter motor is designed to operate under great overload and produce a high horsepower for its size. It can do this only for a short time, since considerable heat accumulates and can cause serious damage. For this reason, the cranking motor must never be used for more than 30 seconds at any one time. Cranking should not be repeated without a pause of at least 2 minutes to permit the heat to escape.

Typical Starting System Components



- a** - Ignition Switch
- b** - 20 Amp Fuse
- c** - Starter Slave Solenoid
- d** - Circuit Breaker
- e** - Starter Motor
- f** - Wire Junction
- g** - Neutral Safety Switch
- h** - 90 Amp. Fuse
- i** - Engine Ground (-)

72930

Positive Current Flow

This is a general description of the positive current flow from the battery through the system until the starter motor cranks.

NOTE: Check that all connections are tight and have the required resistance.

- Battery to the solenoid switch (on starter) (RED battery cable).
- Solenoid switch to circuit breaker (RED).
- Circuit breaker to wire junction (RED-PUR).
- Wire junction to wiring harness plug (RED-PUR) terminal 6.
- Wiring harness plug to 20 amp fuse (RED-PUR).
- 20 amp fuse to ignition switch terminal I (RED-PUR). At this point ignition switch is turned to START.
- Ignition switch terminal I to terminal C.
- Ignition switch terminal C to neutral start switch (YEL-RED). NEUTRAL START SWITCH MUST BE AT NEUTRAL POSITION.
- Neutral start switch to wiring harness plug terminal 7 (YEL-RED).
- Wiring harness plug to starter solenoid (small terminal) (YEL-RED). Also ensure that black (small terminal) wire is grounded.
- Starter solenoid is now "closed," completing circuit between large terminal (RED-PUR) and other large terminal (YEL-RED), causing starter motor to crank.

Battery

Battery Cable Recommendations

IMPORTANT: Terminals must be soldered to cable ends to ensure good electrical contact. Use electrical grade (resin flux) solder only. Do not use acid flux solder as it may cause corrosion and failure.

Cable Length	Cable Gauge	
Up to 3 - 1/2 ft (1.1m)	4	(25 mm ²)
3-1/2 - 6 ft (1.1-1.8m)	2	(35mm ²)
6 ft - 7-1/2 ft (1.8-2.3m)	1	(50mm ²)
7-1/2 - 9-1/2 ft (2.3-2.9m)	0	(50mm ²)
9-1/2 - 12 ft (2.9-3.7m)	00	(70mm ²)
12 - 15 ft (3.7-4.6m)	000	(95mm ²)
15 - 19 ft (4.6-5.8m)	0000	(120m ²)
Both positive (+) and negative (-) cables		

MULTIPLE EFI ENGINE BATTERY PRECAUTIONS

Situation

Alternators: Alternators are designed to charge the battery that supplies electrical power to the engine that the alternator is mounted on. When batteries for two different engines are connected, one alternator will supply all of the charging current for both batteries. Normally, the other engine's alternator will not be required to supply any charging current.

EFI Electronic Control Module (ECM): The ECM requires a stable voltage source. During multiple engine operation, an onboard electrical device may cause a sudden drain of voltage at the engine's battery. The voltage may go below the ECM's minimum required voltage. Also, the alternator on the other engine may now start charging. This could cause a voltage spike in the engine's electrical system.

In either case, the ECM could shut off. When the voltage returns to the range that the ECM requires, the ECM will reset itself. The engine will now run normally. This ECM shut down usually happens so fast that the engine just appears to have an ignition miss.

Recommendations

Batteries: Boats with multi-engine EFI power packages require each engine be connected to its own battery. This ensures that the engine's Electronic Control Module (ECM) has a stable voltage source.

Battery Switches: Battery switches should always be positioned so each engine is running off its own battery. DO NOT operate engines with switches in **BOTH** or **ALL** position. In an emergency, another engine's battery can be used to start an engine with a dead battery.

Battery Isolators: Isolators can be used to charge an auxiliary battery used for powering accessories in the boat. They should not be used to charge the battery of another engine in the boat unless the type of isolator is specifically designed for this purpose.

NOTE: *Sure Power Industries Inc., Model 32023A meets this design specification.*

1. The boat may have 2 engines connected to a single Model 32023A battery isolator.
2. The Model 32023A battery isolator is connected to 2 banks of batteries.
3. Each bank contains 2 batteries with the cranking battery for 1 engine in each bank.
4. The second battery in each bank is connected in parallel to the cranking battery.
5. The Model 32023A battery isolator is designed for this type of use; 2 battery banks, 2 charging sources, 120 amps (maximum alternator output).
6. When the engines are running, either engine's alternator could be charging either bank of batteries through the Model 32023A battery isolator.

Any other manufacturer's battery isolator that is the same type as the Sure Power Inc., Model 32023A could also be used.

Generators: The generator's battery should be considered another engine's battery.

Maintenance

WARNING

DO NOT use jumper cables and a booster battery to start engine. DO NOT recharge a weak battery in the boat. Remove battery and recharge in a well ventilated area away from fuel vapors, sparks or flames.

WARNING

Batteries contain acid which can cause severe burns. Avoid contact with skin, eyes and clothing. Batteries also produce hydrogen and oxygen gases when being charged. This explosive gas escapes fill/vent caps and may form an explosive atmosphere around the battery for several hours after it has been charged; sparks or flames can ignite the gas and cause an explosion which may shatter the battery and could cause blindness or other serious injury.

Safety glasses and rubber gloves are recommended when handling batteries or filling electrolyte. Hydrogen gases that escape from the battery during charging are explosive. When charging batteries, be sure battery compartment, or area where batteries are located, is well vented. Battery electrolyte is a corrosive acid and should be handled with care. If electrolyte is spilled or splashed on any part of the body, immediately flush the exposed area with liberal amounts of water and obtain medical aid as soon as possible.

CAUTION

To prevent damage to the electrical system be sure to adhere to the following:

- When installing battery, be sure to connect the positive (+) battery cable to positive (+) battery terminal first and then the negative (-) battery cable to negative (-) battery terminal.
- Never disconnect the battery cables while the engine is running.
- If a charger or booster is to be used, be sure to connect it in parallel with existing battery (positive to positive and negative to negative).
- When applying a booster charge to battery, disconnect both cables from battery (to prevent damage to voltage regulator).
- Check battery condition periodically.
- Make sure that battery leads are kept clean and tight.

PERIODIC INSPECTION

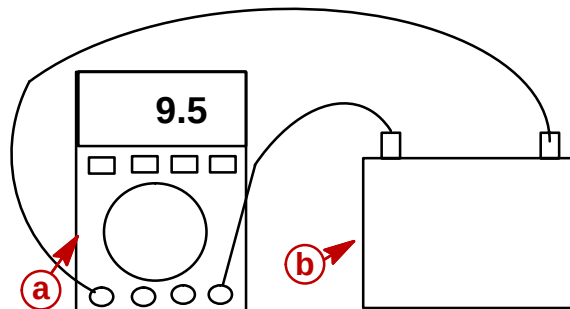
1. Inspect terminals for corrosion and loose connections.
2. Inspect wiring for frayed and worn insulation.
3. Check starter mounting bolts for tightness.

Testing

⚠ CAUTION

Test battery in well ventilated area as gases given off by battery are hazardous.

A strong battery must be maintained. If battery shows less than 9.5 volts when under starting load, (at 80° F or 27° C) it should be recharged. Check with DC voltmeter.



76498

- a** - Voltmeter
b - Battery

Place battery under heavy load (as during engine cranking or with a variable resistor tester) and test cell voltage while under load.

Certain conditions must be met before testing.

- Battery must be 60 to 100°F (16 to 38°C).
 - Electrolyte level must be correct in all cells.
 - Battery must be at least half charged.
 - No obvious defects.
1. Check voltage per manufacturer's specifications.
 2. If readings are low, recharge and retest.
 3. If readings remain low, battery should be replaced.

Storage

1. Remove battery and clean exterior.
2. Check fluid level and fill if low.
3. Cover terminals and bolts with light coat of grease.
4. Set battery on wood or in carton; store in cool, dry place.
5. Check every 20 days for fluid level and slow charge.

IMPORTANT: A discharged battery can be damaged by freezing.

Charging Guide

12 VOLT BATTERY RECOMMENDED RATE¹ AND TIME FOR FULLY DISCHARGED CONDITION

Twenty Hour Rating	5 Amps	10 Amps	20 Amps	30 Amps	40 Amps	50 Amps
50 Ampere-Hours or less	10 Hours	5 Hours	2-1/2 Hours	2 Hours		
Above 50 to 75 Ampere-Hours	15 Hours	7-1/2 Hours	3-1/2 Hours	2-1/2 Hours	2 Hours	1-1/2 Hours
Above 75 to 100 Ampere-Hours	20 Hours	10 Hours	5 Hours	3 Hours	2-1/2 Hours	2 Hours
Above 100 to 150 Ampere-Hours	30 Hours	15 Hours	7-1/2 Hours	5 Hours	3-1/2 Hours	3 Hours
Above 150 Ampere-Hours		20 Hours	10 Hours	6-1/2 Hours	5 Hours	4 Hours

¹ Initial rate for constant voltage taper rate charger.

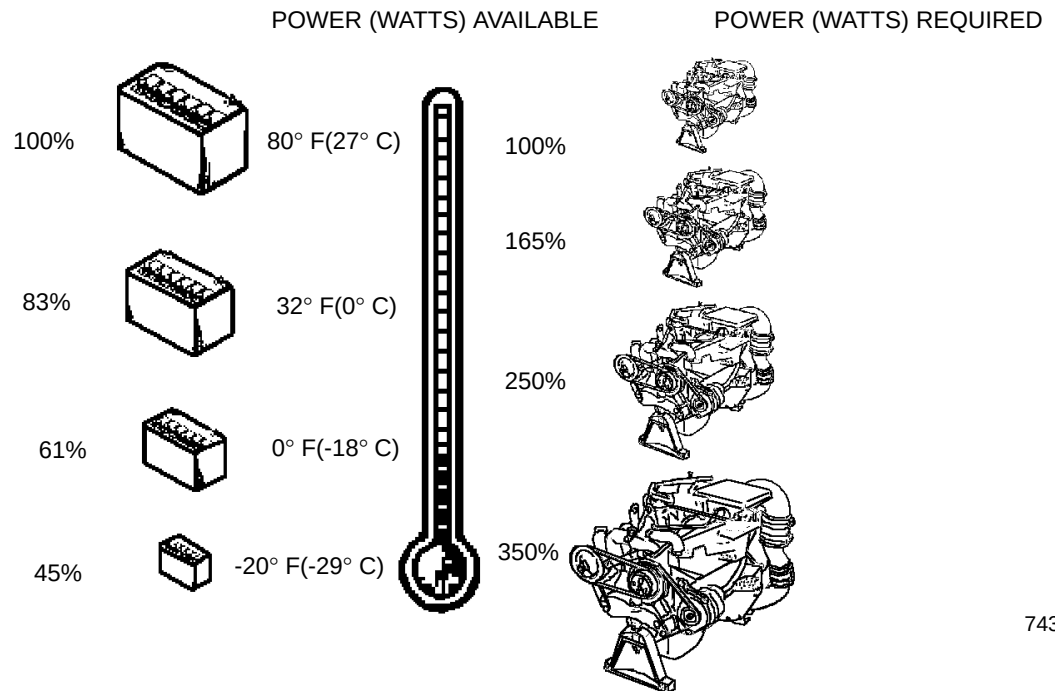
To avoid damage, charging rate must be reduced or temporarily halted, if:

1. Electrolyte temperature exceeds 125° F (52° C).
2. Violent gassing or spewing of electrolyte occurs.

Battery is fully charged when, over a two hour period at a low charging rate in amperes, all cells are gassing freely and no change in specific gravity occurs. For the most satisfactory charging, the lower charging rates in amperes are recommended.

Full charge specific gravity is 1.260-1.280, corrected for temperature with electrolyte level at split ring.

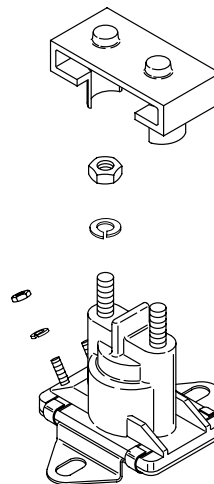
How Temperature Affects Battery Power



74310

Standard Starter Slave Solenoid

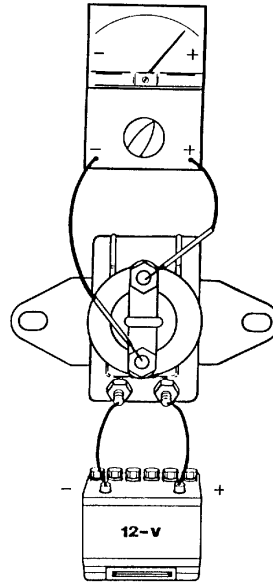
Identification



76517

Testing / Replacement

1. Using continuity meter, connect test leads as shown, and connect 12 volt battery with jumper leads as shown.



72630

2. If no meter movement is present, replace solenoid.

Testing

Starter Motor Voltage

Always test the voltage at the starter motor to ensure that it is getting at least 9.5 volts during cranking.

IMPORTANT: Voltage below 9.5 causes excessive heat build up, which can damage the starter motor and weld the starter solenoid contacts together.

1. Check the battery to ensure that it is not at fault.
2. With a fully charged battery, connect the voltmeter positive (+) lead to the terminal on the starter solenoid.
3. Connect the voltmeter negative (–) lead to the starter motor case. Ensure that there is good metal contact to prevent a false voltage reading.
4. Crank the engine over for about 10 seconds and record voltmeter reading.
5. A reading of 9.5 volts or more shows the starter motor is getting sufficient voltage.

NOTE: *If the starter is getting at least 9.5 volts and the engine is not cranking as it should, remove all the spark plugs and try turning the engine over by hand. If the engine turns over freely by hand, the starter motor could have a problem.*

6. A reading below 9.5 volts suggests voltage loss between the battery and the starter. Refer to "Testing Starting System For Voltage Drop"

Voltage Drop In Starting System

This test should be done anytime a voltage drop is suspected.

1. With a fully charged battery, connect voltmeter positive (+) lead to the battery positive (+) post.
2. Connect the voltmeter negative (–) lead to the starter solenoid terminal where the positive (+) battery cable connects.

NOTE: Connect voltmeter leads to the battery post, NOT the battery cable end.

IMPORTANT: Remove one voltmeter lead before you stop cranking the starter motor in the following steps to prevent the possibility of voltmeter damage.

3. Crank the engine over and record voltmeter reading. The reading should not exceed .5 volts. A reading over .5 volts suggests excessive resistance.
4. Test the negative (–) battery cable by connecting the voltmeter negative (–) lead to the battery negative (–) post.
5. Connect the voltmeter positive (+) lead to the starter motor case. Ensure that there is good contact with metal.
6. Repeat step 3.
7. If either reading was above .5 volts, start with the battery cable and work your way to the starter checking each connection for resistance.

NOTE: Always ensure that paint or corrosion is not causing the high resistance. The mounting surface under the starter motor and the mounting bolts should be free from paint and corrosion.

Delco 14MT Direct Drive Starter

Specifications

Starter Specifications

Direct Drive Starter Motor							
Delco Identification Number	Engine Rotation	No Load Test					Brush Spring Tension Oz. (Grams)
	LH	Volts	Min. Amps	Max. Amps	Min. rpm	Max. rpm	
10455602		10.6	70	120	5400	10800	56-105 (1588-2976)
Pinion Clearance				.010-.140 (0.25-3.5 mm)			
Commutator End Frame Gap				.025 Max. (0.6 mm Max.)			

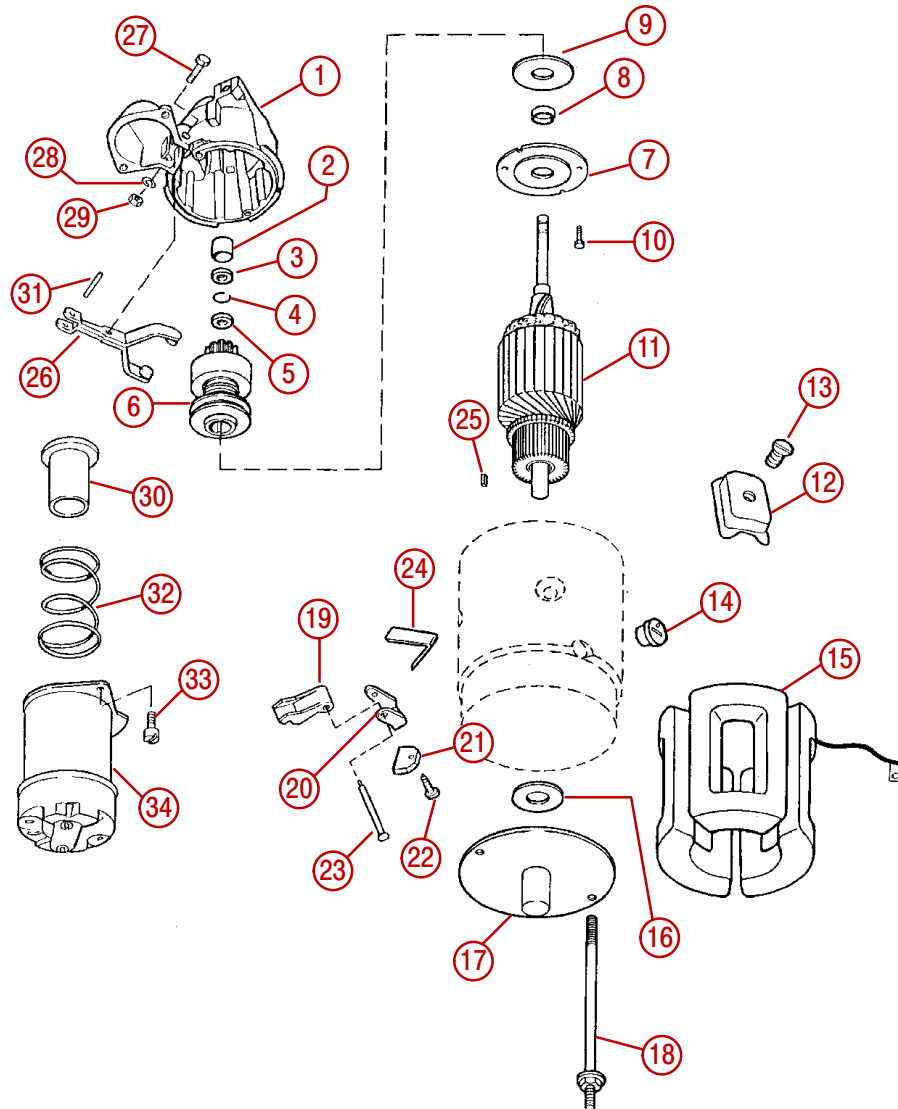
Torque Specifications

Fastener Location	lb-ft	Nm
Starter Motor To Block	50	68
All Other Fasteners	Tighten Securely	

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Liquid Neoprene	92-25711--3
SAE 10W Oil	Obtain Locally
SAE 20W Oil	

Exploded View



72806

- | | |
|---|--|
| 1 - End Housing | 18 - Screw/Stud |
| 2 - End Housing Bushing | 19 - Insulator Holder - Field Frame Brush |
| 3 - Thrust Collar | 20 - Field Frame Brush - Ground Brush |
| 4 - Retaining Ring - Pinion Stop Collar | 21 - Field Frame Brush |
| 5 - Pinion Stop Collar | 22 - Brush Lead Screw |
| 6 - Clutch Drive Assembly | 23 - Ground / Insulated Holders Support Package |
| 7 - Bearing Plate | 24 - Field Frame Brush Spring |
| 8 - Bearing Plate Bushing | 25 - Dowel Pin - Field Frame |
| 9 - Bearing Plate Washer | 26 - Shift Lever |
| 10 - Bearing Plate Screw | 27 - Shift Lever Stud |
| 11 - Armature | 28 - Shift Lever Stud Washer |
| 12 - Pole Shoe - Field Coil | 29 - Shift Lever Stud Nut |
| 13 - Pole Shoe - Field Coil Screw | 30 - Shift Lever Plunger |
| 14 - Field Coil Grommet - Field Frame | 31 - Plunger To Shift Lever Pin |
| 15 - Field Coil Assembly | 32 - Plunger Return Spring |
| 16 - Leather Washer - Commutator End Frame | 33 - Solenoid Switch Screw |
| 17 - Lower Commutator End Frame | 34 - Solenoid Switch Assembly |

Solenoid Switch

The solenoid switch can be removed and replaced if defective.

Removal

1. Remove starter motor as outlined.
2. Remove screw from field coil connector and solenoid attaching screws.
3. Twist solenoid to disengage tab, and remove.

Installation

1. Install solenoid onto plunger.
2. Twist solenoid to engage tab.
3. Install screws and tighten securely.
4. Install field coil connector screw.

Motor

WARNING

Disconnect battery cables at battery before removing starter.

1. Disconnect battery cables from battery.
2. Disconnect wires from solenoid terminals.

Removal

1. Remove starter mounting bolts.
2. Remove from engine.

Cleaning and Inspection

IMPORTANT: DO NOT use grease dissolving solvents for cleaning. Such a solvent would dissolve grease packed in clutch mechanism and damage armature and field coil insulation.

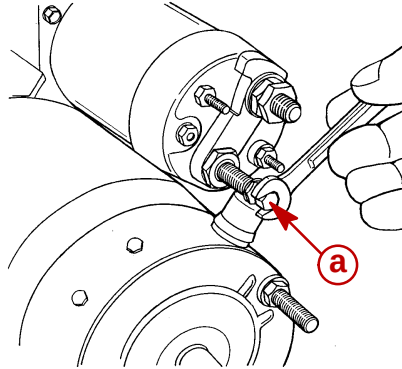
Field coils should be removed only where defects are indicated by tests. Defective parts should be replaced or repaired.

1. Check pinion teeth.
2. Check spring for tension and drive collar for wear.
3. Check that brush holders are not damaged or bent and will hold brushes against commutator.
4. Inspect armature commutator. If rough or out-of-round, turn down and undercut. Inspect points (where armature conductors join commutator bars) for good, firm connection. Burned commutator bar is usually evidence of poor connection.

Checking Pinion Clearance

Pinion clearance must be checked as follows after reassembly of motor to insure proper adjustment.

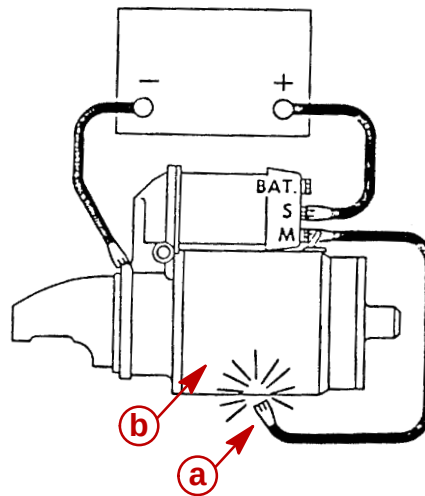
1. Disconnect motor field coil connector from solenoid motor terminal and insulate it carefully.



72631

a - Motor Field Coil Connector

2. Connect 12 volt battery positive (+) lead to solenoid switch and negative (-) lead to solenoid frame.
3. Momentarily touch a jumper lead from solenoid motor terminal M to starter motor frame. This shifts pinion into cranking position where it will remain until battery is disconnected.



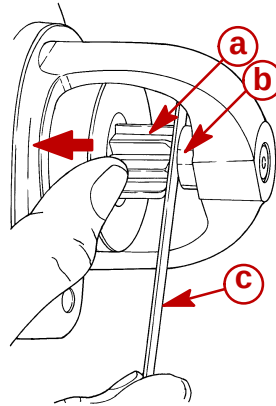
01447

a - Jumper Lead

b - Starter Motor Frame

4. Push pinion back toward commutator end to eliminate slack.
5. Measure distance between pinion and pinion retainer.

6. If clearance is not within limits of .010-.140 in. (0.25-3.5 mm), it may indicate excessive wear of solenoid linkage shift lever yoke buttons or improper assembly of shift lever mechanism. Check for proper assembly, and recheck gap. If still excessive, replace worn or defective parts, since no provision is made for adjusting pinion clearance.



72077

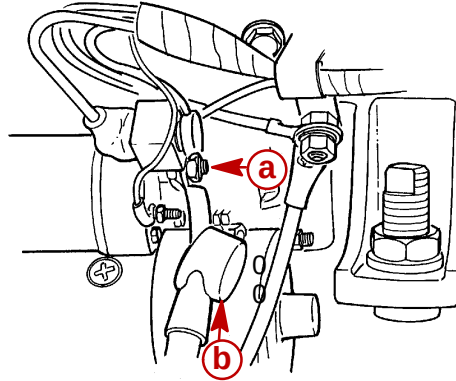
- a** - Pinion
b - Retainer
c - Feeler Gauge

Checking Commutator End Frame Gap

To keep the ignition-proof and safety requirement, the gap between the commutator end frame and field coil housing must be checked. See specifications. If the gap exceeds measurement when checked with a feeler gauge, the end frame should be checked for proper seating on the field coil housing. If properly seated and still found to have excessive gap, the starter motor must be replaced.

Installation

1. Place starter motor in position and install mounting bolts. Torque bolts to 50 lb-ft (68 Nm).
2. Fasten wires.
3. Coat solenoid terminal connections with Quicksilver Liquid Neoprene.
4. Place rubber boot over positive battery cable connection.



- a** - Positive (+) Battery Cable
b - Rubber Boot

72637

Delco PG260F1 Starter

Specifications

Starter Specifications

PG260F1 Starter Motor						
MerCruiser Part Number				50-807904		
Delco Identification Number	Engine Rotation	Volts	No Load Test			
			Min. Amps	Max. Amp	Min. rpm	Max. rpm
9000839 - 9000840	LH	11.5	40	90	3200	4800
Brush Spring Length				Length New - 0.36 - 0.42 in. (9.2 - 10.7 mm) Length Used - 0.18 - 0.23 in. (4.62 - 5.98 mm)		
Pinion Clearance				0.009 - 0.160 in. (0.23-4.06 mm)		
Bearing Depth (Gear)				Flush - Inside		
Bearing Depth (Housing)				.009-.017 (0.4mm) Maximum		

Torque Specifications

Fastener Location	lb-ft	Nm
Starter Mounting Bolts	30	41
All Other Fasteners	Tighten Securely	

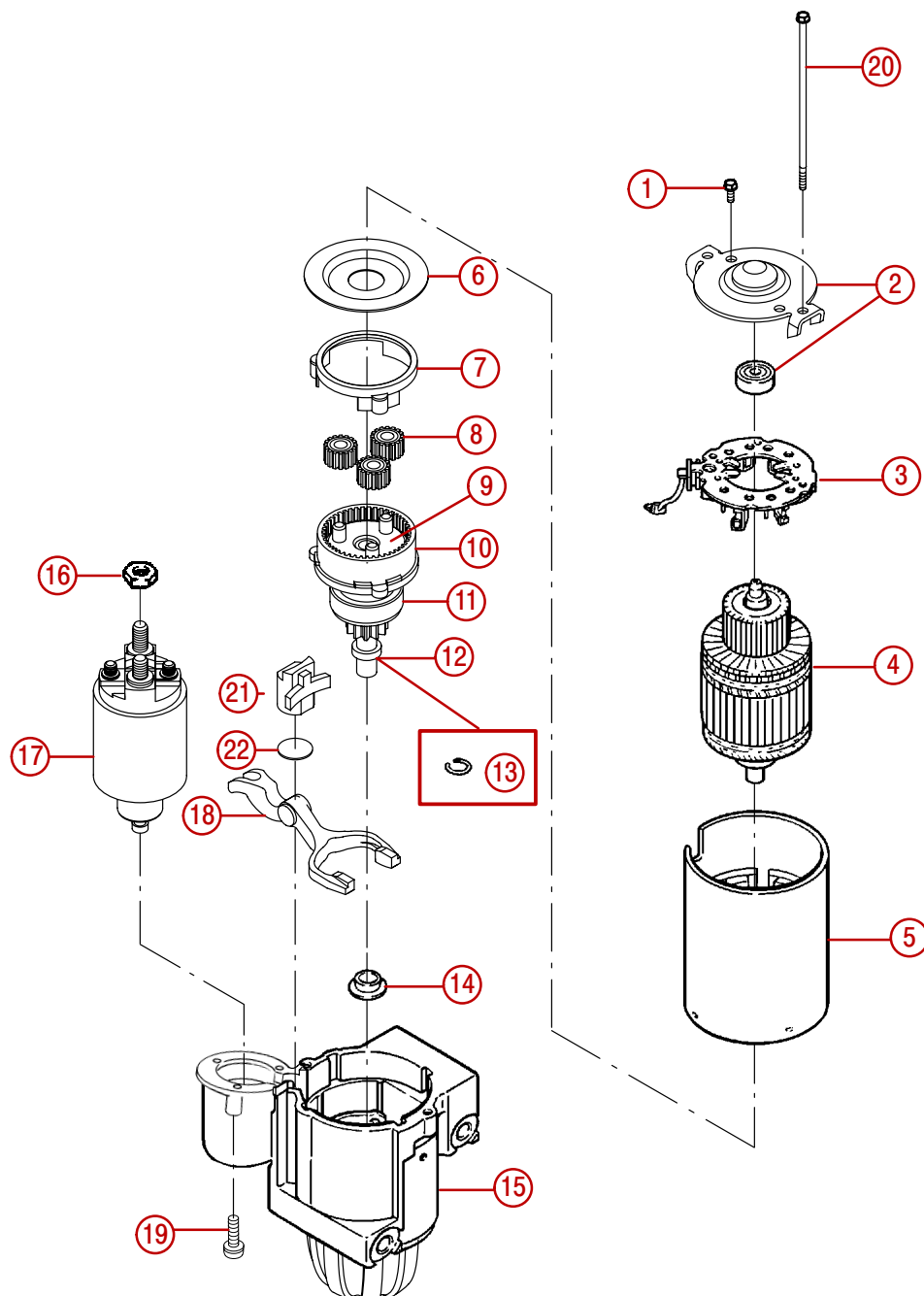
Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Liquid Neoprene	92-25711--3
Quicksilver 2 4 C Marine Lubricant With Teflon	92-825407A3

Description

The Permanent Magnet Gear Reduction (PG200 and PG250) starter motors feature small permanent magnets mounted inside the field frame (NOTE: The actual configuration of these magnets differs between the PG200, PG250 and PG260; the field frames with permanent magnets are not interchangeable. Otherwise, the units are similar.) These magnets take the place of current-carrying field coils mounted on iron pole pieces. Internal gear reduction, approximately 4 to 1, through planetary gears results in armature speeds in the 7000 rpm range. The armature and drive shaft are mounted on roller or ball bearings in place of bushings. The solenoid switch, plunger, return spring, and shift lever are permanently mounted in the drive housing.

Exploded View



- 1** - Screw (2)
- 2** - End Frame and Bearing
- 3** - Brush With Holder
- 4** - Armature
- 5** - Field Frame (With Permanent Magnets)
- 6** - Washer
- 7** - Shield
- 8** - Planetary Gears
- 9** - Shaft
- 10** - Gear
- 11** - Drive

- 12** - Collar
- 13** - Retaining Ring
- 14** - Trust Collar
- 15** - Drive Housing
- 16** - Nut
- 17** - Solenoid
- 18** - Solenoid Drive Arm
- 19** - Screw (3)
- 20** - Long Screw (2)
- 21** - Rubber Grommet
- 22** - Metal Disc

74270

Motor

Removal

⚠ WARNING

Disconnect battery cables at battery before removing starter.

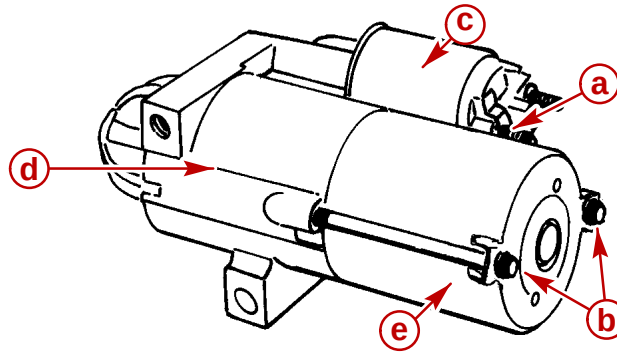
1. Disconnect battery cables from battery.
2. Disconnect wires from solenoid terminals.

IMPORTANT: Some starter motors may use a special mounting shim for gaining flywheel clearance. Do not lose this shim; it will be needed when remounting starter on engine block.

1. Remove starter mounting bolts.
2. Pull starter assembly away from flywheel and remove from engine.

Disassembly

1. Remove brush lead from solenoid and long screws from end frame.

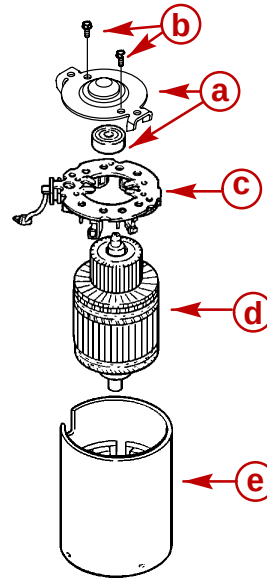


75820

- a** - Brush Lead
- b** - Screws
- c** - Solenoid Switch
- d** - Drive Housing
- e** - Field Frame

2. Remove armature and field frame from drive housing.

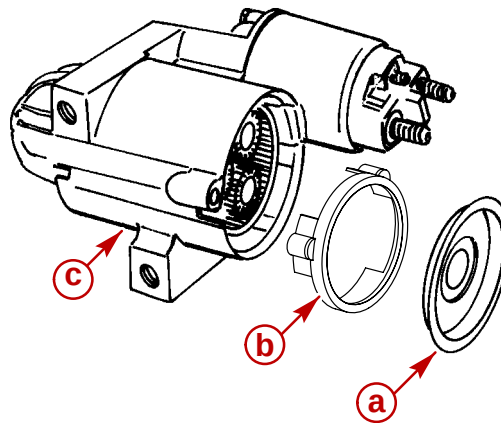
NOTE: Permanent magnets inside field frame will be holding armature in place.



74270

- a-** End Frame and Bearing
- b-** Screws (2)
- c-** Brush Holder
- d-** Armature
- e-** Field Frame

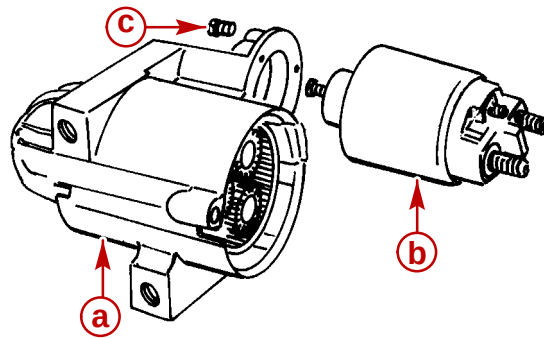
3. Remove shield and washer from drive housing.



74038

- a-** Shield
- b-** Washer
- c-** Drive Housing

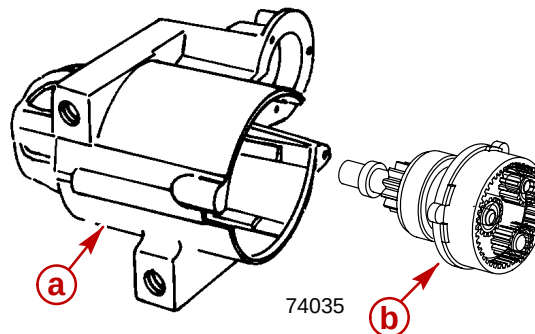
4. Remove the three screws retaining the solenoid. Remove solenoid from drive housing.



74036

- a** - Drive Housing
b - Solenoid
c - Screws (3)

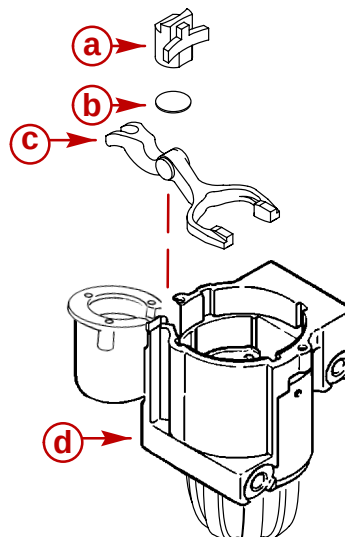
5. Remove drive and associated parts from drive housing.



75821

- a** - Drive Housing
b - Drive

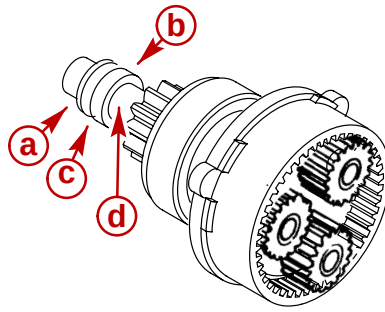
6. Remove solenoid arm, metal disc and rubber grommet from the drive housing.



75821

- a** - Rubber Grommet
b - Metal Disc
c - Solenoid Arm
d - Drive Housing

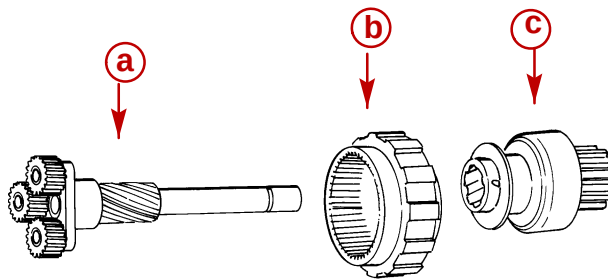
7. Remove thrust collar, retaining ring and collar from planetary shaft with drive.



75821

- a** - Thrust Collar
- b** - Retaining Ring (Inside Collar)
- c** - Collar
- d** - Planetary Shaft and Drive

8. Remove drive and gear from planetary shaft.



74087

Typical

- a** - Gear
- b** - Shaft Assembly
- c** - Drive

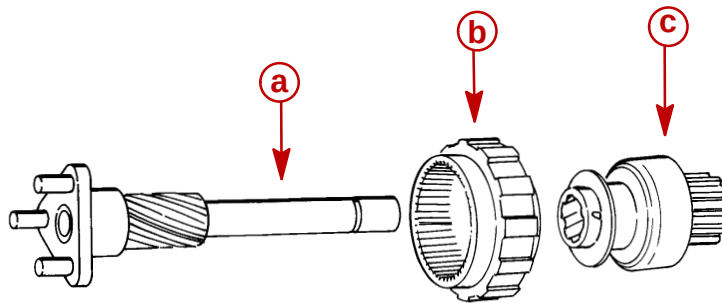
Cleaning and Inspection

IMPORTANT: Do not use grease dissolving solvents to clean electrical components, planetary gears or drive. Solvent will damage insulation and wash the lubricant out of the drive and gears. Use clean rags and compressed air to clean components.

1. Test over-running clutch action of drive. Pinion should turn freely in over-running direction and must not slip in cranking direction.
2. Check pinion teeth.
3. Check spring for tension and drive collar for wear.
4. Check that bearings roll freely. If any roughness is felt, replace bearing.
5. Inspect planetary gear assembly. Gears must mesh easily and roll freely with no binding.

Reassembly

1. Install gear and drive over planetary gear shaft.



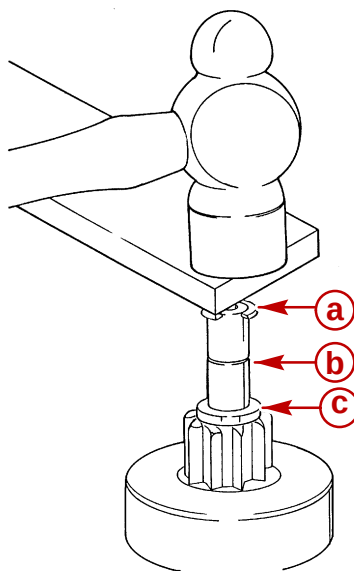
74087

Typical

- a** - Planetary Gear Shaft Assembly
- b** - Gear
- c** - Drive

2. Assemble drive on shaft assembly as follows:
 - a. Lubricate drive end of shaft assembly with SAE 10W oil.
 - b. Place gear over shaft.
 - c. Slide drive assembly onto shaft with pinion facing outward.
 - d. Slide retainer onto shaft with cupped surface facing end of shaft (away from pinion).

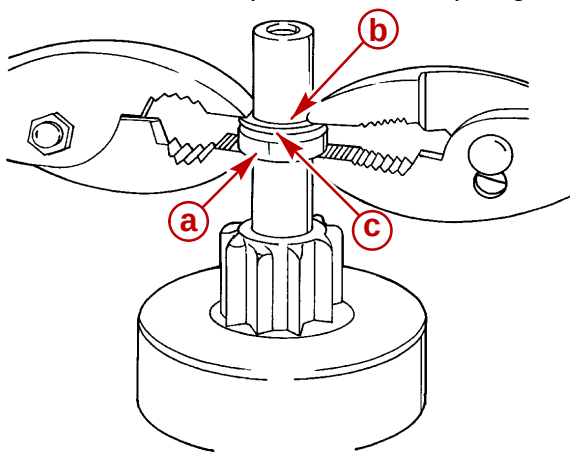
- e. Position snap ring on upper end of shaft and hold in place with block of wood. Strike wood block with hammer, thus forcing snap ring over end of shaft. Slide snap ring down into groove.



72073

- a-** Snap Ring
b- Groove
c- Retainer

- f. Assemble thrust collar on shaft with shoulder next to snap ring.
g. Position retainer and thrust collar next to snap ring. Then, using two pliers, grip retainer and thrust collar and squeeze until snap ring is forced into retainer.

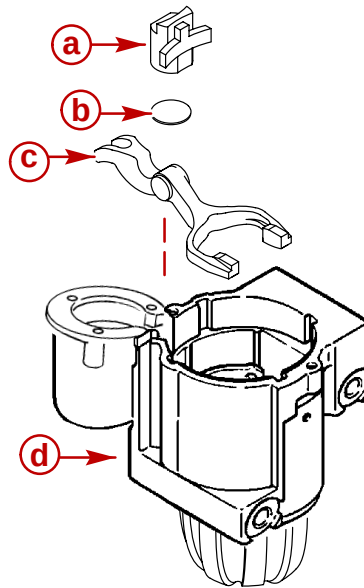


72074

- a-** Retainer
b- Thrust Collar
c- Snap Ring

3. Install the planetary gears on planetary gear shaft assembly.
4. Install solenoid arm, metal disc and rubber grommet in the drive housing.

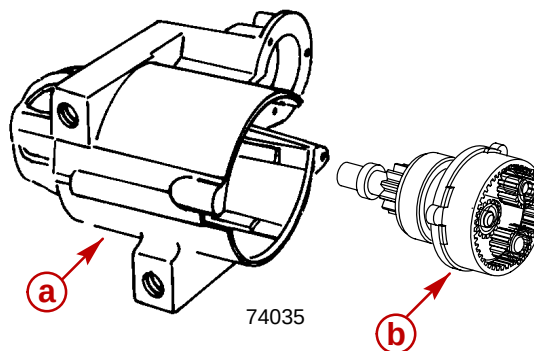
NOTE: Solenoid arm is designed to fit only one way. Do not use force.



75821

- a** - Rubber Grommet
- b** - Metal Disc
- c** - Solenoid Arm
- d** - Drive Housing

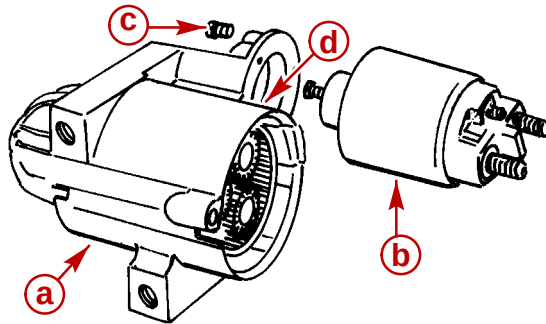
5. Install drive and associated parts in drive housing.



75821

- a** - Drive Housing
- b** - Drive

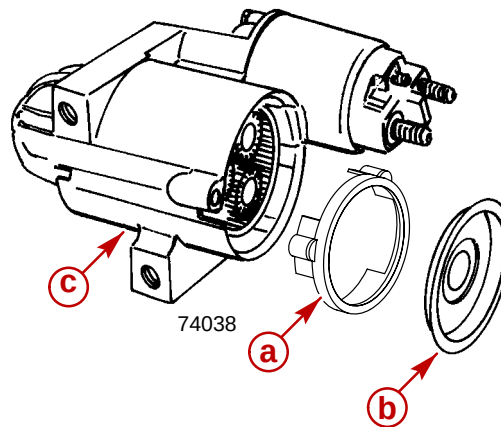
6. Attach solenoid arm to solenoid. Place solenoid in drive housing and tighten screws.



74036

- a-** Drive Housing
b- Solenoid
c- Screw (3)
d- Solenoid Arm

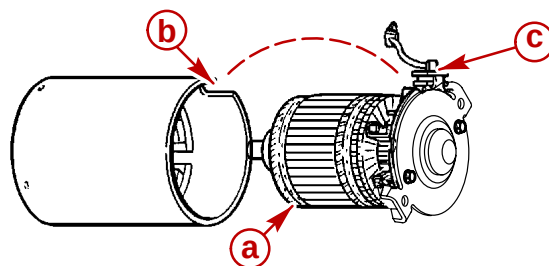
7. Install washer and shield in drive housing.



75821

- a-** Washer
b- Shield
c- Drive Housing

8. Install field frame over armature. Align slot in field frame with rubber grommet.

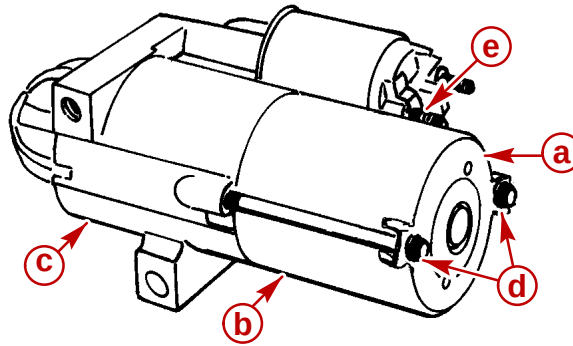


75821

- a-** Armature
b- Field Frame Slot
c- Rubber Grommet

9. Install field frame and end frame in drive housing.

10. Install long screws and brush lead. Tighten fasteners securely.



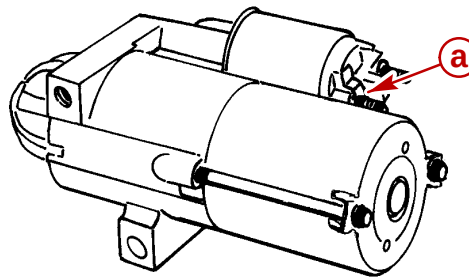
75821

- a** - End Frame
- b** - Field Frame
- c** - Drive Housing
- d** - Long Screws
- e** - Brush Lead

Checking Pinion Clearance

Pinion clearance must be checked after reassembly of starter motor.

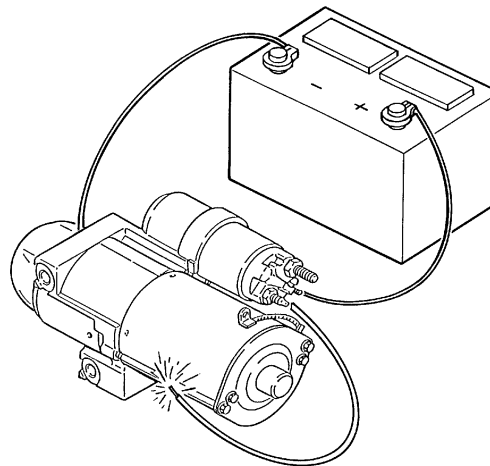
1. Disconnect brush lead from solenoid switch and insulate it carefully.



74041

- a** - Brush Lead

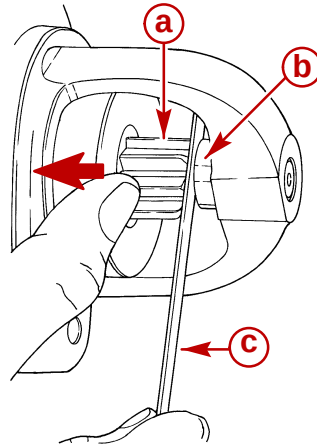
2. Connect 12 volt battery positive (+) lead to battery terminal and negative (–) lead to frame.
3. Momentarily touch a jumper lead from battery terminal to switch terminal. This shifts pinion into cranking position where it will remain until battery is disconnected.



72629

4. Push pinion back toward commutator end to eliminate slack.
5. Measure distance between pinion and pinion retainer.

6. If clearance is not within limits of .010-.160 in. (0.25-4.00 mm), it may indicate excessive wear of solenoid linkage, shift lever yoke, or improper assembly of shift lever mechanism. Replace solenoid switch, since no provision is made for adjusting pinion clearance.



72077

- a** - Pinion
- b** - Retainer
- c** - Feeler Gauge

Installation

IMPORTANT: Install special mounting shim (if equipped) between starter motor and engine block.

1. Place starter motor in position and install mounting bolts. Torque bolts to 30 lb-ft (41 Nm).
2. Connect YELLOW/RED wire to terminal S of solenoid. Connect ORANGE wire, RED wire, and battery cable to large terminal of solenoid. Tighten fasteners securely. Coat terminals with Quicksilver Liquid Neoprene. Install battery cable boot, if so equipped.
3. Connect battery cables to battery in the following order. Connect positive (+) cable to positive (+) battery terminal and tighten cable clamp. Then connect negative (–) cable to negative (–) terminal and tighten clamp.

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ELECTRICAL SYSTEMS

Section 4B - Ignition System

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Ignition Control System Components

Replacement Parts Warning

WARNING

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

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

General Precautions

CAUTION

Avoid personal injury and/or property damage. Listed below are some of the precautions, along with others listed throughout this manual, that you should observe to help ensure an accident-free maintenance experience:

- Always disconnect battery cables from battery BEFORE working on electrical system to prevent injury to yourself or damage to electrical system.
- Be sure that engine compartment is well ventilated and that no gasoline vapors are present, to avoid the possibility of fire.
- Be sure to keep hands, feet and clothing clear of moving parts.
- DO NOT touch or disconnect any ignition system parts while engine is running.
- DO NOT reverse battery cable connections. System is negative (–) ground.
- DO NOT disconnect battery cables while engine is running.
- When working on engine, spark plug holes and carburetor throat should be kept covered to prevent foreign objects from entering combustion chamber.
- Replace a component if there is any doubt as to the condition of the component.

WARNING

When performing the following procedure, be sure to observe the following:

- Be sure that engine compartment is well ventilated and that no gasoline vapors are present, to avoid the possibility of fire.
- Be sure to keep hands, feet and clothing clear of moving parts.
- DO NOT touch or disconnect any ignition system parts while engine is running.
- DO NOT reverse battery cable connections. System is negative (–) ground.
- DO NOT disconnect battery cables while engine is running.

EFI System Maintenance Precautions

WARNING

Avoid Injury or Electrical System Damage: Always disconnect battery cables from battery before working around electrical system components. See CAUTION following:

CAUTION

Avoid damage to the EFI electrical system components: Refer to the following precautions when working on or around the EFI electrical harness, or when adding other electrical accessories:

- DO NOT tap accessories into engine harness.
- DO NOT puncture wires for testing (Probing).
- DO NOT reverse battery leads.
- DO NOT splice wires into harness.
- DO NOT attempt diagnostics without proper, approved Service Tools.

Torque Specifications

Fastener Location	lb-in.	lb-ft	Nm
Spark Plugs (New Cylinder Head)		22	30
Spark Plugs (All Others)		15	20
Knock Sensor		14	19

Tools

Description	Part Number
DMT 2000 Tach / Multi-Meter	91-854009T--1
Torch Lamp	91-63209
Timing Light	91-99379
Timing Jumper Plug	91-805747A2

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Liquid Neoprene	92-27511--3
Loctite 27131	92-809820
Silicone Dielectric Compound	92-802882A1

Ignition System Specifications

Description	Specification
Ignition Timing	
EFI / MPI Models	8° BTDC
Carbureted Models	10° BTDC
Firing Order	1-8-4-3-6-5-7-2

Distributor

Description	GM EST	Mercury
Distributor Part Number	805222A1	805185A36

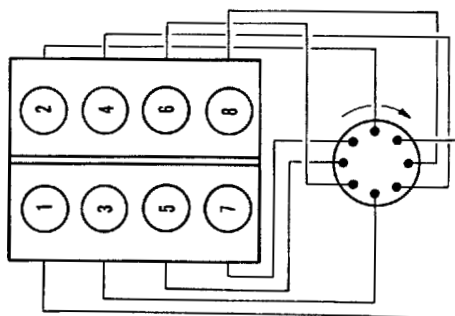
Coil

Description	GM EST	Mercury
Coil Part Number	392-7803A4	392-7803A4
Primary Resistance	.60-.80 Ohms	.60-.80 Ohms
Secondary Resistance	9,400-11,700 Ohms	9,400-11,700 Ohms

Spark Plugs

Model	All MIE and MCM Engines
Spark Plug	.045 in. (1.1 mm)
Spark Plug Type	AC-MR43LTS NGK BPR6EFS Champion RS12YC

Firing Order



72008

Firing Order 1-8-4-3-6-5-7-2

Timing

Thunderbolt V Models

1. Connect timing light to number 1 spark plug wire.
2. Connect a shop tachometer to the engine.

IMPORTANT: Before starting the engine, connect a jumper wire from the ignition timing lead to a good ground. This has to be done before the ignition key is turned ON to lock the Ignition Module into Base Timing Mode.

3. Before starting the engine, connect jumper wire from timing lead to a good ground.

NOTE: The PUR/WHT timing lead is located towards the front of the engine near the fuel line or near the distributor, as equipped for your model.

4. Start engine and run at 1300 rpm until it reaches normal operating temperature.
5. Disconnect throttle cable from the carburetor.
6. With engine at idle rpm, adjust the carburetor idle rpm screw to the specified engine idle rpm.
7. With the engine still at idle rpm, check the ignition timing. If incorrect, rotate the distributor until timing is correct. Torque clamping screw to 18 lb-ft (25 Nm).
8. Adjust the idle mixture screw. Inward is LEAN, outward is RICH.
9. Recheck ignition timing.
10. Stop engine. Remove timing light, jumper wire and shop tachometer.

IMPORTANT: Timing jumper wire has to be removed or the Ignition Module will stay locked in the Base Timing Mode and it will not be able to advance the ignition timing correctly when the engine rpm is increased.

11. Adjust and reinstall throttle cable. Open and close remote control throttle lever to make sure that the carburetor's throttle lever returns against the rpm adjusting screw every time.
12. Restart the engine, increase rpm to 1300 then return to idle position slowly and shut the engine off. Ensure that the carburetor throttle lever came back against the idle rpm screw.
13. Shut engine off.

EFI / MPI Models

1. Connect timing light to number 1 spark plug wire.
2. Start engine and run at 1300 rpm until it reaches normal operating temperature.
3. Stop engine and connect the scan tool or timing tool to the DLC connector on the EFI/ MPI wiring harness.
4. Start engine, allow rpm to stabilize.

NOTE: MEFI-1 models only, manually adjust remote control throttle lever to get 1200 engine rpm.

NOTE: MEFI-2 and MEFI-3 models only, ECM will automatically adjust engine rpm to approximately 1200 rpm when put in the service mode on a scan tool or when using the timing tool.

5. Check ignition timing. If incorrect, rotate the distributor until timing is correct. Torque clamping screw to 18 lb-ft (25 Nm).
6. Recheck ignition timing.
7. Disconnect scan tool or timing tool from DLC connector.
8. If required, return remote control throttle lever to idle position and shut off engine.
9. Restart engine, increase rpm to 1300 then return to idle position slowly. Ensure that engine returns to idle rpm. Readjust throttle cable, if required.
10. Shut engine off.

Spark Plugs

Removal

1. Disconnect spark plug wires (high tension leads) from spark plugs.

NOTE: Use care when removing spark plug wires and boots from spark plugs. Twist the boot 1/2 turn before removing. Firmly grasp and pull on the **boot** to remove the wire end.

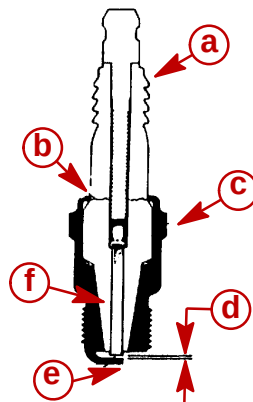
2. Remove spark plugs.

NOTE: A "thin-walled" spark plug socket may be required.

Inspection

1. Inspect each spark plug for manufacturer and spark plug number. All plugs must be from the same manufacturer and have the same spark plug number. Refer to SECTION 1B. - "Specifications" for spark plug numbers.

2. Inspect each plug individually for badly worn electrodes, glazed, broken or blistered porcelain and replace where necessary.

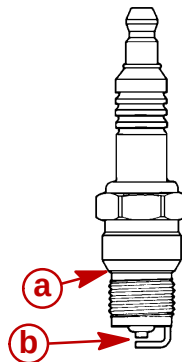


72734

- a** - Porcelain Insulator
- b** - Insulator - Cracks Often Occur at This Point
- c** - Shell
- d** - Proper Gap
- e** - Side Electrode
- f** - Center Electrode (When Adjusting Gap - DO NOT Bend)

Replacing

1. Clean the plug seating area on the cylinder heads.
2. Adjust spark plug gap with a round feeler gauge. Bend side electrode to adjust gap. Refer to SECTION 1B – “Specifications” for correct spark plug gap.



75084

- a** - Seating Area
- b** - Gap

IMPORTANT: It is recommended that spark plugs be torqued to the amount specified. In the absence of a torque wrench or access problems to the plugs, the spark plugs should be hand tightened until the plug seats on the cylinder head. Then, securely tighten with appropriate wrench and socket.

3. Install spark plugs and torque to specifications. Refer to “Torque Specifications,” in this section.
4. Install spark plug wires in proper order. Refer to “Engine Rotation and Firing Order” and/or “Spark Plug Wires,” following.

Spark Plug Wires

IMPORTANT: Proper positioning in spark plug wire supports is important to prevent cross-firing.

Inspection

1. Visually inspect spark plug wires and coil wire for damage, such as cracks.
2. Visually inspect spark plug boots for damage.

NOTE: Use care when removing spark plug wires and boots from spark plugs. Twist the boot 1/2 turn before removing. Firmly grasp and pull on the **boot** to remove the wire end.

3. Check spark plug wires and coil wire for continuity using a Multi-Meter, Digital/Volt/Ohm Meter, or similar. Replace any wires that do not show continuity from end to end.
4. Replace any damaged wires.

Replacing

IMPORTANT: Proper positioning of each spark plug wire is important to prevent cross-firing.

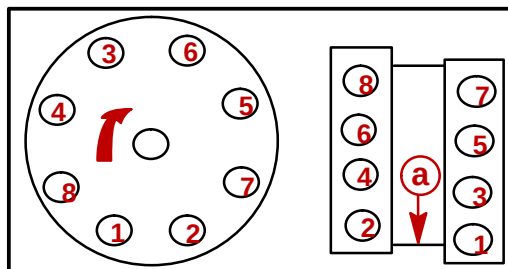
IMPORTANT: Use only spark plug wires recommended for Marine application.

NOTE: When replacing spark plug wires, replace one wire at a time to reduce the risk of error.

1. Disconnect individual spark plug wires.
2. Install spark plug wires in proper order. Observe the following:

IMPORTANT: When replacing plug wires, route the wires correctly through the proper supports. Correct positioning of spark plug wires and supports is important to prevent cross-firing.

- a. Position wires in spark plug wire supports and retainers, as provided.
- b. Attach plug wires to appropriate spark plug and terminal on distributor cap. Each end should fit securely.



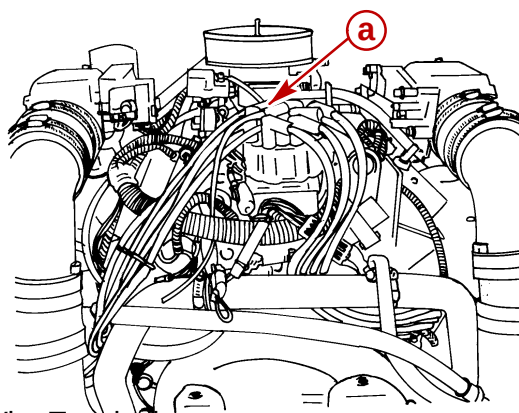
Rotor Rotation On LH Engine

a - Front

IMPORTANT: Mercury Marine Coil Only, before installing coil wire (high tension lead) to coil, apply approximately 1/2 oz. of Silicone Dielectric Compound (Quicksilver 92-802882A1) around top of coil high tension lead tower. Do not apply to inside of tower hole.

- c. Apply Silicone Dielectric Compound. Attach coil wire (high tension lead) to center terminal on distributor cap.

- d. Push end of high tension wire into coil tower. Position boot over coil tower and wipe off excess insulating compound.



76470

a - Distributor Coil Wire Terminal

NOTE: Make sure boot does not come off of tower due to hydraulic air pressure inside boot.

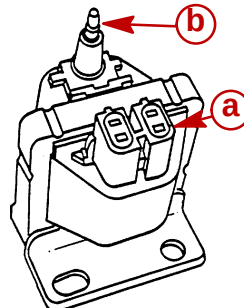
Ignition Coil

NOTICE

Refer to "Service Precautions" in the front of this section **BEFORE** proceeding.

REMOVAL

1. Disconnect wire harness connectors at coil.



72921

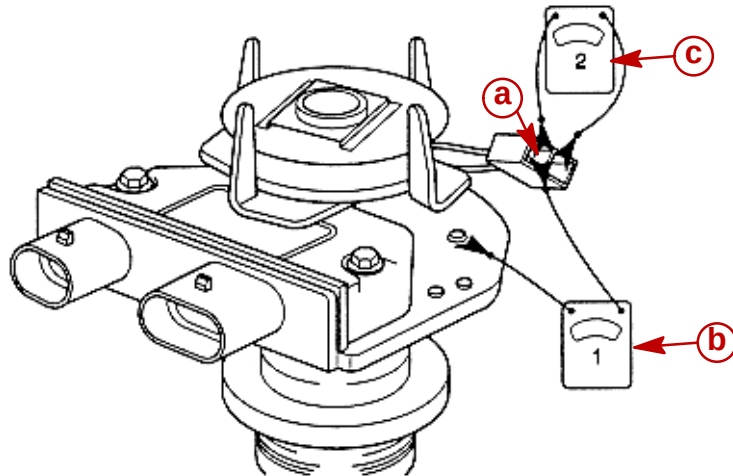
a - Wire Harness Connection

b - High Tension Coil Lead Connection

2. Remove high tension coil lead.
3. Remove coil bracket fasteners and remove coil bracket with coil.

RESISTANCE TEST

1. Check the resistance of the coil with an ohmmeter, as follows:
 - a. Connect an ohmmeter as shown for Test 1. Using the high scale the reading should be infinite. If not, replace the ignition coil.
 - b. Connect an ohmmeter as shown for Test 2. Using the low scale the reading should be very low or zero. If not, replace the ignition coil.



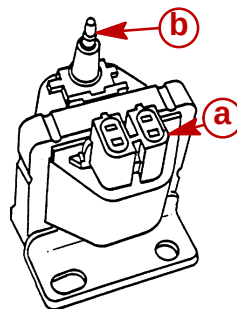
- a** - Ground
- b** - Test 1
- c** - Test 2

INSTALLATION

1. Install coil bracket with coil to engine bracket using fasteners.

IMPORTANT: Mercury Marine Coil Only, before installing coil wire (high tension lead) to coil, apply approximately 1/2 oz. of Silicone Dielectric Compound (Quicksilver 92-802882A1) around top of coil high tension lead tower. Do not apply to inside of tower hole.

2. Connect high tension coil lead.



- a** - Wire Harness Connection
- b** - High Tension Coil Lead Connection

3. Connect wire harness connectors.

Carbureted Engines - Thunderbolt V Ignition

Spark Control Features

IDLE SPEED SPARK CONTROL

The Ignition Module controls ignition timing to maintain a calibrated idle speed by making small spark advance adjustments. This feature is only active between 400-700 rpm.

ACCELERATION SPARK ADVANCE

When accelerating, the Ignition Module may add more spark advance to the "Base Spark Timing Curve." The amount of spark advance added depends on how fast rpm increases. This feature is also active between 1200-4000 rpm. Within this range, the module can add approximately 10 degrees of spark advance to the base spark timing curve.

MEAN-BEST-TIMING (MBT) SPARK ADVANCE

During light load cruising, the Ignition Module maintains optimal ignition timing by making small spark advance adjustments. At a given rpm, the module will add a small amount of advance and wait to see if there is an rpm change. If rpm increases, it will increase timing more. The module will continue to advance timing until it no longer gets an increase in rpm. Conversely, if it senses an rpm drop, it will start to retard some of the spark timing. Between 1200-4000 rpm the Ignition Module can add approximately 10-15 degrees of spark advance to the base spark timing curve.

NOTE: The Audio Warning System is also connected into the Ignition Module circuit. If the audio warning system becomes activated by the closing of one of the audio warning system switches, the MBT feature is deactivated.

OVER-SPEED CONTROL

The Ignition Module will prevent the engine speed from exceeding a preset limit by stopping the spark. The over-speed limit is set slightly higher than the top end of the rpm range. For example, if the recommended range is 4600-5000 rpm, the over-speed limit would be set at 5100 rpm. When rpm reaches this limit, spark is turned-off until engine rpm drops down to a RESET rpm, which would be approximately 4750 rpm for this example. At this point, spark comes back on.

KNOCK RETARD SPARK CONTROL

The knock control feature helps provide protection from harmful detonation. Knock control is handled by the Knock Control Module. This module receives a signal from a sensor that is mounted on the engine block. The Knock Control Module works in conjunction with the Ignition Module to retard the timing if spark knock is present.

Circuit Description

Refer to the circuit wiring diagram on the following page for reference to this circuit description.

IGNITION CONTROL MODULE

- The Ignition Module receives its power (+) through the PUR wire "9."
- Ignition Module ground (–) is accomplished through the BLK wire "10."
- There is also a Case Ground (–) wire "12" that is connected to one of the Ignition Module attaching screws.
- The 12 volt signal from the Ignition Module to the distributor is carried through the WHT/RED wire "8," to the distributor sensor and back to the Ignition Module through the WHT/GRN wire "7."
- The tachometer signal is carried to the instrument panel through the GRY wire "11."
- The PUR/WHT wire "3" carries the signal from the Knock Control Module to the Ignition Control Module.
- There are two BLK wires "5" that have bullet connectors. This circuit is reserved for future options. On current models, the two BLK wires must be connected for the system to function properly.
- The TAN/BLU wire "6" carries a signal from the Audio Warning Circuit to the Ignition Module.

KNOCK CONTROL MODULE

- The Knock Control Module receives its power (+) from the PUR wire "4."
- Knock Module ground (–) is accomplished through the BLK wire "2."
- The PUR/WHT wire "3" carries the signal from the Knock Control Module to the Ignition Control Module.
- The BLU wire "1" carries the signal from the Knock Sensor to the Knock Module.

IGNITION CONTROL SYSTEM TIMING LEAD

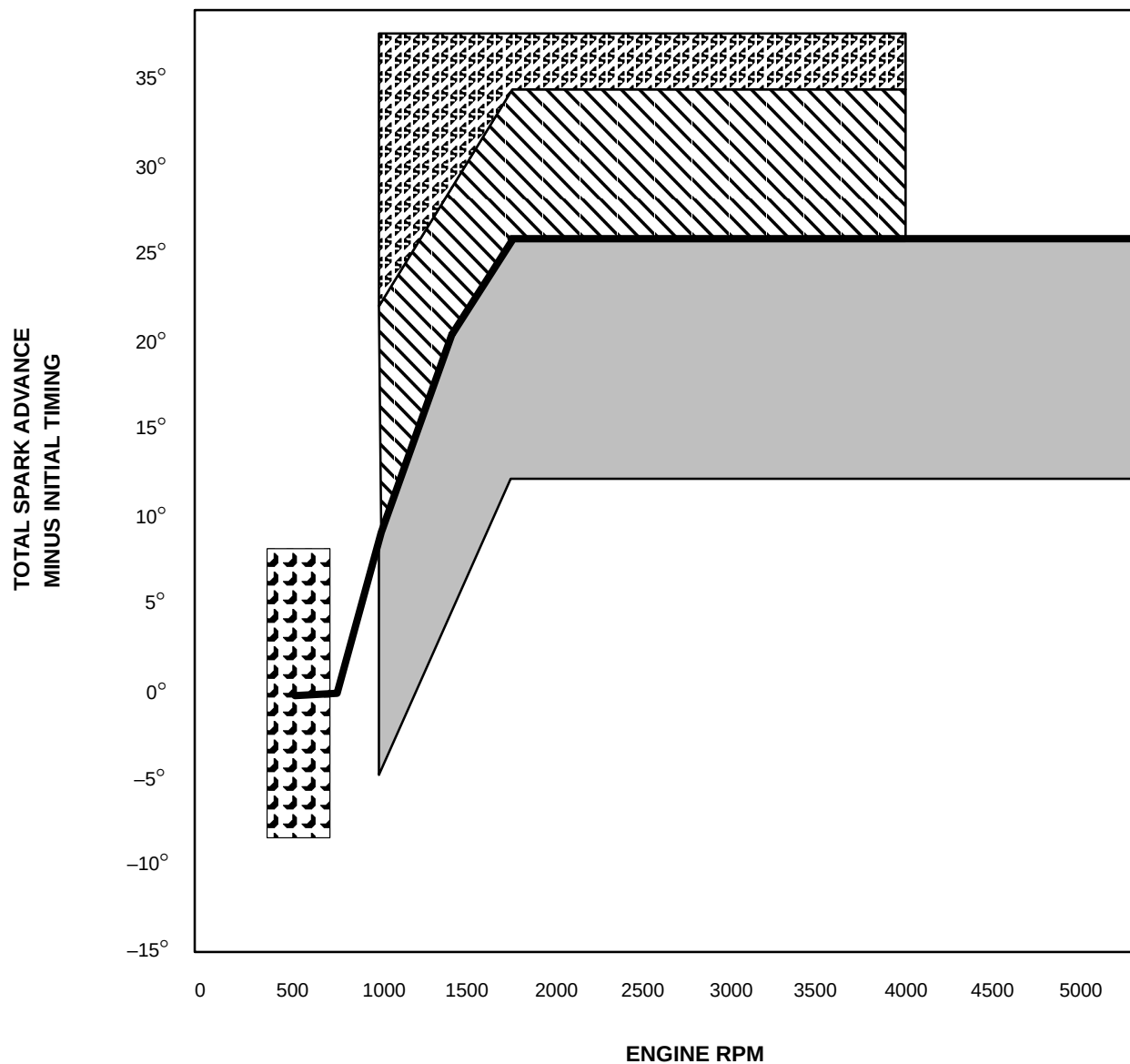
The ignition control system has a lead with bullet connector "11" that is connected into the PUR/WHT wire "3." This lead is used for performing the following tests and procedures:

- Setting Base Ignition Timing
- Setting Engine Idle Speed
- Setting Idle Mixture
- Testing Knock Control Circuit

This lead, when connected to an engine ground (–), locks the Ignition Control Module into the Base Timing Mode.

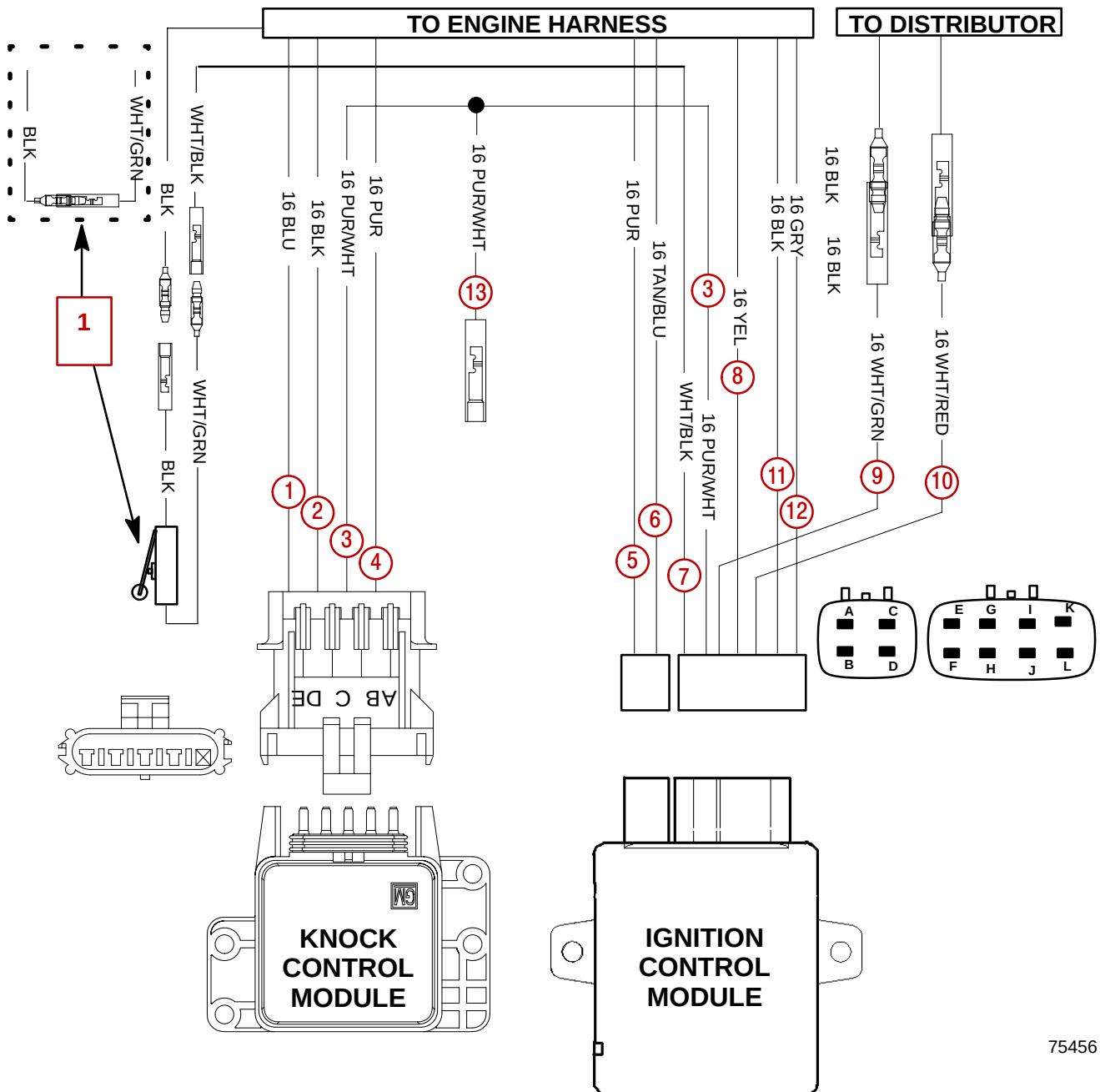
Thunderbolt V Spark Control Graph

IMPORTANT: The graph below shows the typical advance ranges for a Thunderbolt V Ignition Control Module. The numbers plotted on the graph are not representative of any particular model. It is only presented to provide an understanding of how the system functions.



- = Base Timing Advance Curve
-  = Idle Speed Advance Range
-  = Knock Retard Range
-  = Acceleration Advance Range
-  = MBT Advance Range (Not A Function On Ski Model)

Ignition System Wiring Diagram



75456

NOTE: ¹ Alpha Models Are Equipped With A Shift Cut-Out Switch. 305 and 350 cid Bravo Models Will Have Two BLACK Leads Connected Together.

- | | |
|---|---|
| 1 - Knock Sensor Wire | 8 - Water Temperature Switch (For Audio Warning) (Pin H) |
| 2 - Ground Wire (–) For Knock Module | 9 - Distributor Wire (Pin G) |
| 3 - Knock Module Signal Wire | 10 - Distributor Wire (Pin I) |
| 4 - Battery (+) Positive Wire To Knock Module | 11 - Ignition Module Grd (–) Wire (Pin J) |
| 5 - Battery (+) Positive Wire To Ignition Module (Pin C) | 12 - Tachometer Wire (Pin L) |
| 6 - Audio Warning System Wire (Pin D) | 13 - Timing Lead (For Setting Timing and Other Tests) |
| 7 - Shift System Interrupt Switch (If Equipped) (Pin E) | |

Thunderbolt V Ignition Module

REMOVAL

1. Unplug wiring harness connectors from Ignition Module.
2. Remove fasteners and hardware retaining Ignition Module to exhaust elbow.
3. Remove module.

CLEANING AND INSPECTION

1. Check that terminals of wiring harness connector are clean and free of corrosion.

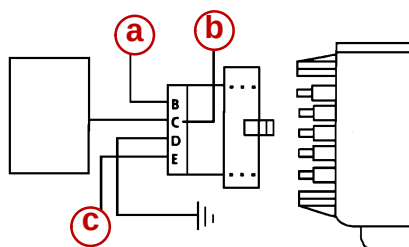
INSTALLATION

1. Install Ignition Module using existing hardware. Tighten securely.
2. Plug connectors into Ignition Module.

Knock Control Module

DESCRIPTION

The Knock Control Module monitors the Knock Sensor's AC voltage signal and supplies an 8-10 volt signal, if no spark knock is present, to the Ignition Control Module. If spark knock is present, the Knock Control Module will remove the 8-10 volt signal to the Ignition Control Module.



Knock Sensor System

- a** - Positive Lead (12 Volts)
- b** - 8-10 Volts To Knock Sensor
- c** - Knock Sensor

IMPORTANT: The correct Knock Module and Sensor must be used. Using an incorrect Knock Module or Sensor will result in unrecognized spark knock and engine damage.

The Knock Module terminal B is powered by 12 volts from the ignition switch. If the 12 volt power source is not present, the Knock Module cannot send an 8-10 volt signal to the Ignition Control Module and a false constant spark retard will result.

Terminal "E" of the Knock Module is the signal line from the Knock Sensor. If this circuit opens or shorts to ground, the Knock Module will never remove the 8-10 volt signal from terminal "C" and no spark retard will occur.

The ground circuit for the Knock Module is connected to terminal "D." If the ground circuit opens, the Knock Module will not be able to remove the 8-10 volt signal and spark knock cannot be controlled.

IMPORTANT: If Knock Sensor wire is routed too close to secondary ignition wires, the Knock Module may see the interference as a knock signal, resulting in false timing retard.

IMPORTANT: If there is abnormal mechanical engine noise (rattles or knocks), they may give a false knock retard signal. If fuel octane is too high or too low, a false signal can also be sent.

TESTING KNOCK MODULE AND KNOCK SENSOR

NOTE: A digital volt-ohmmeter (DVOM) and an unpowered test light (low power test light - 300mA or less) are needed to conduct the following test.

WARNING

Avoid fire or explosion. Ensure that engine compartment is well ventilated and gasoline vapors are not present when performing electrical tests inside the engine compartment. Sparks generated by electrical tests could ignite gasoline vapors causing fire or explosion.

IMPORTANT: The correct Knock Module and Sensor must be used. Using an incorrect Knock Module or Sensor will result in unrecognized spark knock and engine damage.

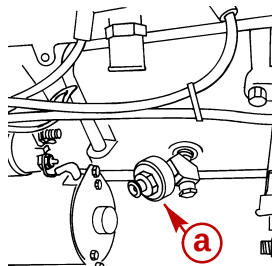
1. Start engine and warm it up to normal operating temperature.
2. Connect the positive (+) lead from the DVOM to the PUR/WHT timing terminal that comes from the engine harness.
3. Connect the negative (–) lead from the DVOM to a good engine ground (–).
4. With the engine running, there should be 8-10 volts on this circuit. If voltage is not present, ensure that there is 12 volts to the Knock Module (PUR wire Terminal “B”).
5. Advance the throttle to approximately 1500 rpm.
6. Disconnect the harness connector (BLU wire) from the Knock Sensor.
7. Connect the unpowered test light to a positive (+) 12 volt source.
8. To simulate an AC voltage, rapidly tap the Knock Sensor harness terminal with test light.
9. If Knock Module and wiring is functioning properly, you should see a voltage drop on the DVOM. If a voltage drop is not seen, check the BLU wire from the sensor to the Knock Module for a short or open circuit. If the circuit is functioning properly to this point, the Knock Sensor may not be functioning.
10. Reconnect the Knock Sensor harness connector to the sensor.
11. While still watching the DVOM, lightly and rapidly tap on the engine block near the Knock Sensor with a small hammer. If the Knock Sensor is functioning properly, you should see the voltage decrease. If a voltage drop is not seen, the Knock Sensor is faulty.

INSTALLATION OF KNOCK SENSOR

IMPORTANT: The correct Knock Module and Sensor must be used. Using an incorrect Knock Module or sensor will result in unrecognized spark knock and engine damage.

IMPORTANT: It is very important that the Knock Sensor be torqued to the exact specification. Incorrect torquing will result in unsatisfactory performance. **DO NOT** use sealer on threads.

1. Install Knock Sensor in engine block. Torque to 14 lb-ft (19 Nm).



a - Knock Sensor

2. Connect electrical connector to Knock Sensor.

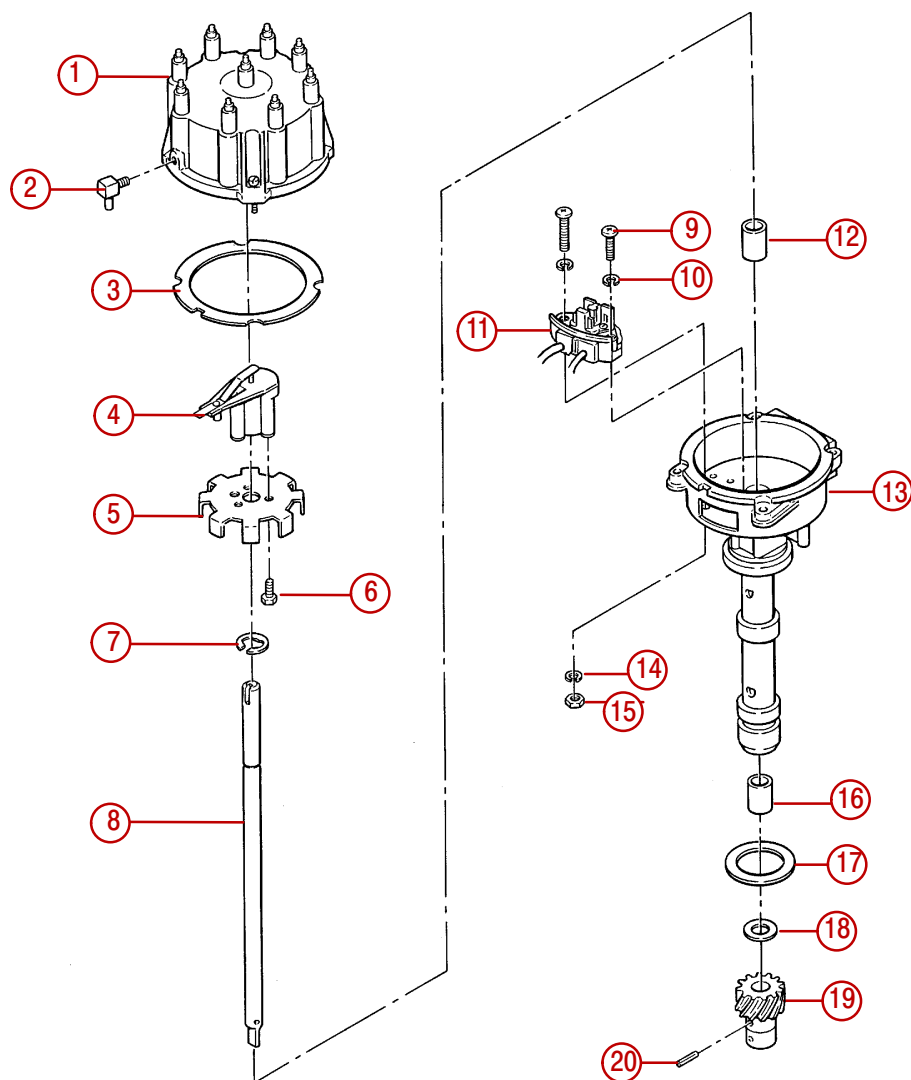
73756

Mercury Marine Distributor

Description

This distributor is used on carbureted models with Thunderbolt V ignition system and EFI/ MPI MEFI 3 ECM models, except Black Scorpion. The Black Scorpion models use the Delco EST ignition system.

Exploded View



- 1 - Distributor Cap
- 2 - Vent
- 3 - Gasket
- 4 - Rotor
- 5 - Sensor Wheel
- 6 - Screws (5)
- 7 - E-Clip
- 8 - Shaft
- 9 - Screws (2)
- 10 - Lockwashers (2)

- 11 - Sensor
- 12 - Upper Bushing
- 13 - Distributor Housing
- 14 - Lockwasher
- 15 - Nut
- 16 - Lower Bushing
- 17 - Gasket
- 18 - Washer
- 19 - Gear
- 20 - Roll Pin

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Distributor Cap

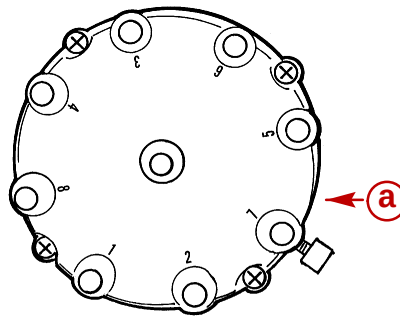
Removal

1. Loosen the distributor cap retaining screws.
2. Lift cap away from distributor.

Cleaning and Inspection

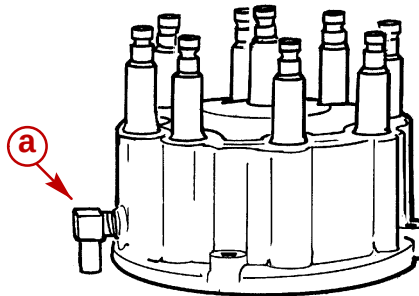
1. Check cap contacts for excessive burning or corrosion.
2. Check center contact for damage.
3. Check cap for cracks or carbon tracks.
4. Clean cap with warm soap and water. Dry with compressed air.

IMPORTANT: If high tension leads are removed from cap refer to “Spark Plug Wires” in this section and the following illustrations for installation.



72726

a - Alignment Notch



72728

a - Vent

Installation

IMPORTANT: Use only a distributor cap recommended for Marine application.

1. Install distributor cap by aligning tab in distributor cap with notch on distributor body. Tighten the retaining screws.

NOTE: Use care when removing spark plug wires and boots from distributor cap. Twist the boot 1/2 turn before removing. Firmly grasp and pull on the **boot** to remove wire end.

2. For best results, individually transfer spark plug wires to replacement cap in order of removal.

Rotor / Sensor Wheel

Removal

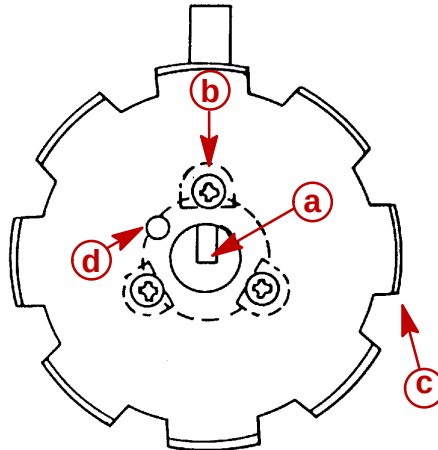
1. Remove distributor rotor / sensor wheel assembly from distributor shaft using two flat blade screwdrivers. Position the screwdrivers opposite each other with the blade tips contacting the shaft. A downward push on both screwdriver handles at the same time will pry off rotor / sensor wheel assembly. The use of a heat lamp will also aid in the removal of the rotor / sensor wheel assembly.

⚠ WARNING

Wear protective gloves when handling heated rotor / sensor wheel assembly to avoid severe burns.

Cleaning and Inspection

1. Inspect the locating key inside the rotor. The locating key will appear as a clean edged, 1/8 in. (3 mm) wide, sloped ramp at the bottom of the splined hole.



72730

- a** - Locating Key
- b** - Screws
- c** - Sensor Wheel
- d** - Locating Pin

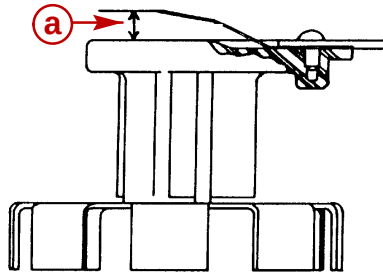
NOTE: If there is any doubt if sensor wheel is located properly, lay sensor wheel on top of the figure above with sensor fingers facing up (toward you). Line up three screw holes and locating pin hole on sensor wheel with the figure. If wheel is indexed properly all the fingers on wheel will line up with those in the figure.

2. Check rotor for burned or corroded center contact or damaged key.
3. Check rotor for cracks and carbon tracks.

Installation

NOTE: Rotor/sensor wheel are sold as an assembly only.

1. Ensure that carbon brush tang has a 1/4 in. (6 mm) gap between rotor and tang.



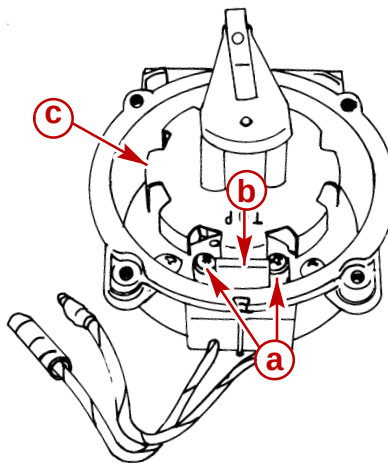
72731

a - 1/4 in. (6 mm)

2. Put 2 drops of Loctite 27131 into the rotor so it lands on the locating key.
3. Put 2 drops of Loctite 27131 in keyway on upper portion of distributor shaft.
4. Immediately install rotor assembly onto distributor shaft.
 - a. Ensure rotor locating key is aligned with keyway in distributor shaft. Press rotor down on the shaft with your hand until it stops.
5. Let Loctite cure overnight with distributor in inverted position.

IMPORTANT: The rotor should fit very tight. It may be necessary to heat rotor with heat lamp to properly install. Do not let any Loctite run down distributor shaft. Loctite could get into top distributor housing bushing.

IMPORTANT: Ensure that the fingers of the sensor wheel are not touching the sensor when the wheel is rotated.



76395

- a** - Adjusting Screws
- b** - Sensor
- c** - Sensor Wheel Fingers

6. Reinstall distributor cap on distributor.

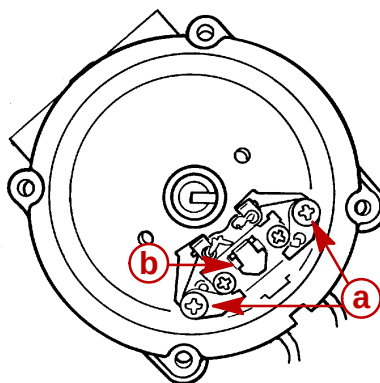
Sensor

Testing

1. Disconnect the two sensor wires from the wiring harness.
2. Using an Ohmmeter, check for an ohm reading between the two sensor wires. If reading is less than 100 ohms, replace sensor.

Removal

1. Remove rotor and sensor wheel.
2. Disconnect sensor wires.
3. Remove two screws that hold sensor into distributor housing. Remove sensor from housing.

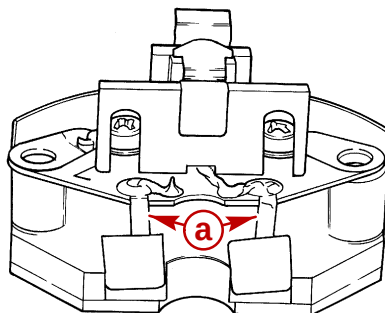


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- a** - Mounting Screws
b - Sensor Assembly

Cleaning and Inspection

1. Use a magnifying glass and light to inspect the two metal “jumper leads” for cracks. If a crack is found in either metal “jumper lead,” install a new sensor.



72733

- a** - Jumper Leads

CAUTION

Do not use any type of silicone sealer on the inside of the distributor. Most silicone sealers give off an acidic vapor during the curing stage of the sealer. This acid can cause corrosion on the ignition components.

Installation

1. Install sensor into housing and install two retaining screws.
2. Install sensor wheel, rotor and distributor cap.
3. Connect WHT/RED and WHT/GRN sensor wires (ring terminals on engine harness wires, or bullet connectors from Ignition Module wires). Tighten hex nuts securely (if equipped).

Distributor Repair

Removal

1. Unplug wiring harness from Ignition Module on distributor housing, or disconnect wires from Ignition Module mounted on exhaust elbow.
2. Disconnect sensor wires.
3. Remove distributor cap. Do not remove high tension leads unless necessary.
4. Crank engine over until timing marks line up and rotor is pointing toward No. 1 cylinder on distributor cap.
5. Mark distributor housing in reference to engine block.
6. Remove bolt and hold-down clamp and remove distributor.

IMPORTANT: To simplify distributor installation, do not turn crankshaft when distributor is removed from engine.

Disassembly

NOTICE
Refer to exploded view preceding for parts identification during disassembly and reassembly.

1. Remove rotor, sensor wheel, sensor and Ignition Module (if mounted on distributor).
2. Remove roll pin, washer and driven gear from distributor shaft.
3. Check for side play between shaft and distributor housing bushings. Maximum side play is .002 in. (0.05 mm).
4. Remove shaft from housing.
5. Check shaft for warp with a dial indicator and V-blocks. Maximum runout is .002 in. (0.5 mm).

Reassembly

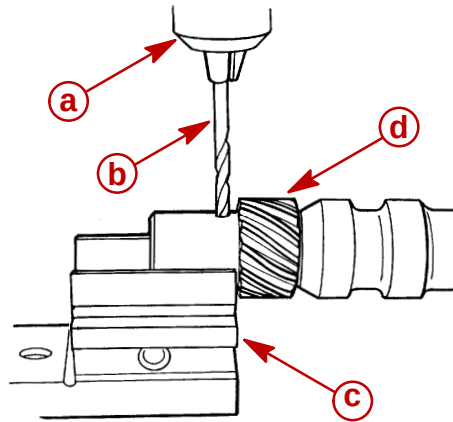
1. Lubricate shaft with engine oil.
2. Install E-clip (if removed) on shaft in housing.
3. Install washer on shaft.
4. Install original gear; slide onto shaft and install roll pin.

IMPORTANT: Hole may be offset and gear will only fit in one direction.

5. If installing a new gear, the gear will come drilled on one side. Slide gear onto shaft; align hole in gear with hole in shaft.

- Using these holes as guides, drill through other side of gear with a 3/16 in. carbide tipped drill.

IMPORTANT: If a new gear has only a dimple, you will have to drill through one side of the gear before you slide gear onto shaft. In most cases it is recommended to have a machine shop complete the drilling operation for new gear installation.



72735

- a** - Drill Press
- b** - 3/16 in. Carbide Tip Drill
- c** - V-Block
- d** - New Gear

- Install sensor, sensor wheel, rotor and Ignition Module (if mounted on distributor)
- Install distributor.

Distributor Installation

ENGINE NOT ROTATED

- Install new gasket on distributor housing.
- Turn rotor approximately 1/8-turn in a counterclockwise direction past mark previously scratched on distributor housing.
- Work distributor down into position in engine block with distributor positioned as noted during removal.

IMPORTANT: You may need to move rotor slightly to start gear into mesh with cam-shaft gear, but rotor should line up with the mark when distributor is in place. Distributor shaft must enter oil pump shaft for complete installation.

- Connect all disconnected wires.
- Install cap.
- Coat any exposed terminals with Quicksilver Liquid Neoprene.

ENGINE ROTATED

1. Locate No. 1 piston in firing position by following instructions a. or b. below:
 - a. Remove No. 1 spark plug and, with finger on plug hole, crank engine until compression is felt in No. 1 cylinder.
 - b. Continue cranking until pointer lines up with timing mark on crankshaft pulley.
 - c. Remove rocker cover and crank engine until No. 1 intake valve closes, continuing to crank slowly until pointer lines up with timing mark on crankshaft pulley.

2. Position distributor to opening in block in normal installed attitude.

IMPORTANT: Make sure oil pump shaft is engaged in the following. Position (align) oil pump shaft end to engage bottom of distributor drive gear prior to inserting distributor if necessary.

3. Position rotor to point toward No. 1 cylinder on cap (with distributor housing held in installed attitude), then turn rotor counterclockwise approximately 1/8-turn more and work distributor down to engage camshaft and oil pump shaft. It may be necessary to rotate rotor slightly until engagement is felt.

** CAUTION**

Avoid severe engine damage. Do not attempt to force distributor into position using hold-down clamp and bolt.

4. When distributor housing contacts intake manifold, camshaft and oil pump shaft are engaged.
5. Connect all disconnected wires.
6. Place distributor cap in position. Ensure that rotor lines up with terminal for No. 1 spark plug.
7. Install new gasket on distributor housing.
8. Install cap.
9. Coat any exposed terminals with Quicksilver Liquid Neoprene.

Replacing Distributor Gear

Removal

1. Remove rotor and sensor wheel.
2. Remove roll pin, washer and driven gear from distributor shaft.
3. Check for side play between shaft and distributor housing bushings. Maximum side play is 0.002 in. (0.05 mm).
4. Remove shaft from housing.
5. Check shaft for warp with a dial indicator and V-blocks. Maximum runout is 0.002 in. (0.05 mm).

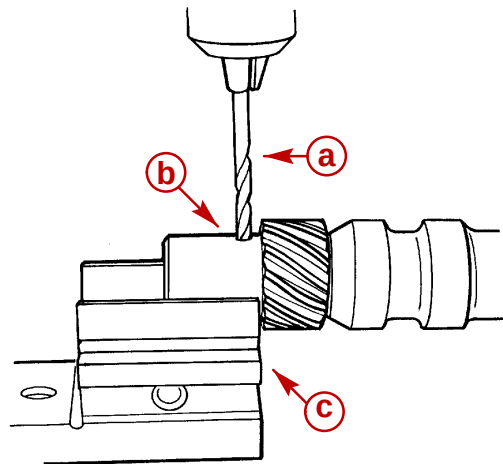
Installation

1. Lubricate shaft with engine oil.
2. Install E-clip on shaft in housing.
3. Install washer on shaft.
4. If installing original gear, slide onto shaft and install roll pin.

IMPORTANT: Gear will only fit in one direction.

5. If installing a new gear, slide gear onto shaft and align hole in gear with hole in shaft.
6. Using these holes as a guide, drill through other side of gear with a 3/16 in. carbide tipped drill bit.

IMPORTANT: If gear only has a dimple, you MUST drill through one side of the gear before you slide it onto the shaft. In most cases, it is recommended that you have a machine shop drill the new gear.



72735

- a** - 3/16 in. Carbide Tip Drill Bit
- b** - Gear
- c** - V-Block

7. Install rotor and sensor wheel.
8. Install distributor.

GM EST Distributor

NOTICE

Refer to "Service Precautions" in the front of this section BEFORE proceeding.

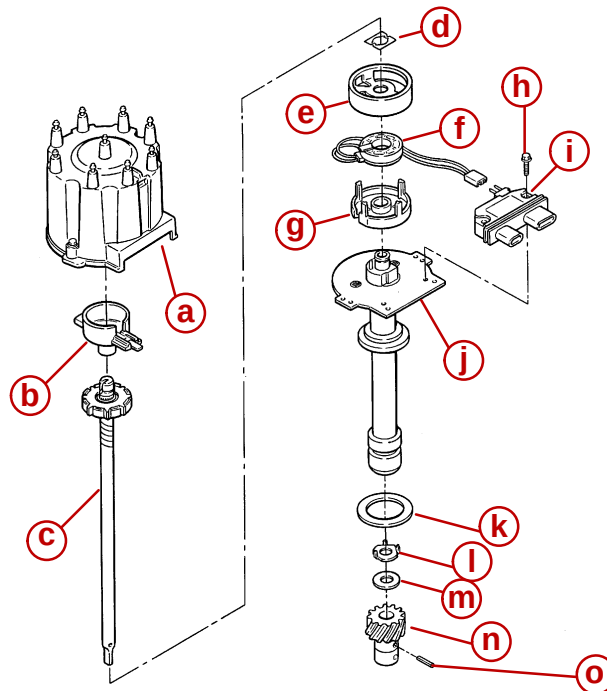
Removal

1. Disconnect electrical connectors at distributor module.
2. Remove distributor cap and set it aside.
3. Scribe a line on distributor housing marking position of rotor. Also, mark position of distributor housing on intake manifold.
4. Remove distributor and gasket from intake manifold.

IMPORTANT: DO NOT crank engine over after distributor has been removed.

5. Align rotor with scribe mark on distributor housing. Scribe a line on the gear, in line with housing to intake manifold scribe mark.

Disassembly



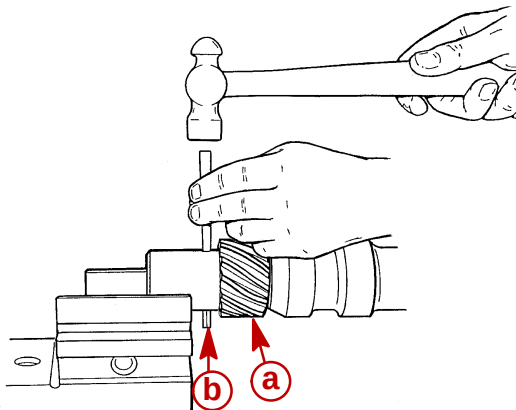
72411

- a - Cap
- b - Rotor
- c - Shaft Assembly
- d - Retainer
- e - Shield
- f - Pickup Coil
- g - Pole Piece
- h - Screw

- i - Module
- j - Housing
- k - Gasket
- l - Tang Washer
- m - Washer
- n - Gear
- o - Pin

NOTE: Whenever disassembling distributor, the retainer must be replaced. DO NOT attempt to use old retainer.

1. Remove rotor from shaft by lifting or prying straight up.
2. Remove roll pin.



72917

a - Gear
b - Roll Pin

3. Remove gear, washer and tang washer.
4. Remove shaft assembly from housing.

CAUTION

Wear eye protection when removing spring steel retainer clips as described in the following steps. Failure to do so may result in serious injury.

5. Remove retainer from housing as follows:
 - a. Use needle nose pliers to bend two corners upward on the fluted end of the retainer.
 - b. Pull the retainer off the center bushing. Discard the retainer.
6. Remove shield from housing.
7. Disconnect pickup coil connector from module by lifting up locking tab with a screwdriver and carefully prying connector from module.
8. Remove pickup coil.
9. Remove module retaining screws and remove module.

Cleaning and Inspection

1. Visually inspect the cap for cracks or carbon tracks. Replace the cap if it shows any sign of damage.
2. Check metal terminals in the cap for evidence of corrosion. Use a knife to scrape surfaces clean. If corrosion is deep, replace the cap.
3. Look for signs of wear or burning at the outer terminal of the rotor. Presence of carbon on the terminal indicates serious rotor wear and need for replacement.
4. Inspect the shaft for shaft-to-bushing looseness. Insert the shaft in the housing. If the shaft wobbles, indicating a loose fit, replace the housing and/or shaft.
5. Clean metal parts in solvent and dry with compressed air.
6. Check housing for signs of cracks or damage; replace if necessary.

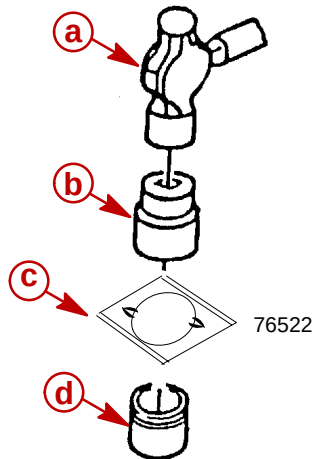
Testing Pickup Coil

1. Connect an ohmmeter to either pickup coil lead and the housing. If the reading is NOT infinite, replace the pickup coil.
2. Connect an ohmmeter to both pickup coil leads. Flex the leads by hand at the coil and the connector to locate any intermittent opens. The ohmmeter should read a constant unchanging value in the 500-1500ohm range. If NOT, replace the pickup coil.

Reassembly

NOTE: When mounting Ignition Module, thoroughly coat bottom of module with Heat Transfer Compound. Failure to do so could result in damage to the module.

1. Coat bottom of module and module mounting pad (on housing) with Heat Transfer Compound.
2. Install Ignition Module to housing with two screws. Tighten screws securely.
3. Install pickup coil, fitting tab at bottom of coil into anchor hole of housing.
4. Connect pickup coil electrical connector to module, making sure locking tab is in place.
5. Install shield onto coil.
6. Install retainer (with teeth facing up) using a 5/8 in. (15 mm) socket centered on retainer. Using a small hammer, tap the retainer evenly, down onto the distributor housing upper bushing. Make sure that both teeth are seated in bushing groove. The retainer should hold shield, pickup coil and pole piece firmly.



- a** - Hammer
- b** - Square Socket, 5/8 in (15 mm)
- c** - Square Retainer (Teeth Pointing Up)
- d** - Distributor Housing Upper Bushing (With Groove)

7. Lubricate shaft with grease and install into housing.
8. Install tang washer, washer and drive gear onto shaft.
9. Temporarily install rotor on shaft. Align scribe marks on gear, housing, and rotor.
10. Install roll pin through gear and shaft.
11. Spin shaft to ensure that teeth on shaft assembly do not contact pole piece.
12. Install rotor onto shaft, fitting tab of rotor into slot of shaft.

Installation

1. Align rotor, housing and intake manifold using scribe marks.
2. Slowly lower distributor (with gasket) through intake manifold and into position. If distributor shaft won't drop into position, pull it out and insert a screwdriver into the hole to turn the oil pump drive shaft. Repeat this adjustment as many times as needed until the distributor can be firmly seated and all components are in alignment.
3. Install hold-down clamp over distributor and bolt it securely to engine surface. Torque bolt to 30 lb-ft (40 Nm).
4. Install distributor cap and secure in place with two screws.
5. Connect electrical connectors to module.

IMPORTANT: Before proceeding to the following step, be certain that engine will obtain an adequate supply of water for cooling. Refer to SECTION 6A, "Seawater Cooled Models."

6. Start engine and check timing.

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ELECTRICAL SYSTEM

Section 4C - Charging System

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General Precautions

The following precautions **MUST BE** observed when working on the alternator system. Failure to observe these precautions may result in serious damage to the alternator or alternator system.

1. DO NOT attempt to polarize the alternator.
2. DO NOT short across or ground any of the terminals on the alternator, except as specifically instructed in the "Troubleshooting Tests," following.
3. NEVER disconnect the alternator output lead or battery cables when the alternator is being driven by the engine.
4. NEVER disconnect regulator lead from alternator regulator terminal when the alternator is being driven by the engine.
5. ALWAYS remove negative (–) battery cable from battery before working on alternator system.
6. When installing battery, BE SURE to connect the positive (+) battery cable to the positive (+) battery terminal and the negative (–) (grounded) battery cable to negative (–) battery terminal.
7. If a charger or booster battery is to be used, BE SURE to connect it in parallel with existing battery (positive to positive; negative to negative).

EFI Electrical System Precautions

NOTE: All references to EFI models apply to all EFI and MPI engines.

CAUTION

Avoid damage to the EFI electrical system and components. Refer to the following precautions when working on or around the EFI electrical harness or when adding other electrical accessories:

- DO NOT tap accessories into engine harness.
- DO NOT puncture wires for testing (Probing).
- DO NOT reverse battery leads.
- DO NOT splice wires into harness.
- DO NOT attempt diagnostics without proper, approved Service Tools.

Replacement Parts Warning

WARNING

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

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

IMPORTANT: Alternators are equipped with an excitation circuit. This circuit will have approximately a 7 milliamp draw on the battery with the key in the off position. This draw is normal.

Multiple EFI Engine Battery Precautions

Situation

Alternators: They are designed to charge the battery that supplies electrical power to the engine that the alternator is mounted on. When batteries for two different engines are connected, one alternator will supply all the charging current for both batteries. Normally, the other engine's alternator will not be required to supply any charging current.

EFI Electronic Control Module (ECM): The ECM requires a stable voltage source. During multiple engine boat operation, an electrical onboard device may cause a sudden drain of voltage at the engine's battery. The voltage may go below the ECM's minimum required voltage. Also, the idle alternator on the other engine may now start charging and this could cause a voltage 'spike' in the engine's electrical system. In either case, the ECM could shut off. When the voltage returns to the range that the ECM requires, the ECM resets itself. The engine will now run normally. This ECM shut down usually happens so fast that the engine just appears to have an 'ignition miss'.

Recommendations

Batteries: Boats with multi-engine EFI power packages require each engine to be connected to its own battery. This ensures that the engine's Electronic Control Module (ECM) has a stable voltage source.

Battery Switches: While engines are running, battery switches should be positioned so each engine is running off its own individual battery. DO NOT run engines with battery switches in "BOTH" or "ALL" position. In an emergency, another engine's battery can be used to start an engine with a dead battery.

Battery Isolators: Isolators can be used to charge an auxiliary battery used for powering accessories in the boat. They should not be used to charge the battery of another engine in the boat unless the type of isolator is specifically designed for this purpose.

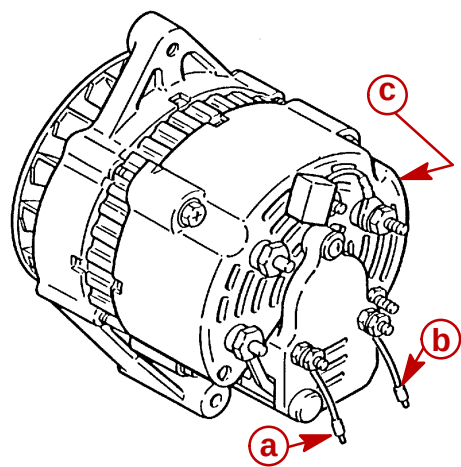
NOTE: *Sure Power Industries Inc., Model 32023A meets this design specification.*

1. The boat may have 2 engines connected to a single Model 32023A battery isolator.
2. The Model 32023A battery isolator is connected to 2 banks of batteries.
3. Each bank contains 2 batteries with the cranking battery for 1 engine in each bank.
4. The second battery in each bank is connected in parallel to the cranking battery.
5. The Model 32023A battery isolator is designed for this type of use; 2 battery banks, 2 charging sources, 120 amps (maximum alternator output).
6. When the engines are running, either engine's alternator could be charging either bank of batteries through the Model 32023A battery isolator.

Any other manufacturer's battery isolator that is the same type as the Sure Power Inc., Model 32023A could also be used.

Generators: The generator's battery should be considered in the same manner as another engine's battery.

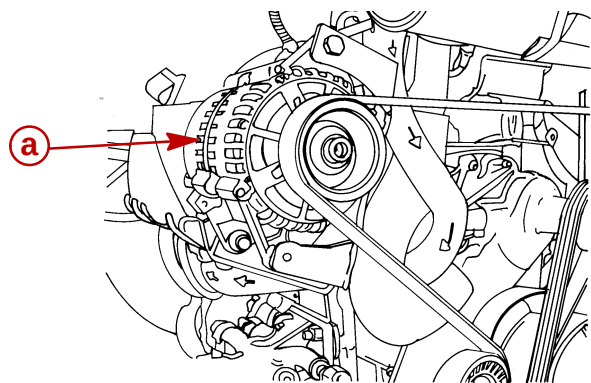
Identification



72078

Mando 55 Amp and 65 Amp Alternator

- a - Excitation Wire - PURPLE
- b - Sensing Wire - RED/PURPLE
- c - Part Number and Amperage Rating (Hidden In This View)



72078

Delco 65 Amp Alternator

- a - Part Number

Specifications

Mando

Description	Specification	
	55 Amp	65 Amp
Excitation Circuit	1.3 to 2.5 Volts	1.3 to 2.5 Volts
Current Output	50 Amp. Min.	60 Amp. Min.
Voltage Output	13.9 to 14.7 Volts	13.9 to 14.7 Volts
Min. Brush Length	1/4 in. (6 mm)	1/4 in. (6 mm)

DelcoRemy

Description	Specification
Rating	12 (V) x 65 (A)
Output (1300 / 2500 / 6500 Grpm)	8 / 47 / 65 (A) @ 20'
Regulator Setting Voltage	14.4 - 15 Volts @ 25'

Tools

Description	Part Number
Bearing Removal and Installation Kit	91-31229A7
Universal Puller Plate	91-37241
Ammeter (0-100 Amp)	Obtain Locally
Multimeter	91-854009A1

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Liquid Neoprene	92-25711--3

Torque Specifications

Fastener Location	lb-in.	lb-ft	Nm
End Frame Screws	55		5.5
Brush Setscrews	18		1.5
Regulator Mounting Screws	42		4.2
Regulator Leads	25		2.5
Ground Terminal Nut	25		2.5
Pulley Nut		42	57
Alternator to Mounting Bracket		35	48
Alternator Mounting Bracket		30	41
Belt Tension	See Note		
Ground Terminal Nut (Delco 65 Amp Alternator)	55		5.5
Pulley Nut (Delco 65 Amp Alternator)		70	95

NOTE: Belt deflection is to be measured on the belt at the location that has the longest distance between two (2) pulleys. Normally this location is between the power steering pump and the belt adjustment pulley. This location will be different on engines with closed cooling or models without power steering.

Description

This package uses an integral regulator charging system. The integrated circuit regulator is a solid state unit that is mounted inside the alternator to the slip ring end frames. All regulator components are enclosed in a solid mold to protect them from the heat and corrosive elements. The regulator voltage cannot be adjusted.

The alternator rotor gearings contain enough grease to eliminate the need for periodic lubrications. Two brushes carry current through two slip rings to the field coil mounted on the rotor. Under normal conditions, this arrangement is capable of providing long periods of attention free service.

Stator windings are assembled inside a laminated core that is mounted between the alternator drive end frame and the slip ring end frame. A rectified bridge that contains six diodes is connected to the stator winding. These diodes electrically change stator AC voltage into DC voltage. This DC voltage is then transmitted to the alternator output terminal.

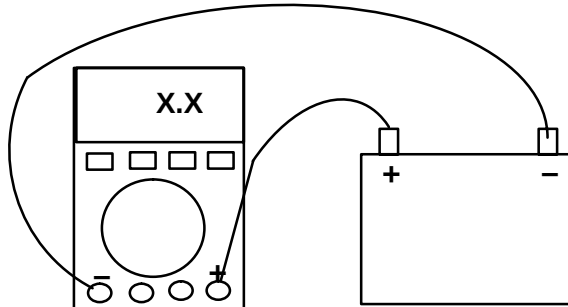
A capacitor or condenser, mounted in the regulator, protects the rectifier bridge. This capacitor also suppresses radio noise.

NOTE: *There are no repair or replacement internal parts for this alternator. The alternator has to be replaced as a complete assembly. The only part that is available is the pulley.*

Testing

Charging System

1. Check belt condition and tension.
2. Check battery condition.

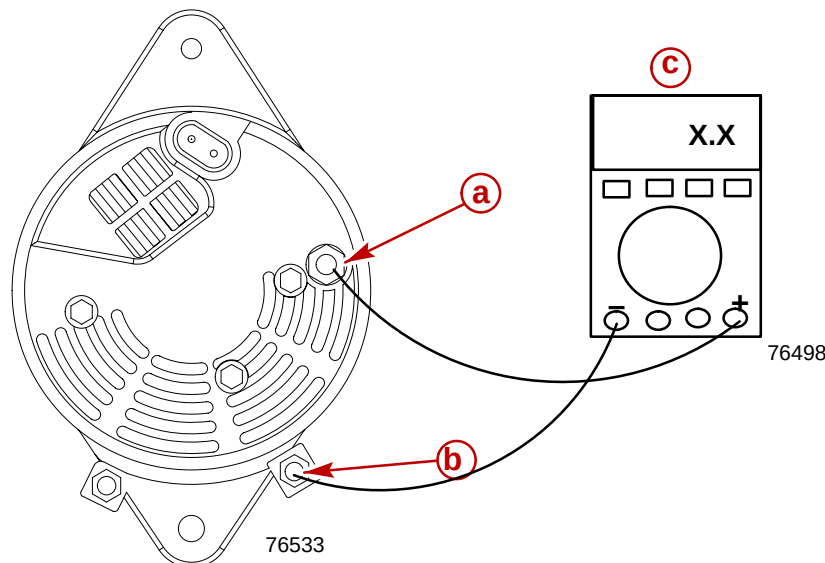


76498

3. With a fully charged battery, connect voltmeter leads directly to the battery posts.
4. Start engine and run at 1300-1500 rpm. Read voltmeter. Most systems will read 13.8-14.8 volts.

NOTE: If the voltage reading is within specifications, switch voltmeter to AC volt position. There should not be more than a 0.250 AC voltage reading with the engine running. A reading more than 0.250 AC volts indicate defective diodes in the alternator.

5. If the voltmeter reading at the battery posts is below 13.5 volts, connect the voltmeter positive (+) lead to the alternator output terminal. Connect the voltmeter negative (-) lead to the ground terminal on the alternator. Repeat step 4.



Typical

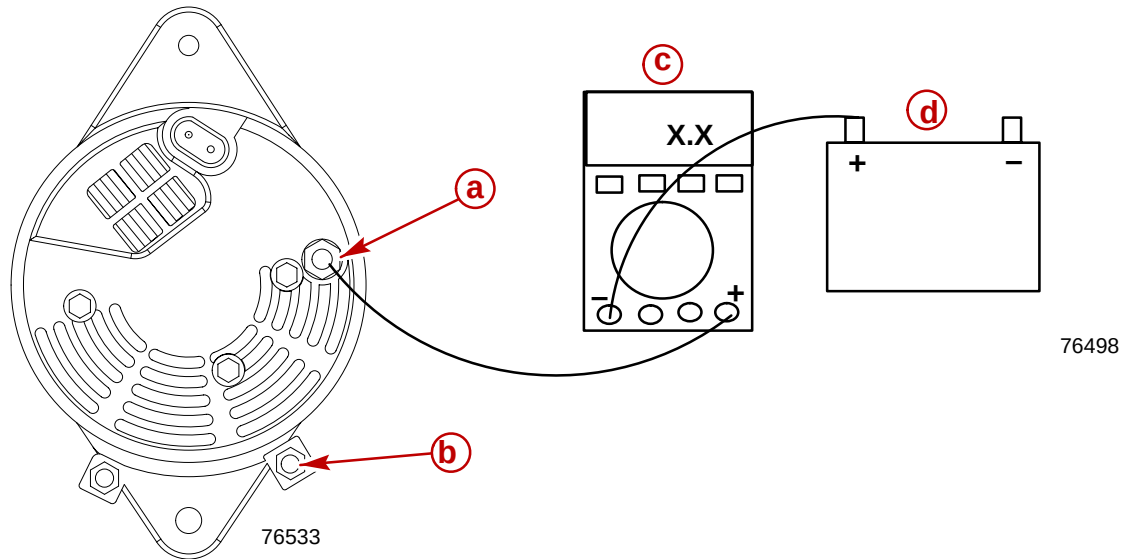
- a** - Output Terminal
- b** - Ground Terminal
- c** - Voltmeter

6. If voltmeter reading is now within specifications, there is too much resistance between the alternator and the battery.
7. If the reading is below 12.5 volts, the alternator may not be charging. Check all wiring leading to the alternator.

Charging System Resistance

1. Ground the ignition coil high tension wire so engine does not start.
2. Crank engine over for 15 seconds to discharge the battery slightly.
3. Reconnect coil high tension wire and turn off all accessories.
4. Connect the voltmeter positive (+) lead to the alternator output terminal. Connect the voltmeter negative (-) lead to the battery positive (+) post.

NOTE: Connect voltmeter leads to the battery post, NOT the battery cable end.

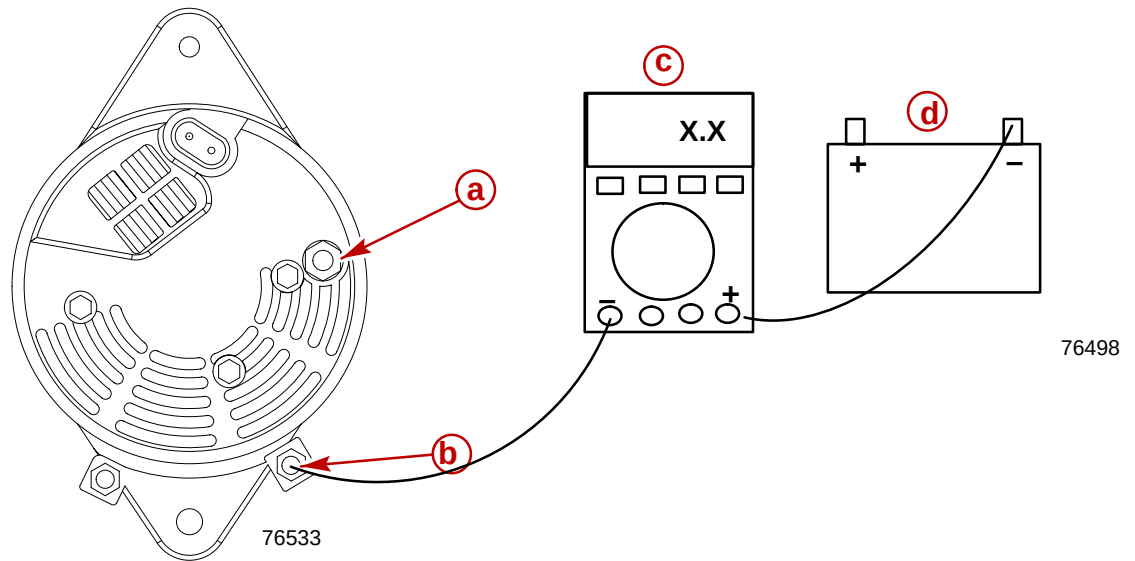


Typical

- a** - Output Terminal
- b** - Ground Terminal
- c** - Voltmeter
- d** - Battery

5. Start engine and run at 1300–1500 rpm. Read voltmeter. A reading of more than 0.5 volts show excessive resistance in wiring.

6. Connect the voltmeter negative (–) lead to the alternator ground terminal. Connect voltmeter positive (+) lead to the battery negative (–) post.

**Typical**

- a** - Output Terminal
- b** - Ground Terminal
- c** - Voltmeter
- d** - Battery

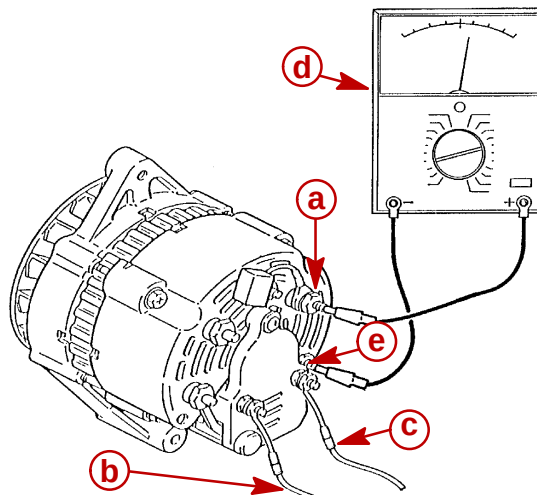
7. Repeat Step 5.

Circuitry

Perform the following tests, using a 0-20 volt DC voltmeter, to check that all of the circuits between the alternator and the other components within the alternator system are in good condition.

OUTPUT CIRCUIT

1. Ensure battery is fully charged by using the hydrometer test outlined in 4A.
2. Start engine and increase RPM to approximately 1500 rpm.
3. Check voltage reading. The voltage should read between 13.8 and 14.2 volts. If the reading is below 13.8 volts:
 - a. Connect positive (+) voltmeter lead to alternator output post.
 - b. Connect negative (–) lead to ground post on alternator.
 - c. Wiggle engine wiring harness while observing voltmeter. Meter should indicate approximate battery voltage and should not vary. If no reading is obtained, or if reading varies, go to “Resistance” in this section.



72784

Typical

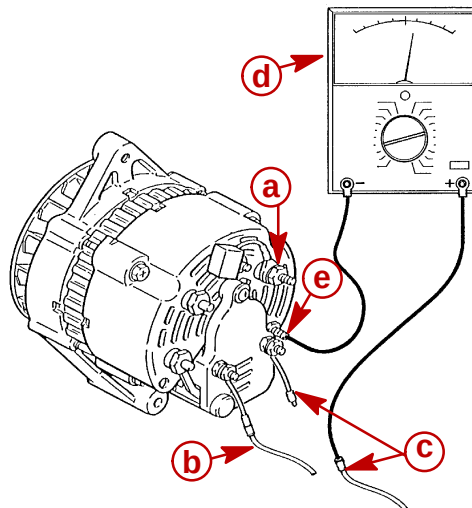
- a** - Output Wire - ORANGE
- b** - Excitation Wire - PURPLE
- c** - Sensing Wire - RED/PURPLE
- d** - Voltmeter (0-20 Volts)
- e** - Ground

EXCITATION CIRCUIT

1. Connect positive (+) voltmeter lead to tie strap terminal on alternator and negative (–) lead to a ground terminal on alternator (Test 1).
2. Turn ignition switch to ON position and note voltmeter reading. Reading should be 1.3 to 2.5 volts.
3. If no reading is obtained, an opening exists in alternator excitation lead or in excitation circuit of regulator. Unplug PURPLE lead from regulator. Connect positive voltmeter lead to PURPLE lead and negative voltmeter leads to ground (Test 2). If voltmeter now indicates approximate battery voltage, voltage regulator is defective and must be replaced. If no voltage is indicated, check excitation circuit for loose or dirty connections or damaged wiring.

SENSING CIRCUIT

1. Unplug RED/PURPLE lead from voltage regulator.
2. Connect positive (+) voltmeter lead to red/purple lead and negative (–) voltmeter lead to ground terminal.
3. Voltmeter should indicate battery voltage. If battery voltage is not present, check sensing circuit (red/purple lead) for loose or dirty connection or damaged wiring.



72786

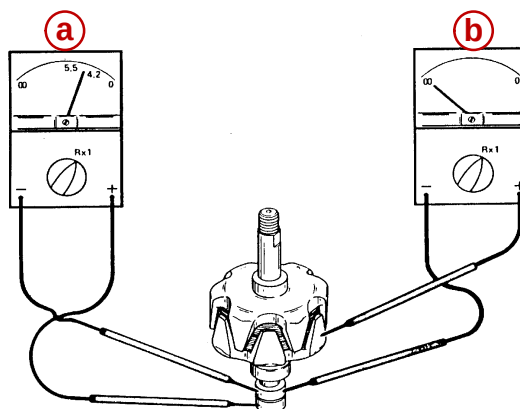
Typical

- a** - Output Wire - ORANGE
- b** - Excitation Wire - PURPLE
- c** - Sensing Wire - RED/PURPLE
- d** - Voltmeter (0-20 Volts)
- e** - Ground

Component

ROTOR

1. Test rotor field circuit for opens, shorts or high resistance (Test 1), using an ohmmeter (set on R x1 scale), as follows:

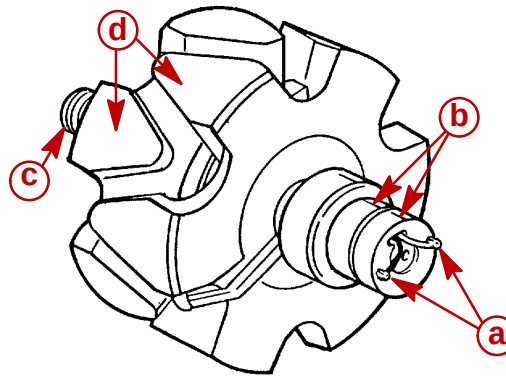


72831

Testing Rotor Field Circuit

- a** - Test 1
 - b** - Test 2
- a. Connect one ohmmeter lead to each slip ring.
 - b. Ohmmeter reading should be 4.2 to 5.5 ohms with rotor at room temperature 70-80°F (21-26°C).

- c. If reading is high or infinite (no meter movement), high resistance or an open exists in the field circuit. Check for poor connections between field winding leads and slip ring terminals. If cause for open or high resistance cannot be found, connect ohmmeter directly to slip ring terminals. If correct reading is now obtained, or if reading is still high or infinite, replace complete rotor assembly.
- d. If reading is low, a short exists in the field circuit. Inspect slip rings to be sure that they are not bent and touching outer slip ring. Also, be sure that excess solder is not shorting terminals to aft slip ring. If cause for short cannot be found, unsolder field winding leads from slip ring terminals and connect ohmmeter directly to leads. If correct reading is now obtained, or if reading is still low, slip rings and rotor field windings are shorted, and complete rotor assembly must be replaced.



73112

- a** - Field Winding Leads
- b** - Slip Rings
- c** - Rotor Shaft
- d** - Pole Pieces

2. Test rotor field circuit for grounds (Test 2), using an ohmmeter (set on R x1 scale) as follows:
 - a. Connect one lead of ohmmeter to either slip ring and the other lead to rotor shaft or pole pieces.
 - b. Meter should indicate no continuity (meter should not move).
 - c. If continuity does exist, complete rotor assembly must be replaced.

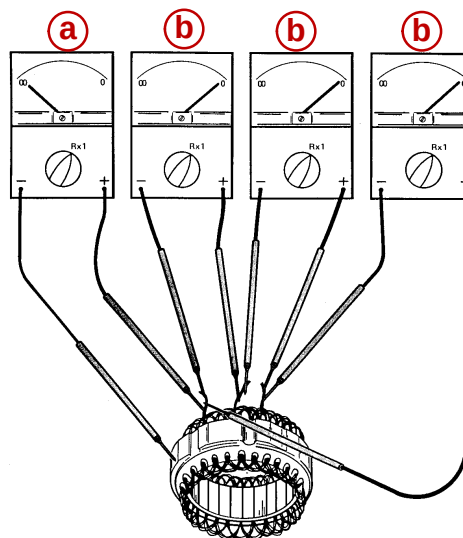
IMPORTANT: If alternator has output at low speeds, but no output at high speeds, rotor field winding may be shorting or grounding out, due to centrifugal force. Replace rotor if all other electrical components test good.

STATOR

IMPORTANT: Stator leads MUST BE disconnected from rectifier for this test.

1. Test stator for grounds (Test 1), using an ohmmeter (set on R x1 scale) as follows:
 - a. Connect one lead of ohmmeter to one of the stator leads and the other lead to stator frame. Be sure that lead makes good contact with frame.
 - b. Meter should indicate no continuity (meter should not move). If continuity does exist, stator is grounded and must be replaced.
2. Test for opens in stator (Test 2), using an ohmmeter (set on R x1 scale) as follows:
 - a. Connect ohmmeter between each pair of stator windings (three different ways).

- b. Continuity should be present in all three cases (meter should move). If it does not, one or more of the windings are open and stator must be replaced.



72833

Testing Stator

a - Test 1

b - Test 2

3. A short in the stator is difficult to detect without special equipment, because of the low windings resistance. If all other electrical components test out good, and alternator fails to produce rated output, stator probably is shorted and should be replaced. Also, examine stator for heat discoloration, as this usually is a sure sign of a short.

RECTIFIER AND DIODE ASSEMBLY

NOTE: Failure of any component in tests following will require replacement of entire rectifier assembly.

NEGATIVE (–) RECTIFIER

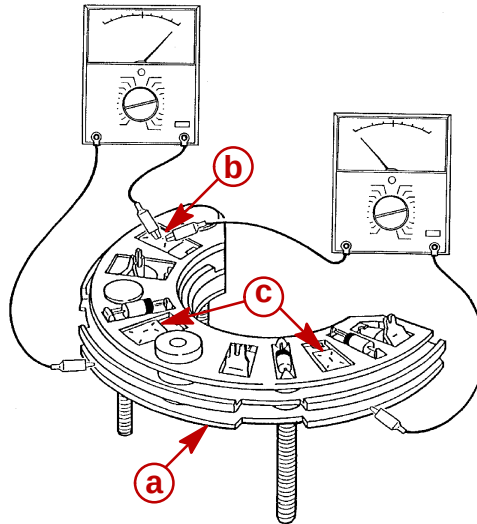
IMPORTANT: Rectifier **MUST BE** disconnected from stator for this test.

CAUTION

DO NOT use a test instrument with more than a 12 volt source (in the following test), as rectifier may be damaged.

1. Connect one lead of an ohmmeter (set on R x1 scale) to negative (–) rectifier heat sink and the other lead to one of the rectifier terminals. Note the reading.
2. Reverse leads and again note reading.
3. Meter should indicate a high or infinite resistance (no meter movement) when connected one way and a low reading when connected the other. If both readings are high or infinite, rectifier is open. If both readings are low, rectifier is shorted.
4. Repeat Steps 1. through 3. for two other rectifiers in heat sink.

5. Replace assembly if any of the rectifiers is shorted or open.



72147

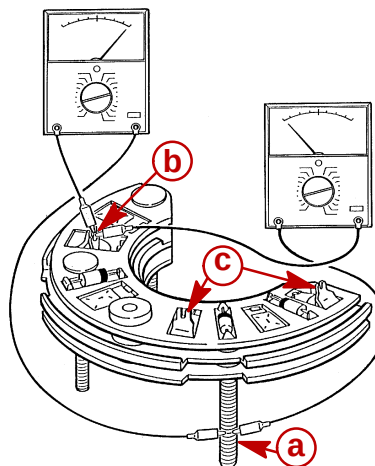
- a** - Heat Sink
- b** - Rectifier Terminal
- c** - Test These Two Rectifiers In The Same Manner

POSITIVE (+) RECTIFIER AND DIODES

⚠ CAUTION

DO NOT use a test instrument with more than a 12 volt source (in the following test), as rectifier may be damaged.

6. Connect one lead of an ohmmeter (set on R x1 scale) to 1/4 in. stud on positive (+) rectifier heat sink and the other lead to one of the rectifier terminals. Note the meter reading.
7. Reverse leads and again note reading.
8. Meter should indicate a high or infinite resistance (no meter movement) when connected one way and a low reading when connected the other. If both readings are high or infinite, rectifier is open. If both readings are low, rectifier is shorted.
9. Repeat Steps 1. through 3. for two other rectifiers in heat sink.

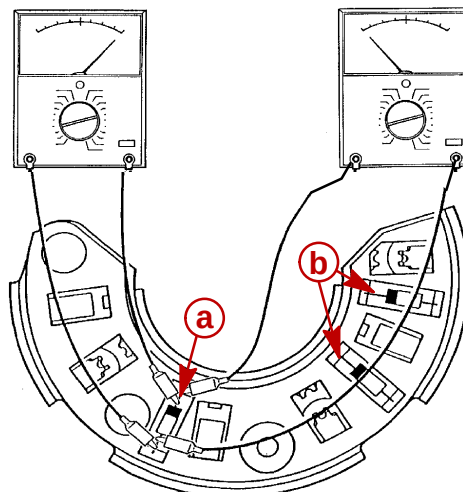


72834

- a** - Stud
- b** - Rectifier Terminal
- c** - Repeat Test Between These Terminals And Stud

10. Replace assembly if any one of the rectifiers is shorted or open.

11. Connect one lead of an ohmmeter (set on R x1) to the common side of the diode and the other lead to the other side, of one of the three diodes.



72148

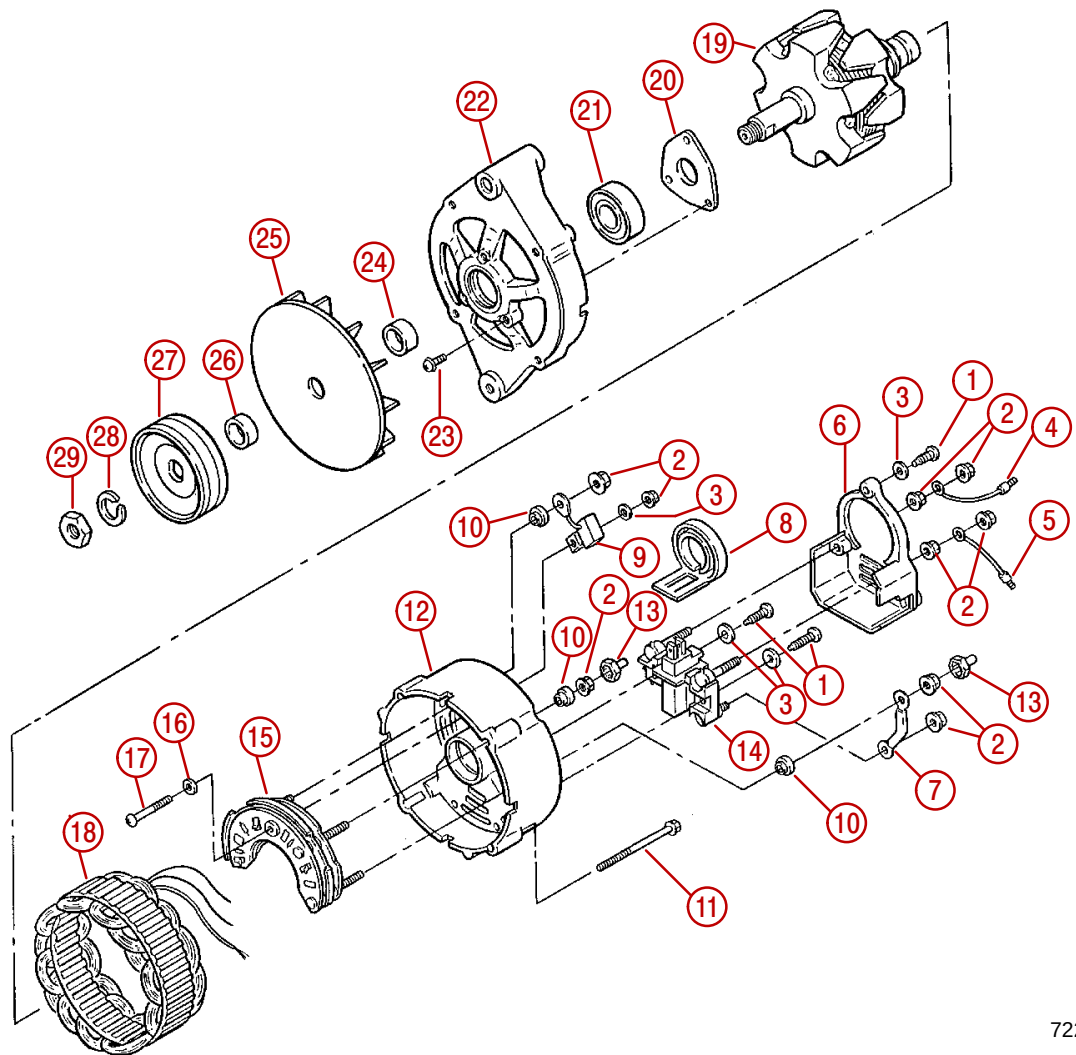
- a** - Common Side Of Diode Circuit Board
- b** - Repeat Test For Two Diodes

12. Reverse leads and again note reading.
13. Meter should indicate a high or infinite resistance (no meter movement) when connected one way and a low reading when connected the other. If both readings are high or infinite, diode is open. If both readings are low, diode is shorted.
14. Repeat Steps 6. through 8. for the other two diodes.
15. Replace rectifier assembly if any one of the diodes is shorted or open.

CONDENSER

1. Using magneto analyzer and accompanying instructions, perform the following condenser tests:
 - a. Condenser Capacity Test (must be .5 mfd).
 - b. Condenser Short or Leakage Test.
 - c. Condenser Series Resistance Test.
2. Replace condenser if test results are not within specifications.

Exploded View



72276

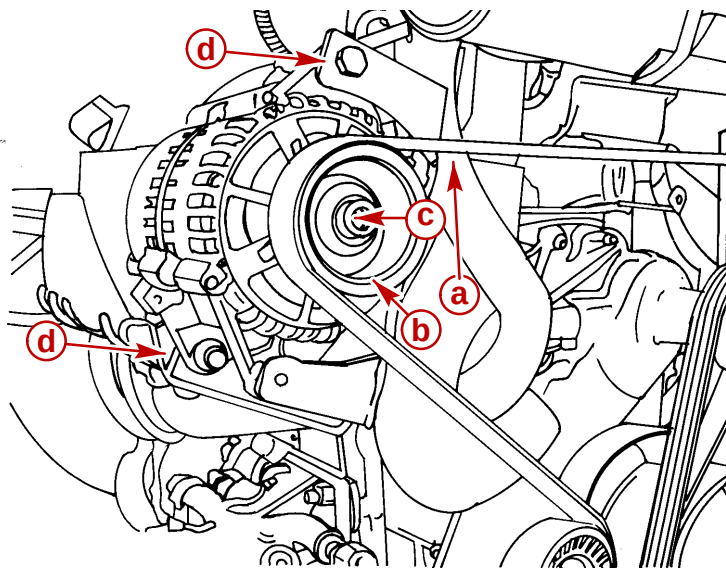
- 1 - Screws (3)
- 2 - Nut (9)
- 3 - Flat Washer (4)
- 4 - Sensing Wire (RED / PUR)
- 5 - Excitation Wire (PUR)
- 6 - Cover
- 7 - Tie Strap
- 8 - Rubber Gasket
- 9 - Condenser
- 10 - Insulator
- 11 - Bolt (4)
- 12 - End Frame (Rear)
- 13 - Cap (2)
- 14 - Brush / Regulator Assembly
- 15 - Rectifier Assembly

- 16 - Flat Washer
- 17 - Screw
- 18 - Stator
- 19 - Rotor And Slip Ring
- 20 - Retaining Plate
- 21 - Front Bearing
- 22 - End Frame (Front)
- 23 - Screw (3)
- 24 - Fan Spacer
- 25 - Fan
- 26 - Pulley Spacer
- 27 - Pulley
- 28 - Lockwasher
- 29 - Nut

Alternator Repair

Removal

1. Disconnect negative (–) battery cable from battery.
2. Disconnect wiring harness from alternator.
3. Loosen serpentine belt with the adjustment pulley.
4. Turn the adjustment stud and loosen belt. Remove belt.
5. Remove alternator mounting bolt, washers and remove alternator.



76465

Delco Alternator Shown, Mando Similar

- a** - Serpentine Belt
- b** - Adjustment Pulley
- c** - Adjustment Stud
- d** - Mounting Bolt

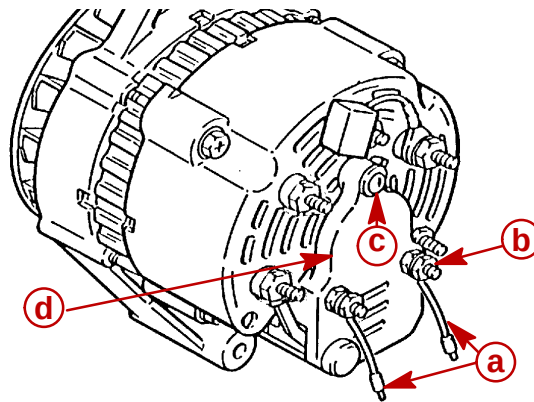
Disassembly

NOTE: Mando Alternator shown throughout, Delco Alternator should be replaced if it tests defective

IMPORTANT: The following instructions are for complete disassembly and overhaul of the alternator. In many cases, however, complete disassembly of alternator is not required and, in those cases, it is necessary only to perform the operations required to repair or replace the faulty part.

1. Mount alternator in a vise so that rear end frame is facing you.

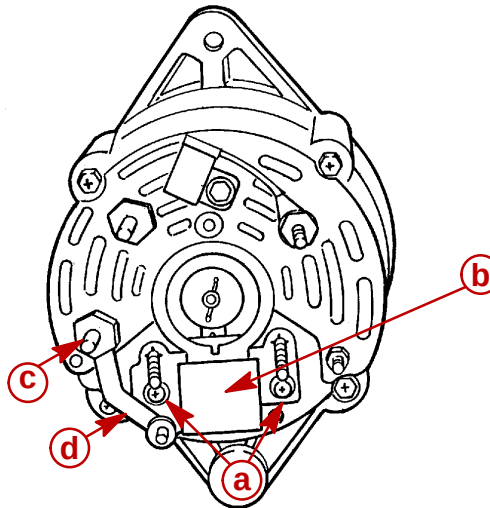
2. Disconnect regulator leads from terminals on rear end frame. Remove four nuts, Phillips head screw and two regulator leads. Then pull regulator cover away from rear end frame.



72963

- a** - Regulator Leads
- b** - Nuts (4)
- c** - Phillips Head Screw
- d** - Regulator Cover

3. Remove stud cover insulator, two nuts and tie strap from brush/regulator assembly.
- IMPORTANT: Scribe pieces during disassembly to assist in exact same positioning during reassembly.**
4. Remove two brush/regulator attaching screws and remove brush/regulator assembly.



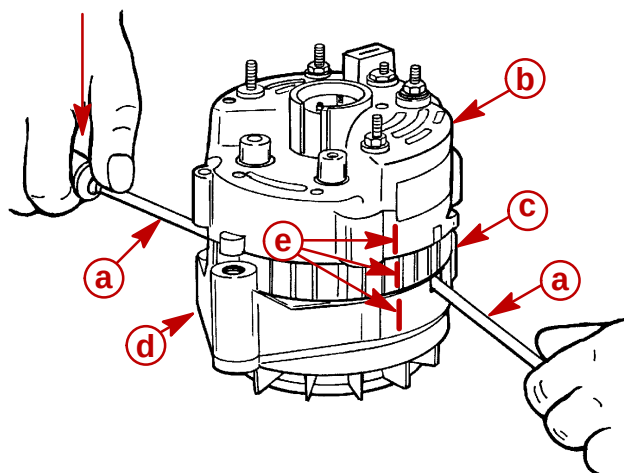
72823

- a** - Screws
- b** - Brush / Regulator Assembly
- c** - Stud Cover Insulator
- d** - Tie Strap

5. Scribe a mark on rear end frame, stator and front end frame to ensure proper reassembly later.
6. Remove four screws which secure end frames and stator together.

IMPORTANT: DO NOT insert screwdriver blades more than 1/16 in. (1.5 mm) into openings (in next step), as stator windings may be damaged.

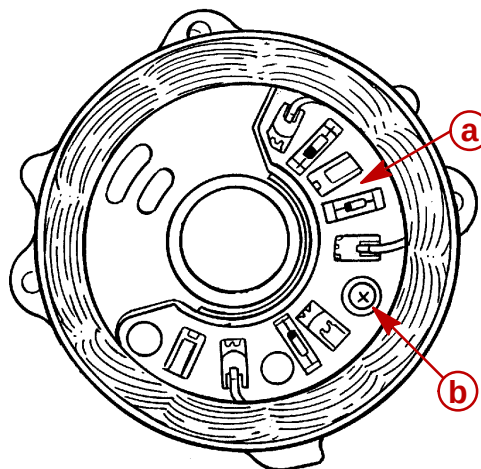
7. Separate rear end frame and stator assembly from front end frame and rotor assembly using two thin blade screwdrivers (positioned 180 degrees apart from one another) at the locations shown. Use the two slots shown to initially separate units.



72824

- a** - DO NOT Insert Screwdriver Blades More Than 1/16 In. (1.5 mm) Into Slots.
- b** - Rear End Frame
- c** - Stator
- d** - Front End Frame
- e** - Scribe Marks

8. Place rear end frame and stator assembly on the bench with stator downward. Be sure that bench is clean and free of metal chips. Remove nuts, washers, insulators and condenser from output and ground studs.
9. Turn end frame over (stator upward) and remove one Phillips head screw which secures rectifiers to end frame.

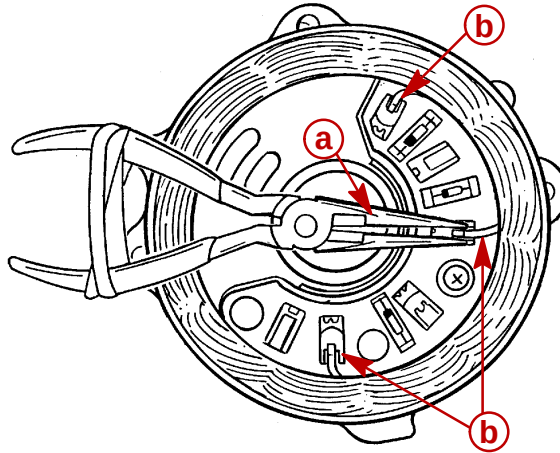


72826

- a** - Rectifier Assembly
- b** - Phillips Head Screw

10. Separate stator and rectifier assembly from rear end frame using screwdriver slots.

11. Unsolder the three stator leads from the rectifier heat sink. Place a needle nose pliers on diode terminal between solder joint and diode body to help prevent heat damage to diodes. Unsolder joints as quickly as possible and allow diode terminal to cool before removing pliers.



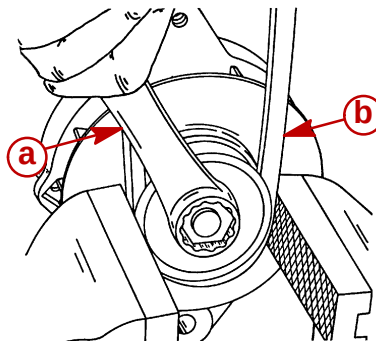
72827

- a** - Heat Sink
b - Stator Leads (3)

IMPORTANT: With alternator disassembled to this point, stator, rectifier, diodes, and rotor may be tested, as explained under "Component Testing," following.

IMPORTANT: DO NOT clamp vise on rotor pole pieces when removing pulley nut (in next step), as pole pieces may be distorted.

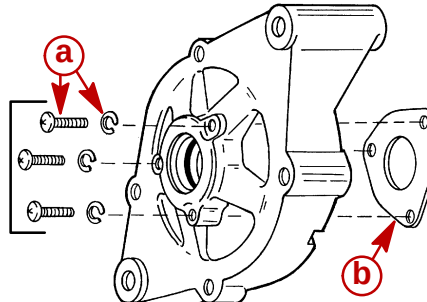
12. Remove pulley retaining nut by clamping pulley in a vise (using an old belt or protective jaws to protect pulley) and turning nut counterclockwise with a wrench. Remove lockwasher, slide pulley and fan from shaft. If pulley is difficult to remove, it may be necessary to use a universal puller.



72828

- a** - Wrench
b - Old Belt To Protect Pulley

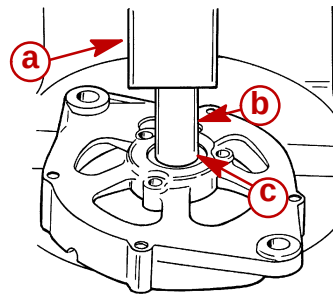
13. Remove the three phillips head screws and lockwashers which secure the front bearing retaining plate.



72829

- a** - Phillips Head Screws and Lockwashers
b - Front Bearing Retaining Plate

14. Remove front bearing from front end frame using an arbor press and a suitable size mandrel. Discard bearing.



72830

- a** - Press
b - Mandrel
c - Bearing

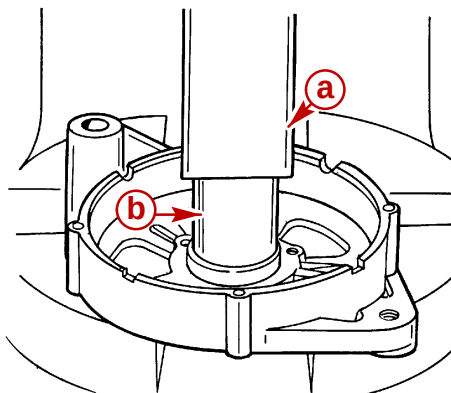
15. If rotor slip rings or rear bearing requires replacement, entire rotor must be replaced. Parts cannot be purchased separately.

Cleaning and Inspection

1. Clean all parts with a clean, soft cloth. DO NOT use solvent, or electrical components may be damaged.
2. Inspect the following parts for wear and damage:
 - a. **Brush/regulator assembly** - inspect for cracked casing, damaged brush leads, poor brush lead solder connections, weak or broken brush springs or worn brushes. Replace brush set if brushes are less than 1/4 in. (6 mm) long.
 - b. **Rotor** - inspect for stripped threads, scuffed pole piece fingers or damaged bearing surfaces (because of bearing turning on shaft).
 - c. **Rotor-slip rings** - clean slip rings with 400 grain (or finer) polishing cloth while spinning rotor in a lathe. Blow off dust with compressed air. Inspect slip rings for grooves, pits, flat spots or out-of-round [.002 in. (0.051 mm) maximum] and replace rotor, if present.
 - d. **Rotor shaft and front end bearings** - inspect for damaged seals, lack of lubrication, discoloration (from overheating) and excessive side or end play. Bearing should turn freely without binding or evidence of rough spots.
 - e. **Stator** - inspect for damaged insulation or wires; also inspect insulating enamel for heat discoloration, as this is usually a sign of a shorted or grounded winding or a shorted diode.
 - f. **Front and rear end frames** - inspect for cracks, distortion, stripped threads or wear in bearing bore (from bearing outer race spinning in bore). End frame(s) MUST BE replaced, if bearing has spun. Also, inspect bearing retainer recess in front end frame for damage.
 - g. **Fan** - inspect for cracked or bent fins, broken welds (bi-rotational fan only) or worn mounting hole (from fan spinning on shaft).
 - h. **Pulley** - inspect pulley mounting bore end for wear. Inspect drive surface of pulley sheaves for trueness, excessive wear, grooves, pits, nicks and corrosion. Repair damaged surfaces, if possible, with a fine file and a wire brush or replace pulley, if beyond repair. Drive surfaces MUST BE perfectly true and smooth or drive belt wear will be greatly accelerated.

Reassembly

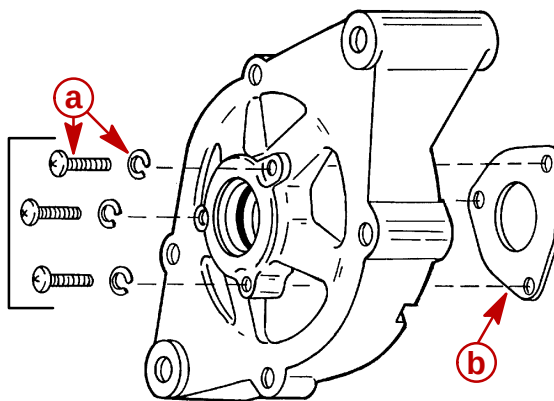
1. Install new front bearing into front end frame bearing bore using an arbor press. If necessary, use a bearing driver that contacts outer race only.



72835

- a** - Press
b - Mandrel

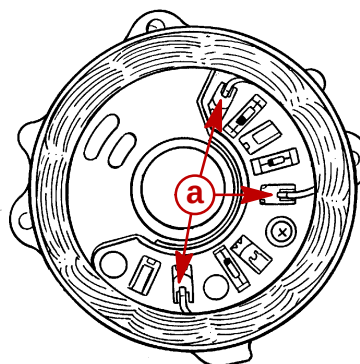
2. Install front bearing retaining plate using three Phillips head screws and lockwashers.



72829

- a** - Phillips Head Screws And Lockwashers
- b** - Front Bearing Retaining Plate

3. Slide front end frame over rotor.
4. Assemble stator to rectifier by soldering the three leads to the three rectifier terminals.



72826

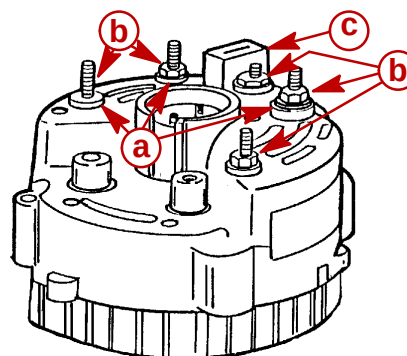
- a** - Stator Lead Connections

NOTE: Be sure to connect leads to their original positions.

5. Install assembled stator and rectifier assembly into rear end frame, aligning scribe marks on each (scribed during disassembly), and install Phillips head screw and washer to retain.

IMPORTANT: The insulating washers **MUST BE** installed as shown or damage to the alternator will result.

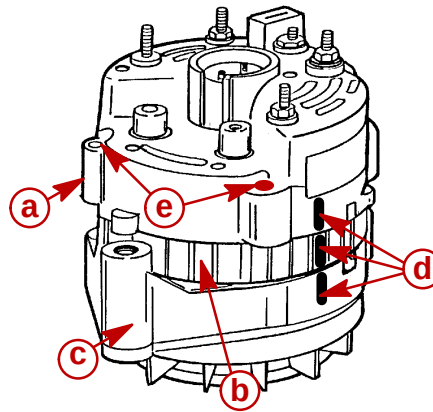
6. Position stator down with rear end frame up and reinstall insulators, nuts and condenser.



72561

- a** - Insulators (3)
- b** - Nuts (5) One Removed
- c** - Condenser

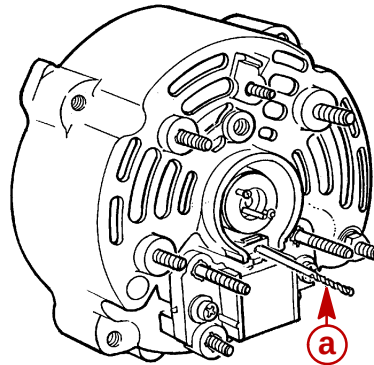
7. Position rear end frame and stator assembly over front end frame and rotor assembly and align scribe marks on each (scribed during disassembly). Hand-press end frames together, then install four screws. Tighten screws securely.



72561

- a** - Rear End Frame
- b** - Stator
- c** - Front End Frame
- d** - Scribe Marks
- e** - Insert Screws (4) (Two Hidden)

8. Depress brushes flush with top of brush holder and insert a #54,.050 in. (1 mm) drill bit or smaller into hole in brush holder to hold brushes compressed during reassembly.

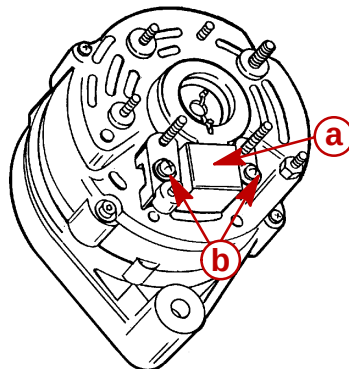


72836

- a** - Drill Bit

NOTE: Rubber gasket shown removed for clarity.

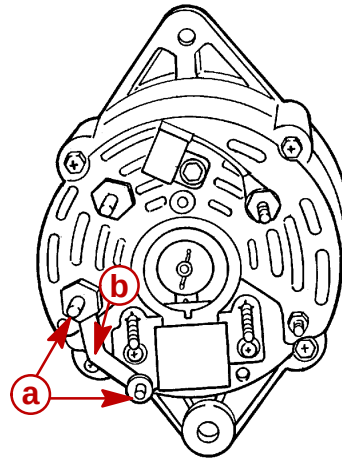
9. Install brush/regulator assembly in rear end frame cavity and secure with two mounting screws, as shown. Tighten screws securely. Remove drill bit to release brushes against slip rings.



72837

- a** - Brush / Regulator Assembly
- b** - Mounting Screws

10. Install tie bar to rectifier stud and stud on brush/rectifier assembly. Tighten nuts securely.

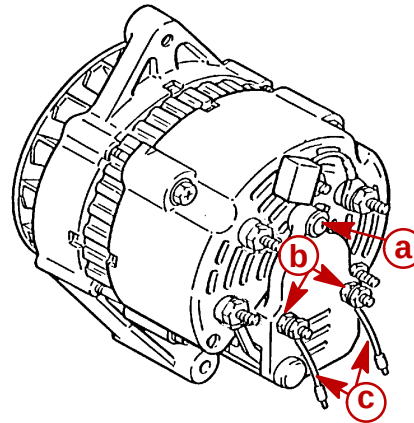


72823

a - Studs

b - Tie Bar

11. Install cover with one phillips head screw and two nuts. Install two leads with nuts.



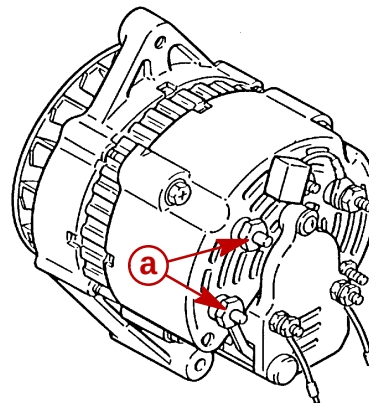
72963

a - Phillips Head Screw

b - Nuts (4)

c - Leads

12. Install insulator caps.

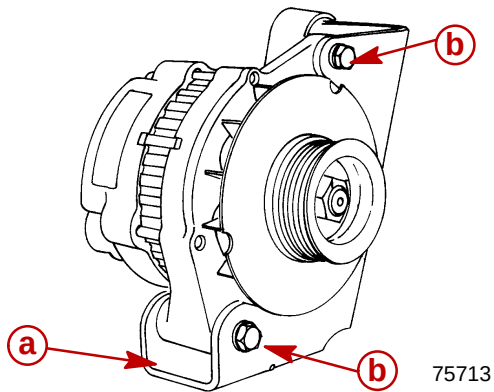


72078

a - Insulator Caps

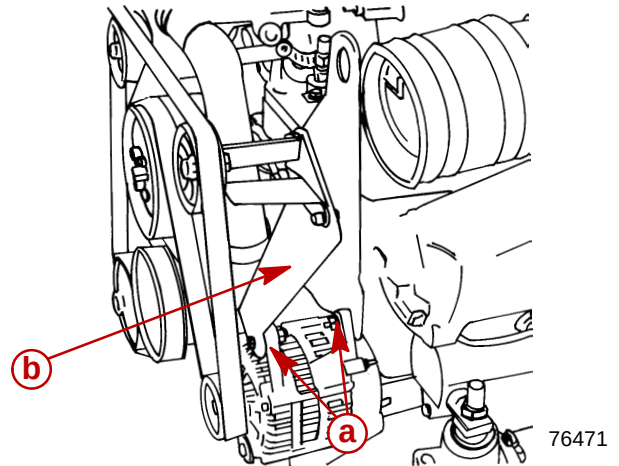
Installation

1. Position alternator in mounting bracket and install mounting bolts. Torque to 35 lb-ft (48 Nm).



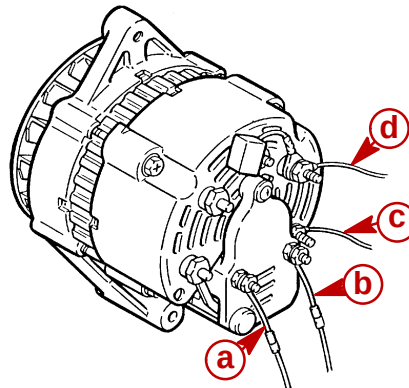
Typical Models

- a** - Bracket
- b** - Bolts



V-Drive Models

2. Position alternator drive belt on pulleys and adjust tension as explained under "Drive Belt Tension Adjustment," preceding.
3. Reconnect wiring harness to alternator.



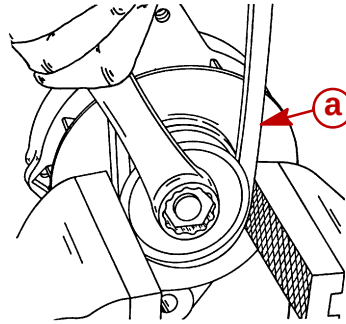
72838

- a** - Excitation Lead -(PURPLE)
- b** - Sensing Lead - (RED / PURPLE)
- c** - Ground Lead - (BLACK)
- d** - Output Lead - (ORANGE)

4. Connect negative battery cable to battery.

Pulley Removal

1. Remove serpentine belt.
2. Clamp pulley in a vise (using an old belt or protective jaws to protect pulley) to remove nut.

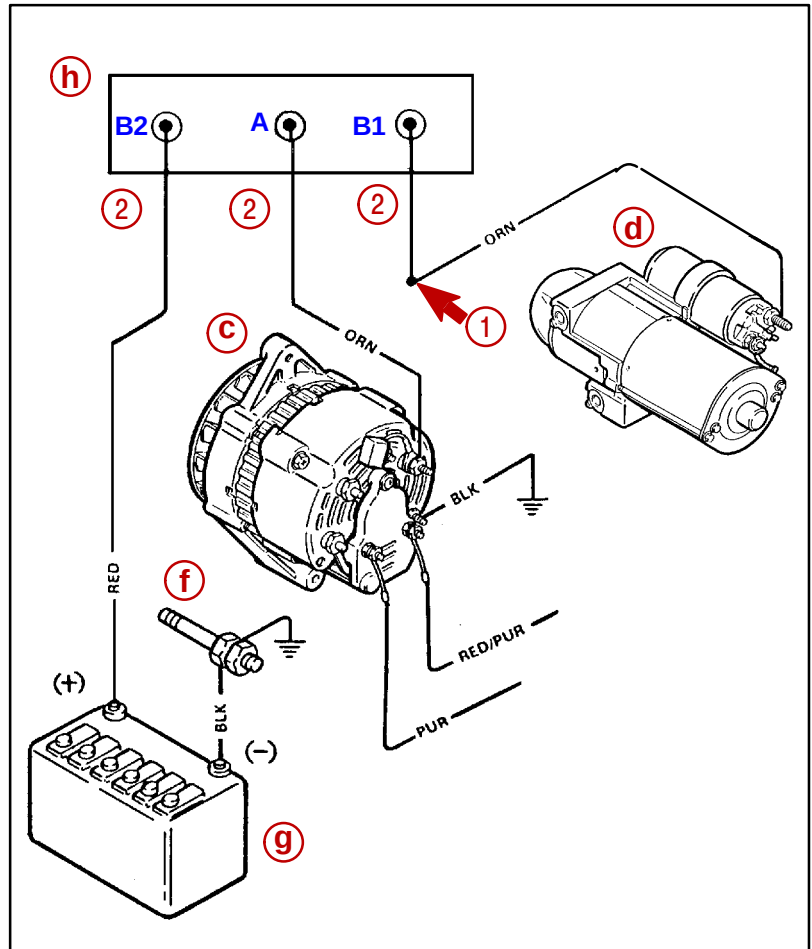
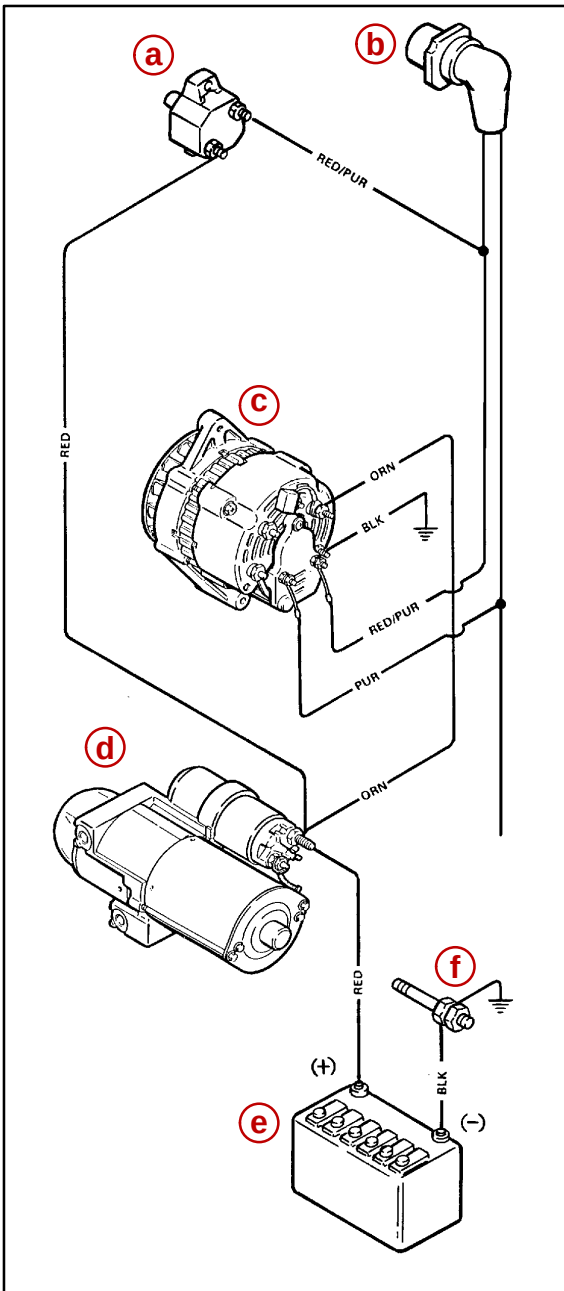


72828

a - Old Belt to Protect Pulley

3. Slide components off of alternator shaft.
4. Install components and pulley on alternator shaft.
5. Torque pulley adjustment nut to specifications.

Battery Isolator Diagram



72934

- a** - Circuit Breaker
- b** - Harness Connector
- c** - Alternator
- d** - Starter
- e** - Cranking Battery
- f** - Ground Stud
- g** - Auxiliary Battery
- h** - Isolator

- 1** - Disconnect Orange Wire From Alternator Battery Terminal. Splice Sufficient Gauge Wire To The Orange Wire And Connect As Shown.
- 2** - 8 Gauge Minimum

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ELECTRICAL SYSTEM

Section 4D - Instrumentation

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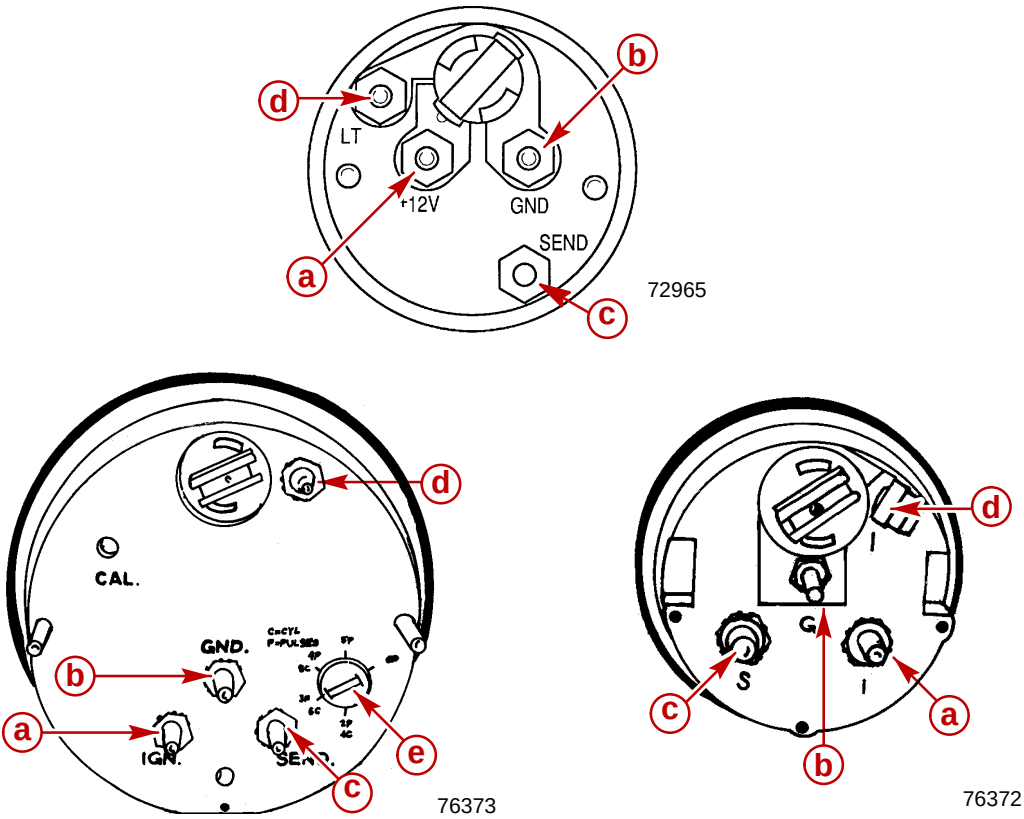
Tools

Description	Part Number
Voltmeter	Obtain Locally
Ohmmeter	
Service Tachometer	
Continuity Meter	

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Liquid Neoprene	92-25711--3
Loctite Pipe Sealant with Teflon	Obtain Locally

Identification



- a - Battery 12v Terminal
- b - Ground Terminal
- c - Sender Terminal
- d - Light Terminal
- e - Engine Type Dial

Description

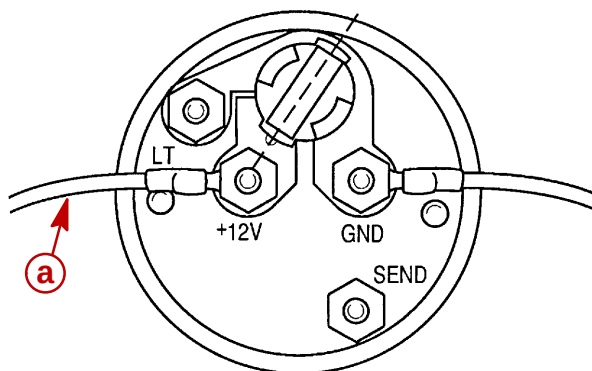
Lighting Options

Some gauges may be wired so that the illumination lighting is provided from the ignition switch or a separate instrumentation lighting switch. By removing contact strip "I" from between + terminal and the screw as shown following, and supplying a separate +12 V power supply to the screw connection, illumination lights can be operated independent of ignition switch.

Other gauges are equipped with optional illumination lighting. Light bulb socket can be removed and contacts can be aligned to be used with ignition switch lighting circuit +12 V or separate instrumentation lighting circuit LT.

IMPORTANT: Light socket must be removed from gauge and turned counterclockwise (facing back of gauge) when adjusting to desired setting. Turning socket while still installed in gauge could result in damage to gauge or socket.

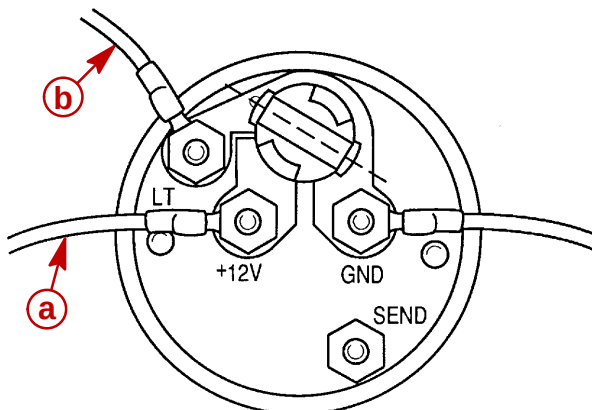
NOTE: For different lighting effects, colored sleeves are available through the Quicksilver Accessories and can be assembled to the bulb.



72968

Typical Ignition Switch Lighting Circuit Position

a - Positive (+) 12 Volt Power Supply From Ignition Switch



72969

Typical Separate Instrumentation Lighting Circuit Position

a - Positive (+) 12 Volt Power Supply From Ignition

b - Positive (+) 12 Volt Power Supply From Separate Instrumentation Lighting Circuit

Gauges

Circuits

Typical gauges are shown. One terminal is the positive (+), the second terminal is the ground (–) and the third terminal is the light. Some gauges will have a terminal for the sender (S). The information below is how most gauges are marked.

IMPORTANT: Some tachometers may have a dial that has to be set to the type and/or number of cylinders the engine has before it will give the correct engine rpm.

If the gauges have different markings, contact that manufacturer.

1. The positive (+) terminal supplies 12v battery voltage to the gauge. The terminal may be marked with a (+), POS, +12v, B+, IGN or I.
2. The ground (–) terminal is the ground for the gauge. The terminal may be marked with a (–), G, GND, GRD or no mark.
3. The light terminal supplies 12v battery voltage to the gauge's light. This terminal may be marked with a LT, light, I or no mark. This terminal is usually next to the light bulb.
4. The sender terminal receives the signal from the sender on the engine. This terminal may be marked with a S, SND or SEND.

IMPORTANT: When changing a gauge, do not overtighten bracket and distort case.

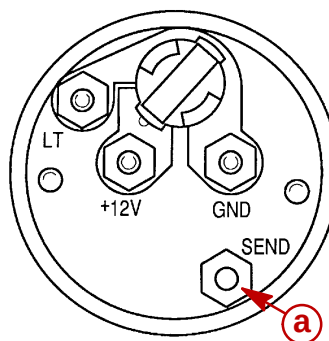
5. When changing or testing a gauge, coat terminals with Quicksilver Liquid Neoprene to protect them.

Oil, Fuel and Temperature

IMPORTANT: If testing proves gauge to be defective, it must be replaced as there is no repair available.

TESTING

1. Turn ignition switch to OFF.
2. Remove wire from terminal S (SEND).

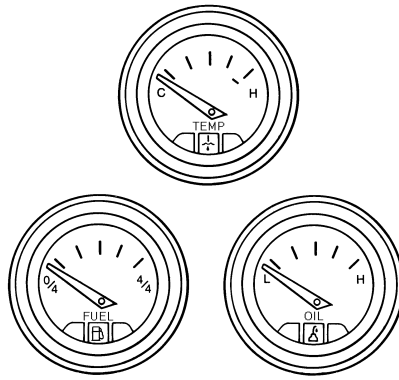


72965

Typical

a - Terminal S (SEND)

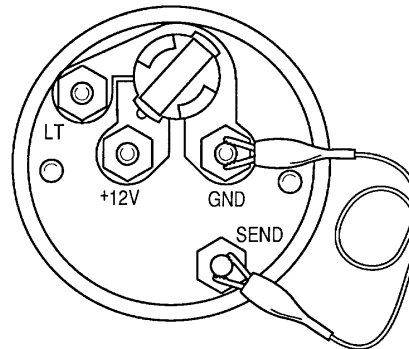
3. Turn ignition switch to RUN. Indicator needle on gauge should be positioned as shown.



72747

Typical

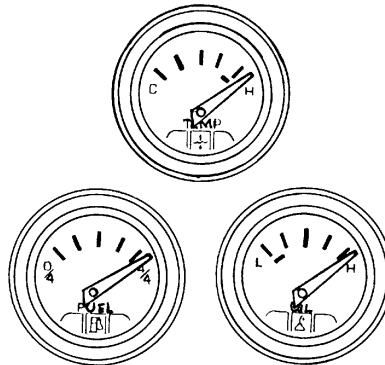
4. Turn ignition switch to OFF.
5. Connect jumper wire from ground terminal to sender terminal.



72748

Typical

6. Turn ignition switch to RUN.
7. Indicator needle must be positioned as shown. If not, replace gauge.



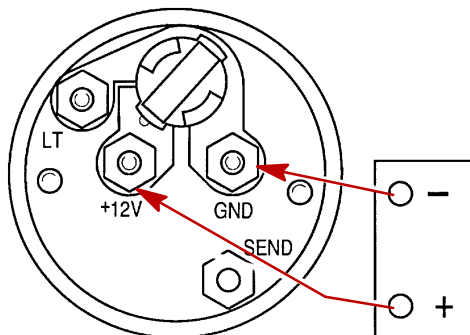
72749

Typical

Battery Gauge

TESTING

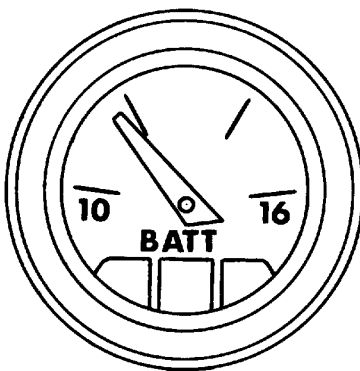
1. Use a fully charged 12v battery. Check voltage with voltmeter.
2. Connect a jumper wire from the positive (+) battery post to the positive (+) gauge terminal.
3. Connect a jumper wire from the negative (-) battery post to the (-) gauge terminal.



72750

Typical

4. Gauge should read approximately the same voltage that the when checking the battery in step1.



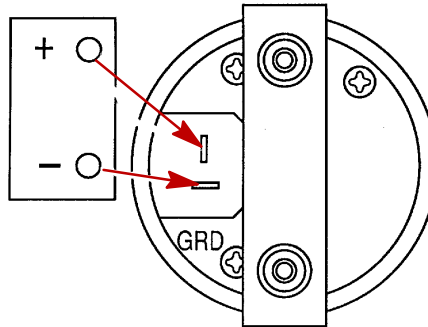
72751

Typical

Cruiselog Meter

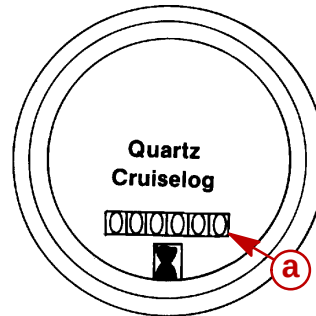
TESTING

1. Connect jumper wire from positive (+) battery terminal to positive (+) gauge terminal.
2. Connect jumper wire from negative (–) battery terminal to negative (–) gauge terminal.



72752

3. Observe gauge run indicator. If indicator is not turning, replace gauge.



72753

a - Indicator

Vacuum Gauge

TESTING

1. Disconnect vacuum hose from engine.
2. Connect service vacuum gauge to engine and record engine vacuum readings at idle, 1000, 2000 and 3000 rpm.
3. Reconnect vacuum hose and compare vacuum gauge readings (at specified rpm) with service gauge readings. Readings should be within 3 inches of vacuum of each other.

IMPORTANT: Make sure that vacuum hose between gauge and engine is not leaking and that all connections are tight.

4. If gauge readings are not within specifications, replace gauge.

Speedometer

TESTING

IMPORTANT: When testing speedometer gauge for accuracy, the air supply used for the test must be regulated to the specified air pressure. Do not apply excessive air pressure to speedometer gauge.

1. Apply air pressure directly to speedometer gauge (specified in chart) and note gauge reading. Lightly tap pressure gauge during accuracy check.
2. If gauge readings are not within specifications, replace gauge.

CALIBRATION CHART

Air Pressure Gauge psi	Speedometer Gauge MPH (km/Hr)
5.3	20±2 (32±1.6)
27.8	45±1 (72±1.6)

Tachometer

TESTING

1. Connect a service tachometer to engine and compare readings between the service tachometer and the original tachometer.
2. Replace if not within specifications.

Tachometer	Allowance
6000 rpm	± 150 rpm

Gauge Replacement

1. Disconnect battery cables from battery.
2. Remove wires from back of gauge.
3. Remove hoses if applicable (vacuum, speedometer gauge).
4. Disconnect light socket, if applicable.
5. Remove holding strap.
6. Remove gauge.
7. Position new gauge assembly in appropriate mounting hole.
8. Install holding strap and nuts. Tighten nuts evenly and securely.

IMPORTANT: Do not distort case or bracket by overtightening.

9. Connect ground (BLK) wire to ground terminal, if gauge is not mounted in metal panel.
10. Connect other wires to gauge as specified.
11. Connect hoses (vacuum, speedometer gauges).
12. Install gauge light socket.
13. Coat all terminals with Quicksilver Liquid Neoprene.
14. Reconnect battery cables to battery.

Senders

Oil Pressure

TESTING

IMPORTANT: Use following test procedure for checking accuracy of oil pressure sender only. If oil pressure gauge indicates zero oil pressure, refer to **SECTION 1C - "Troubleshooting."**

1. Remove wire from sender terminal.
2. Connect ohmmeter between sender terminal and sender case. Check ohms reading without engine running (zero pressure), then check reading with engine running. Compare oil pressure and ohms readings as shown in following chart:

Oil Pressure (psi)	Ohms Reading	
	Single	Dual
0	227-257	114-128
20 (138 kPa)	142-162	71-81
40 (276 kPa)	92-113	46-56
80 (414 kPa)	9-49	5-24

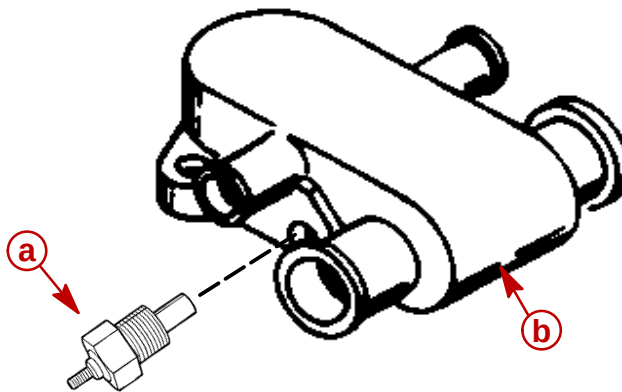
Water Temperature

REMOVAL

1. Drain coolant from closed cooling system into a suitable container. Refer to SECTION 6B.
2. Remove TAN wire from temperature sender.

NOTE: Hoses are shown removed for clarity.

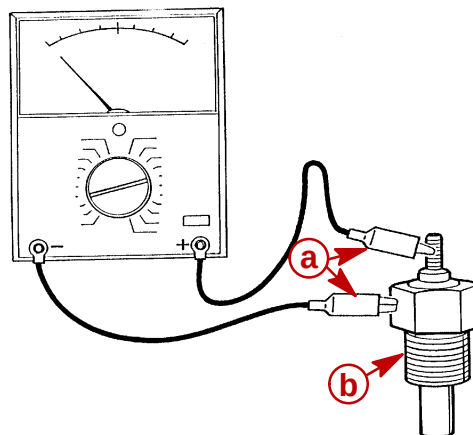
3. Remove temperature sender.



- a** - Water Temperature Sender
b - Thermostat Housing

TESTING

1. Connect an ohmmeter between temperature sender terminal (+) and hex for ground (–) as shown.

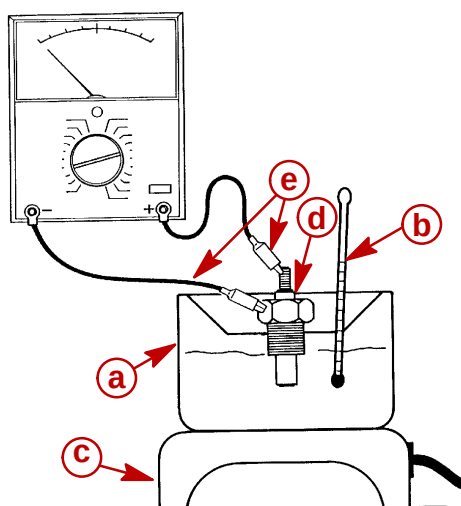


72768

- a** - Ohmmeter Leads
b - Water Temperature Sender

2. With ohmmeter connected as outlined and using suitable container, thermometer and heat source, suspend sender with tip in water.
3. Heat water and observe thermometer.
4. As temperature rises ohmmeter readings must be within the ranges specified for each temperature (see chart below).
5. Turn heat source off. Allow water and components to cool.

NOTE: While water cools you may recheck ohmmeter readings.



72769

- a** - Suitable Container
- b** - Thermometer
- c** - Heat Source
- d** - Water Temperature
- e** - Ohmmeter Leads

Water Temperature	Ohms Reading
140° F (60° C)	121-147
194° F (90° C)	47-55
212° F (100° C)	36-41

6. Replace sender if ohmmeter readings are other than as shown for each temperature.

INSTALLATION

1. Apply Loctite Pipe Sealant with Teflon to threads of temperature sender.
2. Install sender in thermostat housing and tighten securely.
3. Connect tan wire and coat with Liquid Neoprene.
4. Refill closed cooling system with approved coolant. Refer to SECTION 6B.

Switches

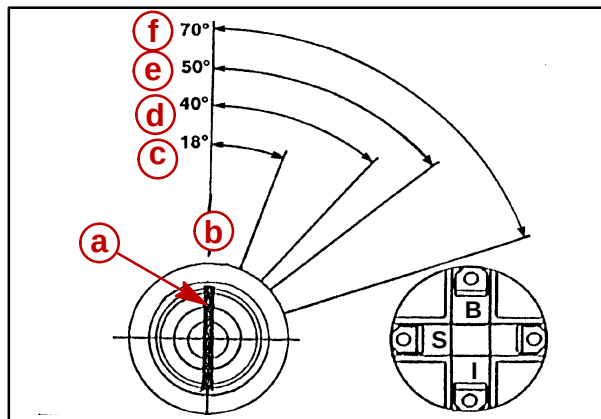
Ignition Key Switch

TESTING

⚠ CAUTION

Disconnect battery cables from battery before testing ignition key switch with wires still connected to switch.

1. Disconnect battery cables, if testing ignition key switch with wires connected to switch.
2. With key switch in OFF position, there should be no continuity between switch terminals.
3. With key switch in RUN position, continuity will exist between switch terminals B to I. There should no continuity between terminal S and any other terminals.
4. With key switch in START, continuity will exist between terminals B to I and B to S.
5. Terminals are to make contact at angles shown and to stay in contact condition as switch is rotated toward START.
6. If ignition key switch tests bad, disconnect wire connections and remove switch. Test switch again, as in Steps 2.-5. If switch tests good, wiring in harness is bad. There should be no continuity between any harness wires with key switch removed.



72760

Key View

Back View

- a** - Key
- b** - Off
- c** - Continuity, B to I Terminals
- d** - Run
- e** - Continuity B to S Terminals
- f** - Start

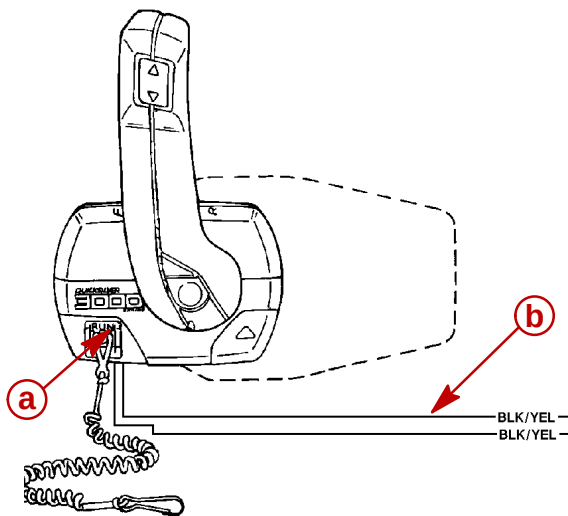
Lanyard Stop Switches

NOTICE

For repair procedures on fuel injected engines, refer to SECTION 5.

TESTING

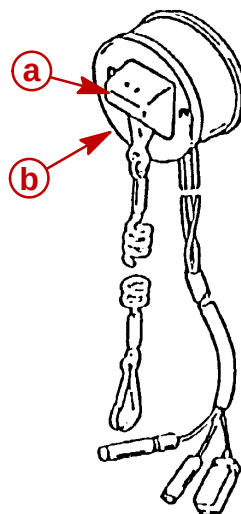
1. Disconnect switch leads.
2. Connect an ohmmeter to leads.
3. There should be continuity with switch lanyard connected and no continuity with switch lanyard disconnected.



74061

Remote Control Mounted Switch

- a** - Switch Lanyard
- b** - Leads



72762

Panel Mounted Switch

- a** - Switch Cap
- b** - Switch

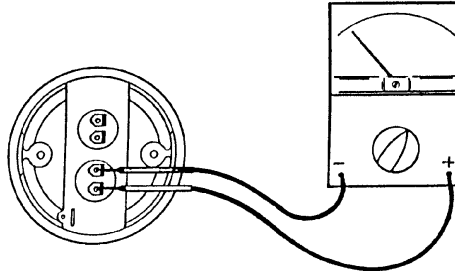
Start/Stop Switch

TESTING

⚠ WARNING

Disconnect battery leads at battery before testing.

1. Disconnect battery leads.
2. Check for continuity between the terminals on the start switch with a continuity meter.



72763

3. No continuity should exist.
4. Depress switch button and continuity should exist.
5. Check stop switch in the same manner.
6. If continuity exists when in the OPEN (not depressed) state, replace panel button.

Audio Warning System

NOTICE

For repair procedures on fuel injected engines, refer to SECTION 5.

Buzzer

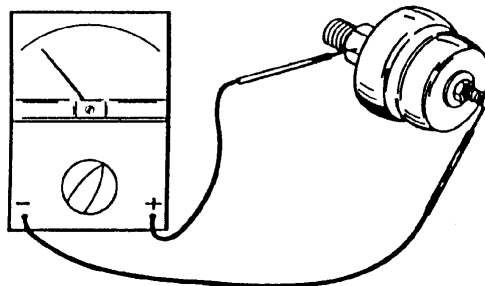
TESTING

1. Turn key to RUN position (engine off).
2. Buzzer should sound briefly.
3. If horn does not sound:
 - a. Disconnect TAN/BLU wire at buzzer and touch it to a known good ground (–).
 - b. If horn sounds, problem is in TAN/BLE wire back to engine or switches on engine.

Oil Pressure Switch

TESTING

1. Remove wire from sender terminal.
2. Connect continuity meter between sender terminal and sender hex. (Sender shown removed for clarity.)



72764

3. With engine not running, meter should indicate full continuity.
4. With engine running and engine oil pressure above 6 psi (41 kPa), meter should indicate no continuity.

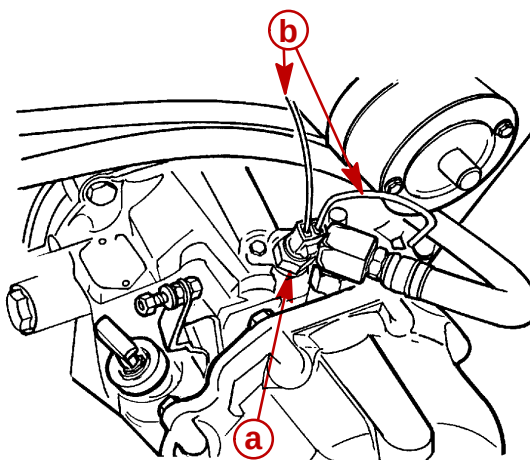
Transmission Fluid Temperature Switch

Switch is located on transmission. Switch is normally open. This switch is used on MIE engines (if equipped).

87-88031 Switch	
Opens	180-200° F (82-93° C)
Closes	220-240° F (104-116° C)

REMOVAL

1. Disconnect harness wires at switch.
2. Remove switch and sealing washer.



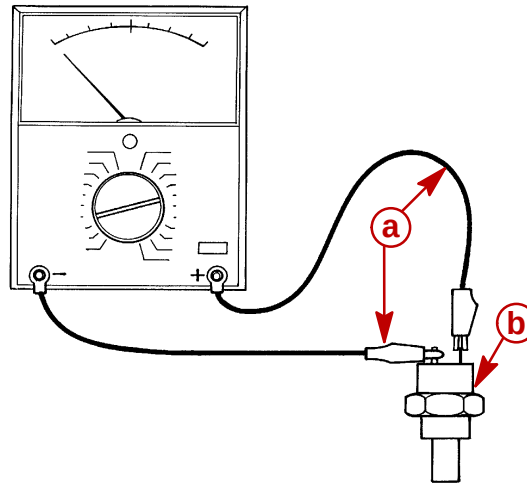
72845

Typical Location

- a** - Transmission Fluid Temperature Switch With Sealing Washer
- b** - Harness Wires

TESTING

1. Connect one lead of an ohmmeter to one terminal of transmission switch. Connect the other lead of ohmmeter to other terminal.



72771

a - Ohmmeter Leads

b - Transmission Fluid Temperature Switch

2. Switches should read no continuity. If continuity exists, replace the switch.

⚠ WARNING

The following test involves the use of intense heat. Failure to follow appropriate procedures or warnings can cause burns can result in severe personal injury. While performing the following test, observe these precautions:

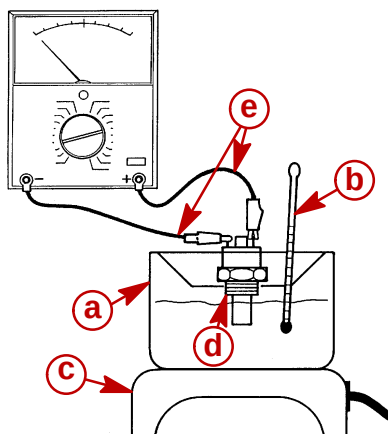
- Wear personal protective clothing such as rubber gloves, a non-flammable apron, and eye protection - preferably full face shield or safety glasses.
- The appropriate heat source should be electric. Heat source should be operated by a qualified person. Be sure to follow all instructions of the manufacturer of the heat source. The heat source should be checked each time it is used to be sure it is functioning properly.
- The thermometer used in the test should be a high-temperature thermometer with a maximum reading of at least 300°F (150°C). Under no circumstances should the operator allow temperatures to exceed test specifications.
- Perform test only in a well ventilated area.
- Use a suitable container, such as metal, to hold the sand. Avoid use of glass containers unless the operator first confirms for himself/herself that the glass container is an appropriate high-temperature vessel.
- Because the components will reach high temperatures DO NOT handle materials or components until COMPLETELY cooled.

⚠ WARNING

Use only clean, dry sand such as used for general sandblasting purposes. Use of sand containing contaminants could result in hazards such as fire, short circuiting, hot-spots or other hazards.

3. With an ohmmeter connected as outlined and using suitable container, thermometer and heat source, suspend sender with tip in sand.

4. Heat sand and observe thermometer and ohmmeter.



72772

- a** - Suitable Container
b - Thermometer
c - Heat Source
d - Switch or sensor
e - Ohmmeter Leads

5. As temperature rises, switch will close and ohmmeter will indicate continuity. Refer to chart below for specifications.

Coolant Temperature Switch		
	Opens	Closes
48952 Switch	150-170°F (66-77°C)	190-200°F (88-93°C)
87-86080 Switch	175-195°F (79-91°C)	215-225°F (102-107°C)

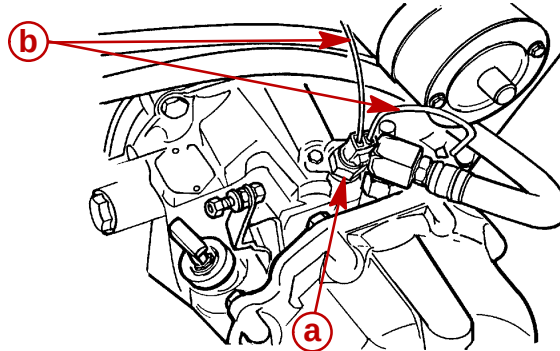
Engine Coolant Temperature (ECT) Sensor		
Temperature - to - Resistance Values (Approximate)		
°F	°C	OHMS
210	100	185
160	70	450
100	38	1,800
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

87-88031 Switch	
Opens	180-200°F (82-93°C)
Closes	220-240°F (104-116°C)

6. Turn heat source off. Allow sand to cool. Note readings again to ensure switch or sensor operates at specified temperature.
7. Replace switch if switch fails within the specified temperature.

INSTALLATION

1. Apply Loctite Pipe Sealant with Teflon to threads of transmission fluid temperature switch.
2. Install switch with sealing washer in transmission and tighten securely.
3. Reconnect harness wires and coat with Liquid Neoprene.



72845

Transmission Fluid Temperature Switch Typical Location

- a** - Switch With Sealing Washer
- b** - Harness Wires

4. Check transmission fluid level.

Sterndrive Gear Lube Monitor Switch

The gear lube monitor is normally open (no continuity between wires) when the gear lube is at the correct level. When the gear lube is low, switch will close causing continuity between wires and buzzer will sound.

If buzzer is sounding, test to verify if switch is defective by disconnecting wires from the harness. If buzzer stops, switch is suspect.

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ELECTRICAL SYSTEMS

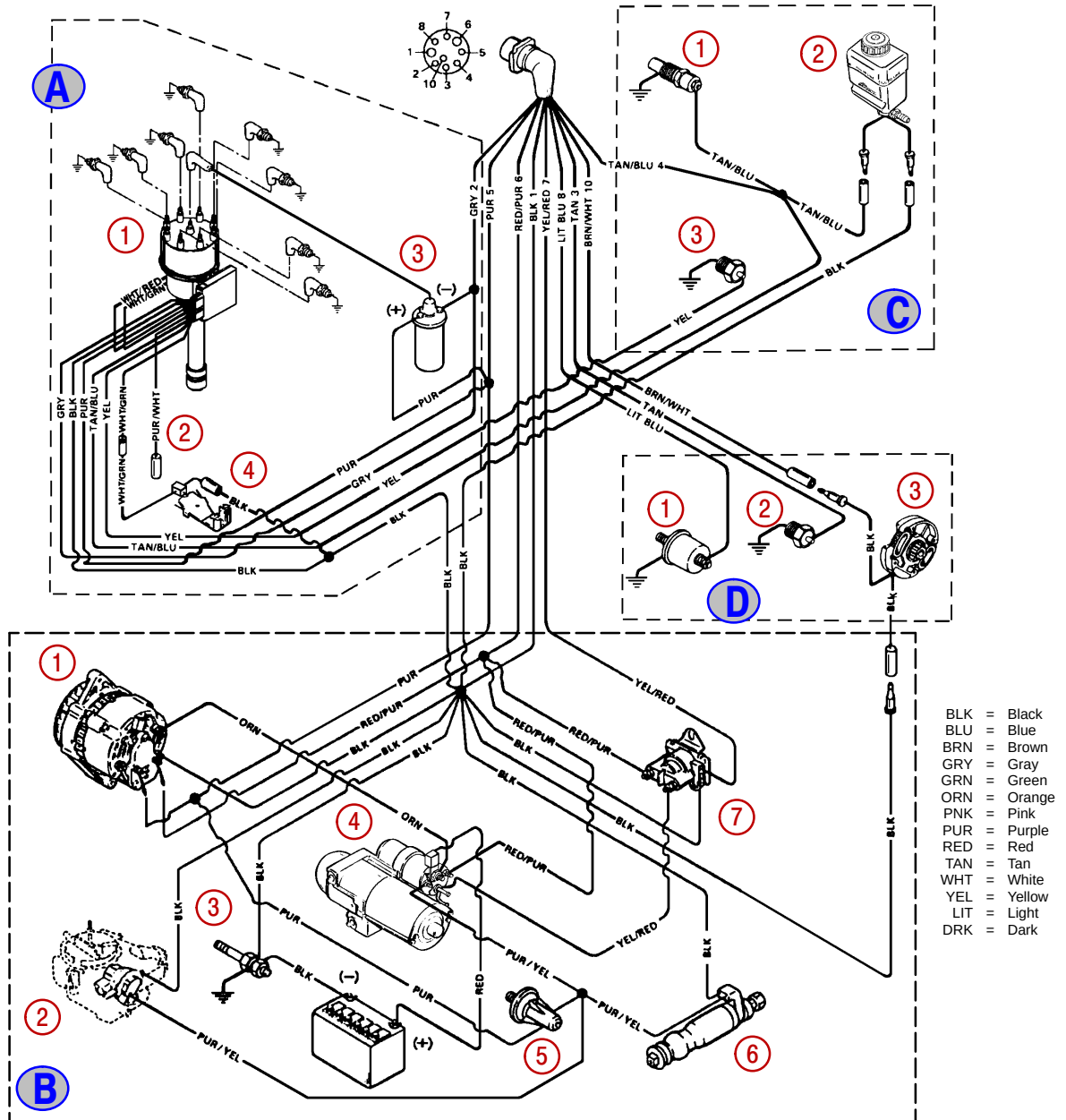
Section 4E - Wiring Diagrams

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Starting and Charging Harness

MCM 5.0L Engines



75568

A - Ignition Components

- 1** - Distributor
- 2** - Timing Lead
- 3** - Ignition Coil
- 4** - Shift Interrupt Switch (not used on Bravo)

B- Starting, Charging and Choke Components

- 1** - Alternator
- 2** - Electric Choke
- 3** - Ground Stud
- 4** - Starter Motor
- 5** - Oil Pressure Switch
- 6** - Fuel Pump
- 7** - Starter Slave Solenoid

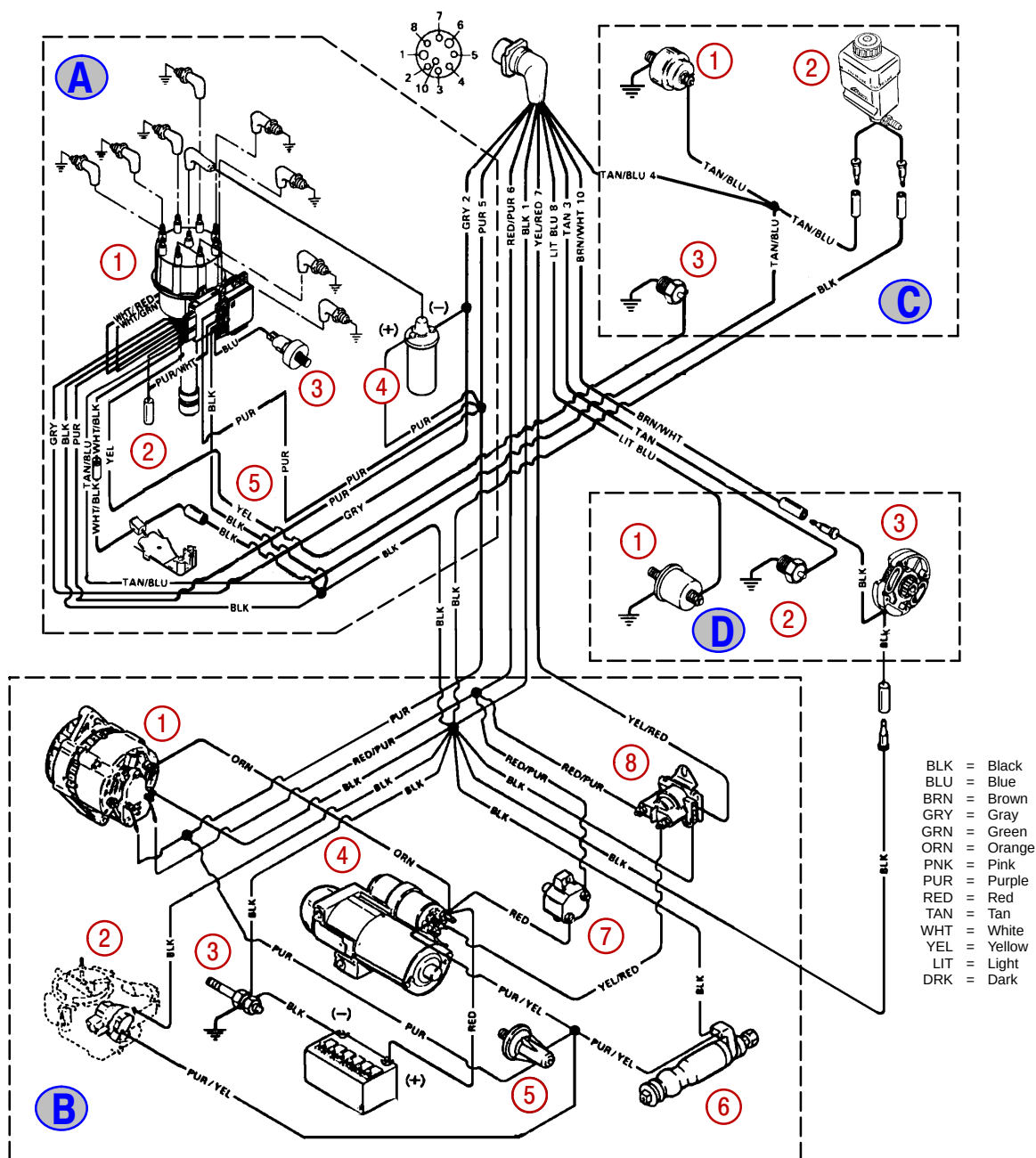
C - Audio Warning Components

- 1** - Oil Pressure Switch
- 2** - Gear Lube Monitor
- 3** - Water Temperature Switch

D - Instrumentation Components

- 1** - Oil Pressure Sender
- 2** - Water Temperature Sender
- 3** - Trim Sender

MCM 5.7L Engines



75548

A - Ignition Components

- 1** - Distributor
- 2** - Timing Lead
- 3** - Knock Sensor
- 4** - Ignition Coil
- 5** - Shift Interrupt Switch (not used on Bravo)

B- Starting, Charging and Choke Components

- 1** - Alternator
- 2** - Electric Choke
- 3** - Ground Stud
- 4** - Starter Motor
- 5** - Oil Pressure Switch
- 6** - Fuel Pump
- 7** - Circuit Breaker
- 8** - Starter Slave Solenoid

C - Audio Warning Components

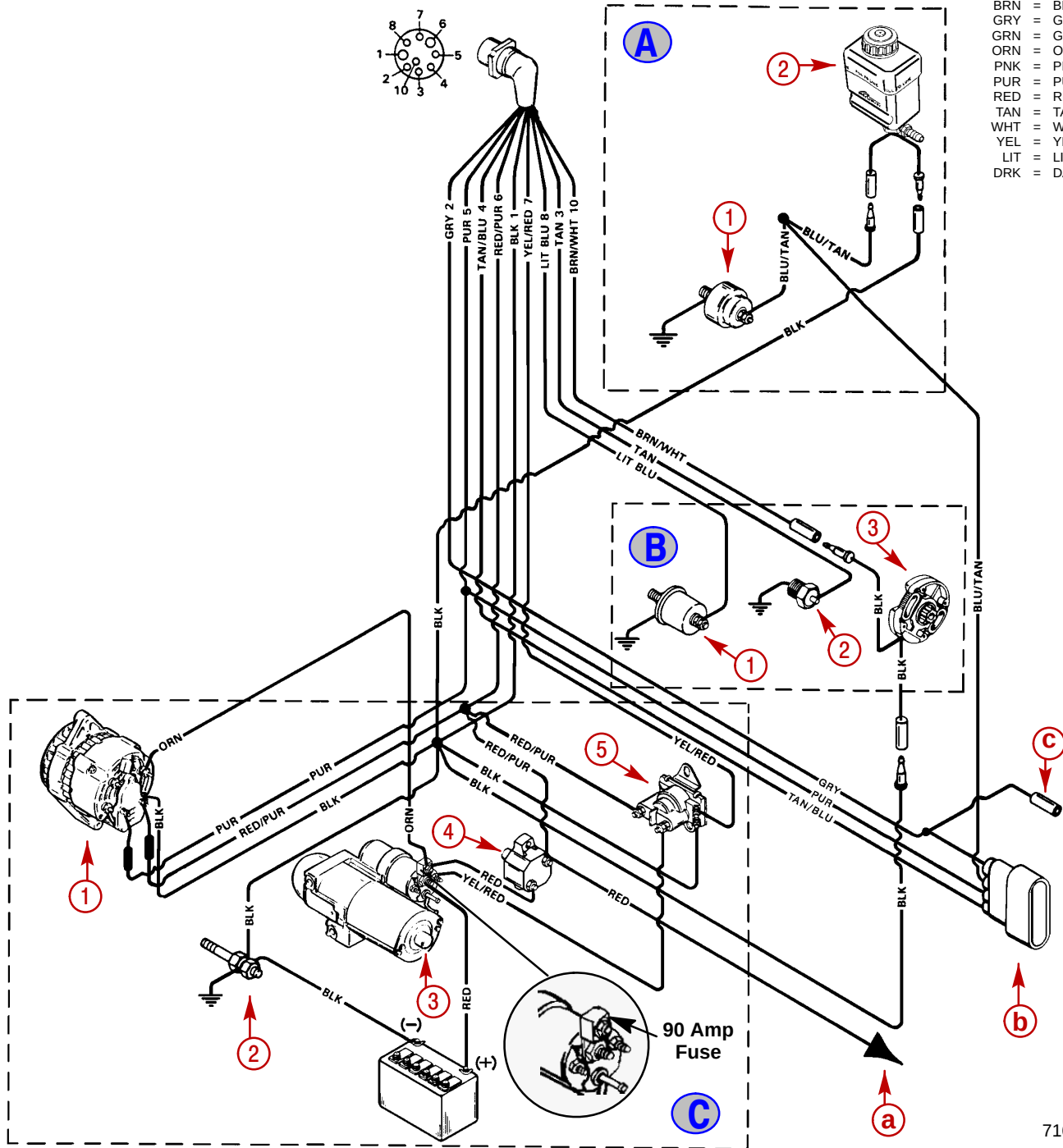
- 1** - Oil Pressure Switch
- 2** - Gear Lube Monitor
- 3** - Water Temperature Switch

D - Instrumentation Components

- 1** - Oil Pressure Sender
- 2** - Water Temperature Sender
- 3** - Trim Sender

MEFI 1 and MEFI 2 MCM 5.0L EFI, 5.7L EFI and 350 Mag MPI Engines

BLK = BLACK
 BLU = BLUE
 BRN = BROWN
 GRY = GRAY
 GRN = GREEN
 ORN = ORANGE
 PNK = PINK
 PUR = PURPLE
 RED = RED
 TAN = TAN
 WHT = WHITE
 YEL = YELLOW
 LIT = LIGHT
 DRK = DARK



71693

A - Audio Warning Components

- 1** - Oil Pressure Switch
- 2** - Drive Unit Oil Level

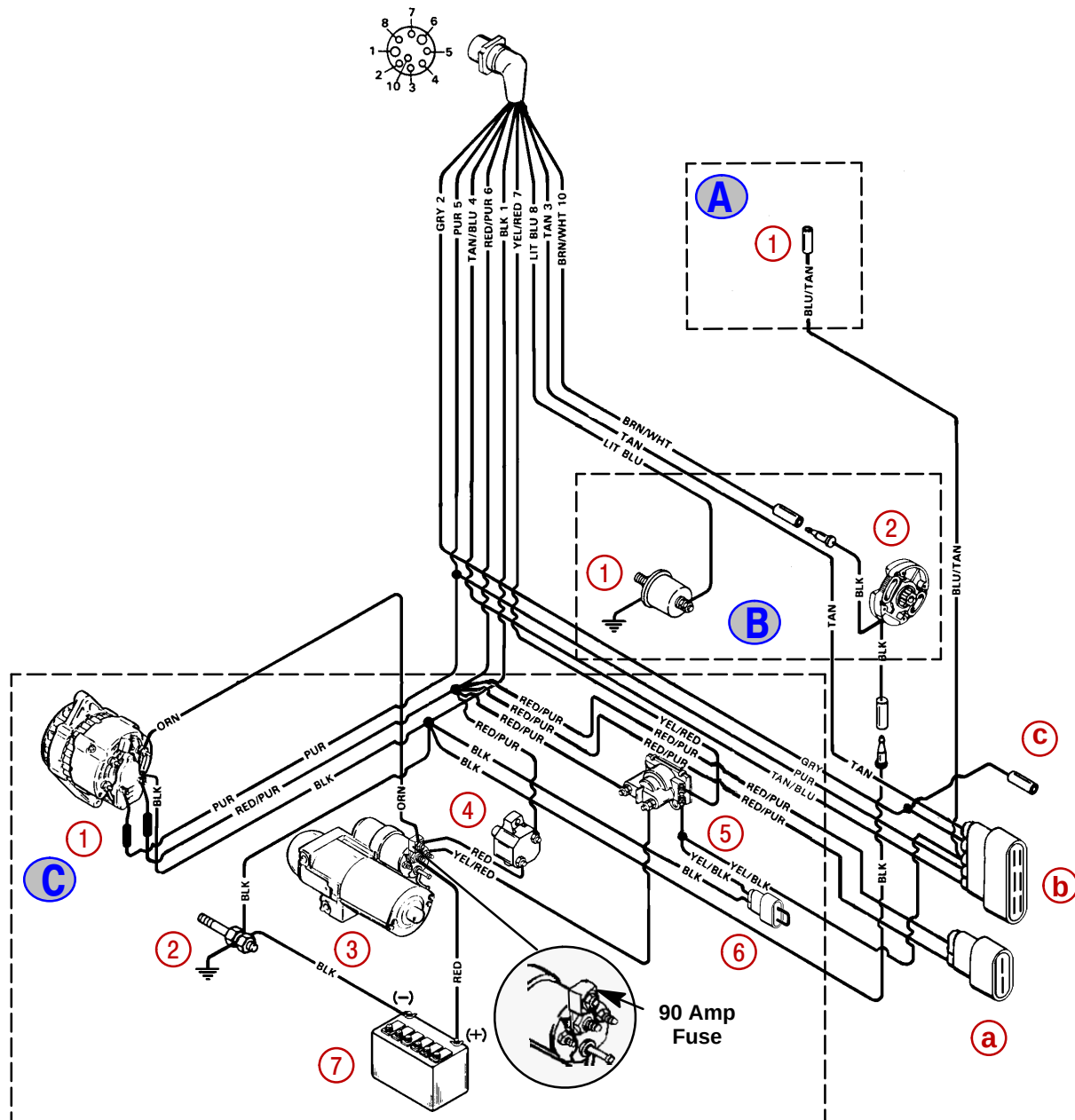
B - Instrumentation Components

- 1** - Oil Pressure Sender
- 2** - Water Temperature Sender
- 3** - Trim Sender

C - Charging and Starting Components

- 1** - Alternator
- 2** - Ground Stud
- 3** - Starter
- 4** - Circuit Breaker
- 5** - Starter Slave Solenoid
- a** - Positive Power Wire To EFI System
Harness
- b** - Harness Connector To EFI System
Harness
- c** - Auxiliary Tachometer Lead

MEFI 3 MCM 5.0L EFI, 5.7L EFI and 350 Mag MPI Engines



76061

A - Audio Warning Components

- 1** - Oil Pressure Switch

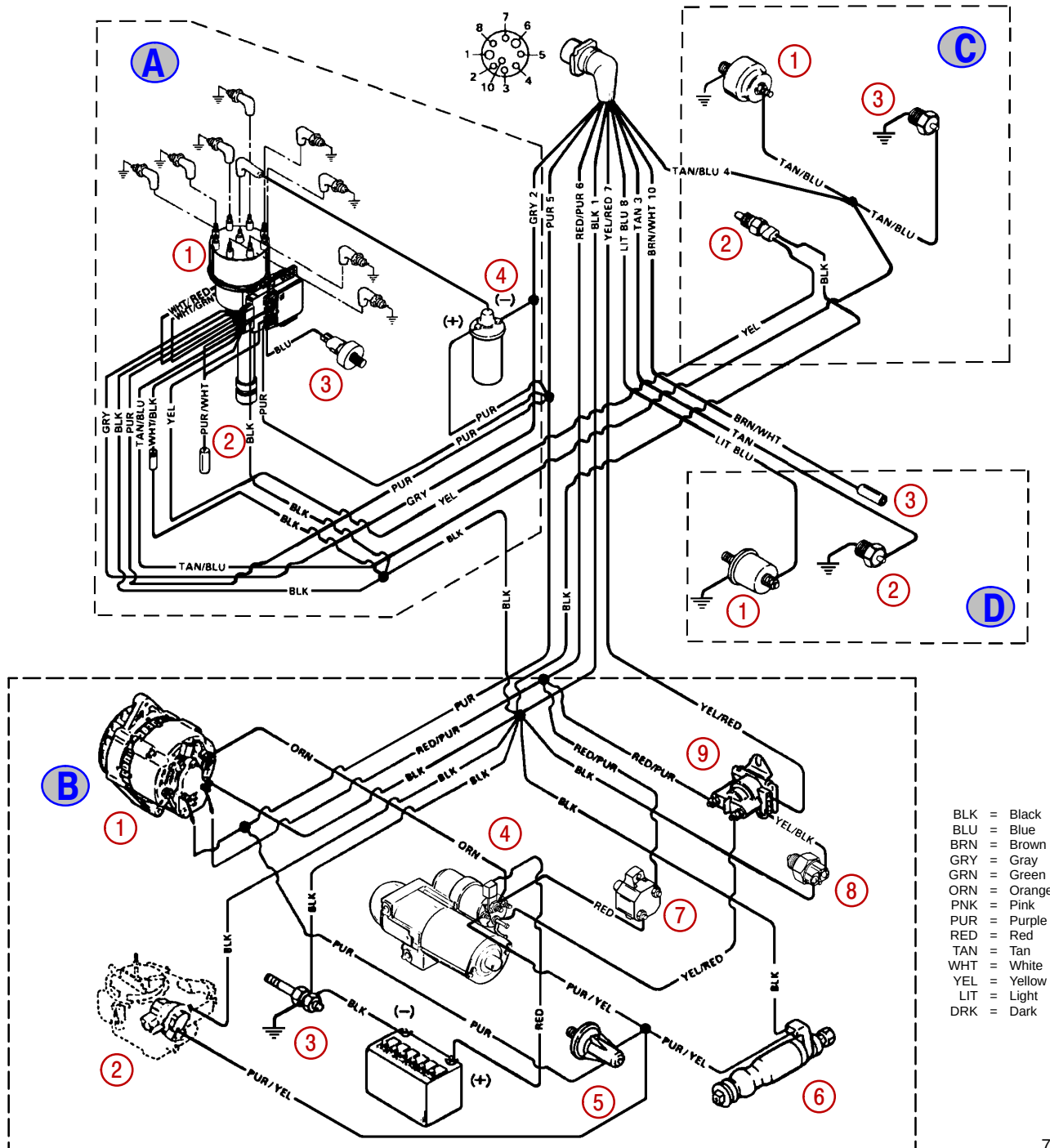
B - Instrumentation Components

- 1** - Oil Pressure Sender
- 2** - Trim Sender

C - Charging and Starting Components

- 1** - Alternator
- 2** - Ground Stud
- 3** - Starter
- 4** - Circuit Breaker
- 5** - Starter Slave Solenoid
- 6** - Jumper Wire Connection
- 7** - Battery
- a** - Positive Power Wire To EFI System Harness
- b** - Harness Connector To EFI System Harness
- c** - Auxiliary Tachometer Lead

MIE 5.7L Inboard



75754

NOTE: BROWN-WHITE wire may be used for an Accessory. LOAD MUST NOT EXCEED 5 AMPS.

A - Ignition Components

- 1** - Distributor
- 2** - Timing Lead
- 3** - Knock Sensor
- 4** - Ignition Coil

B - Starting, Charging and Choke Components

- 1** - Alternator
- 2** - Electric Choke
- 3** - Ground Plug
- 4** - Starter Motor
- 5** - Oil Pressure Switch
- 6** - Fuel Pump
- 7** - Circuit Breaker
- 8** - Neutral Safety Switch
- 9** - Starter Slave Solenoid

C - Audio Warning Components

- 1** - Oil Pressure Switch
- 2** - Water Temperature Switch
- 3** - Transmission Temperature Switch

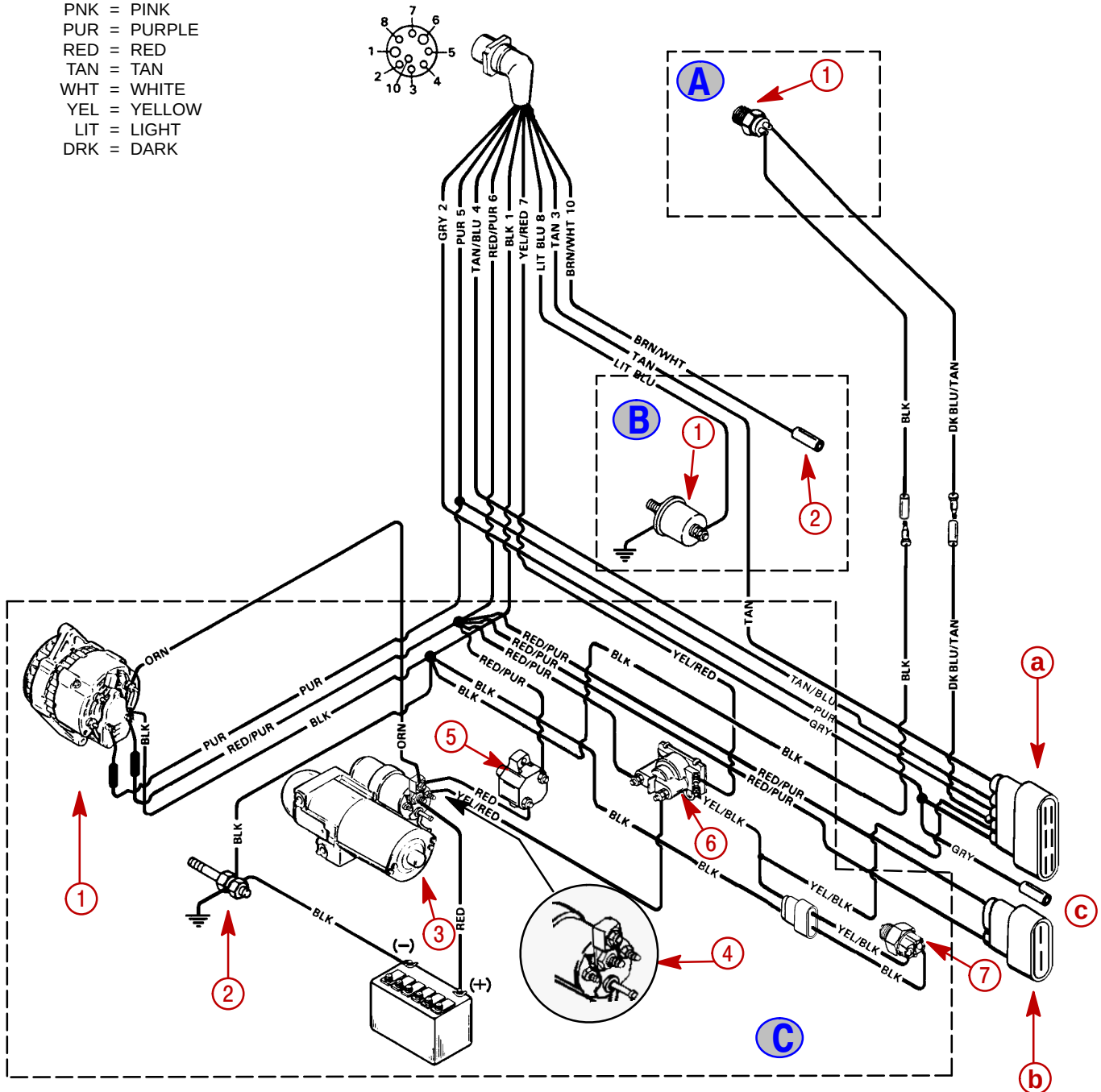
D - Instrumentation Components

- 1** - Oil Pressure Sender
- 2** - Water Temperature Sender
- 3** - See NOTE below

MIE 350 Mag MPI and Black Scorpion Engines - Starting and Charging System Harness

NOTE: Taped back BROWN-WHITE wire may be used for an Accessory. LOAD MUST NOT EXCEED 5 AMPS.

BLK = BLACK
BLU = BLUE
BRN = BROWN
GRY = GRAY
GRN = GREEN
ORN = ORANGE
PNK = PINK
PUR = PURPLE
RED = RED
TAN = TAN
WHT = WHITE
YEL = YELLOW
LIT = LIGHT
DRK = DARK



76062

A - Audio Warning Components

- 1** - Transmission Temperature Switch

B - Instrumentation Components

- 1** - Oil Pressure Sender
- 2** - Wire Not Used

C - Charging and Starting Components

- 1** - Alternator
- 2** - Ground Stud
- 3** - Starter
- 4** - 90 Amp Fuse (DO NOT REMOVE)
- 5** - Circuit Breaker
- 6** - Starter Slave Solenoid
- 7** - Neutral Safety Switch

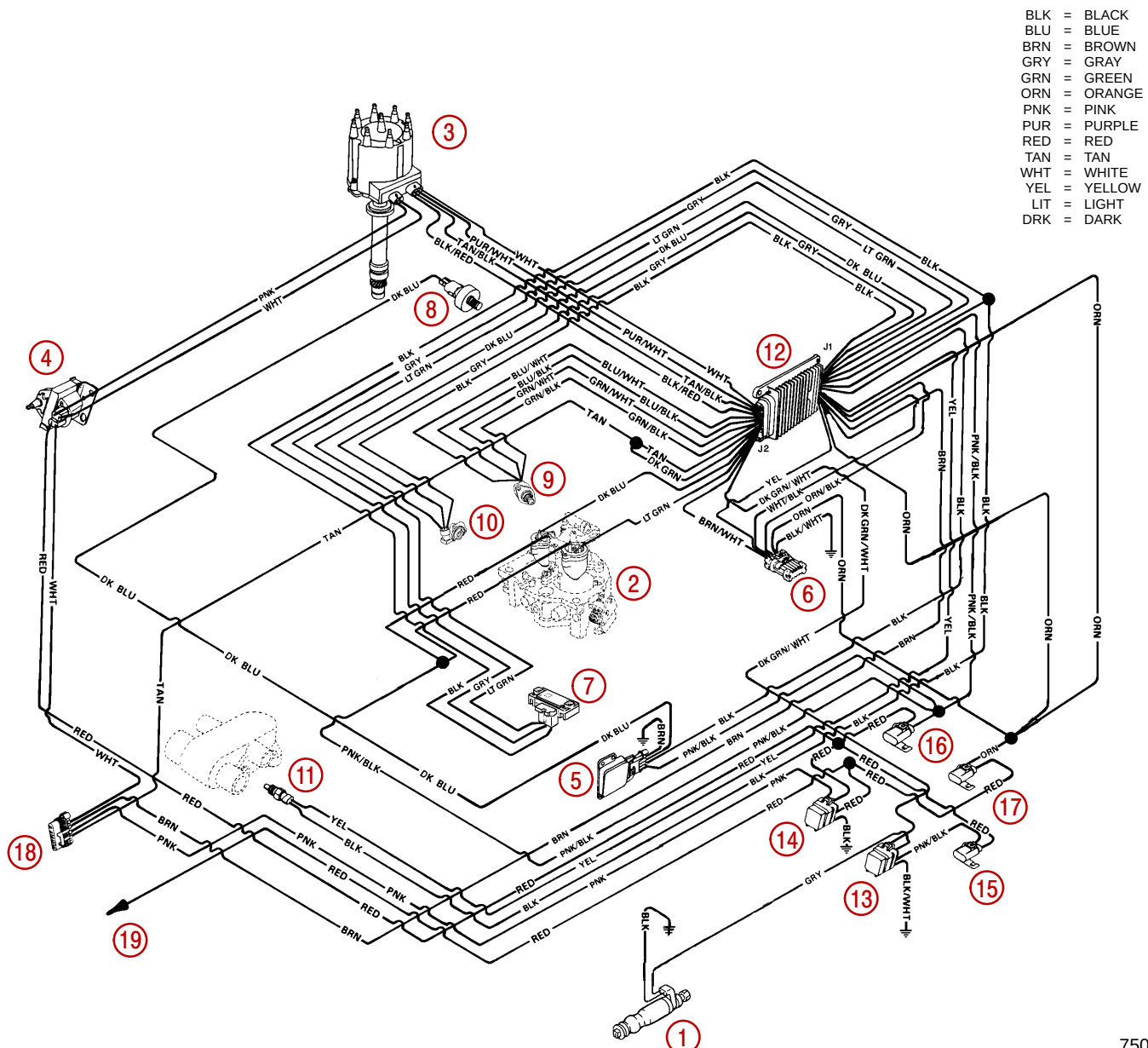
- a** - Positive Power Wire To EFI System Harness
- b** - Harness Connector To EFI System Harness
- c** - Auxiliary Tachometer Lead

Fuel and Ignition System Harness

MEFI 1 MCM 5.0L EFI and 5.7L EFI Alpha Engines

- 1** - Fuel Pump
- 2** - Throttle Body
- 3** - Distributor
- 4** - Coil
- 5** - Electronic Spark Control (KS) Module
- 6** - Data Link Connector (DLC)
- 7** - Manifold Absolute Pressure (MAP) Sensor
- 8** - Knock Sensor
- 9** - Idle Air Control (IAC)
- 10** - Throttle Position (TP) Sensor
- 11** - Engine Coolant Temperature (ECT) Sensor

- 12** - Electronic Control Module (ECM)
- 13** - Fuel Pump Relay
- 14** - Ignition/System Relay
- 15** - Fuse (15 Amp) Fuel Pump
- 16** - Fuse (15 Amp) ECM/DLC/Battery
- 17** - Fuse (10 Amp) ECM/Injector/Ignition/Knock Module
- 18** - Harness Connector To Starting/Charging Harness
- 19** - Positive (+) Power Wire To Engine Circuit Breaker



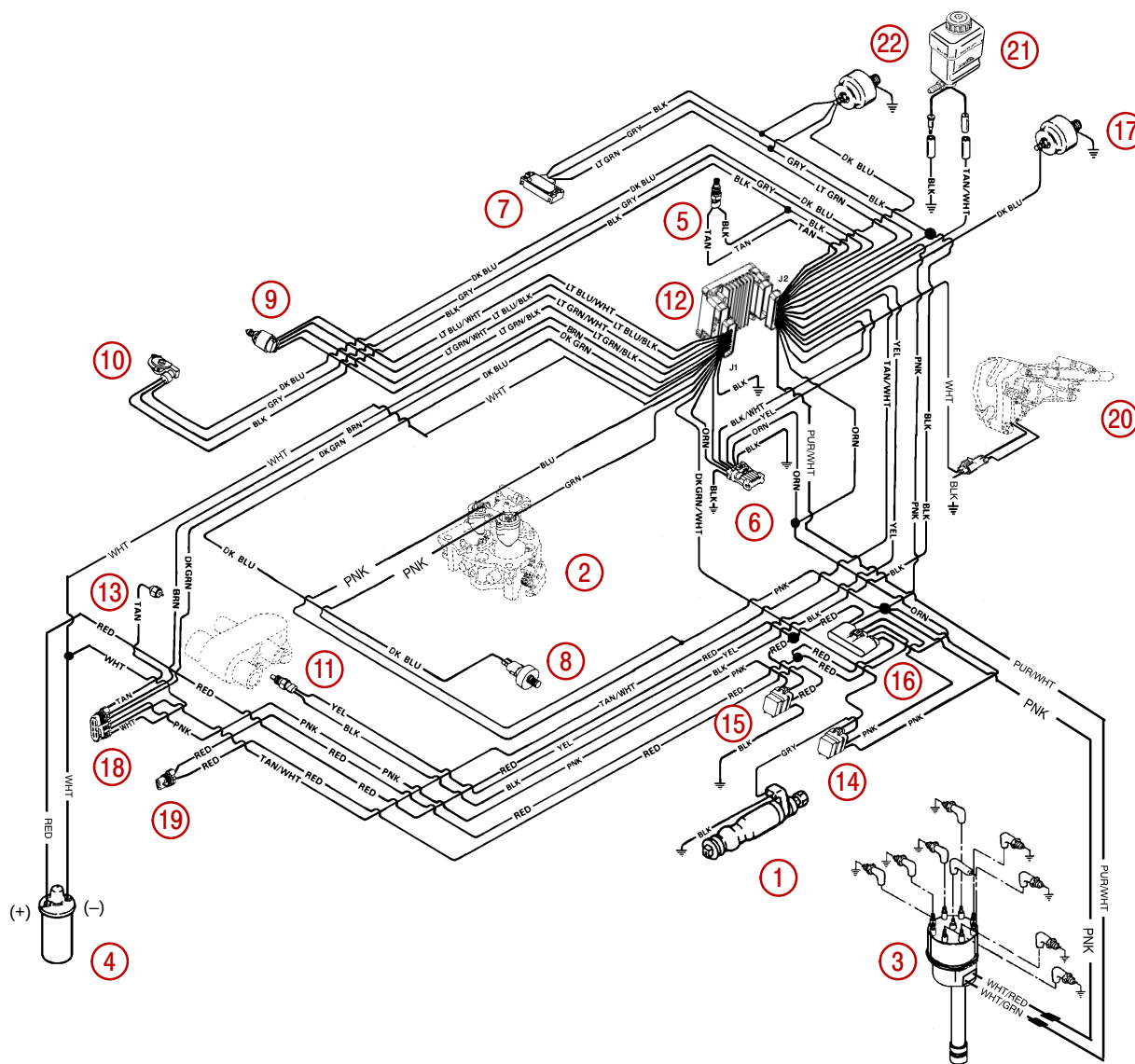
75001

MEFI 3 5.0L EFI and 5.7L EFI Engines

NOTE: All BLACK wires with a ground symbol are interconnected within the EFI system harness.

- | | |
|---|---|
| 1 - Fuel Pump | 12- Electronic Control Module (ECM) |
| 2 - Throttle Body | 13- Water Temperature Sender |
| 3 - Distributor | 14- Fuel Pump Relay |
| 4 - Coil | 15- Ignition/System Relay |
| 5 - Manifold Air Temperature (MAT) Sensor | 16- Fuses (15 Amp) Fuel Pump, (15 Amp) ECM/DLC/Battery, (10 Amp) ECM/Injector/Ignition/Knock Module |
| 6 - Data Link Connector (DLC) | 17- Oil Pressure Sensor |
| 7 - Manifold Absolute Pressure (MAP) Sensor | 18- Harness Connector To Starting/Charging Harness |
| 8 - Knock Sensor | 19- Positive (+) Power Wire To Engine Circuit Breaker |
| 9 - Idle Air Control (IAC) | 20- Shift Plate |
| 10- Throttle Position (TP) Sensor | 21- Gear Lube Monitor |
| 11- Engine Coolant Temperature (ECT) Sensor | 22- Fuel Pressure Switch |

NOTE: Component position and orientation shown is arranged for visual clarity and ease of circuit identification.



76063

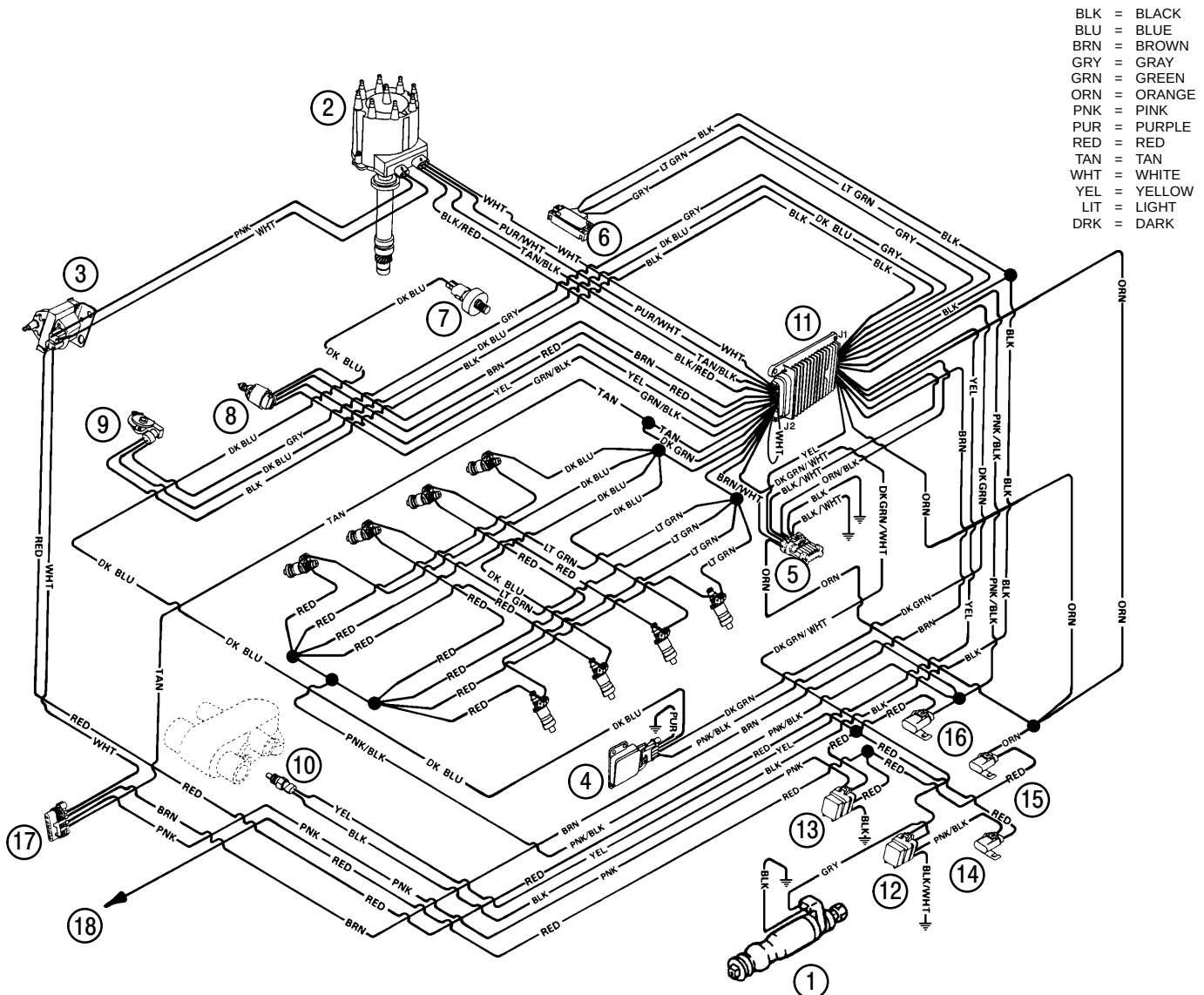
MEFI 1 and MEFI 2 MCM 350 Mag MPI Bravo Engines

NOTE: All BLACK wires with a ground symbol are interconnected within the EFI system harness.

NOTE: Component position and orientation shown is arranged for visual clarity and ease of circuit identification.

- 1 - Fuel Pump
- 2 - Distributor
- 3 - Coil
- 4 - Electronic Spark Control (KS) Module
- 5 - Data Link Connector (DLC)
- 6 - Manifold Absolute Pressure (MAP) Sensor
- 7 - Knock Sensor
- 8 - Idle Air Control (IAC)
- 9 - Throttle Position (TP) Sensor
- 10 - Engine Coolant Temperature (ECT) Sensor

- 11 - Electronic Control Module (ECM)
- 12 - Fuel Pump Relay
- 13 - Ignition/System Relay
- 14 - Fuse (15 Amp) Fuel Pump
- 15 - Fuse (15 Amp) ECM/DLC/Battery
- 16 - Fuse (10 Amp) ECM/Injector/Ignition/Knock Module
- 17 - Harness Connector To Starting/Charging Harness
- 18 - Positive (+) Power Wire To Engine Circuit Breaker



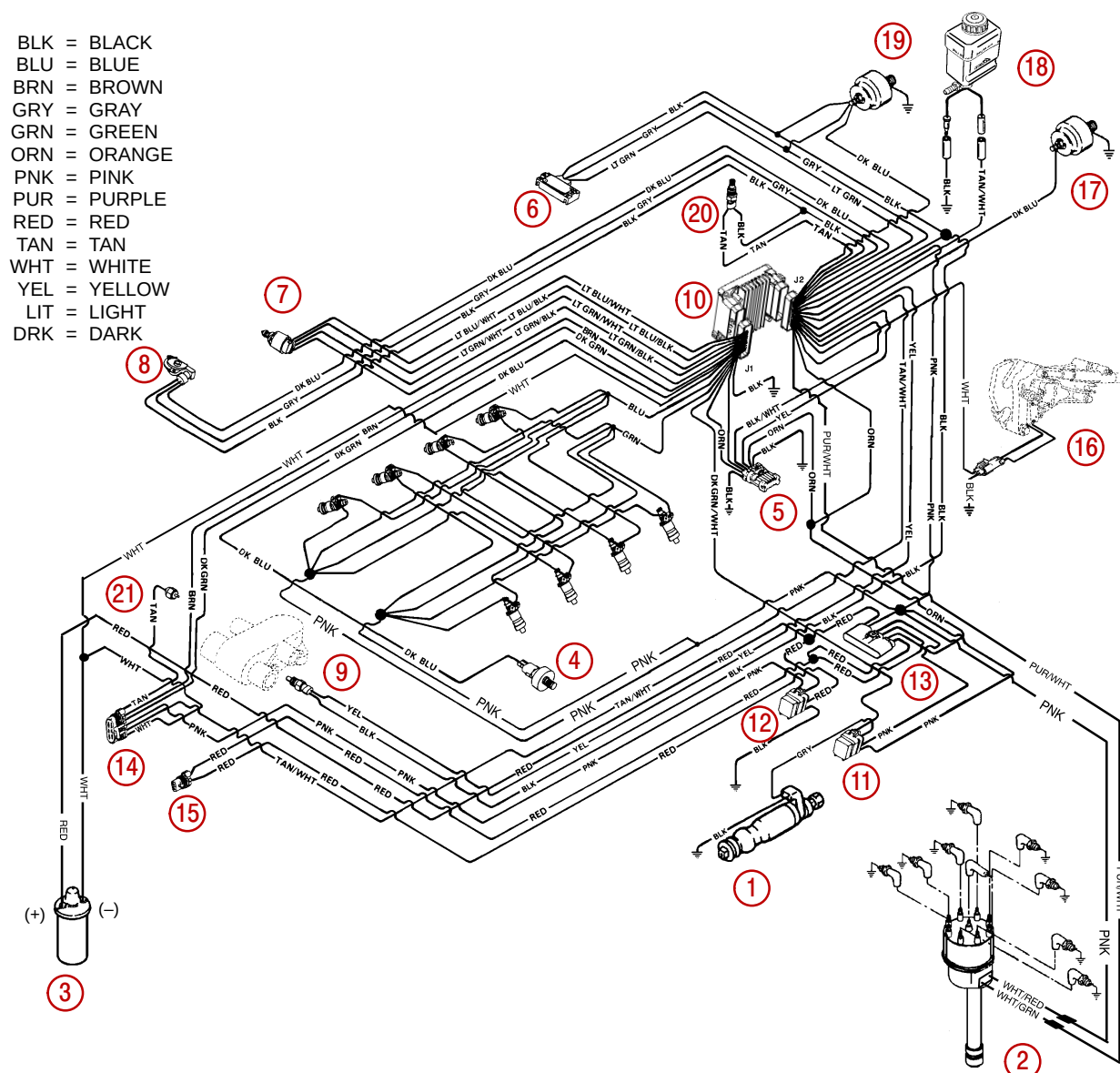
75799

MEFI 3 350 Magnum MPI and All Black Scorpion Engines

NOTE: All BLACK wires with a ground symbol are interconnected within the EFI system harness.

NOTE: Component position and orientation shown is arranged for visual clarity and ease of circuit identification.

- 1** - Fuel Pump
- 2** - Distributor
- 3** - Coil
- 4** - Knock Sensor (KS) Module
- 5** - Data Link Connector (DLC)
- 6** - Manifold Absolute Pressure (MAP) Sensor
- 7** - Idle Air Control (IAC)
- 8** - Throttle Position (TP) Sensor
- 9** - Engine Coolant Temperature (ECT) Sensor
- 10** - Electronic Control Module (ECM)
- 11** - Fuel Pump Relay
- 12** - Ignition/System Relay
- 13** - Fuse (15 Amp) Fuel Pump, Fuse (15 Amp) ECM/DLC/Battery, Fuse (10 Amp) ECM/Injector/Ignition/Knock Module
- 14** - Harness Connector To Starting/Charging Harness
- 15** - Positive (+) Power Wire To Engine Circuit Breaker
- 16** - Shift Plate (Not used on Ski models)
- 17** - Oil Pressure (Audio Warning System)
- 18** - Gear Lube Bottle (Not used on Ski models)
- 19** - Fuel Pressure Switch
- 20** - Water Temperature Sender



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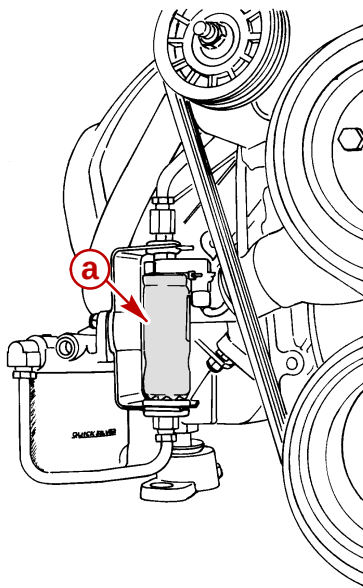
FUEL SYSTEM

Section 5A - Fuel Delivery System For Carbureted Engines

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Fuel Supply Connections	5A-3	Carbureted Models	5A-6

Identification



75523

a - Fuel Pump

Replacement Parts Warning

⚠ WARNING

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

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

Specifications

Description	Specification
Pump Pressure	3-7 PSI (21-48 kPa)

Torque Specifications

Fastener Location	lb-in.	lb-ft	Nm
Fuel Lines		18	24
Fuel Fittings Into Adapter		See Note	

NOTE: Refer To "Fuel Supply Connections" Warning following this chart.

Tools

Description	Part Number
Fuel Pressure Connector (Carburetor)	91-18078
Fuel Pressure Gauge	Obtain Locally

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Perfect Seal	92-34227--1
#592 Loctite Pipe Sealant with Teflon	Obtain Locally

Precautions

WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or flame in the area while changing fuel filters. Wipe up any spilled fuel immediately.

WARNING

Make sure that no fuel leaks exist before closing engine hatch.

CAUTION

DO NOT operate engine without cooling water being supplied to seawater pickup pump, or pump impeller will be damaged and subsequent overheating damage may result.

Fuel Supply Connections

WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak.

- Apply #592 Loctite Pipe Sealant with Teflon to threads of brass fitting or plug. DO NOT USE TEFLON TAPE.
- Thread brass fitting or plug into fuel pump or fuel filter base until finger tight.
- Tighten fitting or plug an additional 1-3/4 to 2-1/4 turns using a wrench. DO NOT OVERTIGHTEN.
- Install fuel line. To prevent overtightening, hold brass fitting with suitable wrench and tighten fuel line connectors securely.
- Check for fuel leaks.

Fuel Delivery System

Recommendations

WARNING

Boating standards (NMMA, ABYC, etc.) and Coast Guard regulations must be adhered to when installing fuel delivery system

GENERAL

The fuel tank is an integrated component of the boat. Refer to the special information on service and maintenance that you have received from the tank manufacturer.

NOTE: On Ski Boat Applications: *If during testing for a particular application, you experience fuel starvation in sharp high speed turns, baffles or a fuel sump may be needed in the tank to help correct this condition.*

Only a few points related to function and safety are listed here. Refer to boating standards (NMMA, ABYC, etc.) and Coast Guard regulations for complete guidelines:

- All connections should be on the upper side of the tank.
- The drain plug at the lowest point on the tank serves to permit the removal of water and sediment.
- The filler pipe outer diameter should be at least 2 in. (51 mm).
- The tank breather pipe must have an inner diameter of at least 1/2 in. (13mm) and must be fitted with a swan neck to prevent water from entering the tank.

It is recommended that the exact route and length of the fuel lines be established at the first installation of the engine to prevent problems later in connecting them to the engine.

All fuel lines must be well secured. The holes where the lines run through the bulkheads should be carefully rounded off or protected with rubber grommets. This prevents damage to the lines from abrasion.

The following, but not limited to the following, additional fuel connection related points, applying to all engines unless otherwise stated, must be considered [Refer to boating standards (NMMA, ABYC, etc.) and Coast Guard regulations for complete guidelines]:

1. Fuel tank should be mounted below carburetor level (if possible) or gravity feed may cause carburetor fuel inlet needle to unseat and flooding may result.
2. Fuel pickup should be at least 1 in. (25mm) from the bottom of fuel tank to prevent picking up impurities.
3. Fuel lines used must be Coast Guard approved (USCG Type A1).

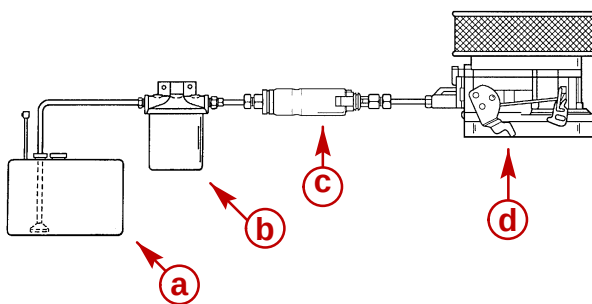
Diameter of fittings and lines must not be smaller than 5/16 in. (8 mm) inside diameter (I.D.)

4. **On Multi-Engine Installations:** It is best to use a fuel pickup and supply line for **each** engine. If a single pickup and line is used, line must not be smaller than 1/2 in. (13mm) I.D.

5. Larger diameter (than previously specified) lines and fittings must be used on installations requiring long lines or numerous fittings.
6. Fuel line(s) should be installed free of stress and firmly secured to prevent vibration and/or chafing.
7. Sharp bends in fuel lines should be avoided.
8. A flexible fuel line must be used to connect fuel supply line to fuel inlet fitting on engine to absorb deflection when engine is running.

Fuel System Components

Carburetor System



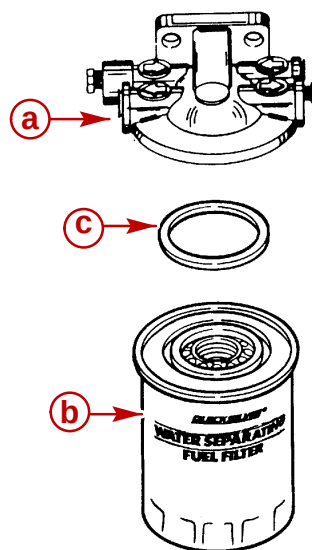
71882

- a** - Fuel Tank
- b** - Water Separating Fuel Filter
- c** - Fuel Pump
- d** - Carburetor

Water Separating Fuel Filter

The water separating fuel filter is standard on all engines.

The fuel filter consists of the fuel filter base and filter element.



72678

- a** - Fuel Filter Mounting Bracket
- b** - Filter Element
- c** - Sealing Ring

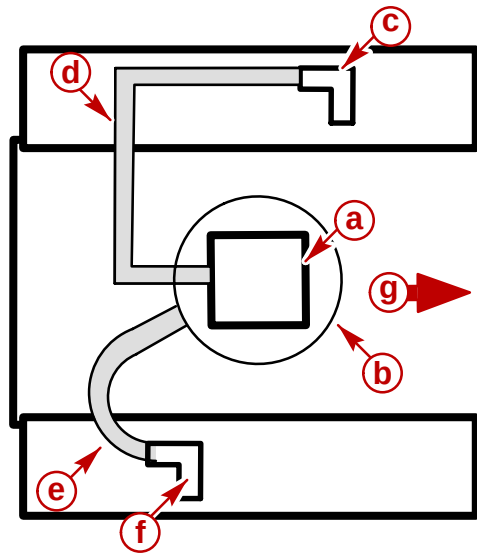
Replacement

NOTICE
Refer to "Precautions" in this section, BEFORE proceeding.

1. Disconnect battery cables from battery.
2. Remove fuel filter from base. A filter wrench may be needed to loosen element.
3. Lubricate sealing ring of new filter with SAE engine oil.
4. Install new filter, tightening securely by hand.
5. Reconnect battery cables.
6. Make sure water is supplied to cooling system.
7. Start engine.
8. Check for fuel leaks.

Vent Hose Routing

Carbureted Models



75826

- a** - Carburetor
- b** - Flame Arrestor
- c** - PCV Valve
- d** - Vent Hose - PCV Valve to Back Of Carburetor
- e** - Vent Hose - Valve Cover Fitting To Flame Arrestor
- f** - Valve Cover Fitting
- g** - Front of Engine

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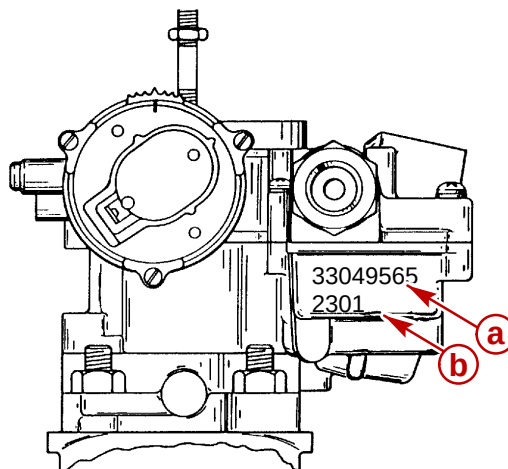
FUEL SYSTEM

Section 5B - Mercarb® 2 Barrel Carburetor

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Identification



72680

2 Barrel MerCarb Carburetor Part Number Location

a - Part Number

b - Date Code

Date Code Explanation: Example 2301

First Figure is Year:

2 = 1992, 3 = 1993, etc.

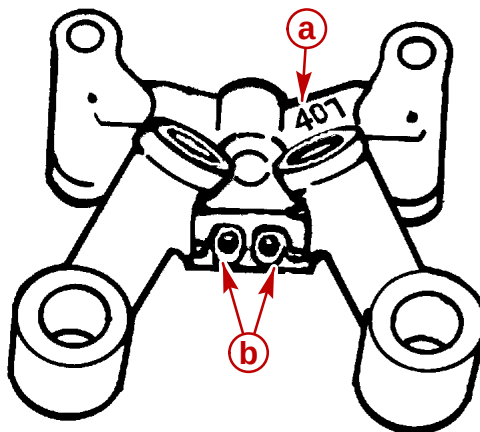
Second Figure is Month:

2 = February, 3 = March, etc.

X = October, Y = November, Z = December

Third and Fourth Figures are Day of Month:

01 = First day, 02 = Second day, etc.



72779

Venturi Cluster Identification

a - Identification Number (See Specifications)

b - Accelerator Pump Discharge Holes

Replacement Parts Warning

WARNING

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

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

General Precautions

WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

WARNING

Be careful when cleaning flame arrestor and crankcase ventilation hose; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or flame in the area while changing fuel filter. Wipe up any spilled fuel immediately.

WARNING

Make sure no fuel leaks exist, before closing engine hatch.

CAUTION

DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

Fuel Delivery System

Recommendations

WARNING

Boating standards (NMMA, ABYC, etc.) and Coast Guard regulations must be adhered to when installing fuel delivery system.

The Fuel Tank is an integrated component of the boat. Refer to the special information on service and maintenance, which you have received from the tank or boat manufacturer.

NOTE: On Ski Boat Applications: *If during testing for a particular application, you experience fuel starvation in sharp high speed turns, baffles or a fuel sump may be needed in the tank to help correct this condition.*

All fuel lines must be well secured. The holes where the lines run through the bulkheads should be carefully rounded off or protected with rubber grommets. This prevents damage to the lines from abrasion.

The following, but not limited to the following, additional fuel connection related points, *applying to all engines unless otherwise stated*, must be considered. Refer to boating standards (NMMA, ABYC, etc.) and Coast Guard regulations for complete guidelines.

1. Fuel pickup should be at least 1 in. (25mm) from the bottom of fuel tank to prevent picking up impurities.
2. Fuel lines used must be Coast Guard approved (USCG Type A1).
3. **On Multi-Engine Gasoline Installations:** It is best to use a fuel pickup and supply line for **each** engine. If a single pickup and line is used, line must not be smaller than 1/2 in. (13mm) I.D.
4. Larger diameter (than previously specified) lines and fittings must be used on installations requiring long lines or numerous fittings.
5. Fuel line(s) should be installed free of stress and firmly secured to prevent vibration and/or chafing.
6. Sharp bends in fuel lines should be avoided.
7. A flexible fuel line must be used to connect fuel supply line to fuel inlet fitting on engine to absorb deflection when engine is running.

Torque Specifications

Description	lb-in.	lb-ft	Nm
Carburetor To Manifold		20	27
Fuel Line to Carburetor		18	24
Fuel Inlet Filter Nut		18	24

Tools

Description	Part Number
Tachometer	79-17391A1
Universal Carburetor Gauge	91-36392
Float Gram Scale	Obtain Locally

Specifications

Engine Model	5.0L	5.7L
Carburetor Type	MerCarb 43mm	MerCarb 43mm
Carburetor Number	3310-861448	3310-861245
Float Level	11/32 in. (9 mm) See Notes	
Float Drop	15/16 in. (24 mm) See Notes	
Pump Rod (Location)	Middle Hole Of Pump Arm	
Choke Setting	2 Marks Right Of Index Mark (Lean)	
Choke Unloader	5/64 in. [.080 mm] See Notes	
Idle Mixture Screw	1-1/2 Turns Out	
Float Weight	9 Grams Maximum	
Main Jet Size	1.65 mm	
Power Valve Size	0.90 mm	
Venturi Cluster I.D. Number	476	475
Accelerator Pump Discharge Hole Size	0.035 (0.889)	0.043 (1.09)

NOTE: Measurement taken from gasket.

NOTE: All measurements are +/- 1/64 in. (0.4 mm)

High Altitude Re-Jetting

Engine flooding problems, at idle rpm, are generally related to the altitude (above sea level) at which they are operated. If engine is running too rich at higher elevation, order a smaller jet from the chart. A jet stamped "165" is a 1.65 mm jet.

Model	Carburetor Part Number	5000 ft (1525 m) and Below	5000-9000 ft (1525-2745 m)	9000 ft (2745 m) and Above
5.0L	1389-9563A_	1.70 mm	1.60 mm	1.55 mm
	3310-806081A_			
	3310-861080A_			
	1389-9670A_	1.85 mm	1.75 mm	1.65 mm
	3310-806082A	1.65 mm	1.50 mm	1.45 mm
	3310-861448A			
5.7L	3310-807312A	1.65 mm	1.50 mm	1.45 mm
	3310-861245A_	0.90 mm	0.90 mm	0.74 mm

JET SIZES

Jet Size	Quicksilver Part Number
1.30	3302-811849
1.35	3302-811850
1.40	3302-811851
1.45	3302-9050
1.50	3302-811852
1.55	3302-811853
1.60	3302-810923
1.65	3302-9058
1.70	3302-9055
1.75	3302-881854
1.80	3302-811855
1.85	3302-811856
1.90	3302-811857

POWER VALVES

Jet Size	Quicksilver Part Number
0.74	3302-9435
0.90	3302-9059

Important Service Information

8 Point Carburetor Check List

To ensure that the carburetor is the cause of the problem, make the following checks BEFORE ordering and installing a new carburetor. If questions 1, 2, 3, 5, 6 and 7 are YES and 8 is NO, the carburetor may not be the problem.

- | | | |
|--|---|-------------|
| 1. Does the choke close completely before starting? | Y | N |
| 2. Does the choke open completely during engine warm-up? | Y | N |
| 3. Is idle mixture screw set correctly?
(Engines with Thunderbolt V ignition must have module locked in Base Timing Mode). | Y | N |
| 4. What is the idle mixture screw setting? | | _____ Turn. |
| 5. Is the engine idle speed rpm correct? | Y | N |
| 6. Is venturi cluster discharging fuel by 2000 rpm? | Y | N |
| 7. Is a good stream of fuel being discharged by both discharge holes in venturi cluster when throttle lever is moved repeatedly while the engine is off. | Y | N |
| 8. Does the engine flood at idle? | Y | N |

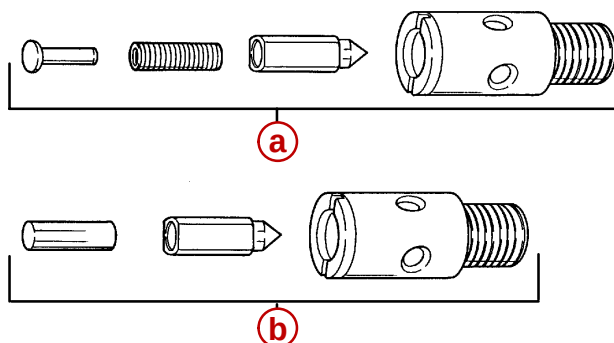
Flooding At Idle RPM

If your engine floods at idle rpm, check the following:

1. Problem in ignition system causing engine to run rough.
2. Idle mixture screw adjusted incorrectly.
3. Bad needle and seat.
4. Incorrect float level or drop.

Needle / Seat Change

MerCarbs are factory equipped with a spring loaded needle. If the preceding steps did not correct your problem, change to the solid type needle.



72290

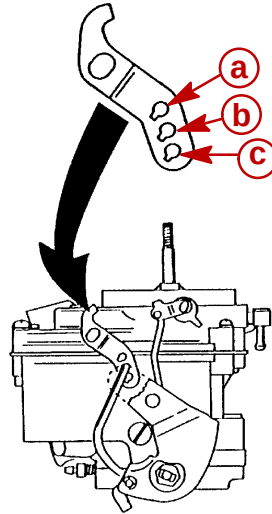
Needle and Seat Assemblies

a - Spring Loaded Type Needle (Kit 3302-9029)

b - Solid Type Needle (Kit 3302-9407)

Adjustable Accelerator Pump Lever

This new 3 hole lever allows you to change the amount of fuel delivered to the engine by the accelerator pump. The hole closest to the lever's shaft will give the same amount of fuel as the single hole lever did. The center hole gives approximately 0.5 cc less fuel and the hole furthest away will give about 1.0 cc less fuel.



73131

- a** - Full Accelerator Pump Stroke
- b** - 0.5 cc Less Fuel per Stroke
- c** - 1.0 cc Less Fuel per Stroke

When installing the 3-hole lever, remove any metal ball that may have been placed in the accelerator pump well to limit pump travel. Also, ensure that the duration spring on the accelerator pump is stock and hasn't had coils removed. Ensure that the correct venturi cluster is being used.

Description

This MerCarb carburetor is a two bore carburetor that has a separate fuel feed for each venturi. This model is equipped with an electric choke. A removable venturi cluster (secured to float bowl assembly) has the calibrated main well tubes and pump jets built into it. The venturi cluster is serviced as a unit. The serviceable main metering jets are bleeds to properly meter the correct fuel / air mixture to the engine.

Maintenance

Flame Arrestor with Carburetor Cover

NOTICE

Refer to "Precautions" in this section, BEFORE proceeding.
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REMOVAL

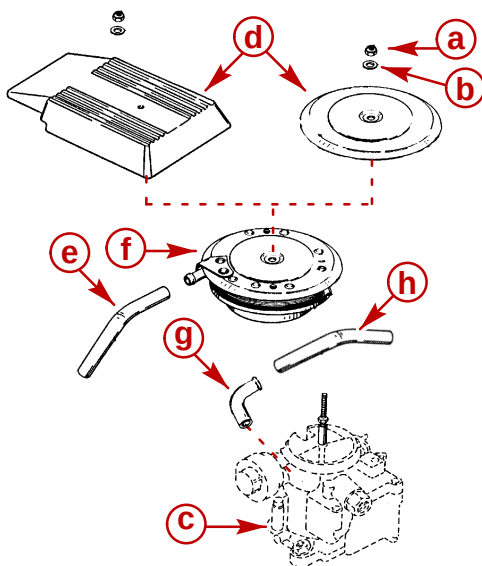
1. Remove nut.
2. Remove sealing washer.
3. Remove carburetor cover.
4. Remove crankcase ventilation hose from flame arrestor and starboard rocker arm cover.
5. Remove Positive Crankcase Vent (PCV) hose to carburetor tube and port rocker arm PCV Valve connection.
6. Remove flame arrestor.

CLEANING AND INSPECTION

1. Clean flame arrestor in solvent and blow dry with compressed air.
2. Clean crankcase ventilation and PCV hoses.
3. Inspect hoses for cracks or deterioration, and replace if necessary.

INSTALLATION

1. Install flame arrestor.
2. Install crankcase ventilation hose to flame arrestor and starboard rocker arm cover.
3. Install positive crankcase vent (PCV) hose from port rocker arm PCV valve connection to carburetor tube.
4. Install carburetor cover.
5. Install sealing washer.
6. Install nut. Tighten securely.



75844

- a** - Nut
- b** - Sealing Washer
- c** - Carburetor
- d** - Cover (Depending On Model)
- e** - Crankcase Ventilation Hose
- f** - Flame Arrestor
- g** - Positive Crankcase Vent (PCV) Hose (On Carburetor)
- h** - Positive Crankcase Vent (PCV) Hose

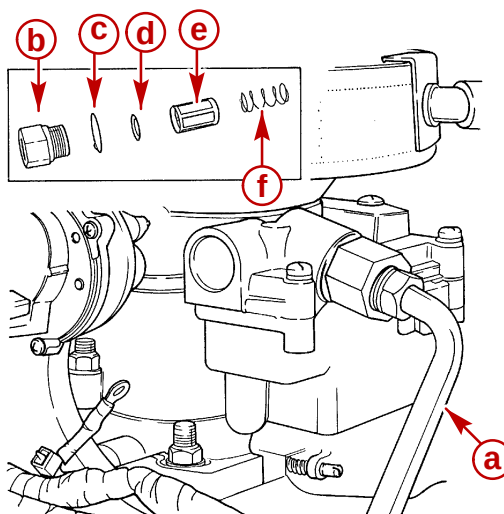
Fuel Inlet Filter

NOTICE

Refer to "Precautions" in this section, BEFORE proceeding.

REMOVAL

1. Remove fuel line from fuel inlet filter nut.
2. Remove fuel inlet filter nut and small gasket.
3. Remove large gasket.
4. Remove filter.
5. Remove spring.
6. Remove small gasket from inside filter nut.



72406

- a** - Fuel Line
- b** - Fuel Inlet Filter Nut
- c** - Gasket (Larger)
- d** - Gasket (Small)
- e** - Filter
- f** - Spring

CLEANING

1. Clean filter nut and spring in solvent and dry with compressed air.

INSTALLATION

1. Install spring in carburetor body.
2. Install filter, open end to inlet filter nut.
3. Install small gasket inside filter nut.
4. Install large gasket over filter nut threads.
5. Install fuel inlet filter nut. Torque nut to 18 lb-ft (24 Nm).

IMPORTANT: Hold filter nut with wrench while torquing fuel line.

6. Install fuel line. Torque to 18 lb-ft (24 Nm).

Choke Inspection

The choke does not require any periodic maintenance. However, if a choke malfunction is suspected, the following should be done:

1. With engine turned OFF, remove flame arrestor.
2. Open and close choke several times to check for binding, loose or disconnected linkages or other signs of damage.
3. If choke or linkage binds or sticks, clean with carburetor choke cleaner.

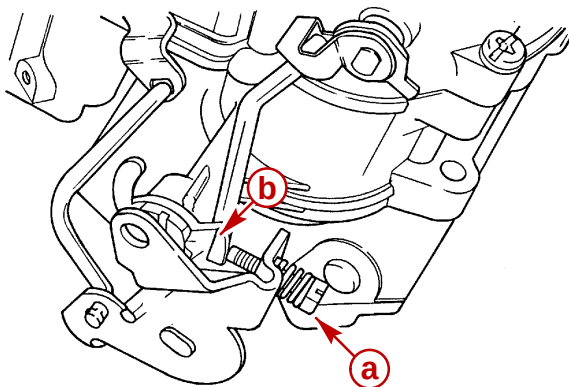
IMPORTANT: Choke valve and shaft and lever assembly is not serviceable. If valve and/or shaft and lever assembly is worn or damaged, air horn assembly must be replaced.

Adjustments

NOTICE
Refer to "Precautions" in this section, BEFORE proceeding.

Pump Rod

1. Loosen idle speed screw until it no longer contacts idle cam.

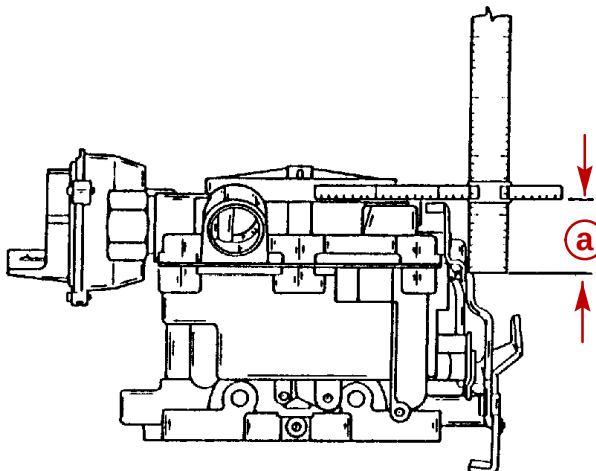


72284

a - Idle Speed Screw

b - Idle Cam

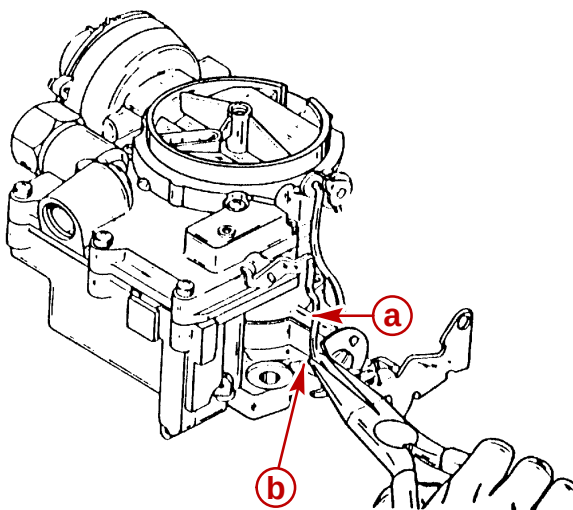
2. With throttle valves completely closed, measure from flame arrestor mounting surface to top of pump rod.



72682

a - See Specifications

3. Carefully bend pump rod (where shown) to obtain specified dimension.



72683

a - Pump Rod

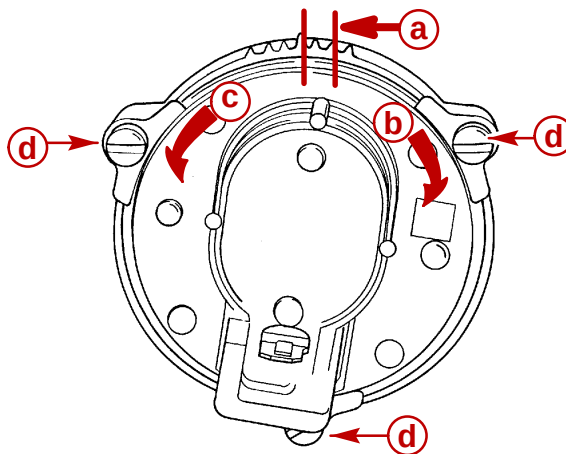
b - Bend Here

Choke Setting

Normal choke setting: mark on cover is set 2 index marks clockwise from larger, center index mark.

If choke adjustment is necessary:

1. Loosen choke cover retaining screws.
2. Adjust as shown.
3. Tighten screws securely.

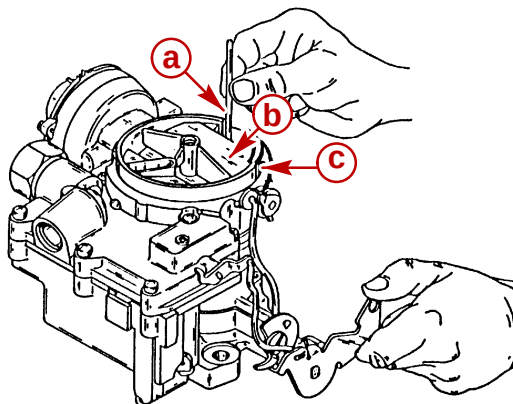


72403

- a** - Scribed Mark
- b** - More Choke
- c** - Less Choke
- d** - 3 Retaining Screws

Choke Unloader

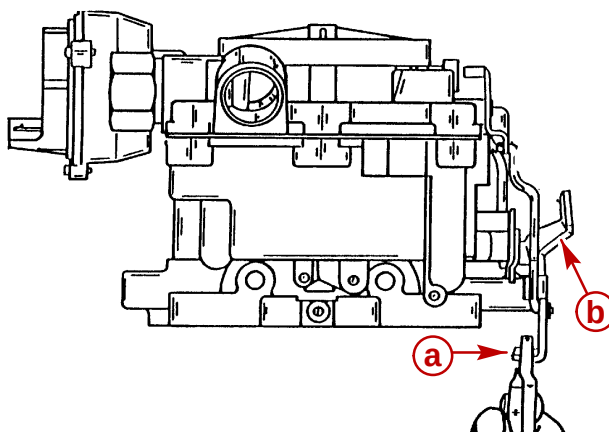
1. Hold throttle valves completely open.
2. Gently press down on choke plate.
3. Using an .080 in. [5/64 in.] (0.2 mm) drill rod, slide rod between upper edge of choke plate and air horn assembly. Rod should just slide through.



72684

- a** - .080 in. (0.2mm) Drill Rod
- b** - Choke Plate
- c** - Air Horn

4. Bend tang on throttle lever, if necessary, to obtain specified dimension.



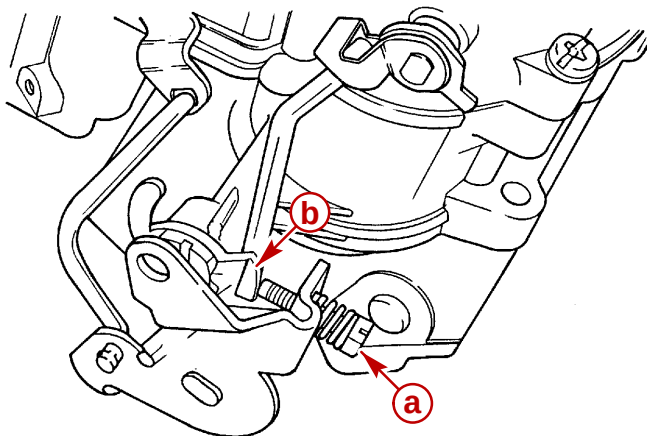
72685

- a** - Tang
b - Throttle Lever

Initial Idle Speed and Mixture

IMPORTANT: The following adjustments will provide a sufficient idle speed and mixture for starting engine. Final adjustments must be made with engine running.

1. Loosen idle speed screw until it no longer contacts idle cam. Turn idle speed screw in until it just contacts idle cam, then turn screw in an additional two turns.

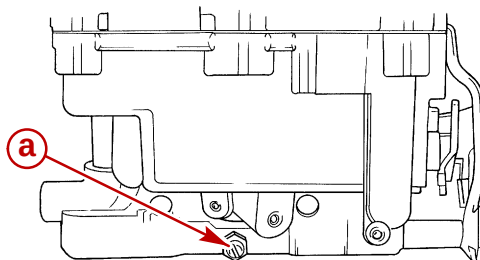


72284

- a** - Idle Speed Screw
b - Idle Cam

IMPORTANT: DO NOT turn idle mixture needle tightly against seat (in the following step), as damage to seat and/or needle may result.

2. Turn idle mixture needle in until lightly seated, then loosen needle 1-1/4 turns.



72281

- a** - Idle Mixture Needle

Final Idle Speed and Mixture

The ignition module must be locked into the timing mode to adjust idle speed and mixture. Refer to SECTION 4B - "Timing - Thunderbolt V Models."

EMISSIONS CARBURETOR

Sealed Carburetor Mixture Screw

The carburetor on this engine has a seal on the carburetor mixture screw. This seal prevents adjustment of the fuel mixture setting.

CAUTION

Do not remove mixture screw seal and/or attempt to adjust fuel mixture setting. Tampering with the mixture setting on this engine could affect the exhaust emissions level, thus voiding the emissions certification. This seal should only be removed by an authorized dealer or emissions testing agency.

Replacing Carburetor

NOTICE

Refer to "Precautions" in this section, BEFORE proceeding.

IMPORTANT: First follow the steps in "8 Point Carburetor Check List" to decide if the problem is with the carburetor.

1. Remove the battery cables.
2. Remove the carburetor.
3. Clean gasket surfaces.
4. Use a new gasket and install new carburetor.
5. Hold the carburetor filter nut with a wrench and tighten fuel line fitting securely.
6. Reconnect or install choke wires, vent hoses and flame arrestor.
7. Adjust carburetor and throttle cable.

Repair

NOTICE

Refer to "Precautions" in this section, BEFORE proceeding.
--

Removal

IMPORTANT: Carburetor problems are, in many cases, caused by the presence of dirt, water or other foreign matter in carburetor. To aid in diagnosis, carefully remove carburetor from engine without draining fuel from bowl. Contents of fuel bowl may then be inspected for contamination as carburetor is disassembled.

1. Remove battery cables.
2. Remove crankcase ventilation and PCV hose from flame arrestor.
3. Remove flame arrestor.

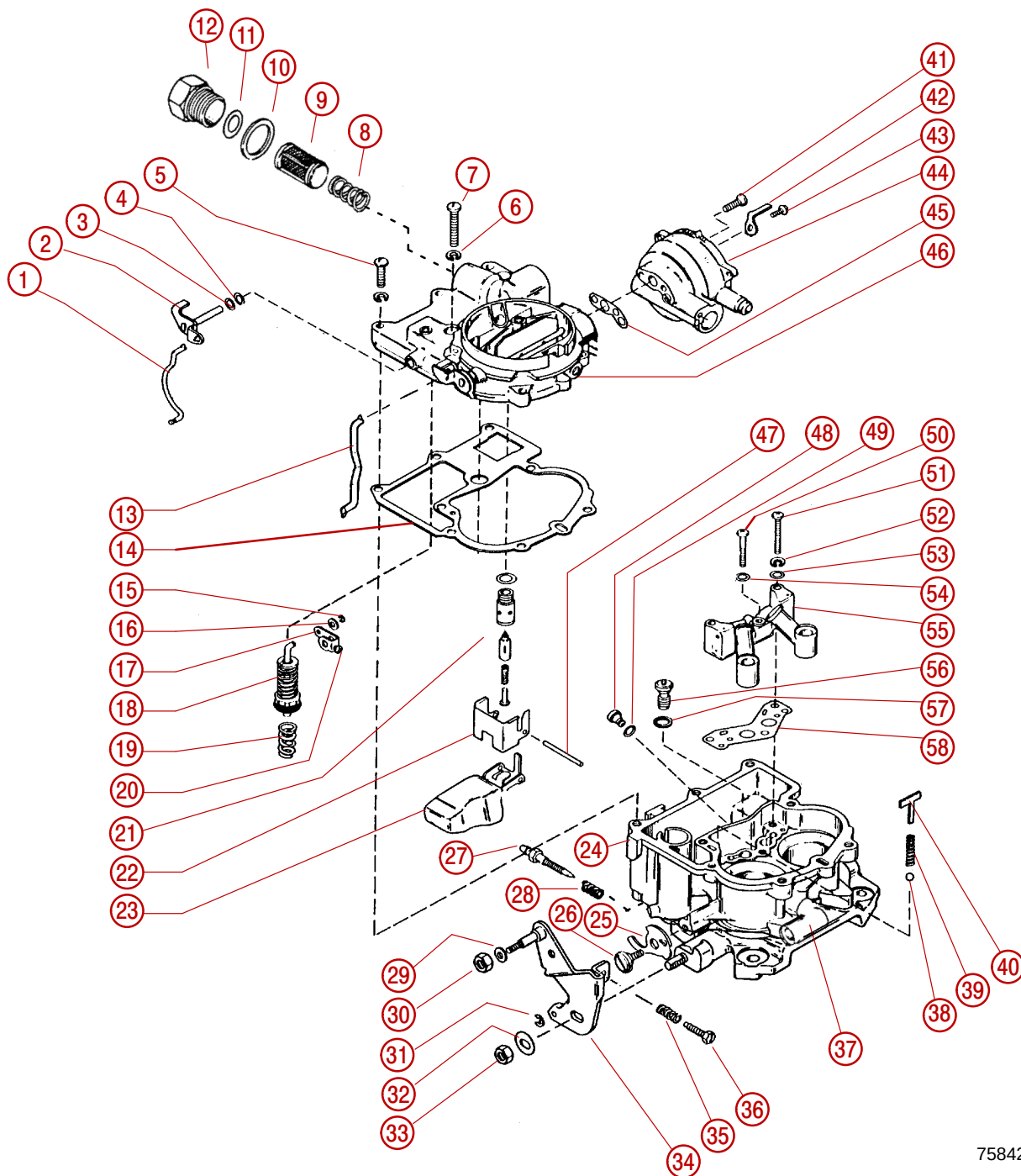
IMPORTANT: Place a clean cloth in bores of carburetor to prevent dirt and foreign material from falling into bores.

4. Turn fuel supply off at fuel tank.
5. Disconnect throttle cable from carburetor.
6. Remove fuel line from fuel inlet nut, using wrench to stabilize fuel inlet nut.
7. Disconnect electric choke.
8. Remove carburetor attaching nuts and washers and remove carburetor.

IMPORTANT: Place a clean cloth over intake manifold opening to prevent dirt or foreign material from entering manifold.

9. Remove and discard gaskets.

Exploded View



75842

Exploded View Parts List

- | | |
|--|---|
| 1 - Rod - Accelerator Pump | 29 - Washer |
| 2 - Accelerator Pump Shaft and Lever Assembly | 30 - Nut |
| 3 - Washer (Outer) | 31 - Clip-Pump Rod |
| 4 - Washer (Inner) | 32 - Washer-Locking |
| 5 - Screw | 33 - Nut |
| 6 - Washer | 34 - Throttle Lever |
| 7 - Screw | 35 - Spring |
| 8 - Spring | 36 - Screw - Idle Speed Adjustment |
| 9 - Filter | 37 - PCV Tube Connection Fitting |
| 10 - Gasket | 38 - Check Ball |
| 11 - Gasket | 39 - Spring |
| 12 - Nut-Fuel Inlet | 40 - Retainer |
| 13 - Choke Rod | 41 - Screw |
| 14 - Gasket | 42 - Lever Assembly |
| 15 - Clip - Retainer | 43 - Screw |
| 16 - Washer | 44 - Choke/Housing |
| 17 - Pump Shaft and Lever Assembly | 45 - Gasket |
| 18 - Accelerator Pump Assembly | 46 - Air Horn |
| 19 - Spring | 47 - Pin |
| 20 - Screw | 48 - Screw |
| 21 - Inlet Needle and Seat (Spring Loaded) | 49 - Gasket |
| 22 - Baffle Plate | 50 - Screw |
| 23 - Float | 51 - Screw |
| 24 - Carburetor Body | 52 - Lock Washer |
| 25 - Cam-Idle | 53 - Flat Washer |
| 26 - Screw | 54 - Gasket |
| 27 - Idle Mixture Adjusting Needle | 55 - Venturi Cluster |
| 28 - Spring | 56 - Power Valve Assembly |
| | 57 - Gasket |
| | 58 - Gasket |

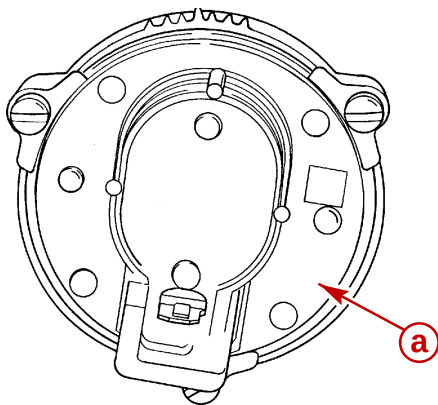
Disassembly

IMPORTANT: Before performing any service on carburetor, it is essential that carburetor be placed in a holding fixture to prevent possible damage to throttle valves.

The following is a step-by-step procedure for completely overhauling the carburetor removed from engine. Complete overhaul is not always necessary. You should perform only those steps required to repair the carburetor malfunction. Read the instructions carefully to prevent unnecessary steps.

CHOKE HOUSING

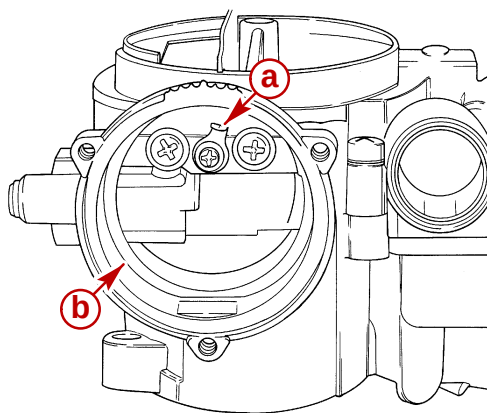
1. Remove choke cover.



72403

a - Choke Cover

2. Remove choke lever. Remove choke housing.



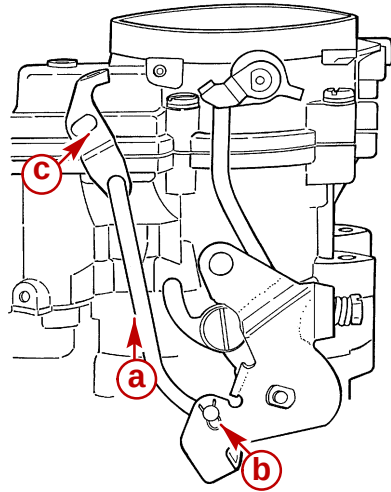
72401

a - Choke Lever

b - Choke Housing

AIR HORN

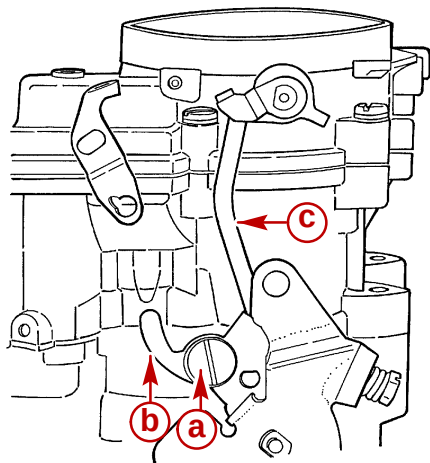
1. Remove fuel inlet filter nut, washers, spring, and filter, as outlined previously.
2. Remove accelerator pump rod retaining clip.
3. Pivot rod (as required) until retaining ear on rod and slot in pump shaft and lever assembly align, allowing rod to be pulled out.



72283

- a** - Accelerator Pump Rod
- b** - Retainer Clip
- c** - Pump Shaft and Lever Assembly

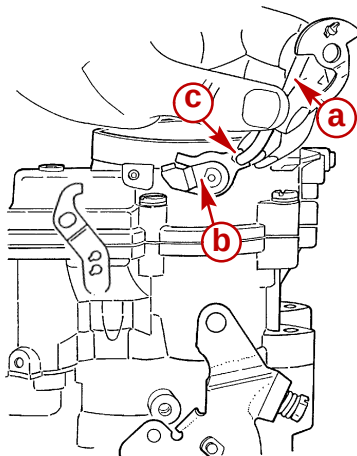
4. Remove idle cam screw.



72282

- a** - Idle Cam Screw
- b** - Idle Cam
- c** - Choke Rod

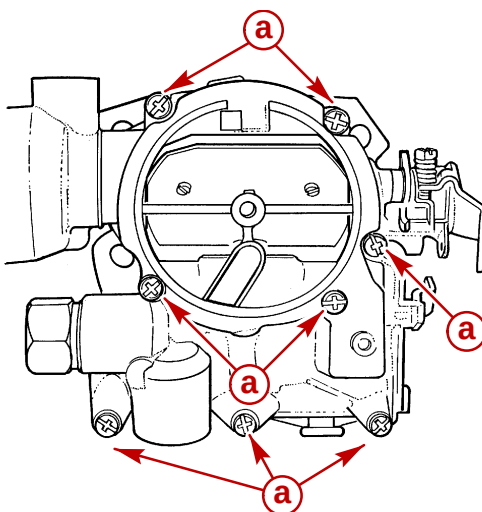
5. Remove choke rod by pivoting rod (as required) until retaining ear on rod and slot in choke lever align, allowing rod to be pulled out.



72286

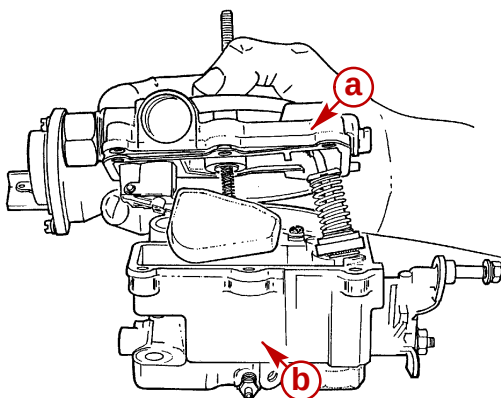
- a** - Choke Rod
- b** - Choke Lever
- c** - Slot

6. Remove air horn attaching screws.
7. Carefully lift air horn from float bowl assembly.



72280

- a** - Air Horn Attaching Screws

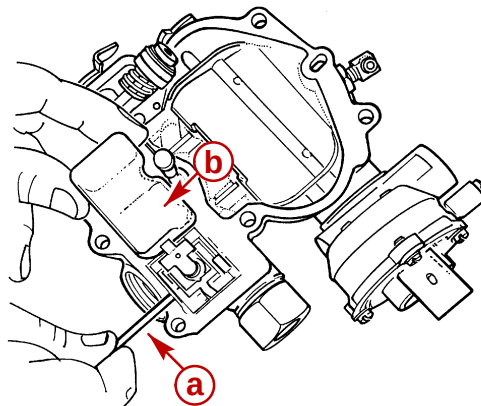


72400

- a** - Air Horn Assembly
- b** - Float Bowl Assembly

8. Invert air horn and carefully lay on bench.

9. Remove float hinge pin and lift float assembly from air horn.

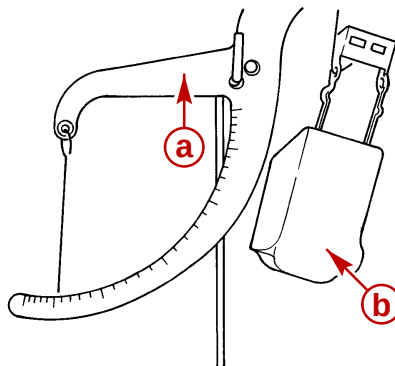


72288

a - Float Hinge Pin

b - Float Assembly

10. Check float weight as shown.

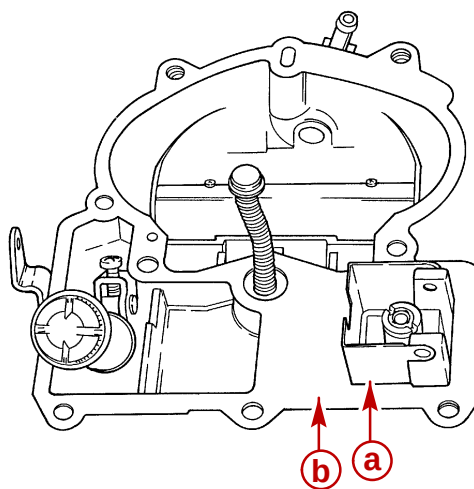


72122

a - Grams Scale

b - Float

11. Remove air horn gasket and baffle.

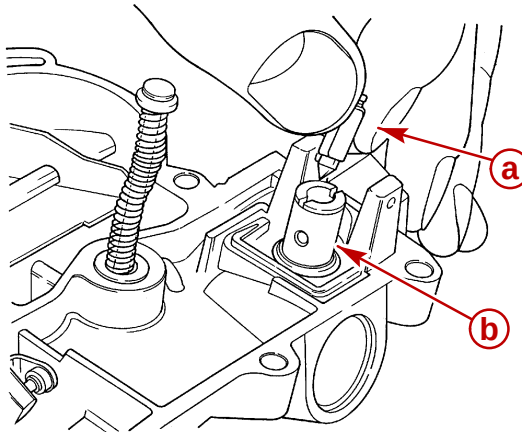


72399

a - Baffle

b - Air Horn Gasket

12. Remove needle assembly.

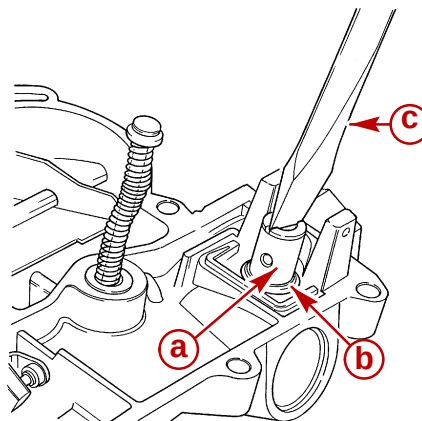


72287

a - Needle Assembly

b - Needle Seat

13. Remove needle seat.

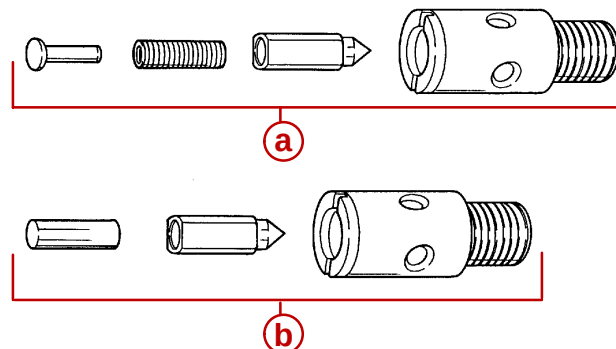


72289

a - Needle Seat

b - Gasket

c - Screwdriver



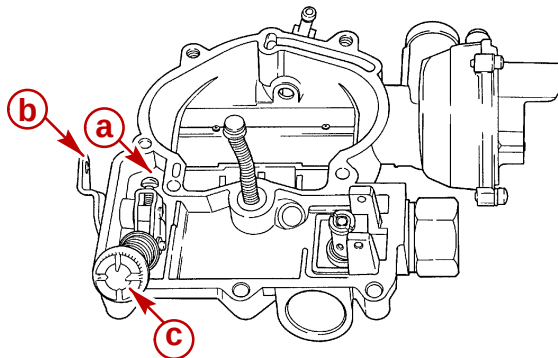
72290

Needle and Seat Assemblies

a - Spring Loaded Type Needle (Kit 3302-9029)

b - Solid Type Needle (Kit 3302-9407)

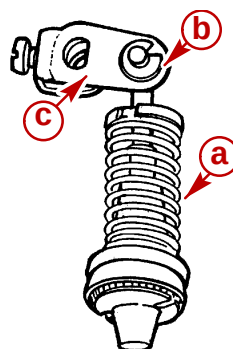
14. Loosen accelerator pump screw.
15. Slide pump shaft and lever assembly (and washer) out of air horn.
16. Remove accelerator pump assembly.



72398

- a** - Set Screw
- b** - Lever Assembly
- c** - Pump Assembly

17. Remove retainer clip and washer from pump shaft and lever assembly, then remove accelerator pump assembly.

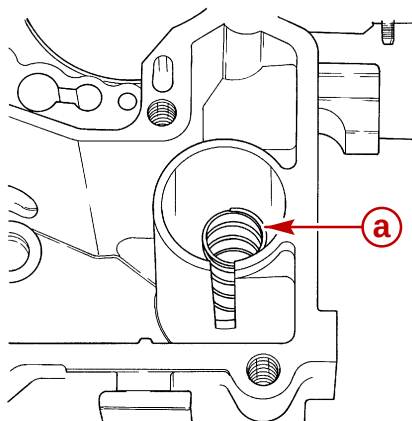


72409

- a** - Pump Assembly
- b** - Retainer Clip
- c** - Lever Assembly

FLOAT BOWL

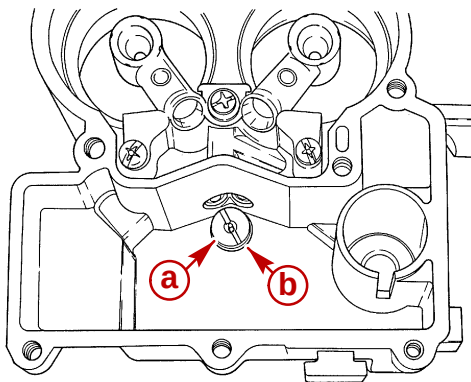
1. Remove accelerator pump return spring from pump well.



72402

- a** - Accelerator Pump Spring

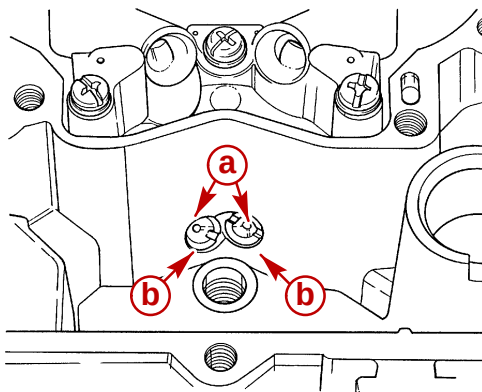
2. Remove power valve assembly and gasket.



72404

- a** - Power Valve Assembly
- b** - Gasket (Not Shown)

3. Remove main metering jets.

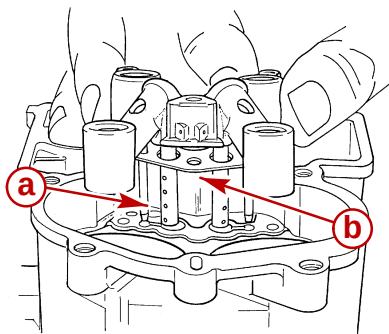


72291

- a** - Main Metering Jets
- b** - Gaskets (Not Shown)

IMPORTANT: Use care when removing venturi cluster to prevent damaging brass tubes which protrude from bottom of cluster. **DO NOT REMOVE TUBES.** These tubes are permanently pressed into the venturi cluster and are not replaceable.

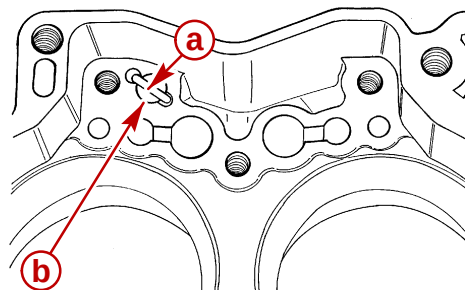
4. Remove venturi cluster screws, and carefully lift cluster and venturi gasket straight up.



72397

- a** - Venturi Cluster Brass Tubes
- b** - Gasket

5. Using a needle-nose pliers, remove accelerator pump check ball spring retainer. Turn float bowl over to remove spring and check ball.

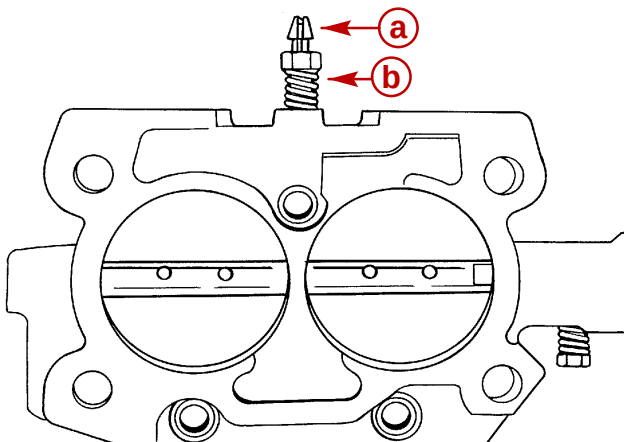


72407

- a** - Spring Retainer
- b** - Spring and Check Ball (Not Shown)

IMPORTANT: Use extreme care when handling carburetor body, so as not to damage throttle valves.

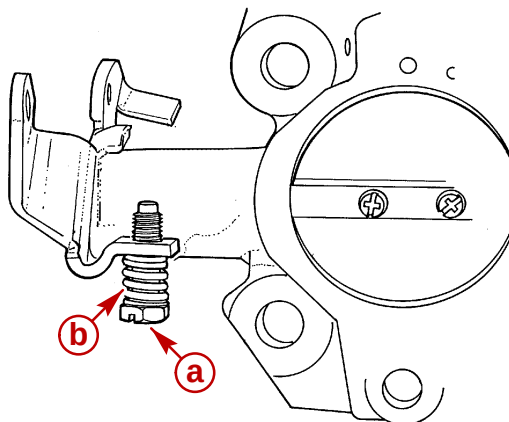
1. Remove idle mixture adjusting needle and spring.



72293

- a** - Idle Mixture Adjusting Needle
- b** - Spring

2. Remove idle speed adjustment screw and spring, if replacement is necessary.



72395

- a** - Idle Speed Screw
- b** - Spring

IMPORTANT: DO NOT remove throttle valves. If any of the throttle parts are found to be worn or damaged, complete carburetor body assembly MUST BE replaced. Assembly can be cleaned in carburetor cleaner.

Cleaning and Inspection

IMPORTANT: DO NOT use a wire or drill to clean jet passages or tubes in carburetor, as this may enlarge orifices and seriously affect carburetor calibration.

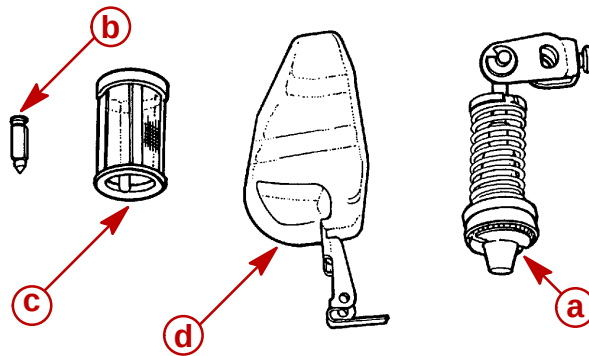
⚠ CAUTION

To avoid damage to carburetor DO NOT leave carburetor in immersion type carburetor cleaner for more than two hours.

IMPORTANT: DO NOT clean float bowl gasket surfaces with a gasket scraper or knife, as sealing bead will be damaged and float bowl replacement will be necessary.

⚠ CAUTION

The float assembly, float needle, accelerator pump plunger, and fuel filter **MUST NOT BE** immersed in carburetor cleaner, as they will swell, harden, and/or distort.



72410

- a** - Accelerator Pump Plunger
- b** - Float Needle
- c** - Fuel Filter
- d** - Float Assembly

⚠ WARNING

Avoid personal injury by always wearing safety goggles when using compressed air.

1. Clean all metal parts in a commercial carburetor cleaner until all deposits have been removed. Follow cleaner manufacturer's instructions for proper cleaning and rinsing procedure. Dry parts with compressed air.
2. Using compressed air, blow out all passages in carburetor to remove any foreign material.
3. Wipe off all parts that cannot be cleaned in carburetor cleaner with a clean, dry cloth.
4. Carefully inspect all carburetor parts for wear and damage. Pay particular attention to the following:
 - a. **Float Needle and Seat:** If float needle or seat is worn or damaged, replace with new needle and seat assembly.

IMPORTANT: Float needle and seat are factory matched and tested and should be replaced as a set only.

- b. **Float Assembly and Hinge Pin:** Check float density (to see if it is saturated with fuel) by comparing weight of float with specifications. If weight is high, float assembly must be replaced. Check hinge pin and holes for wear.
- c. **Fuel and Air Passages:** Passages must be perfectly clean for proper carburetor operation.

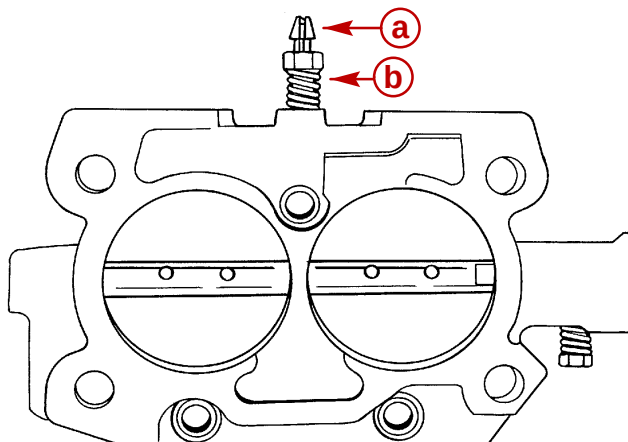
- d. **Accelerator Pump Plunger and Return Spring:** Inspect pump plunger cup, pump plunger spring (on pump assembly) and return spring.
- e. **Power Piston Spring:** Check power piston spring for weakness or distortion.
- f. **Idle Mixture Needle:** Inspect idle mixture needle. If damaged, needle must be replaced.
- g. **Levers and Linkages:** Check levers, links and rods for wear.
- h. **Throttle Valve and Shaft:** Check throttle shaft for excessive looseness in throttle body. Ensure throttle valve and shaft open and close completely. Throttle body assembly must be replaced if throttle valve and shaft are worn or damaged.
- i. **Choke Valve and Shaft and Lever Assembly:** Check shaft and lever assembly for excessive looseness in air horn assembly. Check choke valve and shaft and lever assembly for binding through entire operating range, making sure valve opens and closes completely. Air horn assembly must be replaced if choke valve and shaft and lever assembly are worn or damaged.
- j. **Inspect Casting** for visible damage. Inspect gasket surfaces. Inspect accelerator pump plunger well for scoring or deposits.

Reassembly

CARBURETOR BODY

IMPORTANT: DO NOT force idle mixture needle against seat as damage to needle and/or seat will result.

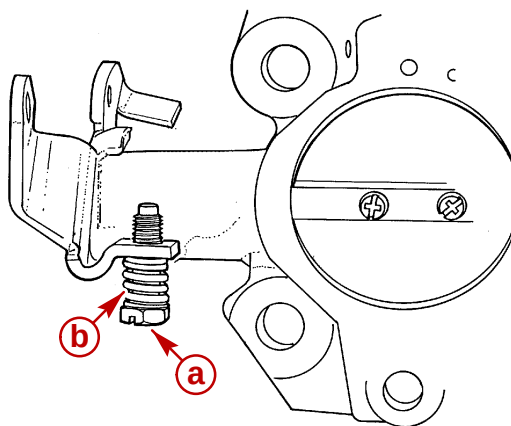
1. Screw idle mixture needle and spring into throttle body until they lightly seat, then back out needle 1-1/2 turns as a preliminary idle mixture setting.



72293

- a** - Idle Mixing Adjusting Needle
b - Spring

2. Thread idle speed adjustment screw and spring into throttle lever.



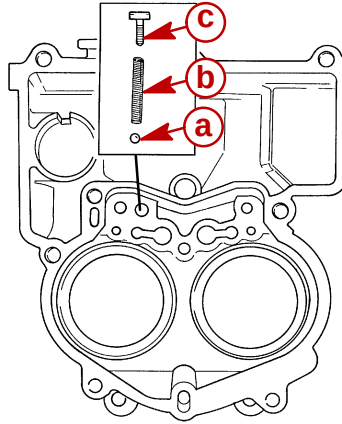
72395

- a** - Idle Speed Screw
b - Spring

FLOAT BOWL

IMPORTANT: Place float bowl and throttle assemblies in holding fixture to prevent throttle valves from being damaged.

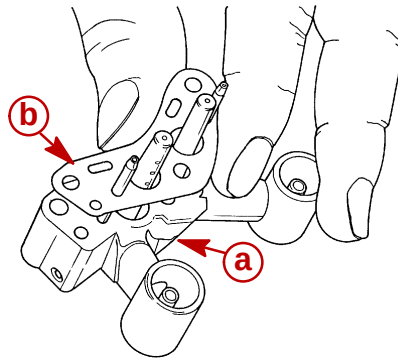
1. Install check ball, spring, and retainer in passage. Push retainer firmly into slots.



72408

- a** - Check Ball
- b** - Spring
- c** - Retainer

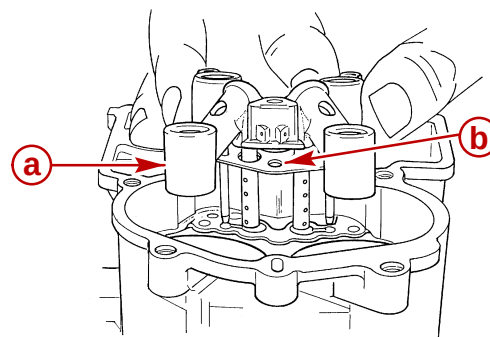
2. Install new gasket on venturi cluster.



72296

- a** - Venturi Cluster
- b** - Gasket

3. Install venturi cluster in carburetor.

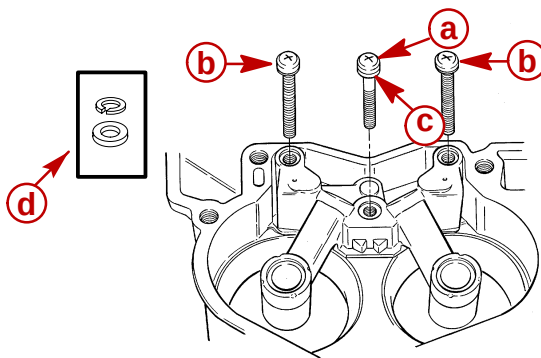


72397

- a** - Venturi Cluster
- b** - Gasket

4. Install flat washer and new fiber washer on center screw. Lockwashers and flat washers are used on outer screws. Tighten screws evenly and securely.

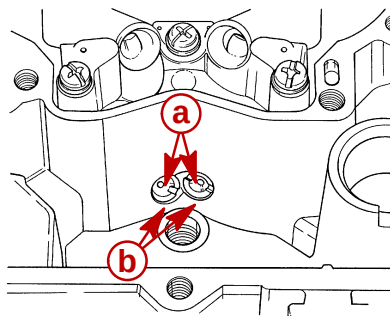
IMPORTANT: Do not damage the fiber washer. A damaged washer will cause improper fueling.



72405

- a** - Center Screw
- b** - Outer Screws
- c** - Fiber Washer
- d** - Lock Washer and Flat Washer

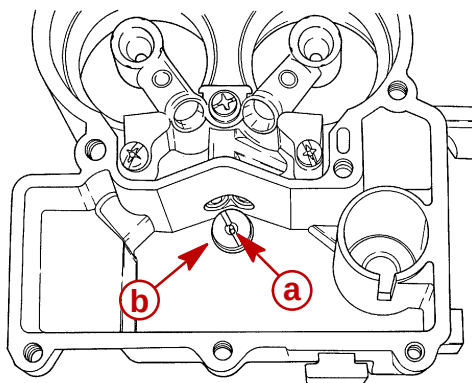
5. Install main metering jets with gaskets. Tighten securely.



72291

- a** - Main Metering Jets
- b** - Gaskets (Not Shown)

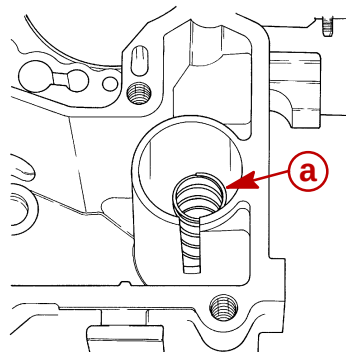
6. Install power valve with new gasket. Tighten securely.



72404

- a** - Power Valve
- b** - Gaskets (Not Shown)

7. Place accelerator pump spring in pump well.



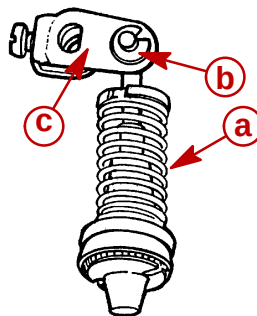
72402

a - Accelerator Pump Spring

AIR HORN

IMPORTANT: Accelerator pump assembly MUST BE installed correctly. If pump assembly is installed incorrectly, top of pump assembly will contact air horn casting.

1. If accelerator pump assembly was removed from pump lever, secure pump assembly to pump lever with washer and retainer clip.



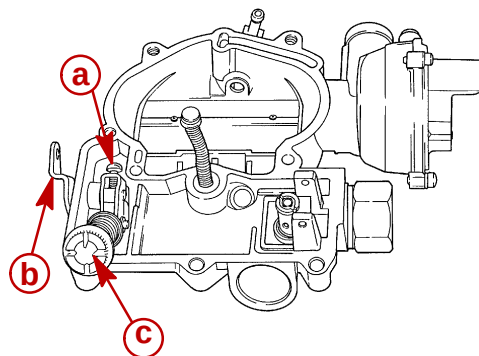
72409

a - Pump Assembly

b - Retainer Clip

c - Pump Lever

2. Insert pump shaft and lever assembly (and washer) into air horn.
3. Align indexed hole in pump lever with shaft and lever assembly and slide shaft all the way into lever so that shoulder on shaft is hitting lever.
4. Tighten set screw securely.



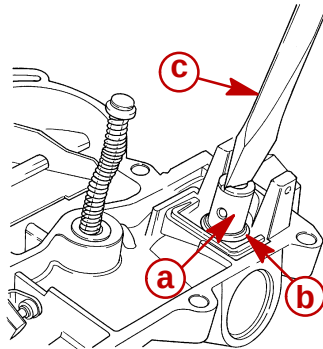
72398

a - Set Screw

b - Lever Assembly

c - Pump Assembly

5. Install needle seat and gasket. Tighten securely.

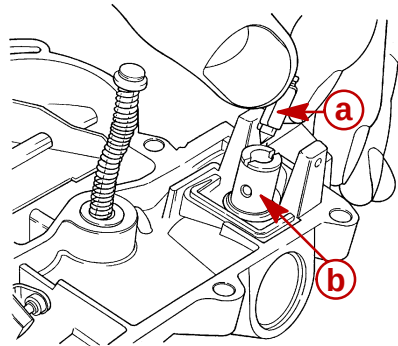


72289

- a** - Needle Seat
- b** - Gasket
- c** - Screwdriver

IMPORTANT: Float needle and needle seat are factory matched and tested and should be replaced as a set only.

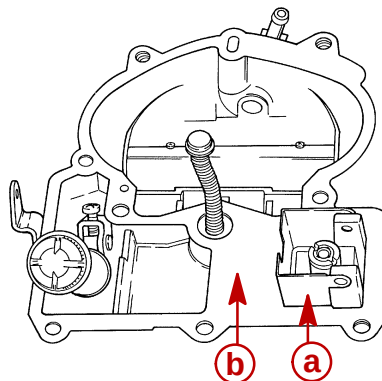
6. Place needle assembly in needle seat.



72287

- a** - Needle Assembly
- b** - Needle Seat

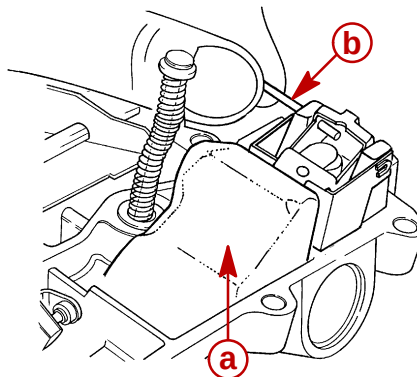
7. Install baffle and gasket.



72399

- a** - Baffle
- b** - Gasket

8. Install float assembly and hinge pin. Pivot float assembly up and down on hinge pin to ensure it moves freely.



72297

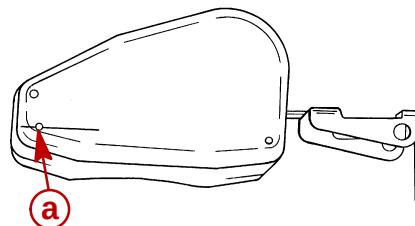
- a** - Float Assembly
b - Float Hinge Pin

FLOAT LEVEL

1. Turn air horn upside down. Pivot float assembly up and down on hinge pin to ensure it moves freely.

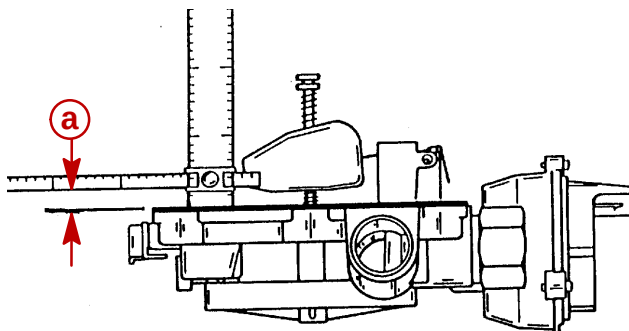
IMPORTANT: Before checking float level, raise float and allow it to fall; however, DO NOT force downward by hand.

2. Measure float level using Universal Carburetor Gauge (91-36392). Measure from gasket to toe of float.



72298

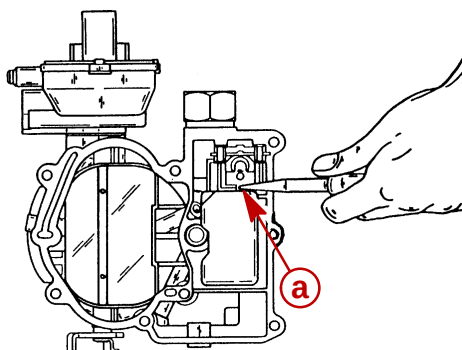
- a** - Measure From This Point (Dot) To Gasket



72687

- a** - Measurement With 2 Piece Solid Inlet Needle - 3/8 in. (10 mm)
b - Measurement with Spring Loaded Inlet Needle - 11/32 in (9 mm)

3. Bend float arm up or down at point shown to obtain specified dimension.



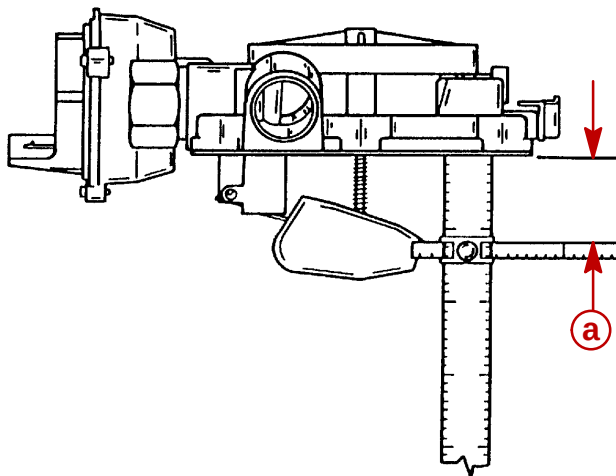
72688

a - Bend Float Arm at This Point

4. Visually check float alignment after adjustment.

FLOAT DROP

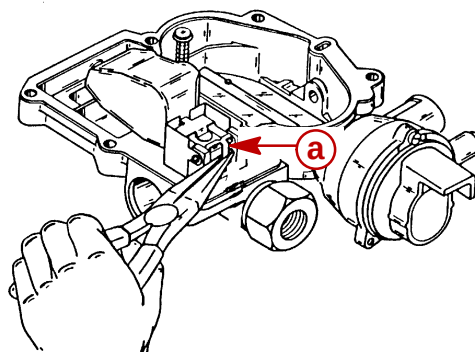
1. Hold air horn right side up to allow float to hang free.
2. Measure float drop using Universal Carburetor Gauge (91-36392). Measure from gasket (air horn) to "dot" on float.



72689

a - Measurement - 15/16 in. (24 mm)

3. Bend float assembly tang, as shown, to obtain specified dimension.

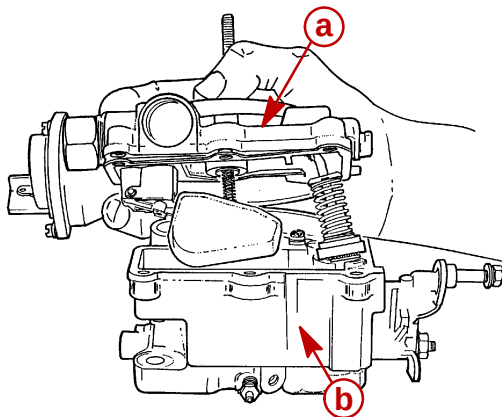


72690

a - Float Assembly Tang

4. Recheck BOTH float level and float drop.

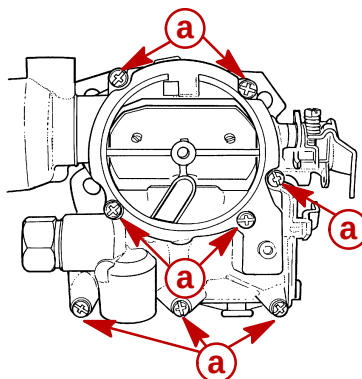
5. Place air horn on float bowl, making sure accelerator pump is correctly positioned in fuel well. Lower air horn straight down to install.



72400

- a** - Air Horn Assembly
- b** - Float Bowl Assembly

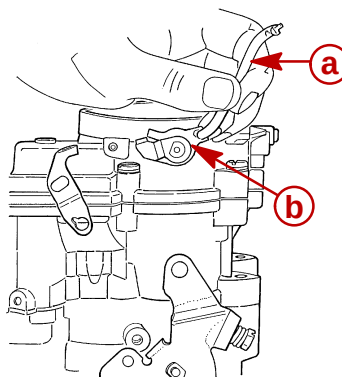
6. Install seven short and one long air horn attaching screws. Tighten screws evenly and securely.



72280

- a** - Air Horn Attaching Screws

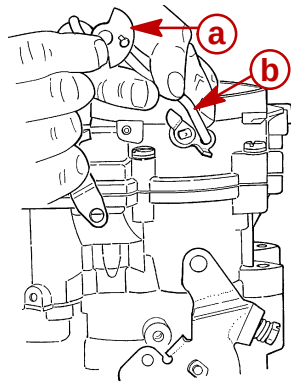
7. Place end of choke rod in choke lever and collar assembly.



72299

- a** - Choke Rod
- b** - Choke Lever and Collar Assembly

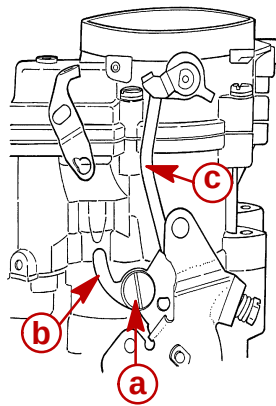
8. Place idle cam on choke rod.



72392

- a** - Idle Cam
b - Choke Rod

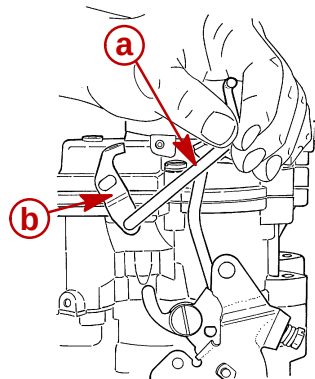
9. Secure idle cam (with choke rod installed on cam) on float bowl assembly, using screw. Ensure that cam is free to move without binding.



72282

- a** - Screw
b - Idle Cam
c - Choke Rod

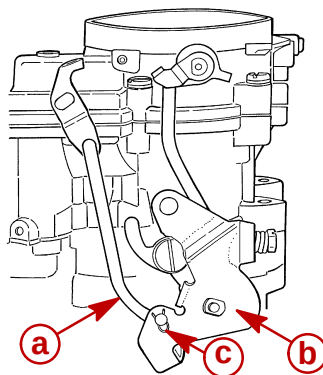
10. Place accelerator pump rod in hole in pump shaft and lever assembly.



72393

- a** - Accelerator Pump Rod
b - Pump Shaft and Lever Assembly

11. Insert other end of accelerator pump rod into hole in throttle lever and secure with retainer clip.

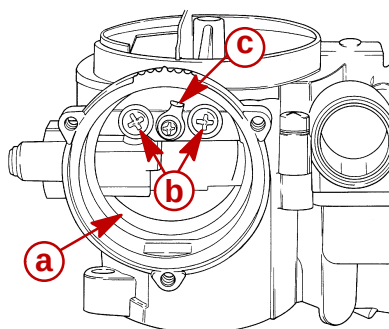


72283

- a** - Accelerator Pump Rod
- b** - Throttle Lever
- c** - Retainer Clip

CHOKE HOUSING

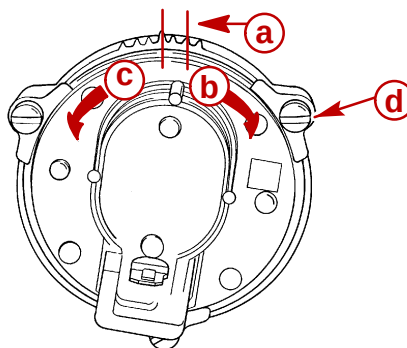
1. Install choke housing on air horn. Tighten screws securely.
2. Install choke lever. Tighten screw securely.



72401

- a** - Choke Housing
- b** - Choke Housing Attaching Screws
- c** - Choke Lever

3. Install choke cover. Make sure hook on end of choke coil engages with choke lever.
4. Adjust choke cover until index marks align as shown. Tighten screws securely.



72403

- a** - Scribed Mark
- b** - More Choke (Richer)
- c** - Less Choke (Leaner)
- d** - Cover Screws

Installation

1. Thoroughly clean gasket surfaces and install new gaskets.
2. Place new carburetor base gasket on intake manifold.
3. Install carburetor and secure with nuts and washers. Torque to 132 lb-in. (15 Nm).
4. If fuel inlet filter nut was disturbed, remove, clean all threads with brush and carburetor cleaner or Quicksilver Leveler, and replace.
5. Connect fuel line to fuel inlet filter nut. Hold filter nut with wrench, tighten fuel line fitting securely.
6. Connect electric choke wires to choke cover.
7. Install throttle cable. Refer to SECTION 2.
8. Install flame arrestor, crankcase ventilation and PCV hose.
9. Reconnect battery cables to battery.
10. Ensure that water is supplied to cooling system.
11. Start engine.
12. Check for gasoline leaks. If leaks exist, STOP ENGINE IMMEDIATELY and recheck connections.
13. Adjust idle speed and idle mixture.

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FUEL SYSTEM

Section 5C - Fuel Delivery System For Electronic Fuel Injection

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Specifications

Description	Specification
Pump Pressure	30 PSI (207 kPa)

Torque Specifications

Fastener Location	lb. ft.	N·m
Fuel Lines	18	24
Fuel Fittings	See Note	

Tools

Description	Part Number
Fuel Pressure Gauge	Obtain Locally

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Perfect Seal	92-34227--1
#592 Loctite Pipe Sealant with Teflon	Obtain Locally

NOTE: Refer To "Fuel Supply Connections" Warning following this chart.

Replacement Parts Warning

 WARNING
Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion. Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Precautions

WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or flame in the area while changing fuel filters. Wipe up any spilled fuel immediately.

WARNING

Make sure that no fuel leaks exist before closing engine hatch

CAUTION

DO NOT operate engine without cooling water being supplied to seawater pickup pump, or pump impeller will be damaged and subsequent overheating damage may result.

Fuel Supply Connections

WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak.

- Apply #592 Loctite Pipe Sealant with Teflon to threads of brass fitting or plug. DO NOT USE TEFLON TAPE.
- Thread brass fitting or plug into fuel pump or fuel filter base until finger tight.
- Tighten fitting or plug an additional 1-3/4 to 2-1/4 turns using a wrench. DO NOT OVER-TIGHTEN.
- Install fuel line. To prevent over-tightening, hold brass fitting with suitable wrench and tighten fuel line connectors securely.
- Check for fuel leaks.

Fuel Delivery System

Recommendations

WARNING

Boating standards (NMMA, ABYC, etc.) and Coast Guard regulations must be adhered to when installing fuel delivery system.

The Fuel Tank is an integrated component of the boat. Refer to the special information on service and maintenance, which you have received from the tank or boat manufacturer.

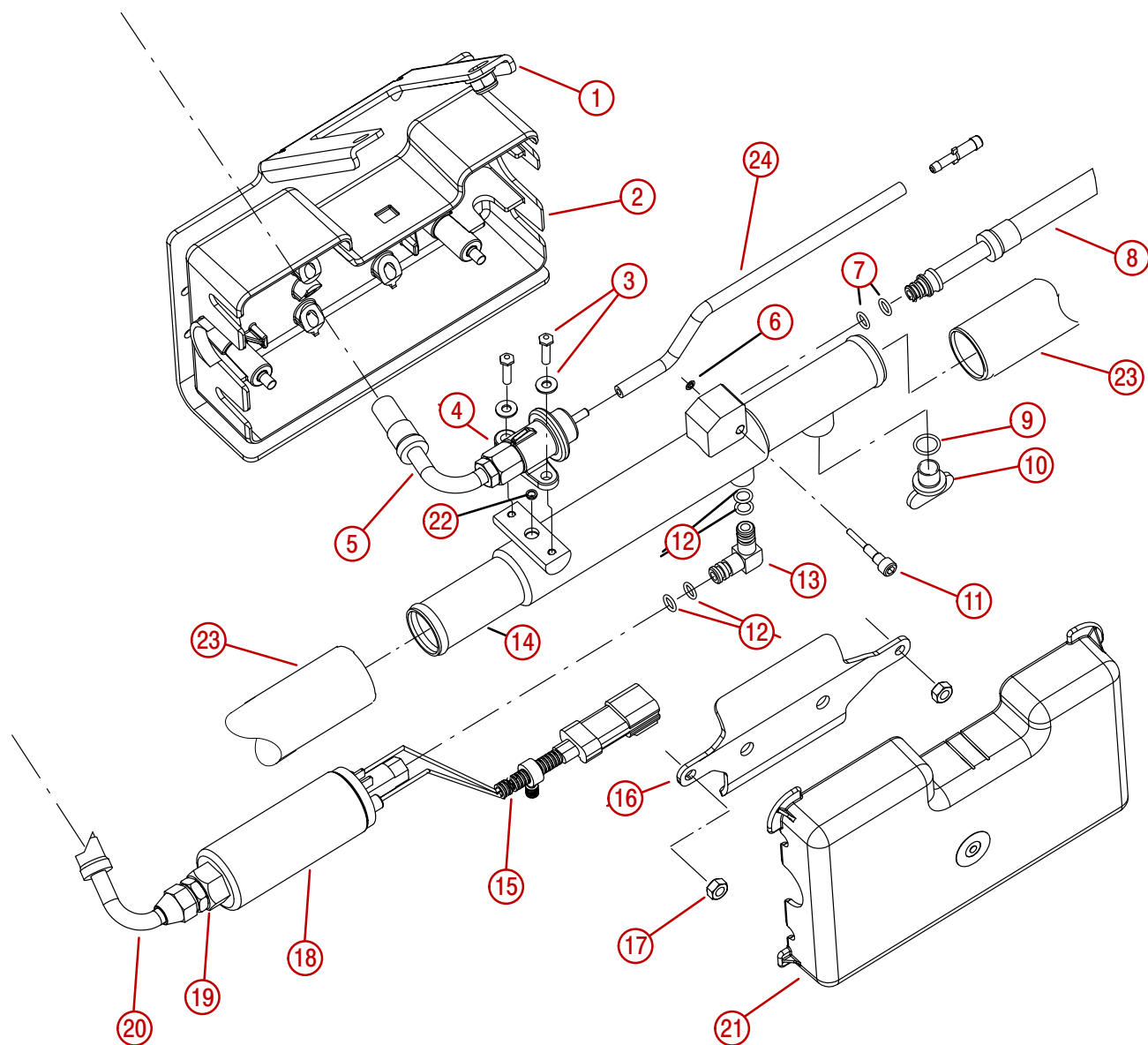
NOTE: On Ski Boat Applications: *If during testing for a particular application, you experience fuel starvation in sharp high speed turns, baffles or a fuel sump may be needed in the tank to help correct this condition.*

All fuel lines must be well secured. The holes where the lines run through the bulkheads should be carefully rounded off or protected with rubber grommets. This prevents damage to the lines from abrasion.

The following, but not limited to the following, additional fuel connection related points, *applying to all engines unless otherwise stated*, must be considered. Refer to boating standards (NMMA, ABYC, etc.) and Coast Guard regulations for complete guidelines.

1. Fuel pickup should be at least 1 in. (25mm) from the bottom of fuel tank to prevent picking up impurities.
2. Fuel lines used must be Coast Guard approved (USCG Type A1).
3. **On Multi-Engine Gasoline Installations:** It is best to use a fuel pickup and supply line for **each** engine. If a single pickup and line is used, line must not be smaller than 1/2 in. (13mm) I.D.
4. Larger diameter (than previously specified) lines and fittings must be used on installations requiring long lines or numerous fittings.
5. Fuel line(s) should be installed free of stress and firmly secured to prevent vibration and/or chafing.
6. Sharp bends in fuel lines should be avoided.
7. A flexible fuel line must be used to connect fuel supply line to fuel inlet fitting on engine to absorb deflection when engine is running.

Cool Fuel System Exploded View



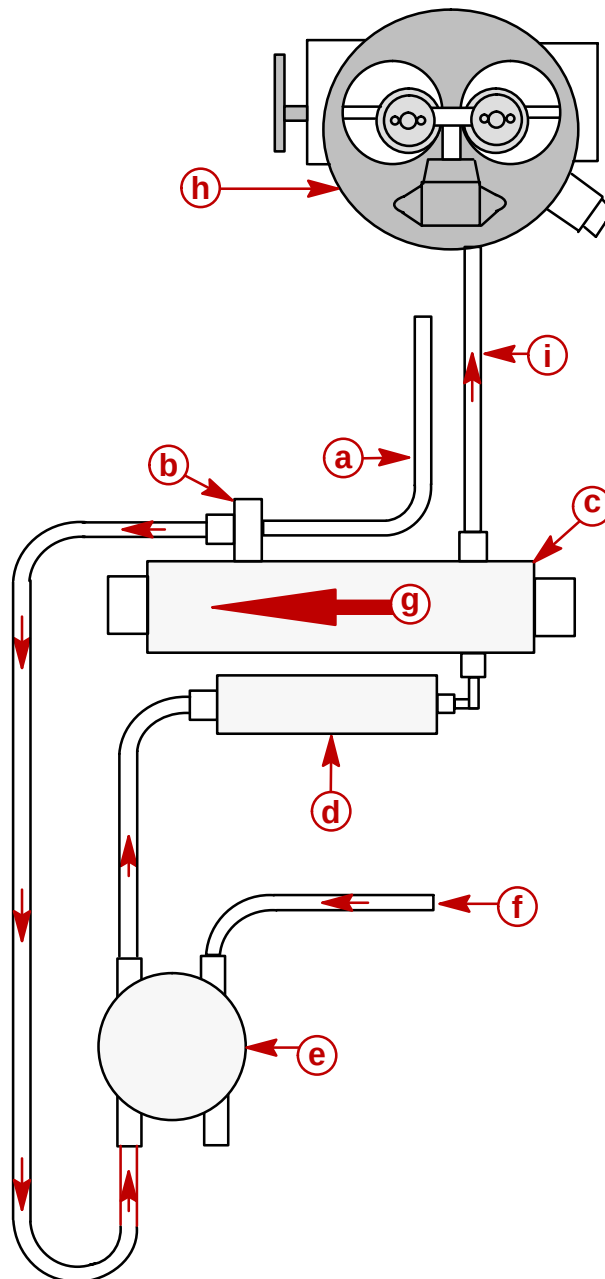
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Exploded View Component List

- | | |
|------------------------------------|--|
| 1 - Bracket | 14 - Fuel Cooler |
| 2 - Cover Base | 15 - Fuel Pump Wiring Harness |
| 3 - Screw and Washer (2) | 16 - Retainer Bracket |
| 4 - Fuel Pressure Regulator | 17 - Nut (2) |
| 5 - Return Fuel Line | 18 - Electric Fuel Pump |
| 6 - Retaining Ring | 19 - Inlet Fitting |
| 7 - O-Rings (2) | 20 - Fuel Line Inlet |
| 8 - Fuel Line To Fuel Rail | 21 - Cover |
| 9 - Gasket | 22 - Filter |
| 10 - Drain Plug | 23 - Seawater Hoses (Hose Clamps Not Shown) |
| 11 - Stepped Screw | 24 - Vacuum Hose |
| 12 - O-Rings (4) | |
| 13 - Elbow | |

Fuel System Flow Diagrams

Throttle Body Injection

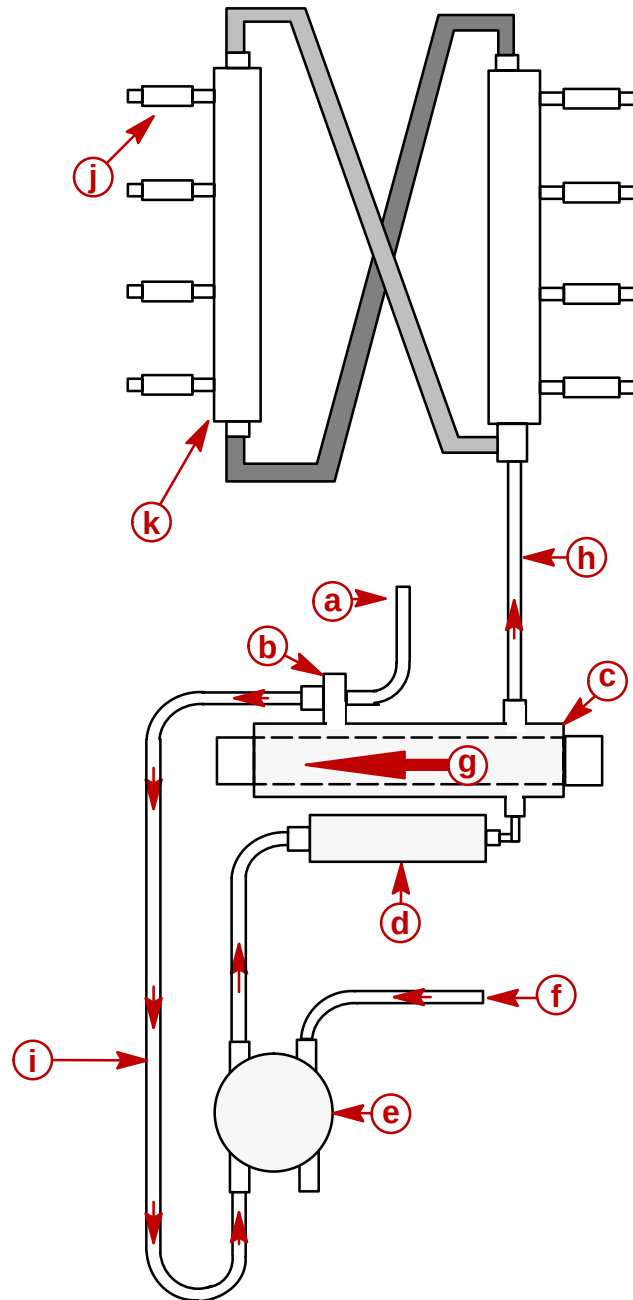


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All Throttle Body Fuel Injection Is Similar

- a** - Diaphragm Rupture Line To Flame Arrestor
- b** - Fuel Pressure Regulator
- c** - Fuel Cooler
- d** - Electric Fuel Pump
- e** - Water Separating Fuel Filter
- f** - Fuel From Tank
- g** - Direction Of Water Flow
- h** - Throttle Body Unit
- i** - Fuel Line To Throttle Body
- j** - Excess Fuel Return To Water Separating Fuel Filter

Multi-Port Injection with MEFI 1 and MEFI 2

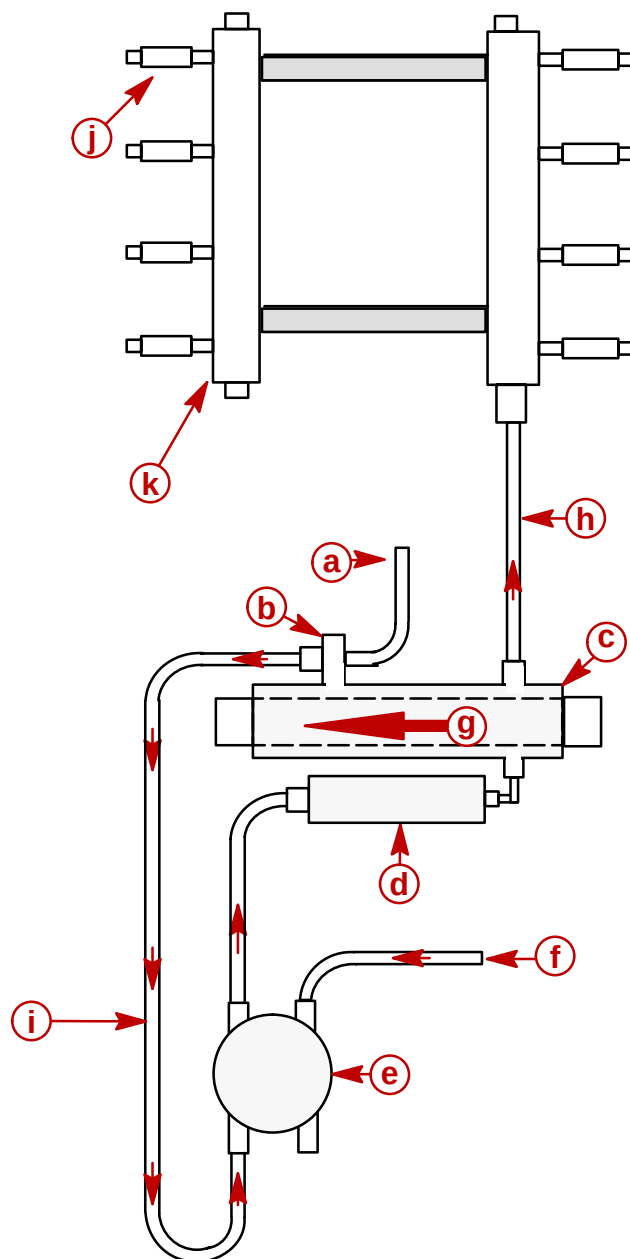


74871

350 Mag MPI Shown - Scorpion Is Similar

- a** - Vacuum Line To Intake Manifold Base
- b** - Fuel Pressure Regulator
- c** - Fuel Cooler
- d** - Electric Fuel Pump
- e** - Water Separating Fuel Filter
- f** - Fuel From Tank
- g** - Direction Of Water Flow
- h** - Fuel Line To Fuel Rail
- i** - Excess Fuel Return To Water Separating Fuel Filter
- j** - Fuel Injectors (8)
- k** - Fuel Rail

Multi-Port Injection with MEFI 3



74871

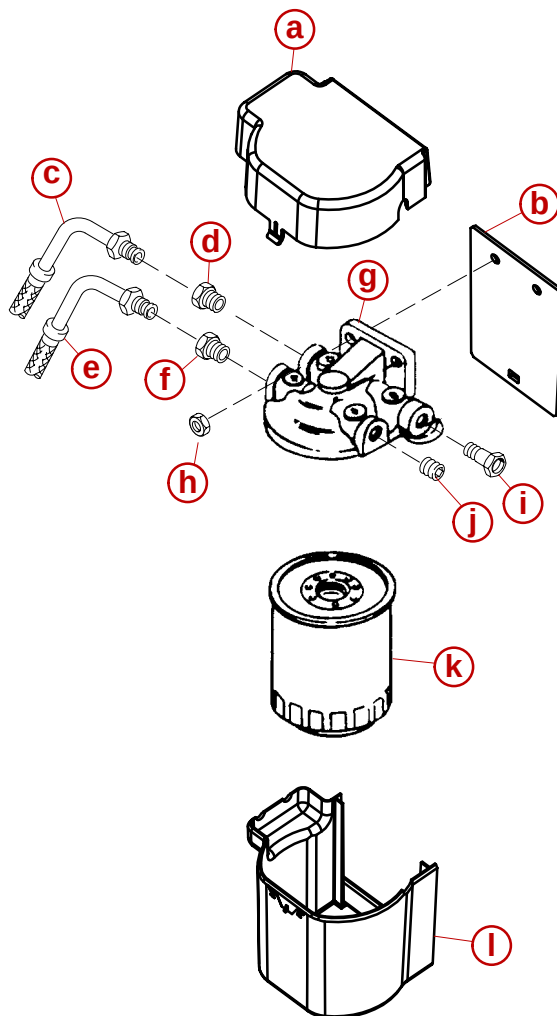
350 Mag MPI Shown - Scorpion Is Similar

- a** - Vacuum Line To Intake Manifold Base
- b** - Fuel Pressure Regulator
- c** - Fuel Cooler
- d** - Electric Fuel Pump
- e** - Water Separating Fuel Filter
- f** - Fuel From Tank
- g** - Direction Of Water Flow
- h** - Fuel Line To Fuel Rail
- i** - Excess Fuel Return To Water Separating Fuel Filter
- j** - Fuel Injectors (8)
- k** - Fuel Rail

Water Separating Fuel Filter

NOTICE

Refer to "Precautions," in this section, BEFORE proceeding.



MCM Model Shown

- a** - Top Cover (Some Models)
- b** - Insulator Plate
- c** - Fuel Return Line from Regulator
- d** - Brass Fitting
- e** - Fuel Line to Fuel Pump
- f** - Brass Fitting
- g** - Fuel Filter Mounting Bracket
- h** - Nut
- i** - Fuel Inlet Fitting
- j** - Plug
- k** - Water Separating Fuel Filter
- l** - Bottom Cover (Some Models)

Water Separating Fuel Filter Replacement

NOTICE

Refer to "Precautions," in this section, BEFORE proceeding.
--

1. Disconnect battery cables from battery.
2. Remove fuel filter from base. A filter wrench may be needed.
3. Lubricate sealing ring(s) of new filter with engine oil.
4. Install new filter. Tighten securely by hand.
5. Reconnect battery cables.
6. Supply water to cooling system.
7. Start engine.
8. Check for fuel leaks.

Cool Fuel System Repair

Removal

1. Disconnect battery cables from battery.

IMPORTANT: Suitably plug open ends of fuel line connections to prevent fuel leaks and entry of water or contaminants into lines while working.

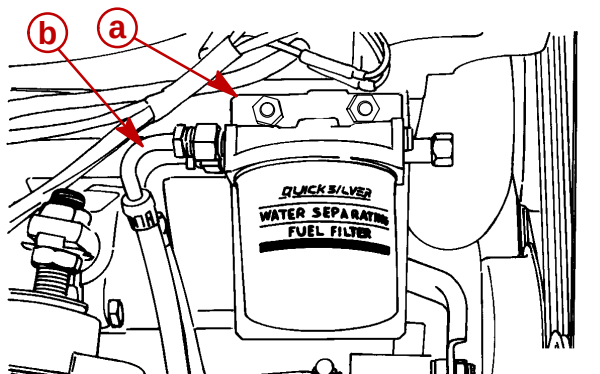
2. Close fuel shutoff valve, if equipped. and remove the fuel tank inlet line from the water separating fuel filter. If boat is not equipped with a fuel tank shut off valve, remove the fuel tank inlet line at the water separating fuel filter and plug the line.

⚠ CAUTION

If boat is to remain in the water, the seacock, if equipped, must remain closed until engine is to be restarted to prevent water from flowing back into seawater cooling system. If boat is not fitted with a seacock, water inlet hose must be disconnected and plugged to prevent water from flowing into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel with the warning that the seacock must be opened or the water inlet hose reconnected prior to starting the engine
--

3. Close seacock, if equipped. If boat is not equipped with a seacock, remove and plug the seawater inlet hose.
4. Drain seawater system. Refer to SECTION 1B.
5. Disconnect seawater hoses from fuel cooler.

6. Disconnect fuel lines from water separating fuel filter adapter.



75533

a - Filter Adapter
b - Fuel Lines

7. Disconnect the fuel line from the rail.
8. Remove the cover from the cool fuel system.
9. Disconnect the fuel pump electrical connector.
10. Disconnect the vacuum hose connected to the pressure regulator.
11. Remove the two upper engine mount bracket nuts retaining fuel cooler bracket to the engine.
12. Carefully remove the cool fuel system assembly.

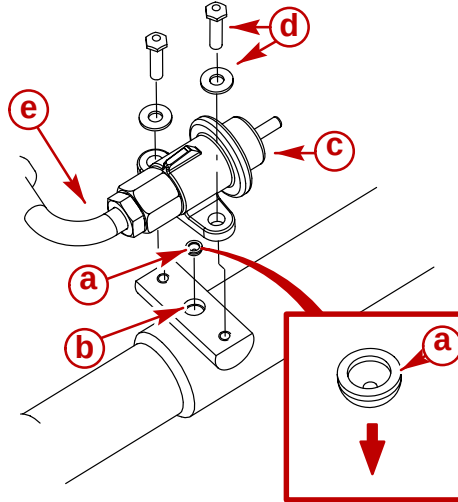
Disassembly

NOTE: Retain all fasteners and hardware unless instructed otherwise.

1. Remove the two nuts from the Cool Fuel retaining bracket studs. Lift the retainer bracket and cooler/pump assembly from the cover base.
2. Disconnect the fuel lines from the assembly.
3. Disconnect the elbow fitting and fuel pump from the cooler assembly.
4. Remove the elbow fitting from the fuel pump (to allow replacement of O-rings during assembly).
5. Remove the two screws retaining the fuel pressure regulator to the fuel cooler.
6. Remove the regulator.
7. Remove and retain the seawater drain plug and seal from the cooler.

Reassembly

1. Install the small filter (conical side DOWN) in the orifice of the new fuel cooler where the fuel pressure regulator mounts.
2. Install the regulator onto the cooler using the two screws with washers. Torque the screws to 53 lb-in. (5.8 Nm).
3. Connect the fuel line to the regulator. Tighten securely.

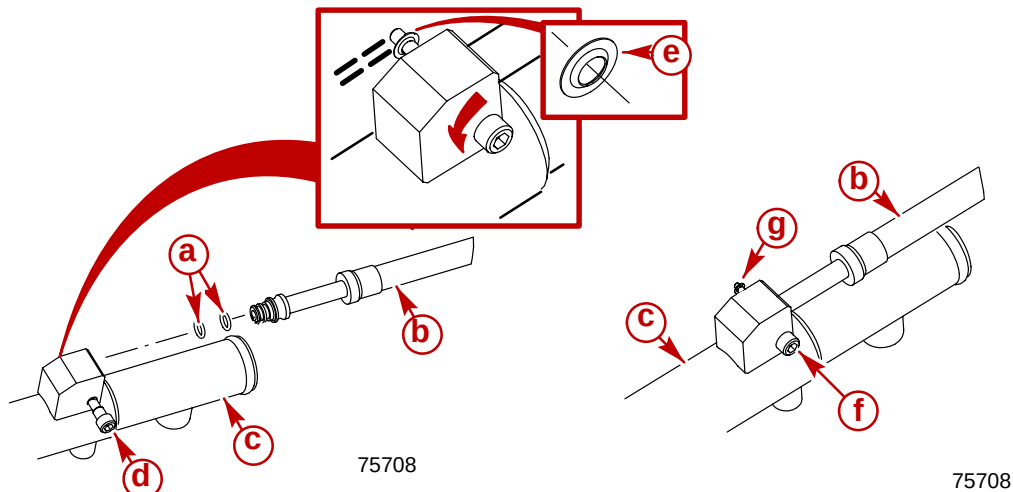


75708

- a** - Filter
- b** - Fuel Cooler Orifice
- c** - Pressure Regulator
- d** - Screw and Washer
- e** - Fuel Line

4. Install the fuel rail fuel line as follows
 - a. Install two (of six) O-rings onto the cooler-to-fuel rail fuel line where it attaches to the cooler, if not already present.
 - b. Completely loosen, but do NOT remove, the stepped screw that retains the fuel line.
 - c. Lubricate the two fuel line O-rings with a small amount of liquid dish soap (obtain locally).
 - d. Insert the fuel line into the cooler orifice. Hand tighten the special screw.
 - e. Torque the stepped screw to 81 lb-in. (9 Nm).

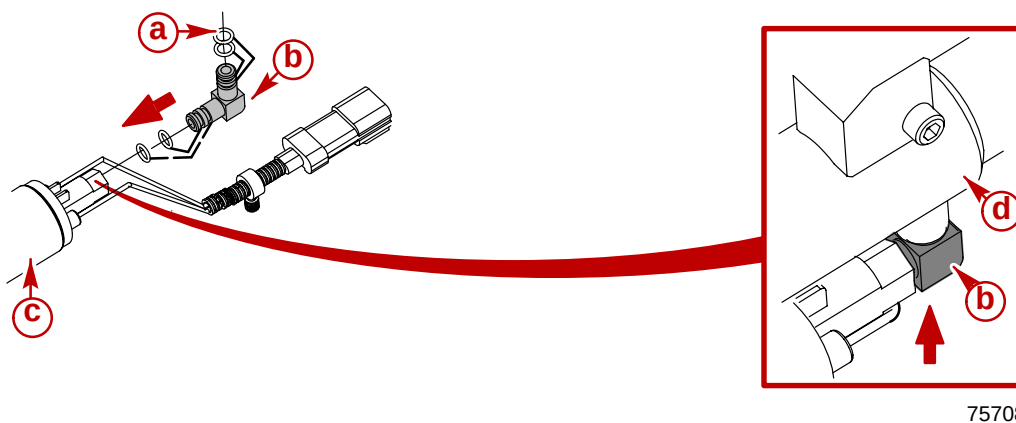
IMPORTANT: To prevent loss of the stepped screw used to secure the cooler-to-fuel rail fuel line, a retainer ring is provided. Do not remove the retainer or stepped screw.



- a** - Fuel Line O-Rings
- b** - Fuel Line, Cooler-to-Fuel Rail
- c** - Fuel Cooler
- d** - Stepped Screw - Loosened To Accept Fuel Line
- e** - Retainer Ring
- f** - Stepped Screw - Torqued
- g** - Retainer Ring

5. Install the fuel pump to the cooler as follows:

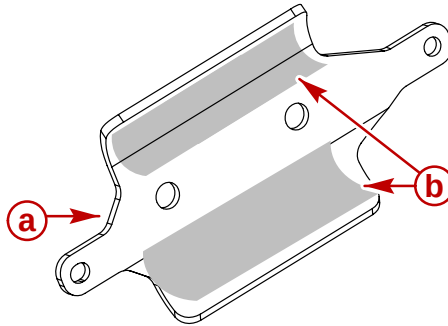
- a. Install the remaining four (of six) O-rings on the fuel pump / cooler elbow fitting as shown.
- b. Lubricate O-rings for the elbow fitting with a small amount of liquid dish soap (obtain locally).
- c. Install the elbow in the fuel pump.
- d. Install the fuel pump with elbow fitting in the cooler assembly.



- a** - O-Rings (4)
- b** - Elbow Fitting
- c** - Fuel Pump
- d** - Fuel Cooler

6. Position the completed fuel cooler assembly in the cover base.

7. Apply a thin, even coating of Thermal Grease on all of the retainer bracket inside surfaces where it contacts the cooler and the fuel pump when installed.

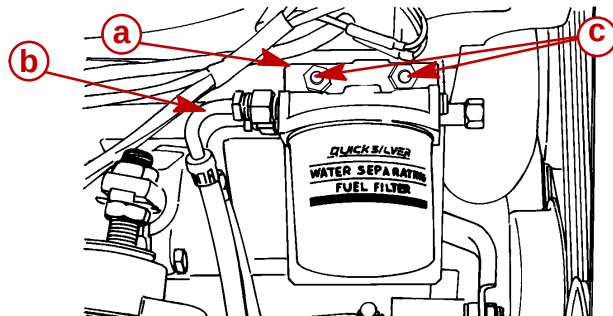


- a** - Retainer Bracket
- b** - Thermal Grease

8. Install the retainer bracket over the cooler and fuel pump. Apply Loctite 242 to the threads of the mounting studs. Torque the two nuts to 50 lb-in. (5.6 Nm).
9. Install and securely tighten the seawater drain plug.

Installation

1. If removed, reinstall the fuel filter assembly and secure using the two self locking nuts. Tighten securely.
2. Connect the fuel lines to the fuel filter adapter. Tighten securely.

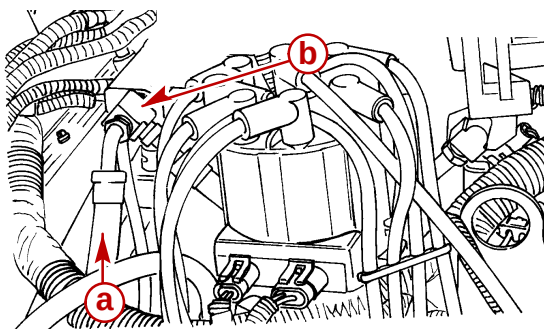


- a** - Filter Assembly
- b** - Fuel Lines
- c** - Lock Nuts

3. Route the fuel lines as needed and place the Cool Fuel assembly on the engine mount studs. Install the two engine mounting nuts. Torque to 30 lb-ft (41 Nm).
4. **On 350 Mag MPI:** Install the cooler-to-fuel rail line as follows:
 - a. Route the fuel line to the back side of engine.

75533

- b. Connect the fuel line to the fuel rail fitting at location shown. Tighten securely.

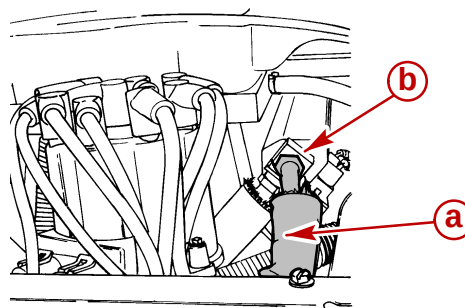


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Typical

- a** - Fuel Line, Fuel Cooler-to-Fuel Rail
b - Fuel Rail Fitting

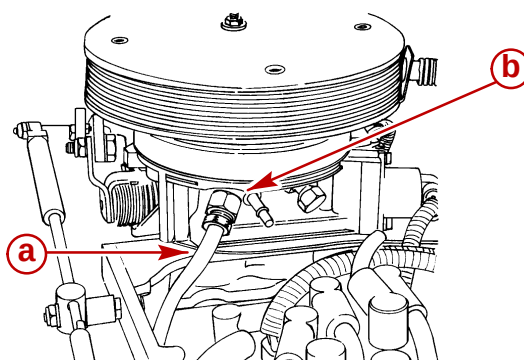
5. **On Black Scorpion:** Install the cooler-to-fuel rail line as follows:
- Route the fuel line to the back side of engine.
 - Connect the fuel line to the fuel rail fitting at location shown. Tighten securely.



75696

- a** - Fuel Line, Fuel Cooler-to-Fuel Rail
b - Fuel Rail Fitting

6. **On Throttle Body EFI:** Install the cooler-to-throttle body fuel line as follows:
- Route the fuel line to the back side of engine.
 - Connect the fuel line to the throttle body fitting at location shown. Tighten securely.



75806

- a** - Fuel Line, Fuel Cooler-to-Fuel Rail
b - Fuel Fitting

- Install distributor cap (if removed).
- Connect vacuum line to fuel pressure regulator.
- Attach engine harness electrical connector to fuel pump harness connector.

⚠ CAUTION

DO NOT operate engine without cooling water being supplied to seawater pickup pump, or pump impeller will be damaged and subsequent overheating damage may result.

10. Connect seawater hoses to Cool Fuel system. Tighten hose clamps securely.
11. Unplug and connect seawater inlet hose. Open seacock, if equipped.
12. Unplug and connect fuel tank supply inlet hose. Tighten hose clamp securely. Open fuel shutoff valve, if equipped.

⚠ CAUTION

When installing battery, be sure to connect POSITIVE (+) battery cable to POSITIVE (+) battery terminal FIRST, and NEGATIVE (–) battery cable to NEGATIVE (–) battery terminal LAST. If battery cables are reversed, or connection order is reversed, electrical system damage will result.

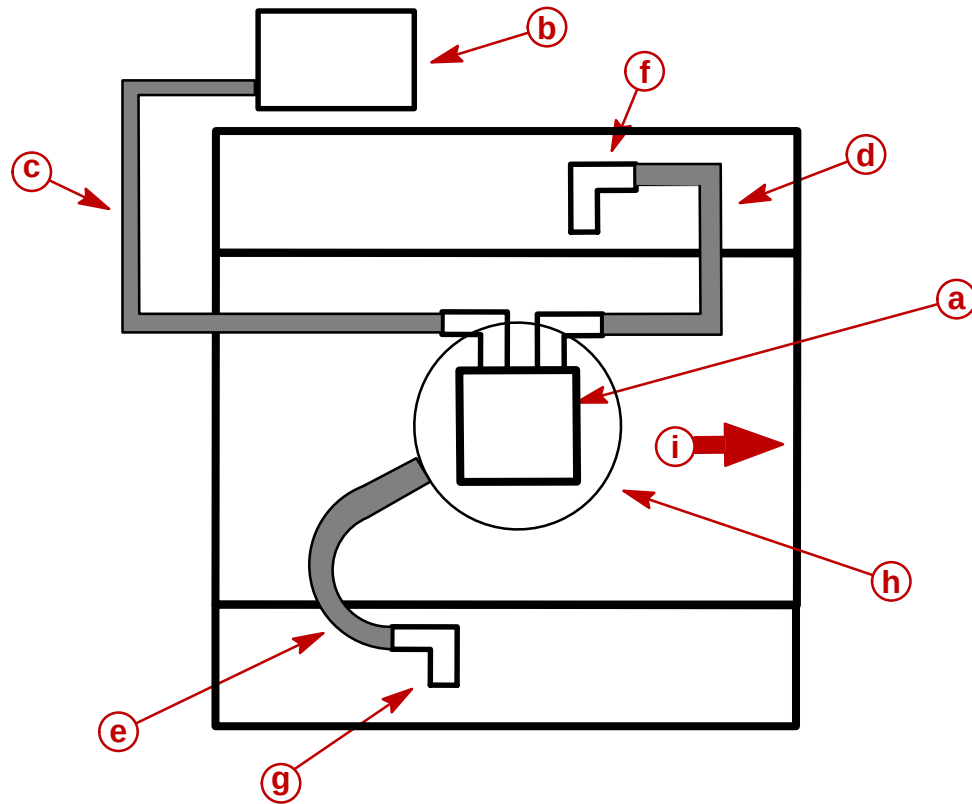
13. Clean battery cable clamps and terminals and reconnect cables (see **CAUTION** listed above). Secure each cable clamp when connecting. Coat terminals with a battery terminal anti-corrosion spray to help retard corrosion.
14. Start the engine and check for fuel and water leaks. Stop the engine immediately if any leaks exist. Make necessary corrections.
15. Install cool fuel system cover.

⚠ WARNING

Make sure no leaks exist before closing engine hatch.

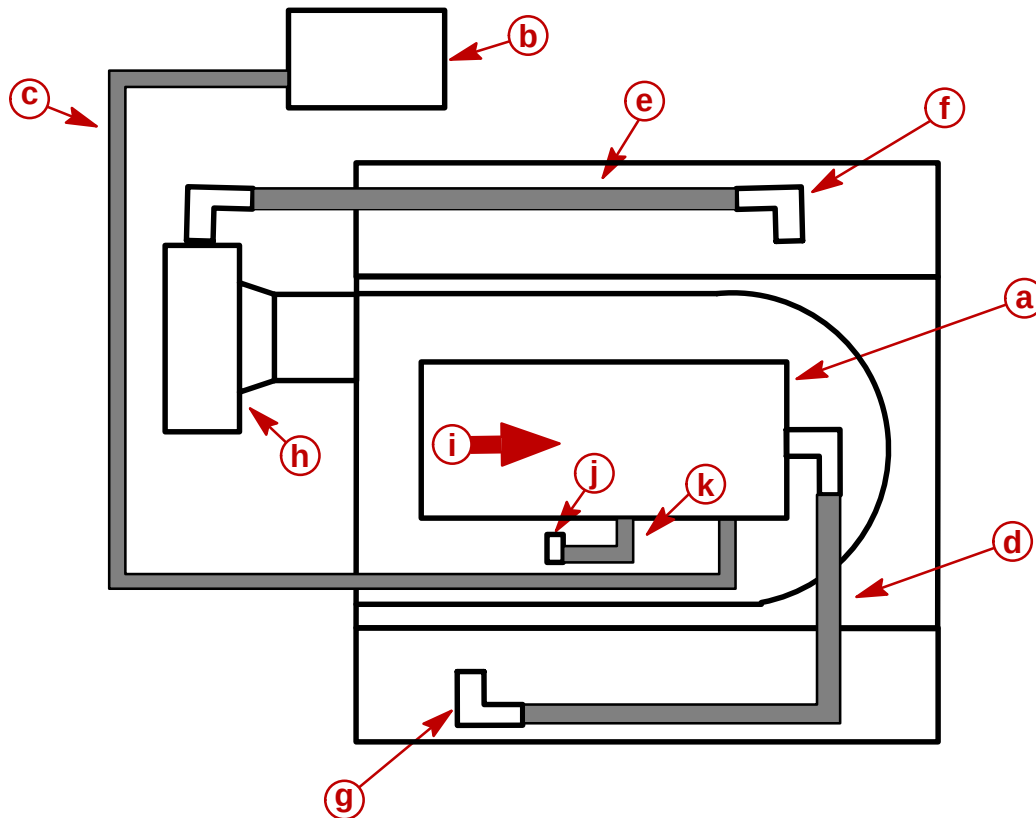
Vacuum And Vent Hose Routing

350 Mag MPI Models



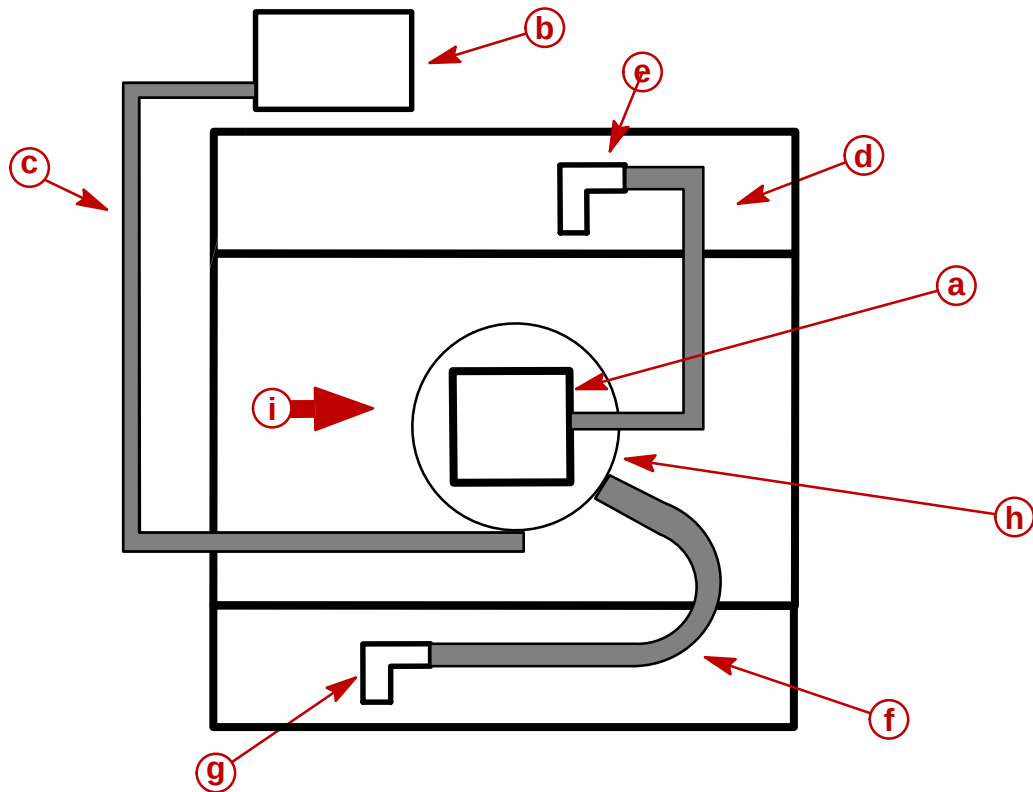
- a** - Throttle Body Adapter
- b** - Cool Fuel Assembly
- c** - Vacuum Hose - Throttle Body Adapter to Fuel Pressure Regulator on Cool Fuel Assembly
- d** - Vent Hose - PCV Valve to Throttle Body Adapter
- e** - Vent Hose - Valve Cover Fitting To Flame Arrestor
- f** - PCV Valve
- g** - Vacuum Hose - T-Fitting to Plenum
- h** - Flame Arrestor
- i** - Front of Engine

Scorpion Models



- a** - Throttle Body Adapter
- b** - Cool Fuel Assembly
- c** - Vacuum Hose - Forward Fitting On Intake Manifold To Fuel Pressure Regulator on Cool Fuel Assembly
- d** - Vent Hose - PCV Valve to Throttle Body Adapter
- e** - Vent Hose - Valve Cover to Flame Arrestor
- f** - PCV Valve
- g** - Vent Hose Fitting
- h** - Flame Arrestor
- i** - Front of Engine
- j** - MAP Sensor
- k** - Vacuum Hose - Rear Fitting On Intake Manifold To MAP Sensor

Throttle Body EFI



- a** - Plenum
- b** - Cool Fuel Assembly
- c** - Diaphragm Rupture Hose - Fuel Pressure Regulator on Cool Fuel Assembly To Side of Flame Arrestor
- d** - Vent Hose - PCV Valve to Throttle Body Adapter
- e** - PCV Valve
- f** - Vent Hose - Valve Cover Fitting To Flame Arrestor
- g** - Valve Cover Fitting
- h** - Flame Arrestor
- i** - Front of Engine

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FUEL SYSTEMS

Section 5D - Fuel Injection Descriptions And System Operation

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Special Tools

Part Number	Tool Name	Description
J-34029-A (Note 1 and 2)	High Impedance Multimeter (DVM)	Minimum 10 megohm input impedance required on all voltage ranges. As ammeter, accurately measures low value current flow. As ohmmeter, reads 0-200 ohms, 2/20/200 kΩ, 2/20 mΩ
J-23738	Vacuum Pump with Gauge - 20 In. Hg Minimum	Gauge monitors manifold engine vacuum. Hand pump used to check fuel pressure regulator
J-34142-B (Note 3)	Unpowered Test Light	Used to check circuit wiring, short to ground, or voltage.
J-34730-2A	Injector Harness Test Light	Visually indicates injector electrical impulses from the ECM.
J-35616	Harness Test Adapter	Allows multi-meter connections with wiring harness.
94050m	MerCruiser Scan Tool Version 3.4 (English)	Displays problem codes stored in the ECM. It also allows monitoring of various circuits and components in the fuel injection system. Allows for test firing injectors. Tool can read MEFI 1, MEFI 2 and MEFI 3 ECM.
94008	Code Mate Tester	Flashes light to display problem codes
91-99379	Timing Light	Used to check ignition timing. Must have inductive signal pickup.
91-16850A5	Fuel Pressure Gauge Kit	Used to check fuel system pressure. Kit includes 91-803135 Test Port Adaptor Kit and 91-806901 TBI Pressure Valve
91-823686A2	Quicksilver Digital Diagnostic Terminal (DDT)	Displays problem codes stored in the ECM. It also allows monitoring of various circuits and components in the fuel injection system.
91-803999	MerCruiser DDT Cartridge Version 2	Displays problem codes stored in the ECM. It also allows monitoring of various circuits and components in the fuel injection system. Tool can read MEFI 1, MEFI 2 and MEFI 3 ECM.
84-822560A2	DDT Adaptor Harness	Displays problem codes stored in the ECM. It also allows monitoring of various circuits and components in the fuel injection system.
91-805747A2	EFI Timing Tool	Used to set Ignition timing. Plug connects to DLC

Special Tools (cont'd)

NOTE: ¹ The High Impedance Multimeter that comes with the existing Outboard 2 Cycle EFI Tester, P/N 91-11001A2 meets the requirements listed above.

NOTE: ² Quicksilver Digital Tachometer / Multi-Meter (DMT 2000) P/N 91-854009A1, meets the requirements listed above.

NOTE: ³ Using a test light with 100 mA or less rating may show a faint glow when test actually states no light.

Kent-Moore Tools, Inc.
29784 Little Mack
Roseville, MI 48066
Phone: 800-345-2233

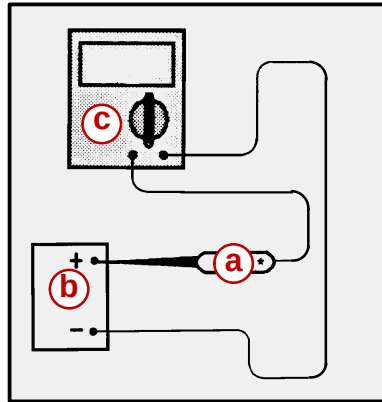
Rinda Technologies
4563 N. Elston Ave.
Chicago, IL 60630
Phone: 773-736-6633
Fax: 773-736-2950
E-mail: rinda@mcs.net

Service Precautions

The following requirements must be observed:

- Before removing any ECM system component, disconnect the negative battery cable.
- Never start the engine without the battery being solidly connected.
- Never separate the battery from the on-board electrical system while the engine is running.
- Never separate the battery feed wire from the charging system while the engine is running.
- When charging the battery, disconnect it from the boat's electrical system.
- Ensure that all cable harnesses are connected solidly and that battery connections are thoroughly clean.
- Never connect or disconnect the wiring harness at the ECM when the ignition is switched ON.
- Before attempting any electric arc welding, disconnect the battery leads and the ECM connector(s).
- When steam cleaning engines, do not direct the steam cleaning nozzle at ECM system components. If this happens, corrosion of the terminals or damage of components can take place.
- Use only the test equipment specified in the diagnostic charts, since other test equipment may either give incorrect results or damage good components.
- All voltage measurements using a voltmeter require a digital voltmeter with a rating of 10 megohms input impedance.

- When a test light is specified, a “low-power” test light must be used. DO NOT use a high-wattage test light. While a particular brand of test light is not suggested, a simple test, as shown below, on any test light will ensure it to be safe for system circuit testing. Connect an accurate ammeter (such as the high impedance digital multimeter) in series with the test light being tested, and power the test light ammeter circuit with the vehicle battery.



- a** - Test Light
- b** - Battery
- c** - Ammeter

IMPORTANT: If the ammeter indicates LESS than 3/10 amp. current flow (.3 A or 300 mA), the test light is **SAFE** to use.

If the ammeter indicates MORE than 3/10 amp. current flow (.3 A or 300 mA), the test light is **NOT SAFE** to use.

NOTE: Using a test light with 100 mA or less rating may show a faint glow when test actually states no light.

- When using a DVOM to perform voltage measurements, turn the ignition OFF when connecting the DVOM to the circuitry to be tested.

General Information

Electrostatic Discharge Damage

Electronic components are often designed to carry very low voltage and are susceptible to damage caused by electrostatic discharge. It is possible for less than 100 volts of static electricity to cause damage to some electronic components. By comparison, it takes 4,000 volts for a person to even feel the effect of a static discharge.

There are several ways for a person to become statically charged. The most common methods of charging are by friction and by induction. An example of charging by friction is a person sliding across a seat, in which a charge of as much as 25,000 volts can build up. Charging by induction occurs when a person with well-insulated shoes stands near a highly charged object and momentarily touches ground. Charges of the same polarity are drained off, leaving the person highly charged with the opposite polarity. Static charges of either type can cause damage. Use care when handling and testing electronic components.

Diagnostic Information

The diagnostic charts and functional checks in this manual are designed to locate a faulty circuit or component through logic based on the process of elimination. **The charts are prepared with the requirement that the system functioned correctly at the time of assembly and that there are no multiple failures.**

Wiring Harness Service

Marine engine control circuits contain many special design features not found in standard land vehicle wiring. Environmental protection is used extensively to protect electrical contacts and proper splicing methods must be used.

The proper operation of low amperage input/output circuits depends upon good continuity between circuit connectors. Before component replacement and/or during normal troubleshooting procedures, visually inspect any questionable mating connector. Mating surfaces should be properly formed, clean and likely to make proper contact. Some typical causes of connector problems are listed below.

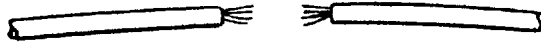
1. Improperly formed contacts and/or connector housing.
2. Damaged contacts or housing due to improper engagement.
3. Corrosion, sealer or other contaminants on the contact mating surfaces.
4. Incomplete mating of the connector halves during initial assembly or during subsequent troubleshooting procedures.
5. Tendency for connectors to come apart due to vibration and/or temperature cycling.
6. Terminals not fully seated in the connector body.
7. Inadequate terminal crimps to the wire.

Wire harnesses should be replaced with proper part number harnesses. When signal wires are spliced into a harness, use the same gauge wire with high temperature insulation only.

With the low current and voltage levels found in the system, it is important that the best possible bond be made at all wire splices by soldering the splices, as shown in the following illustrations. Use care when probing a connector or replacing connector terminals. It is possible to short between opposite terminals. If this happens, certain components can be damaged. Always use jumper wires with the corresponding mating terminals between connectors for circuit checking. **NEVER** probe through connector seals, wire insulation, secondary ignition wires, boots, nipples or covers. Microscopic damage or holes will result in eventual water intrusion, corrosion and/or component or circuit failure.

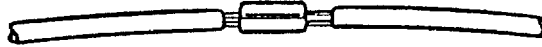
WIRE REPAIR

1. Locate damaged wire.
2. Remove insulation as required.



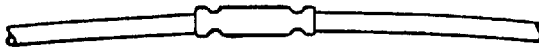
73048

3. Splice two wires together using splice clips and rosin core solder.



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4. Cover splice with heat shrink sleeve to insulate from other wires.



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Wiring Connector Service

Most connectors in the engine compartment are protected against moisture and dirt that could create oxidation and deposits on the terminals. This protection is important because of the very low voltage and current levels found in the electronic system. The connectors have a lock which secures the male and female terminals together. A secondary lock holds the seal and terminal into the connector.

When diagnosing, open circuits are often difficult to locate by sight because oxidation or terminal misalignment are hidden by the connectors. Merely wiggling a connector on a sensor or in the wiring harness may locate the open circuit condition. This should always be considered when an open circuit or failed sensor is indicated. Intermittent problems may also be caused by oxidized or loose connections.

Before making a connector repair, be certain of the type of connector. Some connectors look similar but are serviced differently. Replacement connectors and terminals are listed in the Parts Catalog.

Ensure that the connector seals are not deformed or crushed when mating the connectors together.

Abbreviations

in. hg	Inches Of Mercury	IGN	Ignition
BARO	Barometric Pressure	INJ	Injection
BAT	Battery Positive Terminal, Battery or System Voltage	kPa	Kilopascal
B+	Battery Positive	KS	Knock Sensor System
CKT	Circuit	KV	Kilovolts
CONN	Connector	MAP	Manifold Absolute Pressure
CYL	Cylinder	MIL	Malfunction Indicator Lamp
DEG	Degrees	mSec	Millisecond
DIAG	Diagnostic	N/C	Normally Closed
DIST	Distributor	N/O	Normally Open
DLC	Data Link Connector	PROM	Programmable Read Only Memory
DTC	Diagnostic Trouble Code	RAM	Random Access Memory
DVOM	Digital Volt Ohm Meter	REF HI	Reference High
ECM	Engine Control Module	REF LO	Reference Low
ECT	Engine Coolant Temperature	ROM	Read Only Memory
EEPROM	Electronic Erasable Programmable Read Only Memory	SLV	Slave
HEI	High Energy Ignition	SW	Switch
EMI	Electromagnetic Interference	TACH	Tachometer
ENG	Engine	TERM	Terminal
GND	Ground	TP	Throttle Position
GPH	Gallons Per Hour	V	Volts
IAC	Idle Air Control	VAC	Vacuum
IAT	Intake Air Temperature	WOT	Wide Open Throttle
IC	Ignition Control		

ECM Self-Diagnostics

The ECM performs a continual self-diagnosis on certain control functions. This diagnostic capability is complemented by the diagnostic procedures contained in this manual. The ECM's language for communicating the source of a malfunction is a system of diagnostic codes. The codes are two digit numbers that can range from 12 to 51. When a malfunction is detected by the ECM, a code is set and the Malfunction Indicator Lamp is illuminated.

Diagnostic Code Tool With Malfunction Indicator Lamp

There are various manufacturers of Diagnostic Code Tools. Most Tools are equipped with a Malfunction Indicator Lamp (MIL).

- It informs the service technician that a problem has occurred and that the vessel is in need of service as soon as reasonably possible.
- It displays Codes stored by the ECM which help the technician diagnose system problems.

As a bulb and system check, the lamp will come ON with the key on and the engine not running. When the engine is started, the light will turn OFF. If the lamp remains ON, the self-diagnostic system has detected a problem. If the problem goes away, the light will go out in most cases after ten seconds, but a code will remain stored in the ECM.

When the lamp remains ON while the engine is running, or when a malfunction is suspected due to a driveability problem, "EFI Diagnostic Circuit Check" must be performed. These checks will expose malfunctions which may not be detected if other diagnostics are performed prematurely.

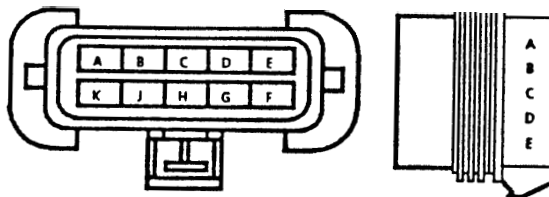
Intermittent Malfunction Indicator Lamp

In the case of an intermittent problem, the Malfunction Indicator Lamp will light for ten seconds and then will go out. However, the corresponding code will be stored in the memory of the ECM. When unexpected codes appear during the code reading process, one can assume that these codes were set by an intermittent malfunction and could be helpful in diagnosing the system.

An intermittent code may or may not reset. IF IT IS AN INTERMITTENT FAILURE, A DIAGNOSTIC CODE CHART IS NOT USED. Consult the "Diagnostic Aids" on the same page as the diagnostic code chart. "Troubleshooting" also covers the topic of "Intermittents." A physical inspection of the applicable sub-system most often will resolve the problem.

Reading Codes

The provision for communicating with the ECM is the Data Link Connector (DLC) connector. It is part of the EFI engine wiring harness, and is a 10-pin connector, which is electrically connected to the ECM. It is used in the assembly plant to receive information in checking that the engine is operating properly before it leaves the plant. The code(s) stored in the ECM's memory can be read either through a scan tool, (a diagnostic scanner that plugs into the DLC connector), or by counting the number of flashes of the Malfunction Indicator Lamp when the diagnostic code tool is installed and SERVICE mode is selected.



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DLC Connector

Once the diagnostic code tool has been connected, the ignition switch must be moved to the ON position, with the engine not running. At this point, the Malfunction Indicator Lamp should flash Code 12 three times consecutively. This would be the following flash sequence: flash, pause, flash-flash, long pause, flash, pause, flash-flash, long pause, flash, pause, flash-flash. Code 12 indicates that the ECM's diagnostic system is operating. If Code 12 is not indicated, a problem is present within the diagnostic system itself, and should be addressed by consulting the appropriate diagnostic chart in "Diagnostics."

Following the output of Code 12, the Malfunction Indicator Lamp will indicate a diagnostic code three times if a code is present, or it will simply continue to output Code 12. If more than one diagnostic code has been stored in the ECM's memory, the codes will be output from the lowest to the highest, with each code being displayed three times.

If a scan tool is used to read the codes, follow the manufacturer's instructions.

SERVICE MODE

When the diagnostic code tool is installed at the Data Link Connector (DLC) and the selector switch is set at SERVICE, the system will enter what is called the SERVICE mode. In this mode the ECM will:

1. Display a Code 12 by flashing the Malfunction Indicator Lamp (indicating the system is operating correctly).
2. Display any stored codes by flashing the Malfunction Indicator Lamp. Each code will be flashed three times, then Code 12 will be flashed again.
3. Holds ignition advance steady.

NORMAL MODE

Engines can be monitored in the normal mode. Certain parameters can be observed without changing the engine operating characteristics.

Scan Tools

The ECM can communicate a variety of information through the DLC connector. This data is transmitted at a high frequency which requires a scan tool for interpretation.

With an understanding of the data which the tool displays, and knowledge of the circuits involved, the tool can be very useful in obtaining information which would be more difficult or impossible to obtain with other equipment.

Scan tools do not make the use of diagnostic charts unnecessary, nor can they indicate exactly where a problem is in a particular circuit. Diagnostic tables incorporate diagnosis procedures using a scan tool where possible or a Diagnostic Code Tool (non-scan) if a scan tool is unavailable.

EFI Diagnostic Circuit Check

After the visual/physical inspection, the On Board Diagnostic (OBD) Circuit Check is the starting point for all diagnostic procedures. Refer to SECTION 5E.

The correct procedure to diagnose a problem is to follow two basic steps.

1. Are the on-board diagnostics working? This is determined by performing the On Board Diagnostic Circuit Check. Since this is the starting point for the diagnostic procedures, always begin here. If the on-board diagnostics are not working, the EFI Diagnostic Circuit Check will lead to a diagnostic chart in "Diagnostics" to correct the problem. If the on-board diagnostics are working correctly, go to step 2.
2. If a code is stored, go directly to the numbered code chart in SECTION 5F or 5G as appropriate. This will determine if the fault is still present.

Scan Tool Use With Intermittents

The scan tool allows manipulation of wiring harnesses or components with the engine not running, while observing the scan tool readout.

The scan tool can be plugged in and observed while running the vessel under the condition when the Malfunction Indicator Lamp turns ON momentarily or when the engine driveability is momentarily poor. If the problem seems to be related to certain parameters that can be checked on the scan tool, they should be checked while running the vessel. If there does not seem to be any correlation between the problem and any specific circuit, the scan tool can be checked on each position, watching for a period of time to see if there is any change in the readings that indicates intermittent operation.

The scan tool is also an easy way to compare the operating parameters of a poorly operating engine with those of a known good one. For example, a sensor may shift in value but not set a trouble code. Comparing the sensor's readings with those of the typical scan tool data readings may uncover the problem.

The scan tool has the ability to save time in diagnosis and prevent the replacement of good parts. The key to using the scan tool successfully for diagnosis lies in the technician's ability to understand the system he is trying to diagnose as well as an understanding of the scan tool operation and limitations. The technician should read the tool manufacturer's operating manual to become familiar with the tool's operation.

Non-Scan Diagnosis of Driveability Concerns (With No Codes Set)

If a driveability concern still exists after following the diagnostic circuit check and reviewing “Troubleshooting,” an out-of-range sensor may be suspected. Because of the unique design of the EFI system, fail-safes have been incorporated into the ECM to replace a sensed value with a default value in the case of a sensor malfunction or sensor wiring concern. By allowing this to occur, limited engine performance is restored until the vessel is repaired. A basic understanding of sensor operation is necessary in order to diagnose an out-of-range sensor.

If the sensor is within its working or acceptable parameters, as shown, the ECM does not detect a problem. If the sensor should happen to fall out of this “window,” a code will be stored. A known default value will replace the sensed value to restore engine performance.

If the sensor is out of range, but still within the operating window of the ECM, the problem will go undetected by the ECM and may result in trouble later.

A good example of this would be if the coolant sensor was reading incorrectly and indicating to the ECM that coolant temperature was at 20° F, but actual coolant temperature was 175° F. This would cause the ECM to deliver more fuel than was actually needed and result in an overly rich, rough running condition. This condition would not have caused a code to set as the ECM interprets this as within its range.

To identify a sensor which is out of range, unplug it while running the engine. After approximately two minutes, the diagnostic code for that sensor will set, a code, and replace the sensed value with a default value. If at that point a noticeable performance increase is observed, the non-scan code chart for that particular sensor should be followed to correct the problem.

NOTE: Be sure to clear each code after disconnecting and reconnecting each sensor. Failure to do so may result in a misdiagnosis of the problem.

Electronic Control Module (ECM) and Sensors

General Description

The MerCruiser Electronic Fuel Injection system is equipped with a computer that provides the operator with state-of-the-art control of fuel and spark delivery. Computers use voltage to send and receive information.

Computers and Voltage Signals

Voltage is electrical pressure. Voltage does not flow in circuits. Instead, voltage causes current. Current does the real work in electrical circuits. It is current, the flow of electrically charged particles, that energizes solenoids, closes relays and lights lamps.

Besides causing currents in circuits, voltage can be used as a signal. Voltage signals can send information by changing levels, changing waveform (shape), or changing the speed at which the signal switches from one level to another. Computers use voltage signals to communicate with one another. The different sections inside computers also use voltage signals to communicate with each other.

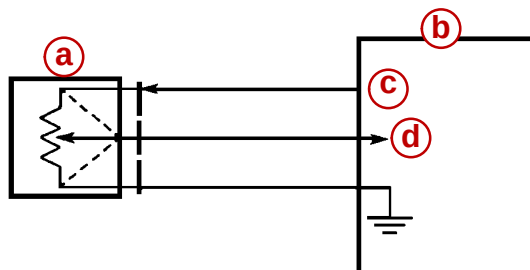
There are two kinds of voltage signals, analog and digital. Both of these are used in computer systems. It's important to understand the difference between them and the different ways they are used.

Analog Signals

An analog signal is continuously variable. This means that the signal can be any voltage within a certain range. An analog signal usually gives information about a condition that changes continuously over a certain range. For example, in a marine engine, temperature is usually provided by an analog signal. There are two general types of sensors that produce analog signals: the 3-wire and the 2-wire sensor.

THREE-WIRE SENSORS (MAP AND TP)

The following figure shows a schematic representation of a 3-wire sensor. All 3-wire sensors have a reference voltage, a ground and a variable "wiper." The lead coming off of the wiper will be the signal to the Engine Control Module (ECM). As this wiper position changes, the signal voltage returned to the computer also changes.

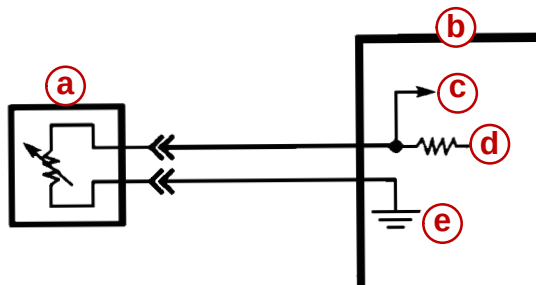


3-Wire Sensor

- a** - Typical Sensor
- b** - ECM
- c** - Voltage Out
- d** - Signal Input
- e** - Sensor Ground

TWO-WIRE SENSOR (ECT)

The following figure is the schematic of a 2-wire type sensor. This sensor is basically a variable resistor in series with a fixed-known resistor within the computer. By knowing the values of the input voltage and the voltage drop across the known resistor, the value of the variable resistor can be determined. The variable resistors that are commonly used are called thermistors. A thermistor's resistance varies inversely with temperature.

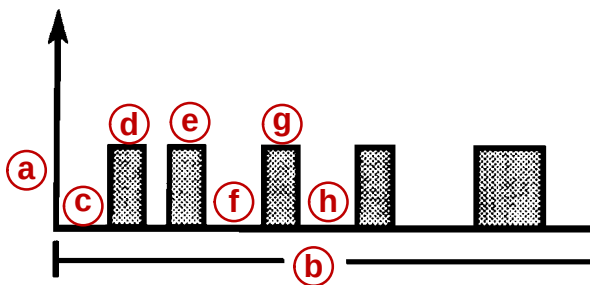


2-Wire Sensor

- a** - Typical Sensor
- b** - ECM
- c** - Signal Sensor
- d** - 5 Volt
- e** - Sensor Ground

Digital Signals

Digital signals are also variable, but not continuously. They can only be represented by distinct voltages within a range. For example, 1 V, 2 V or 3 V would be allowed, but 1.27 V or 2.65 V would not. Digital signals are especially useful when the information can only refer to two conditions - YES and NO, ON and OFF, or HIGH and LOW. This would be called a digital binary signal. A digital binary signal is limited to two voltage levels. One level is a positive voltage, the other is no voltage (zero volts). As you can see in the following figure, a digital binary signal is a square wave.



Digital Binary Signal

- a** - Voltage
- b** - Time
- c** - Lo
- d** - Hi
- e** - On
- f** - Off
- g** - Yes
- h** - No

The computer uses digital signals in a code that contains only ones and zeros. The high voltage of the digital signal represents a one (1), and no voltage represents a zero (0). Each zero and each one is called a bit of information, or just a "bit." Eight bits together are called a "word." A word, therefore, contains some combination of eight binary code bits: eight ones, eight zeros, five ones and three zeros, and so on.

Binary code is used inside a computer and between a computer and any electronic device that understands the code. By stringing together thousands of bits, computers can communicate and store an infinite variety of information. To a computer that understands binary, 11001011 might mean that it should reset engine rpm at a lower level. Although the computer uses 8-bit digital codes internally and when talking to another computer, each bit can have a meaning.

SWITCH TYPES

Switched inputs (also known as discretes) to the computer can cause one bit to change, resulting in information being communicated to the computer. Switched inputs can come in two types: they are "pull-up" and "pull-down" types. Both types will be discussed.

With a pull-up type switch, the ECM will sense a voltage when the switch is CLOSED. With the pull-down switch, the ECM recognizes the voltage when the switch is OPEN.

Discretes can also be used to inform a computer of FREQUENCY information.

PULSE COUNTERS

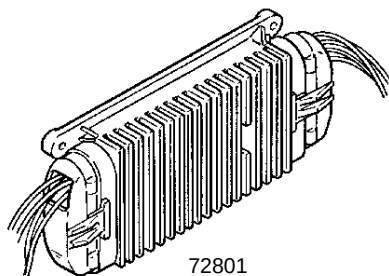
For the computer to determine frequency information from a switched input, the computer must measure the time between voltage pulses. As a number of pulses are recorded in a set amount of time, the computer can calculate the frequency. The meaning of the frequency number can have any number of meanings to the computer.

An example of a pulse counter type of input is the distributor reference pulse input. The computer can count a train of pulses, a given number of pulses per engine revolution, and determine the rpm of the engine.

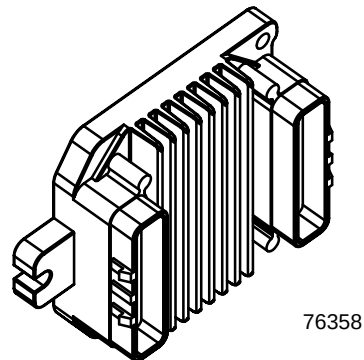
Engine Control Module (ECM)

The Engine Control Module (ECM) is the control center of the fuel injection system. It constantly monitors information from various sensors, and controls the systems that affect engine performance.

The ECM also performs a diagnostic function check of the system. It can recognize operational problems and store a code or codes which identify the problem areas to aid the technician in making repairs.



MEFI-1 and MEFI-2 ECM



MEFI-3 ECM

ECM FUNCTION

The ECM supplies 5 or 12 volts to power various sensors or switches. This is done through resistances in the ECM which are so high in value that a test light will not light when connected to the circuit. In some cases, even an ordinary shop voltmeter will not give an accurate reading because its resistance is too low. Therefore, the use of a **10 megohm input impedance digital voltmeter** is required to assure accurate voltage readings.

MEMORY

There are three types of memory storage within the ECM: ROM, RAM and EEPROM.

Read Only Memory (ROM) is a permanent memory that is physically soldered to the circuit boards within the ECM. The ROM contains the overall control programs. Once the ROM is programmed, it cannot be changed. The ROM memory is non-erasable, and does not need power to be retained.

Random Access Memory (RAM) is the microprocessor "scratch pad." The processor can write into, or read from, this memory as needed. This memory is erasable and needs a constant supply of voltage to be retained.

Electronic Erasable Programmable Read Only Memory (EEPROM) is the portion of the ECM that contains the different engine calibration information that is specific to each marine application.

Speed Density System

The Electronic Fuel Injection system is a speed and air density system. The system is based on speed / density fuel management.

Three specific data sensors provide the ECM with the basic information for the fuel management portion of its operation. That is, three specific signals to the ECM establish the engine speed and air density factors.

SPEED

The engine speed signal comes from the distributor's High Energy Ignition (HEI) module to the ECM on the distributor reference high circuit. The ECM uses this information to determine the speed or rpm factor for fuel and ignition management.

DENSITY

The Manifold Absolute Pressure (MAP) sensor is a 3-wire sensor that monitors the changes in intake manifold pressure which results from changes in engine loads. These pressure changes are supplied to the ECM in the form of electrical signals.

As intake manifold pressure increases (vacuum decreases), the air density in the intake manifold also increases, and additional fuel is required.

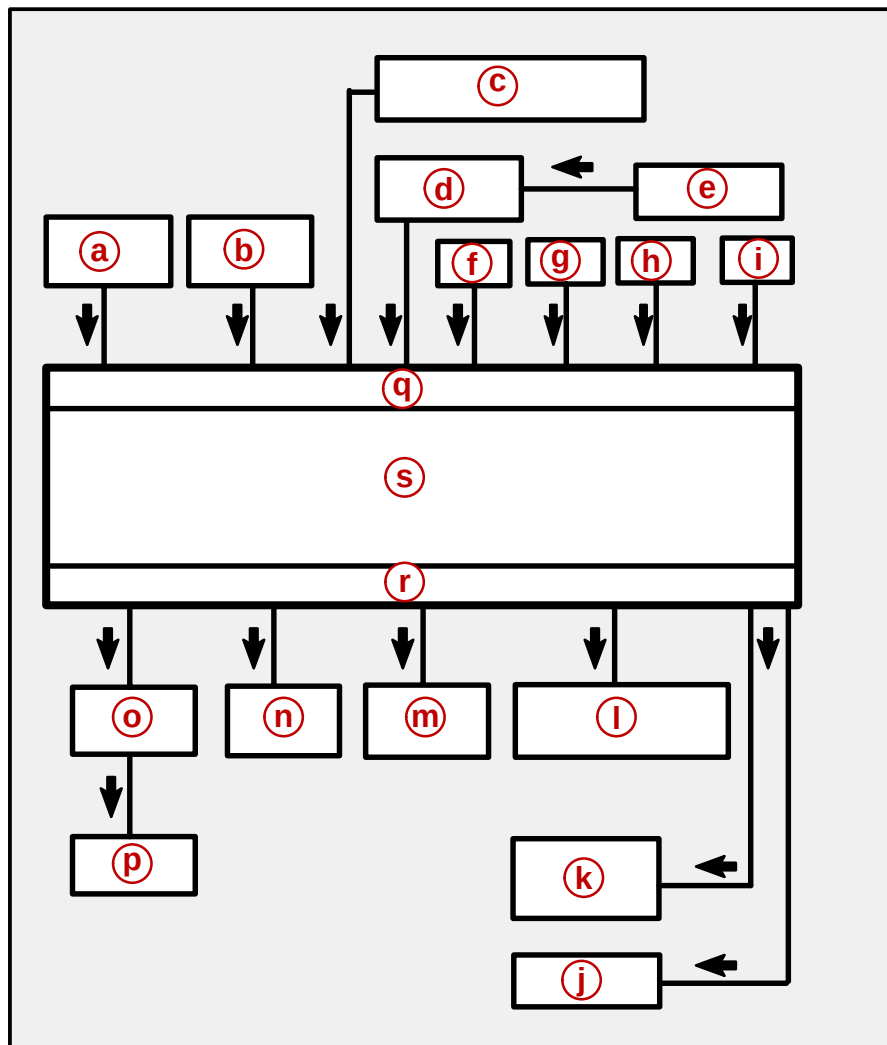
The MAP sensor sends this pressure information to the ECM, and the ECM increases the amount of fuel injected by increasing the injector pulse width. As manifold pressure decreases (vacuum increases), the amount of fuel is decreased.

These two inputs from MAP and rpm are the major determinants of the air/fuel mixture, delivered by the fuel injection system.

The remaining sensors and switches provide electrical inputs to the ECM which are used for modification of the air/fuel mixture, as well as for other ECM control functions, such as Idle Air Control (IAC).

ECM Input and Sensor Descriptions

The following lists the sensors, switches, and other inputs used by the ECM to control its various systems. Although we will not cover them all in great detail, there will be a brief description of each.

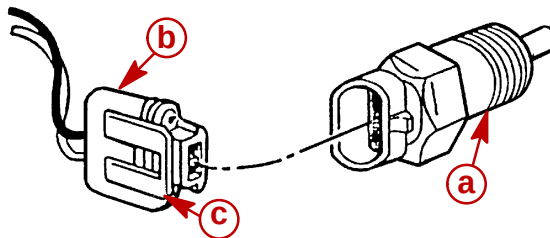


- a** - System Relay
- b** - Distributor For REF rpm
- c** - Discrete Switches (Audio Warning)
- d** - Knock Module
- e** - Knock Sensor
- f** - TP
- g** - MAP
- h** - ECT
- i** - IAT

- j** - Serial Data
- k** - Audio Warning Buzzer
- l** - Fuel Injectors
- m** - IAC Motor
- n** - Ignition Control Module
- o** - Fuel Pump Relay
- p** - Fuel Pump
- q** - Inputs
- r** - Outputs
- s** - ECM

ENGINE COOLANT TEMPERATURE (ECT) SENSOR

The Engine Coolant Temperature (ECT) Sensor is a thermistor (a resistor which changes value based on temperature) immersed in the engine coolant stream. Low coolant temperature produces a high resistance, while high temperature causes low resistance.



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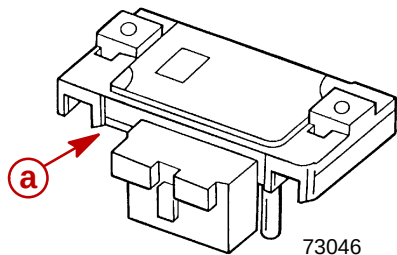
- a** - Engine Coolant Temperature (ECT) Sensor
- b** - Harness Connector
- c** - Locking Tab

The ECM supplies a 5 volt signal to the ECT through a resistor in the ECM and measures the voltage. The voltage will be high when the engine is cold, and low when the engine is hot. By measuring the voltage, the ECM knows the engine coolant temperature. Engine coolant temperature affects most systems the ECM controls.

A failure in the ECT circuit should set Code 14. Remember, this code indicates a failure in the coolant temperature sensor circuit, so proper use of the chart will lead to either repairing a wiring problem or replacing the sensor.

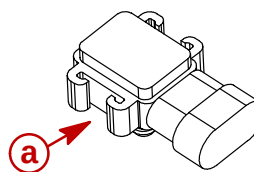
MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

The Manifold Absolute Pressure (MAP) sensor is a pressure transducer that measures the changes in the intake manifold pressure. The pressure changes as a result of engine load and speed change, and the MAP sensor converts this to a voltage output.



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Earlier Style



Later Style

- a** - Manifold Absolute Pressure (MAP) Sensor

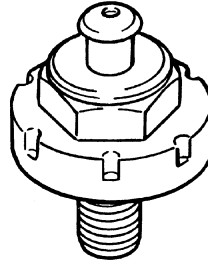
A closed throttle on engine coast-down would produce a relatively low MAP output voltage, while a wide open throttle would produce a high MAP output voltage. This high output voltage is produced because the pressure inside the manifold is the same as outside the manifold, so 100% of outside air pressure is measured. When manifold pressure is high, vacuum is low. The MAP sensor is also used to measure barometric pressure under certain conditions, which allows the ECM to automatically adjust for different altitudes.

The ECM sends a 5 volt reference signal to the MAP sensor. As the manifold pressure changes, the electrical resistance of the MAP sensor also changes. By monitoring the sensor output voltage, the ECM knows the manifold pressure. A higher pressure, low vacuum (high voltage) requires more fuel, while a lower pressure, higher vacuum (low voltage) requires less fuel. The ECM uses the MAP sensor to control fuel delivery and ignition timing.

A failure in the MAP sensor circuit should set a Code 33.

KNOCK SENSOR

On MEFI 1 and MEFI 2, the knock sensor is mounted on the lower right side of the engine block. MEFI 3 models do not have a knock sensor module mounted on the engine; it is located internal to the ECM.

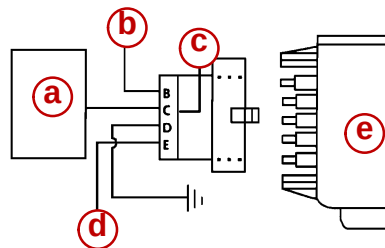


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When abnormal engine vibrations (spark knock) are present, the sensor produces a voltage signal which is sent to the KS Module and then to the ECM. The ECM uses this signal to aid in calculating ignition timing.

KNOCK SENSOR (KS) MODULE (MEFI 1 AND MEFI 2 MODELS ONLY)

When the key switch is turned on, 12 volts are supplied to the KS module B terminal through the system relay. If this 12 volts are not present, the KS module cannot send the 8-10 volt signal to the ECM. This will cause a false constant ignition spark timing retard and a Code will be set.



Knock Sensor System

- a** - Electronic Control Module (ECM)
- b** - 12 Volts Battery Positive
- c** - 8-12 Volts
- d** - Knock Sensor
- e** - Knock Sensor Module

The KS module monitors the knock sensor's AC voltage signal on terminal E. If no spark knock is present, an 8-10 volt signal is sent to the ECM by the KS module's terminal C. If spark knock is present, the module will remove this 8-10 volt signal to the ECM. The ECM will then retard the ignition spark timing to control the spark knock. If the circuit going to the module's E terminal opens or shorts to ground, the KS module cannot remove the 8-10 volt signal to the ECM and no spark retard will occur. The ground circuit for the KS module is connected to terminal D. If this circuit is open, the module cannot remove the 8-10 volt signal to the ECM either and spark knock cannot be controlled.

CAUTION

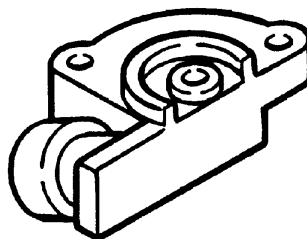
The correct Knock Sensor and KS module for an engine must be used or a spark knock may not be detected causing severe engine damage.

KNOCK SENSOR CIRCUITRY (MEFI-3 MODELS ONLY)

The MEFI-3 ECM is used with the knock sensor to control spark knock. The KS module circuitry is within the MEFI-3 ECM. When spark knock is present, a small AC voltage signal is sent from the knock sensor to the ECM through pin connector J1-30. (If the engine has a second KS, its voltage signal goes through pin connector J1-14). An AC voltage monitor inside the ECM will detect the spark knock and start retarding spark timing. A Code will be set only if the ECM does not see any activity on the KS signal circuit(s).

THROTTLE POSITION (TP) SENSOR

The Throttle Position (TP) Sensor is a potentiometer connected to the throttle shaft on the throttle body. The TP has one end connected to 5 volts from the ECM and the other to ECM ground. A third wire is connected to the ECM to measure the voltage from the TP. As the throttle valve angle is changed, the voltage output of the TP also changes. At a closed throttle position, the voltage output of the TP is low (approximately .5 volt). As the throttle valve opens, the output increases so that at wide-open-throttle (W.O.T.), the output voltage should be near 4.5 volts. By monitoring the output voltage from the TP, the ECM can determine fuel delivery based on throttle valve angle (driver demand). A broken or loose TP can cause intermittent bursts of fuel from the injector and an unstable idle, because the ECM thinks the throttle is moving.



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If the TP circuit is open, the ECM will set a Code 21. If the TP circuit is shorted, and a trouble Code 21 will be set. A problem in any of the TP circuits will set a Code 21. Once a trouble code is set, the ECM will use a default value for TP.

DISTRIBUTOR REFERENCE (DIST REF)

The distributor reference (engine speed signal) is supplied to the ECM by way of the "Dist Ref Hi" line from the High Energy Ignition (HEI). This pulse counter type input creates the timing signal for the pulsing of the fuel injectors, as well as the Ignition Control (IC) functions. This signal is used for a number of control and testing functions within the ECM.

DISCRETE SWITCH INPUTS

Several discrete switch inputs are utilized by the system to identify abnormal conditions that may affect engine operation. These switches are used in conjunction with the ECM to detect critical conditions to engine operation.

The switches which are used with the fuel injection system to detect critical engine operation parameters are:

Switch	Normal State
Oil Pressure	N/O (With Pressure)
Gear Lube Monitor Level on Sterndrive	N/O (When Full)
Transmission Temperature on MCM Models with Two-Speed Transmission	N/O (When Cold)
Transmission Temperature on MIE Models	N/O (When Cold)

Spark Management

High Energy Ignition with Ignition Control (IC)

The Electronic Fuel Injection is controlled by an Engine Control Module (ECM). This module is the nerve/decision center of the system. It uses all the information it gathers to manage ignition spark, delivering increased fuel economy and maximum engine performance.

The system uses inputs from sensors to make decisions on the amount of spark advance or retard allowed.

The system has been designed to control ignition advance and retard electronically by the ECM.

In order for the ECM to properly calculate spark advance, it must always know at what speed the engine is running. The engine speed signal is accomplished by a circuit within the distributor module which converts the pickup coil voltage to a square wave reference signal that can be used by the ECM. This square wave engine speed reference signal is known as REF HI. With MEFI 1 or MEFI 2, the ECM must also have something to compare the REF HI value against. Therefore, an additional line is provided between the ECM and the distributor module that is known as REF LO. These two lines, between the ECM and the distributor, provide a precise indication of engine speed.

With MEFI 1 or MEFI 2, the two other lines between the ECM and distributor that control the Ignition Control (IC) operation are known as the bypass and IC circuits.

Modes Of Operation

DISTRIBUTOR MODULE MODE (MEFI 1 AND MEFI 2 ONLY)

The ignition system operates independent of the ECM. The distributor module in the distributor maintains a base ignition timing and is able to advance timing to a total of 27 degrees. This mode is in control when a Code 42 is detected while engine is running and will have a noticeable affect on engine operation.

The following describes IC operation during cranking and when the engine starts running. To help understand how IC circuits operate, a relay with a double set of contact points is shown in the IC module (refer to the figures "Ignition Control Mode" and "ECM Control Mode"). Solid state circuitry is used in the module, but showing the relay makes it easier to visualize how the IC module functions.

During cranking, the relay is in the de-energized position (see figure "Distributor Module Mode"). This connects the pickup coil to the base of the transistor via the signal converter. When the pickup coil applies a positive voltage to the transistor, the transistor turns ON. When voltage is removed, the transistor turns OFF. When the transistor turns ON, current flows through the primary winding of the ignition coil. When it turns OFF, the primary current stops and a spark is developed at the spark plug. A small amount of advance is built into the IC module via a timing circuit, in case the engine remains in the ignition module timing mode.

With the relay de-energized, a set of contacts (shown closed) would ground the IC line signal.

ECM CONTROL MODE

The ECM control mode controls the ignition timing. The ECM calculates the desired ignition timing based on information it gets from its input sensors.

(MEFI 1 and MEFI 2) When the engine rpm reaches a predetermined value (for this example, 300 rpm), the ECM considers the engine running and applies five volts on the bypass line to the IC module. This energizes the relay and causes the contacts from the pickup coil as well as the grounding contacts for the IC line to open (see figure "ECM Control Mode"). This connects the IC line to the base of the transistor, and bypasses the ignition module timing control.

The IC system is now controlled by the IC signal from the ECM and the time at which the spark occurs can be determined by a variable time circuit in the ECM.

Base Ignition Timing (Continued)

- a** - Ignition Coil Trigger Signal
- b** - Battery
- c** - Relay
- d** - Module Advance
- e** - Signal Converter
- f** - Pick Up Coil
- g** - Ground
- h** - Manifold
- i** - Coolant Temperature
- j** - ECM
- k** - IC
- l** - REF HI
- m** - Bypass
- n** - REF LO
- o** - Grounded
- p** - No Voltage Applied
- q** - Not Grounded
- r** - Voltage Applied

Results of Incorrect Operation

Open IC Line from the ECM to the Distributor Module - While the engine is cranking, the ECM expects to see the IC signal pulled to virtually zero because it is grounded in the distributor module. Since the IC line is open, it cannot be grounded by the module and the IC signal will be able to rise and fall, or do what is called toggling. The ECM recognizes the toggling as an abnormal condition, and will not apply bypass voltage to the distributor module when the engine reaches run rpm.

Since bypass voltage is not applied to the relay, it remains open and the engine continues to run on the pickup coil triggering in the ignition module timing mode.

If this condition occurs while the engine is running, the engine will stop, but it will restart and run in the ignition module timing mode with reduced power.

Grounded IC Line - During cranking, the IC voltage is at virtually zero so the ECM does not recognize a problem. When engine rpm reaches the value for the run condition, the ECM applies bypass voltage to the distributor module. Bypass voltage on the module switches the distributor power transistor to the IC line. Because the IC line is grounded, it will have no voltage applied so it cannot operate the power transistor to enter the IC mode.

If the IC line becomes grounded while the engine is being operated, the engine will stop and will be difficult to restart.

An open or ground in the IC or bypass will cause the engine to run on the distributor module timing. This will cause reduced performance, poor fuel economy and erratic idle.

Grounded or Open Bypass Line - While the engine is cranking, the IC line will be grounded and the ECM will not notice anything abnormal. When run rpm is reached, the ECM applies bypass voltage to the bypass line but because of the ground or open, it will not be able to energize the relay. Therefore, the relay will stay de-energized and the IC line will remain grounded.

When the ECM sees the IC line not toggling, it will not enter the IC mode. Since the relay is de-energized, the engine will continue to run in the ignition module timing mode.

If this condition occurs while the engine is running, the engine will simply operate in the ignition module timing mode.

Open or Grounded REF HI Line - This line provides the ECM with engine speed information. If this line is open or grounded, the ECM will not know that the engine is cranking or running and will not run.

Open or Grounded REF LO Line - This wire is grounded in the ignition module and provides a reference ground from the ignition module to the ECM. The ECM compares reference ground with reference high voltage. If this circuit is open, or grounded at any other location than through the module, it may cause poor performance.

Fuel Metering System

General Description

The function of the fuel metering system is to deliver the correct amount of fuel to the engine under all operating conditions. The fuel is delivered to the engine by individual fuel injectors mounted in the intake manifold near each cylinder (MPI) or from two injectors mounted on top of the intake manifold (EFI).

Cool Fuel Systems

This system was used on later MerCruiser MEFI-1, MEFI-2 and MEFI-3 ECM engines. This system has a fuel cooler and the electric fuel pump inside a box on the lower, port side of the engine. The fuel regulator for this system is mounted on the fuel cooler.

Early versions of the MEFI-1 systems had a second regulator mounted in the fuel rail. This regulator does not control system fuel pressure. It is used to dampen fuel system pulsation only. Later versions of the MEFI-1 and the MEFI-3 have this regulator removed from the fuel rail.

Modes of Operation

The ECM looks at voltages from several sensors to determine how much fuel to give the engine. The fuel is delivered under one of several conditions, called modes. All the modes are controlled by the ECM and are described below.

STARTING MODE

When the ignition switch is turned to the crank position, the ECM turns ON the fuel pump relay and the fuel pump builds up pressure. The ECM then checks the Engine Coolant Temperature (ECT) sensor and Throttle Position (TP) sensor and determines the proper air/fuel ratio for starting. The ECM controls the amount of fuel delivered in the starting mode by changing how long the injectors are turned ON and OFF. This is done by pulsing the injectors for very short times.

CLEAR FLOOD MODE

If the engine floods, it can be cleared by opening the throttle half way (50%). The ECM discontinues fuel injector pulsation as long as the throttle is between 50 to 75 % and the engine rpm is below 300. If the throttle position becomes more than 75% or less than 50%, the ECM returns to the starting mode.

RUN MODE

When the engine is started and rpm is above 300, the system operates in the run mode. The ECM will calculate the desired air/fuel ratio based on these ECM inputs: rpm, Manifold Absolute Pressure (MAP) sensor, and Engine Coolant Temperature (ECT) sensor. Higher engine load (from MAP) and colder engine temperature (from ECT) requires more fuel, or a richer air/fuel ratio.

ACCELERATION MODE

The ECM looks at rapid changes in Throttle Position (TP) and provides extra fuel by increasing the injector pulse width.

FUEL CUTOFF MODE

No fuel is delivered by the injectors when the ignition is OFF, to prevent dieseling. Also, fuel pulses are not delivered if the ECM receives no distributor reference pulses, which means the engine is not running. The fuel cutoff mode is also enabled at high engine rpm, as an overspeed protection for the engine. When cutoff is in effect due to high rpm, injection pulses will resume after engine rpm drops slightly.

DECELERATION MODE

The IAC is similar to a carburetor dashpot. It provides additional air when the throttle is rapidly moved to the idle position to prevent the engine from dying.

REV-LIMIT MODE

A fuel cutoff function is enabled at higher engine rpm. When the ECM senses that the engine has exceeded its specified maximum rpm, no fuel is delivered by the injectors. After the rpm drops below the specified maximum rpm, the ECM will resume fuel delivery.

MEFI-3 LOAD ANTICIPATION MODE

The Load Anticipation mode is available on MIE inboard engines only. The function is used to help inboard engines during shifting. An electrical signal from the neutral safety switch (on the transmission) is used to tell the ECM if the switch is closed or open. In neutral gear, the neutral safety switch is closed (signal grounded). When shifting into gear, the switch opens (signal open).

When the transmission is shifted into gear, the open signal causes the ECM to add a calibrated amount of bypass air with the IAC. This is done to increase the load handling capability of the engine when going into gear on larger boats. When shifting back into neutral gear, the additional IAC bypass air is removed in an attempt to limit engine rpm flares. The amount of IAC air used is constantly monitored by the ECM. After the transmission is shifted, and the engine has stabilized, the ECM calculates an 'error band' from the Moving Desired rpm mode and adjusts the Load Anticipation mode IAC count accordingly. This allows the ECM to 'learn' the best IAC bypass air position to use for shift conditions in each particular boat.

MOVING DESIRED RPM MODE

IMPORTANT: An improperly adjusted throttle cable can cause the engine idle rpm to be higher than the normal 600 rpm even when the control lever returns to the idle rpm position.

A Moving Desired RPM mode has been added to the MEFI 3 ECM. this mode will increase the desired idle rpm to a calibrated set point according to the throttle position. When the Throttle Position (TP) sensor is at the closed throttle setting, the ECM will use Idle Air Control (IAC) and Ignition Control (IC) to maintain the calculated desired rpm. This will smooth the transition from idle (closed throttle) to higher throttle settings. It will also help maintain constant low engine speeds from approximately 600 to 1200 rpm. At 5% or greater TP sensor setting, the Moving Desired RPM mode is not active.

Throttle Body Injection Components

FUEL PUMP ELECTRICAL COMPONENTS

When the ignition switch is turned to the RUN position, the ECM will turn ON the fuel pump relay for two seconds.

When the ignition switch is turned to the crank position, the ECM turns the fuel pump relay ON causing the fuel pump to start.

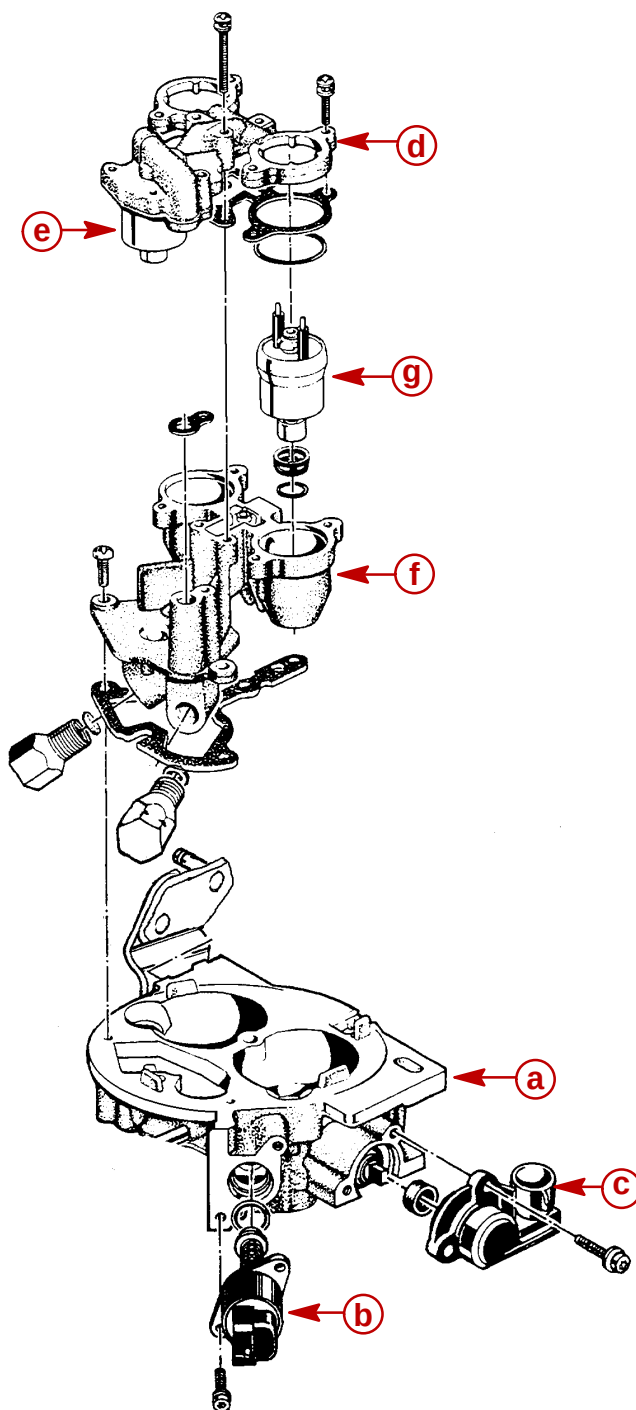
If the ECM does not receive ignition reference pulses (engine cranking or running), it shuts Off the fuel pump relay, causing the fuel pump to stop.

THROTTLE BODY UNIT

The throttle body unit consists of three assemblies.

- Fuel meter cover and fuel damper
- Fuel meter body and fuel injectors
- Throttle Body
 - Two Throttle Valves To Control Air Flow Into The Engine
 - Idle Air Control (IAC) Valve
 - Throttle Position (TP) Sensor

THROTTLE BODY UNIT EXPLODED VIEW



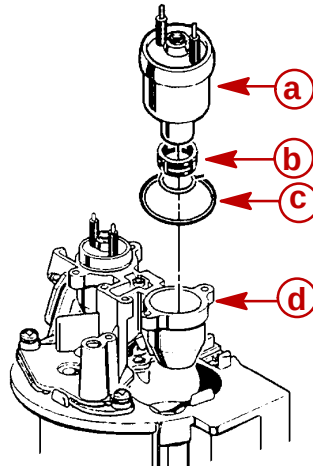
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- a** - Throttle Body
- b** - Idle Air Control (IAC) Valve
- c** - Throttle Position (TP) Sensor
- d** - Fuel Meter Cover
- e** - Fuel Damper
- f** - Fuel Meter Body
- g** - Fuel Injector (2)

FUEL INJECTORS

The injector assembly is a solenoid operated device, controlled by the ECM, that meters pressurized fuel to the intake manifold. The ECM energizes the injector solenoid, which opens a ball valve, allowing fuel to flow past the ball valve, and through a recessed flow director plate.

The director plate has six machined holes that control the fuel flow, generating a conical spray pattern of finely atomized fuel at the injector tip. Fuel is directed at the throttle, causing it to become further atomized before entering the intake manifold.

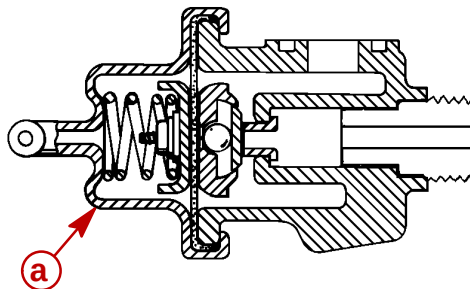


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- a** - Fuel Injector
- b** - Fuel Filter
- c** - Seal Ring
- d** - Fuel Meter Body

FUEL PRESSURE REGULATOR

The pressure regulator is a diaphragm-operated relief valve with fuel pump pressure on one side, and regulator spring pressure on the other. The regulator's function is to maintain a constant pressure differential across the injectors at all times. The regulator is located on the cool fuel assembly. Refer to "Fuel Delivery" Section of this manual.

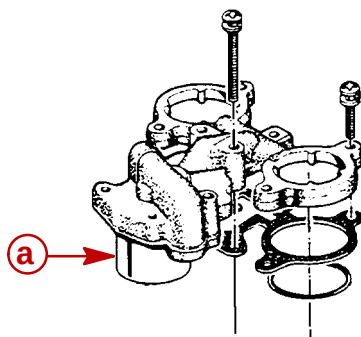


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- a** - Fuel Pressure Regulator

FUEL DAMPER

The fuel damper acts as an equalization device to reduce the pressure spikes caused by the fuel injectors.

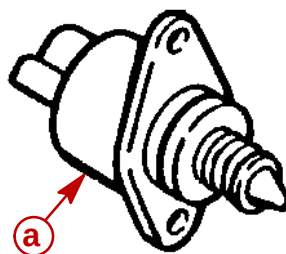


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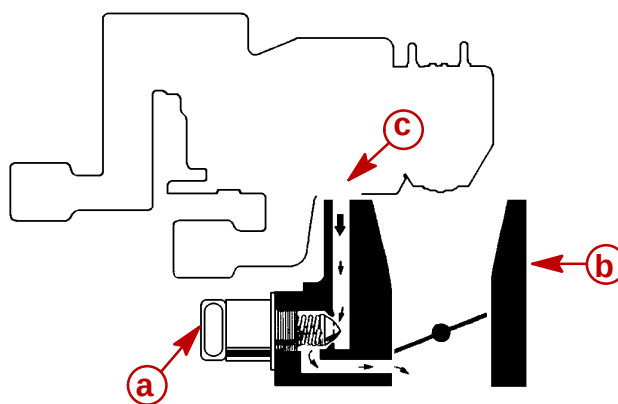
a - Fuel Damper

IDLE AIR CONTROL (IAC) VALVE

The purpose of the IAC valve assembly is to control engine idle speed, while preventing stalls due to changes in engine load. The IAC valve, mounted in the throttle body, controls bypass air around the throttle valves.



72800



IAC Valve Air Flow Diagram

- a** - IAC Valve
- b** - EFI Throttle Body
- c** - Air Flow

By moving a conical valve known as a pintle, IN, toward the seat (to decrease air flow), or OUT, away from the seat (to increase air flow), a controlled amount of air moves around the throttle valve. If rpm is too low, more air is bypassed around the throttle valve to increase it. If rpm is too high, less air is bypassed around the throttle valve to decrease it.

The ECM moves the IAC valve in small steps, called counts. These can be measured by scan tool test equipment, which plugs into the DLC.

During idle, the proper position of the IAC valve is based on engine rpm. If the rpm drops below specification and the throttle valve is closed, the ECM senses a near stall condition and calculates a new valve position to prevent stalling.

- Engine idle speed is a function of total air flow into the engine based on IAC valve pintle position + throttle valve stop screws and PCV.
- “Controlled” idle speed is programmed into the ECM, which determines the correct IAC valve pintle position to maintain the desired idle speed for all engine operating conditions and loads.
- The minimum idle air rate is set at the factory with stop screws. This setting allows enough air flow by the throttle valves to cause the IAC valve pintle to be positioned a calibrated number of steps (counts) from the seat during “controlled” idle operation.
- If the IAC valve is disconnected and reconnected with the engine running, the idle speed may be wrong. In this case, the IAC valve can be reset by doing the following: turn off engine, wait ten seconds, and restart engine.

350 Mag MPI And Black Scorpion - Multi-Port Injection Components

FUEL PUMP ELECTRICAL CIRCUIT

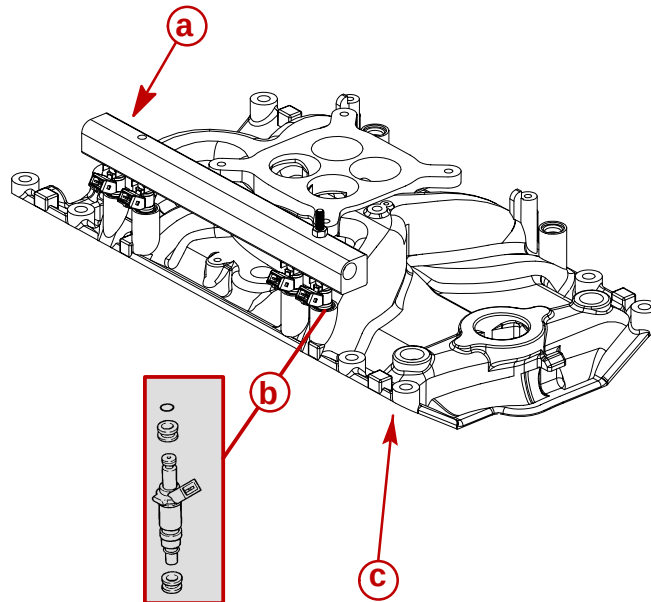
When the ignition switch is turned to the RUN position, the ECM will turn ON the fuel pump relay for two (2) seconds.

When the ignition switch is turned to the crank position, the ECM turns the fuel pump relay ON causing the fuel pump to start.

If the ECM does not receive ignition reference pulses (engine cranking or running), it shuts OFF the fuel pump relay, causing the fuel pump to stop.

FUEL RAIL / INTAKE MANIFOLD ASSEMBLY

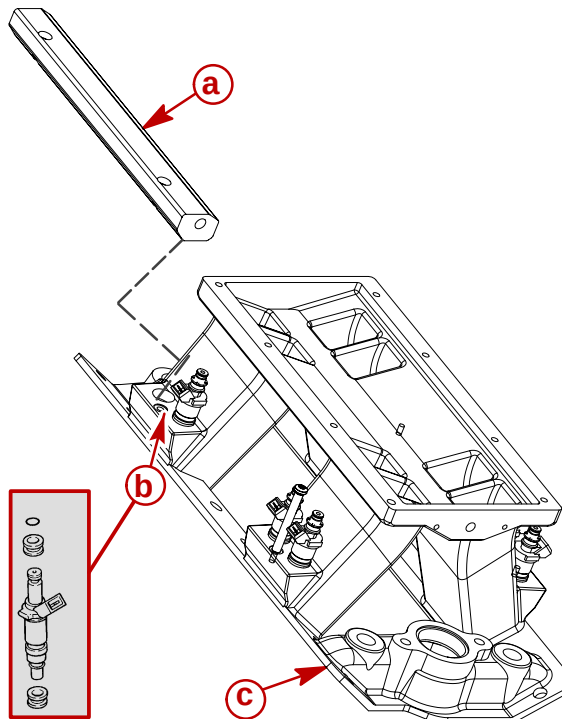
The fuel rail performs several functions. It positions the injectors in the intake manifold, distributes fuel evenly to the injectors.



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350 Mag MPI Models

- a** - Fuel Rail
- b** - Fuel Injector
- c** - Intake Manifold



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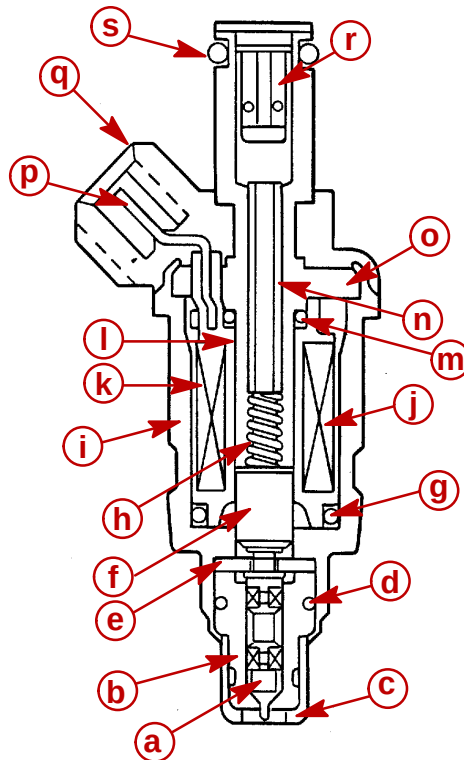
Black Scorpion Models

- a** - Fuel Rail
- b** - Fuel Injector
- c** - Intake Manifold

FUEL INJECTORS

The EFI injector assembly is a solenoid-operated device, controlled by the ECM, that meters pressurized fuel to a single engine cylinder. The ECM grounds the injector solenoid, which opens a pintle valve, allowing fuel to flow past the pintle valve. The injector tip has holes that control the fuel flow, generating a conical spray pattern of finely atomized fuel at the injector tip. Fuel is directed at the intake valve, causing it to become further atomized and vaporized before entering the combustion chamber.

An injector that is stuck partly open will cause loss of pressure after engine shutdown. This can result in long cranking times. Dieseling can also occur, because some fuel might be delivered to the engine after the ignition is turned OFF.



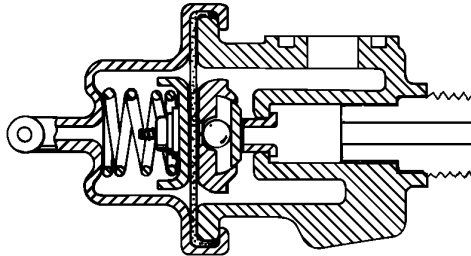
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MEFI 1 Injector Shown

- a** - Nozzle
- b** - Cap
- c** - O-Ring
- d** - Valve Stopper
- e** - Core
- f** - O-Ring
- g** - Spring
- h** - Housing
- i** - Solenoid Coil
- j** - Tape
- k** - Bobbin
- l** - O-Ring
- m** - Inner Collar
- n** - Sleeve
- o** - Terminal
- p** - Connector
- q** - Filter
- r** - O-Ring

FUEL PRESSURE REGULATOR ASSEMBLY

MEFI 1 and MEFI 2 Only: The pressure regulator is a diaphragm-operated relief valve with fuel pump pressure on one side, and regulator spring pressure and intake manifold vacuum on the other. The regulator's function is to maintain a constant pressure differential across the injectors at all times. The pressure regulator compensates for engine load by increasing fuel pressure as engine vacuum drops. The fuel pressure regulator is located on the cool fuel assembly.



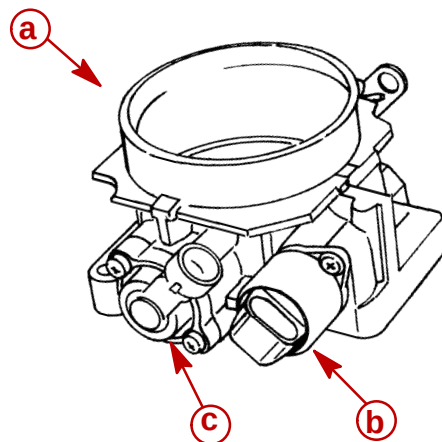
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THROTTLE BODY ASSEMBLY

The throttle body assembly is used to control air flow into the engine, thereby controlling engine output. The throttle valve within the throttle body is opened by the operator through the accelerator controls. During engine idle, the throttle valve is almost closed, and air flow control is handled by the Idle Air Control (IAC) valve, described later in this section.

THROTTLE POSITION (TP) SENSOR

The throttle body provides the location for mounting the Throttle Position (TP) sensor for sensing throttle valve position.



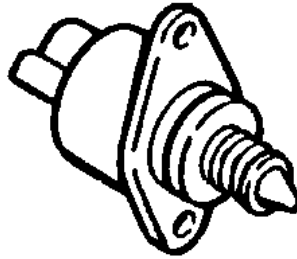
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350 Mag MPI Shown - Scorpion Is Similar

- a** - Throttle Body
- b** - Idle Air Control (IAC) Valve
- c** - Throttle Position Sensor

IDLE AIR CONTROL (IAC) VALVE

The purpose of the IAC valve assembly is to control engine idle speed, while preventing stalls due to changes in engine load. The IAC valve, mounted in the throttle body, controls bypass air around the throttle valves.



72800

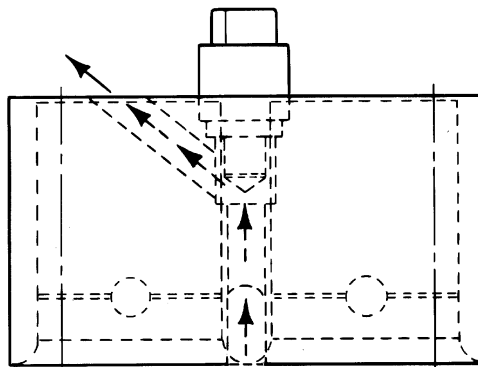
Idle Air Control (IAC) Valve

By moving a conical valve known as a pintle, IN, toward the seat (to decrease air flow), or OUT, away from the seat (to increase air flow), a controlled amount of air moves around the throttle valve. If rpm is too low, more air is bypassed around the throttle valve to increase it. If rpm is too high, less air is bypassed around the throttle valve to decrease it.

The ECM moves the IAC valve in small steps, called counts. These can be measured by scan tool test equipment, which plugs into the DLC connector.

During idle, the proper position of the IAC valve is engine load, and engine rpm. If the rpm drops below specification and the throttle valve is closed, the ECM senses a near stall condition and calculates a new valve position to prevent stalling.

- Engine idle speed is a function of total air flow into the engine based on IAC valve pintle position.
- “Controlled” idle speed is programmed into the ECM, which determines the correct IAC valve pintle position to maintain the desired idle speed for all engine operating conditions and loads.
- The minimum idle air rate is set at the factory with stop screws. This setting allows enough air flow by the throttle valves to cause the IAC valve pintle to be positioned a calibrated number of steps (counts) from the seat during “controlled” idle operation.
- If the IAC valve is disconnected and reconnected with the engine running, the idle speed may be wrong. In this case, the IAC valve can be reset by doing the following: Turn off engine, wait ten seconds, and restart engine.



IAC Valve Air Flow Diagram

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FUEL SYSTEM

Section 5E - Fuel Injection Disassembly And Reassembly

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Knock Sensor	5E-18	Throttle Body Assembly	5E-51
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Flame Arrestor	5E-25	(ECT) Sensor	5E-62
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Fuel Pressure Relief Procedure	5E-27	(MAP) Sensor	5E-63
Black Scorpion Components	5E-27	Throttle Position (TP) Sensor	5E-64
Flame Arrestor	5E-27	Idle Air Control (IAC) Valve	5E-65
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Plenum	5E-35	Vacuum And Vent Hose Routing	5E-68
Fuel Rails	5E-37	Throttle Body EFI Models	5E-68
Fuel Injectors	5E-39		

Service Precautions

WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

WARNING

Be careful when cleaning flame arrestor and crankcase ventilation hose; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in the area while changing fuel filter(s). Wipe up any spilled fuel immediately.

WARNING

Be sure that the engine compartment is well ventilated and that no gasoline vapors are present to avoid the possibility of fire.

WARNING

Make sure no fuel leaks exist, before closing engine hatch.

CAUTION

Fuel pressure MUST BE relieved before servicing high pressure component in the fuel system.

CAUTION

DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

The following information MUST BE adhered to when working on the fuel system:

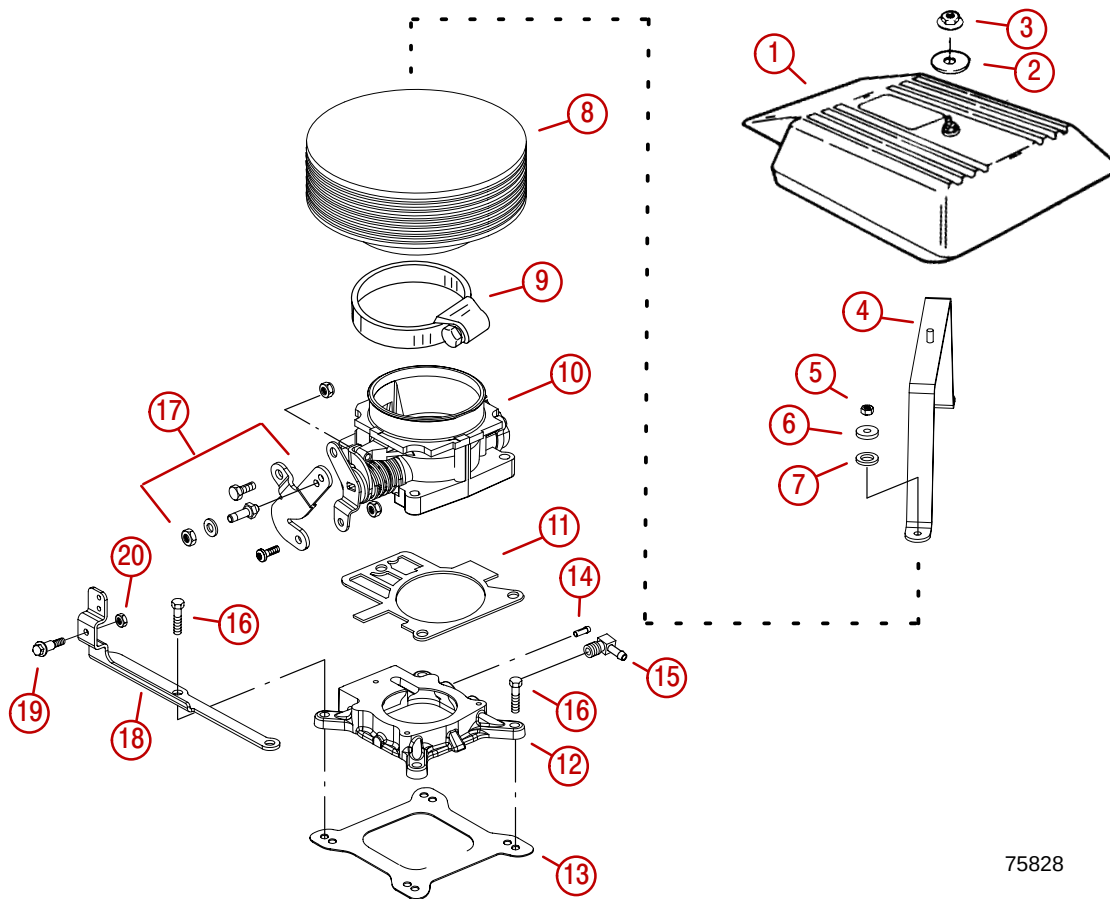
- Always keep a dry chemical fire extinguisher at the work area.
- Always install new O-rings when assembling fuel pipe fittings.
- DO NOT replace fuel pipe with fuel hose.
- DO NOT attempt any repair to the fuel system until instructions and illustrations relating to that repair are thoroughly understood.
- Observe all Notes and Cautions.

Torque Specifications

Fastener Location	lb-in.	lb-ft	Nm
Throttle Body to Adapter		15	19
TP Sensor	20		2
IAC Valve	20		2
MAP Sensor	44-62		5-7
Knock Sensor to Block		12-16	16.3-21.7
Intake Manifold to Plenum	150		17
Fuel Rail	105		12
Fuel Line Connections		18	24
Fuel Meter Cover Assembly Screws	28		3
Fuel Inlet and Return Lines		23	31
ECT Sensor	Hand Tight + 2 1/2 turns maximum		
Flame Arrestor Cover Bracket	Tighten Securely		
Flame Arrestor Clamp			

Exploded Views - 350 Mag MPI

Flame Arrestor And Throttle Body

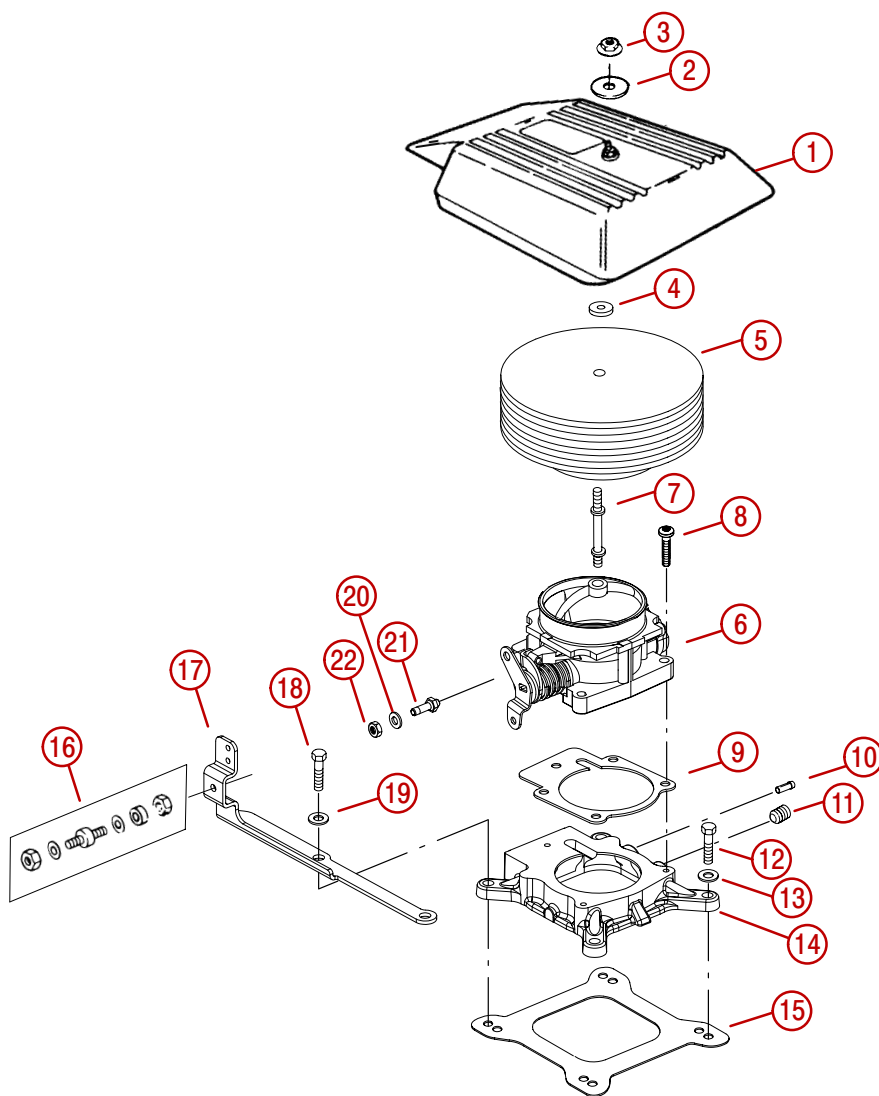


75828

Earlier Models

- 1** - Cover
- 2** - Washer
- 3** - Nut (1/4-28)
- 4** - Flame Arrestor Bracket
- 5** - Nut (1/4-20)
- 6** - Washer
- 7** - Washer
- 8** - Flame Arrestor
- 9** - Clamp
- 10** - Throttle Body Assembly
- 11** - Gasket
- 12** - Throttle Body Adaptor Plate
- 13** - Gasket
- 14** - 3/16 In. Barb Fitting (From Fuel Pressure Regulator)
- 15** - 3/8 In. Barb Elbow Fitting (From PCV Valve)
- 16** - Screw [5/16-18 x 1-1/4 in. (32 mm)]
- 17** - Throttle Lever and Linkage
- 18** - Throttle Cable Bracket
- 19** - Shoulder Screw
- 20** - Nut (1/4-20)

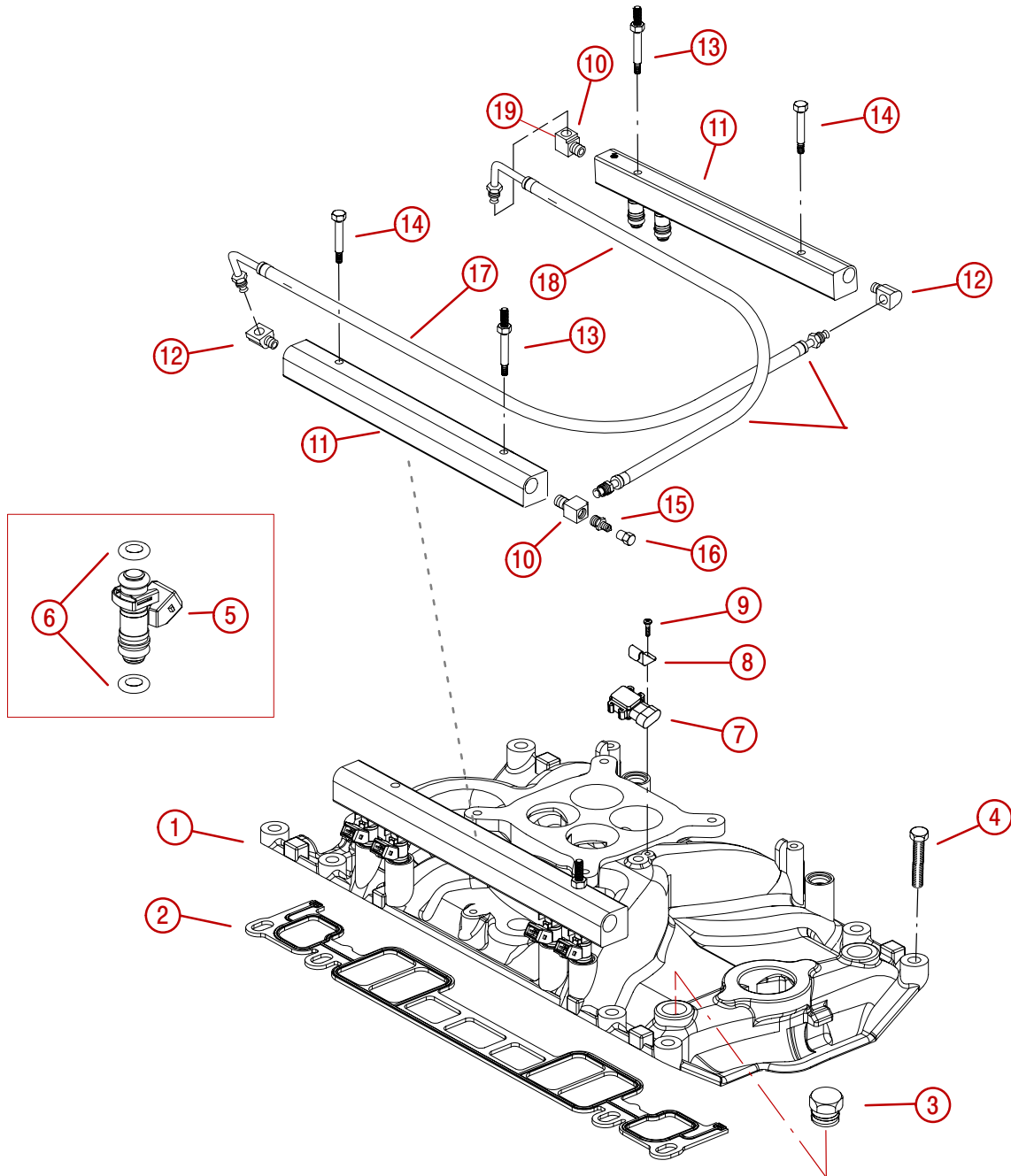
Flame Arrestor And Throttle Body



Later Models

- | | |
|--|---|
| 1 - Cover | 12 - Screw [5/16-18 x 1-1/4 in. (32 mm)] |
| 2 - Washer | 13 - Washer |
| 3 - Nut (1/4-28) | 14 - Throttle Body Adaptor Plate |
| 4 - Washer | 15 - Gasket |
| 5 - Flame Arrestor | 16 - Stud Kit |
| 6 - Throttle Body Assembly | 17 - Throttle Cable Bracket |
| 7 - Stud | 18 - Screw (5/16-18 x 1 in.) |
| 8 - Screw (1/4-20) | 19 - Washer |
| 9 - Gasket | 20 - Washer |
| 10 - 3/16 in. Barb Fitting (From Fuel Pressure Regulator) | 21 - Stud (1/4 x 1-3/4 in.) |
| 11 - Pipe Plug (1/4-18 Socket Head) | 22 - Nut (1/4-28) |

Intake Manifold And Fuel Rail

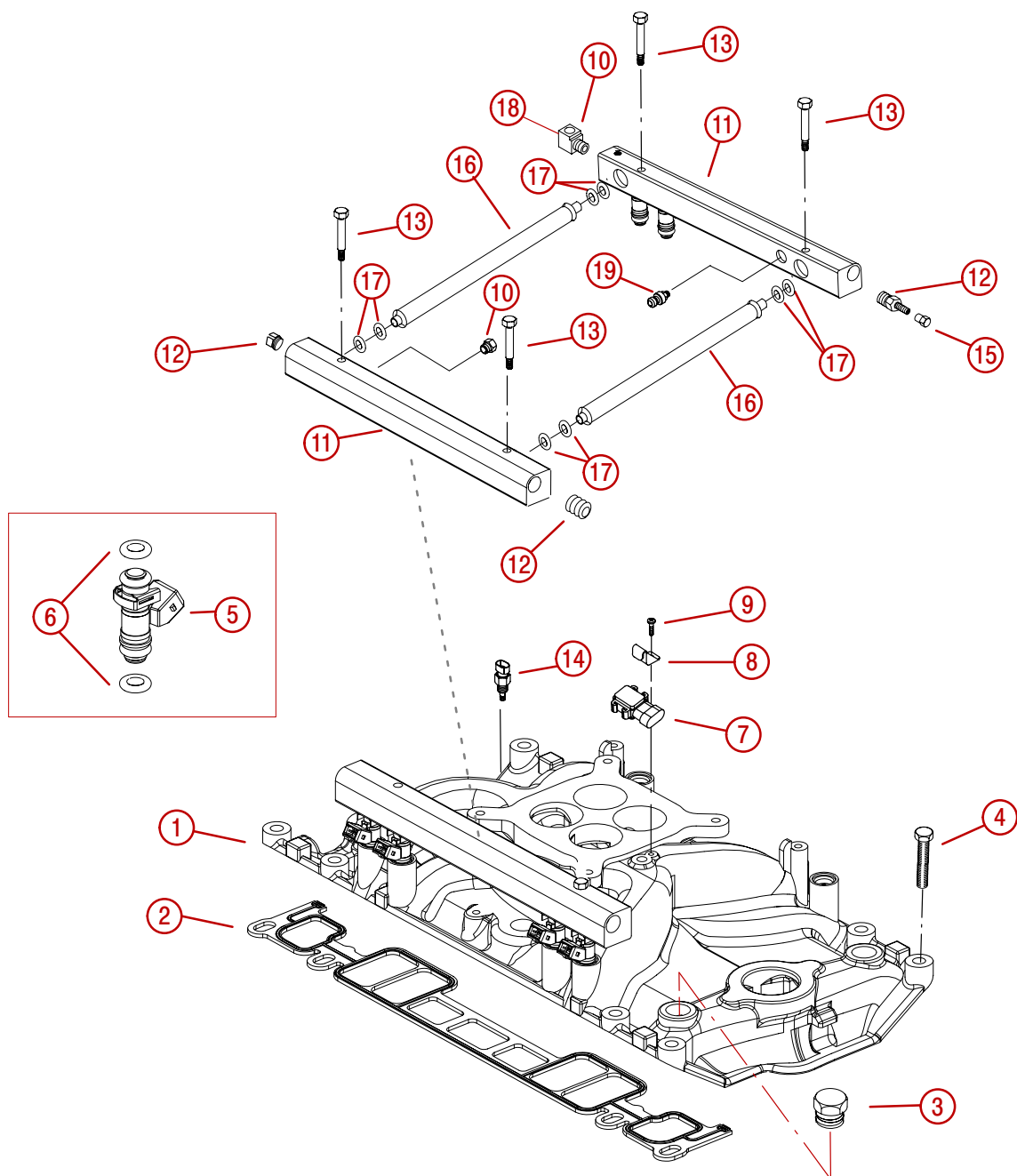


75829

MEFI 1 and MEFI 2 Models

- | | |
|---|--|
| 1 - Intake Manifold | 11 - Fuel Rail |
| 2 - Gasket | 12 - Elbow Fitting |
| 3 - Pipe Plug | 13 - Stud (2) |
| 4 - Screw [5/16-18 x 1-3/8 in.(35 mm)] | 14 - Screw (1/4-20) |
| 5 - Fuel Injector | 15 - Schrader Valve |
| 6 - Upper O-Ring | 16 - Cap |
| 7 - MAP Sensor | 17 - 24 In. (609 mm) Fuel Line |
| 8 - Clip | 18 - 21 In. (533 mm) Fuel Line |
| 9 - Screw [#8-32 x 1/4 in. (6 mm)] | 19 - Location of Fuel Line From Fuel Pump |
| 10 - T-Fitting | |

Intake Manifold And Fuel Rail



75829

MEFI 3 Models

- | | |
|--|--|
| 1 - Intake Manifold | 11 - Fuel Rail |
| 2 - Gasket | 12 - Schrader Valve |
| 3 - Pipe Plug | 13 - Screws (1/4-20 x 1-1/2 in.) |
| 4 - Screw [5/16-18 x 1-3/8 in. (35 mm)] | 14 - MAT Sensor |
| 5 - Fuel Injector | 15 - Cap |
| 6 - O-Ring | 16 - Fuel Lines |
| 7 - MAP Sensor | 17 - O-Rings |
| 8 - Clip | 18 - Location of Fuel Line From Fuel Pump |
| 9 - Screw [#8-32 x 1/4 in. (6 mm)] | 19 - Pressure Sensor |
| 10 - Pipe Plug (1/8 in. hex head) | |

Fuel Pressure Relief Procedure

NOTICE

Refer to "Service Precautions," at front of this section BEFORE proceeding.

1. Disconnect electrical connector at fuel pump.
2. Crank engine for ten seconds (if engine starts allow it run until it stops) to relieve any fuel pressure in the system.

350 Mag MPI Components

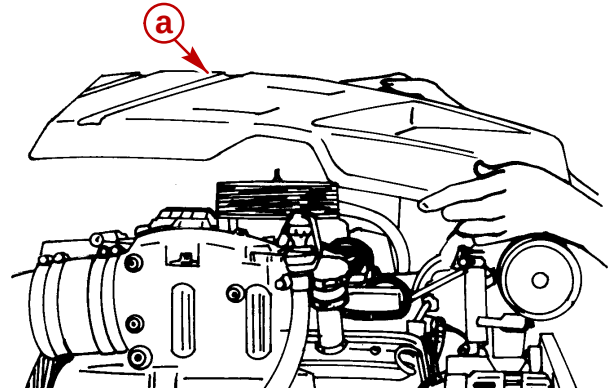
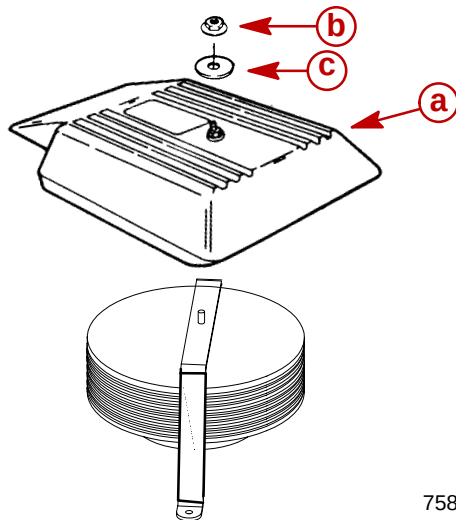
Flame Arrestor

NOTICE

Refer to "Service Precautions," at front of this section BEFORE proceeding.

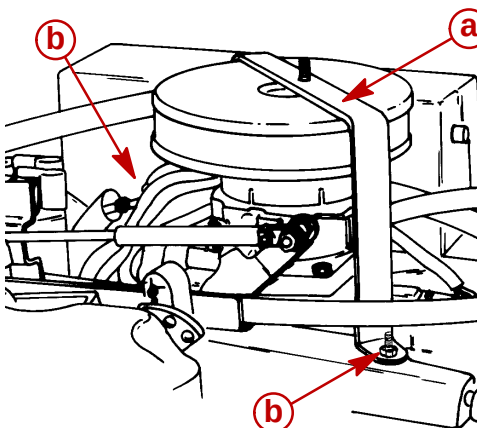
REMOVAL

1. Remove the flame arrestor cover.

**Typical Connections**

- a** - Flame Arrestor Cover
- b** - Nut
- c** - Washer

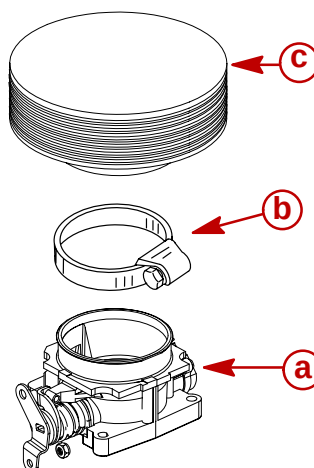
2. If equipped, remove flame arrestor cover bracket. DO NOT remove the fuel rail stud.



75830

- a** - Bracket
- b** - Nuts and Fuel Rail Stud

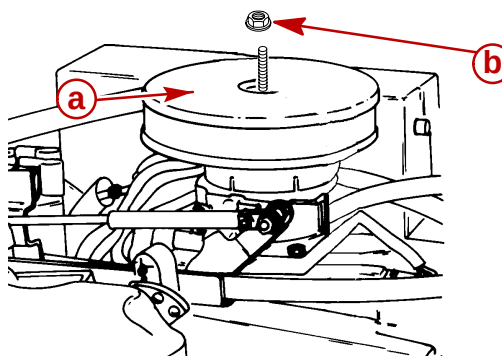
3. If equipped, loosen the clamp and remove the flame arrestor.



75828

- a** - Throttle Body
- b** - Clamp
- c** - Flame Arrestor

4. If equipped, loosen the nut and remove the flame arrestor.



76501

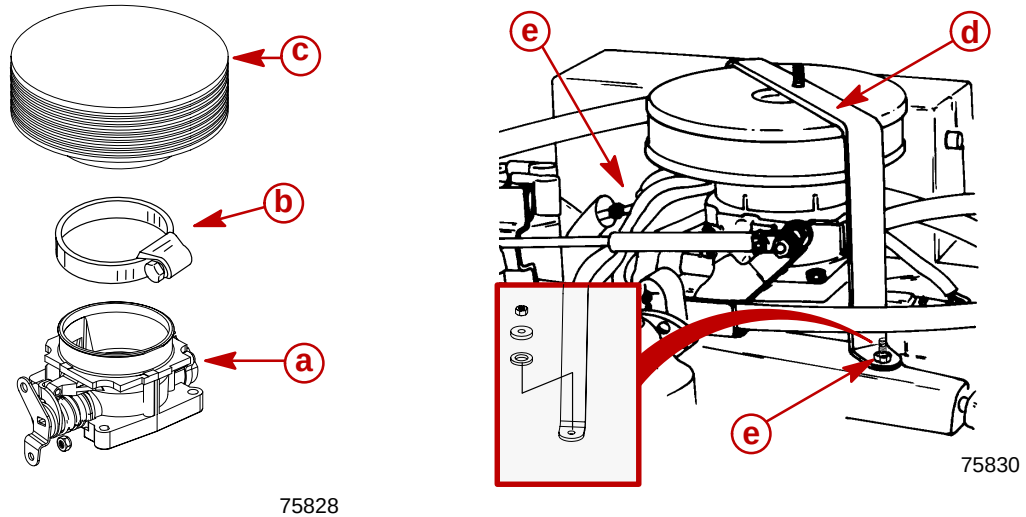
- a** - Flame Arrestor
- b** - Nut

CLEANING AND INSPECTION

1. Clean flame arrestor in solvent.
2. Wear eye protection. Dry flame arrestor with compressed air.

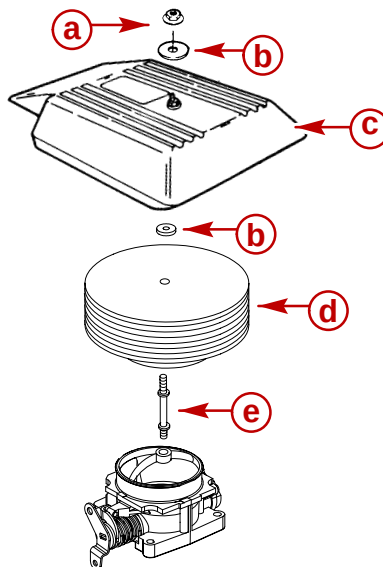
INSTALLATION

1. Replace components as appropriate for your model. Tighten all fasteners securely



Earlier Models

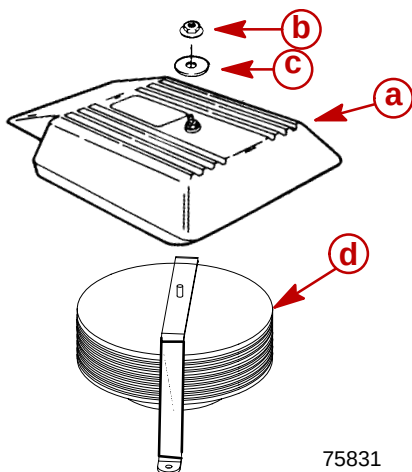
- a** - Throttle Body
- b** - Clamp
- c** - Flame Arrestor
- d** - Bracket
- e** - Nut and Washers



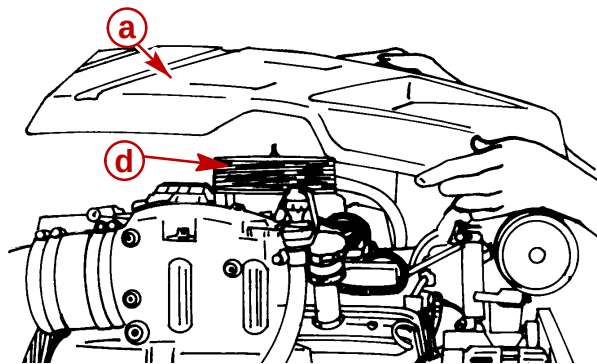
Later Models

- a** - Nut
- b** - Washer
- c** - Flame Arrestor Cover
- d** - Flame Arrestor
- e** - Stud

2. Install flame arrestor cover. Secure with washer and locknut.



75831



76365

Typical Connections

- a** - Flame Arrestor Cover
- b** - Nut
- c** - Washer
- d** - Flame Arrestor

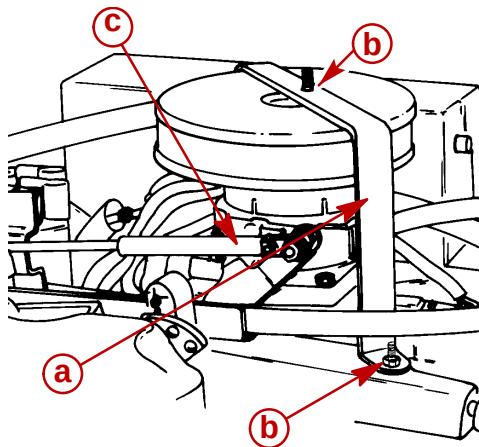
Throttle Body

NOTICE

Refer to "Service Precautions," at front of this section BEFORE proceeding.

REMOVAL

1. Remove the flame arrestor.
2. Disconnect the throttle linkage from the throttle body.

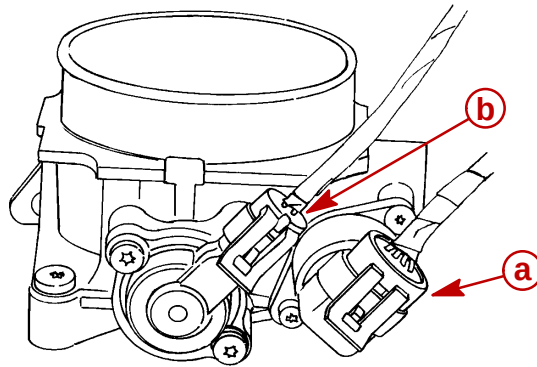


75830

Typical

- a** - Bracket (If Equipped)
- b** - Nuts (Both Sides or Top, As Equipped)
- c** - Throttle Cable

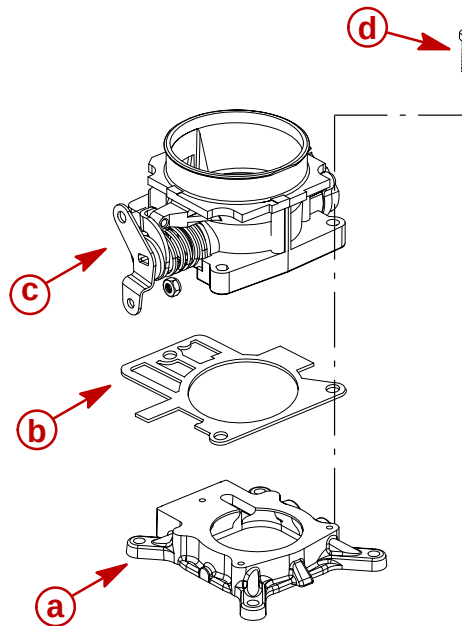
3. Disconnect the wiring connectors from the IAC valve and the TP sensor.



75788

- a** - IAC Valve Connector
- b** - Throttle Position Sensor Connector

4. Remove the screws (3) retaining the throttle body and remove the throttle body from the adapter. Refer to "Exploded View".



75828

- a** - Adapter
- b** - Gasket
- c** - Throttle Body
- d** - Screws

IMPORTANT: Insert a clean shop towel into the opening of the plenum to prevent foreign material from entering the engine.

CLEANING AND INSPECTION

IMPORTANT: DO NOT use cleaners containing methyl ethyl ketone. It is not necessary for cleaning throttle bore and valve deposits.

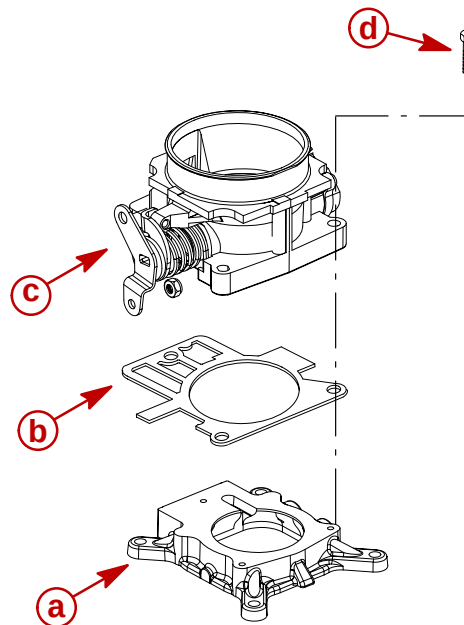
IMPORTANT: DO NOT allow the TP sensor and IAC valve to come into contact with solvent or cleaner.

IMPORTANT: Use care when removing gasket material from adapter and throttle body. Failure to do so could result in damage to the adapter and throttle body.

1. Carefully remove all gasket material from adapter and throttle body.
2. Thoroughly clean all parts of throttle body. Make certain that all passages are free of dirt and burrs.
3. Inspect mating surfaces for damage that could affect gasket sealing.
4. Inspect throttle body for cracks in casting.
5. Inspect throttle plates, linkage, return springs, etc., for damage, wear and foreign material.
6. Check adapter for loose parts and foreign material.

INSTALLATION

1. Place the throttle body gasket between the throttle body and the adapter.
2. Place the throttle body on the adapter. Install the screws and torque to 75 lb-in. (8.5 Nm).

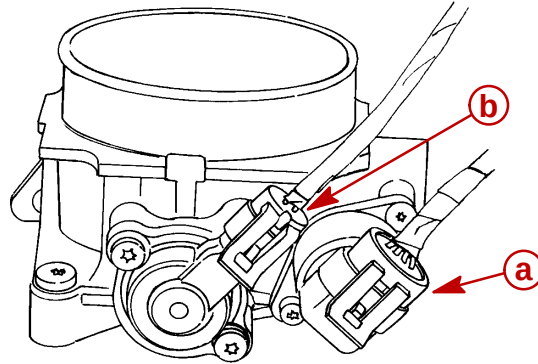


Typical

- a** - Adapter
- b** - Gasket
- c** - Throttle Body
- d** - Screws

75828

3. Connect the harness connectors to the TP sensor and IAC valve.



75788

- a** - IAC Valve Connector
- b** - Throttle Position Sensor Connector

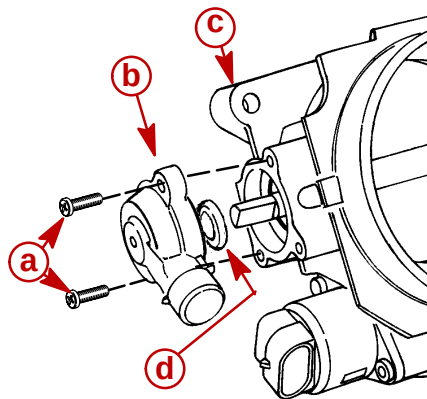
4. Connect the throttle cable to the throttle lever. Refer to SECTION 2 for throttle cable adjustment.
5. Install the flame arrestor and tighten the clamp.
6. Install the flame arrestor cover bracket.
7. Install the flame arrestor cover.

Throttle Position Sensor

NOTICE

Refer to "Service Precautions," in front of this section BEFORE proceeding.

1. Remove the flame arrestor cover.
2. Remove the flame arrestor from the throttle body.
3. Disconnect the harness connector from the TP sensor.
4. Remove the throttle body from the adapter.
5. Disconnect the harness connector from the TP sensor.
6. Remove the screws from the TP sensor.
7. Remove the TP sensor from the throttle body.



75832

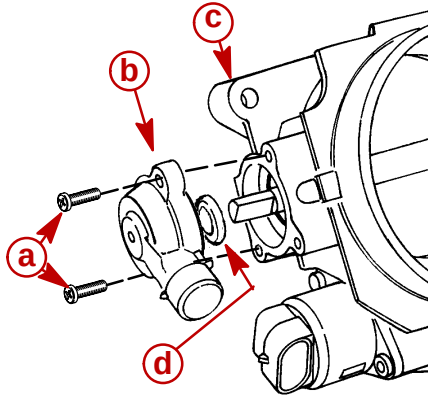
- a** - Screw (2)
- b** - Throttle Position (TP) Sensor
- c** - Throttle Body
- d** - Dust Seal

CLEANING AND INSPECTION

1. Clean the surfaces of the TP sensor with a dry cloth.
2. Inspect the sensor for signs of wear or damage.

INSTALLATION

1. Apply Loctite 242 to screw threads. Install the TP sensor and dust seal on the throttle body using the screws. Torque screws to 20 lb-in. (2 Nm).



75832

- a** - Screw (2)
- b** - Throttle Position (TP) Sensor
- c** - Throttle Body
- d** - Dust Seal

2. Place a new gasket on the adapter.
3. Install throttle body on the adapter. Torque screws to 89 lb-in. (10 Nm).
4. Connect the harness connector to the TP sensor.
5. Place the flame arrestor over the throttle body and tighten clamp securely.
6. Install the flame arrestor cover. Tighten nut securely.
7. When negative (–) battery cable has been reconnected, start engine and check for TP sensor output voltage. It should be approximately .7 Volts at idle and 4.5 Volts at wide open throttle.

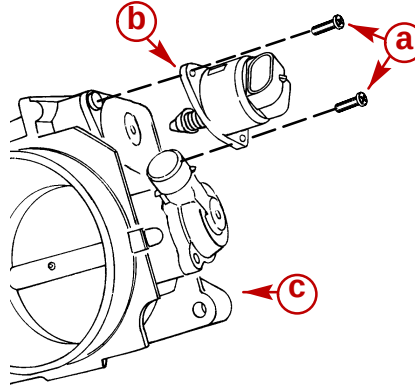
Idle Air Control (IAC) Valve

NOTICE

Refer to "Service Precautions," in front of this section BEFORE proceeding.
--

REMOVAL

1. Remove the flame arrestor, throttle cable and throttle body.
2. Remove the IAC valve from the throttle body.



75657

- a** - Screw (2)
- b** - Idle Air Control (IAC) Valve
- c** - Throttle Body

CLEANING AND INSPECTION

IMPORTANT: Do not push or pull on the IAC valve pintle. Force exerted on the pintle might damage the worm drive. **DO NOT** use a cleaner that contains the extremely strong solvent methyl ethyl ketone.

1. Remove and discard sealing O-ring from IAC valve. Clean sealing surfaces, pintle valve seat, and air passage with a carburetor cleaner to remove carbon deposits, being careful not to push or pull on the IAC valve pintle.

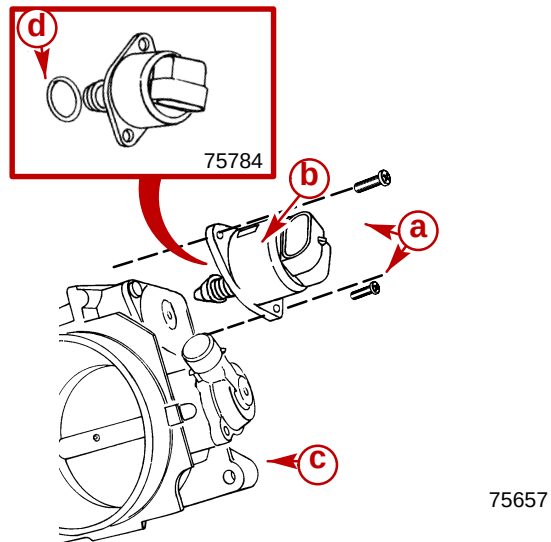
NOTE: Shiny spots on the pintle, or seat, are normal and do not indicate misalignment or a bent pintle shaft.

2. Inspect the entire assembly for any obvious physical damage.

INSTALLATION

IMPORTANT: If installing a new IAC valve, be sure to replace it with an identical part. IAC valve pintle shape and diameter are designed for the specific application.

1. Install new O-ring on IAC valve.



- a** - Screw (2)
- b** - Idle Air Control (IAC) Valve
- c** - Throttle Body
- d** - O-Ring

2. Install IAC valve in throttle body using screws. Torque to 20 lb-in. (2 Nm).
3. Place a new gasket between throttle body and adapter.
4. Install the throttle body on the adapter and torque the screws to 89 lb-in. (10 Nm).
5. Reset IAC valve pintle position as follows:
 - a. Turn ignition key ON for ten seconds.
 - b. Turn ignition key OFF for ten seconds.
 - c. Restart engine and check for proper idle operation.

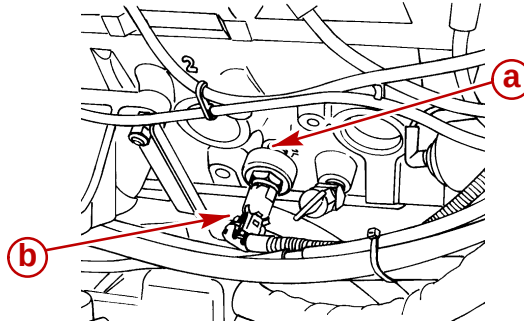
Knock Sensor

NOTICE

Refer to "Service Precautions," in front of this section BEFORE proceeding.
--

REMOVAL

1. Disconnect electrical connector at Knock Sensor located just ahead of starter motor.



75678

Starboard Side Shown

- a** - Knock Sensor
- b** - Electrical Connector

2. Remove Knock Sensor from engine block.

CLEANING AND INSPECTION

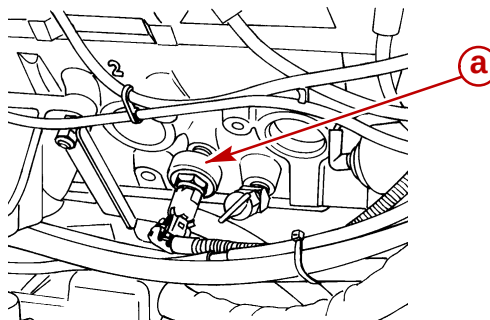
1. Clean Knock Sensor with a dry cloth, paying special attention to threads on base.
2. Inspect surfaces of Knock Sensor for signs of wear or physical damage.

INSTALLATION

IMPORTANT: If installing a new Knock Sensor, be sure to replace it with an identical part. Knock Sensors are very sensitive and designed for each specific application.

IMPORTANT: In the following step, it is very important that the Knock Sensor be torqued to the precise specification. Incorrect torquing will result in unsatisfactory performance. **DO NOT** use sealer on threads.

1. Install Knock Sensor in engine block. Torque to 12-16 lb-ft (16-22 Nm).



75678

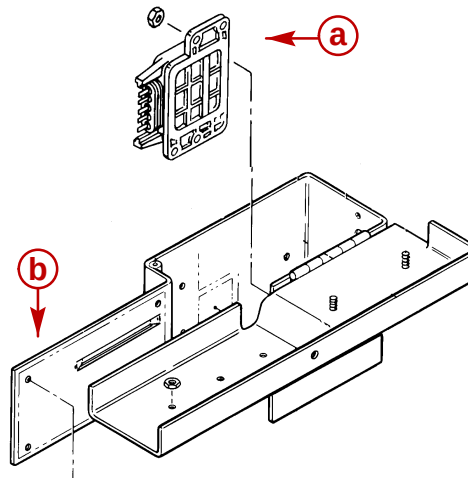
Starboard Side Shown

- a** - Knock Sensor

2. Connect electrical connector to Knock Sensor.

Knock Sensor Module

1. Remove the Knock Sensor Module from the electrical box.



75833

a - Knock Sensor Module

b - Electrical Box

2. Disconnect electrical connector at Knock Sensor (KS) module.

CLEANING AND INSPECTION

1. Clean the external surfaces of the KS module with a dry cloth.
2. Inspect surfaces of KS module for evidence of damage.

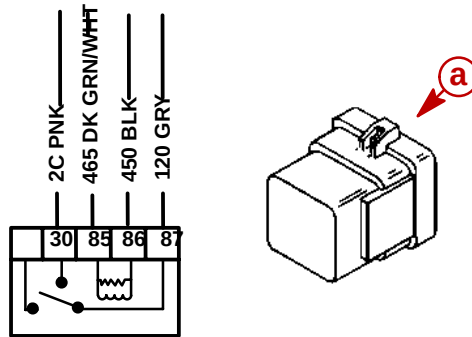
INSTALLATION

1. Mount KS module on bracket.
2. Connect electrical connector to the KS module.

Fuel Pump Relay

REMOVAL

1. Remove fuel pump relay from electrical box.



75834

a - Fuel Pump Relay

2. Disconnect electrical connector and remove fuel pump relay.

CLEANING AND INSPECTION

IMPORTANT: The fuel pump relay is an electrical component. DO NOT soak in any liquid cleaner or solvent; damage may result.

1. Clean the external surfaces with a dry cloth.
2. Inspect surfaces for evidence of damage.

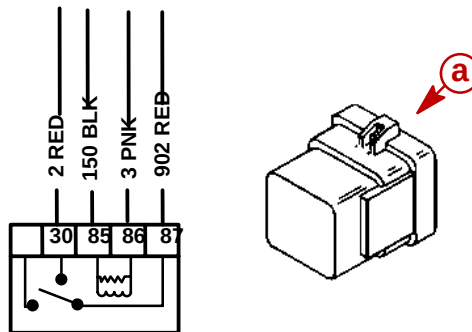
INSTALLATION

1. Connect electrical connector to fuel pump relay.
2. Attach fuel pump relay to bracket.

System Relay

REMOVAL

1. Remove system relay from electrical box.



75835

a - System Relay

2. Disconnect electrical connector and remove relay.

CLEANING AND INSPECTION

IMPORTANT: The system relay is an electrical component. DO NOT soak in any liquid cleaner or solvent; damage may result.

1. Clean the external surfaces with a dry cloth.
2. Inspect surfaces for evidence of damage.

INSTALLATION

1. Attach electrical connector to relay.
2. Place system relay in electrical box.

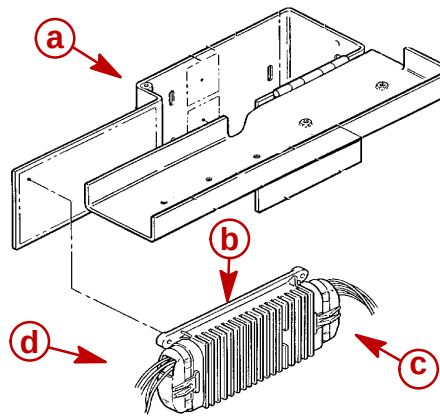
Electronic Control Module (ECM)

NOTICE
Refer to "Service Precautions," in front of this section BEFORE proceeding.

IMPORTANT: The ECM is a sensitive electrical device, subject to electrostatic damage. **DO NOT** touch connector pins when removing or installing the module.

REMOVAL

1. Disconnect J1 and J2 electrical connectors at engine control module (ECM). **DO NOT** touch connector pins when removing.



75836

Typical

- a** - Electrical Bracket
 - b** - MEFI 1 and MEFI 2 ECM
 - c** - J1- Electrical Connector (Front Connector)
 - d** - J2- Electrical Connector (Rear Connector)
2. Remove ECM from electrical bracket.

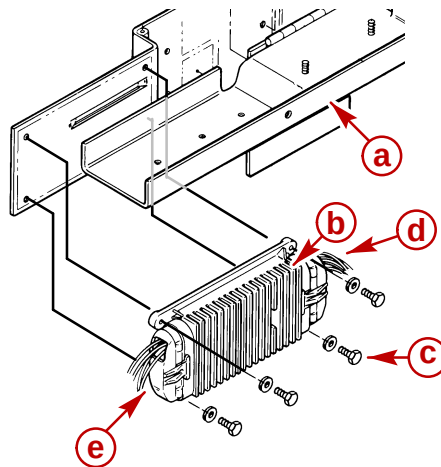
CLEANING AND INSPECTION

1. Clean the exterior of the ECM with a dry cloth being careful to avoid contact with connector pins.
2. Inspect outer surfaces for any obvious damage
3. Visually inspect electrical pins at both ends of ECM for straightness and corrosion.
4. Visually inspect J1 and J2 connectors on the wiring harness for corrosion and terminals that may have backed out of the harness.

NOTE: The ECM is a sealed electrical component. If a Code 51 or 52 check has shown it to be defective, replace the unit with another ECM having the same part number as the original.

INSTALLATION

1. Mount new ECM to electrical bracket using screws and washers.
2. Connect J1 and J2 electrical connectors to the ECM. DO NOT touch connector pins when installing.



75836

Typical

- a - Electrical Bracket
- b - ECM
- c - Screw [4 – 1/4-20 x 1-1/4 In. (32 mm)] and Washer
- d - J1- Electrical Connector (Front Connector)
- e - J2- Electrical Connector (Rear Connector)

Engine Coolant Temperature (ECT) Sensor

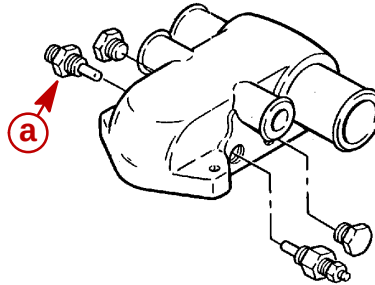
NOTICE

Refer to "Service Precautions," in front of this section BEFORE proceeding.
--

REMOVAL

NOTE: Handle the ECT carefully as any damage to it will affect operation of the system.

1. Disconnect electrical connector at engine coolant temperature (ECT) sensor.



72799

a - Engine Coolant Temperature (ECT) Sensor

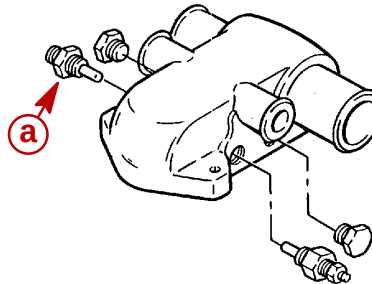
2. Remove ECT sensor from thermostat housing.

CLEANING AND INSPECTION

1. Clean with a dry cloth, removing any excess sealant from the base threads.
2. Look for evidence of any physical damage to base or connector surfaces of the ECT sensor.

INSTALLATION

1. Install ECT sensor. Tighten hand tight plus 2-1/2 turns maximum.



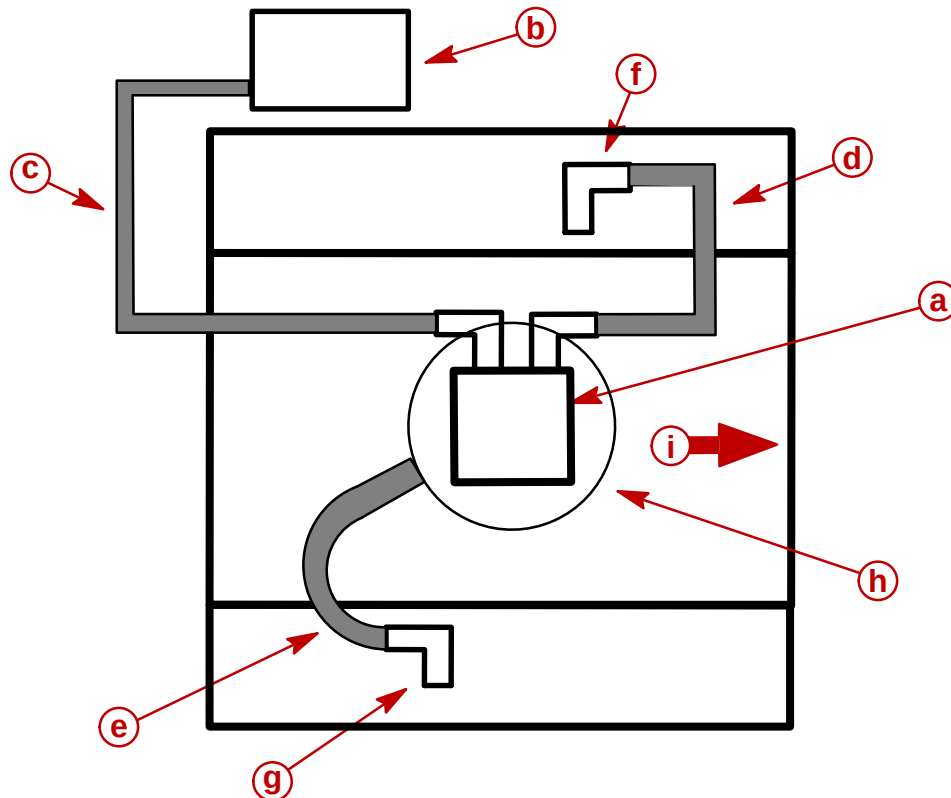
72799

a - Engine Coolant Temperature (ECT) Sensor

2. Connect electrical connector to ECT sensor.

Vacuum And Vent Hose Routing

350 Mag MPI Models

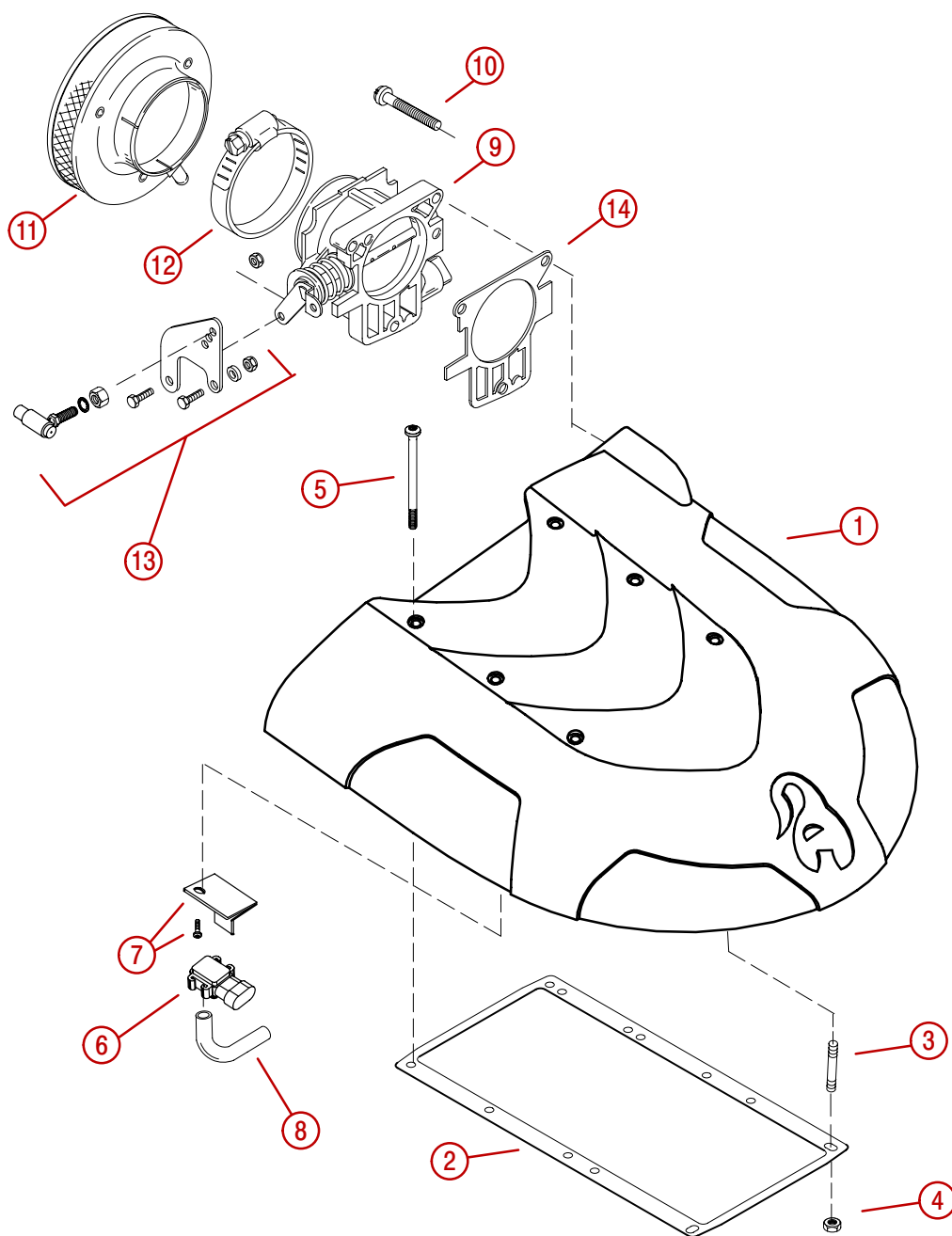


75837

- a** - Throttle Body Adapter
- b** - Cool Fuel Assembly
- c** - Vacuum Hose - Throttle Body Adapter to Fuel Pressure Regulator on Cool Fuel Assembly
- d** - Vent Hose - PCV Valve to Throttle Body Adapter
- e** - Vent Hose - Valve Cover Fitting To Flame Arrestor
- f** - PCV Valve
- g** - Vacuum Hose - T-Fitting to Plenum
- h** - Flame Arrestor
- i** - Front of Engine

Exploded Views - Black Scorpion

Plenum, Throttle Body And Flame Arrestor

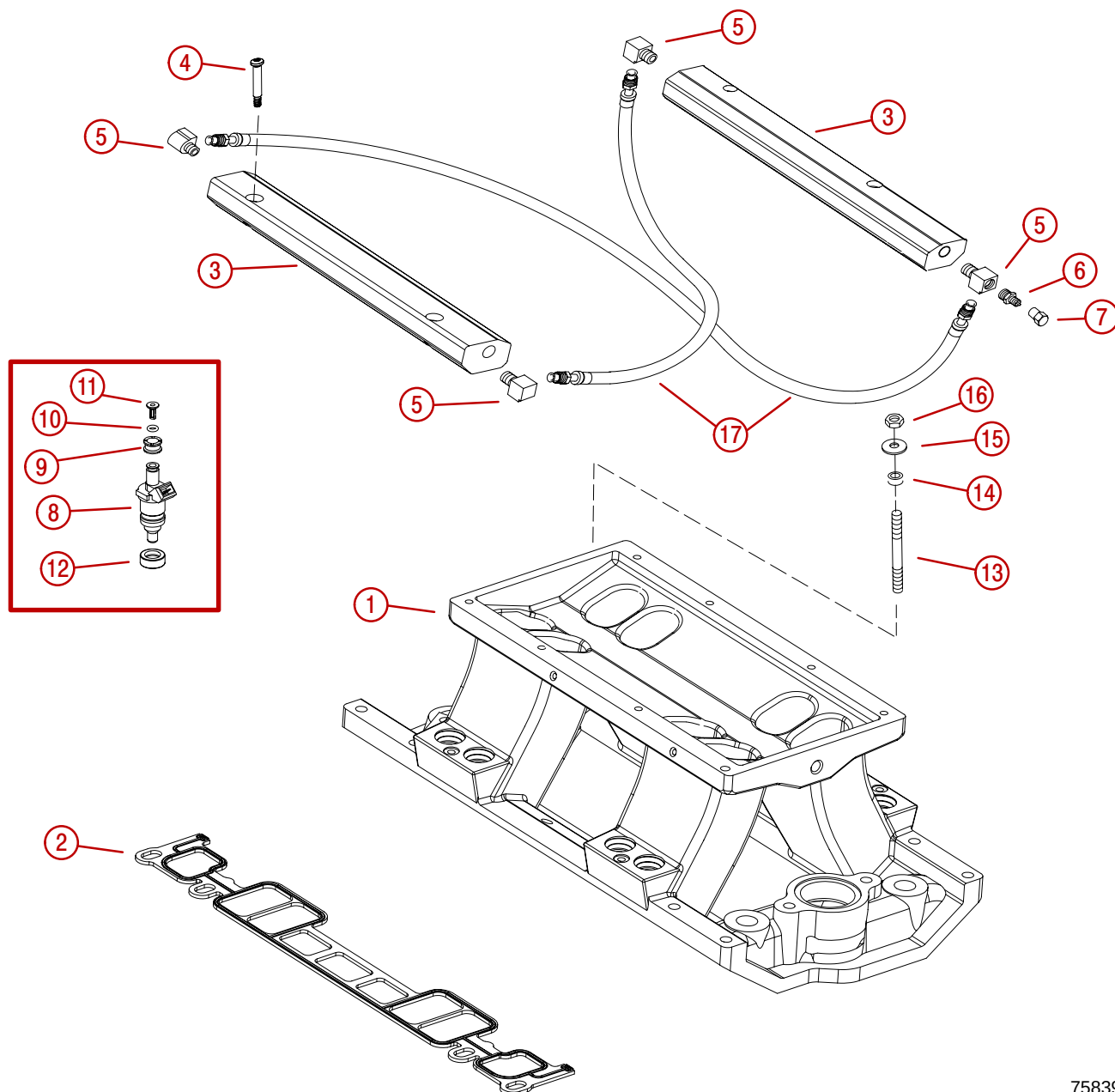


- 1 - Intake Plenum
- 2 - Gasket
- 3 - Stud
- 4 - Nut (2)
- 5 - Plenum Screw
- 6 - MAP Sensor
- 7 - Screw and Bracket

- 8 - Hose
- 9 - Throttle Body
- 10 - Screw
- 11 - Flame Arrestor
- 12 - Clamp
- 13 - Throttle Lever and Linkage
- 14 - Gasket - See Changes Previously

75838

Intake Manifold And Fuel Rails



75839

- | | |
|-------------------------------|------------------------|
| 1 - Intake Manifold | 10 - O-Ring |
| 2 - Intake Gasket (2) | 11 - Screen |
| 3 - Fuel Rail (2) | 12 - Lower Seal |
| 4 - Screw | 13 - Stud |
| 5 - Connector Fittings | 14 - Spacer |
| 6 - Schrader Valve | 15 - Washer |
| 7 - Cap | 16 - Nut |
| 8 - Fuel Injector | 17 - Fuel Lines |
| 9 - Upper Seal | |

Fuel Pressure Relief Procedure

NOTICE

Refer to "Service Precautions," in front of this section BEFORE proceeding.
--

1. Disconnect electrical connector at fuel pump.
2. Crank engine for ten seconds (if engine starts allow it run until it stops) to relieve any fuel pressure in the system.

Black Scorpion Components

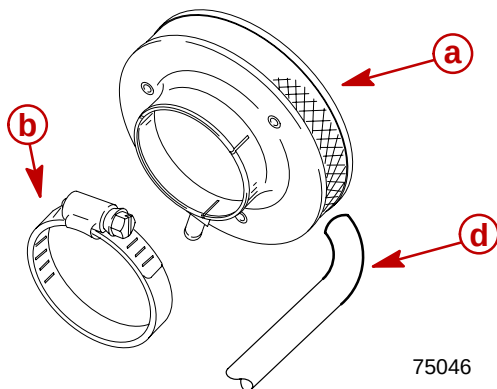
Flame Arrestor

NOTICE

Refer to "Service Precautions," in front of this section BEFORE proceeding.
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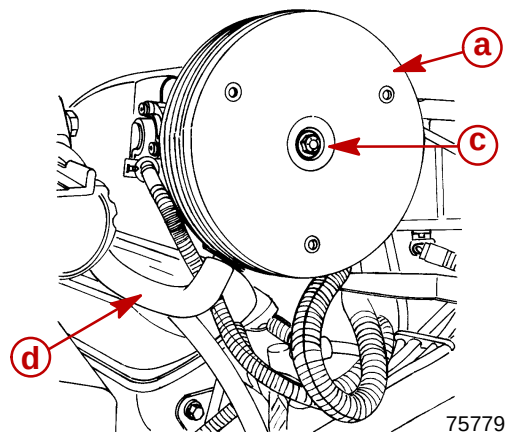
REMOVAL

1. Remove flame arrestor and related components in the following order:
2. **EARLIER STYLE** - Remove clamp.
3. **LATER STYLE** - Remove nut.
4. Remove crankcase ventilation hose from against flame arrestor and rocker arm cover fittings.
5. Remove flame arrestor.



Earlier Style Flame Arrestor

- a** - Flame Arrestor
- b** - Clamp (Earlier Style)
- c** - Nut (Later Style)
- d** - Vent Hose



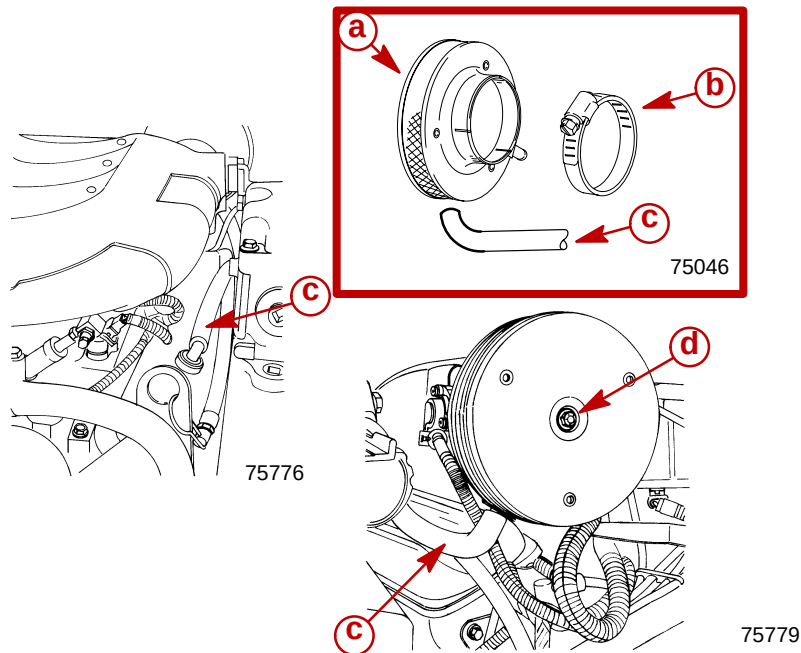
Later Style Flame Arrestor

CLEANING AND INSPECTION

1. Clean flame arrestor in solvent. Blow dry with compressed air or allow to air dry completely.
2. Clean crankcase ventilation hoses in solvent. Blow dry with compressed air or allow to air dry completely.
3. Inspect crankcase ventilation hoses for cracks or deterioration, and replace if necessary.

INSTALLATION

1. **EARLIER STYLE** - Position clamp on flame arrestor.
2. Install flame arrestor.
3. **EARLIER STYLE** - Tighten clamp securely.
4. **LATER STYLE** - Tighten nut.
5. Position crankcase ventilation hose against flame arrestor and attach to rocker arm cover fittings.



- a** - Flame Arrestor
- b** - Clamp (Earlier Style)
- c** - Vent Hose
- d** - Nut (Later Style)

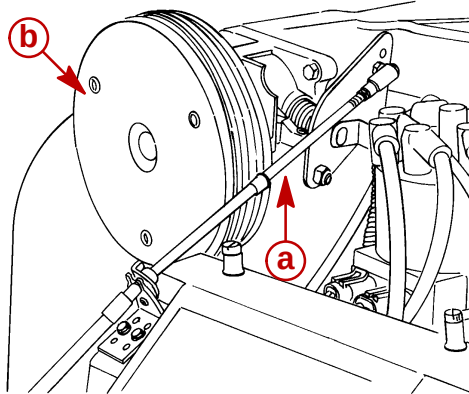
Throttle Body

NOTICE

Refer to "Service Precautions," in front of this section BEFORE proceeding.
--

REMOVAL

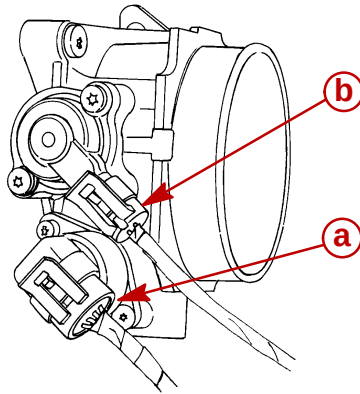
1. Remove the flame arrestor.
2. Disconnect the throttle cable from the throttle lever.



74838

- a** - Throttle Cable
b - Flame Arrestor

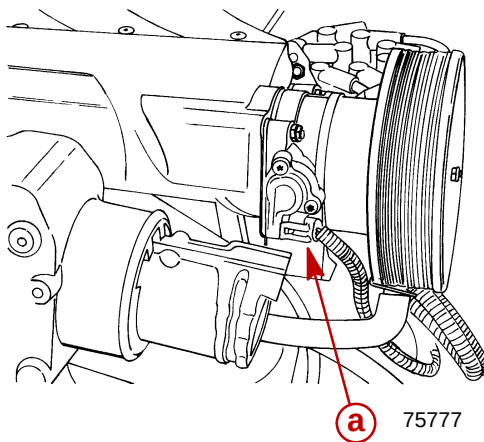
3. Disconnect the wiring connectors from the IAC valve and the TP sensor.



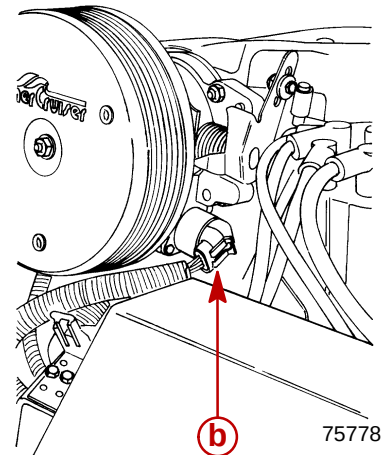
75788

Earlier Style Throttle Body

- a** - IAC Valve Connector
- b** - Throttle Position Sensor Connector



75777

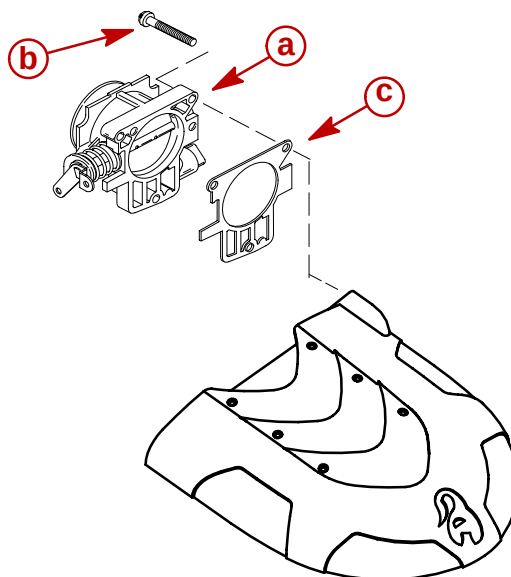


75778

Later Style Throttle Body

- a** - Throttle Position Sensor Connector
- b** - IAC Valve Connector

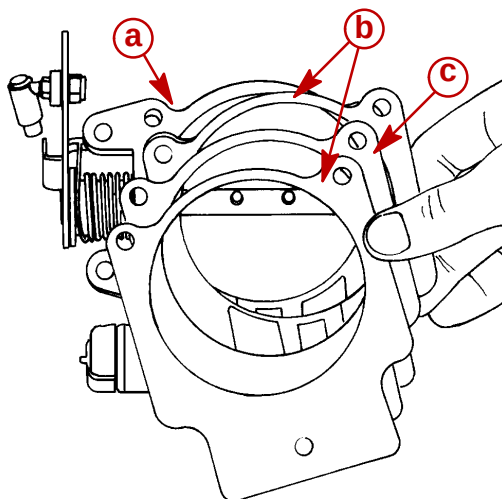
4. Remove the hardware retaining the throttle body and remove the throttle body from the adapter. Refer to "Exploded View."



75838

- a** - Throttle Body
- b** - Screws
- c** - Gasket (Single On Earlier Models)

NOTE: The later style throttle body uses two gaskets and a plate between the throttle body and the plenum.



75783

Later Style With Gaskets and Plate

- a** - Throttle Body
- b** - Gaskets
- c** - Plate

IMPORTANT: Insert a clean shop towel into the opening of the plenum to prevent foreign material from entering the engine.

CLEANING AND INSPECTION

IMPORTANT: DO NOT use cleaners containing methyl ethyl ketone. It is not necessary for cleaning throttle bore and valve deposits.

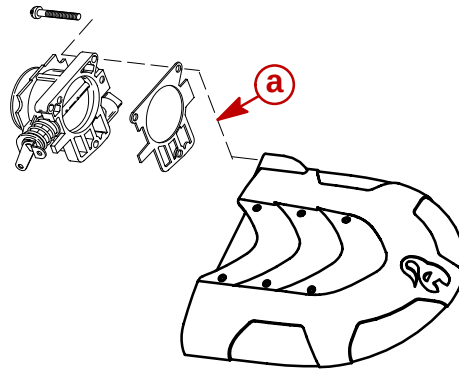
IMPORTANT: DO NOT allow the TP sensor and IAC valve to come into contact with solvent or cleaner.

IMPORTANT: Use care when removing gasket material from plenum and throttle body. Failure to do so could result in damage to the plenum and throttle body.

1. Carefully remove all gasket material from plenum and throttle body.
2. Thoroughly clean all parts of throttle body. Make certain that all passages are free of dirt and burrs.
3. Inspect mating surfaces for damage that could affect gasket sealing.
4. Inspect throttle body for cracks in casting.
5. Inspect throttle plates, linkage, return springs, etc., for damage, wear and foreign material.
6. Check for loose parts and foreign material.

INSTALLATION

1. Place the throttle body gasket (s) between the throttle body and the plenum.

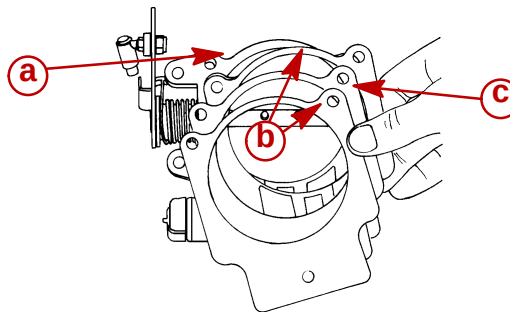


75838

Early Style With Single Gasket

a - Gasket

NOTE: The later style throttle body uses two gaskets and a plate between the throttle body and the plenum.



75783

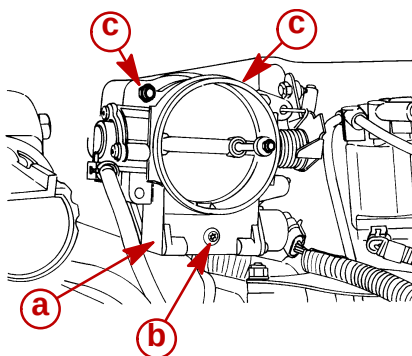
Later Style With Gaskets and Plate

a - Throttle Body

b - Gaskets

c - Plate

2. Place the throttle body on the plenum. Install the screw and nuts (or 3 screws on Earlier Style) and torque to 75 lb-in. (8.5 Nm).

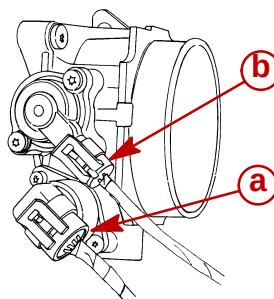


75781

Later Style With Screw And Nuts

- a** - Throttle Body
- b** - Screw
- c** - Nuts

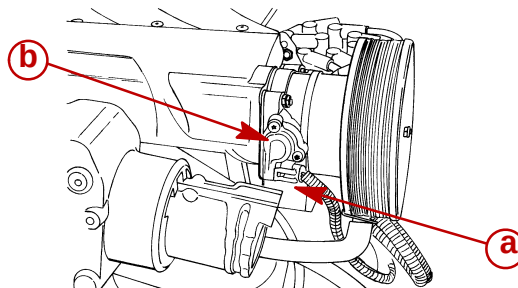
3. Connect the harness connectors to the TP sensor and IAC valve.



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Earlier Style Throttle Body

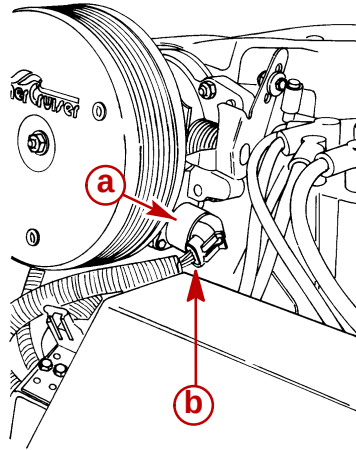
- a** - IAC Valve Connector
- b** - Throttle Position Sensor Connector



75777

Later Style Throttle Body

- a** - TP Sensor
- b** - Connector



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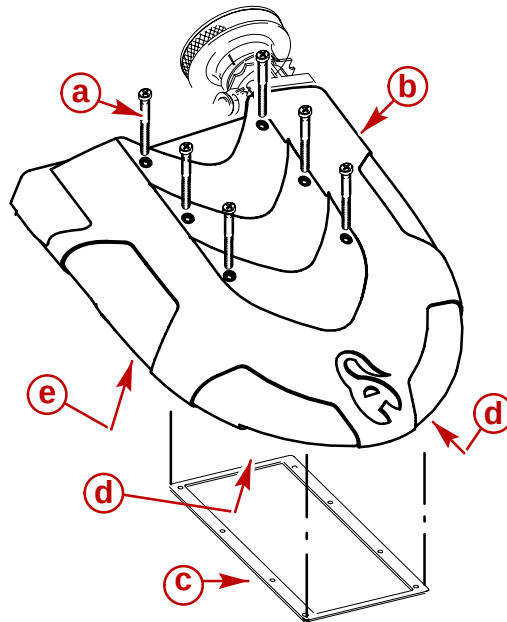
Later Style Throttle Body**a** - IAC Valve**b** - Connector

4. Connect the throttle cable to the throttle lever. Refer to SECTION 2 for throttle cable adjustment.
5. Install the flame arrestor.

Plenum

REMOVAL

1. Disconnect the throttle cable.
2. Disconnect the harness connector and the vacuum hose from the MAP sensor. The sensor is located on the underside of the plenum on the starboard side.
3. Remove the screws retaining the intake plenum to the manifold. Remove the two nuts from the underside of the plenum in the front. Remove the plenum and gasket.



- a** - Screws (6)
- b** - Plenum
- c** - Gasket
- d** - Nuts
- e** - MAP Sensor Location

75710

CLEANING AND INSPECTION

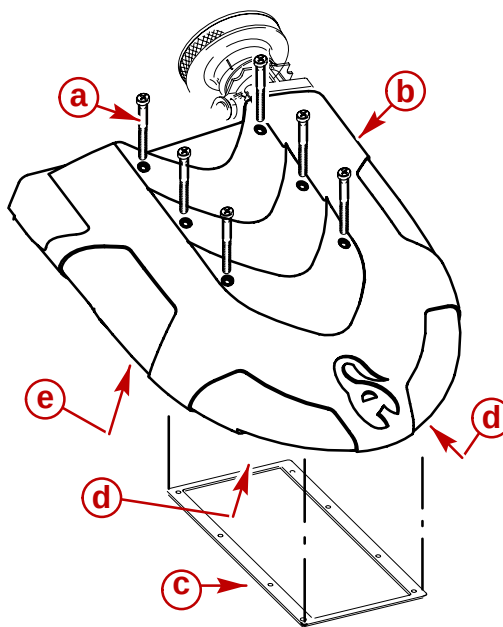
IMPORTANT: Use care when removing gasket material from intake manifold and plenum. Failure to do so could result in damage to the intake manifold and plenum.

1. Carefully remove all gasket material from intake manifold and plenum.
2. Clean plenum in solvent and dry with compressed air.
3. Inspect mating surfaces for damage that could affect gasket sealing.
4. Inspect plenum for cracks in casting.

INSTALLATION

1. If not previously accomplished, remove all old gasket material.
2. Position the new plenum gasket on the intake manifold. The word "FRONT" faces UP on the gasket at front edge of the intake manifold.
3. Place the plenum over the gasket.
4. Install the the screws retaining the intake plenum to the manifold. Install the two nuts on the underside of the plenum in front.

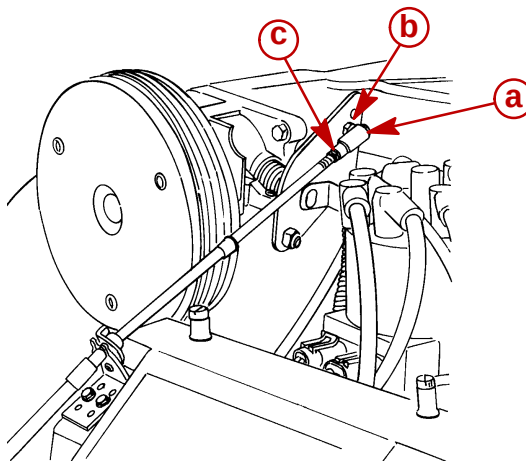
5. Torque the fasteners evenly in a diagonal pattern to 150 lb-in. (17Nm).



75710

- a** - Screws (6)
- b** - Plenum
- c** - Gasket
- d** - Nuts
- e** - MAP Sensor Location

6. Place remote control throttle lever in idle position. Attach cable to throttle lever stud. Refer to SECTION 2 for throttle cable adjustment.
7. After throttle cable is adjusted, tighten locknut against cable end.



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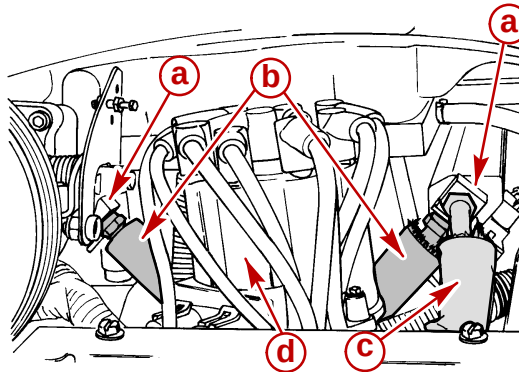
- a** - Cable End
- b** - Throttle Lever Stud
- c** - Locknut

8. Connect the harness connector and the vacuum hose to the MAP sensor.

Fuel Rails

REMOVAL

1. Remove distributor cap.
2. Disconnect fuel lines from aft end fuel rail connector fittings.

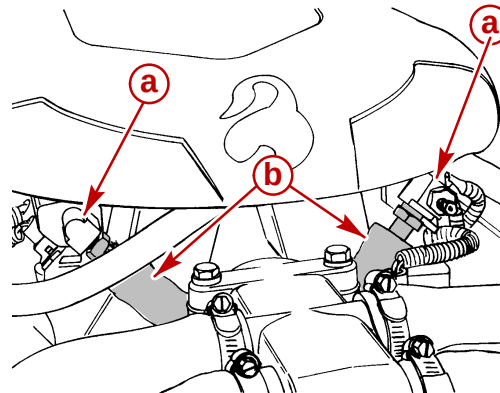


75696

Fuel Lines and Connections - Aft View

- a** - Fuel Rail Connector Fittings
- b** - Rail-to-Rail Fuel Lines
- c** - Cool Fuel-to-Fuel Rail Line
- d** - Distributor Cap

3. Disconnect fuel lines from front end of fuel rail connector fittings.



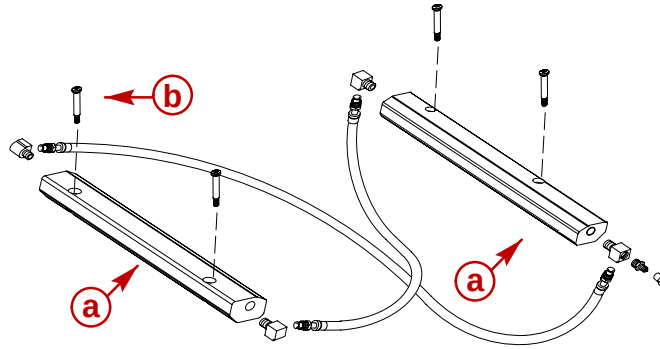
75697

Fuel Lines and Connections - Front View

- a** - Fuel Rail Connector Fittings
- b** - Rail-to-Rail Fuel Lines

4. Remove plenum.
5. Disconnect harness connector from each injector.
6. Remove fuel rail screws.
7. Gently move rail back and forth while lifting rail upward.

8. Remove fuel rails.



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Typical

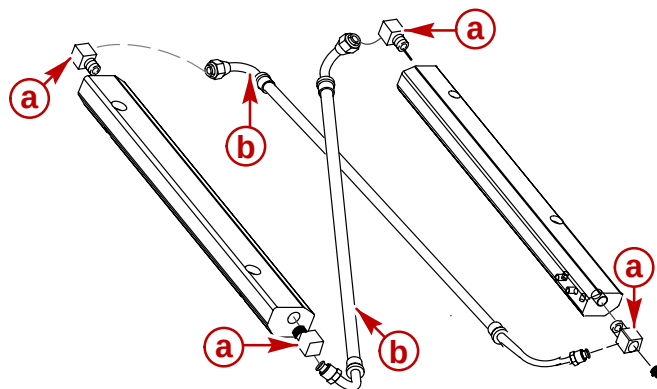
- a** - Fuel Rails
- b** - Screws (2 Each Side)

CLEANING AND INSPECTION

1. Clean fuel rails in solvent and dry with compressed air.
2. Inspect injector cavities for damage that could affect proper sealing of the injectors in the rail.
3. Inspect rails for cracks.

INSTALLATION

1. Position injectors in the fuel rails.
2. Install fuel rail by pushing down gently while moving it back and forth.
3. Install fuel rail fasteners. Torque to 105 lb-in. (12 Nm).
4. Route the rail-to-rail fuel lines as shown. Temporarily hand tighten the lines to the fuel rail connector fittings.
5. Torque the four fuel line connections to 18 lb-ft (24 Nm).



75710

Typical

- a** - Fuel Rail Connector Fittings
 - b** - Rail-to-Rail Fuel Lines
6. Install the plenum and throttle body.

Fuel Injectors

REMOVAL

NOTE: Use care in removing fuel injectors to prevent damage to the electrical connector and nozzle.

IMPORTANT: The fuel injector is an electrical component. **DO NOT** soak in any liquid cleaner or solvent, as damage may result.

1. Remove flame arrestor, throttle body, plenum and fuel rails as outlined in this section.
2. Remove fuel injectors from fuel rail and intake manifold.

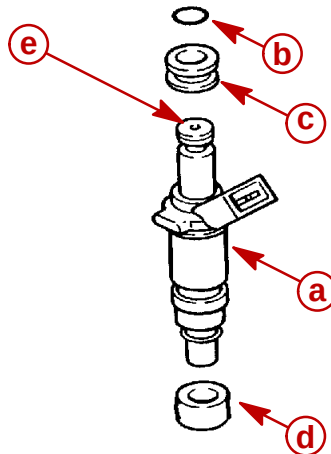
CLEANING AND INSPECTION

1. Inspect fuel injectors for damage; replace if necessary.
2. Inspect screen on inlet side of injector for debris. Clean or replace as necessary.

INSTALLATION

IMPORTANT: When replacing injectors, be certain to replace with the identical part and part number. Other injectors may have the same appearance, yet have a different part number and be calibrated for a different flow rate, and if installed, would cause performance difficulty or damage to the ECM.

1. Install new O-rings on fuel injectors. Lubricate O-rings using a water soap solution.



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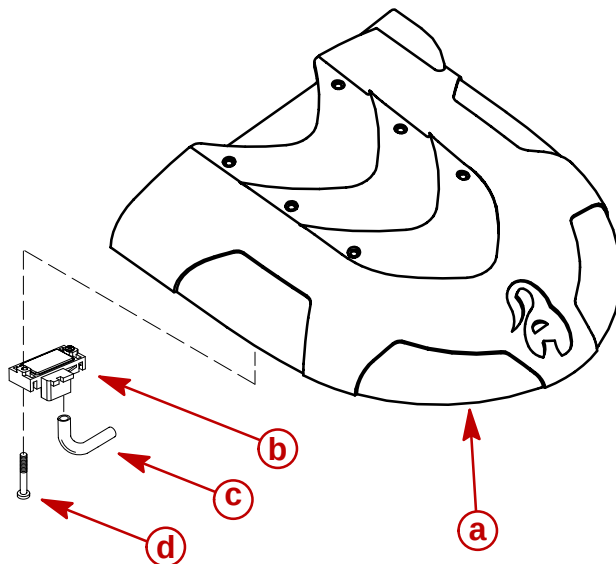
- a** - Fuel Injector
- b** - O-Ring
- c** - Upper Seal
- d** - Lower Seal
- e** - Screen

2. Install fuel injectors in the intake manifold.
3. Install fuel rails.

MAP Sensor

REMOVAL

1. Disconnect electrical connector at manifold absolute pressure (MAP) sensor.



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- a** - Plenum
- b** - Manifold Absolute Pressure (MAP) Sensor
- c** - Vacuum Hose To Intake Manifold
- d** - Screws (2)

2. Remove MAP sensor.

CLEANING AND INSPECTION

1. Clean off any foreign matter with a dry cloth.
2. Inspect for any obvious signs of physical damage to the sensor.

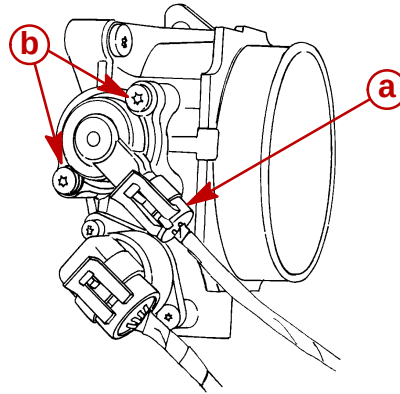
INSTALLATION

1. Install MAP sensor using screws. Torque screws to 44-62 lb-in. (5-7 Nm).
2. Connect electrical connector to MAP sensor.
3. Connect vacuum hose to intake manifold fitting.

Throttle Position Sensor

REMOVAL

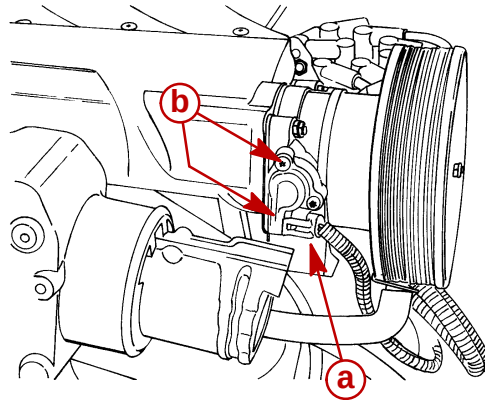
1. Disconnect electrical connector at throttle position (TP) sensor.
2. Remove TP sensor from throttle body. Remove the dust seal.



75788

Earlier Style Throttle Body

- a** - Throttle Position (TP) Sensor Harness
- b** - Screws



75777

Later Style Throttle Body

- a** - Throttle Position (TP) Sensor Harness
- b** - Screws

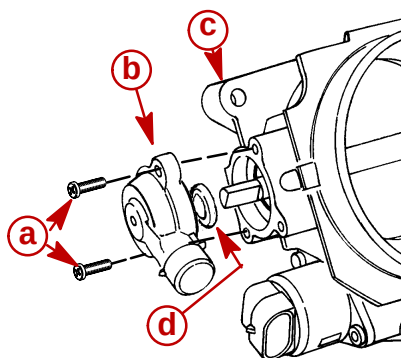
CLEANING AND INSPECTION

1. Clean the surfaces of the TP sensor with a dry cloth.
2. Inspect the TP sensor for signs of wear or damage.

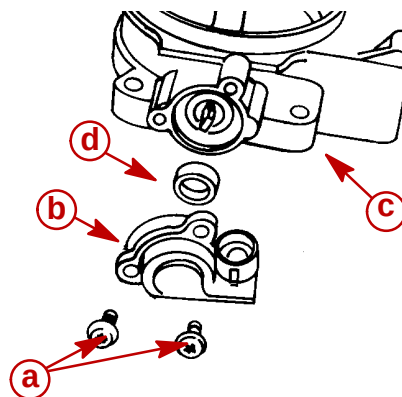
INSTALLATION

IMPORTANT: If the TP sensor is to be replaced with a new unit, be sure to secure it in place with the new screws which are included in the service package.

1. Install TP sensor and gasket on throttle body using screws with washers and Loctite 242 applied to threads. Torque screws to 20 lb-in. (2 Nm).



Earlier Style Throttle Body



75785

Later Style Throttle Body

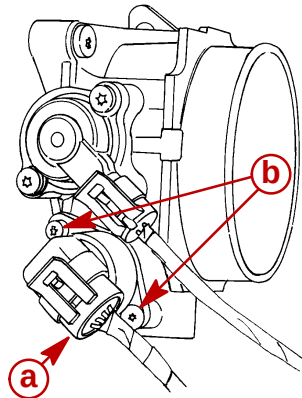
- a** - Screws
- b** - Throttle Position (TP) Sensor
- c** - Throttle Body
- d** - Seal

2. Connect electrical connector to TP sensor.
3. Install throttle body, throttle linkage and flame arrestor.
4. Start engine and check for TP sensor output voltage. It should be approximately .7 V at idle and 4.5 V at WOT.

Idle Air Control (IAC) Valve

REMOVAL

1. Remove flame arrestor, throttle cable and throttle body.
2. Disconnect electrical connector at idle air control (IAC) valve.

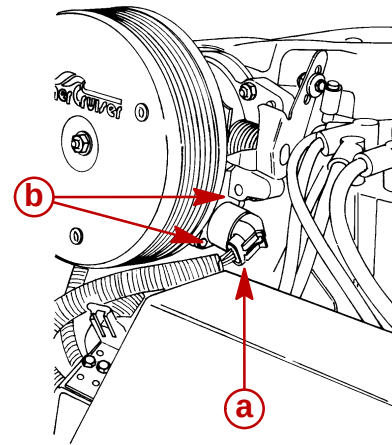


75788

Earlier Style Throttle Body

- a** - Idle Air Control (IAC) Valve Connector
b - Screws

3. Remove IAC from throttle body.



75788

Later Style Throttle Body

CLEANING AND INSPECTION

1. Remove and discard sealing O-ring from IAC valve. Clean sealing surfaces, pintle valve seat, and air passage with a carburetor cleaner to remove carbon deposits, being careful not to push or pull on the IAC valve pintle. Force exerted on the pintle might damage the worm drive. DO NOT use a cleaner that contains the extremely strong solvent methyl ethyl ketone.

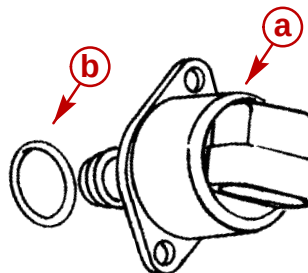
NOTE: Shiny spots on the pintle, or seat, are normal and do not indicate misalignment or a bent pintle shaft.

2. Inspect the entire assembly for any obvious physical damage.

INSTALLATION

IMPORTANT: If installing a new IAC valve, be sure to replace it with the correct IAC valve pintle shape and diameter are designed for the specific application.

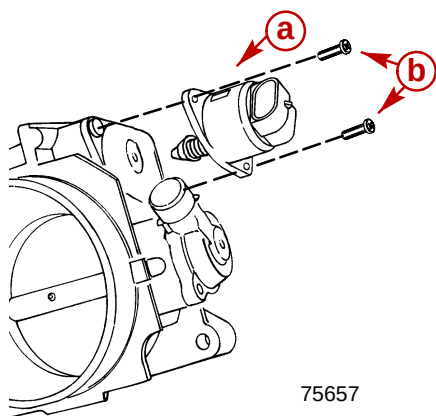
1. Install new O-ring on IAC valve.



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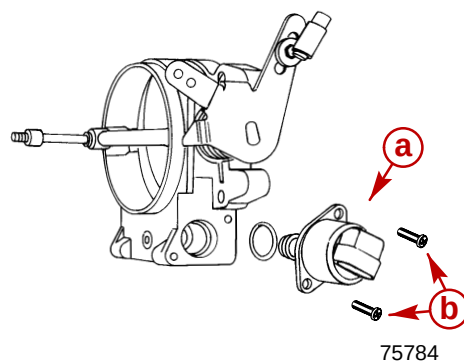
- a** - Idle Air Control (IAC) Valve
b - O-Ring

2. Install IAC valve on throttle body using screws. Torque to 20 lb-in. (2 Nm).



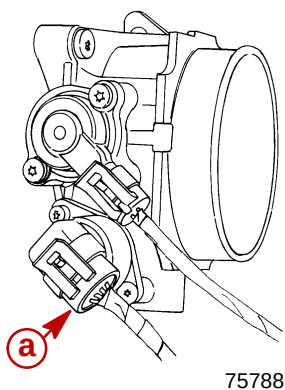
Earlier Style Throttle Body

- a** - Idle Air Control (IAC) Valve
- b** - Screws



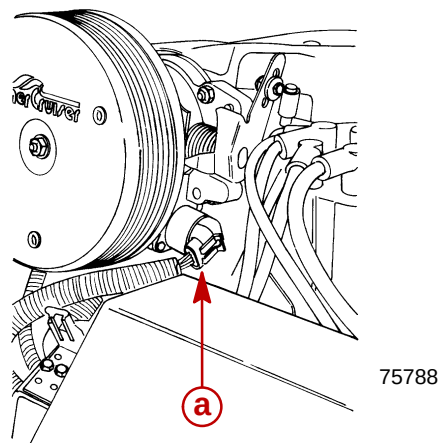
Later Style Throttle Body

3. Connect electrical connector to IAC valve.



Earlier Style Throttle Body

- a** - Idle Air Control (IAC) Valve Connector



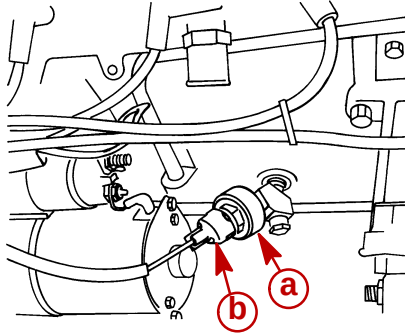
Later Style Throttle Body

4. Reset IAC valve pintle position after reconnecting negative (–) battery cable.
 - a. Turn ignition key ON for ten seconds.
 - b. Turn ignition key OFF for ten seconds.
 - c. Restart engine and check for proper idle operation.

Knock Sensor

REMOVAL

1. Disconnect electrical connector at Knock Sensor located just ahead of starter motor.



73757

- a** - Knock Sensor
- b** - Harness Connector

2. Remove Knock Sensor from engine block.

CLEANING AND INSPECTION

1. Clean Knock Sensor with a dry cloth, paying special attention to threads on base.
2. Inspect surfaces of Knock Sensor for signs of wear or physical damage.

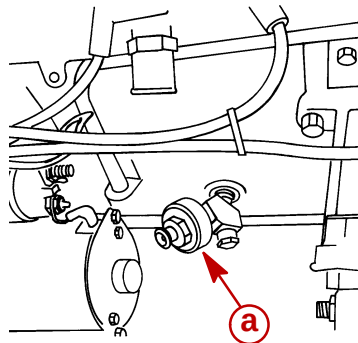
INSTALLATION

IMPORTANT: If installing a new Knock Sensor, be sure to replace it with an identical part. Knock Sensors are very sensitive and designed for each specific application.

IMPORTANT: In the following step, it is very important that the Knock Sensor be torqued to the precise specification. Incorrect torquing will result in unsatisfactory performance. **DO NOT** use sealer on threads.

IMPORTANT: Ensure that the Knock Sensor is installed in the upper location on the Y-fitting.

1. Install Knock Sensor in engine block. Torque to 12-16 lb-ft (16-22 Nm).



73756

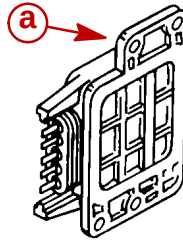
- a** - Knock Sensor

2. Connect electrical connector to Knock Sensor.

Knock Sensor Module

REMOVAL

1. Remove Knock Sensor Module (KS) from electrical box.



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a - Knock Sensor (KS) Module

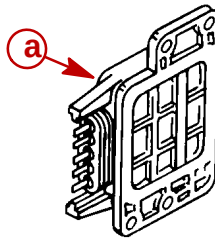
2. Disconnect electrical connector at Knock Sensor Module.

CLEANING AND INSPECTION

1. Clean the external surfaces of the KS module with a dry cloth.
2. Inspect surfaces of KS module for evidence of damage.

INSTALLATION

1. Connect electrical connector to the Knock Sensor Module.
2. Place KS module in electrical box.



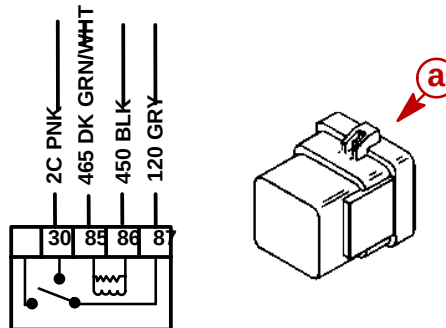
00000

a - Knock Sensor (KS) Module

Fuel Pump Relay

REMOVAL

1. Remove fuel pump relay from electrical box.



00000

a - Fuel Pump Relay

2. Disconnect electrical connector and remove fuel pump relay.

IMPORTANT: The fuel pump relay is an electrical component. DO NOT soak in any liquid cleaner or solvent; damage may result.

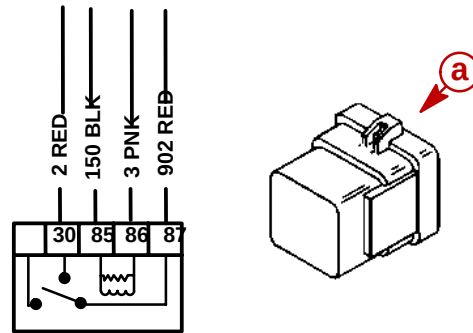
INSTALLATION

1. Attach electrical connector to fuel pump relay.
2. Place fuel pump relay in electrical box.

System Relay

REMOVAL

1. Remove system relay from electrical box.



00000

a - System Relay

2. Disconnect electrical connector and remove relay.

IMPORTANT: The system relay is an electrical component. DO NOT soak in any liquid cleaner or solvent; damage may result.

INSTALLATION

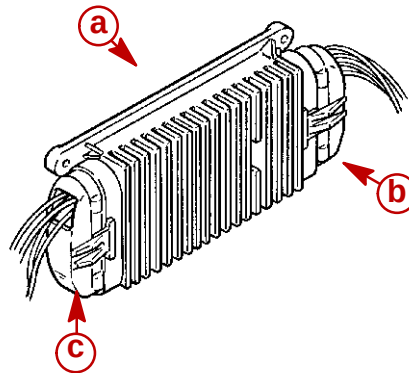
1. Attach electrical connector to relay.
2. Place system relay in electrical box.

Engine Control Module

IMPORTANT: The ECM is a sensitive electrical device, subject to electrostatic damage. Therefore, take care not to touch connector pins when removing or installing the module.

REMOVAL

1. Disconnect J1 and J2 electrical connectors at engine control module (ECM).



72801

a - MEFI 1 and MEFI 2 ECM Shown, MEFI 3 Similar

b - J1- Electrical Connector (Starboard Connector - MEFI 1 and MEFI 2, Port Connector - MEFI 3)

c - J2- Electrical Connector (Port Connector - MEFI 1 and MEFI 2, Starboard Connector - MEFI 3)

2. Remove ECM from electrical box.

CLEANING AND INSPECTION

1. Clean the exterior of the ECM with a dry cloth being careful to avoid contact with connector pins.
2. Inspect outer surfaces for any obvious damage
3. Visually inspect electrical pins at both ends of ECM for straightness and corrosion.
4. Visually inspect J1 and J2 connectors on the wiring harness for corrosion and terminals that may have backed off the harness.

NOTE: The ECM is a sealed electrical component. If a Code 51 check has shown it to be defective, replace the unit with another ECM having the same part number as the original.

INSTALLATION

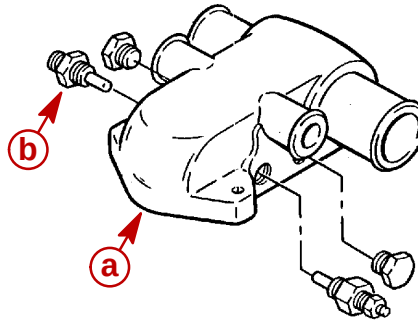
1. Mount new ECM to electrical bracket using screws and washers.
2. Connect J1 and J2 electrical connectors to the ECM. DO NOT touch connector pins when installing.

Engine Coolant Temperature Sensor

REMOVAL

NOTE: Handle the ECT sensor carefully. Damage to it will affect operation of the system.

1. Disconnect electrical connector at Engine Coolant Temperature (ECT) sensor.



72799

a - Thermostat Housing

b - Engine Coolant Temperature (ECT) Sensor

2. Remove ECT sensor from thermostat housing.

CLEANING AND INSPECTION

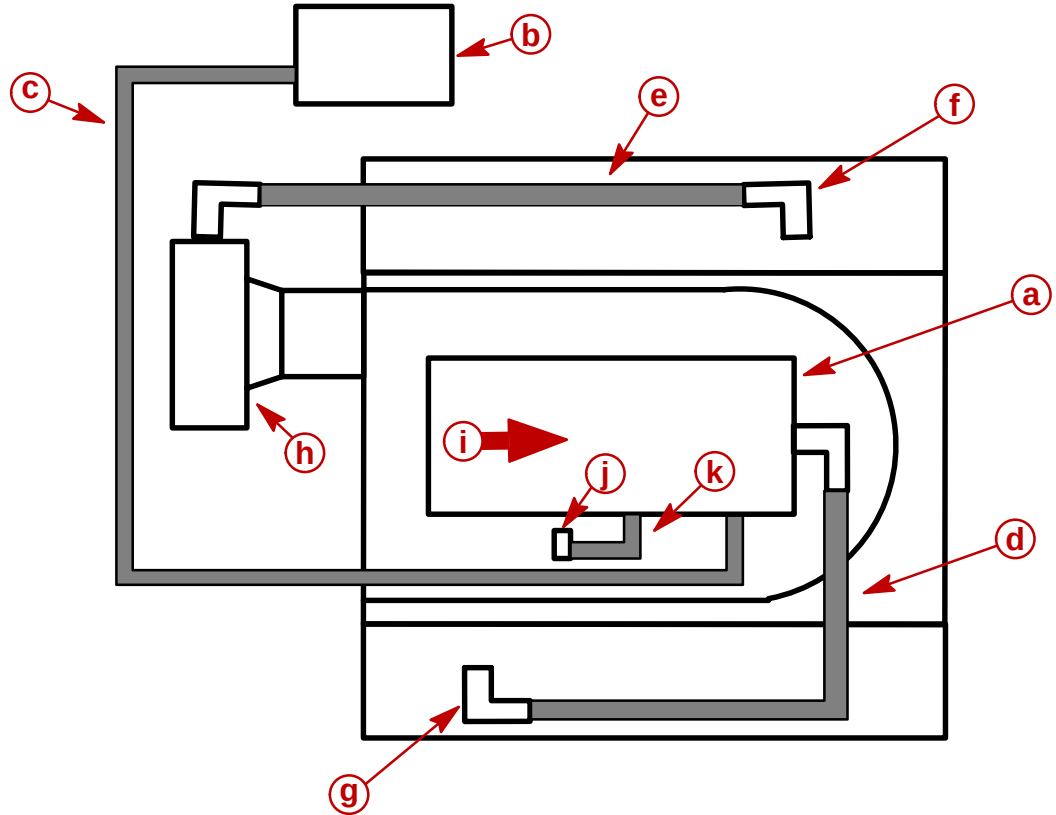
1. Clean with a dry cloth, removing any excess sealant from the base threads.
2. Look for evidence of any physical damage to base or connector surfaces of the ECT sensor.

INSTALLATION

1. Install ECT sensor in thermostat housing. Tighten hand tight plus 2-1/2 turns maximum.
2. Connect electrical connector to ECT sensor.

Vacuum And Vent Hose Routing

Scorpion Models

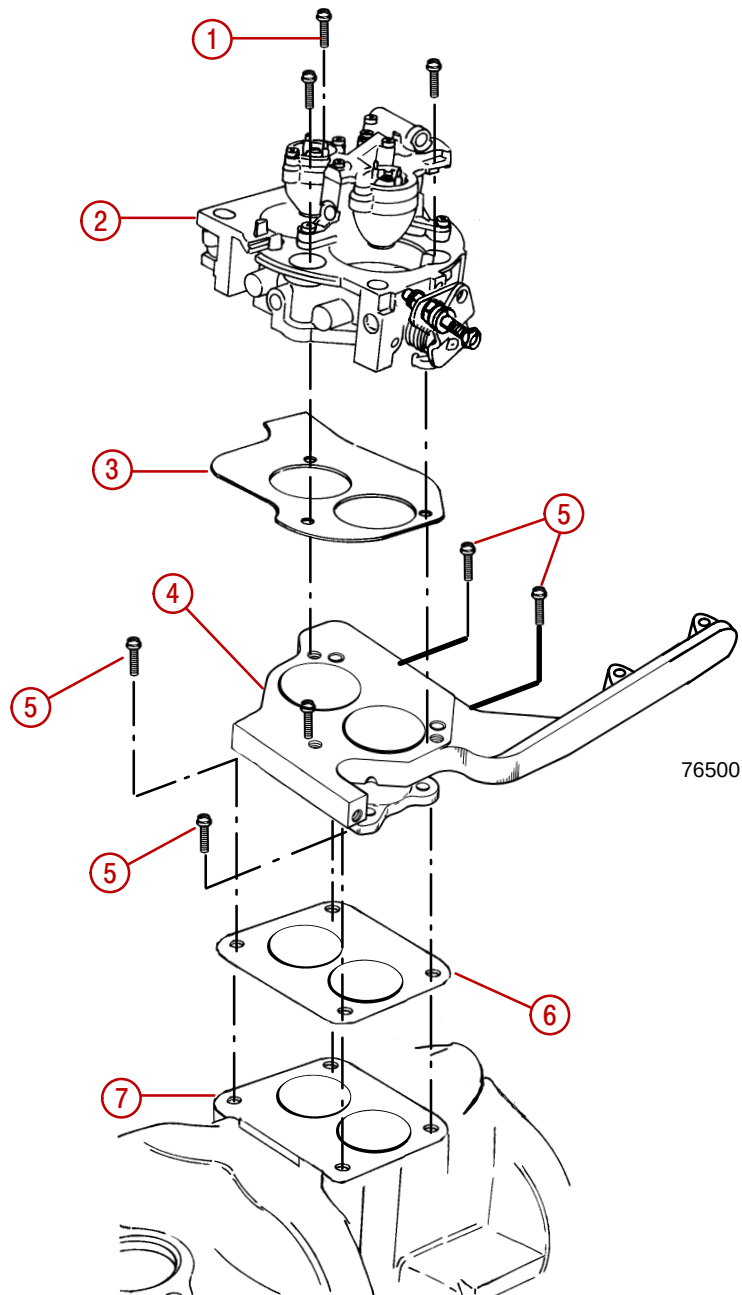


- a** - Throttle Body Adapter
- b** - Cool Fuel Assembly
- c** - Vacuum Hose - Forward Fitting On Intake Manifold To Fuel Pressure Regulator on Cool Fuel Assembly
- d** - Vent Hose - PCV Valve to Throttle Body Adapter
- e** - Vent Hose - Valve Cover to Flame Arrestor
- f** - PCV Valve
- g** - Vent Hose Fitting
- h** - Flame Arrestor
- i** - Front of Engine
- j** - MAP Sensor
- k** - Vacuum Hose - Rear Fitting On Intake Manifold To MAP Sensor

00000

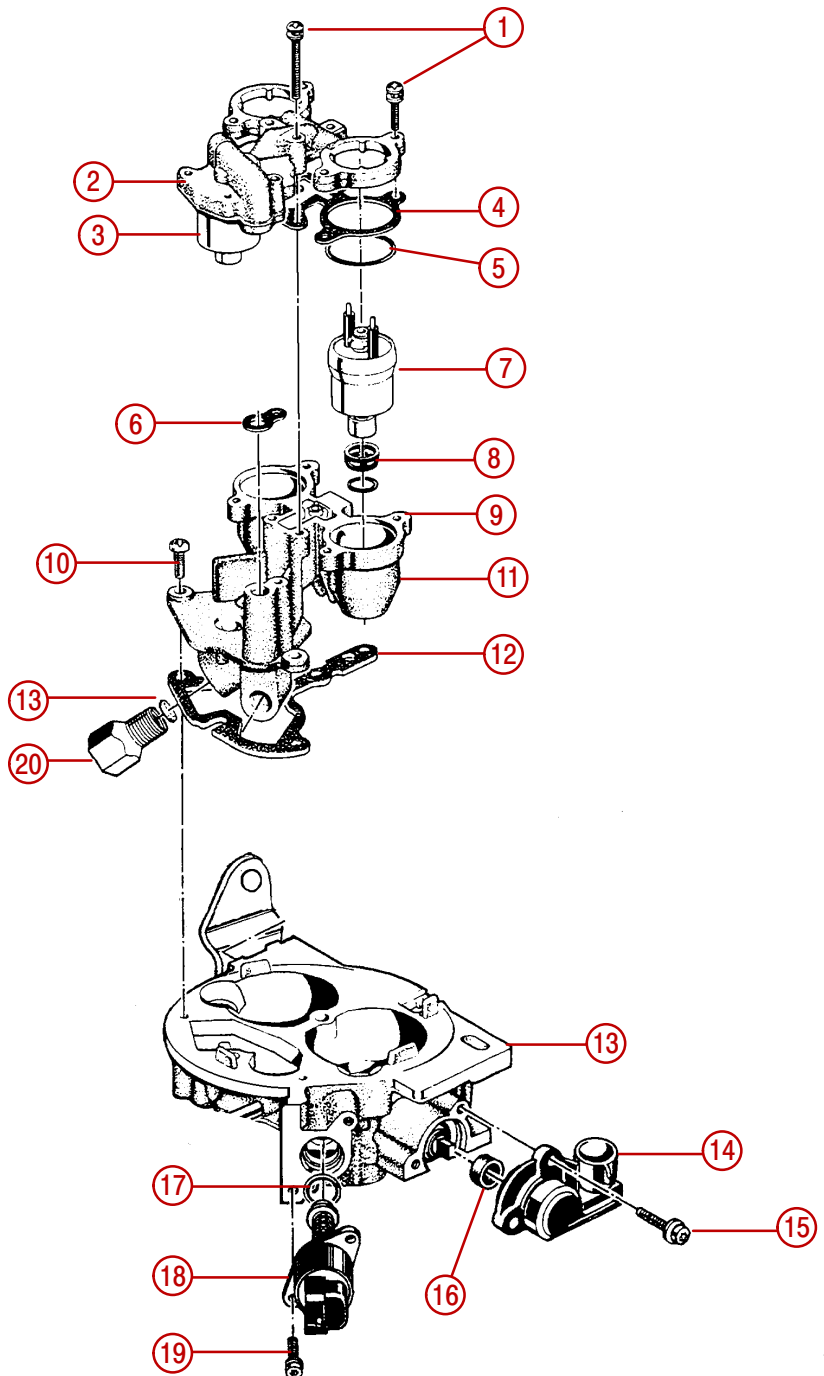
Exploded Views - Throttle Body EFI

Throttle Body Body And Adapter



- 1 - Throttle Body
- 2 - Screws (3)
- 3 - Gasket
- 4 - Throttle Body Adapter
- 5 - Screws (4)
- 6 - Gasket
- 7 - Intake Manifold

Throttle Body Assembly



- 1 - Cap Screw
- 2 - Cover Assembly
- 3 - Fuel Pressure Regulator
- 4 - Cover Assembly Gasket
- 5 - Upper O-Ring
- 6 - Fuel Meter Outlet Gasket
- 7 - Fuel Injector (2)
- 8 - Fuel Filter (2)
- 9 - Lower O-Ring
- 10 - Screw

- 11 - Body
- 12 - Throttle Body To Fuel Meter Body Gasket
- 13 - Throttle Body
- 14 - Throttle Position (TP) Sensor
- 15 - Screws (2)
- 16 - Seal
- 17 - O-Ring
- 18 - Idle Air Control (IAC) Valve
- 19 - Screws (2)
- 20 - Fuel Inlet

73766

Fuel Pressure Relief Procedure

NOTICE

Refer to "Service Precautions," in front of this section BEFORE proceeding.

1. Disconnect electrical connector at fuel pump.
2. Crank engine for ten seconds (if engine starts allow it run until it stops) to relieve any fuel pressure in the system.

Throttle Body EFI Components

Fuel Meter Cover Assembly

NOTICE

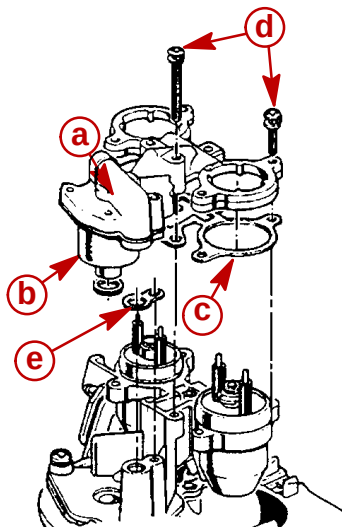
Refer to "Service Precautions," at front of this section BEFORE proceeding.

⚠ CAUTION

DO NOT remove the four screws securing the pressure regulator to the fuel meter cover. The fuel pressure regulator includes a large spring under heavy compression which, if accidentally released, could cause personal injury.

REMOVAL

1. Remove the flame arrestor from the throttle body.
2. Disconnect electrical connectors to fuel injectors. (Squeeze plastic tabs and pull straight up.)
3. Remove the fuel meter cover screw assemblies.
4. Remove fuel meter cover assembly.



73767

- a** - Fuel Meter Cover
- b** - Fuel Damper
- c** - Gaskets (Regulator Passages)
- d** - Screws
- e** - Fuel Meter Outlet Gasket

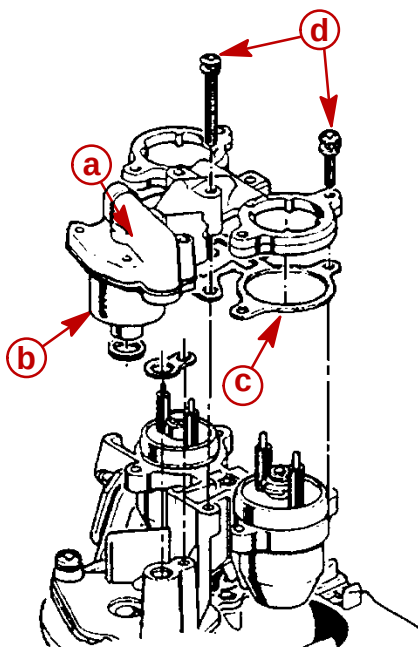
CLEANING AND INSPECTION

IMPORTANT: DO NOT immerse the fuel meter cover (with pressure regulator) in cleaner, as damage to the regulator diaphragm and gasket could occur.

1. Inspect pressure regulator seating area for damage. Use a magnifying glass if necessary. If damaged, replace the cover assembly.

INSTALLATION

1. Install new pressure regulator seal, fuel meter outlet passage gasket, and cover gasket.
2. Install fuel meter cover assembly.
3. Install attaching screws, precoated with appropriate locking compound to threads. (Short screws are next to injectors.)
4. Torque screws to 28 lb-in. (3 Nm).
5. Connect electrical connectors to fuel injectors.
6. With engine OFF, and ignition ON, check for leaks around gasket and fuel line couplings.



- a** - Fuel Meter Cover
- b** - Pressure Regulator Assembly
- c** - Gaskets (Regulator Passages)
- d** - Screws

73767

Fuel Injectors

NOTICE

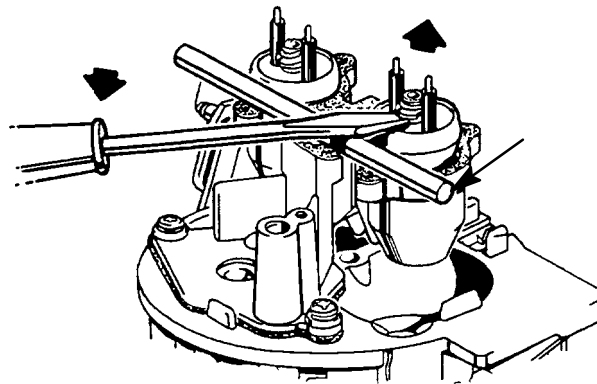
Refer to "Service Precautions," at front of this section BEFORE proceeding.
--

REMOVAL

NOTE: Use care in removing fuel injectors to prevent damage to the electrical connector and nozzle.

IMPORTANT: The fuel injector is an electrical component. **DO NOT** soak in any liquid cleaner or solvent, as damage may result.

1. Remove flame arrestor and fuel meter cover as outlined in this section.
2. Using a screwdriver carefully pry up on fuel injector to remove it from the fuel meter body (Use a screwdriver or rod under the the screwdriver when prying up. Leave old gasket in place to prevent damage to fuel meter body).

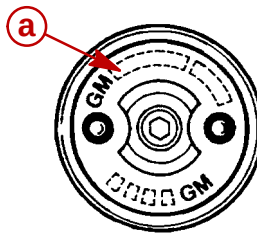


73770

CLEANING AND INSPECTION

Inspect fuel injectors for damage; replace if necessary.

IMPORTANT: When replacing injectors, be certain to replace with the identical part and part number. Other injectors may have the same appearance, yet have a different part number and be calibrated for a different flow rate, and if installed, would cause performance difficulty or damage to the ECM.

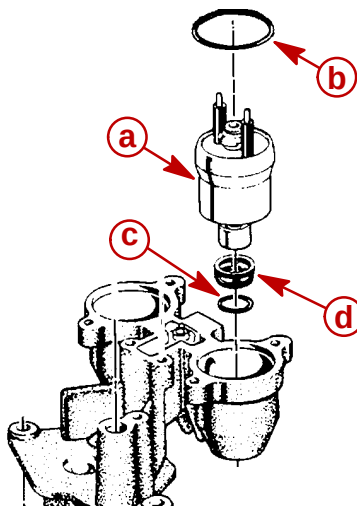


73772

a - Part Identification Number

INSTALLATION

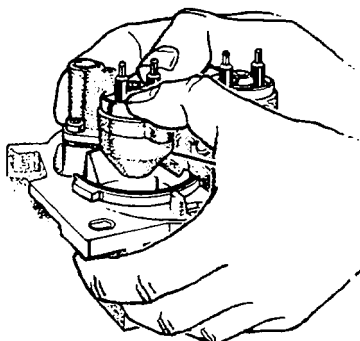
1. Install new lower O-rings on fuel injectors. Lubricate O-rings using a water soap solution.



73766

- a** - Fuel Injector
- b** - Upper O-Ring
- c** - Lower O-Ring
- d** - Fuel Filter

2. Install upper O-rings in fuel meter body. Lubricate O-rings with water soap solution.
3. Install fuel injectors into the fuel meter body. Align the raised lug on the injector base with the notch in fuel meter cavity.



73771

NOTE: The electrical terminals of the injectors should be parallel with throttle shaft.

4. Install gasket and fuel meter cover, torque screws to 28 lb-in. (3.0 Nm) and flame arrestor as outlined in this section.
5. Connect electrical connections to fuel injectors.
6. With engine OFF, and ignition ON, check for leaks around gasket and fuel line couplings.

Throttle Body

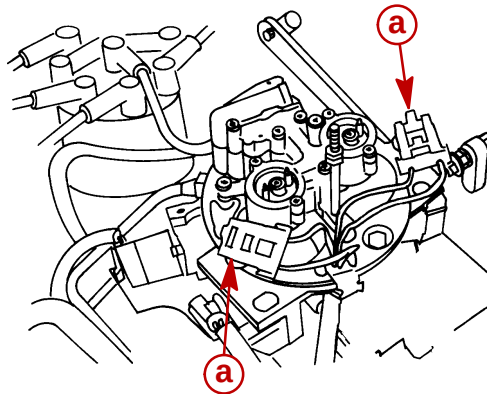
REMOVAL

⚠ CAUTION

Ensure that fuel pressure is relieved before removing the fuel inlet and return lines.

IMPORTANT: DO NOT allow the TP sensor, fuel pressure regulator, fuel injectors and IAC valve to come into contact with solvent or cleaner. These components should be removed prior to immersion in solvent.

1. Remove the flame arrestor from the throttle body.
2. Disconnect throttle cable.
3. Disconnect the electrical connections from the TP sensor, IAC and fuel injectors. (Squeeze plastic tabs on injectors and pull straight up).



73750

a - Electrical Connections

4. Remove fuel inlet and outlet lines from throttle body.
5. Remove screws retaining the throttle body to adapter plate.

NOTE: Place a shop rag over the intake manifold opening to prevent debris from entering intake manifold.

CLEANING AND INSPECTION

1. Thoroughly clean metal parts of throttle body in a cold immersion type cleaner. Dry with compressed air. Make certain that all passages are free of dirt and burrs.
2. Inspect mating surfaces for damage that could affect gasket sealing.
3. Inspect throttle body for cracks in casting.
4. Inspect throttle plates, linkage, return springs, etc., for damage, wear and foreign material.
5. Check intake manifold plenum for loose parts and foreign material.

INSTALLATION

1. Install fuel injectors and fuel meter body.
2. Install a new gasket on adapter plate.
3. Install throttle body on adapter plate and torque the screws 30 lb-ft (40 Nm).
4. Connect throttle linkage to throttle body.
5. Move throttle from idle to WOT and check that the throttle movement is not binding.
6. Connect the fuel inlet and return lines. Torque to 23 lb-ft (31 Nm).
7. Connect TP sensor, IAC, and fuel injectors connections.
8. Turn key to on position and check for fuel leaks around the inlet and return line connections.
9. Start engine and check for fuel leaks.

Throttle Body Adapter Plate

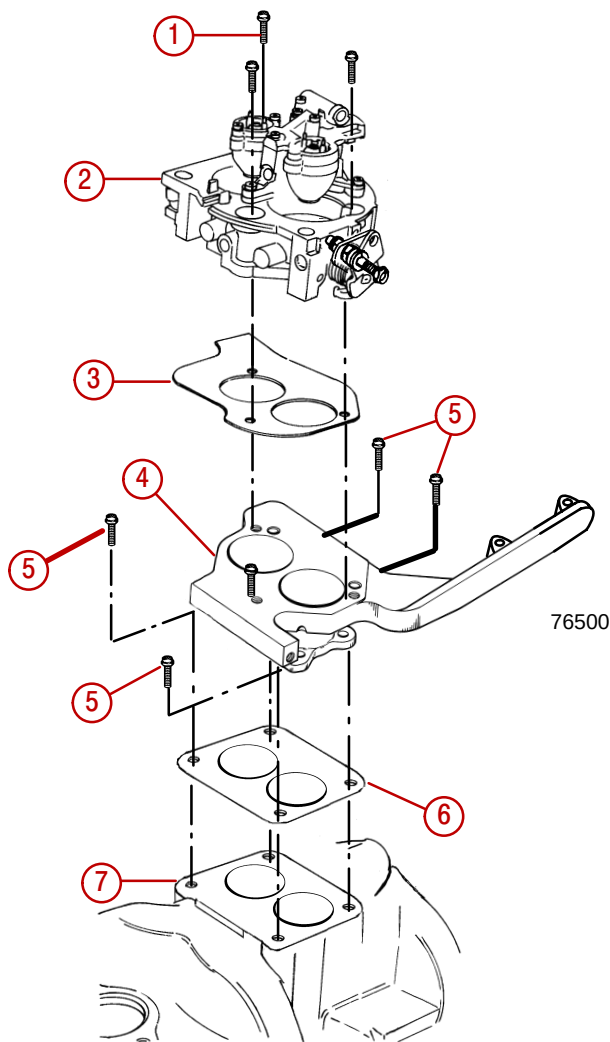
NOTICE

Refer to "Service Precautions," at front of this section BEFORE proceeding.
--

REMOVAL

IMPORTANT: Place a clean shop towel over the intake manifold opening to prevent foreign material from entering the engine.

1. Remove flame arrestor.
2. Remove throttle body refer to Throttle Body Section.
3. Remove screws and the throttle body adapter from the intake manifold.



Typical

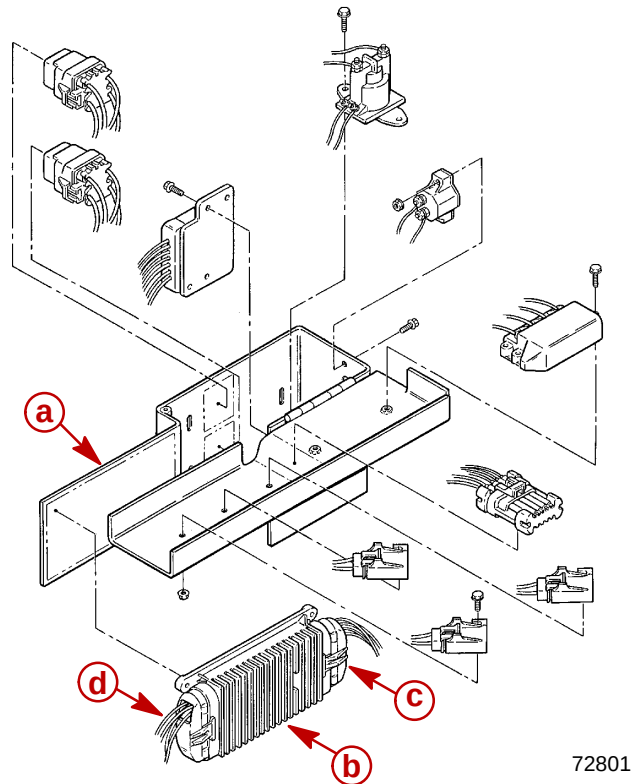
- 1 - Throttle Body
- 2 - Screws (3)
- 3 - Gasket
- 4 - Throttle Body Adapter
- 5 - Screws (4)
- 6 - Gasket
- 7 - Intake Manifold

Engine Control Module (ECM)

IMPORTANT: The ECM is a sensitive electrical device, subject to electrostatic damage. Therefore, take care not to touch connector pins when removing or installing the module.

REMOVAL

1. Disconnect J1 and J2 electrical connectors at engine control module (ECM).



MEFI 1 Shown

- a** - Electrical Bracket
- b** - ECM
- c** - J1- Electrical Connector (Front Connector)
- d** - J2- Electrical Connector (Rear Connector)

2. Remove ECM from electrical bracket.

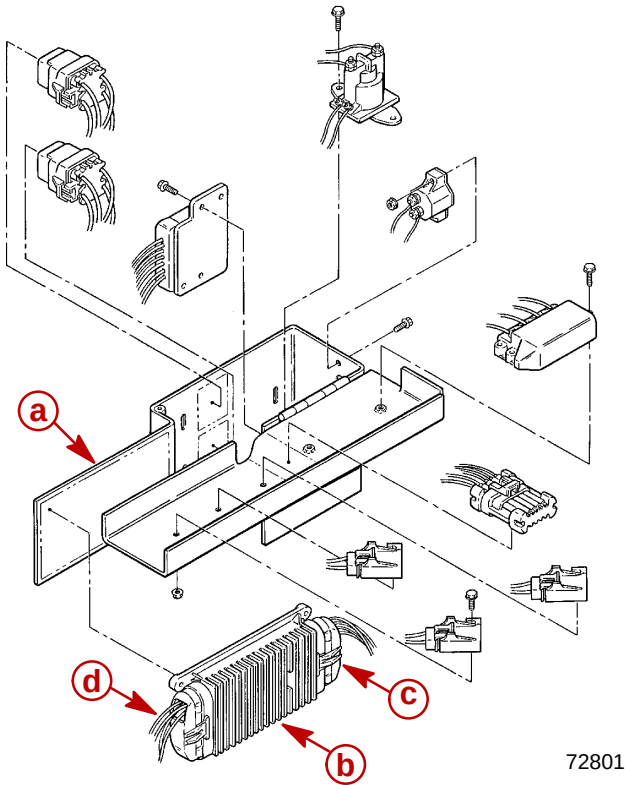
CLEANING AND INSPECTION

1. Clean the exterior of the ECM with a dry cloth being careful to avoid contact with connector pins.
2. Inspect outer surfaces for any obvious damage
3. Visually inspect electrical pins at both ends of ECM for straightness and corrosion.
4. Visually inspect J1 and J2 connectors on the wiring harness for corrosion and terminals that may have backed of the harness.

NOTE: The ECM is a sealed electrical component. If a Code 51 check has shown it to be defective, replace the unit with another ECM having the same part number as the original.

INSTALLATION

1. Mount new ECM to electrical bracket.
2. Connect J1 and J2 electrical connectors to the ECM.



MEFI 1 Shown

- a** - Electrical Bracket
- b** - ECM
- c** - J1- Electrical Connector (Front Connector)
- d** - J2- Electrical Connector (Rear Connector)

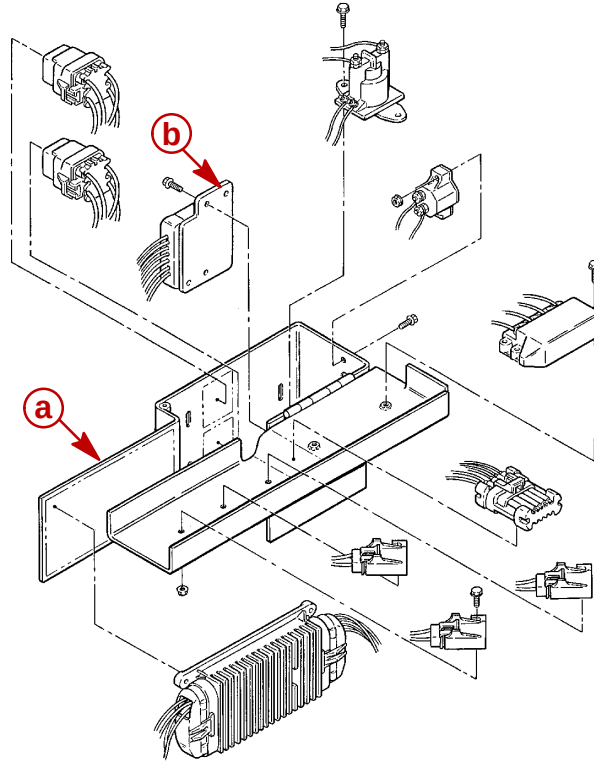
Knock Sensor (KS) Module (MEFI 1 and MEFI 2 Only)

NOTICE

Refer to "Service Precautions," at front of this section BEFORE proceeding.

REMOVAL

1. Remove Knock Sensor from electrical bracket.



72801

MEFI 1 Shown

- a** - Electrical Bracket
- b** - Knock Sensor (KS) Sensor

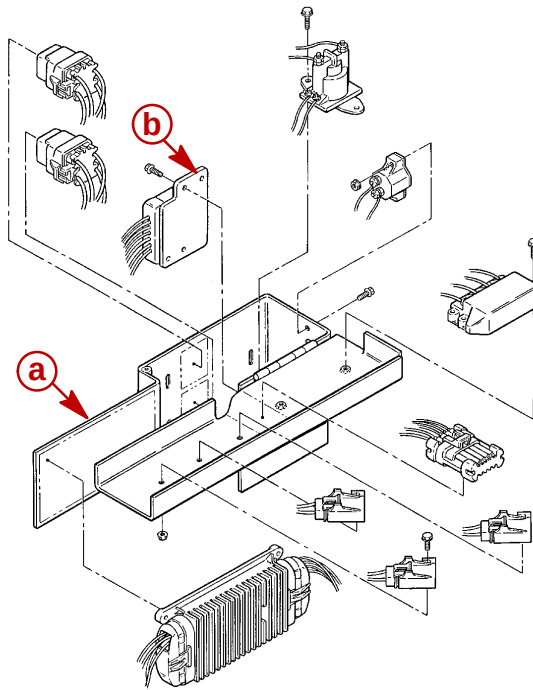
2. Disconnect electrical connector at Knock Sensor (KS) Module.

CLEANING AND INSPECTION

1. Clean the external surfaces of the KS module with a dry cloth.
2. Inspect surfaces of KS module for evidence of damage.

INSTALLATION

1. Connect electrical connector to the Knock Sensor (KS) Module.
2. Mount KS module to electrical bracket.



72801

MEFI 1 Shown

- a** - Electrical Bracket
- b** - Knock Sensor (KS) Sensor

Engine Coolant Temperature (ECT) Sensor

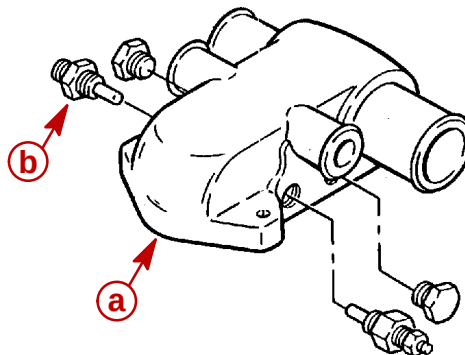
NOTICE

Refer to "Service Precautions," at front of this section **BEFORE** proceeding.

REMOVAL

NOTE: Handle the ECT carefully as any damage to it will affect operation of the system.

1. Disconnect electrical connector at Engine Coolant Temperature (ECT) sensor.



72799

- a** - Thermostat Housing
 - b** - Engine Coolant Temperature (ECT) Sensor
2. Remove ECT from thermostat housing.

CLEANING AND INSPECTION

1. Clean with a dry cloth, removing any excess sealant from the base threads.
2. Look for evidence of any physical damage to base or connector surfaces of the ECT.

INSTALLATION

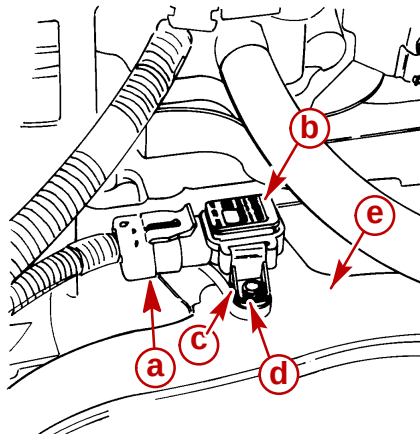
1. Install ECT in thermostat housing. Tighten hand tight plus 2-1/2 turns maximum.
2. Connect electrical connector to ECT.

Manifold Absolute Pressure (MAP) Sensor

NOTICE
Refer to "Service Precautions," at front of this section BEFORE proceeding.

REMOVAL

1. Disconnect electrical connector from manifold absolute pressure (MAP) sensor.



75840

- a** - Electrical Connector
- b** - Manifold Absolute Pressure (MAP) Sensor
- c** - Clip
- d** - Screw
- e** - Intake Manifold

2. Remove MAP sensor from throttle body adapter.

CLEANING AND INSPECTION

1. Clean the surfaces of the MAP sensor with a dry cloth.
2. Inspect the MAP sensor for signs of wear or damage.
3. Inspect seal on MAP sensor. Replace if deteriorated or hardened.

INSTALLATION

1. Install seal on MAP sensor.
2. Install MAP sensor on intake manifold using clip and screw. Torque screw to 44-62 lb-in. (5-7 Nm).
3. Connect electrical connector to MAP sensor.

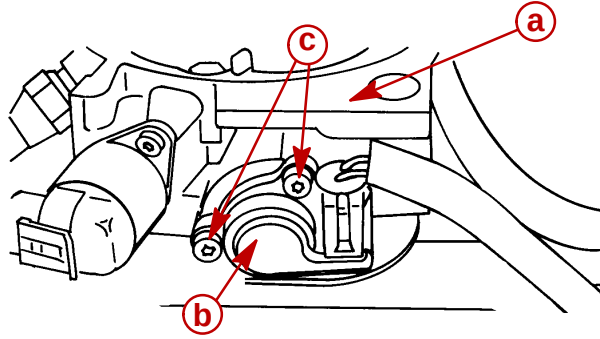
Throttle Position (TP) Sensor

NOTICE

Refer to "Service Precautions," at front of this section BEFORE proceeding.

REMOVAL

1. Disconnect electrical connector at throttle position (TP) sensor.
2. Remove TP sensor from throttle body.



73758

- a** - Throttle Body
- b** - Throttle Position (TP) Sensor
- c** - Screws

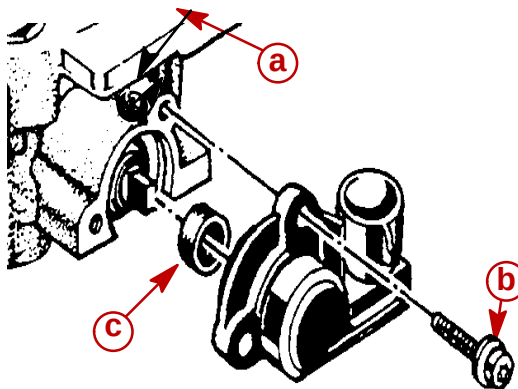
CLEANING AND INSPECTION

1. Clean the surfaces of the TP sensor with a dry cloth.
2. Inspect the TP sensor for signs of wear or damage.

INSTALLATION

IMPORTANT: If the TP sensor is to be replaced with a new unit, be sure to secure it in place with the new screws which are included in the service package.

1. Install TP sensor to throttle body using screws with washers and Loctite 242 applied to threads. Torque screws to 20 lb-in. (2 Nm).



73758

- a** - Throttle Body
- b** - Screws With Lockwashers
- c** - Seal

2. Connect electrical connector to TP sensor.
3. Install throttle body, throttle linkage and flame arrestor as outlined in "Throttle Body."
4. Start engine and check for TP sensor output voltage. It should be approximately .7 V at idle and 4.5 V at WOT.

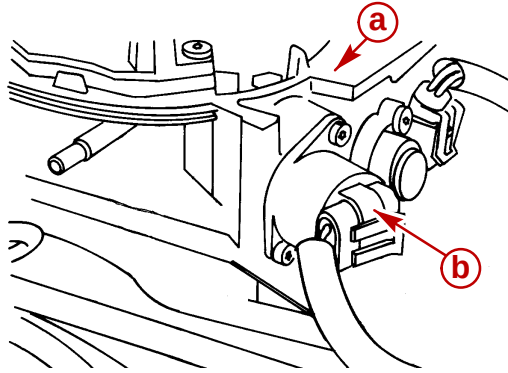
Idle Air Control (IAC) Valve

NOTICE

Refer to "Service Precautions," at front of this section BEFORE proceeding.
--

REMOVAL

1. Remove flame arrestor, throttle cable and throttle body.
2. Disconnect electrical connector at idle air control (IAC) valve.



73754

a - Throttle Body

b - Idle Air Control (IAC) Valve

3. Remove IAC from throttle body.

CLEANING AND INSPECTION

1. Remove and discard sealing O-ring from IAC valve. Clean sealing surfaces, pintle valve seat, and air passage with a carburetor cleaner to remove carbon deposits, being careful not to push or pull on the IAC valve pintle. Force exerted on the pintle might damage the worm drive. DO NOT use a cleaner that contains the extremely strong solvent methyl ethyl ketone.

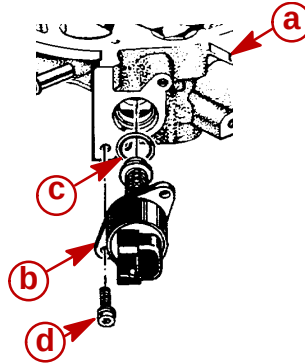
NOTE: Shiny spots on the pintle, or seat, are normal and do not indicate misalignment or a bent pintle shaft.

2. Inspect the entire assembly for any obvious physical damage.

INSTALLATION

IMPORTANT: If installing a new IAC valve, be sure to replace it with the correct IAC valve pintle shape and diameter are designed for the specific application.

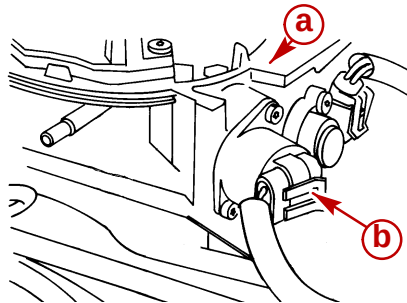
1. Install new O-ring on IAC valve.



73766

- a** - Throttle Body
- b** - Idle Air Control (IAC) Valve
- c** - O-Ring
- d** - Screws

2. Install IAC valve in throttle body using screws. Torque to 20 lb-in. (2 Nm).
3. Connect electrical connector to IAC valve.



73754

- a** - Throttle Body
- b** - Idle Air Control (IAC) Valve

4. Reset IAC valve pintle position after reconnecting negative (–) battery cable.
 - a. Turn ignition key ON for ten seconds.
 - b. Turn ignition key OFF for ten seconds.
 - c. Restart engine and check for proper idle operation.

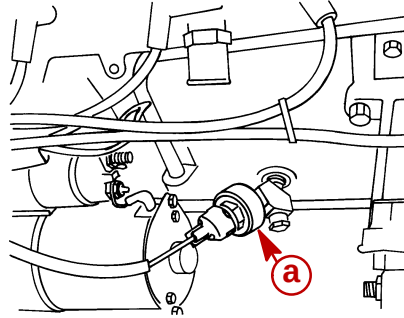
Knock Sensor

NOTICE

Refer to "Service Precautions," at front of this section BEFORE proceeding.
--

REMOVAL

1. Disconnect electrical connector at Knock Sensor located just ahead of starter motor.



73757

a - Knock Sensor

2. Remove Knock Sensor from engine block.

CLEANING AND INSPECTION

1. Clean Knock Sensor with a dry cloth, paying special attention to threads on base.
2. Inspect surfaces of Knock Sensor for signs of wear or physical damage.

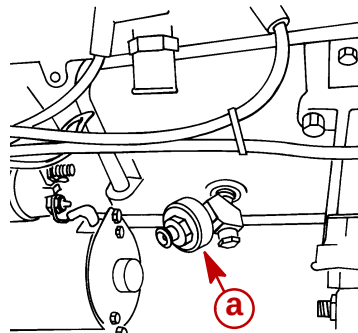
INSTALLATION

IMPORTANT: If installing a new Knock Sensor, be sure to replace it with an identical part. Knock Sensors are very sensitive and designed for each specific application.

IMPORTANT: In the following step, it is very important that the Knock Sensor be torqued to the precise specification. Incorrect torquing will result in unsatisfactory performance. **DO NOT** use sealer on threads.

IMPORTANT: Ensure that the Knock Sensor is installed in the upper location on the Y-fitting.

1. Install Knock Sensor in engine block. Torque to 12-16 lb-ft (16-22 Nm).



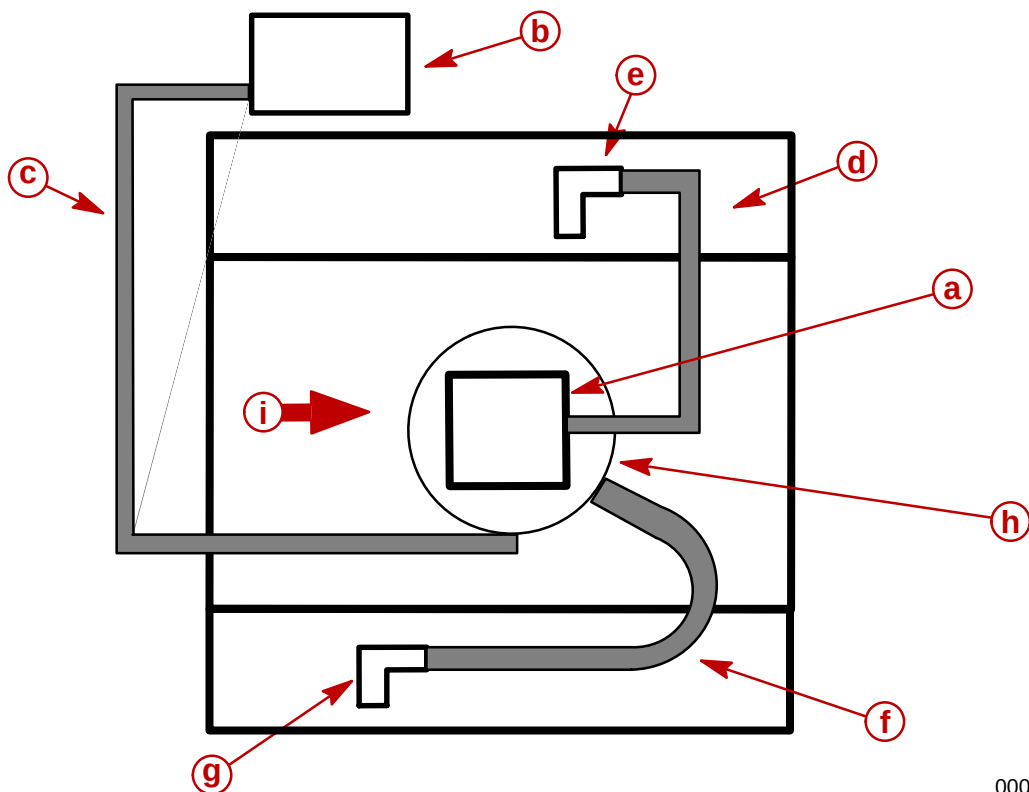
73756

a - Knock Sensor

2. Connect electrical connector to Knock Sensor.

Vacuum And Vent Hose Routing

Throttle Body EFI Models



00000

- a** - Plenum
- b** - Cool Fuel Assembly
- c** - Diaphragm Rupture Hose - Fuel Pressure Regulator on Cool Fuel Assembly To Side of Flame Arrestor
- d** - Vent Hose - PCV Valve to Throttle Body Adapter
- e** - PCV Valve
- f** - Vent Hose - Valve Cover Fitting To Flame Arrestor
- g** - Valve Cover Fitting
- h** - Flame Arrestor
- i** - Front of Engine

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FUEL SYSTEM

Section 5E - Fuel Injection Disassembly And Reassembly

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Engine Coolant Temperature		Engine Coolant Temperature Sensor .	5E-41
(ECT) Sensor	5E-18	Vacuum And Vent Hose Routing	5E-42
Vacuum And Vent Hose Routing	5E-19	MX 6.2 Black Scorpion Models	5E-42
MX 6.2 MPI Models	5E-19		

Service Precautions

WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

WARNING

Be careful when cleaning flame arrestor and crankcase ventilation hose; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in the area while changing fuel filter(s). Wipe up any spilled fuel immediately.

WARNING

Be sure that the engine compartment is well ventilated and that no gasoline vapors are present to avoid the possibility of fire.

WARNING

Make sure no fuel leaks exist before closing engine hatch.

CAUTION

Fuel pressure MUST BE relieved before servicing high pressure components in the fuel system.

CAUTION

DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

The following information MUST BE adhered to when working on the fuel system:

- Always keep a dry chemical fire extinguisher at the work area.
- Always install new O-rings when assembling fuel pipe fittings.
- DO NOT replace fuel pipe with fuel hose.
- DO NOT attempt any repair to the fuel system until instructions and illustrations relating to that repair are thoroughly understood.
- Observe all Warnings, Notes and Cautions.

Specifications

Torque Specifications

Fastener Location	lb-in.	lb-ft	Nm
Throttle Body Screws	75		8.5
Throttle Body on Adapter	89		10
Throttle Body on Plenum	75		8.5
TP Sensor And Dust Seal	20		2
IAC Valve	20		2
MAP Sensor	44-62		5-7
Knock Sensor		12-16	16-22
Black Scorpion Plenum	150		17
Fuel Rail Fasteners	105		12
Rail-to-Rail Fuel Line		18	24
Fuel Meter Cover Assembly Screws	28		3
Fuel Inlet and Return Lines		23	31
Engine Coolant Temperature Sensor	Tighten Hand Tight + 2 1/2 turns maximum		
Flame Arrestor Cover Bracket	Tighten Securely		
Flame Arrestor Clamp			

Lubricants / Sealants / Adhesives

Description	Part Number
Loctite 242	

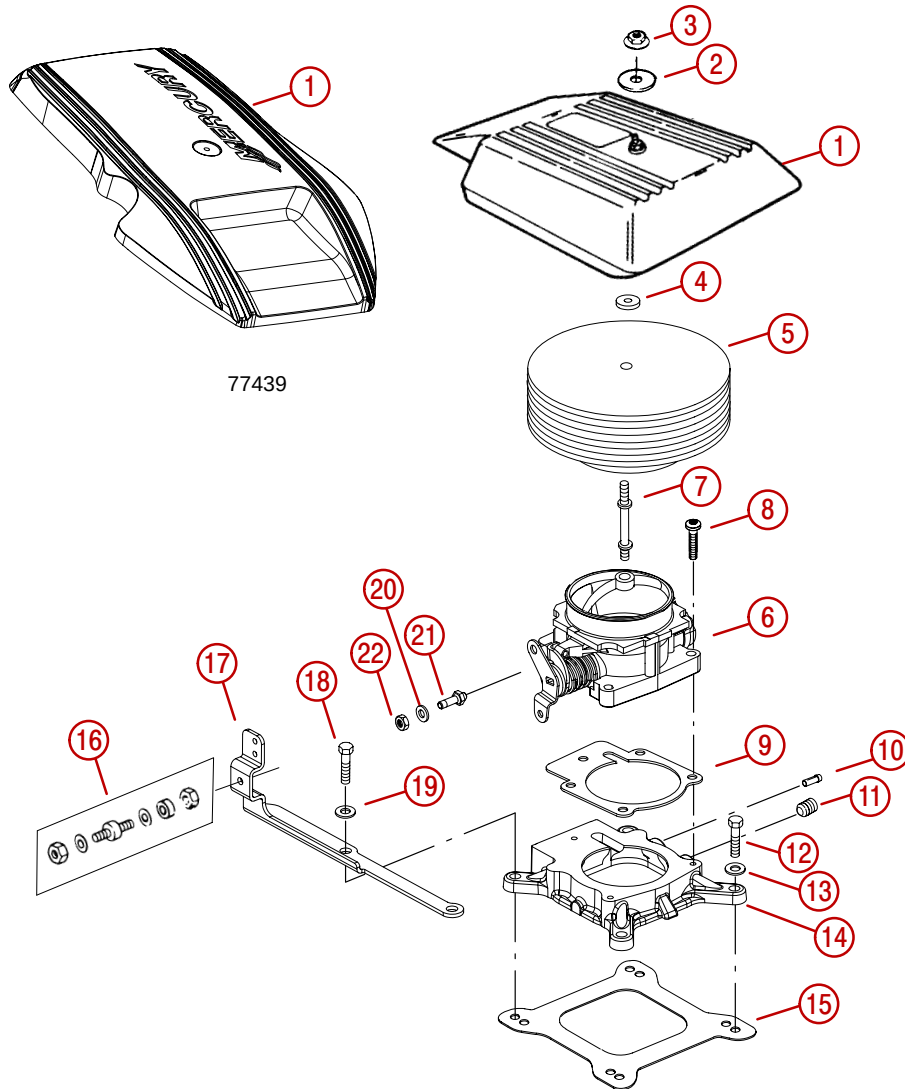
Sensor Voltage

Description	Voltage at Idle	Voltage at WOT
Throttle Position (TP) Sensor	.7	4.5
Knock Sensor (KS)		
Engine Coolant Temperature (ECT) Sensor		
Manifold Absolute Pressure (MAP) Sensor		

Exploded Views - MX 6.2L MPI

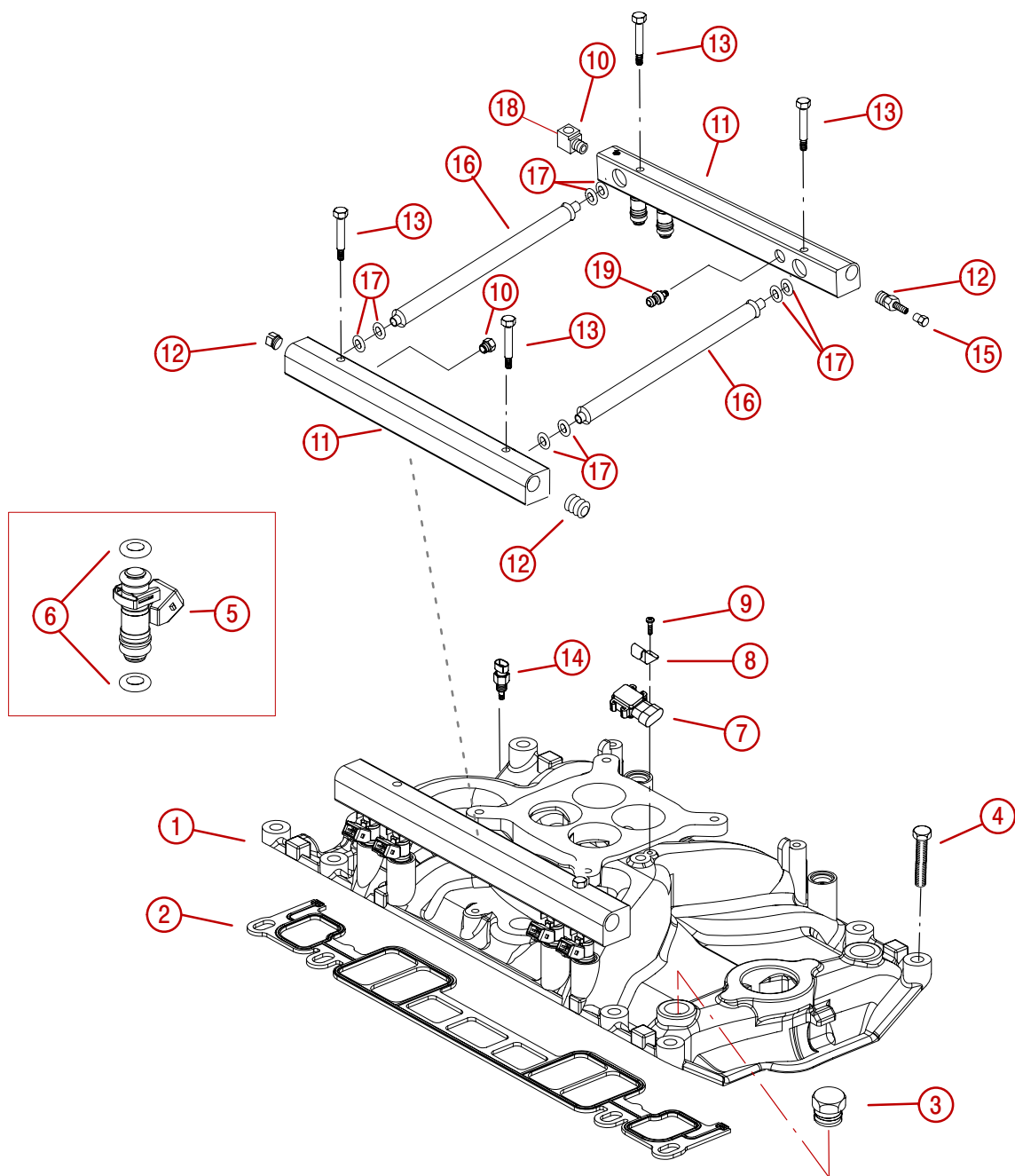
Flame Arrestor And Throttle Body

NOTE: The 6.2L engine may be equipped with one of two covers. Both covers are shown below, but most pictures will show the early model cover.



- | | |
|--|---|
| 1 - Cover | 12 - Screw [5/16-18 x 1-1/4 in. (32 mm)] |
| 2 - Washer | 13 - Washer |
| 3 - Nut (1/4-28) | 14 - Throttle Body Adaptor Plate |
| 4 - Washer | 15 - Gasket |
| 5 - Flame Arrestor | 16 - Stud Kit |
| 6 - Throttle Body Assembly | 17 - Throttle Cable Bracket |
| 7 - Stud | 18 - Screw (5/16-18 x 1 in.) |
| 8 - Screw (1/4-20) | 19 - Washer |
| 9 - Gasket | 20 - Washer |
| 10 - 3/16 in. Barb Fitting (From Fuel Pressure Regulator) | 21 - Stud (1/4 x 1-3/4 in.) |
| 11 - Pipe Plug (1/4-18 Socket Head) | 22 - Nut (1/4-28) |

Intake Manifold And Fuel Rail



75829

- | | |
|--|--|
| 1 - Intake Manifold | 11 - Fuel Rail |
| 2 - Gasket | 12 - Schrader Valve |
| 3 - Pipe Plug | 13 - Screws (1/4-20 x 1-1/2 in.) |
| 4 - Screw [5/16-18 x 1-3/8 in. (35 mm)] | 14 - MAT Sensor |
| 5 - Fuel Injector | 15 - Cap |
| 6 - O-Ring | 16 - Fuel Lines |
| 7 - MAP Sensor | 17 - O-Rings |
| 8 - Clip | 18 - Location of Fuel Line From Fuel Pump |
| 9 - Screw [#8-32 x 1/4 in. (6 mm)] | 19 - Pressure Sensor |
| 10 - Pipe Plug (1/8 in. hex head) | |

Fuel Pressure Relief Procedure

NOTICE

Refer to "Service Precautions," at front of this section BEFORE proceeding.
--

1. Disconnect electrical connector at fuel pump.
2. Crank engine for ten seconds (if engine starts allow it run until it stops) to relieve any fuel pressure in the system.

MX 6.2 MPI Components

Flame Arrestor

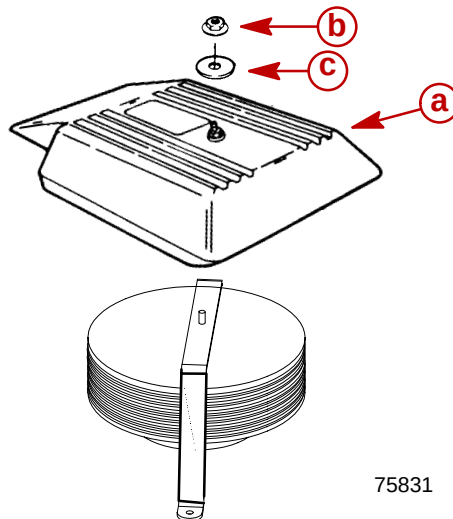
NOTICE

Refer to "Service Precautions," at front of this section BEFORE proceeding.
--

NOTE: The 6.2L engine may be equipped with one of two covers. Both covers are shown below, but most pictures will show the early model cover.

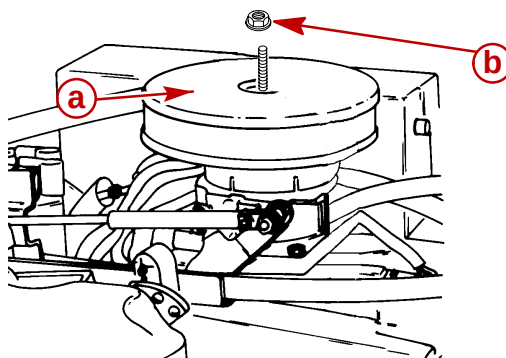
REMOVAL

1. Remove the flame arrestor cover.



- a** - Flame Arrestor Cover
- b** - Nut
- c** - Washer

2. Loosen the nut and remove the flame arrestor.



76501

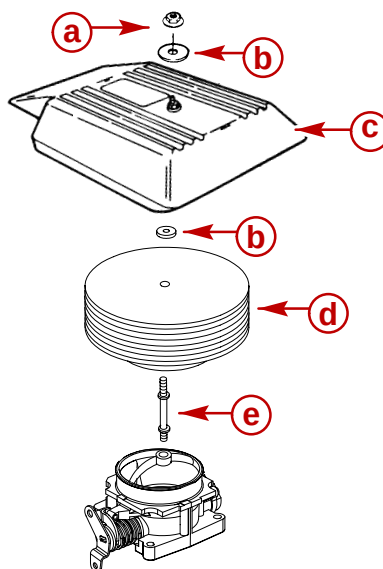
- a** - Flame Arrestor
b - Nut

CLEANING AND INSPECTION

1. Clean flame arrestor in solvent.
2. Wear eye protection. Dry flame arrestor with compressed air.

INSTALLATION

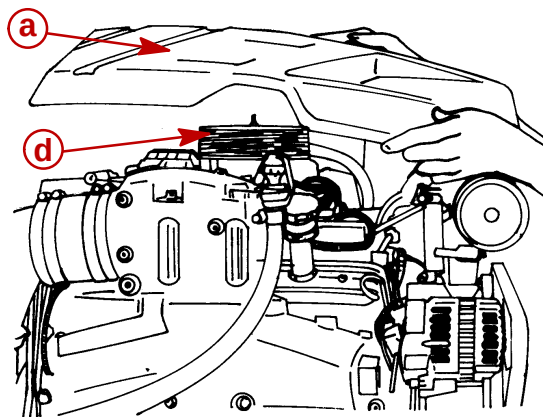
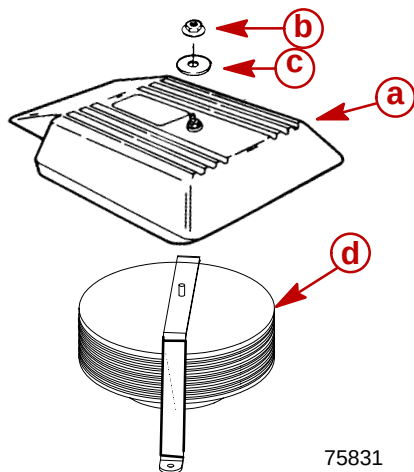
1. Replace components as appropriate for your model. Tighten all fasteners securely.



76518

- a** - Nut
b - Washer
c - Flame Arrestor Cover
d - Flame Arrestor
e - Stud

2. Install flame arrestor cover. Secure with washer and locknut.



- a** - Flame Arrestor Cover
- b** - Nut
- c** - Washer
- d** - Flame Arrestor

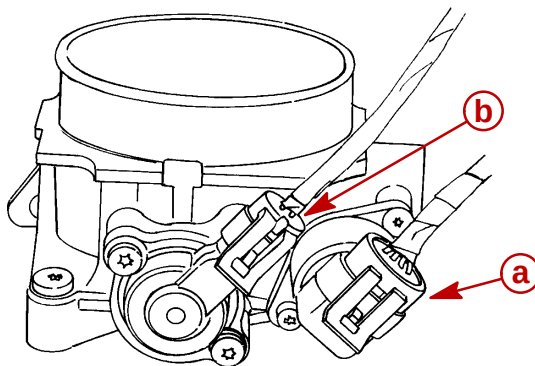
Throttle Body

NOTICE

Refer to "Service Precautions," at front of this section BEFORE proceeding.

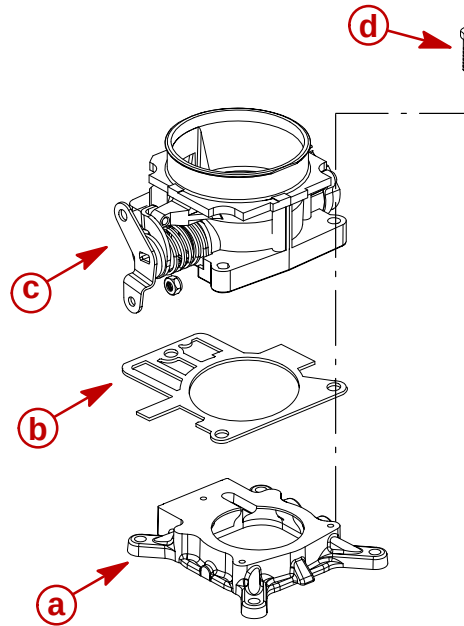
REMOVAL

1. Remove the flame arrestor.
2. Disconnect the throttle linkage from the throttle body.
3. Disconnect the wiring connectors from the IAC valve and the TP sensor.



- a** - IAC Valve Connector
- b** - Throttle Position Sensor Connector

4. Remove the screws (3) retaining the throttle body and remove the throttle body from the adapter. Refer to "Exploded View".



- a** - Adapter
- b** - Gasket
- c** - Throttle Body
- d** - Screws

75828

IMPORTANT: Insert a clean shop towel into the opening of the plenum to prevent foreign material from entering the engine.

CLEANING AND INSPECTION

IMPORTANT: DO NOT use cleaners containing methyl ethyl ketone. It is not necessary for cleaning throttle bore and valve deposits.

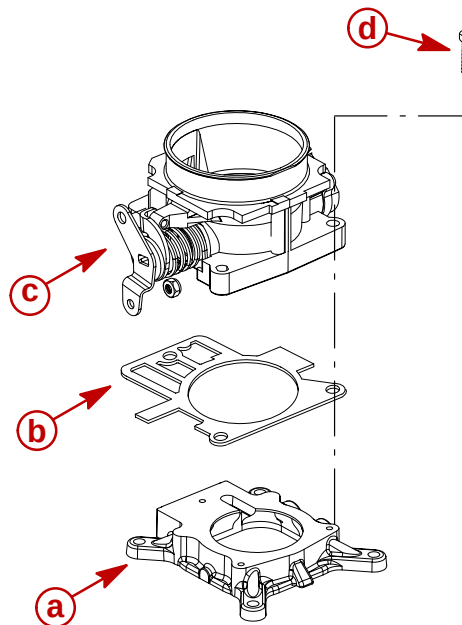
IMPORTANT: DO NOT allow the TP sensor and IAC valve to come into contact with solvent or cleaner.

IMPORTANT: Use care when removing gasket material from adapter and throttle body. Failure to do so could result in damage to the adapter and throttle body.

1. Carefully remove all gasket material from adapter and throttle body.
2. Thoroughly clean all parts of throttle body. Make certain that all passages are free of dirt and burrs.
3. Inspect mating surfaces for damage that could affect gasket sealing.
4. Inspect throttle body for cracks in casting.
5. Inspect throttle plates, linkage, return springs, etc., for damage, wear and foreign material.
6. Check adapter for loose parts and foreign material.

INSTALLATION

1. Place the throttle body gasket between the throttle body and the adapter.
2. Place the throttle body on the adapter. Install the screws and torque to 75 lb-in. (8.5 Nm).

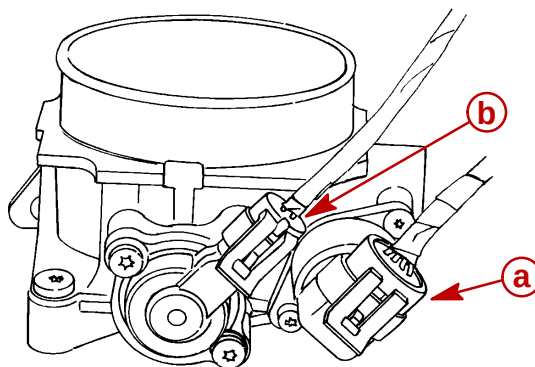


75828

Typical

- a** - Adapter
- b** - Gasket
- c** - Throttle Body
- d** - Screws

3. Connect the harness connectors to the TP sensor and IAC valve.



75788

- a** - IAC Valve Connector
b - Throttle Position Sensor Connector

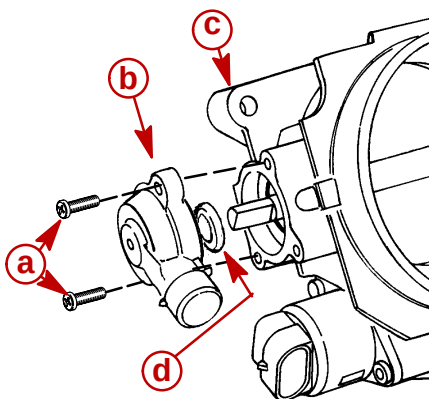
4. Connect the throttle cable to the throttle lever. Refer to SECTION 2 for throttle cable adjustment.
5. Install the flame arrestor.
6. Install the flame arrestor cover.

Throttle Position Sensor

NOTICE

Refer to "Service Precautions," in front of this section BEFORE proceeding.

1. Remove the flame arrestor cover.
2. Remove the flame arrestor from the throttle body.
3. Disconnect the harness connector from the TP sensor.
4. Remove the throttle body from the adapter.
5. Disconnect the harness connector from the TP sensor.
6. Remove the screws from the TP sensor.
7. Remove the TP sensor from the throttle body.



75832

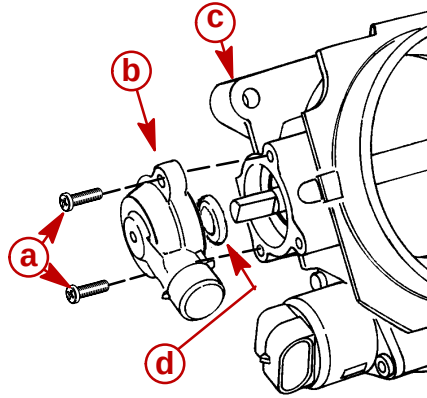
- a** - Screw (2)
b - Throttle Position (TP) Sensor
c - Throttle Body
d - Dust Seal

CLEANING AND INSPECTION

1. Clean the surfaces of the TP sensor with a dry cloth.
2. Inspect the sensor for signs of wear or damage.

INSTALLATION

1. Apply Loctite 242 to screw threads. Install the TP sensor and dust seal on the throttle body using the screws. Torque screws to 20 lb-in. (2 Nm).



75832

- a** - Screw (2)
- b** - Throttle Position (TP) Sensor
- c** - Throttle Body
- d** - Dust Seal

2. Place a new gasket on the adapter.
3. Install throttle body on the adapter. Torque screws to 89 lb-in. (10 Nm).
4. Connect the harness connector to the TP sensor.
5. Place the flame arrestor over the throttle body and tighten clamp securely.
6. Install the flame arrestor cover. Tighten nut securely.
7. When negative (–) battery cable has been reconnected, start engine and check for TP sensor output voltage. It should be approximately .7 Volts at idle and 4.5 Volts at wide open throttle.

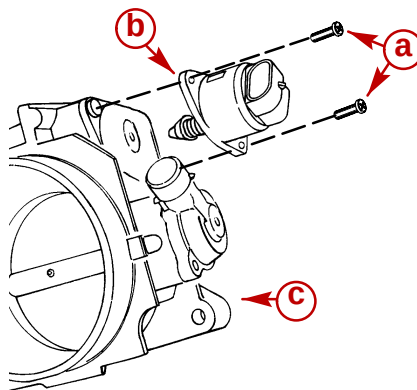
Idle Air Control (IAC) Valve

NOTICE

Refer to "Service Precautions," in front of this section BEFORE proceeding.

REMOVAL

1. Remove the flame arrestor, throttle cable and throttle body.
2. Remove the IAC valve from the throttle body.



75657

- a** - Screw (2)
- b** - Idle Air Control (IAC) Valve
- c** - Throttle Body

CLEANING AND INSPECTION

IMPORTANT: Do not push or pull on the IAC valve pintle. Force exerted on the pintle might damage the worm drive. **DO NOT** use a cleaner that contains the extremely strong solvent methyl ethyl ketone.

1. Remove and discard sealing O-ring from IAC valve. Clean sealing surfaces, pintle valve seat, and air passage with a carburetor cleaner to remove carbon deposits, being careful not to push or pull on the IAC valve pintle.

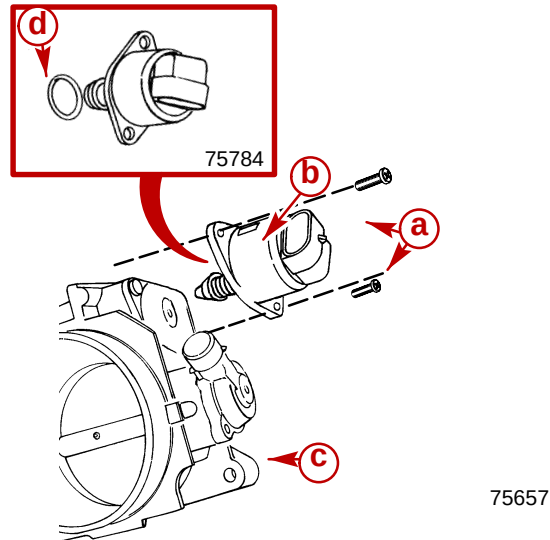
NOTE: Shiny spots on the pintle, or seat, are normal and do not indicate misalignment or a bent pintle shaft.

2. Inspect the entire assembly for any obvious physical damage.

INSTALLATION

IMPORTANT: If installing a new IAC valve, be sure to replace it with an identical part. IAC valve pintle shape and diameter are designed for the specific application.

1. Install new O-ring on IAC valve.



- a** - Screw (2)
- b** - Idle Air Control (IAC) Valve
- c** - Throttle Body
- d** - O-Ring

2. Install IAC valve in throttle body using screws. Torque to 20 lb-in. (2 Nm).
3. Place a new gasket between throttle body and adapter.
4. Install the throttle body on the adapter and torque the screws to 89 lb-in. (10 Nm).
5. Reset IAC valve pintle position as follows:
 - a. Turn ignition key ON for ten seconds.
 - b. Turn ignition key OFF for ten seconds.
 - c. Restart engine and check for proper idle operation.

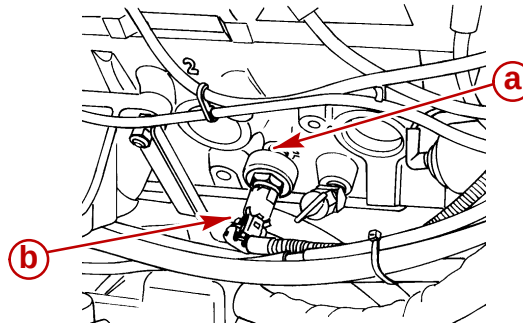
Knock Sensor

NOTICE

Refer to "Service Precautions" in front of this section **BEFORE** proceeding.

REMOVAL

1. Disconnect electrical connector at knock sensor located just ahead of starter motor.



75678

Starboard Side Shown

- a** - Knock Sensor
- b** - Electrical Connector

2. Remove knock sensor from engine block.

CLEANING AND INSPECTION

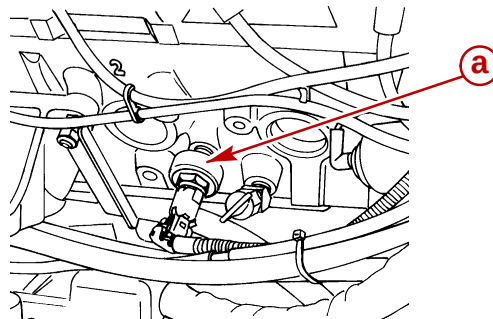
1. Clean knock sensor with a dry cloth, paying special attention to threads on base.
2. Inspect surfaces of knock sensor for signs of wear or physical damage.

INSTALLATION

IMPORTANT: If installing a new Knock Sensor, be sure to replace it with an identical part. Knock Sensors are very sensitive and designed for each specific application.

IMPORTANT: In the following step, it is very important that the Knock Sensor be torqued to the precise specification. Incorrect torquing will result in unsatisfactory performance. **DO NOT** use sealer on threads.

1. Install knock sensor in engine block. Torque to 12-16 lb-ft (16-22 Nm).



75678

Starboard Side Shown

- a** - Knock Sensor

2. Connect electrical connector to knock sensor.

Knock Sensor Module

1. Remove the knock sensor module from the electrical bracket.
2. Disconnect electrical connector at knock sensor (KS) module.

CLEANING AND INSPECTION

1. Clean the external surfaces of the KS module with a dry cloth.
2. Inspect surfaces of KS module for evidence of damage.

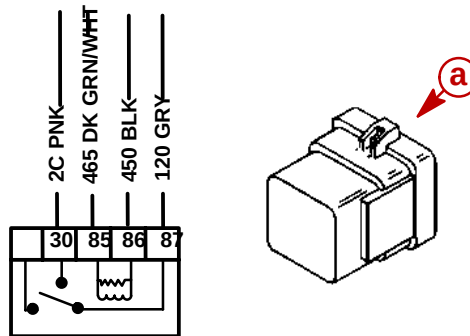
INSTALLATION

1. Mount KS module on bracket.
2. Connect electrical connector to the KS module.

Fuel Pump Relay

REMOVAL

1. Remove fuel pump relay from electrical bracket.



75834

a - Fuel Pump Relay

2. Disconnect electrical connector and remove fuel pump relay.

CLEANING AND INSPECTION

IMPORTANT: The fuel pump relay is an electrical component. DO NOT soak in any liquid cleaner or solvent; damage may result.

1. Clean the external surfaces with a dry cloth.
2. Inspect surfaces for evidence of damage.

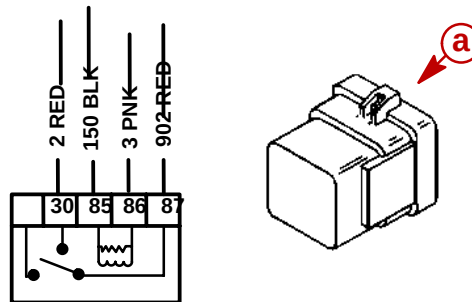
INSTALLATION

1. Connect electrical connector to fuel pump relay.
2. Attach fuel pump relay to bracket.

System Relay

REMOVAL

1. Remove system relay from electrical bracket.



a - System Relay

2. Disconnect electrical connector and remove relay.

CLEANING AND INSPECTION

IMPORTANT: The system relay is an electrical component. **DO NOT** soak in any liquid cleaner or solvent; damage may result.

1. Clean the external surfaces with a dry cloth.
2. Inspect surfaces for evidence of damage.

INSTALLATION

1. Attach electrical connector to relay.
2. Place system relay in electrical box.

Electronic Control Module (ECM)

NOTICE

Refer to "Service Precautions" in front of this section **BEFORE** proceeding.

IMPORTANT: The ECM is a sensitive electrical device, subject to electrostatic damage. **DO NOT** touch connector pins when removing or installing the module.

REMOVAL

1. Disconnect J1 and J2 electrical connectors at engine control module (ECM). **DO NOT** touch connector pins when removing.
2. Remove ECM from electrical bracket.

CLEANING AND INSPECTION

1. Clean the exterior of the ECM with a dry cloth being careful to avoid contact with connector pins.
2. Inspect outer surfaces for any obvious damage
3. Visually inspect electrical pins at both ends of ECM for straightness and corrosion.
4. Visually inspect J1 and J2 connectors on the wiring harness for corrosion and terminals that may have backed out of the harness.

NOTE: The ECM is a sealed electrical component. If a Code 51 or 52 check has shown it to be defective, replace the unit with another ECM having the same part number as the original.

INSTALLATION

1. Mount new ECM to electrical bracket using screws and washers.
2. Connect J1 and J2 electrical connectors to the ECM. DO NOT touch connector pins when installing.

Engine Coolant Temperature (ECT) Sensor

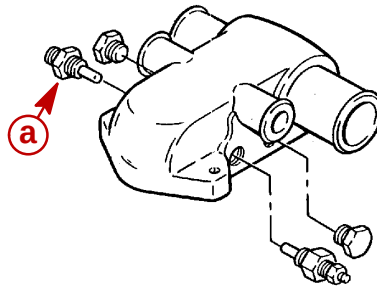
NOTICE

Refer to "Service Precautions" in front of this section BEFORE proceeding.

REMOVAL

NOTE: Handle the ECT carefully as any damage to it will affect operation of the system.

1. Disconnect electrical connector at engine coolant temperature (ECT) sensor.



72799

a - Engine Coolant Temperature (ECT) Sensor

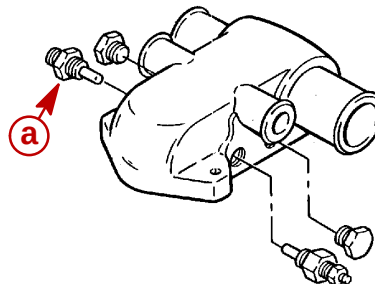
2. Remove ECT sensor from thermostat housing.

CLEANING AND INSPECTION

1. Clean with a dry cloth, removing any excess sealant from the base threads.
2. Look for evidence of any physical damage to base or connector surfaces of the ECT sensor.

INSTALLATION

1. Install ECT sensor. Tighten hand tight plus 2-1/2 turns maximum.



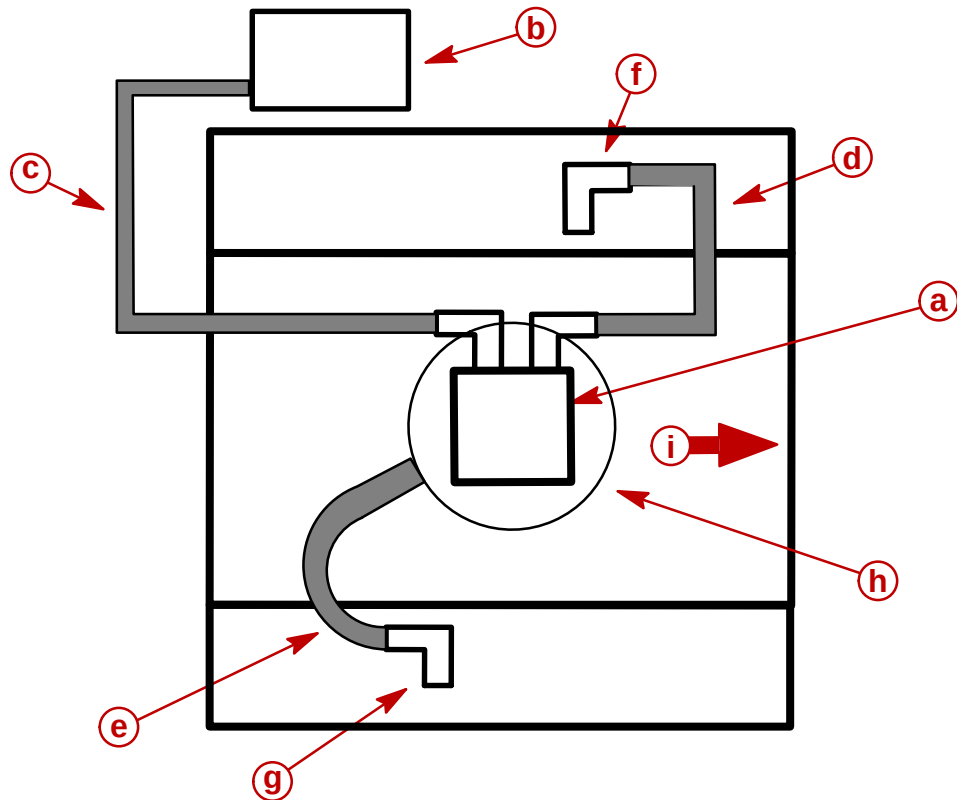
72799

a - Engine Coolant Temperature (ECT) Sensor

2. Connect electrical connector to ECT sensor.

Vacuum And Vent Hose Routing

MX 6.2 MPI Models

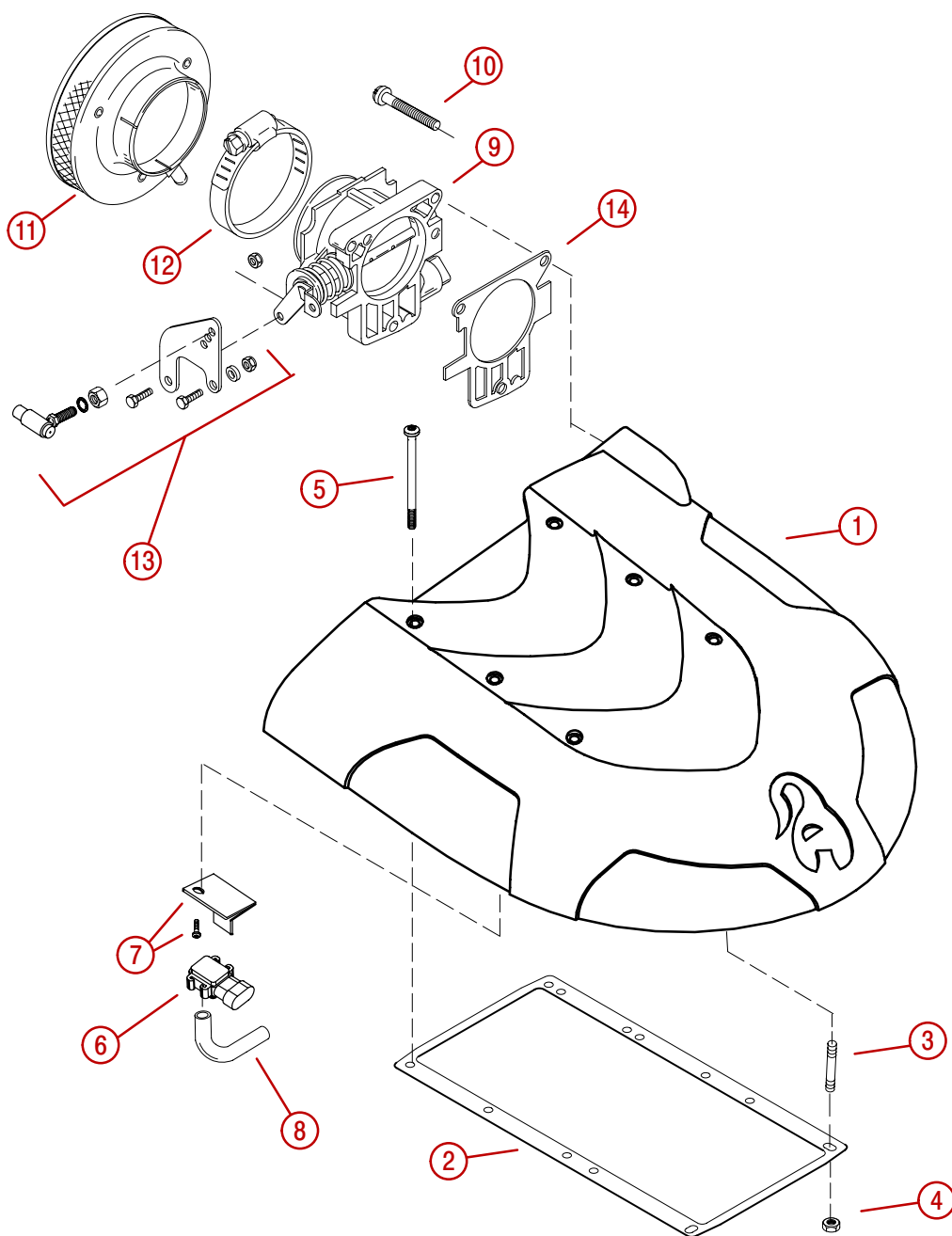


75837

- a** - Throttle Body Adapter
- b** - Cool Fuel Assembly
- c** - Vacuum Hose - Throttle Body Adapter to Fuel Pressure Regulator on Cool Fuel Assembly
- d** - Vent Hose - PCV Valve to Throttle Body Adapter
- e** - Vent Hose - Valve Cover Fitting To Flame Arrestor
- f** - PCV Valve
- g** - Vacuum Hose - T-Fitting to Plenum
- h** - Flame Arrestor
- i** - Front of Engine

Exploded Views - MX 6.2 Black Scorpion

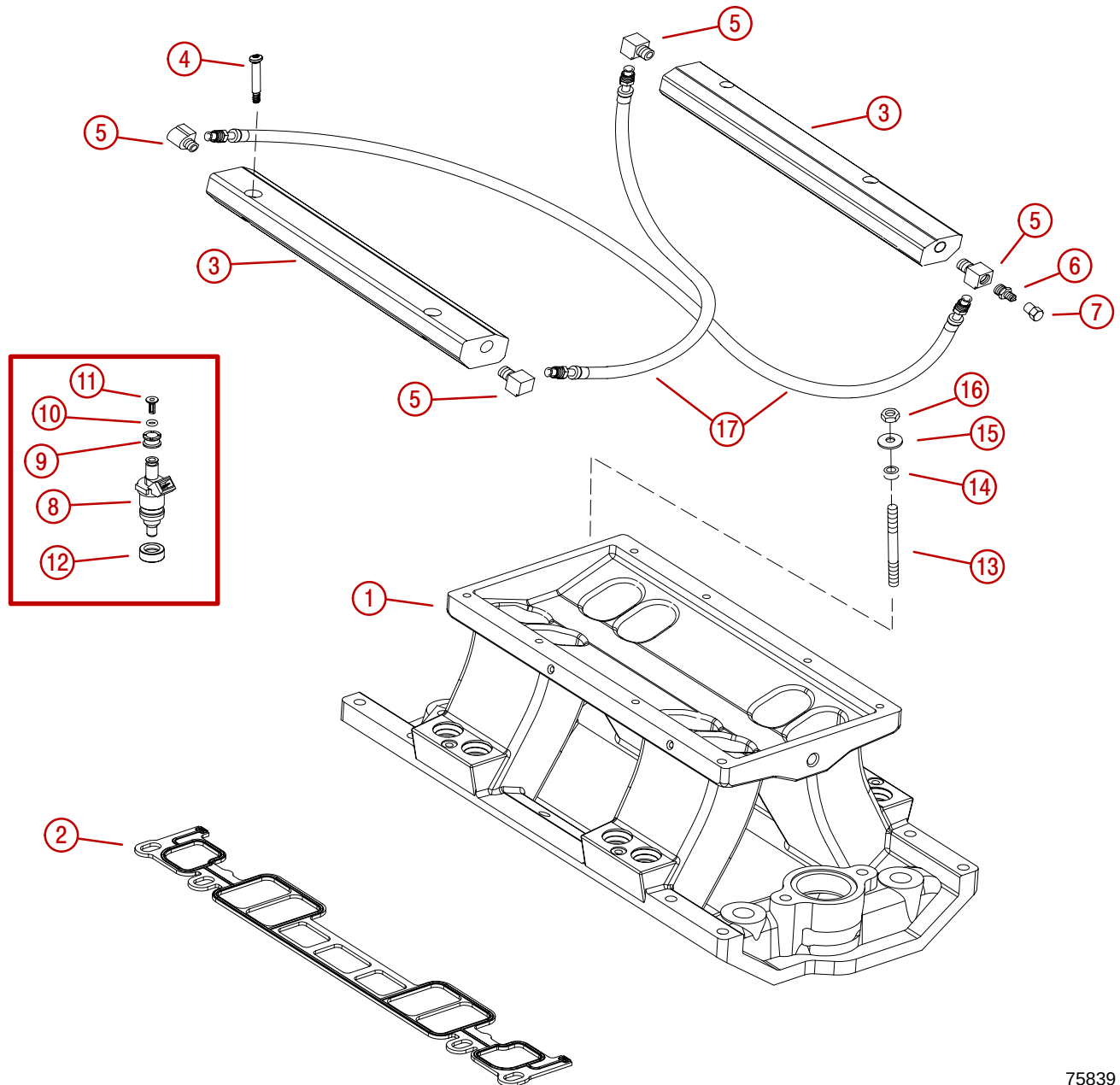
Plenum, Throttle Body And Flame Arrestor



75838

- | | |
|-----------------------|--------------------------------------|
| 1 - Intake Plenum | 8 - Hose |
| 2 - Gasket | 9 - Throttle Body |
| 3 - Stud | 10 - Screw |
| 4 - Nut (2) | 11 - Flame Arrestor |
| 5 - Plenum Screw | 12 - Clamp |
| 6 - MAP Sensor | 13 - Throttle Lever and Linkage |
| 7 - Screw and Bracket | 14 - Gasket - See Changes Previously |

Intake Manifold And Fuel Rails



75839

- | | |
|-------------------------------|------------------------|
| 1 - Intake Manifold | 10 - O-Ring |
| 2 - Intake Gasket (2) | 11 - Screen |
| 3 - Fuel Rail (2) | 12 - Lower Seal |
| 4 - Screw | 13 - Stud |
| 5 - Connector Fittings | 14 - Spacer |
| 6 - Schrader Valve | 15 - Washer |
| 7 - Cap | 16 - Nut |
| 8 - Fuel Injector | 17 - Fuel Lines |
| 9 - Upper Seal | |

Fuel Pressure Relief Procedure

NOTICE

Refer to "Service Precautions" in front of this section BEFORE proceeding.

1. Disconnect electrical connector at fuel pump.
2. Crank engine for ten seconds (if engine starts allow it run until it stops) to relieve any fuel pressure in the system.

MX 6.2 Black Scorpion Components

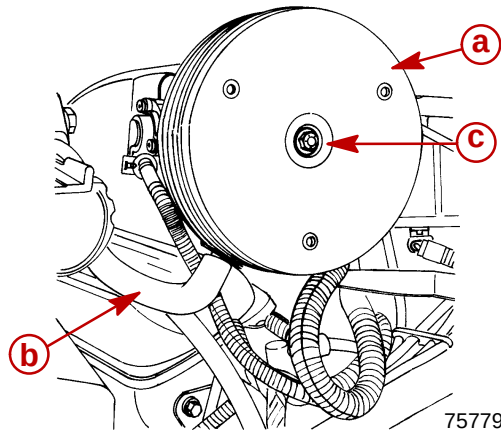
Flame Arrestor

NOTICE

Refer to "Service Precautions" in front of this section BEFORE proceeding.

REMOVAL

1. Remove flame arrestor and related components.
2. Remove nut.
3. Remove crankcase ventilation hose from against flame arrestor and rocker arm cover fittings.
4. Remove flame arrestor.



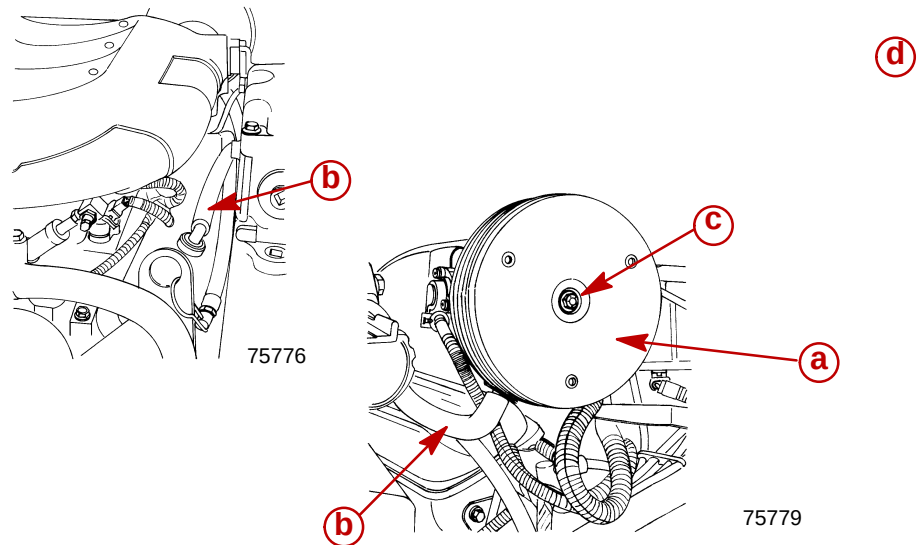
- a** - Flame Arrestor
b - Vent Hose
c - Nut (Later Style)

CLEANING AND INSPECTION

1. Clean flame arrestor in solvent. Blow dry with compressed air or allow to air dry completely.
2. Clean crankcase ventilation hoses in solvent. Blow dry with compressed air or allow to air dry completely.
3. Inspect crankcase ventilation hoses for cracks or deterioration, and replace if necessary.

INSTALLATION

1. Install flame arrestor.
2. Tighten nut.
3. Position crankcase ventilation hose against flame arrestor and attach to rocker arm cover fittings.



- a** - Flame Arrestor
b - Vent Hose
c - Nut (Later Style)

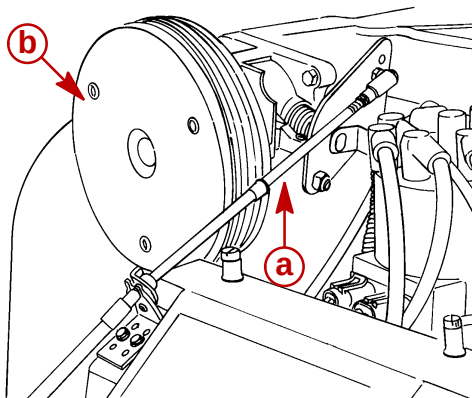
Throttle Body

NOTICE

Refer to "Service Precautions" in front of this section BEFORE proceeding.

REMOVAL

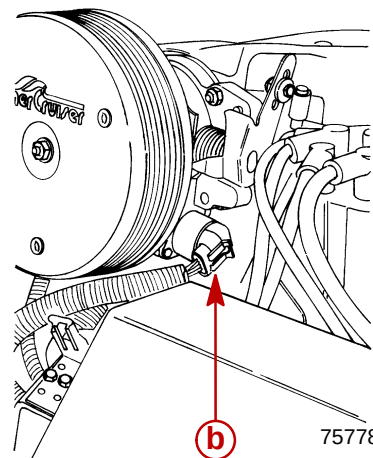
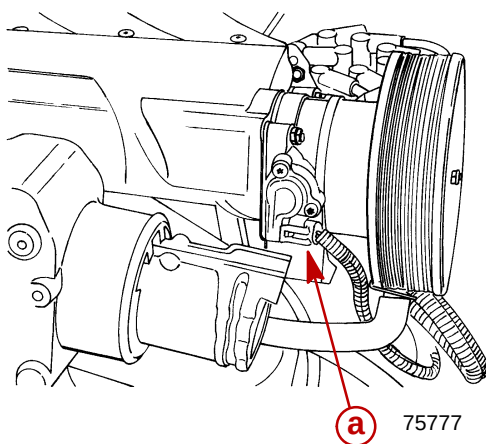
1. Remove the flame arrestor.
2. Disconnect the throttle cable from the throttle lever.



74838

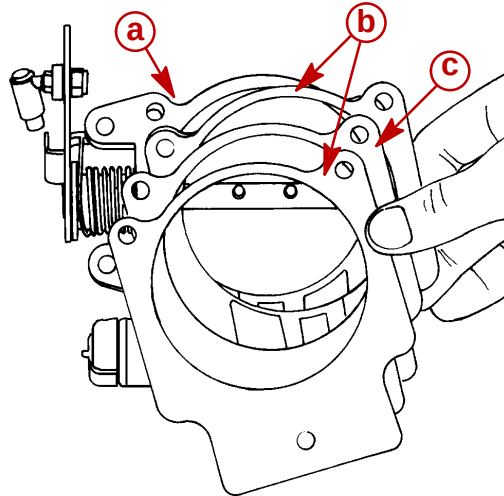
- a** - Throttle Cable
b - Flame Arrestor

3. Disconnect the wiring connectors from the IAC valve and the TP sensor.



- a** - Throttle Position Sensor Connector
b - IAC Valve Connector

4. Remove the hardware retaining the throttle body and remove the throttle body from the adapter. Refer to "Exploded View."



75783

- a** - Throttle Body
- b** - Gaskets
- c** - Plate

IMPORTANT: Insert a clean shop towel into the opening of the plenum to prevent foreign material from entering the engine.

CLEANING AND INSPECTION

IMPORTANT: DO NOT use cleaners containing methyl ethyl ketone. It is not necessary for cleaning throttle bore and valve deposits.

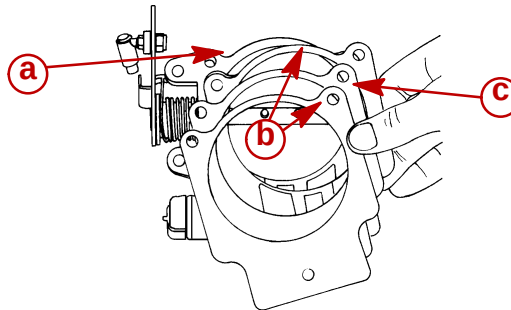
IMPORTANT: DO NOT allow the TP sensor and IAC valve to come into contact with solvent or cleaner.

IMPORTANT: Use care when removing gasket material from plenum and throttle body. Failure to do so could result in damage to the plenum and throttle body.

1. Carefully remove all gasket material from plenum and throttle body.
2. Thoroughly clean all parts of throttle body. Make certain that all passages are free of dirt and burrs.
3. Inspect mating surfaces for damage that could affect gasket sealing.
4. Inspect throttle body for cracks in casting.
5. Inspect throttle plates, linkage, return springs, etc., for damage, wear and foreign material.
6. Check for loose parts and foreign material.

INSTALLATION

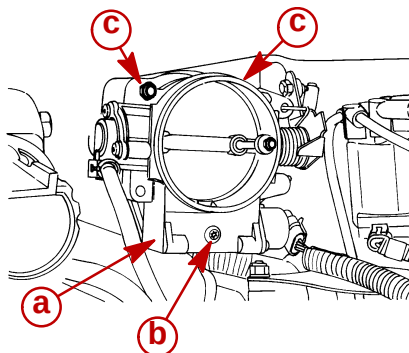
1. Place the throttle body gasket (s) between the throttle body and the plenum.



75783

- a** - Throttle Body
- b** - Gaskets
- c** - Plate

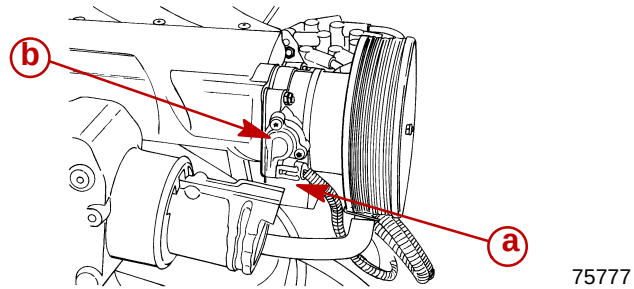
2. Place the throttle body on the plenum. Install the screw and nuts and torque to 75 lb-in. (8.5 Nm).



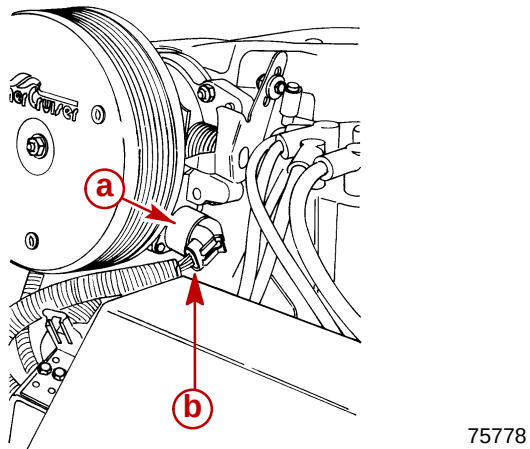
75781

- a** - Throttle Body
- b** - Screw
- c** - Nuts

3. Connect the harness connectors to the TP sensor and IAC valve.



a - TP Sensor
b - Connector



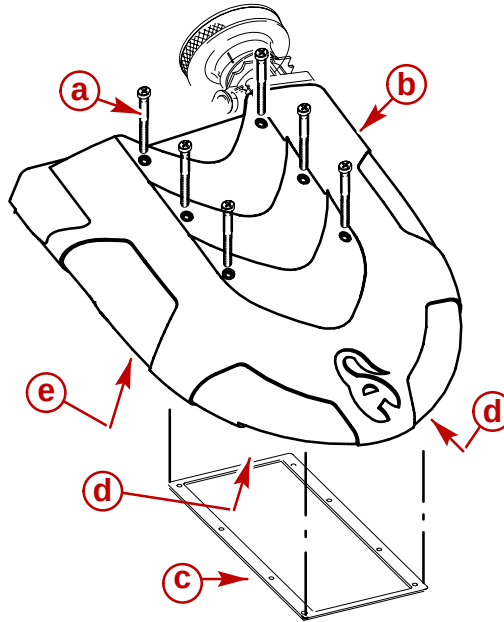
a - IAC Valve
b - Connector

4. Connect the throttle cable to the throttle lever. Refer to SECTION 2 for throttle cable adjustment.
5. Install the flame arrestor.

Plenum

REMOVAL

1. Disconnect the throttle cable.
2. Disconnect the harness connector and the vacuum hose from the MAP sensor. The sensor is located on the underside of the plenum on the starboard side.
3. Remove the screws retaining the intake plenum to the manifold. Remove the two nuts from the underside of the plenum in the front. Remove the plenum and gasket.



75710

- a - Screws (6)
- b - Plenum
- c - Gasket
- d - Nuts
- e - MAP Sensor Location

CLEANING AND INSPECTION

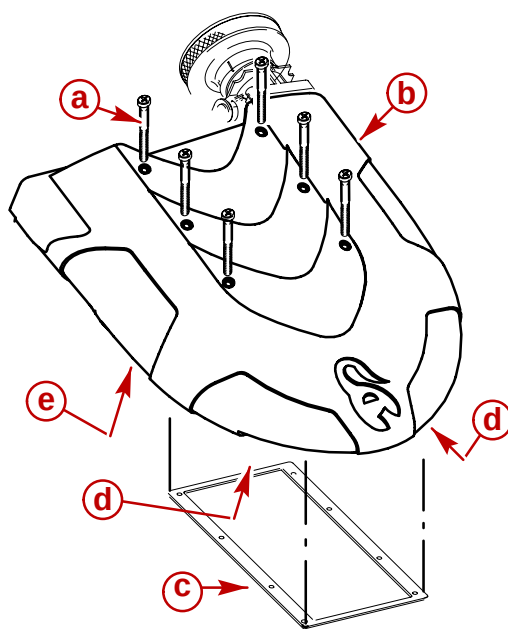
IMPORTANT: Use care when removing gasket material from intake manifold and plenum. Failure to do so could result in damage to the intake manifold and plenum.

1. Carefully remove all gasket material from intake manifold and plenum.
2. Clean plenum in solvent and dry with compressed air.
3. Inspect mating surfaces for damage that could affect gasket sealing.
4. Inspect plenum for cracks in casting.

INSTALLATION

1. If not previously accomplished, remove all old gasket material.
2. Position the new plenum gasket on the intake manifold. The word "FRONT" faces UP on the gasket at front edge of the intake manifold.
3. Place the plenum over the gasket.
4. Install the the screws retaining the intake plenum to the manifold. Install the two nuts on the underside of the plenum in front.

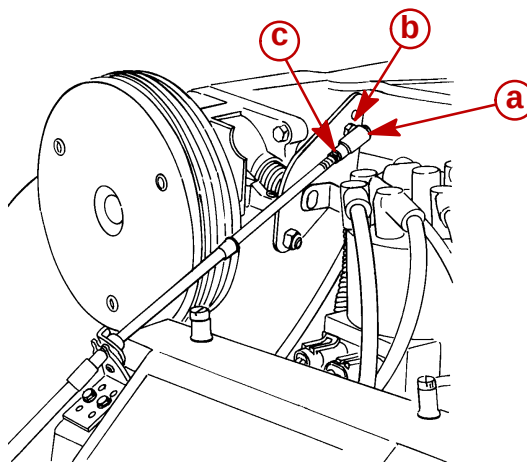
5. Torque the fasteners evenly in a diagonal pattern to 150 lb-in. (17 Nm).



75710

- a** - Screws (6)
- b** - Plenum
- c** - Gasket
- d** - Nuts
- e** - MAP Sensor Location

6. Place remote control throttle lever in idle position. Attach cable to throttle lever stud. Refer to SECTION 2 for throttle cable adjustment.
7. After throttle cable is adjusted, tighten locknut against cable end.



74838

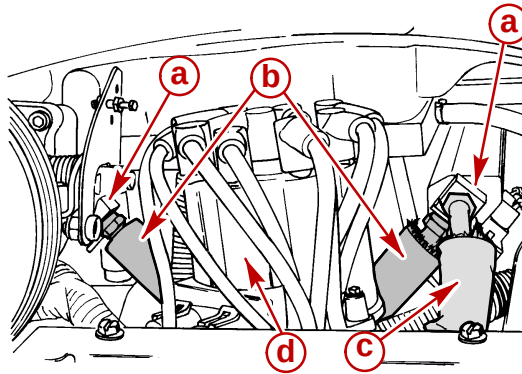
- a** - Cable End
- b** - Throttle Lever Stud
- c** - Locknut

8. Connect the harness connector and the vacuum hose to the MAP sensor.

Fuel Rails

REMOVAL

1. Remove distributor cap.
2. Disconnect fuel lines from aft end fuel rail connector fittings.

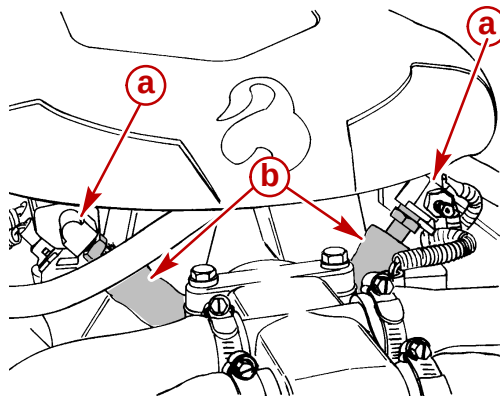


75696

Fuel Lines and Connections - Aft View

- a** - Fuel Rail Connector Fittings
- b** - Rail-to-Rail Fuel Lines
- c** - Cool Fuel-to-Fuel Rail Line
- d** - Distributor Cap

3. Disconnect fuel lines from front end of fuel rail connector fittings.



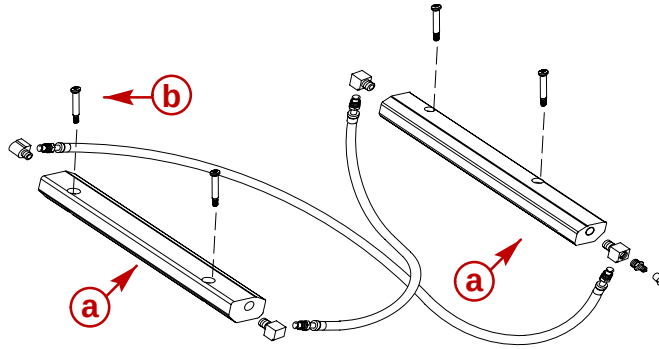
75697

Fuel Lines and Connections - Front View

- a** - Fuel Rail Connector Fittings
- b** - Rail-to-Rail Fuel Lines

4. Remove plenum.
5. Disconnect harness connector from each injector.
6. Remove fuel rail screws.
7. Gently move rail back and forth while lifting rail upward.

8. Remove fuel rails.



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Typical

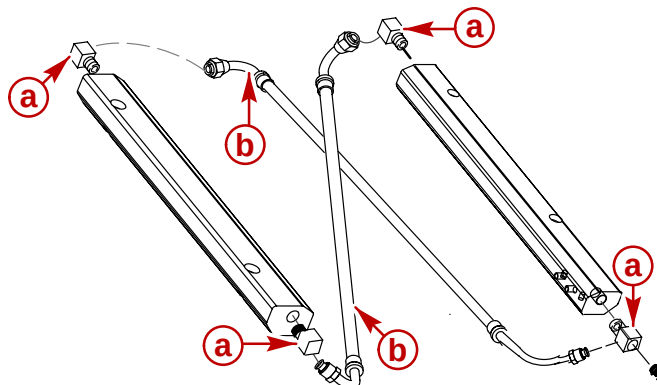
- a** - Fuel Rails
- b** - Screws (2 Each Side)

CLEANING AND INSPECTION

1. Clean fuel rails in solvent and dry with compressed air.
2. Inspect injector cavities for damage that could affect proper sealing of the injectors in the rail.
3. Inspect rails for cracks.

INSTALLATION

1. Position injectors in the fuel rails.
2. Install fuel rail by pushing down gently while moving it back and forth.
3. Install fuel rail fasteners. Torque to 105 lb-in. (12 Nm).
4. Route the rail-to-rail fuel lines as shown. Temporarily hand tighten the lines to the fuel rail connector fittings.
5. Torque the four fuel line connections to 18 lb-ft (24 Nm).



75710

Typical

- a** - Fuel Rail Connector Fittings
- b** - Rail-to-Rail Fuel Lines

6. Install the plenum and throttle body.

Fuel Injectors

REMOVAL

NOTE: Use care in removing fuel injectors to prevent damage to the electrical connector and nozzle.

IMPORTANT: The fuel injector is an electrical component. DO NOT soak in any liquid cleaner or solvent, as damage may result.

1. Remove flame arrestor, throttle body, plenum and fuel rails.
2. Remove fuel injectors from fuel rail and intake manifold.

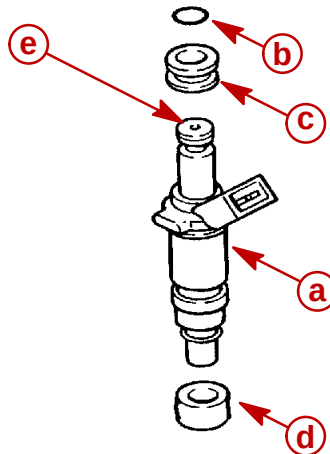
CLEANING AND INSPECTION

1. Inspect fuel injectors for damage; replace if necessary.
2. Inspect screen on inlet side of injector for debris. Clean or replace as necessary.

INSTALLATION

IMPORTANT: When replacing injectors, be certain to replace with the identical part and part number. Other injectors may have the same appearance, yet have a different part number and be calibrated for a different flow rate, and if installed, would cause performance difficulty or damage to the ECM.

1. Install new O-rings on fuel injectors. Lubricate O-rings using a water and soap solution.



72799

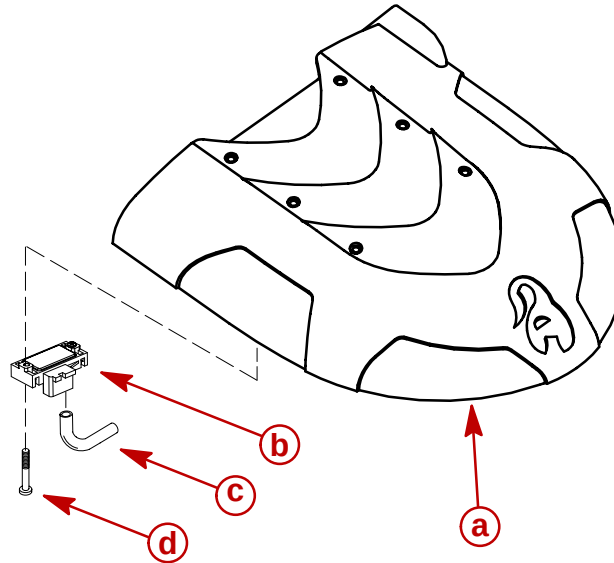
- a** - Fuel Injector
- b** - O-Ring
- c** - Upper Seal
- d** - Lower Seal
- e** - Screen

2. Install fuel injectors in the intake manifold.
3. Install fuel rails.

MAP Sensor

REMOVAL

1. Disconnect electrical connector at manifold absolute pressure (MAP) sensor.



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- a** - Plenum
- b** - Manifold Absolute Pressure (MAP) Sensor
- c** - Vacuum Hose To Intake Manifold
- d** - Screws (2)

2. Remove MAP sensor.

CLEANING AND INSPECTION

1. Clean off any foreign matter with a dry cloth.
2. Inspect for any obvious signs of physical damage to the sensor.

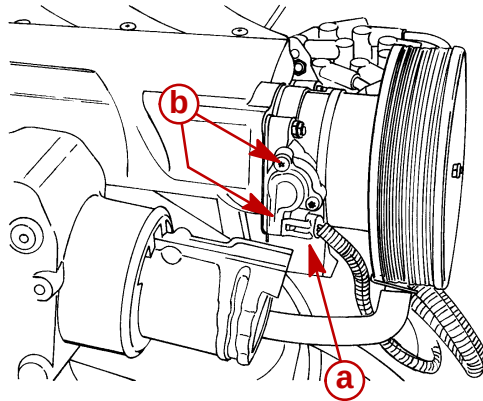
INSTALLATION

1. Install MAP sensor using screws. Torque screws to 44-62 lb-in. (5-7 Nm).
2. Connect electrical connector to MAP sensor.
3. Connect vacuum hose to intake manifold fitting.

Throttle Position Sensor

REMOVAL

1. Disconnect electrical connector at throttle position (TP) sensor.
2. Remove TP sensor from throttle body. Remove the dust seal.



75777

- a** - Throttle Position (TP) Sensor Harness
b - Screws

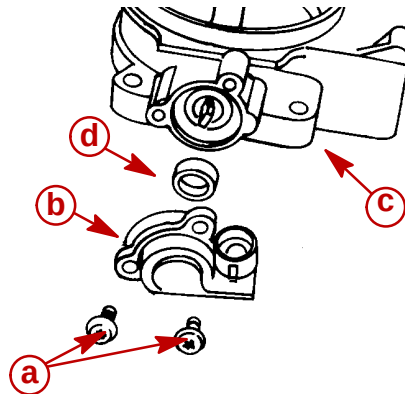
CLEANING AND INSPECTION

1. Clean the surfaces of the TP sensor with a dry cloth.
2. Inspect the TP sensor for signs of wear or damage.

INSTALLATION

IMPORTANT: If the TP sensor is to be replaced with a new unit, be sure to secure it in place with the new screws which are included in the service package.

1. Install TP sensor and gasket on throttle body using screws with washers and Loctite 242 applied to threads. Torque screws to 20 lb-in. (2 Nm).



75785

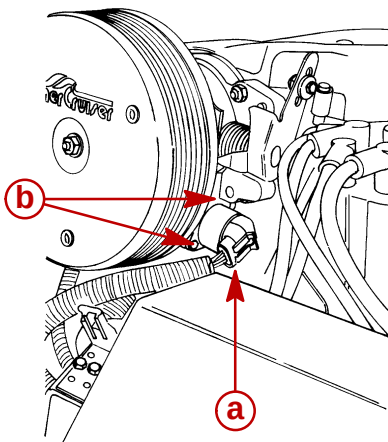
- a** - Screws
b - Throttle Position (TP) Sensor
c - Throttle Body
d - Seal

2. Connect electrical connector to TP sensor.
3. Install throttle body, throttle linkage and flame arrestor.
4. Start engine and check for TP sensor output voltage. It should be approximately .7 V at idle and 4.5 V at WOT.

Idle Air Control (IAC) Valve

REMOVAL

1. Remove flame arrestor, throttle cable and throttle body.
2. Disconnect electrical connector at idle air control (IAC) valve.



75788

- a** - Idle Air Control (IAC) Valve Connector
b - Screws

3. Remove IAC from throttle body.

CLEANING AND INSPECTION

1. Remove and discard sealing O-ring from IAC valve. Clean sealing surfaces, pintle valve seat, and air passage with a carburetor cleaner to remove carbon deposits, being careful not to push or pull on the IAC valve pintle. Force exerted on the pintle might damage the worm drive. DO NOT use a cleaner that contains the extremely strong solvent methyl ethyl ketone.

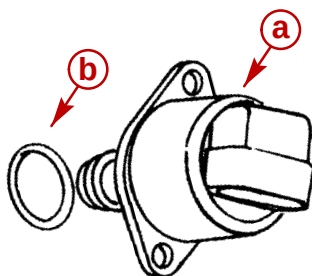
NOTE: Shiny spots on the pintle, or seat, are normal and do not indicate misalignment or a bent pintle shaft.

2. Inspect the entire assembly for any obvious physical damage.

INSTALLATION

IMPORTANT: If installing a new IAC valve, be sure to replace it with the correct IAC valve pintle shape and diameter are designed for the specific application.

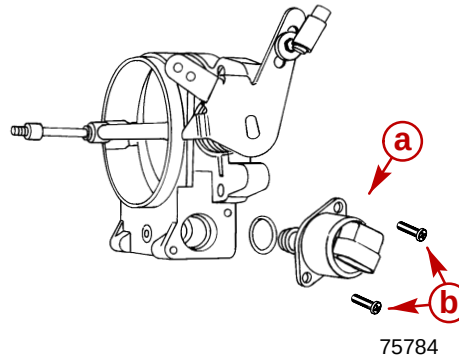
1. Install new O-ring on IAC valve.



75784

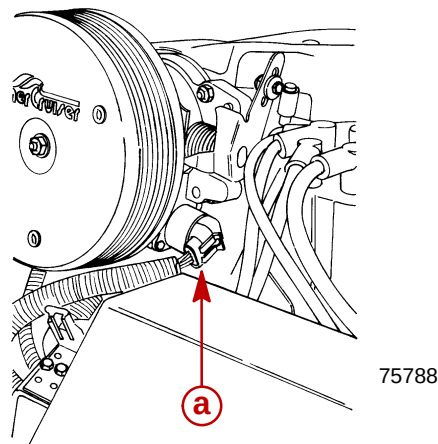
- a** - Idle Air Control (IAC) Valve
b - O-Ring

2. Install IAC valve on throttle body using screws. Torque to 20 lb-in. (2 Nm).



- a** - Idle Air Control (IAC) Valve
- b** - Screws

3. Connect electrical connector to IAC valve.



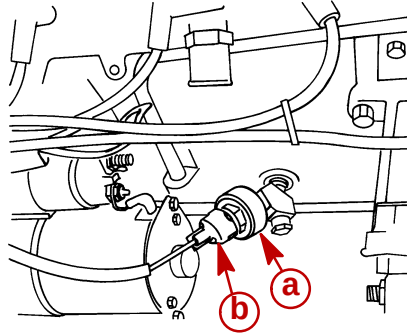
- a** - Idle Air Control (IAC) Valve Connector

4. Reset IAC valve pintle position after reconnecting negative (–) battery cable.
 - a. Turn ignition key ON for ten seconds.
 - b. Turn ignition key OFF for ten seconds.
 - c. Restart engine and check for proper idle operation.

Knock Sensor

REMOVAL

1. Disconnect electrical connector at knock sensor located just ahead of starter motor.



73757

- a** - Knock Sensor
b - Harness Connector

2. Remove knock sensor from engine block.

CLEANING AND INSPECTION

1. Clean knock sensor with a dry cloth, paying special attention to threads on base.
2. Inspect surfaces of knock sensor for signs of wear or physical damage.

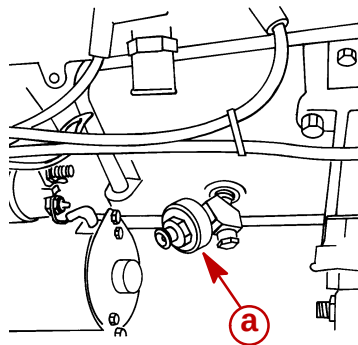
INSTALLATION

IMPORTANT: If installing a new knock sensor, be sure to replace it with an identical part. Knock sensors are very sensitive and designed for each specific application.

IMPORTANT: In the following step, it is very important that the knock sensor be torqued to the precise specification. Incorrect torquing will result in unsatisfactory performance. **DO NOT** use sealer on threads.

IMPORTANT: Ensure that the knock sensor is installed in the upper location on the Y-fitting.

1. Install knock sensor in engine block. Torque to 14 lb-ft (19 Nm).



73756

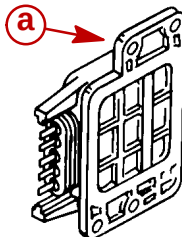
- a** - Knock Sensor

2. Connect electrical connector to knock sensor.

Knock Sensor Module

REMOVAL

1. Remove knock sensor module (KS) from electrical box.



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a - Knock Sensor (KS) Module

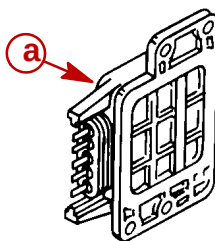
2. Disconnect electrical connector at knock sensor module.

CLEANING AND INSPECTION

1. Clean the external surfaces of the KS module with a dry cloth.
2. Inspect surfaces of KS module for evidence of damage.

INSTALLATION

1. Connect electrical connector to the knock sensor module.
2. Place KS module in electrical box.



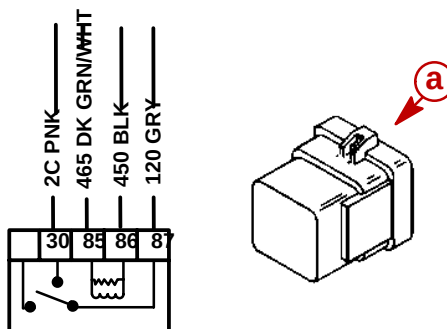
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a - Knock Sensor (KS) Module

Fuel Pump Relay

REMOVAL

1. Remove fuel pump relay from electrical box.



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a - Fuel Pump Relay

2. Disconnect electrical connector and remove fuel pump relay.

IMPORTANT: The fuel pump relay is an electrical component. DO NOT soak in any liquid cleaner or solvent; damage may result.

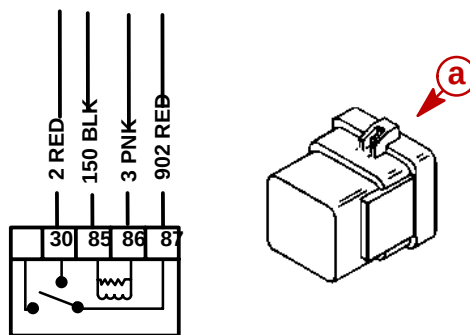
INSTALLATION

1. Attach electrical connector to fuel pump relay.
2. Place fuel pump relay in electrical box.

System Relay

REMOVAL

1. Remove system relay from electrical box.



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a - System Relay

2. Disconnect electrical connector and remove relay.

IMPORTANT: The system relay is an electrical component. DO NOT soak in any liquid cleaner or solvent; damage may result.

INSTALLATION

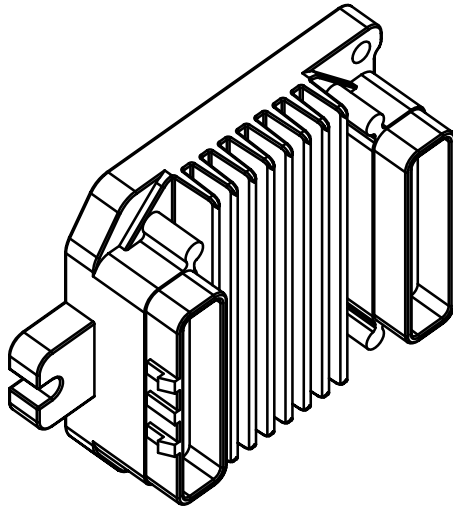
1. Attach electrical connector to relay.
2. Place system relay in electrical box.

Engine Control Module

IMPORTANT: The ECM is a sensitive electrical device, subject to electrostatic damage. Therefore, take care not to touch connector pins when removing or installing the module.

REMOVAL

1. Disconnect J1 and J2 electrical connectors at engine control module (ECM).



76358

2. Remove ECM from electrical box.

CLEANING AND INSPECTION

1. Clean the exterior of the ECM with a dry cloth being careful to avoid contact with connector pins.
2. Inspect outer surfaces for any obvious damage
3. Visually inspect electrical pins at both ends of ECM for straightness and corrosion.
4. Visually inspect J1 and J2 connectors on the wiring harness for corrosion and terminals that may have backed off the harness.

NOTE: The ECM is a sealed electrical component. If a Code 51 check has shown it to be defective, replace the unit with another ECM having the same part number as the original.

INSTALLATION

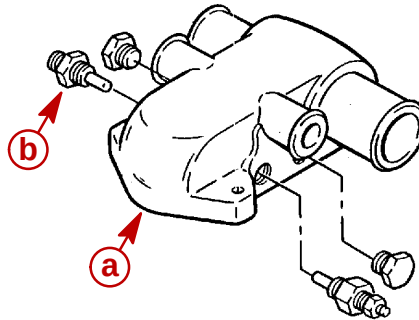
1. Mount new ECM to electrical bracket using screws and washers.
2. Connect J1 and J2 electrical connectors to the ECM. DO NOT touch connector pins when installing.

Engine Coolant Temperature Sensor

REMOVAL

NOTE: Handle the ECT sensor carefully. Damage to it will affect operation of the system.

1. Disconnect electrical connector at Engine Coolant Temperature (ECT) sensor.



72799

- a** - Thermostat Housing
b - Engine Coolant Temperature (ECT) Sensor

2. Remove ECT sensor from thermostat housing.

CLEANING AND INSPECTION

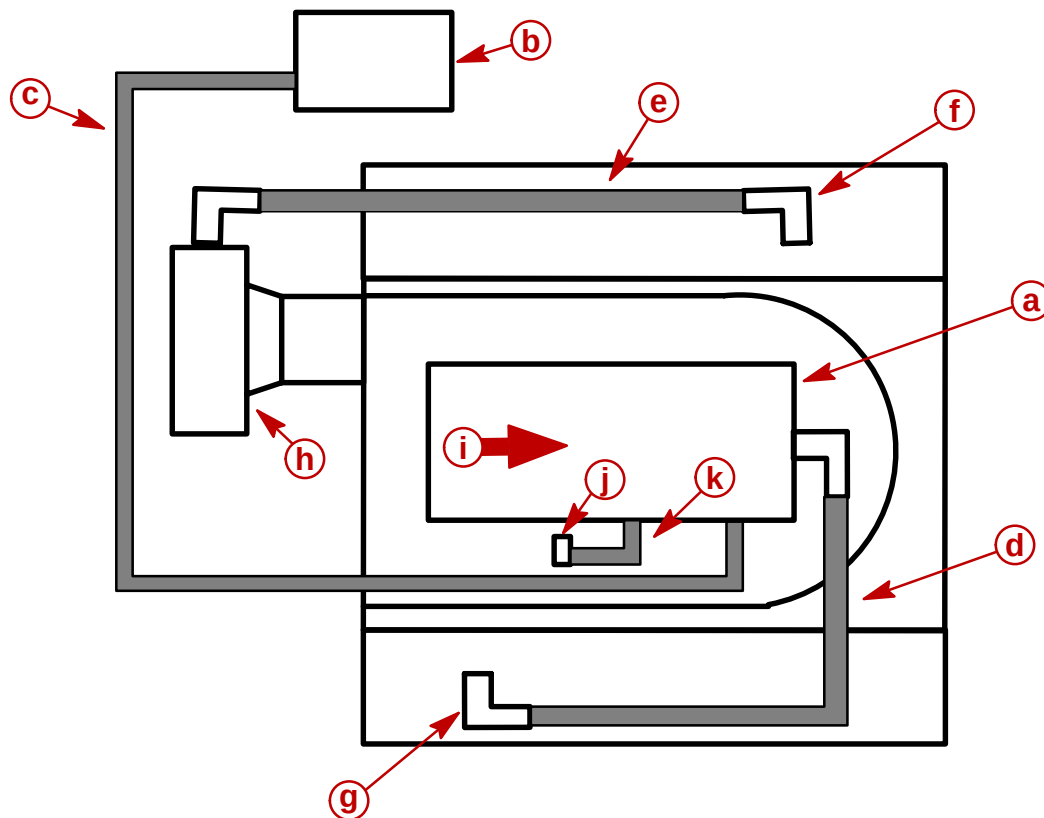
1. Clean with a dry cloth, removing any excess sealant from the base threads.
2. Look for evidence of any physical damage to base or connector surfaces of the ECT sensor.

INSTALLATION

1. Install ECT sensor in thermostat housing. Tighten hand tight plus 2-1/2 turns maximum.
2. Connect electrical connector to ECT sensor.

Vacuum And Vent Hose Routing

MX 6.2 Black Scorpion Models



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- a** - Throttle Body
- b** - Cool Fuel Assembly
- c** - Vacuum Hose - Forward Fitting On Intake Manifold To Fuel Pressure Regulator on Cool Fuel Assembly
- d** - Vent Hose - PCV Valve to Throttle Body
- e** - Vent Hose - Valve Cover to Flame Arrestor
- f** - PCV Valve
- g** - Vent Hose Fitting
- h** - Flame Arrestor
- i** - Front of Engine
- j** - MAP Sensor
- k** - Vacuum Hose - Rear Fitting On Intake Manifold To MAP Sensor

FUEL SYSTEMS

Section 5F - Fuel Injection System Troubleshooting

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Scan Tool Normal Specifications

(Idle / Warm Engine / Closed Throttle / Neutral)

Scan Position	Units Displayed	Typical Data Value
rpm	rpm	600-700 rpm
Desired rpm	rpm	600 or 650 rpm - Depends on Model ²
Coolant Temp.	° F(° C)	150-170° F (66-77° C)
Manifold Air Temp.	° F (° C)	Varies with Ambient Temperature
Throttle Position	Volts	.4 to .8 Volts
Throttle Angle	0-100 %	0-1%
MAP	Volts or kPa	1-3 Volts or (45-55 kPa) (Depends on Vacuum and Baro Pressure)
Baro	Volts or kPa	3-5 Volts (Depends on Altitude and Barometric Pressure)
Bat	Volts	12.0-14.5 Volts
Spark Advance	Degrees	-10 to 30°
Knock Retard	Degrees	0°
Idle Air Control IAC	Counts (Steps)	0-40 Counts
Minimum IAC Position	Counts (Steps)	0-40 Counts
Idle Air Control Follower	Counts (Steps)	0 Counts
Injector Pulse Width	msec.	2-3 msec.
Injector On Time Cranking	msec.	2.5–3.5 msec. (Depends on Water/Air Temperature)
Fuel Consumption	GPH (L/h)	1-2 GPH(3.7-7.5 L/h)
Time From Start	0:00:00-1092:00	Varies
Memory Calibration Check Sum	Calibration and Check Sum	Varies with Software revision in ECM
Oil Press/IO Level ¹	OK/LO	OK
Engine Overtemp	OK/Overheating	OK
Lanyard Stop Mode	OFF/ON	OFF

¹: MCM will read I/O Level and MIE will read Trans.

² : Refer to “Engine and Tune-Up Specifications.”

Important Preliminary Checks

Before Starting

Before using this section you should have performed the “On-Board Diagnostic (OBD) System Check” in the “General System Diagnostics” section and determined that:

- The ECM and/or MIL (Malfunction Indicator Lamp) are operating correctly.
- There are no DTC(s) stored.

Verify the customer complaint and locate the correct symptom in the table of contents. Check the items indicated under that symptom.

Visual / Physical Check

Several of the symptom procedures call for a careful Visual/ Physical Check. The importance of this step cannot be stressed too strongly. It can lead to correcting a problem without further checks and can save valuable time. This check should include:

- Engine in good mechanical condition.
- ECM grounds and sensor connections for being clean, tight and in their proper location.
- Vacuum hoses for splits, kinks and proper connections. Check thoroughly for any type of leak or restriction.
- Air leaks at throttle body mounting area and intake manifold sealing surfaces.
- Ignition wires for cracking, hardness, proper routing and carbon tracking.
- Wiring for proper connections, pinches and cuts. If wiring harness or connector repair is necessary, refer to “Description and System Operation” section for correct procedure.
- Moisture in primary or secondary ignition circuit connections.
- Salt corrosion on electrical connections and exposed throttle body linkages.

Intermittents

IMPORTANT: Problem may or may not turn “ON” the Malfunction Indicator Lamp (MIL) or store a DTC. DO NOT use the Diagnostic Trouble Code (DTC) tables for intermittent problems. The fault must be present to locate the problem.

Most intermittent problems are caused by faulty electrical connections or wiring. Perform careful visual/physical check. Check for the following conditions:

- Poor mating of the connector halves, or a terminal not fully seated in the connector body (backed out or loose).
- Improperly formed or damaged terminals and/or connectors.

All connector terminals in the problem circuit should be carefully checked for proper contact tension.

- Poor terminal to wire connection (crimping). This requires removing the terminal from the connector body to check. Refer to “Wiring Harness Service” in the “Description and System Operation” section.

The vessel may be driven with a Digital Multimeter connected to a suspected circuit. An abnormal voltage when malfunction occurs is a good indication that there is a fault in the circuit being monitored.

A scan tool (see “Special Tools” for part numbers) can be used to help detect intermittent conditions. The scan tools have several features that can be used to locate an intermittent condition. The following features can be used in finding an intermittent fault:

The “Record” feature or choosing not to erase data can be triggered to capture and store engine parameters within the scan tool when the malfunction occurs. This stored information can then be reviewed by the service technician to see what caused the malfunction.

To check loss of DTC memory, disconnect TP sensor and idle engine until the MIL comes “ON.” A trouble code should be stored and kept in memory when ignition is turned “OFF.” If not, the ECM is faulty. When this test is completed, make sure that you clear the DTC 22 from memory.

An intermittent MIL with no stored DTC may be caused by the following:

- Ignition coil shorted to ground and arcing at ignition wires or plugs.
- MIL wire to ECM shorted to ground.
- Poor ECM grounds, Go to ECM wiring diagrams.
- Check for an electrical system interference caused by a sharp electrical surge. Normally, the problem will occur when the faulty component is operated.
- Check for improper installation of electrical options such as lights, ship to shore radios, sonar, etc.
- Check that knock sensor wires are routed away from spark plug wires, ignition system components and charging system components.
- Check for secondary ignition components shorted to ground, or an open ignition coil ground (coil mounting brackets).
- Check for components internally shorted to ground such as starters, alternators or relays.

All Ignition Control (IC) module wiring should be kept away from the alternator. Check all wires from the ECM to the ignition control module for poor connections.

Hard Start Symptom

Step	Action	Yes	No
		PROCEED TO	
Definition: Engine cranks OK, but does not start for a long time. Does eventually run, or may start but immediately dies.			
1	Was the “On-Board Diagnostic” (OBD) System Check performed?	Step 2	OBD
2	Does the driver know the correct starting procedure?	Step 3	System normal
3	Was visual/physical check performed?	Step 4	Visual/ Physical Check
4	1. Check for proper operation of fuel pump relay circuit. • Refer to Table A-5 in “General System Diagnostics” section. Was a problem found?	OBD	Step 5
5	1. Check for contaminated fuel. 2. Check water separating fuel filter. Was a problem found?	OBD	Step 6
6	1. Check for proper fuel pressure. • Refer to Table A-4 in “General System Diagnostics” section. Was fuel pressure 30 psi for EFI or 3–7 psi for carbureted engines?	OBD	Step 7
7	1. Check for proper ignition voltage output. • Refer to Table A-7 in “General System Diagnostics” section. Was a problem found?	OBD	Step 8
8	Is a scan tool being used?	Step 10	Step 9
9	1. Check for a ECT sensor shifted in value. 2. With engine completely cool, measure the resistance of the ECT sensor. 3. Refer to the Engine Coolant Temperature Sensor Temperature -vs- Resistance value table on the facing page of DTC 14 in the “Trouble Code Diagnostics” section. Compare the approximate temperature of the ECT sensor to an accurate reading of ambient air temperature. Are the readings within the specified value?	Step 14	Step 13
10	1. Check ECT sensor for being shifted in value. 2. With the engine completely cool, compare the ECT sensor temperature with an accurate reading of ambient air temperature. Are the temperatures within 10° F (-12° C) of each other?	Step 11	Step 13

Hard Start Symptom (Continued)

Step	Action	Yes	No
		PROCEED TO	
11	1. Using a scan tool, display ECT sensor temperature and note value. 2. Check resistance of ECT sensor. 3. Go to Engine Coolant Temperature Sensor Temperature -vs- Resistance value table on the facing page of DTC 14 in the <i>Diagnostics</i> section. Is resistance value of ECT sensor near the resistance of the value noted?	Step 14	Step 12
12	1. Locate and repair high resistance or poor connection in the ECT signal circuit or the ECT sensor ground. Is action complete?		—
13	Replace the ECT sensor.		—
14	1. Check for intermittent opens or shorts to ground in the MAP sensor circuits. Was a problem found?		Step 15
15	1. Check for proper operation of the TP sensor. 2. Check or throttle linkage sticking, binding or worn causing TP sensor voltage to be higher than normal. Is TP sensor operating improperly or is voltage higher than normal?		Step 16
16	1. Check for proper operation of the IAC valve. (Table A-8) Was a problem found?		Step 17
17	1. Check or the following engine problems: • Low compression. • Leaking cylinder head gaskets. • Worn or incorrect camshaft. • Proper valve timing/valve train problem. • Restricted exhaust system. Was a problem found?	OBD	Step 18
18	1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: • Visual/physical inspection. • Scan tool data. • All electrical connections within a suspected circuit and/or system.	OBD	Contact MerCruiser Customer Service

Surges and/or Chuggles Symptom

Step	Action	Yes	No
		PROCEED TO	
Definition: Engine power variation under steady throttle or cruise. Feels like the engine speeds up and slows down with no change in the throttle lever position.			
1	Was the “On-Board Diagnostic” (OBD) System Check performed?	Step 2	OBD
2	Was visual/physical check performed?	Step 3	Visual/ Physical Check
3	1. Check for contaminated fuel. 2. Check fuel filters and water separator. Was a problem found?	OBD	Step 4
4	1. Check for proper fuel pressure while the condition exists. • Refer to Table A-4 in “General System Diagnostics” section. Was fuel pressure 30 psi for EFI or 3–7 psi for carbureted engines?		Step 5
5	1. Check for intermittent opens or short to grounds in the ECT sensor, MAP sensor and TP sensor circuits. Also check or throttle linkage sticking, binding or worn. 2. An intermittent failure may not store a DTC. Was a problem found?		Step 6
6	1. Check for proper ignition voltage output. • Refer to Table A-7 in “General System Diagnostics” section. Was a problem found?		Step 7
7	1. Check ignition coil for cracks or carbon tracking. Were cracks or carbon tracks found?		Step 8
8	1. Check integrity of the primary and secondary wiring. 2. Check routing of the wiring. 3. Check condition of IC module, pick-up coil, distributor cap, rotor and spark plug wires. 4. If a problem is found, repair as necessary. Was a problem found?		Step 9

Surges and/or Chuggles Symptom (Continued)

Step	Action	Yes	No
		PROCEED TO	
9	1. Remove spark plugs and check for wet plugs, cracks, wear, improper gap, burned electrodes or heavy deposits. Refer to Distributor Ignition System in "Description and System Operation" section. NOTE: If spark plugs are gas or oil fouled, the cause of the fouling must be determined before replacing the spark plugs. Were spark plugs damaged?	OBD	Step 10
10	1. Check fuel delivery system items that can cause the engine to run rich. Was a problem found?		Step 11
11	1. Check fuel delivery system items that can cause the engine to run lean. Was a problem found?		Step 12
12	1. Check the injector connections for proper mating. 2. If any of the injectors connectors are connected to an incorrect cylinder, correct as necessary. Were any injectors improperly connected?		Step 13
13	1. Check ECM grounds for being clean, tight and in the proper locations. Were ECM grounds dirty, loose or improperly connected?		Step 14
14	1. Visually/physically check vacuum hoses for splits, kinks and proper connections and routing. Was a problem found?		Step 15
15	1. Check or proper alternator voltage output. Is voltage between 11 - 16 volts?		Step 16
16	1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: - Visual/physical inspection. - Scan tool data. - All electrical connections within a suspected circuit and/or system. Was a problem found?		Contact MerCruiser Customer Service

Lack of Power, Sluggish or Spongy Symptom

Step	Action	Yes	No
		PROCEED TO	
Definition: Engine delivers less than expected power. Little or no increase in speed when throttle lever is advanced part way.			
1	Was the “On-Board Diagnostic” (OBD) System Check performed?	Step 2	OBD
2	If possible, compare engine performance with a similar engine. Is engine performance close to similar engine?	No problem found	Step 3
3	Was visual / physical check performed?	Step 4	Visual/ Physical Check
4	1. Remove and check flame arrestor for dirt, or for being restricted. 2. Clean or replace flame arrestor. Was flame arrestor dirty or restricted?		Step 5
5	1. Check for contaminated fuel. 2. Check water separating fuel filter. Was a problem found?		Step 6
6	1. Check for proper fuel pressure while the condition exists. • Refer to Table A-4 in “General System Diagnostics” section. Was fuel pressure 30 psi for EFI or 3–7 psi for carbureted engines?		Step 7
7	1. Check for injector driver CKT 467 or CKT 468 for an open. Did you find an open?		Step 8
8	1. Check for proper operation of Ignition Control (IC) circuit and the Knock Sensor (KS) circuit. Was a problem found?		Step 9
9	1. Check for proper ignition voltage output. • Refer to Table A-7 in “General System Diagnostics” section. Was a problem found?		Step 10
10	1. Remove spark plugs, check for wet plugs, cracks, wear, improper gap, burned electrodes or heavy deposits. • Refer to “Distributor Ignition System” in “Description and System Operation” section. NOTE: If park plugs are gas or oil fouled, the cause of the fouling must be determined before replacing the spark plugs. Were spark plugs damaged?		OBD

Lack of Power, Sluggish or Spongy Symptom (Continued)

Step	Action	Yes	No
		PROCEED TO	
11	1. Check ignition coil for cracks or carbon tracking. Were cracks or carbon tracks found?	OBD	Step 12
12	1. Check for intermittent opens or short to grounds in the ECT sensor, MAP sensor and TP sensor circuits. Also check or throttle linkage sticking, binding or worn. 2. An intermittent failure may not store a DTC. Was a problem found?		Step 13
13	1. Check ECM grounds for being clean, tight and in their proper locations. Were ECM grounds dirty, loose or improperly connected?		Step 14
14	1. Check diagnostic test CKT 451 for being shorted to ground. This will cause the rpm to be lowered. Was a problem found?	OBD	Step 15
15	1. Check for proper alternator voltage output. Is voltage between 11 - 16 volts?		Step 16
16	1. Check for the following Engine Mechanical problems: • Low compression. • Leaking cylinder head gaskets. • Worn or incorrect camshaft. • Proper valve timing/valve train problem. • Restricted exhaust system. Was a problem found?		Step 17
17	1. Check for excessive resistance on the bottom of the boat such as dirt, barnacles, etc. 2. Check for proper propeller size and pitch for that application. Was a problem found?	OBD	Step 18
18	1. Review all diagnostic procedures within this table. 2. When all procedures have been completed and no malfunctions are found, review/inspect the following: • Visual/physical inspection. • Scan tool data. • All connections within a suspected circuit and/or system. Was a problem found?	OBD	Contact MerCruiser Customer Service

Detonation / Spark Knock Symptom

Step	Action	Yes	No
		PROCEED TO	
Definition: A mild to severe ping, usually worse under acceleration. The engine makes sharp metallic knocks that change with throttle opening.			
1	Was the “On-Board Diagnostic” (OBD) System Check performed?	Step 2	OBD
2	Was visual/physical check performed?	Step 3	Visual/ Physical Check
3	1. Check base timing. • Refer to Ignition Timing Set Procedure in the Distributor Ignition section. Was a problem found?		Step 4
4	1. Check for proper operation of Ignition Control (IC) circuit and the Knock Sensor (KS) circuit. Was a problem found?		Step 5
5	1. Check for good ignition system ground. 2. Check spark plugs for proper gap and heat range. Was a problem found?		Step 6
6	1. Check for contaminated fuel. 2. Check for poor fuel quality and proper octane rating. Was a problem found?		Step 7
7	1. Check for proper fuel pressure. • Refer to Table A-4 in “General System Diagnostics” section. Was fuel pressure 30 psi for EFI or 3–7 psi for carbureted engines?		OBD
8	Is a scan tool being used?	Step 9	Step 10
9	1. If scan tool readings are normal (Refer to “Scan Tool Normal Specifications” in this section) and there are no engine mechanical faults, fill fuel tank with a known high quality gasoline. Is detonation present?	Step 10	OBD
10	1. Check for obvious overheating problems: • Loose water pump belt. • Faulty or incorrect water pump. • Restriction in cooling system. • Faulty or incorrect thermostat. Was a problem found?	OBD	Step 11

Detonation / Spark Knock Symptom (Continued)

Step	Action	Yes	No
		PROCEED TO	
11	1. Check fuel delivery system items that can cause an engine to run lean. Was a problem found?	OBD	Step 12
12	1. Check for ECT sensor being shifted in value. 2. Check for proper output voltage of the TP sensor at closed throttle and wide open throttle. Also check throttle linkage for sticking, binding or worn. Was a problem found?		Step 13
13	1. Check for the following Engine Mechanical problems: • Low compression. • Low oil level. • Excessive oil in the combustion chambers due to valve seals leaking. • Worn or incorrect camshaft. • Proper valve timing/valve train problem. • Combustion chambers for excessive carbon build up. Was a problem found?		Step 14
14	1. Remove excessive carbon buildup with a top engine cleaner. • Refer to instructions on top engine cleaner can. 2. Re-evaluate engine performance. Is detonation still present?	Step 15	OBD
15	1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: • Visual/physical inspection. • Scan tool data. • All electrical connections within a suspected circuit and/or system. Was a problem found?	OBD	Contact MerCruiser Customer Service

Hesitation, Sag, Stumble Symptom

Step	Action	Yes	No
		PROCEED TO	
Definition: Momentary lack of response as the throttle lever is advanced. Can occur at all engine speeds. Usually most severe when first starting out. May cause engine to stall if severe enough.			
1	Was the “On-Board Diagnostic” (OBD) System Check performed?	Step 2	OBD
2	Was visual/physical check performed?	Step 3	Visual/ Physical Check
3	1. Check for contaminated fuel. 2. Check water separating fuel filter. Was a problem found?		Step 4
4	1. Check or proper fuel pressure while the condition exists. • Refer to Table A-4 in “General System Diagnostics” section. Was a problem found?		Step 5
5	1. Check fuel injectors. • Refer to Injector Balance Test in “Test General System Diagnostics” section. Was a problem found?		Step 6
6	1. Check for proper operation of Ignition Control (IC) circuit and the Knock Sensor (KS) circuit. Was a problem found?		Step 7
7	1. Check integrity of the primary and secondary wiring. 2. Check routing of the wiring. 3. Check condition of IC module, pick-up coil, distributor cap, rotor and spark plug wires. Was a problem found?		Step 8
8	1. Remove spark plugs and check for wet plugs, cracks. wear, improper gap, burned electrodes or heavy deposits. • Refer to Distributor Ignition System. NOTE: If park plugs are gas or oil fouled, the cause of the fouling must be determined before replacing the spark plugs. Were spark plugs damaged?		OBD

Hesitation, Sag, Stumble Symptom (Continued)

Step	Action	Yes	No
		PROCEED TO	
9	1. Check for the ECT sensor shifted in value. 2. Check for intermittent opens or short to grounds in the ECT sensor, MAP sensor and TP sensor circuits. Also check for throttle linkage sticking, binding or worn. 3. An intermittent failure may not store a DTC. Was a problem found?	OBD	Step 10
10	1. Check for proper alternator voltage output. Is voltage between 11 - 16 volts?	Go to OBD System Check	Step 11
11	1. Check for faulty or incorrect thermostat. Is thermostat faulty?		Step 12
12	1. Check intake valves for valve deposits and remove if found. Were deposits found on the intake valves?		Step 13
13	1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: • Visual/physical inspection. • Scan tool data. • All electrical connections within a suspected circuit and/or system. Was a problem found?		Contact MerCruiser Customer Service

Cuts Out, Misses Symptom

Step	Action	Yes	No
		PROCEED TO	
Definition: Steady pulsation or jerking that follows engine speed, usually more pronounced as engine load increases. The exhaust has a steady spitting sound at idle, low speed or on hard acceleration for fuel starvation that can cause engine to cut out.			
1	Was the “On-Board Diagnostic” (OBD) System Check performed?	Step 2	OBD
2	Was visual/physical check performed?	Step 3	Visual/ Physical Check
3	1. Check for contaminated fuel. 2. Check water separating fuel filter. Was a problem found?		Step 4
4	1. Check for proper fuel pressure while the condition exists. • Refer to Table A-4 in “General System Diagnostics” section. Was fuel pressure 30 psi for EFI or 3–7 psi for carbureted engines?		Step 5
5	1. Disconnect all injector harness connectors and install an injector test light J 34730-2 between the harness terminal connector of each injector. 2. Crank engine and note light on each connector. If test light fails to blink at any one of the connectors, it is a faulty injector drive circuit harness, connector or terminal. Was a problem found?		Step 6
6	1. Check fuel injectors. • Refer to Injector Balance Test in “General System Diagnostics” section. Was a problem found?		Step 7
7	1. Check for proper spark at each cylinder. Was a problem found?		OBD
8	1. Check the spark plugs for the following: • Insulator cracks. • Improper gap. • Burned electrodes. • Heavy deposits. NOTE: If spark plugs are gas or oil fouled, the cause of the fouling must be determined before replacing the spark plugs. Were spark plugs damaged?	OBD	Step 9

Cuts Out, Misses Symptom (Continued)

Step	Action	Yes	No
		PROCEED TO	
9	1. Check engine mechanical for the following conditions. • Low compression. • Sticking or leaking valves. • Bent push rods • Worn rocker arms. • Broken valve springs. • Worn camshaft lobe(s). • Incorrect valve timing. Was a problem found?	OBD	Step 10
10	1. Check Intake and exhaust manifold(s) for casting flash. Was a problem found?		Step 11
11	1. Check for Electromagnetic Interference (EMI). A missing condition can be caused by EMI on the reference circuit. EMI can usually be detected by monitoring engine rpm with a scan tool or tachometer. A sudden increase in rpm with little change in actual engine rpm change, indicates EMI is present. 2. If EMI is present, locate and repair the source. Was a problem found?		Step 12
12	1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: • Visual/physical inspection. • Scan tool data. • All electrical connections within a suspected circuit and/or system. 3. If a problem is found, repair as necessary. Was a problem found?		Contact MerCruiser Customer Service

Rough, Unstable, or Incorrect Idle, Stalling Symptom

Step	Action	Yes	No
		PROCEED TO	
Definition: Engine runs unevenly at idle. If severe, the engine or vessel may shake. Engine idle speed may vary in rpm. Either condition may be severe enough to stall the engine.			
1	Was the “On-Board Diagnostic” (OBD) System Check performed?	Step 2	OBD
2	Was visual/physical check performed?	Step 3	Visual/ Physical Check
3	1. Check for proper operation of the IAC valve. • Refer to Table A-8 in “General System Diagnostics” section. Was a problem found?		Step 4
4	1. Check for proper operation of Ignition Control (IC) circuit and the Knock Sensor (KS) circuit. Was a problem found?		Step 5
5	1. Check integrity of the primary and secondary wiring. 2. Check routing of the wiring. 3. Check condition of IC module, pick-up coil, distributor cap, rotor and spark plug wires. Was a problem found?		Step 6
6	1. Check ignition coil for cracks or carbon tracking. Were cracks or carbon tracks found?		Step 7
7	1. Remove spark plugs, check for wet plugs, cracks, wear, improper gap, burned electrodes or heavy deposits. • Refer to Distributor Ignition System. NOTE: If park plugs are gas or oil fouled, the cause of the fouling must be determined before replacing the spark plugs. Were spark plugs damaged?		Step 8
8	1. Check the injector connections. Correct as necessary. Was a problem found?	OBD	Step 9

Rough, Unstable, or Incorrect Idle, Stalling Symptom (Continued)

Step	Action	Yes	No
		PROCEED TO	
9	1. Disconnect all injector harness connectors and install an injector test light J 34730-2 between the harness terminal connector of each injector. 2. Crank engine and note light on each connector. If test light fails to blink at any one of the connectors, it is a faulty injector drive circuit harness, connector or terminal. Was a problem found?		Step 10
10	1. Check fuel injectors. • Refer to Injector Balance Test in "General System Diagnostics" section. Was a problem found?		Step 11
11	1. Check for fuel in pressure regulator vacuum hose. 2. If fuel is present, replace the fuel pressure regulator assembly. • Refer to Fuel Metering System in "Description and System Operation" section. Was a problem found?		Step 12
12	1. Check for intermittent opens or short to grounds in the ECT sensor, MAP sensor and TP sensor circuits. Also check or throttle linkage sticking, binding or worn. 2. An intermittent failure may not store a DTC. Was a problem found?		Step 13
13	1. Check ECM grounds for being clean, tight and in their proper locations. 2. Also check that battery cables and ground straps are clean and secure. Were ECM grounds dirty, loose or improperly connected?		Step 14
14	1. Check fuel delivery system items that can cause the engine to run rich. Was a problem found?		Step 15
15	1. Check fuel delivery system items that can cause the engine to run lean. Was a problem found?	OBD	Step 16

Rough, Unstable, or Incorrect Idle, Stalling Symptom (Continued)

Step	Action	Yes	No
		PROCEED TO	
16	1. Check or proper alternator voltage output. 2. The voltage should be between specified values. Is voltage between 11 - 16 volts?	OBD	Step 17
17	1. Check the following Engine Mechanical items: • Check compression. • Sticking or leaking valves. • Worn camshaft lobe(s). • Valve timing. • Broken valve springs. Was a problem found?		Step 18
18	1. Check intake valves for valve deposits. 2. If deposits are found, remove as necessary. Were deposits found on the intake valves?		Step 19
19	1. Check for faulty motor mounts. Was a problem found?		Step 20
20	1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: • Visual/physical inspection. • Scan tool data. • All electrical connections within a suspected circuit and/or system. Was a problem found?		Contact MerCruiser Customer Service

Poor Fuel Economy Symptom

Step	Action	Yes	No
		PROCEED TO	
Definition: Fuel economy is noticeably lower than expected. Also, economy is noticeably lower than it was on this engine at one time.			
1	Was the “On-Board Diagnostic” (OBD) System Check performed?	Step 2	OBD
2	Was visual/physical check performed?	Step 3	Visual/ Physical Check
3	1. .Check operators driving habits. Are excessively heavy loads being carried? Is operator accelerating too much, too often? Was a problem found?	System normal	Step 4
4	1. Check flame arrestor for dirt or being plugged. 2. Check for fuel leaks. Was a problem found?		Step 5
5	1. Check for proper fuel pressure. • Refer to Table A-4 in “General System Diagnostics” section. Was fuel pressure 30 psi for EFI or 3–7 psi for carbureted engines?		Step 6
6	1. Check for proper operation of Ignition Control (IC) circuit and the Knock Sensor (KS) circuit. Was a problem found?		Step 7
7	1. Remove spark plugs, check for wet plugs, cracks, wear, improper gap, burned electrodes or heavy deposits. • Refer to Distributor Ignition System. NOTE: If spark plugs are gas or oil fouled, the cause of the fouling must be determined before replacing the spark plugs. Were spark plugs damaged?		Step 8
8	1. Visual (physically) check vacuum hoses for splits, kinks and improper connections and routing. Was a repair required?		Step 9
9	1. Check engine compression for being low. Was a problem found?		OBD

Poor Fuel Economy Symptom (Continued)

Step	Action	Yes	No
		PROCEED TO	
10	1. Check exhaust system for possible restriction. 2. Inspect exhaust system for damaged or collapsed pipes. Was a problem found?	OBD	Step 11
11	1. Check for excessive resistance on the bottom of the boat such as dirt, barnacles, etc. 2. Check for proper propeller size and pitch for that application. Was a problem found?	OBD	Step 12
12	1. Review all diagnostic procedures within this table. 2. When all procedures have been completed and no malfunctions are found, review/inspect the following: • Visual/physical inspection. • Scan tool data. • All connections within a suspected circuit and/or system. Was a problem found?	OBD	Contact MerCruiser Customer Service

Dieseling, Run-On Symptom

Step	Action	Yes	No
		PROCEED TO	
Definition: Engine continues to run after key is turned "OFF," but runs very rough. If engine runs smooth, check ignition switch and adjustment.			
1	Was the "On-Board Diagnostic" (OBD) System Check performed?	Step 2	OBD
2	Was visual/physical check performed?	Step 3	Visual/ Physical Check
3	1. Check for leaking fuel injectors. • Refer to Table A-4 in "General System Diagnostics" section. Was a problem found?	OBD	Step 4
4	1. Check for proper operation of Ignition Control (IC) circuit and the Knock Sensor (KS) circuit. Was a problem found?	OBD	Step 5
5	1. Check for obvious overheating problems: • Loose water pump belt. • Faulty or incorrect water pump. • Restriction in cooling system. • Faulty or incorrect thermostat. Was a problem found?	OBD	Step 6
6	1. Check for proper operation of the EFI system relay. • Refer to Table A-6 in "General System Diagnostics" section. Was a problem found?	OBD	Step 7
7	1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: • Visual physical inspection. • Scan tool data. • All electrical connections within a suspected circuit and/or system. Was a problem found?	OBD	Contact MerCruiser Customer Service

Backfire Symptom

Step	Action	Yes	No
		PROCEED TO	
Definition: Fuel ignites in the intake manifold, or in the exhaust system, making loud popping noise.			
1	Was the “On-Board Diagnostic” (OBD) System Check performed?	Step 2	OBD
2	Was visual/physical check performed?	Step 3	Visual/ Physical Check
3	1. Check flame arrestor for proper installation. Was a problem found?		Step 4
4	1. Check for proper fuel pressure. • Refer to Table A-4 in “General System Diagnostics” section. Was fuel pressure 30 psi for EFI or 3–7 psi for carbureted engines?		Step 5
5	1. Check the injector connections. Correct as necessary. Was a problem found?		Step 6
6	1. Check fuel injectors. • Refer to Injector Balance Test in “General System Diagnostics” section. Was a problem found?		Step 7
7	1. Check for proper operation of Ignition Control (IC) circuit and the Knock Sensor (KS) circuit. Was a problem found?		Step 8
8	1. Check integrity of the primary and secondary wiring. 2. Check routing of the wiring. 3. Check condition of IC module, pick-up coil, distributor cap, rotor and spark plug wires. Was a problem found?		Step 9
9	1. Check ignition coil for cracks or carbon tracking. Were cracks or carbon tracks found?		OBD

Backfire Symptom (Continued)

Step	Action	Yes	No
		PROCEED TO	
10	1. Check for proper ignition voltage input to the ECM. 2. Check for intermittent open or short to ground on the ignition voltage input circuit to the ECM. Was a problem found?	OBD	Step 11
11	1. Remove spark plugs, check for wet plugs, cracks, wear, improper gap, burned electrodes or heavy deposits. • Refer to Distributor Ignition System in "Description and System Operation" section. NOTE: If park plugs are gas or oil fouled, the cause of the fouling must be determined before replacing the spark plugs Were spark plugs damaged?		Step 12
12	1. Check for intermittent opens or short to grounds in the MAP sensor and TP sensor circuits. Also check for throttle linkage sticking, binding or worn. 2. An intermittent failure may not store a DTC. Was a problem found?		Step 13
13	1. Check engine mechanical for the following conditions: • Low compression. • Sticking or leaking valves. • Worn camshaft lobe(s). • Incorrect valve timing. Was a problem found?		Step 14
14	1. Check Intake and exhaust manifold(s) for casting flash. Was a problem found?		Step 15
15	1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: • Visual/physical inspection. • Scan tool data. • All electrical connections within a suspected circuit and/or system. Was a problem found?		Contact MerCruiser Customer Service

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FUEL SYSTEMS

Section 5G - Diagnostics

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Special Tools

Part Number	Tool Name	Description
J-34029-A (Note 1 and 2)	High Impedance Multimeter (DVM)	Minimum 10 megohm input impedance required on all voltage ranges. As ammeter, accurately measures low value current flow. As ohmmeter, reads 0-200 ohms, 2/20/200 kΩ, 2/20 mΩ
J-23738	Vacuum Pump with Gauge - 20 In. Hg Minimum	Gauge monitors manifold engine vacuum. Hand pump used to check fuel pressure regulator
J-34142-B (Note 3)	Unpowered Test Light	Used to check circuit wiring, short to ground, or voltage.
J-34730-2A	Injector Harness Test Light	Visually indicates injector electrical impulses from the ECM.
J-35616	Harness Test Adapter	Allows multi-meter connections with wiring harness.
94050m	MerCruiser Scan Tool Version 3.4 (English)	Displays problem codes stored in the ECM. It also allows monitoring of various circuits and components in the fuel injection system. Allows for test firing injectors. Tool can read MEFI 1, MEFI 2 and MEFI 3 ECM.
94008	Code Mate Tester	Flashes light to display problem codes
91-99379	Timing Light	Used to check ignition timing. Must have inductive signal pickup.
91-16850A5	Fuel Pressure Gauge Kit	Used to check fuel system pressure. Kit includes 91-803135 Test Port Adaptor Kit and 91-806901 TBI Pressure Valve
91-823686A2	Quicksilver Digital Diagnostic Terminal (DDT)	Displays problem codes stored in the ECM. It also allows monitoring of various circuits and components in the fuel injection system.
91-803999	MerCruiser DDT Cartridge Version 2	Displays problem codes stored in the ECM. It also allows monitoring of various circuits and components in the fuel injection system. Tool can read MEFI 1, MEFI 2 and MEFI 3 ECM.
84-822560A2	DDT Adaptor Harness	Displays problem codes stored in the ECM. It also allows monitoring of various circuits and components in the fuel injection system.
91-805747A2	EFI Timing Tool	Used to set Ignition timing. Plug connects to DLC

Special Tools (cont'd)

NOTE: ¹ The High Impedance Multimeter that comes with the existing Outboard 2 Cycle EFI Tester, P/N 91-11001A2 meets the requirements listed above.

NOTE: ² Quicksilver Digital Tachometer / Multi-Meter (DMT 2000) P/N 91-854009A1, meets the requirements listed above.

NOTE: ³ Using a test light with 100 mA or less rating may show a faint glow when test actually states no light.

Kent-Moore Tools, Inc.
29784 Little Mack
Roseville, MI 48066
Phone: 800-345-2233

Rinda Technologies
4563 N. Elston Ave.
Chicago, IL 60630
Phone: 773-736-6633
Fax: 773-736-2950
E-mail: rinda@mcs.net

Diagnostic Circuit Check

IMPORTANT: All references to Scan Tool work with either the Quicksilver Digital Diagnostic Tool or the Rinda Scan Tool.

The Diagnostic Circuit Check is an organized approach to identifying a problem created by an electronic engine control system malfunction.

NOTE: A scan tool that displays faulty data should not be used. This could result in misdiagnosis and unnecessary parts replacement.

The scan tool data listed in the following table may be used for comparison after finding the on-board diagnostics functioning properly and no trouble codes displayed. The "Typical Data Values" are intended to represent what a normally functioning system would display.

Only the parameters listed in the scan position column below are used in this manual. If a scan reads other parameters, the values are not recommended for use in diagnosing. If all values are within the range illustrated, refer to "Troubleshooting."

Scan Tool Normal Specifications (Idle/Warm Engine/Closed Throttle/Neutral)

Scan Position	Units Displayed	Typical Data Value
rpm	rpm	600-700 rpm
Desired rpm	rpm	600 or 650 rpm (Depends on Model ²)
Coolant Temp.	° F (° C)	150-170° F (66-77° C)
Manifold Air Temp.	° F (° C)	Varies with Ambient Temperature
Throttle Position	Volts	.4 to .8 Volts
Throttle Angle	0-100 %	0-1%
MAP	Volts or kPa	1-3 Volts or (45-55 kPa) (Depends on Vacuum and Baro Pressure)
Baro	Volts or kPa	3-5 Volts (Depends on Altitude and Barometric Pressure)
Bat	Volts	12.0-14.5 Volts
Spark Advance	Degrees	-10 to 30°
Knock Retard	Degrees	0°
Idle Air Control IAC	Counts (Steps)	0-40 Counts
Minimum IAC Position	Counts (Steps)	0-40 Counts
Idle Air Control Follower	Counts (Steps)	0 Counts
Injector Pulse Width	msec.	2-3 msec.
Injector On Time Cranking	msec.	2.5-3.5 msec. (Depends on Water/Air Temperature)
Fuel Consumption	GPH (L/h)	1-2 GPH (3.7-7.5 L/h)
Time From Start	0:00:00-1092:00	Varies
Memory Calibration Check Sum	Calibration Check Sum	Varies with Software revision in ECM
Oil Press/IO Level ¹	OK/LO	OK
Engine Overtemp	OK/Overheating	OK
Lanyard Stop Mode	OFF/ON	OFF

¹: MCM will read I/O Level and MIE will read Trans.

²: Refer to "Engine and Tune-Up Specifications."

Diagnostic Trouble Codes

Code Number	Code Description	MEFI		
		1	2	3
Code 14	(ECT) Engine Coolant Temperature - Low Temperature Indicated	x	x	x
Code 15	(ECT) Engine Coolant Temperature - High Temperature Indicated		x	x
Code 21	(TP) Throttle Position Sensor - Signal Voltage High	x	x	x
Code 22	(TP) Throttle Position Sensor - Signal Voltage Low		x	x
Code 23	(MAT) Manifold Air Temperature - Low Temperature Indicated			x
Code 25	(MAT) Manifold Air Temperature - High Temperature Indicated			x
Code 33	(MAP) Manifold Absolute Pressure - Signal Voltage High	x	x	x
Code 34	(MAP) Manifold Absolute Pressure - Signal Voltage Low		x	x
Code 41	(IC) Ignition Control - Open IC Circuit		x	x
Code 42	(IC) Ignition Control - Grounded IC Circuit, Open or Grounded Bypass	x	x	x
Code 43	(KS) Knock Sensor - Continuous Knock Detected	x	x	x
Code 44	(KS) Knock Sensor - No Knock Detected		x	x
Code 45	Coil Driver			x
Code 51	(ECM) Calibration Memory Failure	x	x	x
Code 61	Fuel Pressure High			x
Code 62	Fuel Pressure Low			x

ECM Connector and EFI Symptoms Chart

The following charts will aid in diagnosis of symptoms. These voltages were derived from a known good engine. The voltages shown were done with the electrical system intact and operational. These are voltage requirements to operate the different circuits.

⚠ CAUTION

Do not attempt to obtain these voltages by probing wires and connectors. Serious damage could result in loss of engine operation or wiring damage. Voltages can vary with battery conditions.

In the following J-1 and J-2 Circuit/Symptom Charts only those pins which are used by the ECM are shown. Pin numbers not listed are not used.

NOTE: All pins are not used on all models.

IMPORTANT: The following conditions must be met before testing.

1. Engine at operating temperature.
2. Ignition on or engine running.
3. Scan tool not connected.

THESE NOTES APPLY TO FOLLOWING ECM CONNECTOR AND SYMPTOM CHARTS.
The "B+" Symbol indicates a system voltage (battery).

NOTE: ¹ Battery voltage for first two seconds, then 0 volts.

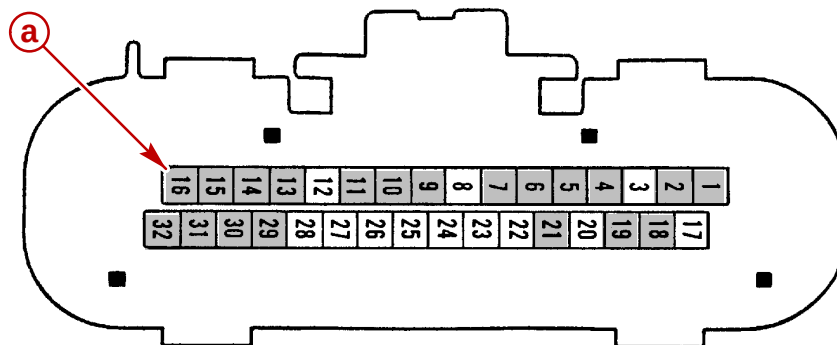
NOTE: ² Varies with temperature.

NOTE: ³ Varies with manifold vacuum.

NOTE: ⁴ Varies with throttle movement.

NOTE: ⁵ Less than .5 volt (500 mV).

J-1 Circuits with MEFI 1 and MEFI 2



J-1 Front Pin 32 Pin Input Connector

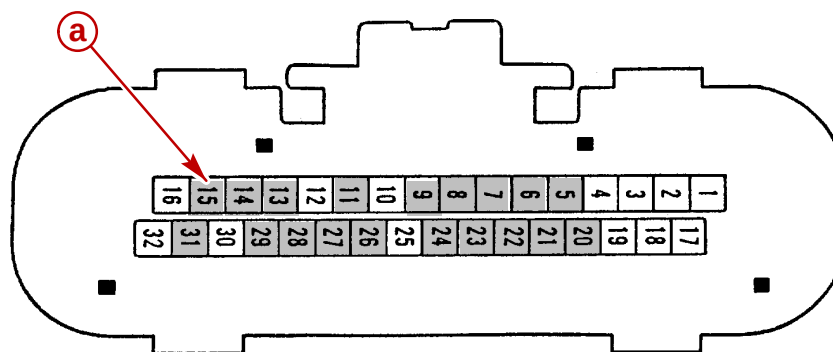
a - Shaded Area Denotes Pin Connector Location Used On Terminal

J-1 Circuits with MEFI 1 and MEFI 2 (Continued)

Pin	Pin Function	CKT	Wire Color	Normal Voltage		DTC	Possible Symptoms
				Ignition ON	Engine Running		
J1-1	Knock Sensor	485	GRN	9.5V	9.5V	43	Poor Fuel Economy, Poor Performance Detonation
J1-2	ECT Signal	410	YEL	1.95V (NOTE 2)	1.95V (NOTE 2)	14	Poor Performance, Exhaust Odor, Rough Idle rpm Reduction
J1-4	Discrete Switch	931	BRN	—	—	None	Power Reduction Mode Alarm Activation
J1-5	Master/Slave	916	YEL	B+	B+	None	Lack Of Data From Other Engine (Dual Engine Only)
J1-6	Discrete Switch	931	BRN	—	—	None	Power Reduction Mode Alarm Activation
J1-7	Diagnostic Test	451	BLK/ WHT	B+	B+	None	Incorrect Idle, Poor Performance
J1-9	Map Signal	432	LT GRN	4.9V	1.46V (NOTE 3)	33	Poor Performance, Surge, Poor Fuel Economy, Exhaust Odor
J1-10	TP Signal	417	DK BLU	.62V (NOTE 4)	.62V (NOTE 4)	21	Poor Performance And Acceleration, Incorrect Idle
J1-11	Ignition Fused	439	PNK/ BLK	B+	B+	None	No Start
J1-13	Sensor Ground	813	BLK	0 (NOTE 5)	0 (NOTE 5)	21,23	High Idle, Rough Idle, Poor Performance Exhaust Odor
J1-14	ECM Ground	450	BLK/ WHT	0 (NOTE 5)	0 (NOTE 5)	None	No Start
J1-15	TP 5V Power	416	GRY	5V	5V	21	Lack Of Power, Idle High
J1-16	Battery	440	ORN	B+	B+	None	No Start
J1-18	Serial Data	461	ORN/ BLK	5V	5V	None	No Serial Data
J1-19	Shift Switch	923	WHT	0	0	None	Incorrect Idle
J1-21	Lanyard Stop	942	PNK	0	0	None	No Start
J1-29	MAP Ground	814	BLK	0 (NOTE 5)	0 (NOTE 5)	33	Lack Of Performance, Exhaust Odor, Stall
J1-30	ECM Ground	450	BLK/ WHT	0 (NOTE 5)	0 (NOTE 5)	None	No Start
J1-31	MAP 5V Power	416	GRY	5V	5V	33	Lack Of Power, Surge, Rough Idle, Exhaust Odor
J1-32	Battery	440	ORN	B+	B+	None	No Start

See Page 5G-6 For NOTES

J-2 Circuits with MEFI 1 and MEFI 2



J-2 Rear 32 Pin Output Connector

a - Shaded Area Denotes Pin Connector Location Used On Terminal

Pin	Pin Function	CKT	Wire Color	Normal Voltage		DTC	Possible Symptoms
				Ignition ON	Engine Running		
J2-5	Injector Driver	468	LT GRN	B+	B+	None	Rough Idle, Lack Of Power, Stall
J2-6	Ignition Control Ref. Low	463	RED/ BLK	0 (NOTE 5)	0 (NOTE 5)	None	Poor Performance
J2-7	Port Fuel Jumper	901	WHT	—	—	None	—
J2-8	Ignition Control Ref. High	430	PUR/ WHT	5V	1.6V	None	No Restart
J2-9	Fuel Pump Relay Driver	465	DK GRN/ WHT	0 (NOTE 1&5)	B+	None	No Start
J2-11	Coolant Over temp.	112	DK GRN	0	0	None	Power Reduction Mode or Improper Audio Warning
J2-13	IAC "A" Low	442	RED	Not Usable	Not Usable	None	Rough Unstable or Incorrect Idle
J2-14	IAC "B" Low	443	YEL	Not Usable	Not Usable	None	Rough Unstable or Incorrect Idle
J2-15	Injector Ground	450	BLK/ WHT	0 (NOTE 5)	0 (NOTE 5)	None	Rough Running, Lack Of Power, Poor Performance

NOTE: J2-7 is not used on the Throttle Body Injection system.

See Page 5G-6 For NOTES

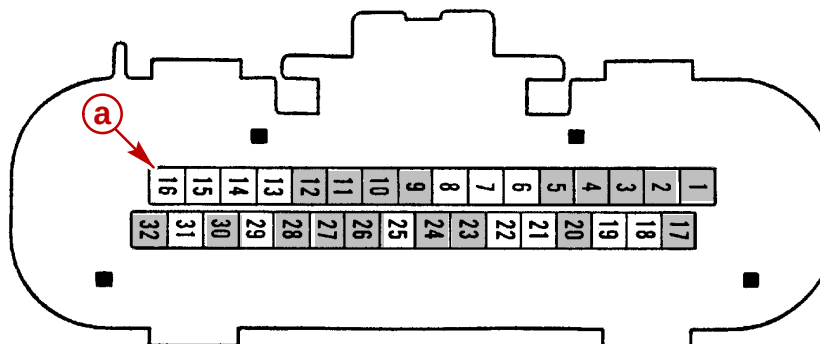
J-2 Circuits with MEFI 1 and MEFI 2 (Continued)

Pin	Pin Function	CKT	Wire Color	Normal Voltage		DTC	Possible Symptoms
				Ignition ON	Engine Running		
J2-20	Fuel Injector Ground	450	BLK/ WHT	0 (NOTE 5)	0 (NOTE 5)	None	Rough Running, Poor Idle, Lack Of Performance
J2-21	Injector Driver	467	DK BLU	B+	B+	None	Rough Idle, Lack Of Power, Stalling
J2-22	Port Fuel Jumper	901	WHT	—	—	—	—
J2-23	Ignition Control Signal	423	WHT	0 (NOTE 5)	1.2V	42	Stall, Will Restart In Bypass Mode, Lack Of Power
J2-24	Ignition Control Bypass	424	TAN/ BLK	0 (NOTE 5)	4.5V	42	Lack Of Power, Fixed Timing
J2-26	Discrete Switch	31	TAN	—	—	—	Audio Warning System Activation
J2-27	Discrete Switch	31	TAN	—	—	—	Audio Warning System Activation
J2-28	IAC "A" High	441	BRN	Not Usable	Not Usable	None	Rough, Unstable or Incorrect Idle
J2-29	IAC "B" Low	444	GRN/ BLK	Not Usable	Not Usable	None	Rough, Unstable or Incorrect Idle
J2-31	MIL Lamp	419	BRN/ WHT	0 (NOTE 5)	0 (NOTE 5)	None	Lamp Inoperative

NOTE: J2-22 is not used on the Throttle Body Injection system.

See Page 5G-6 For NOTES

J-1 Circuits with MEFI 3



J-1 Front Pin 32 Pin Input Connector

a - Shaded Area Denotes Pin Connector Location Used On Terminal

Pin	Pin Function	CKT	Wire Color	Normal Voltage		DTC	Possible Symptoms
				Ignition ON	Engine Running		
J1-1	Injector Driver	467	DK BLU	B+	B+	None	Rough Idle, Lack Of Power, Stalling
J1-2	Ignition Coil	121	WHT	Not Usable	Not Usable	45	Rough Running, Poor Idle, Lack of Performance
J1-3	Ignition Control Ref. Low	453	RED/ BLK	0 (NOTE 5)	0 (NOTE 5)	None	Poor Performance
J1-4	ECM Ground	450	BLK	0 (NOTE 5)	0 (NOTE 5)	None	No Start
J1-5	ECM Ground	450	BLK	0 (NOTE 5)	0 (NOTE 5)	None	No Start
J1-9	MIL Lamp	419	BRN/ WHT	0 (NOTE 5)	0 (NOTE 5)	None	Lamp Inoperative
J1-10	Ignition Control Signal	423	WHT	0 (NOTE 5)	1.2V	42	Stall, Will Restart In Bypass Mode, Lack Of Power
J1-11	IAC "B" Low	443	GRN/ WHT	Not Usable	Not Usable	None	Rough Unstable or Incorrect Idle
J1-12	IAC "A" Low	442	BLU/ BLK	Not Usable	Not Usable	None	Rough Unstable or Incorrect Idle
J1-17	Injector Driver	468	DK GRN	B+	B+	None	Rough Idle, Lack Of Power, Stall
J1-20	ECM Ground	450	BLK	0 (NOTE 5)	0 (NOTE 5)	None	Rough Running, Poor Idle, Lack Of Performance

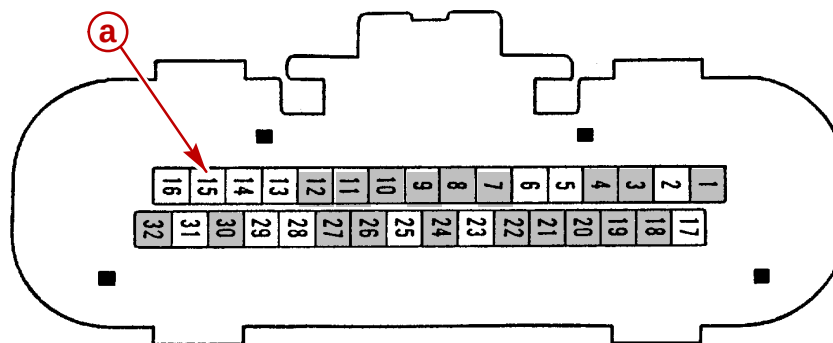
See Page 5G-6 For NOTES

J-1 Circuits with MEFI 3 (Continued)

Pin	Pin Function	CKT	Wire Color	Normal Voltage		DTC	Possible Symptoms
				Ignition ON	Engine Running		
J1-23	Fuel Pump Relay Driver	465	DK GRN/ WHT	0 (NOTES 1&5)	B+	None	No Start
J1-24	Ignition Control Bypass	424	TAN/ BLK	0 (NOTE 5)	4.5V	42	Lack Of Power, Fixed Timing
J1-26	Audio Warning Horn	29	DK GRN	—	—	None	—
J1-27	IAC "B" Low	444	GRN/ BLK	Not Usable	Not Usable	None	Rough Unstable or Incorrect Idle
J1-28	IAC "A" High	441	BLU/ WHT	Not Usable	Not Usable	None	Rough Unstable or Incorrect Idle
J1-30	Knock Sensor Signal	496	BLU	—	—	43, 44	Poor Fuel Economy, Poor Performance Detonation
J1-32	Serial Data	461	ORN	5V	5V	None	No Serial Data

See Page 5G-6 For NOTES

J-2 Circuits with MEFI 3



J-2 Rear 32 Pin Output Connector

a - Shaded Area Denotes Pin Connector Location Used On Terminal

Pin	Pin Function	CKT	Wire Color	Normal Voltage		DTC	Possible Symptoms
				Ignition ON	Engine Running		
J2-1	Battery	440	ORN	B+	B+	None	No Start
J2-3	Sensor Ground	813	BLK	0 (NOTE 5)	0 (NOTE 5)	21,23	High Idle, Rough Idle, Poor Performance Exhaust Odor
J2-4	TP 5V Power	416	GRY	5V	5V	21	Lack Of Power, Idle High
J2-7	Discrete Switch	114	BLU	—	—	None	—
J2-8	Discrete Switch	585	TAN/ WHT	—	—	None	—
J2-9	Shift Switch	923	WHT	0	0	None	Incorrect Idle
J2-10	Ignition Control Ref. High	430	PUR/ WHT	5V	1.6V	None	No Restart
J2-11	ECT Signal	410	YEL	1.95V (NOTE 2)	1.95V (NOTE 2)	14	Poor Performance, Exhaust Odor, Rough Idle rpm Reduction
J2-12	Fuel Pressure	475	GRN	3V	3V	61, 62	—
J2-18	MAP Ground	814	BLK	0 (NOTE 5)	0 (NOTE 5)	33	Lack Of Performance, Exhaust Odor, Stall
J2-19	MAP 5V Reference	416	GRY	5V	5V	33	Lack Of Power, Surge, Rough Idle, Exhaust Odor
J2-20	Discrete Switch	208	BRN	—	—	—	—

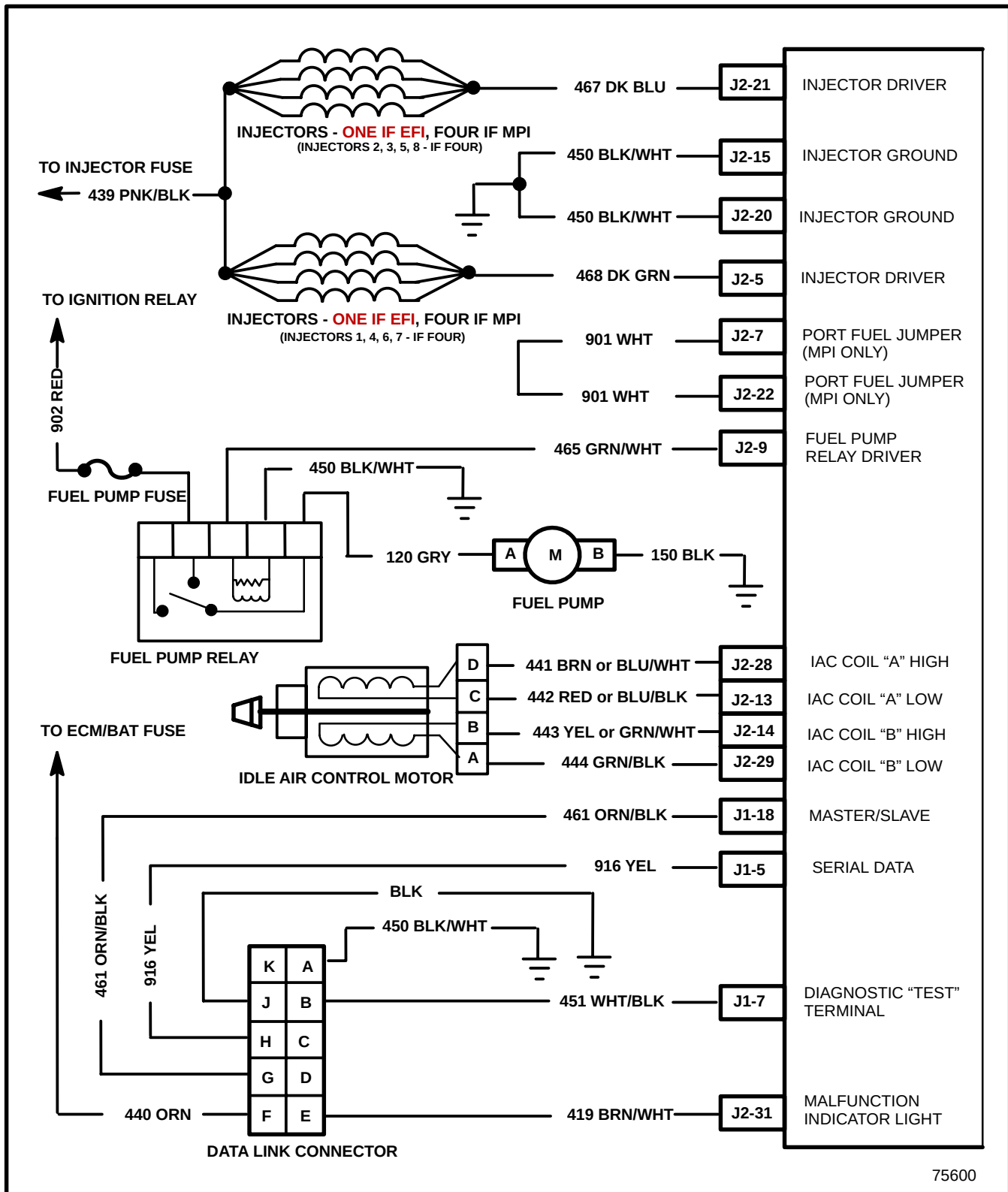
J-2 Circuits with MEFI 3 (Continued)

Pin	Pin Function	CKT	Wire Color	Normal Voltage		DTC	Possible Symptoms
				Ignition ON	Engine Running		
J2-21	Master/Slave	916	YEL	B+	B+	None	Lack Of Data From Other Engine (Dual Engine Only)
J2-22	Diagnostic Test	451	BLK/WHT	B+	B+	None	Incorrect Idle, Poor Performance
J2-24	Discrete Switch	906	TAN/WHT	—	—	None	
J2-26	TP Signal	417	DK BLU	.62V (NOTE 4)	.62V (NOTE 4)	21	Poor Performance And Acceleration, Incorrect Idle
J2-27	Map Signal	432	LT GRN	4.9V	1.46V (NOTE 3)	33	Poor Performance, Surge, Poor Fuel Economy, Exhaust Odor
J2-30	IAT Sensor	472	TAN	5V	(NOTE 2)	23	Poor Fuel Economy, Exhaust Odor
J2-32	Ignition Fused	439	PNK	B+	B+	None	No Start

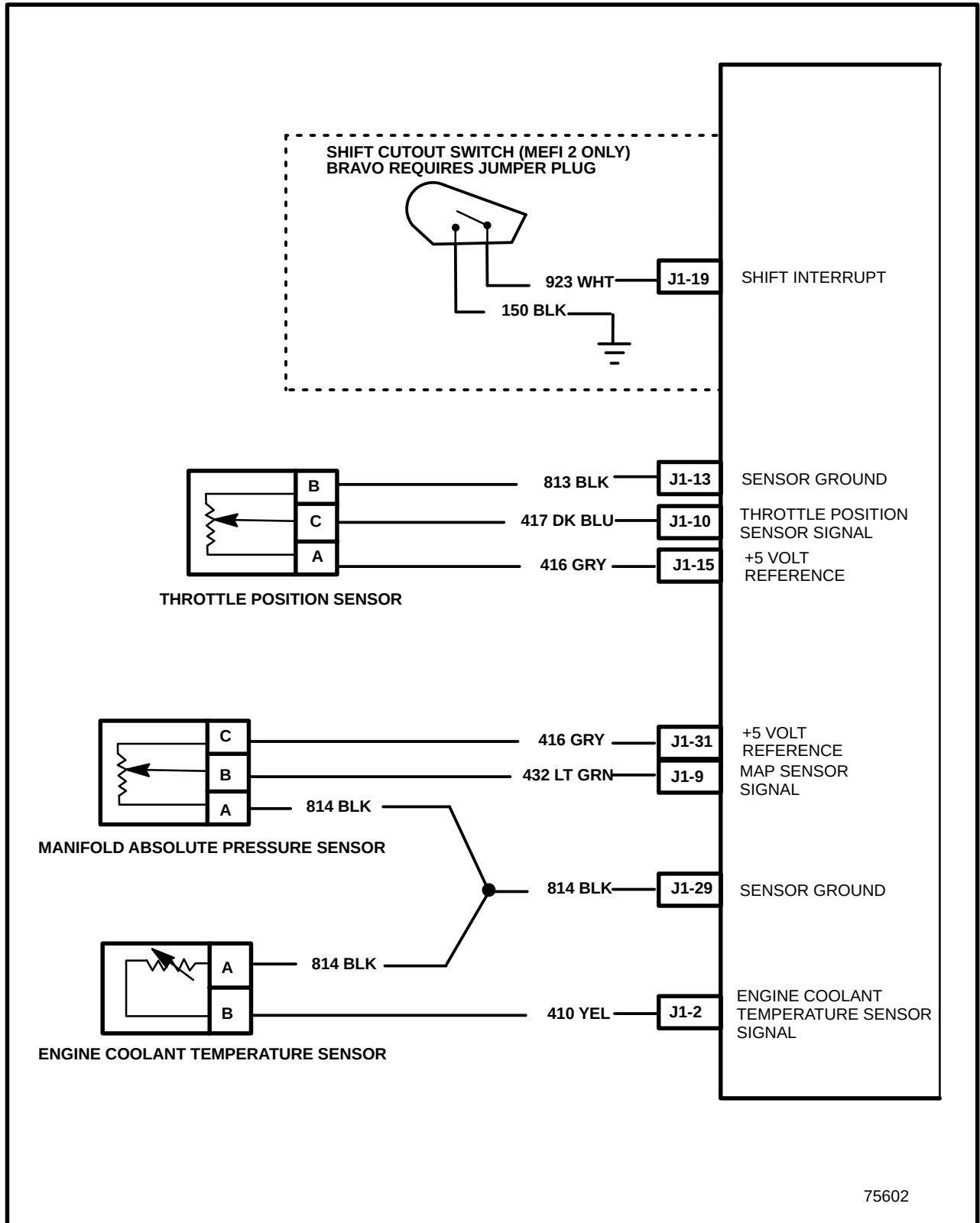
See Page 5G-6 For NOTES

Wiring System Diagrams

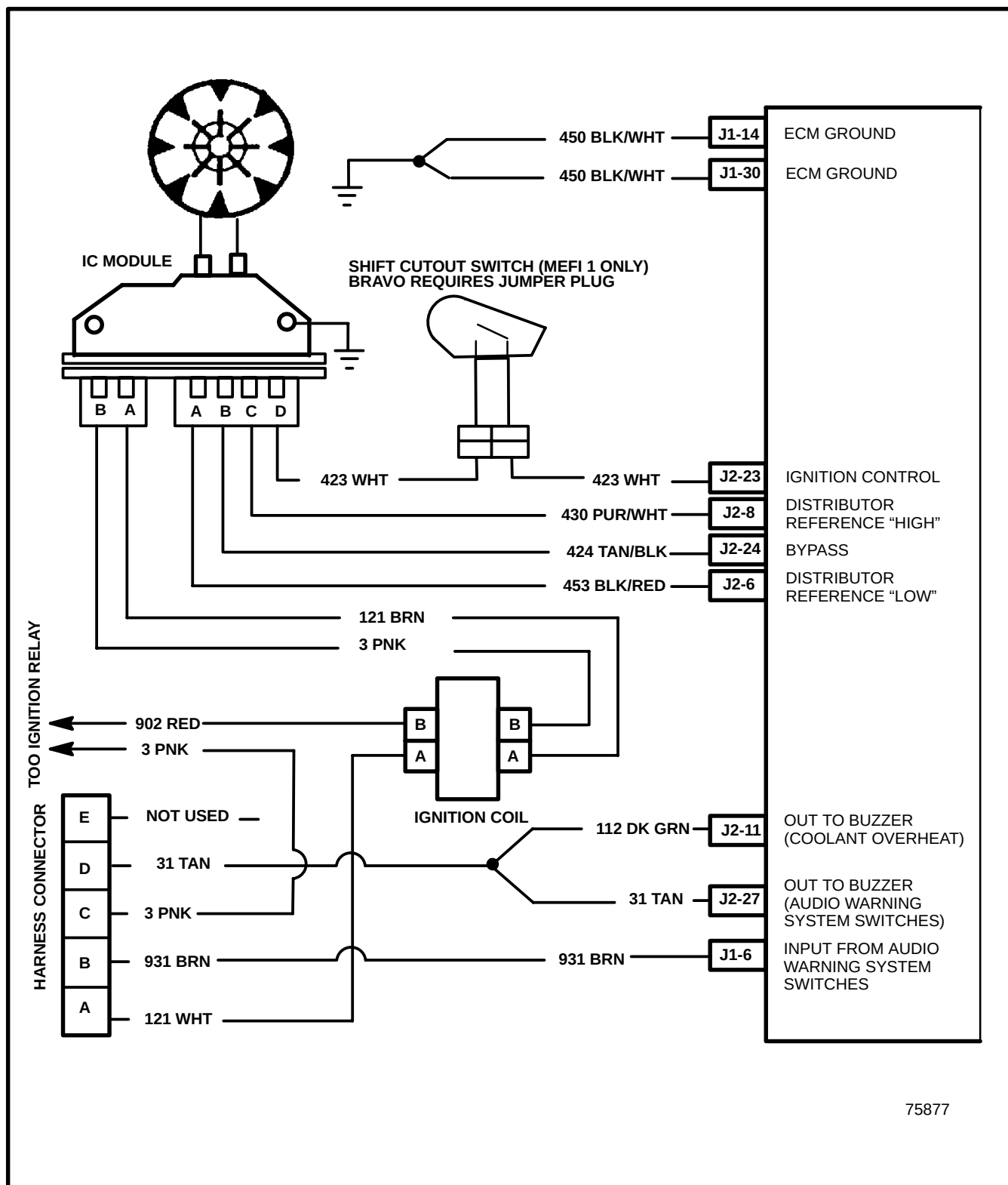
MEFI 1 and MEFI 2



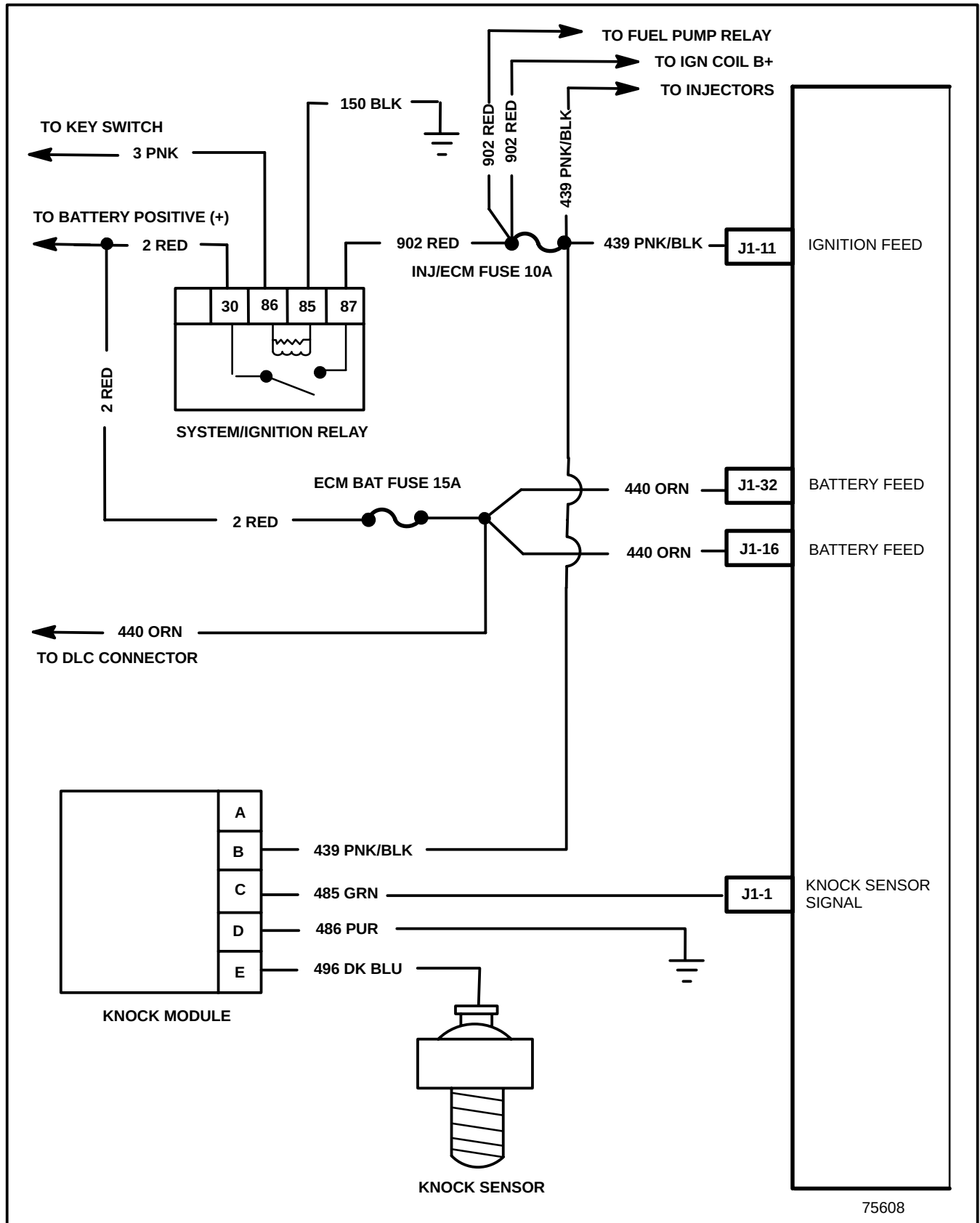
MEFI 1 and MEFI 2 (Continued)



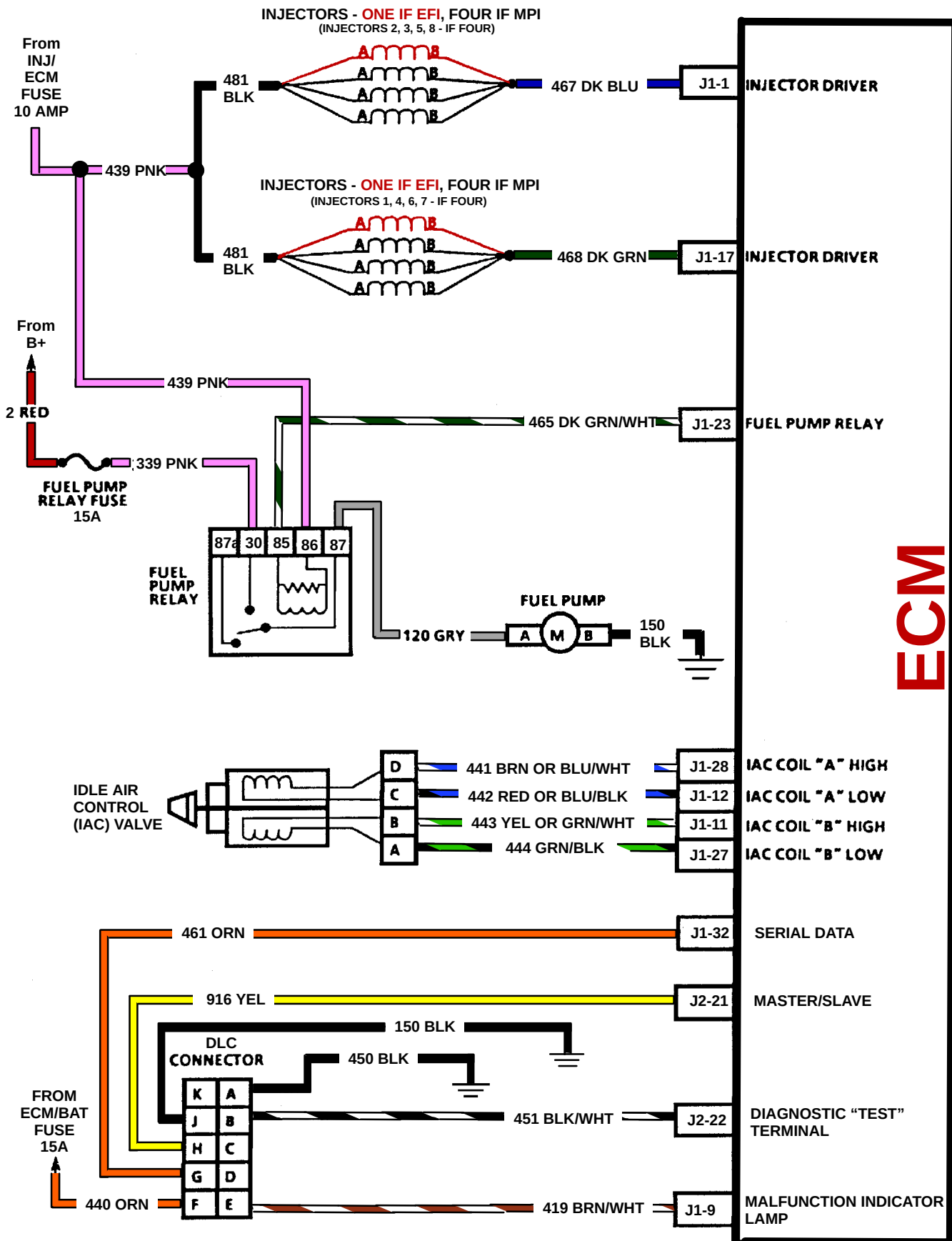
MEFI 1 and MEFI 2 (Continued)



MEFI 1 and MEFI 2 (Continued)

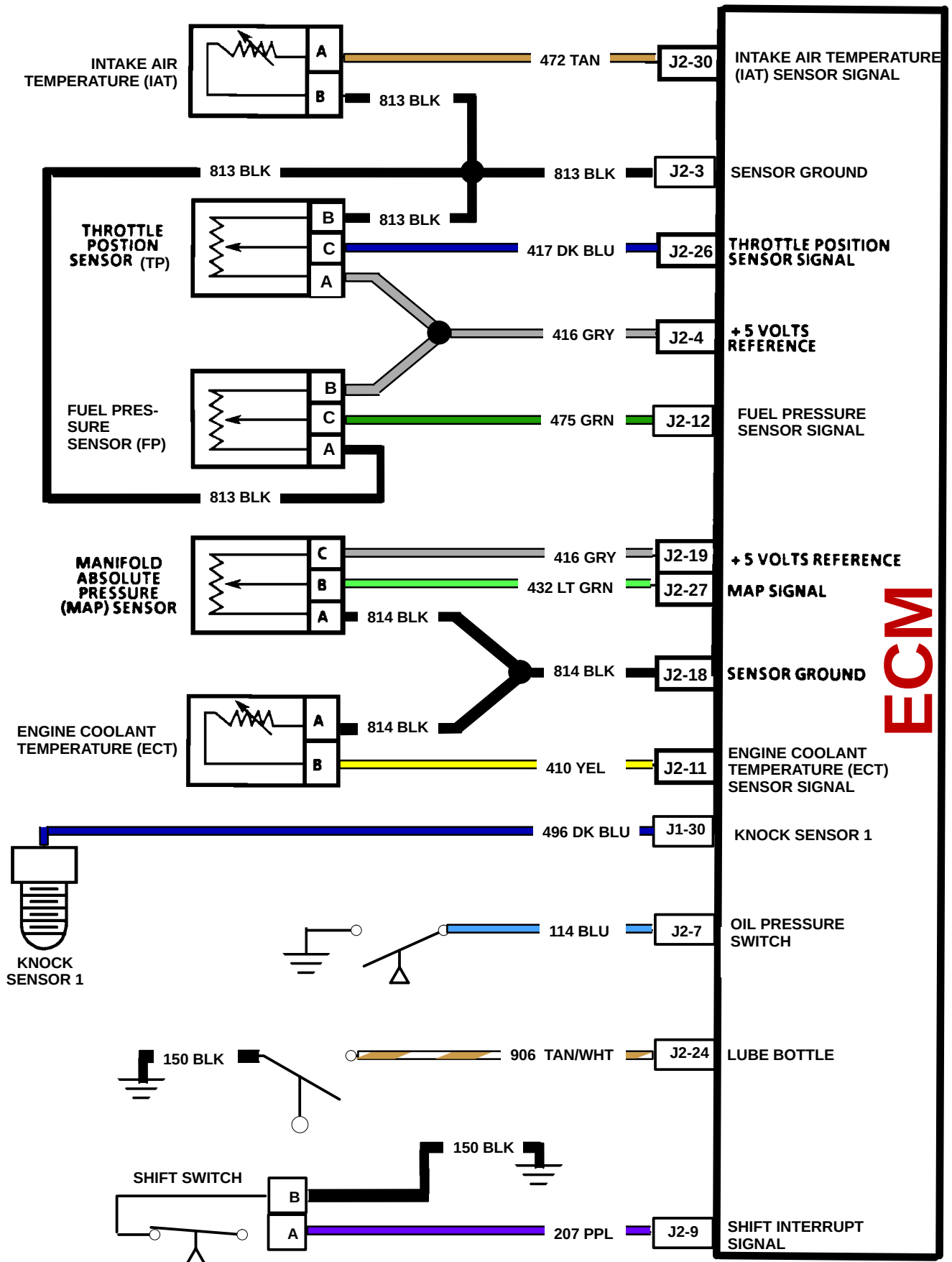


MEFI 3



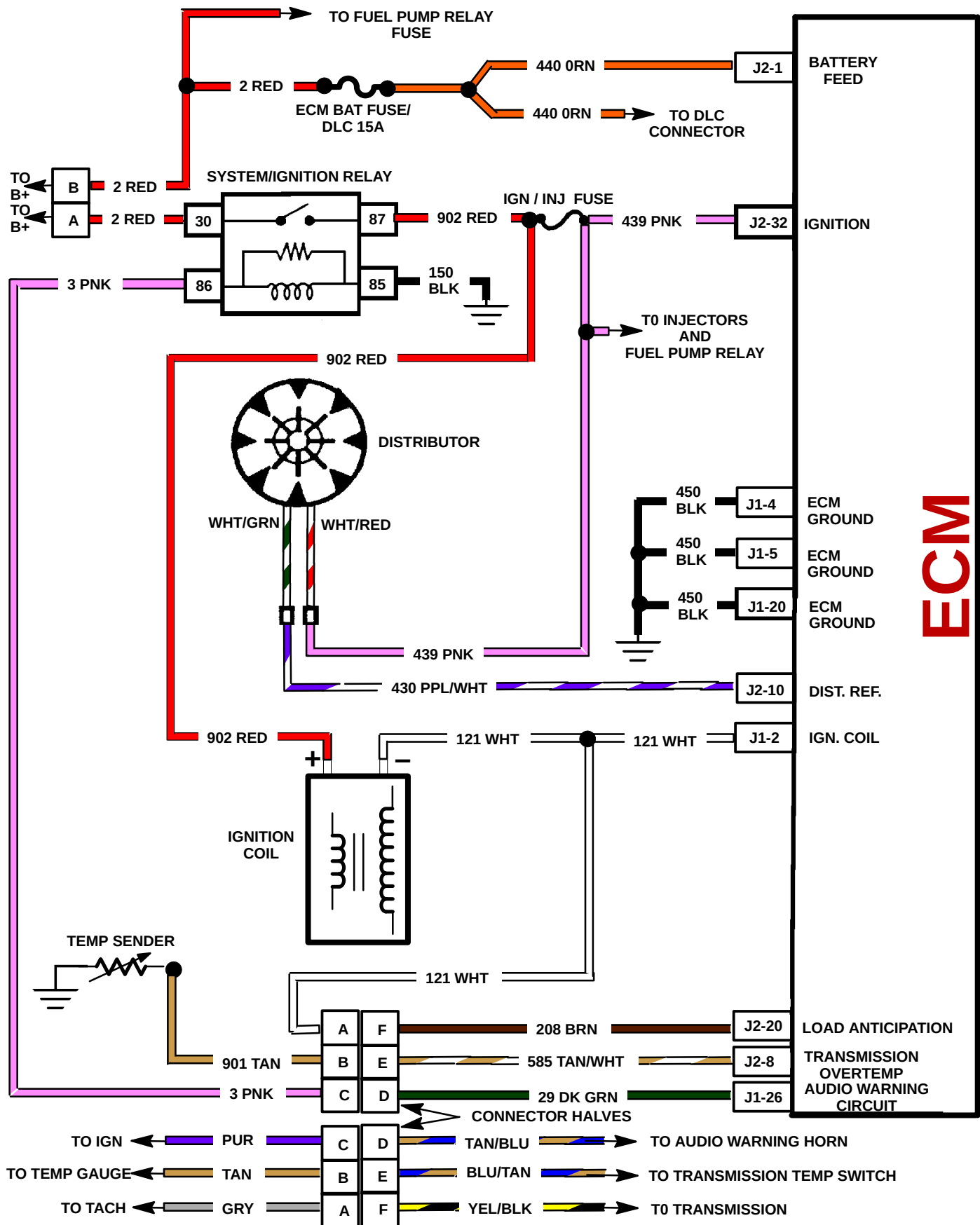
76097

MEFI 3 (Continued)



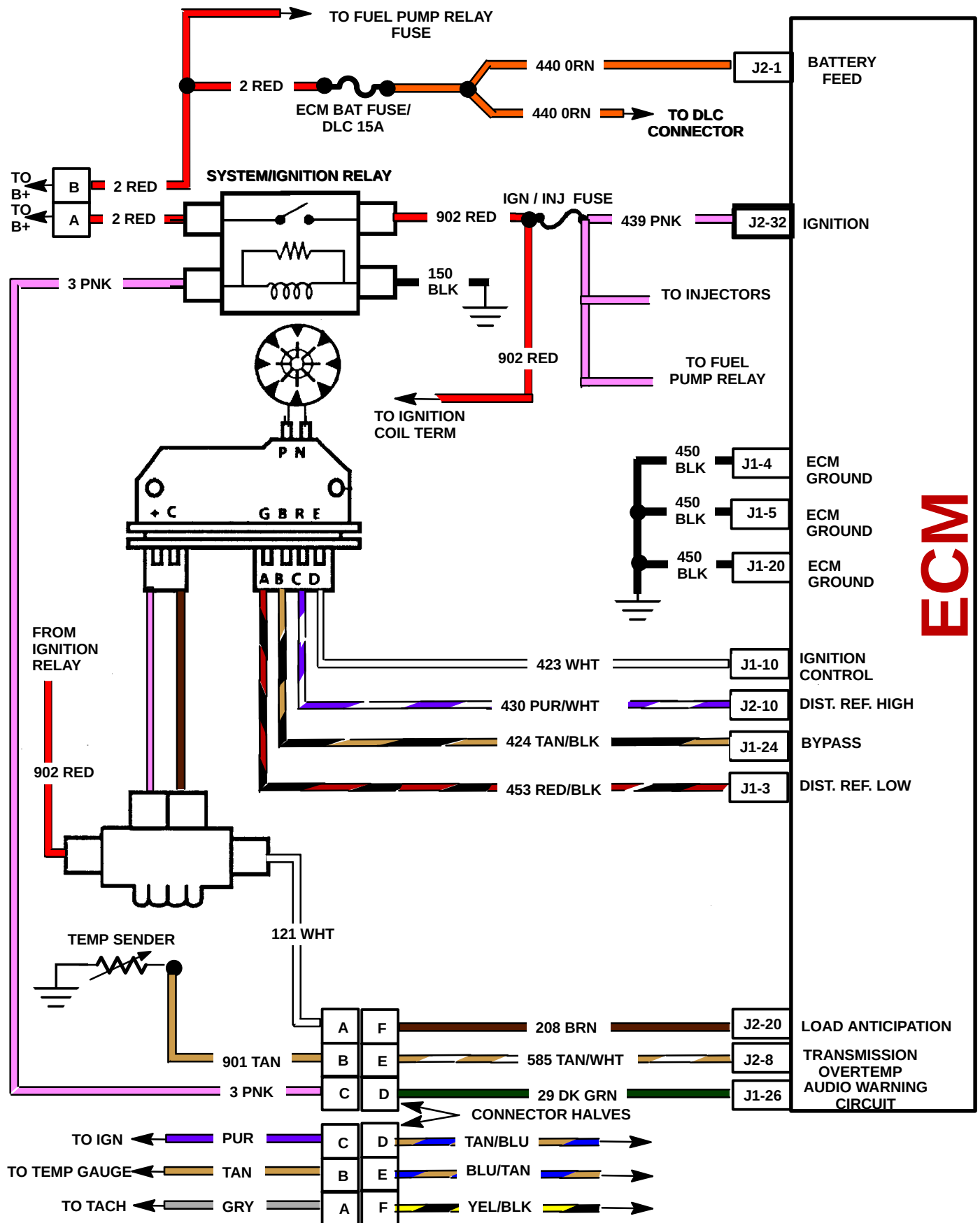
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MEFI 3 With Mercury Distributor



76099

MEFI 3 With GM EST Distributor



76099

Injector Balance Test (Multi-Port Models)

Test Procedure

The injector balance tester is a tool used to turn the injector ON for a precise amount of time, thus spraying a measured amount of fuel into the manifold. This causes a drop in fuel rail pressure that we can record and compare between each injector. All injectors should have the same amount of pressure drop. Injector testers are available for various manufacturers. For 454 and 502 engines; the tester must be capable of selecting an injector pulse width in the range of 200-400 milliseconds (msec). The recommended starting point for these engines is approximately 300 msec. In any case, a pulse width that drops the fuel rail pressure to half the normal operating pressure should be used.

STEP 1

Engine cool down period (ten minutes) is necessary to avoid irregular readings due to "heat soak" fuel boiling. Relieve fuel pressure in the fuel rail as outlined in "Fuel Pressure Relief Procedure" in "Repair Procedures." Remove plenum as outlined in "Repair Procedures." With ignition OFF, connect fuel pressure gauge to fuel pressure tap.

Disconnect harness connectors at all injectors and connect injector tester to one injector. Use adaptor harness furnished with injector tester to energize injectors. Follow manufacturer's instructions for use of adaptor harness. Ignition must be OFF at least ten seconds to complete ECM shutdown cycle. Fuel pump should run about two seconds after ignition is turned ON.

At this point, insert clear tubing attached to vent valve into a suitable container and bleed air from gauge and hose to ensure accurate gauge operation. Repeat this step until all air is bled from gauge.

STEP 2

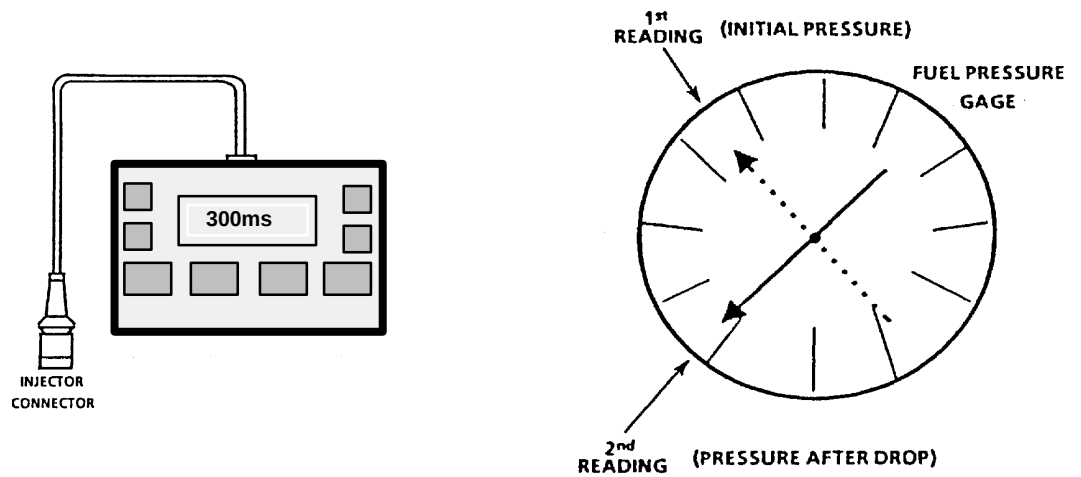
Turn ignition OFF for ten seconds and then ON again several times to get fuel pressure to its maximum. Record this initial pressure reading. Energize tester one time and note pressure drop at its lowest point. Disregard any slight pressure increase after drop hits low point. By subtracting this second pressure reading from the initial pressure, we have the actual amount of injector pressure drop.

STEP 3

Repeat Step 2 on each injector and compare the amount of drop. Usually, good injectors will have virtually the same drop. Retest any injector that has a pressure difference of 1.5 psi (10 kPa), more or less than the average of the other injectors on the engine. Replace any injector that fails the retest. If the pressure drop of all injectors is within 1.5 psi (10 kPa) of this average, the injectors appear to be flowing properly. Reconnect them and review "Troubleshooting."

NOTE: The entire test should not be repeated more than once without running the engine to prevent flooding. (This includes any retest on faulty injectors.)

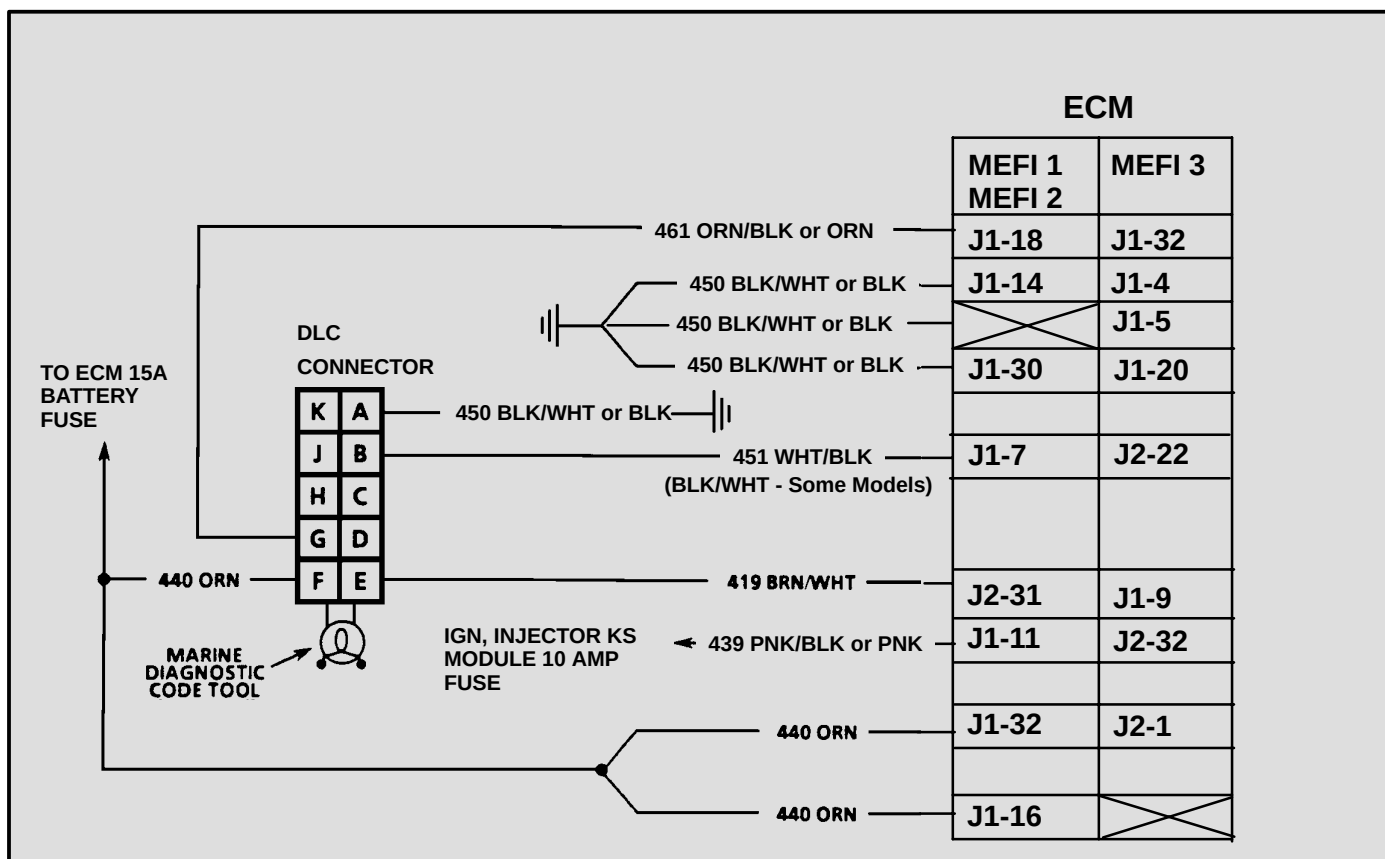
Test Example



Example								
Cylinder	1	2	3	4	5	6	7	8
1st. Reading	38 psi (262 kPa)	38 psi (262 kPa)	38 psi (262 kPa)	38 psi (262 kPa)	38 psi (262 kPa)	38 psi (262 kPa)	38 psi (262 kPa)	38 psi (262 kPa)
2nd Reading	19 psi (131 kPa)	17 psi (117 kPa)	21 psi (145 kPa)	19 psi (131 kPa)	19 psi (131 kPa)	19 psi (131 kPa)	19 psi (131 kPa)	19 psi (131 kPa)
Amount of Drop	19 psi (131 kPa)	21 psi (145 kPa)	17 psi (117 kPa)	19 psi (131 kPa)	19 psi (131 kPa)	19 psi (131 kPa)	19 psi (131 kPa)	19 psi (131 kPa)
	OK	Rich (Too Much Fuel Drop)	Lean (Too Little Fuel Drop)	OK	OK	OK	OK	OK

General Diagnostic Tests

On-Board Diagnostic (OBD) System Check



CIRCUIT DESCRIPTION:

The on-board diagnostic system check must be the starting point for any diagnosis. Before using this procedure, check the ECM and engine grounds for cleanliness and tightness.

The on-board diagnostic system check is an organized approach to identifying a problem created by an electronic engine control system malfunction.

DIAGNOSTIC AIDS:

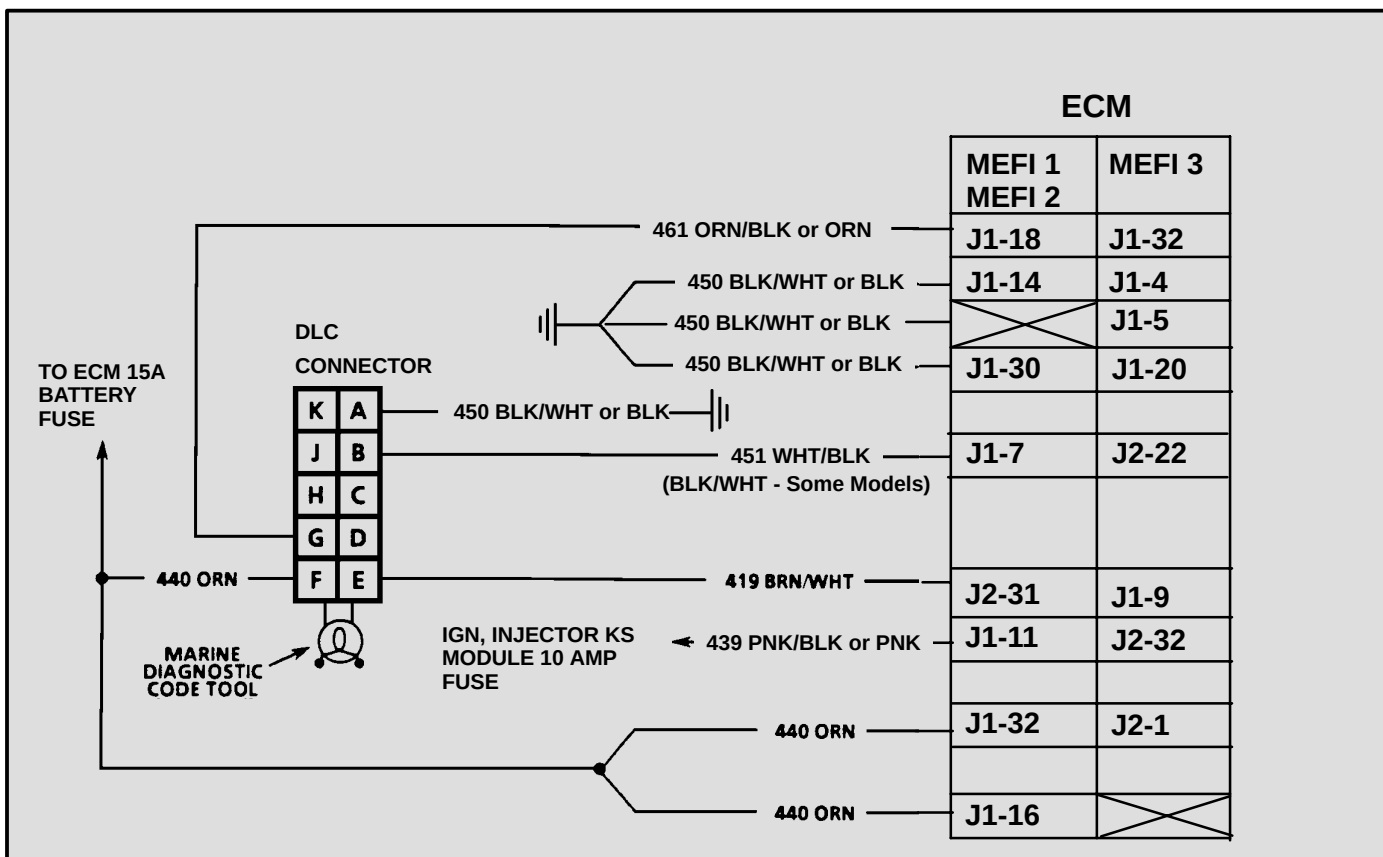
An intermittent may be caused by a poor connection, rubbed through wire insulation or a wire broken inside the insulation. Check for the following items:

- Poor connection or damaged harness. Inspect the ECM harness and connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wire connection and damaged harness.

On-Board Diagnostic (OBD) System Check

Step	Action	Yes	No
		PROCEED TO	
1.	Are you using a Scan Tool?	Step 2.	Step 6.
2.	a. Ignition OFF. b. Install a scan tool. c. Ignition ON. d. Attempt to display ECM data with the scan tool. Does The Scan Tool Display ECM Data?	Step 3.	Chart A-1
3.	Attempt to start the engine. Did The Engine Start And Continue To Run?	Step 4.	Chart A-3
4.	Select "Display DTCs" with the scan tool. Are Any Trouble Codes Stored?	DTC Chart	Step 5.
5.	Compare ECM data values displayed on the scan tool to the typical scan tool data values page. Are The Displayed Values Normal Or Close To The Typical Values?	Trouble-shooting	Diagnostic Testing
6.	a. Ignition ON, engine OFF. b. Install CodeMate Tester and switch it to "Normal Mode." c. Observe the MIL. Is the MIL ON?	Step 7.	Chart A-1
7.	a. With CodeMate Tester on "normal mode." b. Ignition ON, engine OFF. c. Observe the MIL on the CodeMate Tester. Does the MIL Flash DTC 12?	Step 12.	Step 8.
8.	a. Switch CodeMate Tester to "Service Mode." b. Ignition ON, engine OFF. c. Observe the MIL on the CodeMate Tester. Does the MIL Flash DTC 12?	Step 9.	Chart A-2
9.	a. Switch CodeMate Tester to "Normal Mode." b. Attempt to start the engine. Did The Engine Start And Continue To Run?	Step 10.	Chart A-3
10.	a. Ignition ON, Engine OFF. b. Switch CodeMate Tester to "Service Mode." Are Any Additional DTC Stored?	DTC Chart	Step 11.
11.	Does A Customer Complaint Or Driveability Problem Currently Exist?	Symptoms	Diagnostic Aids
12.	Check CKT 451 for a short to ground.	Verify Repair	—

Chart A-1 (1 of 2): No MIL or No DLC Data



CIRCUIT DESCRIPTION:

When the CodeMate Tester is installed, it plugs into the DLC terminals "F" and "E." It receives voltage through CKT 440 terminal "F." Terminal "E" is ground through CKT 419. There should always be a steady MIL with the ignition ON and the engine stopped. The Engine Control Module (ECM) turns the MIL on by grounding the MIL driver circuit.

DIAGNOSTIC AIDS:

An intermittent may be caused by a poor connection, rubbed through wire insulation or a wire broken inside the insulation. Check for the following items:

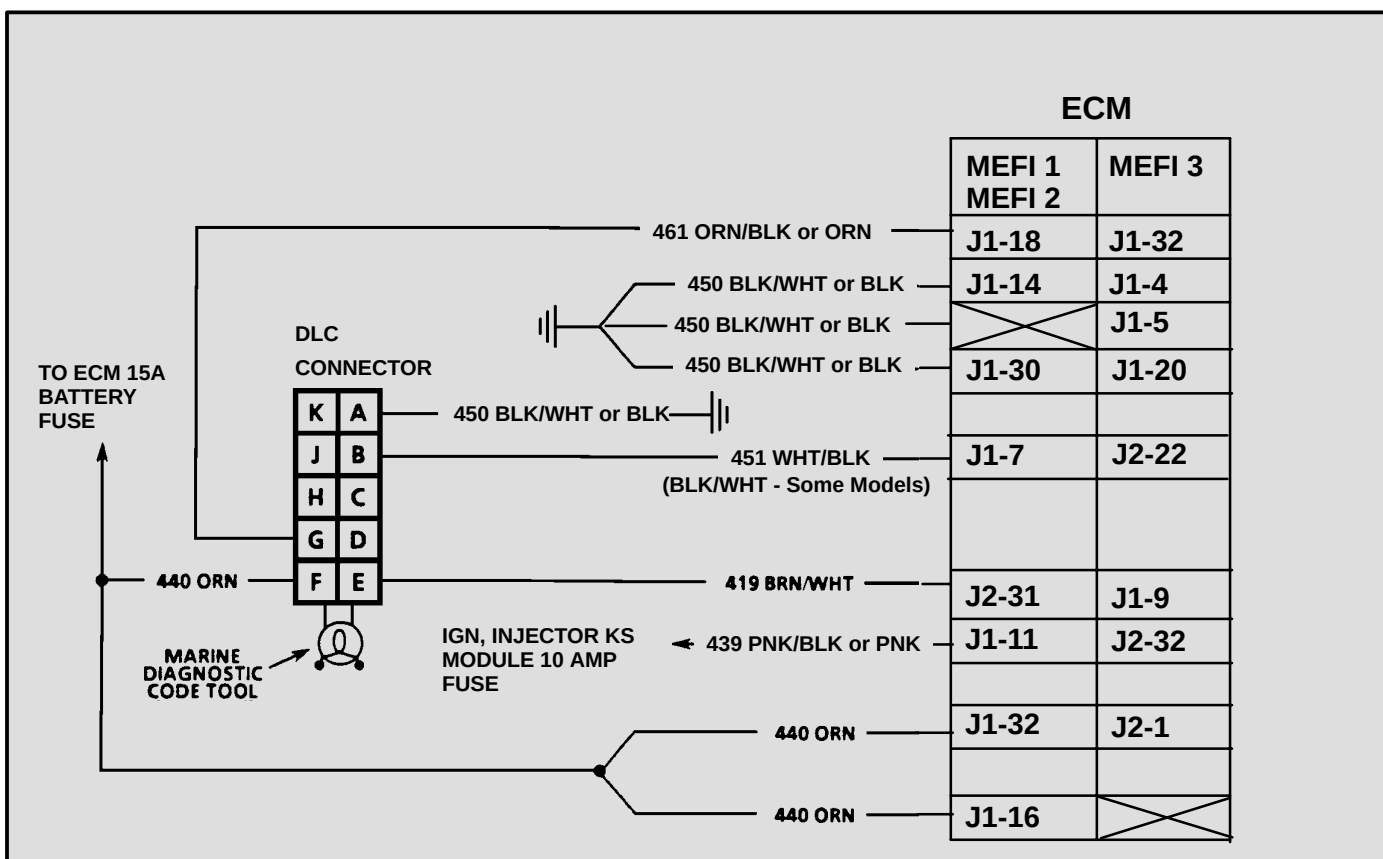
- Poor connection or damaged harness. Inspect the ECM harness and connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wire connection and damaged harness.

If the engine runs OK, check for a faulty light bulb or an open in the MIL driver circuit (CKT 419). If the engine cranks but will not run, check for an open ECM ignition or battery feed or a poor ECM to engine ground.

Chart A-1 (2 of 2): No MIL or No DLC Data

Step	Action	Yes	No
		PROCEED TO	
1.	Was the "On-Board Diagnostic" (OBD) System Check Performed?	Step 2.	OBD
2.	a. Remove CodeMate Tester or Scan Tool. b. Ignition ON, engine OFF. c. Using a test light connected to ground (–), probe terminal "F" of the DLC. Does The Test Light Illuminate?	Step 3.	Step 10.
3.	Using a test light connected to battery positive (B+), probe terminal "E" of the DLC. Does The Test Light Illuminate?	Step 11.	Step 4.
4.	a. Ignition OFF. b. Disconnect ECM connectors. c. Using a DVOM, measure the resistance between ECM CKT 419 and DLC terminal "E." Is The Resistance Less Than 1 ohm?	Step 5.	Step 13.
5.	Are you using a Scan Tool?	Step 6.	Step 11.
6.	Check the ECM / DLC fuse. Is The Fuse Good?	Step 7.	Step 14.
7.	a. Ignition OFF. b. Disconnect the ECM connectors. c. Using a test light connected to ground, probe ECM CKT 440. Does The Test Light Illuminate?	Step 8.	Step 10.
8.	a. Ignition ON, engine OFF. b. Using a test light connected to ground (–), probe ECM CKT 439. Does The Test Light Illuminate?	Step 12.	Step 9.
9.	Check the Ignition / Injection fuse. Is The Fuse Good?	Chart A-6	Step 15.
10.	Locate and repair open or short to ground in CKT 440.	Verify Repair	–
11.	Repair or replace faulty CodeMate Tester.		
12.	If problem was no DLC data (using scan tool), check serial data CKT 461 for an open or short to ground or locate and repair faulty ECM grounds.		
13.	Locate and repair open in CKT 419.		
14.	Locate and repair short to ground in the battery feed circuit.		
15.	Locate and repair short to ground in CKT 439.		

Chart A-2 (1 of 2): MIL ON Steady - Will Not Flash DTC 12



CIRCUIT DESCRIPTION:

When the CodeMate Tester is installed, it plugs into the DLC terminals "F" and "E." It receives voltage through CKT 440 terminal "F." Terminal "E" is ground through CKT 419 from the ECM. There should always be a steady MIL with the ignition ON and the engine stopped. The Engine Control Module (ECM) turns the MIL ON by grounding the MIL driver circuit.

When the diagnostic tests terminal on the DLC is grounded by jumping terminal "B" to terminal "A," the ground circuit is completed. The MIL will flash a DTC 12 followed by any DTC stored in memory. A steady light suggests CKT 419 is shorted to ground or an open in CKT 451 from the ECM to the DLC.

DIAGNOSTIC AIDS:

An intermittent may be caused by a poor connection, rubbed through wire insulation or a wire broken inside the insulation. Check for the following items:

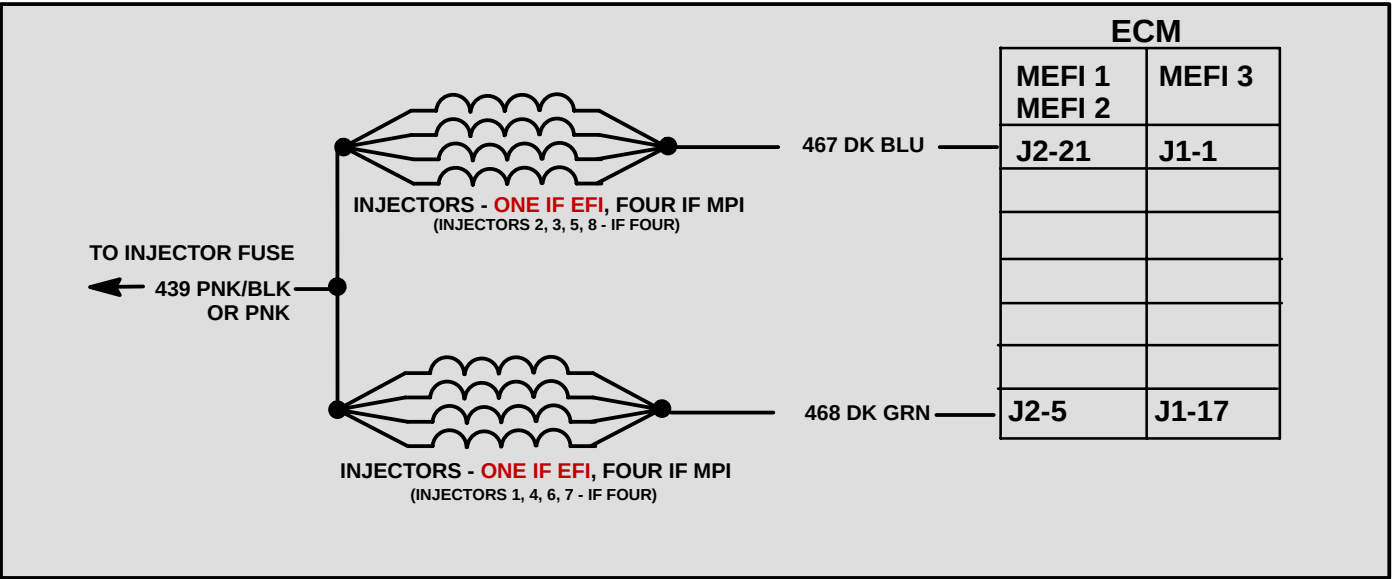
- Poor connection or damaged harness. Inspect the ECM harness and connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wire connection and damaged harness.

If the engine runs OK, check for a faulty light bulb or an open in the MIL driver circuit (CKT 419). If the engine cranks but will not run, check for an open ECM ignition or battery feed or a poor ECM to engine ground.

Chart A-2 (2 of 2): MIL ON Steady - Will Not Flash DTC 12

Step	Action	Yes	No
		PROCEED TO	
1.	<i>Was the "On-Board Diagnostic" (OBD) System Check Performed?</i>	Step 2.	OBD
2.	a. Ignition ON, engine OFF. b. Switch CodeMate Tester to "Normal Mode." <i>Does The MIL Flash DTC 12?</i>	Step 9.	Step 3.
3.	a. Ignition ON, engine OFF. b. Switch CodeMate Tester to "Service Mode." <i>Does The MIL Flash DTC 12?</i>	Step 10.	Step 4.
4.	a. Ignition OFF, disconnect ECM connectors. b. Ignition ON, engine OFF, observe the MIL. <i>Is The MIL ON?</i>	Step 7.	Step 5.
5.	a. Ignition OFF. b. With ECM connectors disconnected, jump terminals "A" to "B" at the DLC. c. Connect test light between CKT 451 and battery positive (B+). <i>Does Test Light Illuminate?</i>	Step 6.	Step 8.
6.	Verify correct operation of CodeMate Tester on a known good system.	Verify Repair	—
7.	Locate and repair short to ground in CKT 419.		
8.	Locate and repair open in CKT 450 and/or CKT 451.		
9.	Check CKT 451 for short to ground.		
10.	Locate and repair intermittent faulty connections.		

Chart A-3 (1 of 2): Engine Cranks But Will Not Run



CIRCUIT DESCRIPTION:

In the Distributor Ignition (DI) system and the fuel injector circuit, the supply voltage comes from the EFI system relay. From the EFI system relay, CKT 902 delivers supply voltage to the injector/ECM fuse, and to the ignition coil.

After supply voltage passes through the injector/ECM fuse, it branches out into two separate CKT's 439. The ECM will control the opening and closing of the injectors through injector driver CKT 467 and CKT 468 by connecting them to ground.

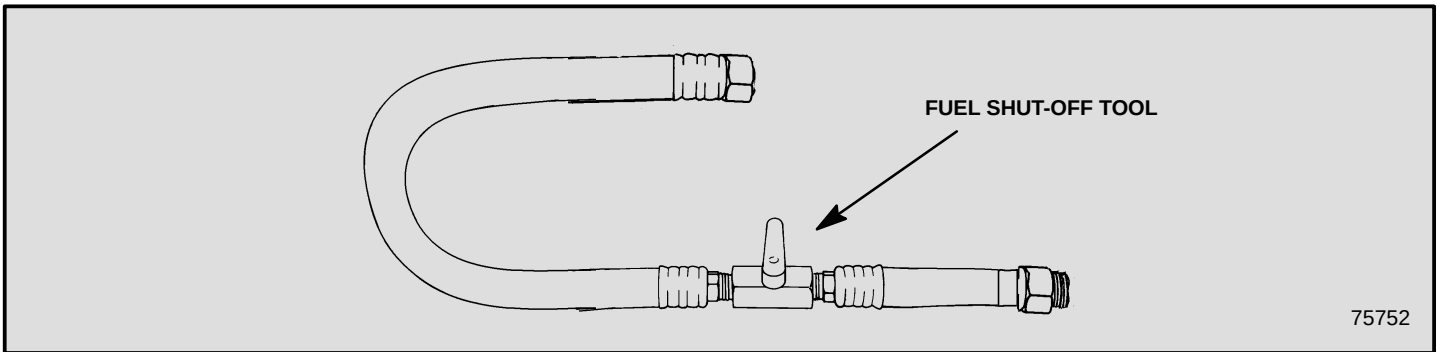
DIAGNOSTIC AIDS:

- This chart assumes that battery voltage and engine cranking speed are OK, and there is adequate fuel in the tank.
- Water or foreign material in fuel system can cause a no start.
- A defective MAP sensor may cause a no start or a start and stall condition. To determine if the MAP sensor is causing the problem, disconnect the electrical connector. The ECM will then use a default value for the sensor. If the condition is corrected and the connections are OK, then replace the sensor.
- An intermittent may be caused by a poor connection, rubbed through wire insulation or a wire broken inside the insulation. Check for the following items:
- Poor connection or damaged harness. Inspect the ECM harness and connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wire connection, and damaged harness.
- If above are all OK, refer to "Hard Start" in "Troubleshooting" section.

Chart A-3 (2 of 2): Engine Cranks But Will Not Run

Step	Action	Yes	No
		PROCEED TO	
1.	Was the "On-Board Diagnostic" (OBD) System Check Performed?	Step 2.	OBD
2.	a. Key OFF for minimum of 10 seconds. b. Key ON. c. Listen for fuel pump to run. Does Fuel Pump Run For 2 Seconds?	Step 3.	Chart A-5
3.	Check for secondary ignition spark. Is Adequate Spark Present?	Step 4.	Chart A-7
4.	a. Install fuel pressure gauge. b. Ignition OFF for 10 seconds. c. Ignition ON. Fuel pump will run for about 2 seconds. d. Note fuel pressure with pump running. The pressure may drop after the pump stops running. Is Fuel Pressure Greater Than 25 psi (172 kPa)?	Step 5.	Chart A-4
5.	a. Ignition OFF. b. Disconnect ECM connectors. c. Measure resistance between ECM CKT 467 and ECM CKT 468. Is The Resistance Greater Than 1 ohm?	Step 6.	Step 10.
6.	Check resistance across each injector in the circuit. MPI: Is Resistance Greater Than 10 ohms? TBI: Is Resistance Greater Than 1 ohm?	Step 7.	Step 8.
7.	a. Reconnect injectors. b. Ignition OFF. c. Disconnect ECM. d. Ignition ON. e. Using a test light connected to ground, probe ECM CKT 467 and CKT 468. Does Test Light Illuminate?	Step 11.	Step 9.
8.	Locate and repair short to ground or replace any injector that measures low.	Verify Repair	—
9.	Locate and repair open in CKT 467 or CKT 468.		
10.	Check for short to ground in CKT 467 or CKT 468.		
11.	a. Disconnect all injectors. b. Ignition ON. c. Using a test light connected to ground, probe CKT 467 and CKT 468 on the ECM side of the injector harness (Test one injector harness on each side of the engine). If light is ON, locate and repair short to voltage.		

Chart A-4 (1 of 2): Fuel System Diagnosis



CIRCUIT DESCRIPTION:

When the ignition is turned ON, the Engine Control Module (ECM) will turn the fuel pump ON for 2 seconds. During engine cranking, the ECM will turn ON the fuel pump. It will remain ON as long as the engine is cranking or running, and the ECM is receiving ignition reference pulses. If there are no reference pulses, the ECM will shut OFF the fuel pump.

The pump will deliver fuel to the fuel rail and injectors, then to the pressure regulator, where the system pressure is controlled to approximately:

TBI Models: 28-32 psi (193-221 kPa)

MPI Models: 34-38 psi (234-262 kPa).

Excess fuel is then returned to the water separating fuel filter.

DIAGNOSTIC AIDS:

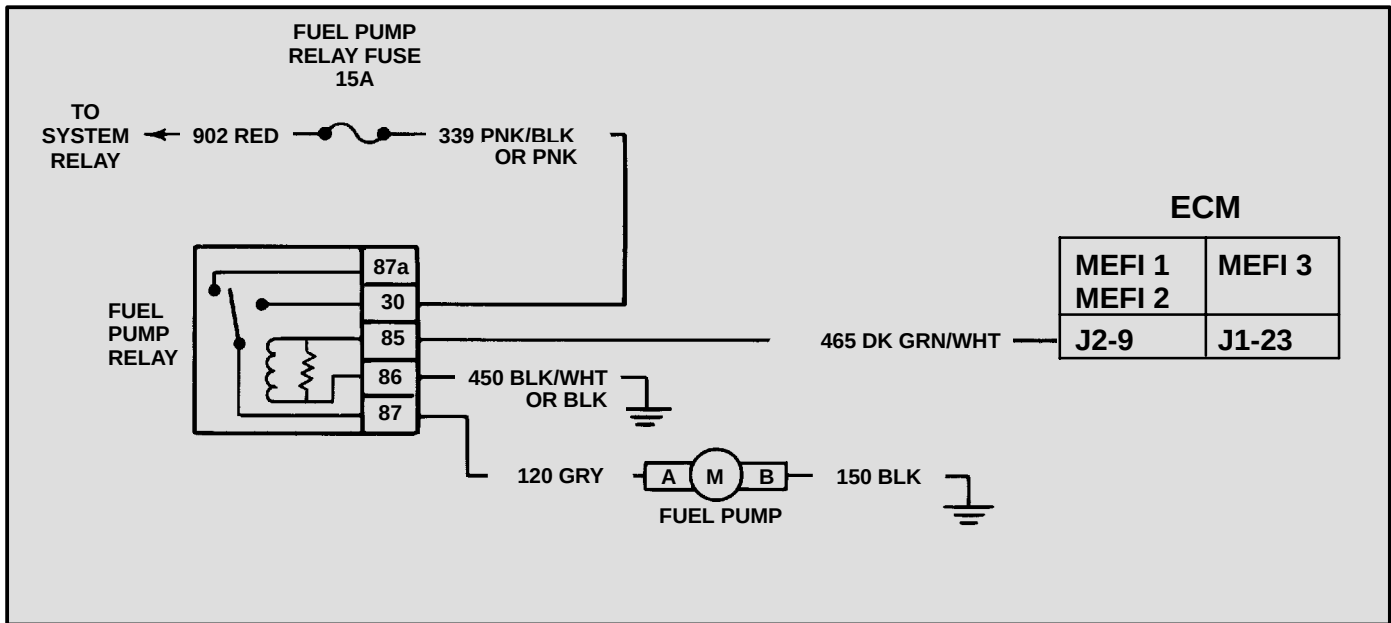
An intermittent may be caused by a poor connection, rubbed through wire insulation or a wire broken inside the insulation. Check for the following items:

- Poor connection or damaged harness. Inspect the ECM harness and connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wire connection and damaged harness.
- Contaminated or dirty fuel may cause the fuel pump to seize, which will cause the fuel pump relay fuse to fail.
- The ability to maintain a constant fuel pressure is very critical in the driveability of fuel injection. If the fuel pressure drops below the specification of that application, multiple driveability problems may occur. The vessel may have to be operated under a load, or certain conditions, as the lack of fuel pressure may be intermittent.

Chart A-4 (2 of 2): Fuel System Diagnosis

Step	Action	Yes	No
		PROCEED TO	
1.	Was the "On-Board Diagnostic" (OBD) System Check Performed?	Step 2.	OBD
2.	a. Install fuel pressure gauge. b. Ignition OFF. c. Ignition ON. d. Fuel pump will run for about 2 seconds. Note fuel pressure with pump running. The pressure may drop after the pump stops running, but should not drop immediately to 0 psi. Is fuel pressure below 25 psi (172 kPa)?	Step 3.	Step 5.
3.	Attempt to start engine and idle at normal operating temperature. Did engine start?	Step 4.	Step 6.
4.	With engine still idling, connect an external vacuum source to the fuel pressure regulator and apply 10 inches of vacuum. Did fuel pressure drop by approximately 5 psi (34 kPa)?	Step 13.	Step 11.
5.	Was fuel pressure present at all?	Step 6.	Chart A-5
6.	Does the system establish fuel pressure and then drop quickly to 0 psi?	Step 7.	Step 9.
7.	a. Ignition OFF. b. Block fuel pressure line between the fuel pump and fuel rail (or throttle body inlet fitting on TBI Models) using fuel shut-off valve tool. c. Ignition ON. Does fuel pressure hold?	Step 10.	Step 8.
8.	a. Ignition OFF. b. Block fuel return line using fuel shut-off valve tool. c. Ignition ON. Does fuel pressure hold?	Step 11.	Step 12.
9.	Check for restricted fuel lines.	Verify Repair	—
10.	Locate and repair leaking injector(s) or fuel line connections.		
11.	Replace faulty fuel pressure regulator.		
12.	Check for leaking pump fittings or lines, inlet filter, and low battery voltage. If OK, replace faulty fuel pump.		
13.	Problem is intermittent or fuel supply to engine is restricted or low.		

Chart A-5 (1 of 2): Fuel System Electrical Test



CIRCUIT DESCRIPTION

The fuel system circuit receives a supply voltage from the system relay CKT 902. The fuel system is protected by a 15 amp fuse. After the fuse, supply voltage is delivered by CKT 339 to fuel pump relay terminal "30." The fuel pump relay is turned on by the ECM by supplying voltage to CKT 465. The fuel pump relay will remain ON as long as the engine is running or cranking and the ECM is receiving reference pulses. If no reference pulses are present, the ECM de-energizes the fuel pump relay within 2 seconds after the ignition is turned ON or the engine is stopped.

DIAGNOSTIC AIDS

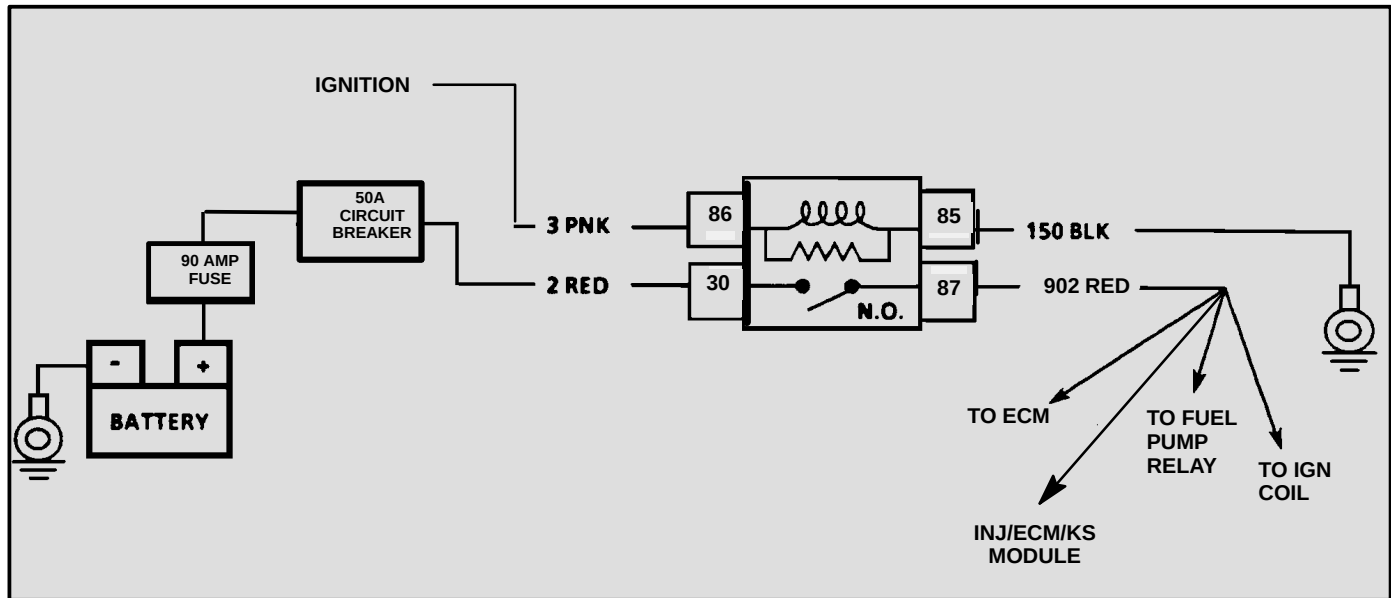
An intermittent may be caused by a poor connection, rubbed through wire insulation or a wire broken inside the insulation. Check for the following items:

- Poor connection or damaged harness. Inspect the ECM harness and connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wire connections and damaged harness.
- Contaminated or dirty fuel may cause the fuel pump to seize, which will cause the fuel pump relay fuse to fail.

Chart A-5 (2 of 2): Fuel System Electrical Test

Step	Action	Yes	No
		PROCEED TO	
1.	<i>Was the "On-Board Diagnostic" (OBD) System Check Performed?</i>	Step 2.	OBD
2.	a. Ignition OFF. b. Remove fuel pump relay. c. Ignition ON. d. Using test light connected to ground, probe fuel pump relay harness connector terminal "30." <i>Does Test Light Illuminate?</i>	Step 3.	Step 6.
3.	a. Ignition OFF. b. Using a fused jumper wire, connect terminals "30" and "87" of the fuel pump relay connector together. c. Ignition ON. <i>Does Fuel Pump Run?</i>	Step 4.	Step 11.
4.	a. Ignition OFF. b. Disconnect fused jumper wire. c. Using a test light connected to battery positive (B+), probe terminal "86" of the fuel pump relay connector. <i>Does The Test Light Illuminate?</i>	Step 5.	Step 12.
5.	a. Using a test light connected to ground, probe terminal "85" of the fuel pump relay connector. b. Ignition ON. <i>Does Test Light Illuminate For 2 Seconds And Then Go Off?</i>	Step 8.	Step 7.
6.	Check fuel pump relay fuse. <i>Is Fuse Ok?</i>	Step 9.	Step 10.
7.	Locate and repair faulty ECM connection at "J2-9" or repair open in CKT 465.	Verify Repair	—
8.	Check for plugged fuel filter, vapor lock condition, restricted fuel lines, disconnected hoses, and proper fuel level.		
9.	Locate and repair open in CKT 339 or CKT 902.		
10.	Locate and repair short to ground in CKT 339 or CKT 120. Also check for contamination in fuel lines or fuel tank. If OK, replace fuel pump and fuse.		
11.	Locate and repair open in CKT 120 or CKT 150. If okay, replace faulty fuel pump.		
12.	Locate and repair open in CKT 450.		

Chart A-6 (1 of 2): EFI System/Ignition Relay Check



CIRCUIT DESCRIPTION:

Battery voltage is constantly supplied to terminal “30” of the system relay. When the ignition switch is moved to the “RUN” position, battery voltage is supplied to terminal “86” of the system relay. The pull-in coil is then energized creating a magnetic field which closes the contacts of the system relay. Voltage and current are then supplied to the ignition control module, injectors, ECM, and fuel pump relay through terminal “87” CKT 902 of the system relay.

DIAGNOSTIC AIDS

An intermittent may be caused by a poor connection, rubbed through wire insulation or a wire broken inside the insulation. Check for the following items:

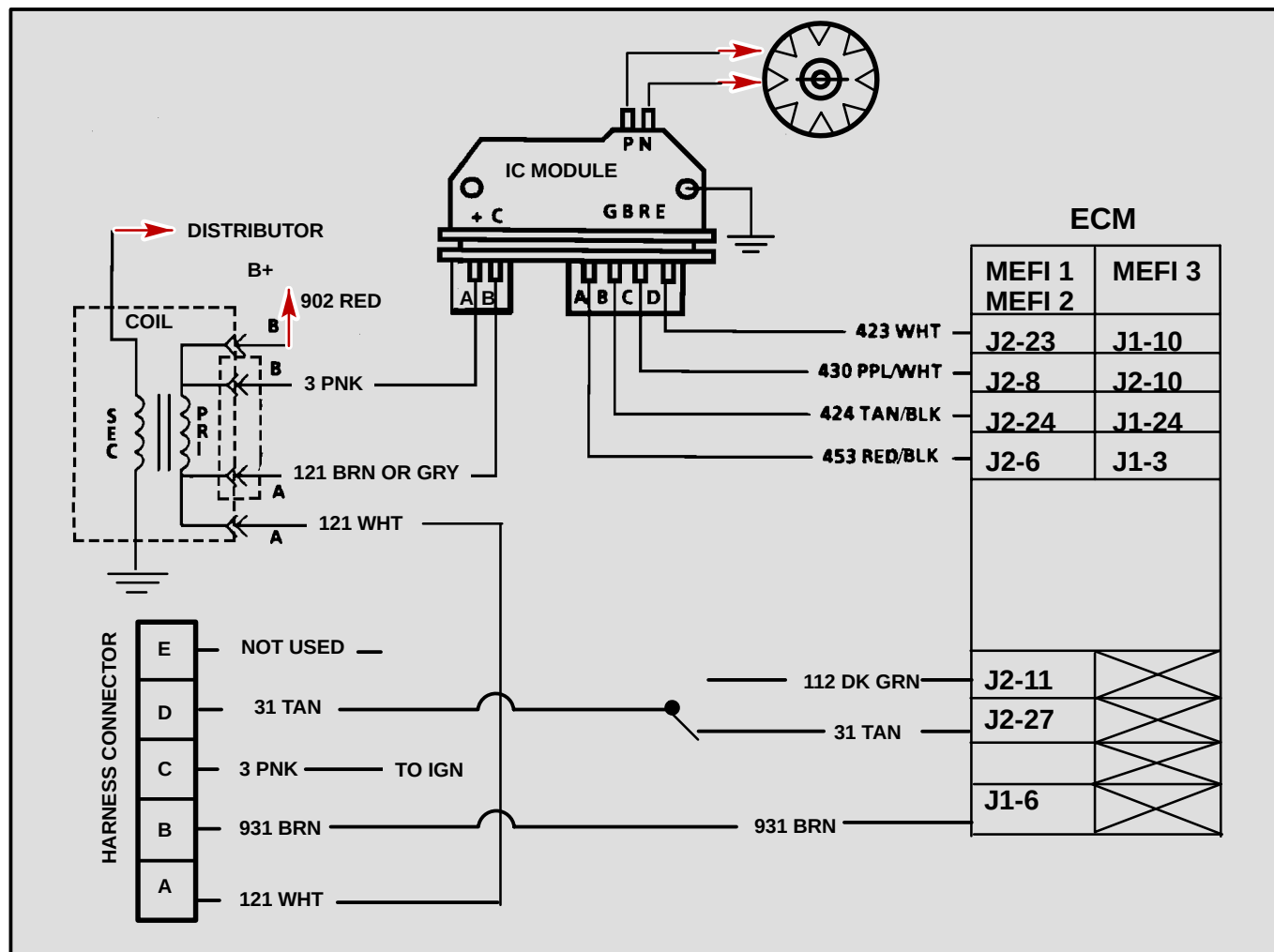
- Poor connection or damaged harness. Inspect the ECM harness and connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wire connection, and damaged harness.
- Contaminated or dirty fuel may cause the fuel pump to seize, which will cause the fuel pump relay fuse to fail.

Chart A-6 (2 of 2): EFI System/Ignition Relay Check

Step	Action	Yes	No
		PROCEED TO	
1.	Was the "On-Board Diagnostic" (OBD) System Check Performed?	Step 2.	OBD
2.	a. Ignition OFF. b. Remove EFI system relay connector. c. Ignition ON. d. With test light still connected to ground, probe relay harness connector terminals "86" and "30." Does Test Light Illuminate On Both Terminals?	Step 3.	Step 5.
3.	Using test light connected to battery positive (B+), probe relay harness connector terminal "85." Does Test Light Illuminate?	Step 4.	Step 6.
4.	Check relay connector for poor contact or corrosion. If OK, replace faulty EFI system relay.	Verify Repair	—
5.	Locate and repair open or short to ground in circuit that did not light (CKT 2 and/or CKT 3).		
6.	Locate and repair open ground CKT 150.		

Chart A-7 (1 of 6): Ignition System Check

MEFI 1, MEFI 2 AND MEFI 3 BLACK SCORPION:



CIRCUIT DESCRIPTION MEFI 1, MEFI 2 AND MEFI 3 BLACK SCORPION:

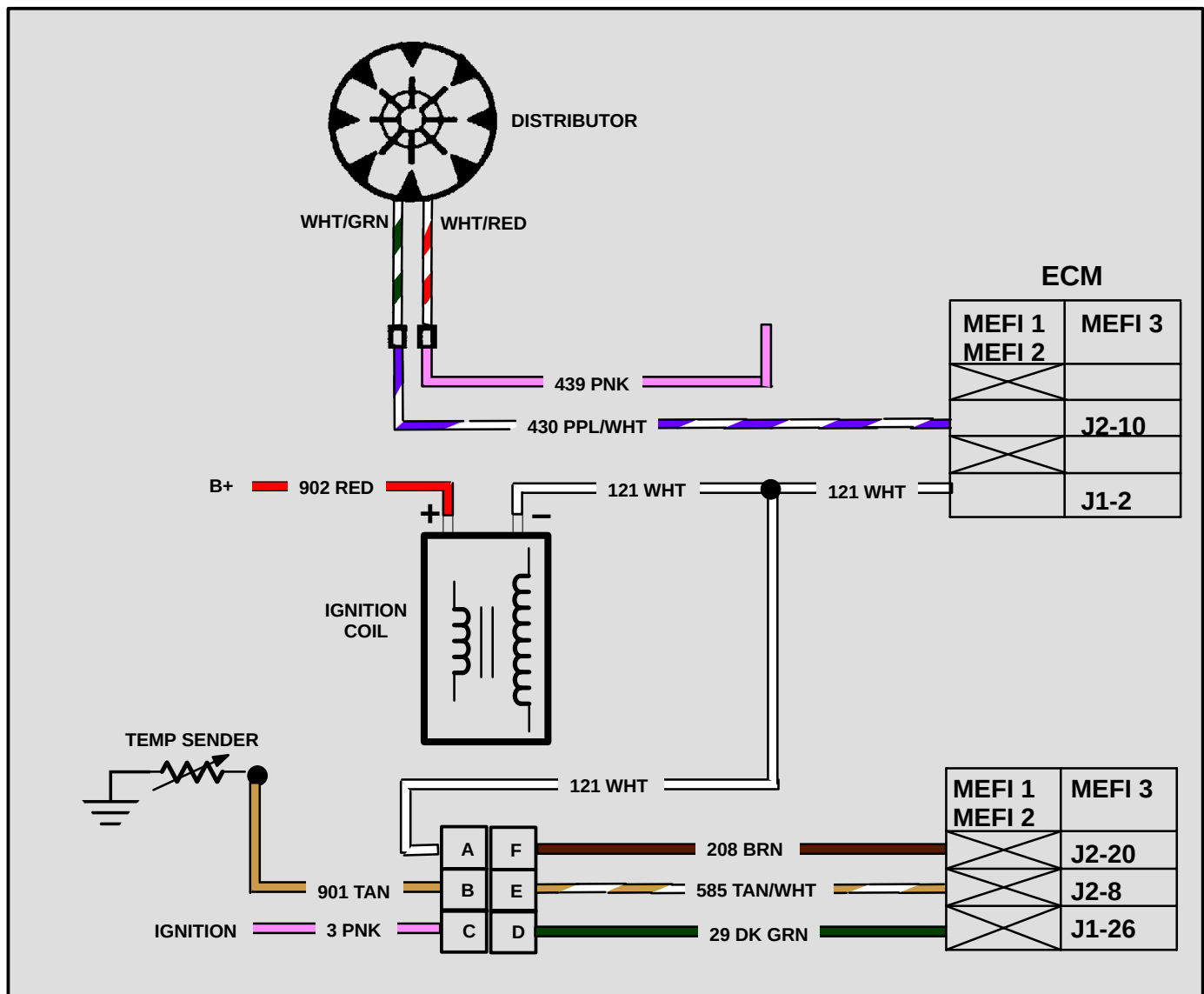
The Distributor Ignition (DI) system receives supply voltage from the system relay through CKT 902 to the ignition coil gray connector "B". Inside the ignition coil, the gray connector terminal "B" is connected to the black connector terminal "B." Supply voltage is delivered from the ignition coil black connector terminal "B" to the distributor Ignition Control (IC) module "+" terminal through CKT 3.

Inside the distributor, the pick-up coil and pole piece will produce a voltage signal for cylinder spark. The voltage signals are processed in the IC module and sent to the ECM. The ECM will decide if the engine is in the cranking or running mode and adjust timing accordingly. The voltages or signals are sent between the ECM and the IC module through CKT's 423, 430, and 424. CKT 453 is the ground circuit.

The IC module will send the voltage signal to the ignition coil black connector terminal "A" through CKT 121. The signal will trigger the coil creating secondary spark to be produced. This secondary spark is sent to the distributor by a high tension lead.

Chart A-7 (2 of 6): Ignition System Check

MEFI 3 (EXCEPT BLACK SCORPION)



CIRCUIT DESCRIPTION MEFI 3:

The Distributor Ignition (DI) system receives supply voltage from the system relay through CKT 902 to the ignition coil positive (+) connector.

Inside the distributor, the pick-up sensor will produce a voltage signal for cylinder spark. The voltage signals are processed in the ECM. The ECM will decide if the engine is in the cranking or running mode and adjust timing accordingly.

The ECM will send a signal to the ignition coil negative (-) terminal through CKT 121. The signal will trigger the coil creating secondary spark to be produced. This secondary spark is sent to the distributor by a high tension lead.

Chart A-7 (3 of 6): Ignition System Check

DIAGNOSTIC AIDS:

An intermittent may be caused by a poor connection, rubbed through wire insulation or a wire broken inside the insulation. Check for the following items:

- Poor connection or damaged harness. Inspect the ECM harness and connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wire connection, and damaged harness
- The “tach” needs to be disconnected while testing the ignition system. You will also need a place to check coil trigger voltage. By disconnecting the 5-way or 6-way harness connector, you will get test terminals to check coil trigger voltage as needed in several steps. After “tach” is disconnected, try starting the engine. If the engine starts, check for a short to ground in the boat tach circuit.
- Check all terminal connections at distributor, ignition module, and ignition coil. Is the battery OK? Is the distributor clamping screw tight?

Chart A-7 (4 of 6): Ignition System Check

Step	Action	Yes	No
		PROCEED TO	
1.	<i>Was the "On-Board Diagnostic" (OBD) System Check Performed?</i>	Step 2.	OBD
2.	a. Check spark plug wires for open circuits, cracks in insulation, or improper seating of terminals at spark plugs, distributor cap, and coil tower before proceeding with this table. b. Disconnect 5-way or 6-way harness connectors. c. Install a temporary jumper wire between CKT 3 and the purple ignition lead in the harness connectors. d. Attempt to start engine and check for secondary spark. If there is "no spark" at one wire, check a few more wires. A few sparks and then nothing is considered "no spark." <i>Is Adequate Spark Present?</i>	Step 23.	Step 3.
3.	Remove distributor cap and verify rotation of distributor rotor. <i>Is The Distributor Rotor Turning?</i>	Step 4.	Step 22.
4.	<i>Do you have a MEFI 3 ECM and a distributor with a two-wire connection?</i>	Step 24.	Step 5.
5.	a. Disconnect distributor 4-wire connector. b. Check for secondary spark. <i>Is Adequate Spark Present?</i>	Step 17.	Step 6.
6.	a. Reconnect distributor 4-wire connector. b. Check for secondary spark from the coil tower using a known good coil wire. <i>Is Adequate Spark Present?</i>	Step 18.	Step 7.
7.	a. Disconnect distributor 2-wire connector. b. Ignition ON, engine OFF. c. Using DVOM, check voltage at both terminals. <i>Is Voltage Reading Greater Than 10 Volts?</i>	Step 8.	Step 19.
8.	a. Reconnect distributor 2-wire connector. b. Ignition ON engine OFF. c. Using DVOM, check voltage from CKT 121 tach terminal to ground. <i>Is Voltage Reading Greater Than 10 Volts?</i>	Step 9.	Step 14.
9.	a. Using a test light connected to ground , probe CKT 121 tach terminal at the 5-way or 6-way harness connector. b. Observe the test light while cranking engine. <i>Is Test Light Blinking?</i>	Step 12.	Step 10.

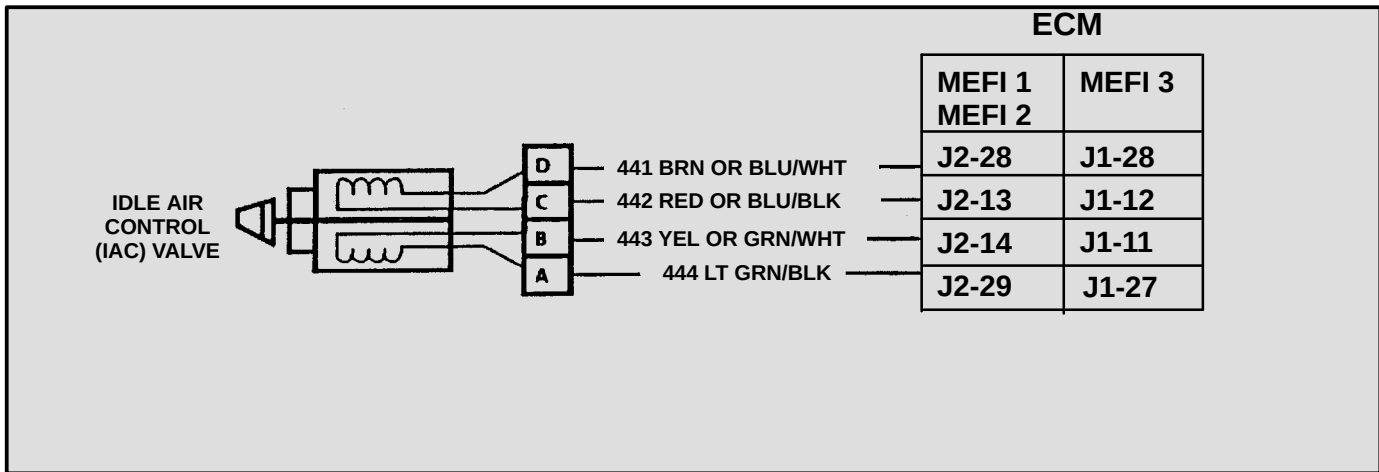
Chart A-7 (5 of 6): Ignition System Check

Step	Action	Yes	No
		PROCEED TO	
10.	a. Disconnect distributor 4-wire connector. b. Remove distributor cap. c. Disconnect pick-up coil connector from the distributor ignition control module. d. Connect DVOM to CKT 121 tach terminal at the 5-way or 6-way harness connector and ground. e. Ignition ON, engine OFF. f. Connect positive (+) end of a known good 1.5 volt test battery to the "P" terminal on the distributor ignition control module. Observe the voltage at the tach terminal as the negative (-) end of the test battery is momentarily grounded to a known good ground. Does The Voltage Drop?	Step 11.	Step 20.
11.	Check for spark from the coil wire as the test battery lead is removed? Is Adequate Spark Present?	Step 16.	Step 12.
12.	Replace ignition coil and recheck for spark using Steps 10. and 11. Is Adequate Spark Present?	Step 13.	—
13.	Reinstall coil and check coil wire from distributor cap. If OK, replace ignition module.	Verify Repair	—
14.	Check for faulty connections or open tach lead. If OK, replace ignition module and recheck for spark using Steps 10. and 11. Is Adequate Spark Present?		Step 15.
15.	Replace ignition coil.		—
16.	Is the rotating pole piece still magnetized?	Step 17.	Step 21.
17.	Replace faulty pick-up coil.	Verify Repair	—
18.	Inspect distributor cap for water, cracks, etc. If OK, replace faulty distributor rotor.		
19.	Check for open or short to ground in CKT 3, open CKT 902, open or short to ground in CKT 121. If OK, replace faulty ignition coil.		
20.	Check ignition module ground. If OK, replace faulty ignition module.		
21.	Replace distributor pole piece and shaft assembly.		
22.	A mechanical repair will be necessary before continuing with this test.		
23.	Locate and repair intermittent faulty connections.		

Chart A-7 (6 of 6): Ignition System Check

Step	Action	Yes	No
		PROCEED TO	
24.	With key in RUN position, measure voltage at positive (+) terminal on ignition coil. Is Voltage Greater Than 10 Volts?	Step 25.	Chart A-6
25.	Unplug WHT/RED bullet connectors from distributor and measure voltage on CKT 439 from harness. Is Voltage Greater Than 10 Volts?	Step 26.	Step 28.
26.	a. Reconnect WHT/RED bullet connectors. b. Remove high tension lead from distributor at coil. c. Insert a spark gap tester from coil tower to ground. d. Disconnect WHT/GRN lead from distributor. e. Ignition ON. f. Rapidly (2 – 3 times per second) strike the terminal of the PPL/WHT lead from the harness against ground (–). Is There Spark at Coil?	Step 29.	Step 27.
27.	a. Substitute a new ignition coil. b. Repeat above test. Is There Spark at Coil?	Step 30.	Step 31.
28.	Check IGN / INJ fuse. Is Fuse Good?	Step 32.	Step 33.
29.	Replace ignition sensor in distributor.	Verify Repair	–
30.	Install new ignition coil.		
31.	Repair CKT 430.		
32.	Repair open CKT 439 to distributor.		
33.	Replace fuse.		

Chart A-8 (1 of 2): Idle Air Control (IAC) Functional Test



CIRCUIT DESCRIPTION:

The ECM controls idle speed to a calibrated "desired" rpm based on sensor inputs and actual engine rpm. The ECM uses four (4) circuits to move the Idle Air Control (IAC) valve. The movement of the IAC valve varies the amount of air flow bypassing the throttle plates. The ECM controls idle speed by determining the position of the IAC valve.

DIAGNOSTIC AIDS:

An intermittent may be caused by a poor connection, rubbed through wire insulation or a wire broken inside the insulation. Check for the following items:

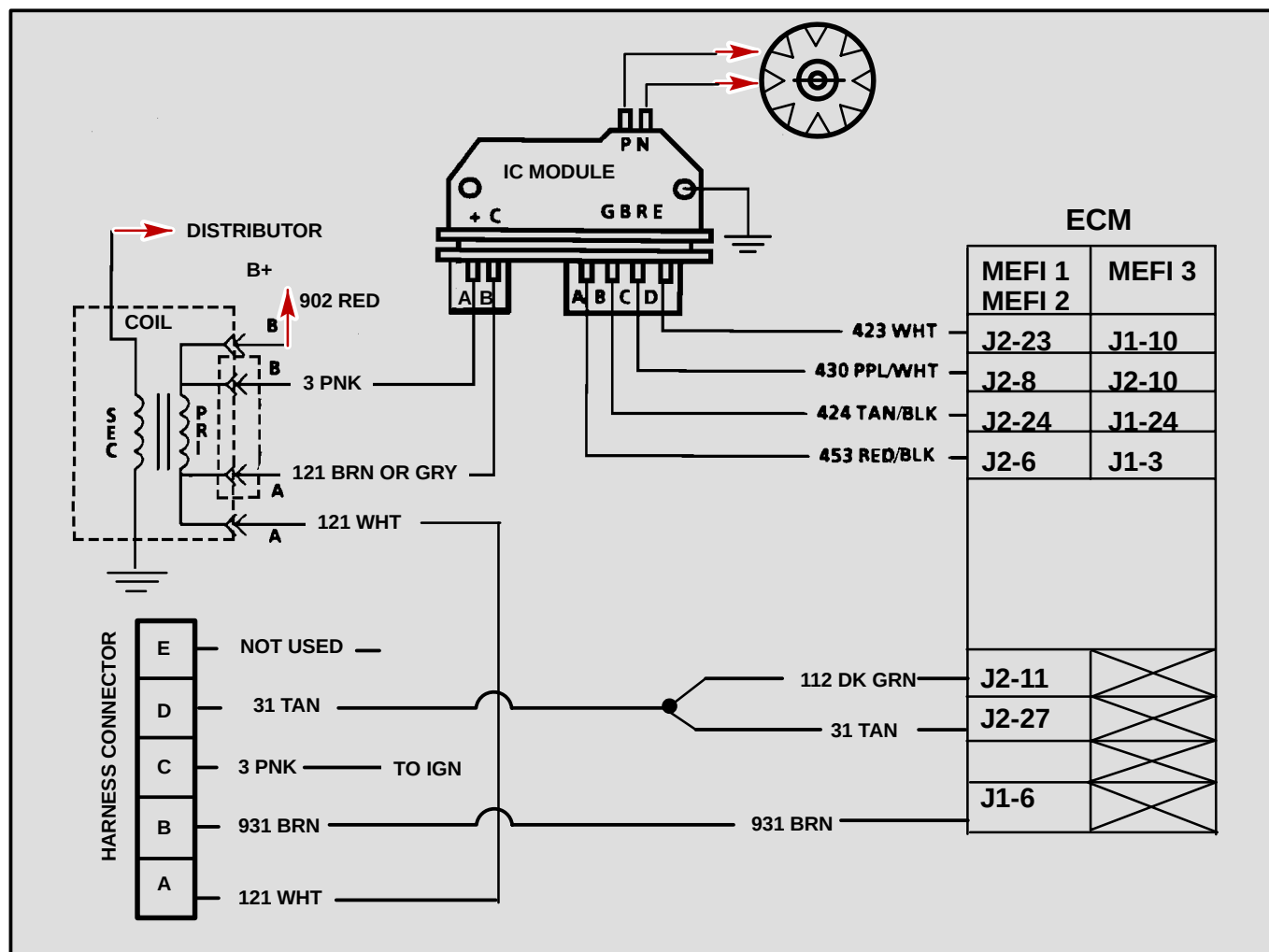
- Poor connection or damaged harness. Inspect the ECM harness and connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wire connection, and damaged harness.
- Check for vacuum leaks, disconnected or brittle vacuum hoses, cuts, etc. Examine manifold and throttle body gaskets for proper seal. Check for cracked intake manifold.
- Check for poor connections, opens, or short to grounds in CKT's 441, 442, 443, and 444. This may result in improper idle control.
- An IAC valve which is "frozen" and will not respond to the ECM, a throttle stop screw which has been tampered with, or a damaged throttle body or linkage may cause improper idle.

Chart A-8 (2 of 2): Idle Air Control (IAC) Functional Test

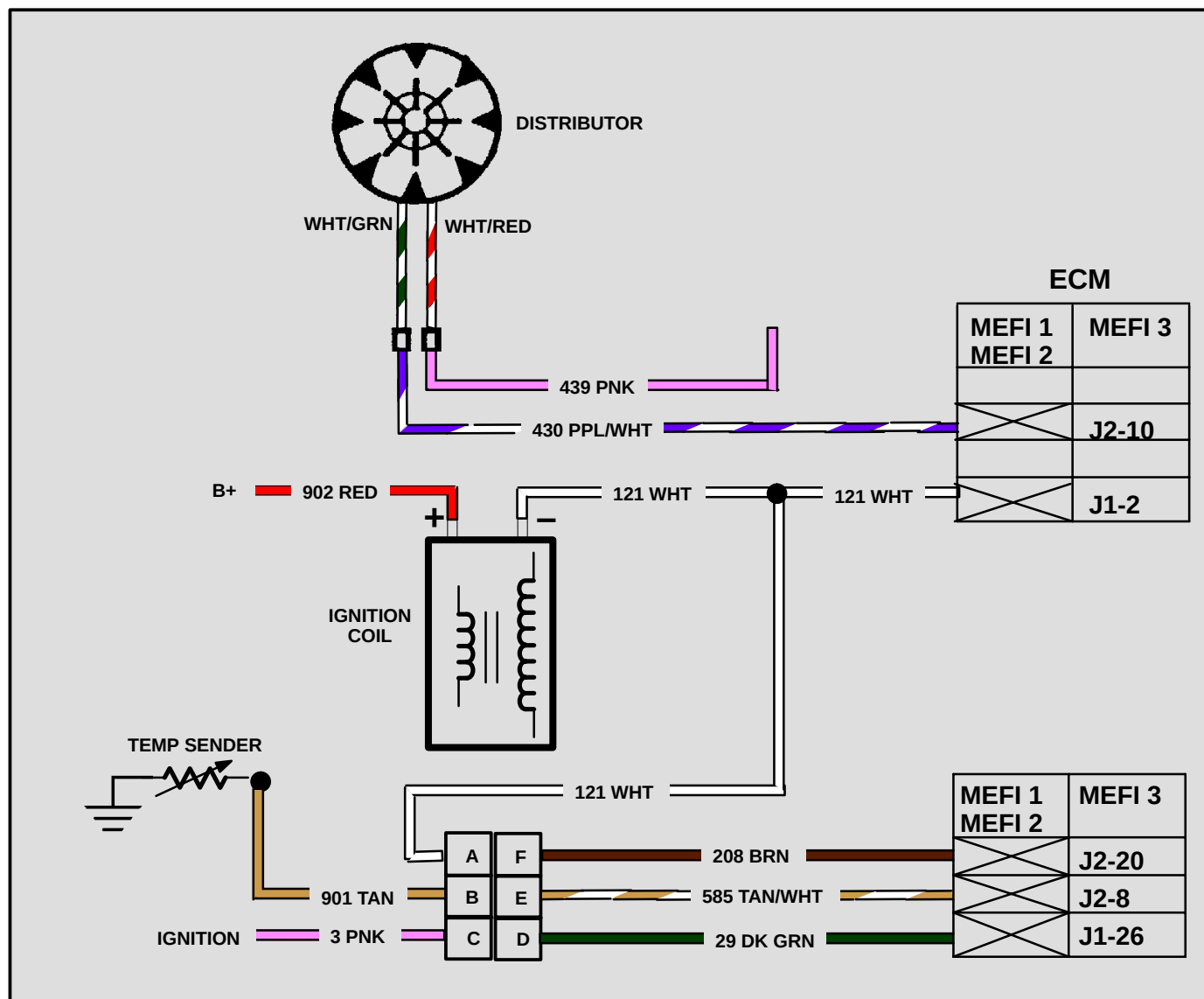
Step	Action	Yes	No
		PROCEED TO	
1.	<i>Was the “On-Board Diagnostic” (OBD) System Check Performed?</i>	Step 2.	OBD
2.	a. Engine should be at normal operating temperature. b. Start engine and allow idle to stabilize. c. Record rpm. d. Ignition OFF for 10 seconds. e. Disconnect IAC harness connector. f. Restart engine and record rpm. <i>Is rpm Higher Than The First Recorded rpm By More Than 200 rpm?</i>	Step 3.	Step 4.
3.	a. Reinstall IAC harness connector. b. Idle speed should gradually return within 75 rpm of the original recorded rpm within 30 seconds. <i>Does rpm Return To Original Recorded rpm?</i>	Step 5.	Step 4.
4.	a. Ignition OFF for 10 seconds. b. Disconnect IAC harness connector. c. Restart engine. d. Using a test light connected to ground, probe each one of the four IAC harness terminals. <i>Does The Test Light Blink On All Four Terminals?</i>	Step 7.	Step 6.
5.	IAC circuit is functioning properly.	—	—
6.	Locate and repair poor connection, open, or short to ground in the IAC circuit that did not blink or repair faulty ECM connections	Verify Repair	
7.	Check for poor IAC connections or replace the faulty IAC valve.		

Discrete Input Circuit Check - Non-Scan Only (1 of 5)

MEFI 1, MEFI 2 AND BLACK SCORPION MEFI 3



MEFI 3 (EXCEPT BLACK SCORPION)



CIRCUIT DESCRIPTION:

Several discrete switch inputs are utilized by the fuel injection system to identify abnormal conditions that may affect engine operation. A pull-up switch is currently used in conjunction with the ECM to detect critical conditions to engine operation.

If a discrete switch changes states from its normal at-rest position, that is normally open to closed (or closed to open), the ECM senses a change in voltage and responds by activating the audio warning system.

DIAGNOSTIC AIDS:

- Check engine oil and gear lube levels. Check transmission fluid for overheat condition.

An intermittent problem may be caused by a poor or corroded connection, rubbed through wire connection, or a wire that is broken inside the insulation.

Discrete Input Circuit Check(2 of 5)

NOTE: The ECM should only be replaced after all switches and circuits have been tested and found to be functioning properly.

TESTING BUZZER

Step	Action	Yes	No
		PROCEED TO	
1.	Key ON, Engine OFF. Does buzzer sound?	Step 2.	OBD
2.	Start engine. Does buzzer sound?	Step 3.	Step 6.
3.	a. Disconnect TAN/BLU or BLU wire at buzzer. b. Key ON, Engine OFF. c. Touch TAN/BLU or BLU wire to ground (–). Does buzzer sound?	Step 4.	Step 5.
4.	Buzzer is working properly. Proceed to “Testing Switches” or “Testing Circuits.”	–	–
5.	Ensure that there is battery power (+) to the PUR wire going to buzzer. If there is, replace buzzer.	Verify Repair.	–
6.	Discrete switches may all be functioning properly. Proceed to check all discrete circuits to verify each works properly.	Verify Repair.	–

TESTING OIL PRESSURE SWITCH

Step	Action	Yes	No
		PROCEED TO	
1.	a. Disconnect MEFI 1 or MEFI 2 BLU/TAN or MEFI 3 BLU wire from oil pressure switch. b. Engine OFF. c. Check for continuity between terminal on switch and ground (–). Is there continuity?	Step 2.	Step 3.
2.	a. Start engine. b. Check for continuity between terminal on switch and ground (–). Is there continuity?	Step 3.	Switch OK
3.	Replace oil pressure switch.	Verify Repair.	–

Discrete Input Circuit Check (3 of 5)

TESTING GEAR LUBE MONITOR SWITCH

Step	Action	Yes	No
		PROCEED TO	
1.	a. Disconnect BLU/TAN or TAN/WHT wire from gear lube monitor. b. Empty gear lube from monitor. c. Check for continuity between TAN/BLU wire and ground (-). Is there continuity?	Step 2.	Step 3.
2.	a. Refill gear lube monitor. b. Check for continuity between TAN/BLU wire and ground (-). Is there continuity?	Step 3.	Switch OK
3.	Replace gear lube monitor.	Verify Repair.	—

TESTING TRANSMISSION TEMPERATURE SWITCH

Step	Action	Yes	No
		PROCEED TO	
1.	a. Disconnect BLU/TAN and BLK wires from transmission temperature switch. b. Ensure switch is at a cool temperature (less than normal operating temperature). c. Check for continuity between both terminals. Is there continuity?	Step 2.	Step 3.
2.	a. Heat the switch to a temperature high enough to activate it. (Refer to SECTION 4D of this manual for procedure). b. Check for continuity between both terminals. Is there continuity?	Step 3.	Switch OK
3.	Replace transmission temperature switch.	Verify Repair.	—

Discrete Input Circuit Check (4 of 5)

TESTING CIRCUITS FOR SHORT-TO-GROUND (–)

Step	Action	Yes	No
		PROCEED TO	
1.	a. Disconnect BLU/TAN or BLU wire from oil pressure switch. b. Disconnect BLU/TAN or TAN/WHT wire from gear lube monitor. c. Disconnect BLU/TAN wire from transmission temperature switch (if equipped). d. Key ON, engine OFF. Does audio warning buzzer sound?	Step 2.	Step 3.
2.	a. Key OFF. b. Disconnect ECM connectors. c. Check for continuity between all wires disconnected in Step 1. and engine ground (–). Is there continuity on MEFI 1 or MEFI 2 BLU/TAN or MEFI 3 BLU wire from oil pressure switch? Is there continuity on MEFI 1 or MEFI 2 BLU/TAN or MEFI 3 TAN/WHT wire from gear lube switch? Is there continuity on BLU/TAN wire from transmission switch?	Step 4.	Step 3.
3.	Circuit(s) is not shorted to ground (–). Check switches.	–	–
4.	Repair short-to-ground (–) in affected circuit.	–	–

Discrete Input Circuit Check (5 of 5)

TESTING FOR OPEN CIRCUITS

Step	Action	Yes	No
		PROCEED TO	
1.	a. Disconnect BLU/TAN or BLU wire from oil pressure switch. b. Disconnect BLU/TAN or TAN/WHT wire from gear lube monitor. c. Disconnect BLU/TAN wire from transmission temperature switch (if equipped). d. Key ON, engine OFF. e. One at a time, touch each wire to ground (–) that was disconnected. <i>Does audio warning buzzer sound when grounding MEFI 1 or MEFI 2 BLU/TAN or MEFI 3 BLU wire from oil pressure switch?</i> <i>Does audio warning buzzer sound when grounding MEFI 1 or MEFI 2 BLU/TAN or MEFI 3 TAN/WHT wire from gear lube switch?</i> <i>Does audio warning buzzer sound when grounding BLU/TAN wire from transmission switch?</i>	Step 3.	Step 2.
2.	a. Key OFF. b. Disconnect ECM connectors. <i>Is there continuity on MEFI 1 or MEFI 2 BLU/TAN or MEFI 3 BLU wire from oil pressure switch to ECM CKT?</i> <i>Is there continuity on MEFI 1 or MEFI 2 BLU/TAN or MEFI 3 TAN/WHT wire from gear lube switch to ECM CKT?</i> <i>Is there continuity on BLU/TAN wire from transmission switch to ECM CKT?</i>	Step 3.	Step 4.
3.	Circuit(s) is not open.	–	–
4.	Repair open circuit.	–	–

Clearing Trouble Codes

Clearing Codes Using CodeMate Tester

NOTE: When clearing codes without the use of a scan tool, the battery must be fully charged. The ability to clear codes is directly dependent on the battery being fully charged and able to start the engine with adequate cranking rpm.

1. Install diagnostic CodeMate Tester.
2. Turn key ON.
3. Select "Service Mode" on CodeMate Tester.
4. To clear codes, move the throttle, while in NEUTRAL, from 0% to 100% then back to 0%.
5. Exit "Service Mode" on CodeMate Tester.
6. Start engine and let run for fifteen seconds.
7. Turn key OFF for 5 seconds.
8. Select "Service Mode" on CodeMate Tester.
9. Turn key ON and read codes. If codes are still present, check preceding "Note" and repeat from Step 1.
10. Refer to appropriate Troubleshooting and/or Diagnostic Charts.

A poorly charged battery or engine cranking problem may result in an ECM "reset" and may not allow stored trouble codes to be cleared from EEPROM memory. If this condition exists, BE SURE the battery is fully charged.

NOTE: If a low battery condition does exist the audio warning buzzer will come on for 2 seconds (as a result of an ECM reset) after engine start-up.

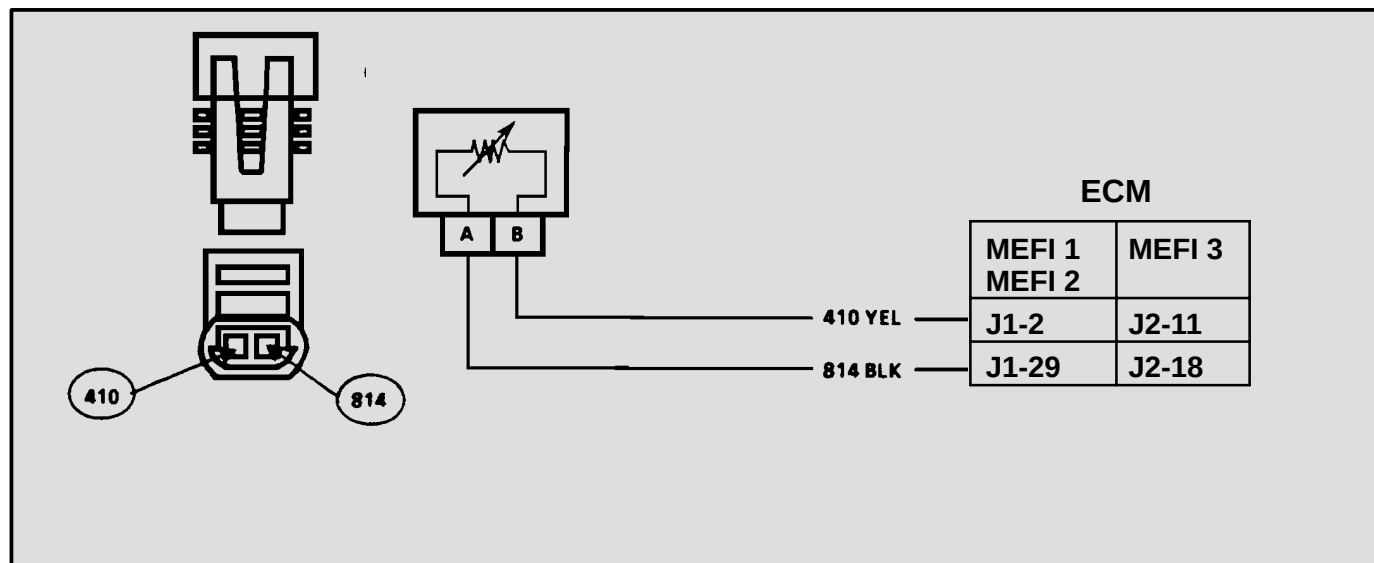
Clearing Codes Using Scan Tool

IMPORTANT: All references to Scan Tool work with either the Quicksilver Digital Diagnostic Tool or the Rinda Scan Tool.

1. Connect scan tool.
2. Start engine.
3. Select clear codes function.
4. Clear codes.
5. Turn key OFF.
6. Turn key ON and read codes. If codes are still present, there is a real fault in system. Refer to appropriate Troubleshooting and/or Diagnostic Charts.

Diagnostic Testing

Code 14 (1 of 3): Engine Coolant Temperature (ECT) Sensor Circuit



CIRCUIT DESCRIPTION:

The Engine Coolant Temperature (ECT) Sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage on CKT 410 to the sensor. When the engine coolant is cold, the sensor (thermistor) resistance is high. Therefore, the ECM will see high signal voltage. As the engine coolant warms, the sensor resistance becomes less and the voltage drops.

DIAGNOSTIC AIDS:

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage. If the harness appears to be OK, observe the ECT display on the scan tool while moving connectors and wiring harnesses related to the ECT sensor. A change in the ECT display will indicate the location of the fault.
- A scan tool displays engine coolant temperature in degrees celsius and fahrenheit. If the engine is cold (not running within 8 hours), the scan tool should display a ECT sensor value within a few degrees of outside air temperature. This may help aid in diagnosing a "shifted" coolant sensor. After engine is started, the temperature should rise steadily and then stabilize at operating temperature when the thermostat opens.
- Check harness routing for a potential short to ground in CKT 410.

After repairs, clear DTC following "Clearing Trouble Codes" procedure at the front of this section. Failure to do so may result in DTC not properly being cleared.

Code 14 (2 of 3): Engine Coolant Temperature (ECT) Sensor Circuit

Step	Action	Yes	No
		PROCEED TO	
1.	Was the "On-Board Diagnostic" (OBD) System Check Performed?	Step 2.	OBD
2.	Are you using a Scan Tool?	Step 3.	Step 8.
3.	a. Ignition ON. Does scan tool display a coolant temperature value greater than 266° F (130° C) or less than -22° F (-30° C)?	Step 4.	Step 5.
4.	Does scan tool display a coolant temperature value greater than 266° F (130° C)?	Step 6.	Step 7.
5.	Code 14 is intermittent. If no additional codes were stored, refer to "Diagnostic Aids."	—	—
6.	a. Ignition OFF. b. Disconnect ECT sensor. c. Ignition ON. Does scan tool display coolant temperature below -22° F (-30° C).	Step 12.	Step 14.
7.	a. Ignition OFF. b. Disconnect ECT sensor. c. Jumper terminals "A" and "B" together. d. Ignition ON. Does scan tool display coolant temperature above 266° F (130° C).	Step 12.	Step 15.
8.	NOTE: Following steps do not require a Scan Tool. a. Ignition OFF. b. Disconnect ECT sensor connector. c. Ignition ON, engine OFF. d. Connect DVOM across coolant sensor harness terminals. Is voltage above 4 volts?	Step 12.	Step 9.
9.	a. Connect positive DVOM lead from harness terminal "B" CKT 410 (5 volt reference). b. Connect negative DVOM lead to a good ground (–) on engine. Is voltage above 4 volts?	Step 16.	Step 10.

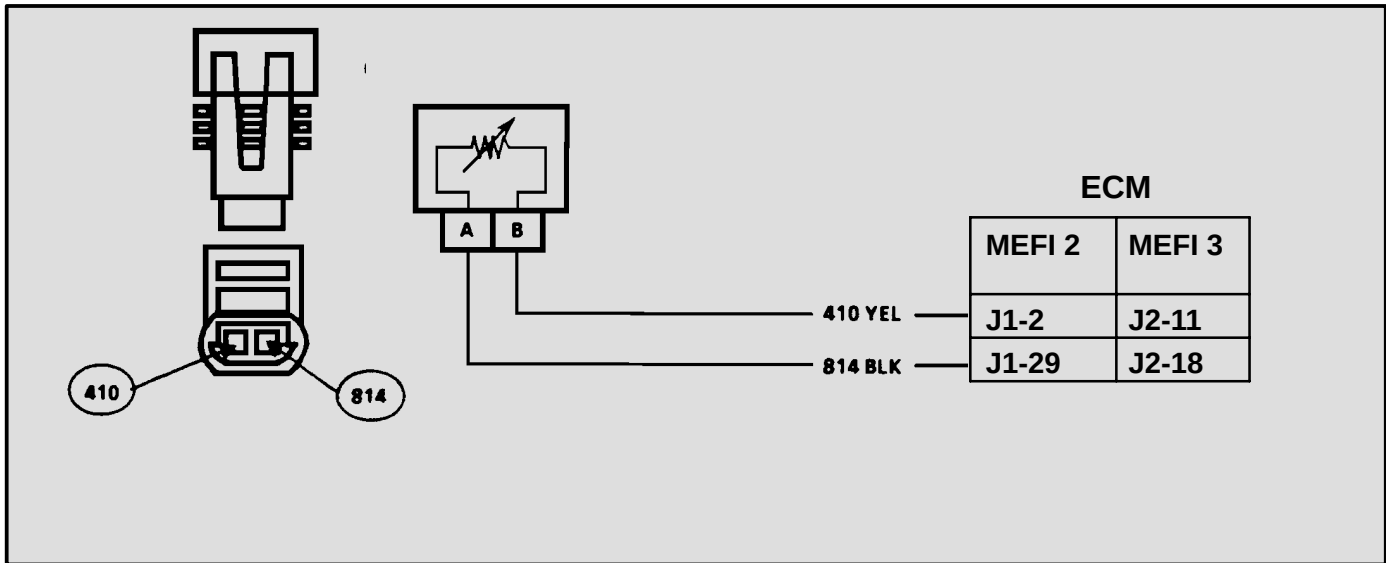
Code 14 (3 of 3): Engine Coolant Temperature (ECT) Sensor Circuit

Step	Action	Yes	No
		PROCEED TO	
10.	a. Remove DVOM. b. Ignition ON. c. Connect a test light to battery positive (B+). d. Touch test light to sensor harness terminal "B" CKT 410. Is test light on?	Step 13.	Step 11.
11.	Locate and repair open in CKT 410 or faulty connection at ECM.	—	—
12.	Locate and repair Intermittent connections or replace faulty ECT sensor (refer to chart below for sensor values).	—	—
13.	For MEFI 1 and 2, disconnect J-1 connector. For MEFI 3, disconnect J-2 connector. Is test light on?	Step 14.	Step 15.
14.	CKT 410 shorted to ground. Locate and repair short.	—	—
15.	CKT 410 shorted to sensor ground or faulty ground. Locate and repair.	—	—
16.	Locate and repair open sensor ground in CKT 814 or faulty connection at ECM.	—	—

ENGINE COOLANT TEMPERATURE SENSOR CHART

ECT Sensor		
Temperature - to - Resistance Values (Approximate)		
°F	°C	OHMS
210	100	185
160	70	450
100	38	1,800
70	20	3,400
40	4	7,500
20	-7	13,500
0	-18	25,000
-40	-40	100,700

Code 15 (1 of 2): Engine Coolant Temperature (ECT) Sensor Circuit



CIRCUIT DESCRIPTION:

The Engine Coolant Temperature (ECT) Sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage on CKT 410 to the sensor. When the engine coolant is cold, the sensor (thermistor) resistance is high, therefore, the ECM will see high signal voltage. As the engine coolant warms, the sensor resistance becomes less, and the voltage drops.

DIAGNOSTIC AIDS:

Check for the following conditions:

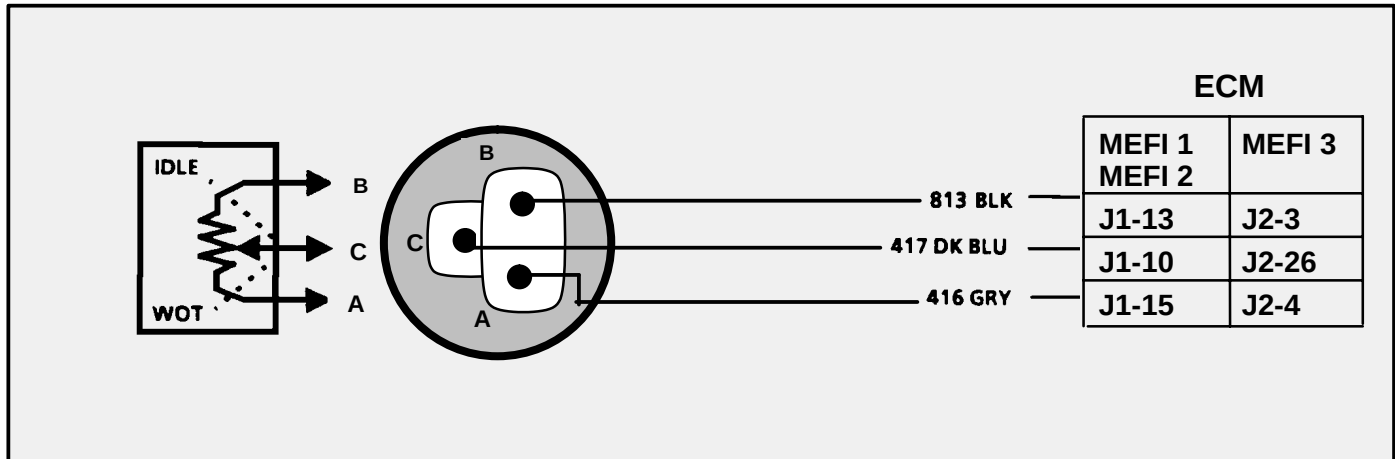
- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage. If the harness appears to be OK, observe the ECT display on the scan tool while moving connectors and wiring harnesses related to the ECT sensor. A change in the ECT display will indicate the location of the fault.
- A scan tool displays engine coolant temperature in degrees celsius and fahrenheit. If the engine is cold (not running within 8 hours), the scan tool should display a ECT sensor value within a few degrees of outside air temperature. After engine is started, the temperature should rise steadily and then stabilize at operating temperature when the thermostat opens.
- Check harness routing for a potential short to ground in CKT 410.

After repairs, clear DTC following "Clearing Trouble Codes" procedure at the front of this section. Failure to do so may result in DTC not properly being cleared.

Code 15 (2 of 2): Engine Coolant Temperature (ECT) Sensor Circuit

Step	Action	Yes	No
		PROCEED TO	
1.	Was the "On-Board Diagnostic" (OBD) System Check Performed?	Step 2.	OBD
2.	Are you using a Scan Tool?	Step 3.	Step 5.
3.	Ignition ON. Does the scan tool display a coolant temperature greater than 266°F (130°C)?	Step 4.	Step 6.
4.	a. Ignition OFF. b. Disconnect ECT harness connector. c. Ignition ON, engine OFF. Does scan tool display a coolant temperature below -22°F (-30°C)?	Step 6.	Step 7.
5.	a. Ignition OFF. b. Disconnect ECT sensor harness terminals. c. Ignition ON, engine OFF. d. Connect DVOM across the coolant sensor harness terminals. Is voltage above 4 Volts?	Step 6.	Step 7.
6.	Locate and repair intermittent faulty connections or replace faulty ECT sensor.	Verify Repair	—
7.	Locate and repair short to ground in CKT 410 or repair faulty ECM connections. Was a problem found?		

Code 21 (1 of 3): Throttle Position (TP) Sensor Circuit



CIRCUIT DESCRIPTION:

The Throttle Position (TP) Sensor provides a voltage signal that changes as throttle blades open or close. Signal voltage should vary from about .5 volts at idle to about 4.5 volts at Wide Open Throttle (WOT).

The TP signal is one of the most important inputs used by the Electronic Control Module (ECM) for fuel control and for most of the ECM controlled outputs.

DIAGNOSTIC AIDS:

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage. If the harness appears to be OK, observe the TP sensor display on the scan tool while moving connectors and wiring harnesses related to the TP sensor. A change in the TP sensor display will indicate the location of the fault.
- The scan tool reads throttle position in voltage and percentage relative to the throttle blade opening. With ignition ON, engine OFF, throttle blades closed (idle), the voltage should be 0.3-0.8 volts. The voltage should steadily increase as the throttle is moved toward Wide Open Throttle (WOT).
- If DTC 34 is also set, check for a short to ground in CKT 416.

After repairs, clear DTC following "Clearing Trouble Codes" procedure at the front of this section. Failure to do so may result in DTC not properly being cleared.

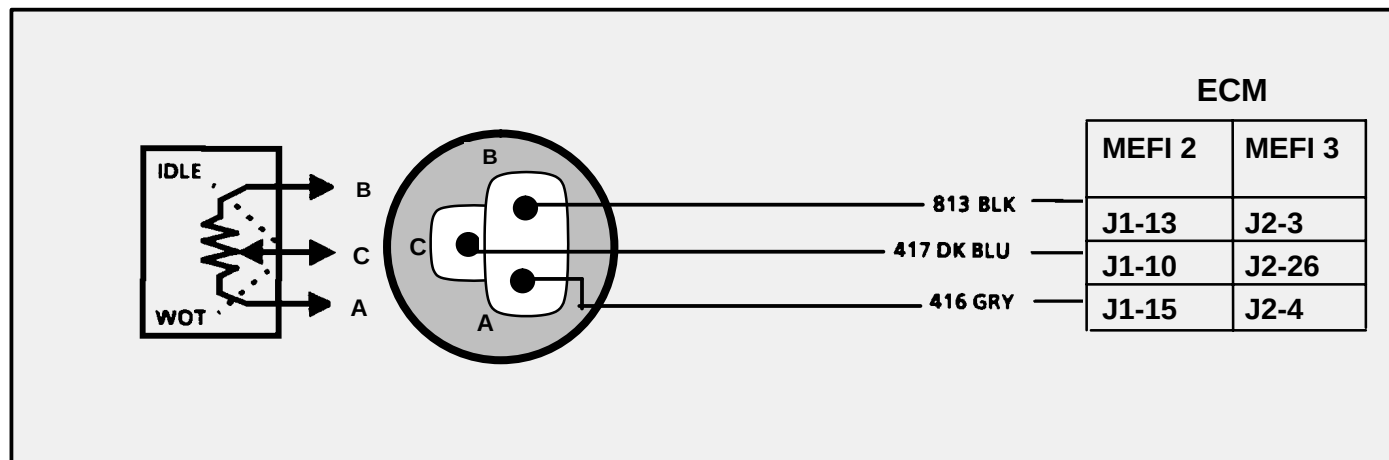
Code 21 (2 of 3): Throttle Position (TP) Sensor Circuit

Step	Action	Yes	No
		PROCEED TO	
1.	<i>Was the "On-Board Diagnostic" (OBD) System Check Performed?</i>	Step 2.	OBD
2.	<i>Are you using a Scan Tool?</i>	Step 3.	Step 7.
3.	a. Throttle closed. b. Ignition ON. <i>Does scan tool indicate throttle position sensor voltage <u>greater</u> than 4 volts?</i>	Step 6.	Step 4.
	<i>Does scan tool indicate throttle position sensor voltage <u>less</u> than .3 volts?</i>	Step 5.	Step 4.
4.	Code 21 is intermittent, refer to "Diagnostic Aids" on facing page.	—	—
5.	a. Ignition OFF. b. Disconnect throttle position sensor electrical connector. Jumper throttle position sensor harness terminals "A" and "C" together. c. Ignition ON <i>Does scan tool indicate throttle position sensor voltage <u>greater</u> than 4 volts?</i>	Step 15.	Step 7.
6.	a. Ignition OFF. b. Disconnect throttle position sensor connector. c. Ignition ON. <i>Does scan tool indicate voltage over 4 volts?</i>	Step 13.	Step 7.
7.	a. Ignition OFF. b. Disconnect throttle position sensor harness connector. c. Ignition ON. d. Connect DVOM from harness terminal "A" (5 volt reference to harness terminal "B" (sensor ground). <i>Is voltage reading over 4 volts?</i>	Step 8.	Step 11.
8.	Connect DVOM from harness terminal "A" (CKT 416) to harness terminal "C" (throttle position sensor signal, CKT 417). <i>Is voltage reading over 4 volts?</i>	Step 9.	Step 10.

Code 21 (3 of 3): Throttle Position (TP) Sensor Circuit

Step	Action	Yes	No
		PROCEED TO	
9.	a. Ignition OFF. b. Connect a test light to battery positive (B+). c. Touch test light to harness terminal "C" (throttle position sensor signal). <i>Is test light on?</i>	Step 12.	Step 15.
10.	Connect DVOM between harness terminal "C" and engine ground (-). <i>Is voltage reading over 4 volts?</i>	Step 13.	Step 14.
11.	Connect DVOM from throttle position sensor harness terminal "A" to a good ground on engine. <i>Is voltage reading over 4 volts?</i>	Step 18.	Step 17.
12.	a. Disconnect ECM. b. Touch test light to harness terminal "C" (throttle position sensor signal). <i>Is test light on?</i>	Step 16.	Step 14.
13.	Check for CKT 417 shorted to voltage.	—	—
14.	Locate and repair open in CKT 417 or faulty connection at ECM.	—	—
15.	Replace throttle position sensor.	—	—
16.	Check for CKT 417 shorted to ground.	—	—
17.	CKT 416 open or shorted to ground or faulty connection at ECM.	—	—
18.	CKT 813 open faulty connection at ECM.	—	—

Code 22 (1 of 3): Throttle Position (TP) Sensor Circuit



CIRCUIT DESCRIPTION:

The Throttle Position (TP) Sensor provides a voltage signal that changes as throttle blades open or close. Signal voltage should vary from about .5 volts at idle to about 4.5 volts at Wide Open Throttle (WOT).

The TP signal is one of the most important inputs used by the Electronic Control Module (ECM) for fuel control and for most of the ECM controlled outputs.

DIAGNOSTIC AIDS:

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage. If the harness appears to be OK, observe the TP sensor display on the scan tool while moving connectors and wiring harnesses related to the TP sensor. A change in the TP sensor display will indicate the location of the fault.
- The scan tool reads throttle position in voltage and percentage relative to the throttle blade opening. With ignition ON, engine OFF, throttle blades closed (idle), the voltage should be 0.3-0.8 volts. The voltage should steadily increase as the throttle is moved toward Wide Open Throttle (WOT).
- If DTC 34 is also set, check for a short to ground in CKT 416.

After repairs, clear DTC following "Clearing Trouble Codes" procedure at the front of this section. Failure to do so may result in DTC not properly being cleared.

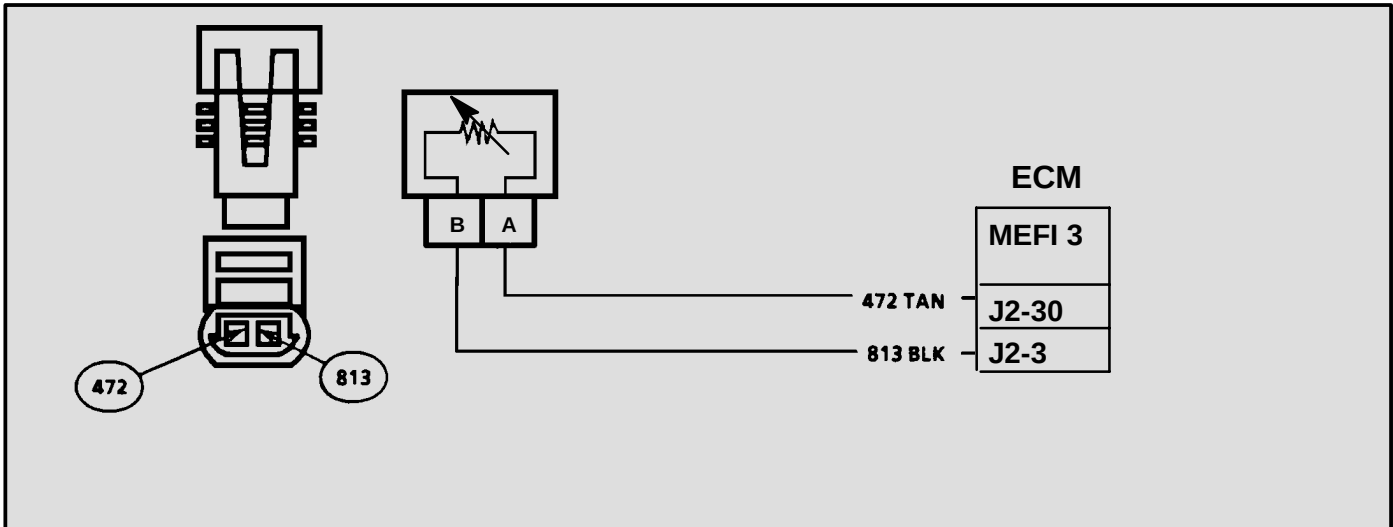
Code 22 (2 of 3): Throttle Position (TP) Sensor Circuit

Step	Action	Yes	No
		PROCEED TO	
1.	Was the "On-Board Diagnostic" (OBD) System Check Performed?	Step 2.	OBD
2.	Are you using a Scan Tool?	Step 3.	Step 7.
3.	a. Throttle closed. b. Ignition OFF. Does scan tool indicate TP sensor voltage less than .30 volt?	Step 4.	Step 6.
4.	a. Ignition OFF b. Disconnect TP sensor harness connector. c. Connect a jumper wire from harness terminal "A" CKT 416 to harness terminal "B" CKT 417. d. Ignition ON, engine OFF. Does scan tool indicate TP sensor voltage greater than 4 volts?	Step 9.	Step 5.
5.	a. Ignition OFF. b. Connect DVOM from harness terminal "A" (CKT 416) to a known good ground. Does scan tool indicate TP sensor voltage greater than the specified value?	Step 10.	Step 11.
6.	Trouble code 22 is intermittent. Locate and repair intermittent faulty connections. Refer to "Diagnostic Aids."	—	—
7.	a. Switch CodeMate Tester to the normal mode. b. Ignition OFF. c. Disconnect throttle sensor harness connector. d. Connect a jumper wire form harness terminal "A" CKT 416 to harness terminal "C" CKT 417. e. Start engine and idle for 2 minutes or until CodeMate Tester indicates a stored trouble code, whichever occurs first. f. Ignition ON, engine OFF. g. Switch CodeMate Tester to "Service Mode" and note trouble code. Is trouble code 21 present?	Step 9.	Step 10.
8.	a. Remove jumper wire from CKT 416 and CKT 417. b. Connect DVOM from harness terminal "A" CKT 416 to harness terminal "B" CKT 813. Is voltage reading above 4 volts?	Step 10.	Step 11.

Code 22 (3 of 3): Throttle Position (TP) Sensor Circuit

Step	Action	Yes	No
		PROCEED TO	
9.	Locate and repair intermittent faulty connections or replace faulty throttle position sensor.	Verify Repair	—
10.	Locate and repair open or short to ground in CKT 417 or faulty ECM connections.		—
11.	Locate and repair open or short to ground in CKT 416 or faulty ECM connections.		—

Code 23 (1 of 3): Intake Air Temperature (IAT) Sensor Circuit



CIRCUIT DESCRIPTION:

The Intake Air Temperature (IAT) Sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage on CKT 472 to the sensor. When the intake air is cold, the sensor (thermistor) resistance is high, therefore, the ECM will see high signal voltage. As the intake air warms, the sensor resistance becomes less, and the voltage drops. At normal engine operating temperature, 160-180°F (71-82°C), the voltage will measure about 1.5 to 2.0 volts.

DIAGNOSTIC AIDS:

Check for the following conditions:

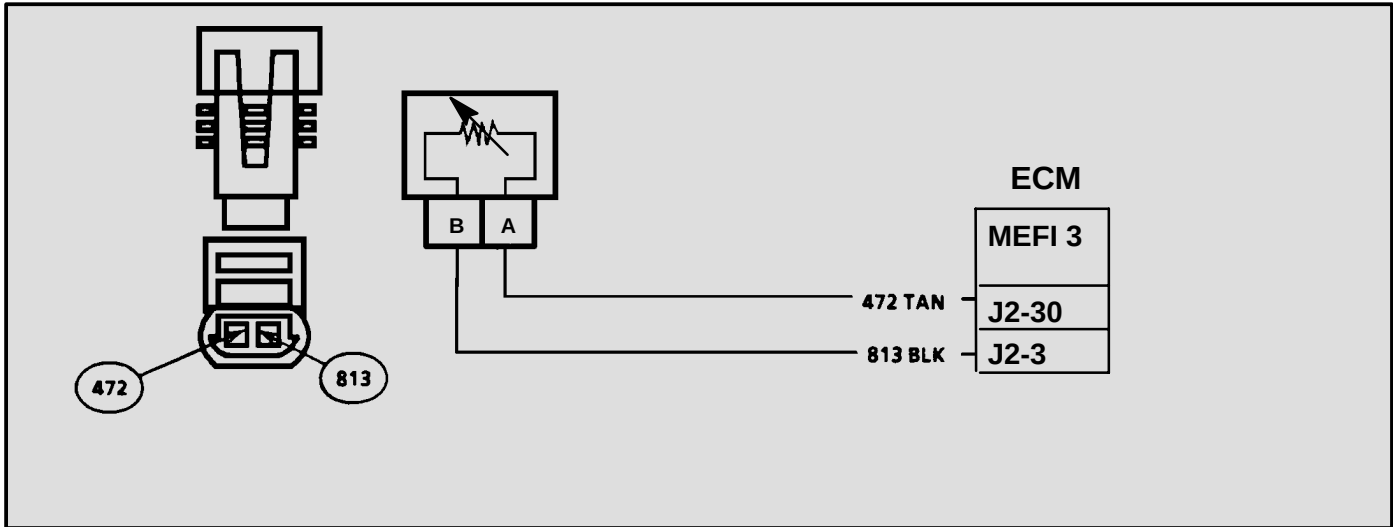
- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage. If the harness appears to be OK, observe the IAT display on the scan tool while moving connectors and wiring harnesses related to the IAT sensor. A change in the IAT display will indicate the location of the fault.
- The scan tool displays intake air temperature in degrees Celsius and Fahrenheit. If the intake air is cold (not running within 8 hours), the scan tool should display a IAT sensor value within a few degrees of outside air temperature. This may help aid in diagnosing a "shifted" sensor. After engine is started, the temperature should rise steadily and then stabilize at operating temperature.
- If DTC 21 is also set, check for open ground CKT 813.

After repairs, clear DTC following "Clearing Trouble Codes" procedure at the front of this section. Failure to do so may result in DTC not properly being cleared.

Code 23 (2 of 3): Intake Air Temperature (IAT) Sensor Circuit

Step	Action	Yes	No
		PROCEED TO	
1.	<i>Was the "On-Board Diagnostic" (OBD) System Check Performed?</i>	Step 2.	OBD
2.	<i>Are you using a Scan Tool?</i>	Step 3.	Step 7.
3.	Ignition ON <i>Does the scan tool display a temperature less than -22°F (-30°C)?</i>	Step 4.	Step 5.
4.	a. Ignition OFF b. Disconnect IAT harness connector. c. Connect a jumper wire from harness terminal "A" CKT 472 to harness terminal "B" CKT 813. d. Ignition ON, engine OFF. <i>Does scan tool display a temperature above 266°F (130°C)?</i>	Step 9.	Step 6.
5.	Trouble code 23 is intermittent. Locate and repair intermittent faulty connections.	Verify Repair	—
6.	Locate and repair open in CKT 472 or CKT 813.		
7.	a. Ignition OFF. b. Disconnect IAT sensor harness terminals. c. Ignition ON, engine OFF. 4. Connect DVOM across the sensor harness terminals. <i>Is voltage above 4 volts?</i>	Step 9.	Step 8.
8.	a. Connect positive (+) DVOM lead to harness terminal "B" CKT 472 (5 volt reference). b. Connect negative (-) DVOM lead to a known good ground. <i>Is voltage above 4 volts?</i>	Step 11.	Step 10.
9.	Locate and repair intermittent faulty connections. If OK, replace faulty IAT sensor.	Verify Repair	—
10.	Locate and repair open CKT 472 or faulty ECM connections.		—
11.	Locate and repair open ground CKT 813 or faulty ECM connections.		—

Code 25 (1 of 3): Intake Air Temperature (IAT) Sensor Circuit



CIRCUIT DESCRIPTION:

The Intake Air Temperature (IAT) Sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage on CKT 472 to the sensor. When the intake air is cold, the sensor (thermistor) resistance is high, therefore, the ECM will see high signal voltage. As the intake air warms, the sensor resistance becomes less, and the voltage drops. At normal engine operating temperature, 160-180°F (71-82°C), the voltage will measure about 1.5 to 2.0 volts.

DIAGNOSTIC AIDS:

Check for the following conditions:

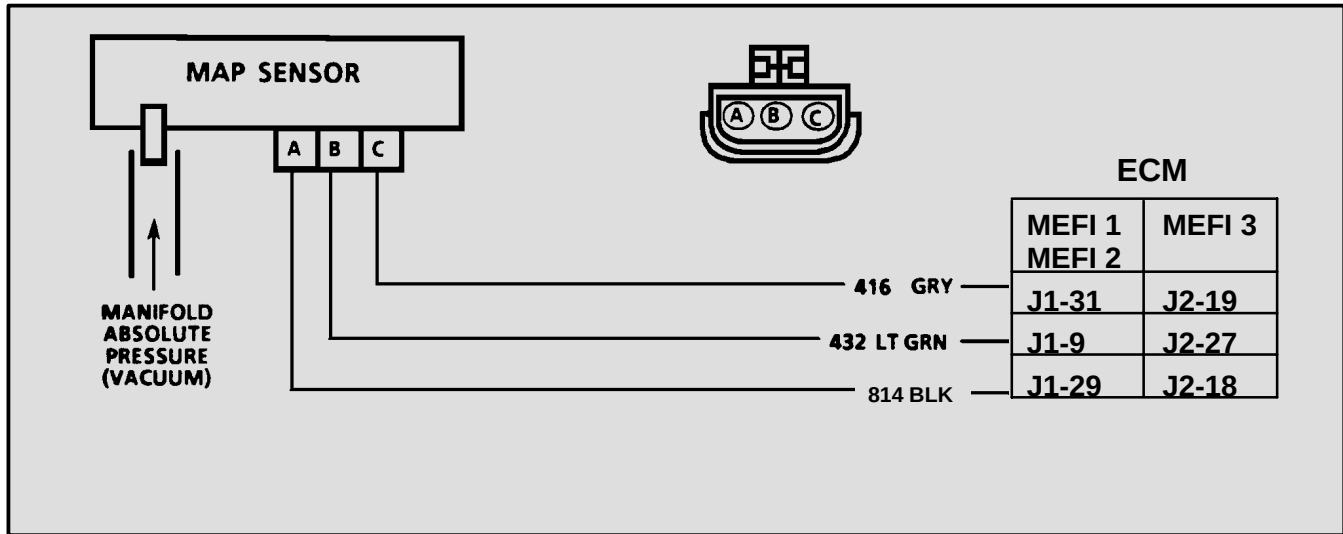
- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage. If the harness appears to be OK, observe the IAT display on the scan tool while moving connectors and wiring harnesses related to the IAT sensor. A change in the IAT display will indicate the location of the fault.
- The scan tool displays intake air temperature in degrees celsius and fahrenheit. If the engine is cold (not running within 8 hours), the scan tool should display a IAT sensor value within a few degrees of outside air temperature. This may help aid in diagnosing a "shifted" sensor. After engine is started, the temperature should rise steadily and then stabilize at operating temperature.
- Check harness routing for a potential short to ground in CKT 472.

After repairs, clear DTC following "Clearing Trouble Codes" procedure at the front of this section. Failure to do so may result in DTC not properly being cleared.

Code 25 (2 of 2): Engine Coolant Temperature (IAT) Sensor Circuit

Step	Action	Yes	No
		PROCEED TO	
1.	Was the "On-Board Diagnostic" (OBD) System Check Performed?	Step 2.	OBD
2.	Are you using a Scan Tool?	Step 3.	Step 7.
3.	Ignition ON. Does the scan tool display a temperature greater than 266°F (130°C)?	Step 4.	Step 5.
4.	a. Ignition OFF. b. Disconnect IAT harness connector. c. Ignition ON, engine OFF. Does scan tool display a temperature below -22°F (-30°C)?	Step 8.	Step 6.
5.	Trouble code 25 is intermittent. Locate and repair intermittent faulty connections. Refer to "Diagnostic Aids."	Verify Repair	—
6.	Locate and repair short to ground in CKT 472. If a problem is found, repair as necessary. Was a problem found?		Step 10.
7.	a. Ignition OFF. b. Disconnect IAT sensor harness terminals. c. Ignition ON, engine OFF. d. Connect DVOM across the sensor harness terminals. Is voltage above 4 volts?	Step 8.	Step 9.
8.	Locate and repair intermittent faulty connections or replace faulty IAT sensor.	Verify Repair	—
9.	Locate and repair short to ground in CKT 472.		Step 10.
10.	Repair faulty ECM connections.		—

Code 33 (1 of 3): Manifold Absolute Pressure (MAP) Sensor Circuit



CIRCUIT DESCRIPTION:

The Manifold Absolute Pressure (MAP) sensor responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that will vary from about 1.0-2.0 volts at idle to about 4.0-5.0 volts at Wide Open Throttle (WOT).

If the MAP sensor fails, the ECM will substitute a default MAP value that will vary with rpm.

A reference voltage of 5 volts is provided to the MAP sensor through CKT 416. CKT 814 is the ground circuit for the MAP sensor. MAP sensor CKT 432 will send a voltage signal to the ECM proportional to the manifold pressure.

DIAGNOSTIC AIDS:

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage. If the harness appears to be OK, observe the MAP sensor display on the scan tool while moving connectors and wiring harnesses related to the MAP sensor. A change in the MAP sensor display will indicate the location of the fault.
- If the idle is rough or unstable, refer to "Troubleshooting" section for items which may cause an unstable idle.
- With the ignition ON, engine OFF, the manifold pressure is equal to atmospheric pressure and the signal voltage will be high. This information is used by the ECM as an indication of altitude and is referred to as BARO. Comparison of this BARO reading, with a known good MAP sensor, is a good way to check the accuracy of a "suspect" sensor. Reading should be the same, plus or minus 0.4 volt.
- If DTC 14 is also set, check for open in ground CKT 814.

After repairs, clear DTC following "Clearing Trouble Codes" procedure at the front of this section. Failure to do so may result in DTC not properly being cleared.

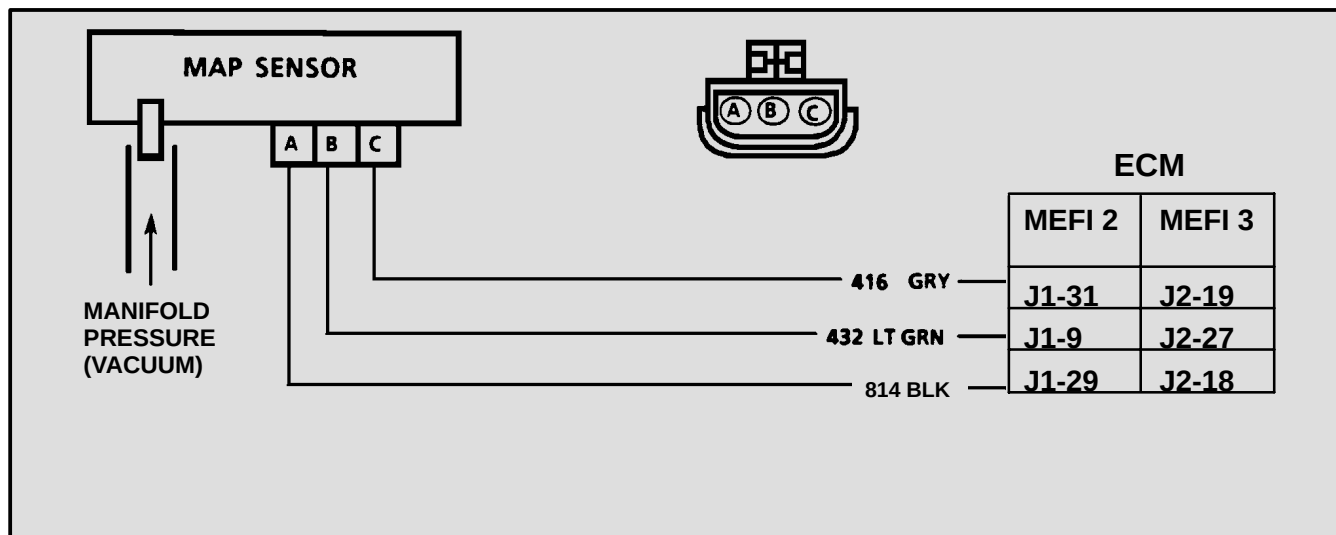
Code 33 (2 of 3): Manifold Absolute Pressure (MAP) Sensor Circuit

Step	Action	Yes	No
		PROCEED TO	
1.	<i>Was the "On-Board Diagnostic" (OBD) System Check Performed?</i>	Step 2.	OBD
2.	<i>Are you using a Scan Tool?</i>	Step 3.	Step 7.
3.	a. Ignition OFF. b. Install a vacuum gauge to manifold vacuum. c. Start engine and raise rpm to 1000 in NEUTRAL. <i>Is the vacuum reading steady and above 14 in. HG (45.5 kPa)?</i>	Step 4.	Step 10.
4.	Allow the engine to idle. <i>Does the scan tool indicate MAP sensor voltage greater than 4 volts?</i>	Step 5.	Step 11.
5.	a. Ignition OFF. b. Disconnect MAP sensor harness connector. c. Ignition ON, engine OFF. <i>Does the scan tool indicate MAP sensor voltage less than 1 volt?</i>	Step 6.	Step 13.
6.	a. Ignition OFF. b. Connect DVOM from harness terminal "A" CKT 814 to harness terminal "C" CKT 416. c. Ignition ON, engine OFF. <i>Does the scan tool indicate MAP sensor voltage greater than 4 volts?</i>	Step 12.	Step 14.
7.	a. Ignition OFF. b. Install a vacuum gauge. c. Start engine and raise rpm to 1000 in NEUTRAL. <i>Is the vacuum reading steady and above 14 In. Hg (45.5 kPa)?</i>	Step 8.	Step 10.

Code 33 (3 of 3): Manifold Absolute Pressure (MAP) Sensor Circuit

Step	Action	Yes	No
		PROCEED TO	
8.	a. Switch CodeMate Tester to the "Normal Mode." b. Ignition OFF. c. Disconnect MAP sensor harness connector. d. Start engine and idle for 2 minutes or until CodeMate Tester indicates a stored trouble code, whichever occurs first. e. Ignition ON, engine OFF. f. Switch CodeMate Tester to the "Service Mode and note trouble code. <i>Is trouble code 34 present?</i>	Step 12.	Step 9.
9.	a. MAP sensor harness connector disconnected. b. Ignition ON engine OFF. c. Connect DVOM from harness terminal "A" CKT 814 to harness terminal "C" CKT 416. <i>Is voltage reading above 4 volts?</i>	Step 13.	Step 14.
10.	Repair low or unsteady vacuum problem.	Verify Repair	—
11.	Trouble code is intermittent. Locate and repair intermittent faulty connections. Refer to "Diagnostic Aids."		—
12.	Check for plugged or leaking sensor vacuum fitting. If OK, replace faulty MAP sensor.		—
13.	Locate and repair short to voltage in CKT 432 or faulty ECM connections.		—
14.	Locate and repair open in CKT 814 or repair faulty ECM connections.		—

Code 34 (1 of 3): Manifold Absolute Pressure (MAP) Sensor Circuit



CIRCUIT DESCRIPTION:

The Manifold Absolute Pressure (MAP) sensor responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that will vary from about 1.0-2.0 volts at idle to about 4.0-5.0 volts at Wide Open Throttle (WOT).

If the MAP sensor fails, the ECM will substitute a default MAP value that will vary with rpm.

A reference voltage of 5 volts is provided to the MAP sensor through CKT 416. CKT 814 is the ground circuit for the MAP sensor. MAP sensor CKT 432 will send a voltage signal to the ECM proportional to the manifold pressure.

DIAGNOSTIC AIDS:

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage. If the harness appears to be OK, observe the MAP sensor display on the scan tool while moving connectors and wiring harnesses related to the MAP sensor. A change in the MAP sensor display will indicate the location of the fault.
- If the idle is rough or unstable, refer to "Troubleshooting" section for items which may cause an unstable idle.
- With the ignition ON, engine OFF, the manifold pressure is equal to atmospheric pressure and the signal voltage will be high. This information is used by the ECM as an indication of altitude and is referred to as BARO. Comparison of this BARO reading, with a known good MAP sensor, is a good way to check the accuracy of a "suspect" sensor. Reading should be the same, plus or minus 0.4 volt.
- If DTC 14 is also set, check for open in ground CKT 814.

After repairs, clear DTC following "Clearing Trouble Codes" procedure at the front of this section. Failure to do so may result in DTC not properly being cleared.

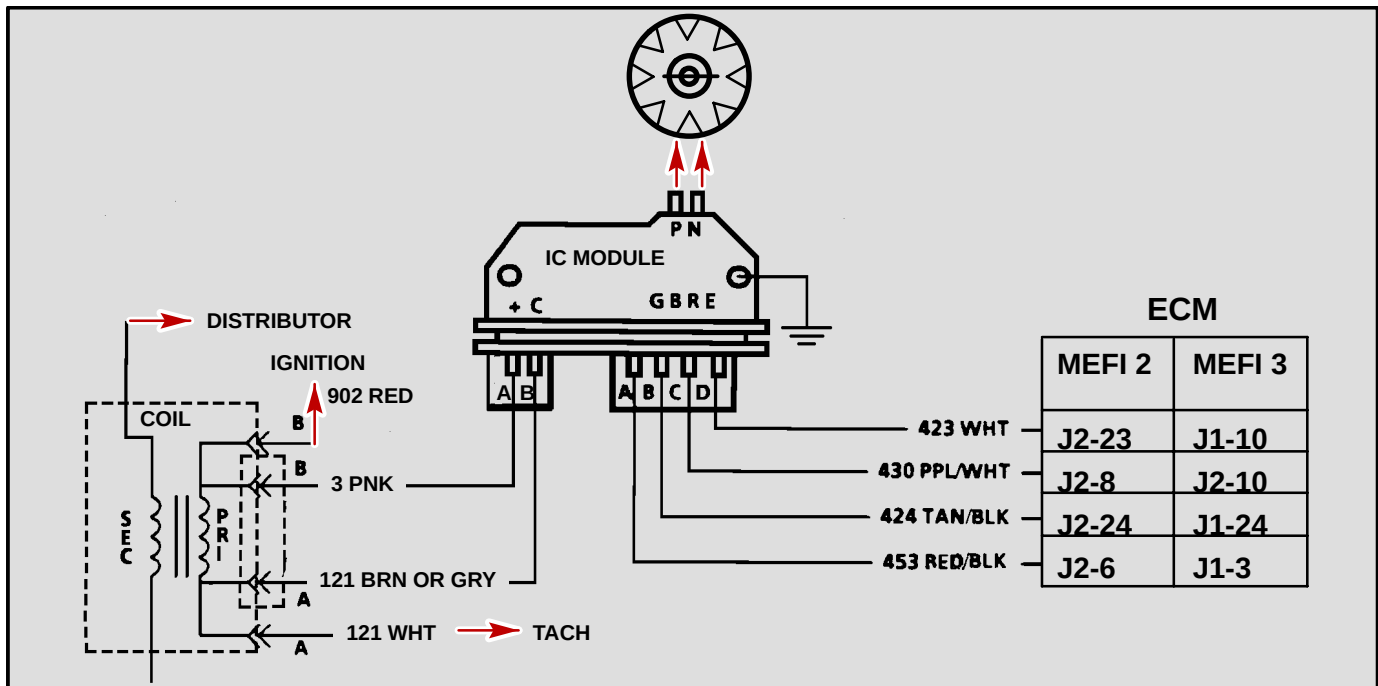
Code 34 (2 of 3): Manifold Absolute Pressure (MAP) Sensor Circuit

Step	Action	Yes	No
		PROCEED TO	
1.	Was the "On-Board Diagnostic" (OBD) System Check Performed?	Step 2.	OBD
2.	Are you using a Scan Tool?	Step 3.	Step 7.
3.	a. Ignition OFF b. Install a vacuum gauge. c. Start engine and raise rpm to 1000 in NEUTRAL. Is the vacuum reading steady and above 14 in. HG (45.5 kPa)?	Step 4.	Step 9.
4.	Allow the engine to idle. Does the scan tool indicate MAP sensor voltage less than 1 volt?	Step 5.	Step 11.
5.	a. Ignition OFF. b. Disconnect MAP sensor harness connector. c. Connect a jumper wire from harness terminal "B" CKT 432 to harness terminal "C" CKT 416. d. Ignition ON, engine OFF. Does the scan tool indicate MAP sensor voltage greater than 4 volts?	Step 10.	Step 6.
6.	a. Ignition OFF. b. Connect DVOM from harness terminal "C" CKT 416 to a known good ground. c. Ignition ON, engine OFF. Does the scan tool indicate MAP sensor voltage greater than 4 volts?	Step 12.	Step 13.
7.	a. Switch CodeMate Tester to "Normal Mode". b. Ignition OFF. c. Disconnect MAP sensor harness connector. d. Connect a jumper wire from terminal "B" CKT 432 to harness terminal "C" CKT 416. e. Start engine and raise rpm to 1000 in NEUTRAL. f. Ignition ON, engine OFF. g. Switch CodeMate Tester to "Service Mode" and watch for a trouble code. Is trouble code 33 present?	Step 11.	Step 8.

Code 34 (3 of 3): Manifold Absolute Pressure (MAP) Sensor Circuit

Step	Action	Yes	No
		PROCEED TO	
8.	a. Remove the jumper wire from CKT416 and 432. b. Connect DVOM from harness terminal "A" CKT 814 to harness terminal "C" CKT 416. <i>Is voltage reading above 4 volts?</i>	Step 12.	Step 13.
9.	Repair low or unsteady vacuum problem.	Verify Repair	—
10.	Check for plugged or leaking sensor vacuum fitting. If OK, replace faulty MAP sensor.		—
11.	Locate and repair intermittent faulty connections. If OK, replace faulty MAP sensor.		—
12.	Locate and repair open or short to ground in CKT 432 or faulty ECM connections.		—
13.	Locate and repair open or short to ground in CKT 416 or faulty ECM connections. Also check CKT 416 to the TP sensor for a short to ground.		—

Code 41 (1 of 2): Ignition Control (IC) Circuit



CIRCUIT DESCRIPTION:

When the system is running on the ignition module or in crank mode, there is no voltage on CKT 424, and the ignition module grounds CKT 423. The ECM expects to detect a low voltage on CKT 423 during this condition. If the ECM sees voltage, it sets Code 41 and will not go into the Ignition Control (IC) mode.

When the rpm for IC is reached (about 300 rpm), and CKT 424 voltage applied, CKT 423 should no longer be grounded in the ignition module, and the voltage should be varying.

If CKT 424 is open or grounded, the ignition module will not switch to IC mode. The CKT 423 voltage will be low and Code 42 will be set.

If CKT 423 stays grounded, the IC module will switch to IC mode but, because the line is grounded, there will not be an IC signal and a trouble code 42 will be set.

DIAGNOSTIC AIDS:

Check for the following conditions:

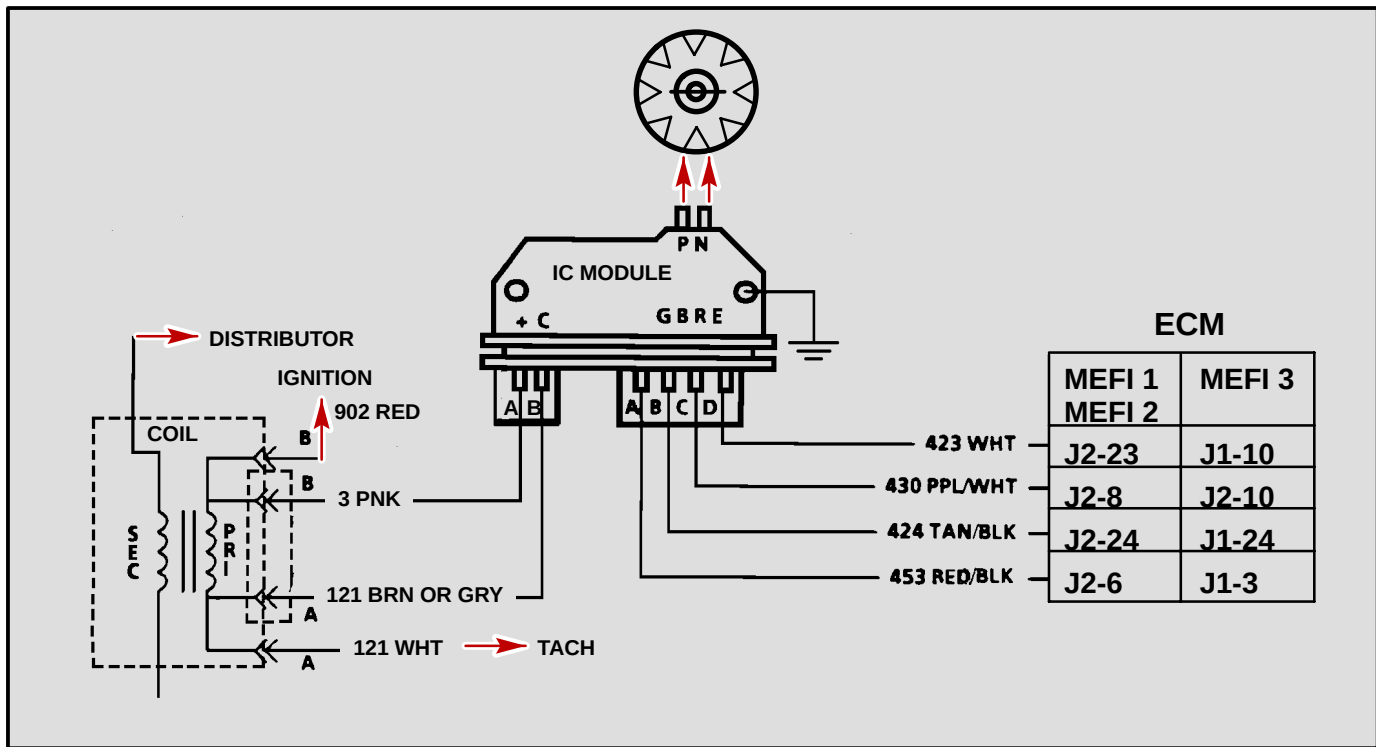
- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage.
- If the engine starts and stalls, it may set a false DTC 41 or 42. Clear DTC and repair stalling condition.

After repairs, clear DTC following "Clearing Trouble Codes" procedure at the front of this section. Failure to do so may result in DTC not properly being cleared.

Code 41 (2 of 2): Ignition Control (IC) Circuit

Step	Action	Yes	No
		PROCEED TO	
1.	Was the "On-Board Diagnostic" (OBD) System Check Performed?	Step 2.	OBD
2.	a. Clear trouble code 41. b. Start engine and idle for 2 minutes or until trouble code 41 sets, whichever occurs first. Is trouble code 41 present?	Step 3.	Step 7.
3.	a. Ignition OFF. b. Disconnect ECM harness connectors. c. Using a DVOM set on Ohms, probe ECM CKT 423 to ground. Is resistance above 3000 ohms?	Step 4.	Step 5.
4.	a. Reconnect ECM. b. Start engine and idle for 2 minutes or until trouble code 41 sets, whichever occurs first. Is trouble code 41 present?	Step 5.	Step 7.
5.	Locate and repair open in CKT 423 or faulty ECM connections. Was a problem found?	Verify Repair	Step 6.
6.	Replace faulty distributor ignition module.		—
7.	Trouble code is intermittent. Refer to "Diagnostic Aids" on facing page. Check harness and connectors for an intermittent open in CKT 423.		—

Code 42 (1 of 3): Ignition Control (IC) Circuit



When the system is running on the ignition module or in crank mode, there is no voltage on CKT 424 and the ignition module grounds CKT 423. The ECM expects to detect a low voltage on CKT 423 during this condition. If the ECM sees voltage, it sets Code 41 and will not go into the Ignition Control (IC) mode.

When the rpm for IC is reached (about 300 rpm), and CKT 424 voltage applied, CKT 423 should no longer be grounded in the ignition module, and the voltage should be varying.

If CKT 424 is open or grounded, the ignition module will not switch to IC mode. The CKT 423 voltage will be low and Code 42 will be set.

If CKT 423 stays grounded, the IC module will switch to IC mode but, because the line is grounded, there will not be an IC signal and a trouble code 42 will be set.

DIAGNOSTIC AIDS:

Check for the following conditions:

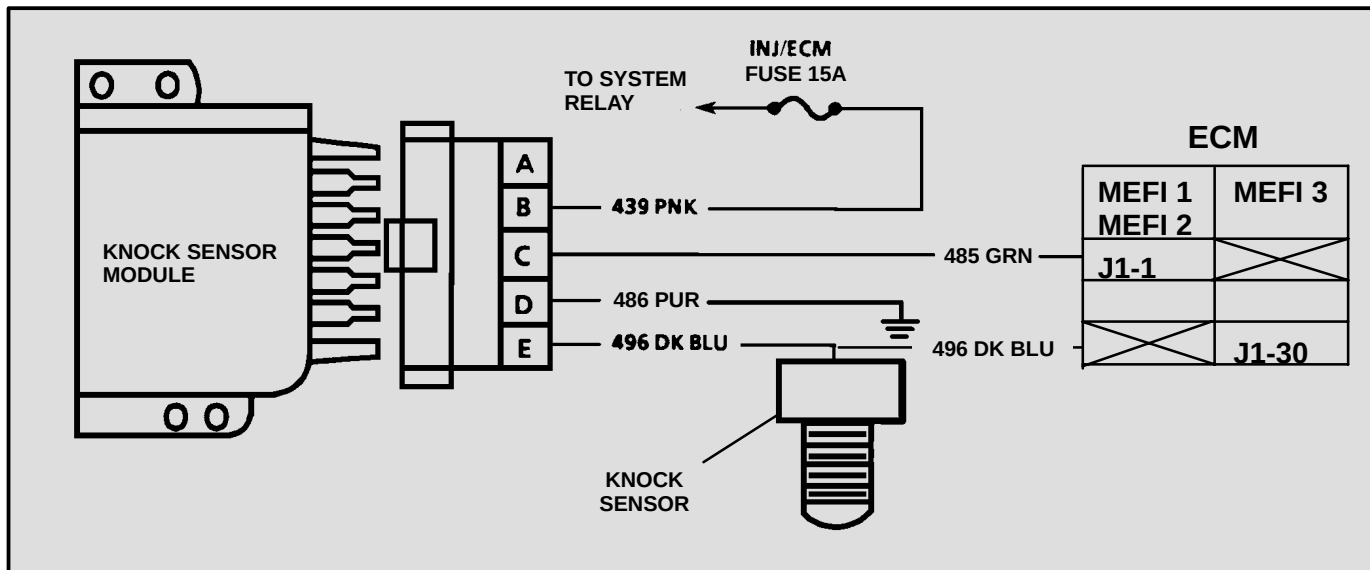
- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage.
- If the engine starts and stalls, it may set a false DTC 41 or 42. Clear DTC and repair stalling condition.

After repairs, clear DTC following "Clearing Trouble Codes" procedure at the front of this section. Failure to do so may result in DTC not properly being cleared.

Code 42 (2 of 2): Ignition Control (IC) Circuit

Step	Action	Yes	No
		PROCEED TO	
1.	<i>Was the "On-Board Diagnostic" (OBD) System Check Performed?</i>	Step 2.	OBD
2.	a. Clear trouble code 42. b. Start engine and idle for 2 minutes or until trouble code 42 sets, whichever occurs first. <i>Is trouble code 42 present?</i>	Step 3.	Step 11.
3.	a. Ignition OFF. b. Disconnect ECM harness connectors. c. Using a DVOM selected for Ohms, probe ECM harness terminal CKT 423 to ground. <i>Is resistance over 3000 ohms?</i>	Step 4.	Step 7.
4.	a. Leave DVOM connected from ECM harness terminal CKT 423 to ground. b. Using a test light connected to battery positive (B+), probe ECM CKT 424. c. As the test light contacts CKT 424, the resistance should switch from over 3000 Ohms to under 1000 Ohms. <i>Does the resistance switch to under 1000 ohms?</i>	Step 11.	Step 5.
5.	Using a test light connected to battery positive (B+), probe ECM CKT 424. <i>Does test light illuminate?</i>	Step 6.	Step 8.
6.	Disconnect the ignition module 4-wire connector. <i>Does the test light illuminate?</i>	Step 9.	Step 10.
7.	Locate and repair short to ground in CKT 423 or faulty ECM connections. <i>Was a problem found?</i>	Verify Repair	Step 10.
8.	Locate and repair open in CKT 424. <i>Was a problem found?</i>		Step 10.
9.	Locate and repair short to ground in CKT 424 or faulty ECM connections.		—
10.	Replace faulty ignition module.		—
11.	Trouble code 42 is intermittent. Refer To "Diagnostic Aids" on facing page. Check harness and connectors for an intermittent open or short to ground in CKT 424 or an intermittent short to ground in CKT 423.	—	—

Code 43 (1 of 3): Knock Sensor (KS) Circuit



CIRCUIT DESCRIPTION:

MEFI 1 and MEFI 2

Engine detonation or spark knock is sensed with a module that sends a voltage signal to the ECM. As the knock sensor detects engine knock, the voltage from the KS module to the ECM drops, and this signals the ECM to start retarding timing. The ECM will retard timing when knock is detected and rpm and engine coolant temperature are above a certain value.

MEFI 3

Engine detonation or spark knock is detected with a sensor that sends a voltage signal to the ECM. As the knock sensor detects engine knock, the voltage output level increases and this signals the ECM to start retarding timing. The ECM will retard timing when knock is detected and rpm and engine coolant temperature are above a certain value.

NOTE: On MEFI 3 products do not have a knock module. The sensor connects directly to the ECM.

DIAGNOSTIC AIDS

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage.
- If CKT 496 is routed too close to secondary ignition wires, the KS module may see the interference as a knock signal, resulting in false timing retard.

After repairs, clear DTC following "Clearing Trouble Codes" procedure at the front of this section. Failure to do so may result in DTC not properly being cleared.

NOTE: If there are abnormal mechanical engine noises (rattles or knocks), they may give a false DTC 43. If fuel octane is too low, a false DTC 43 may be set.

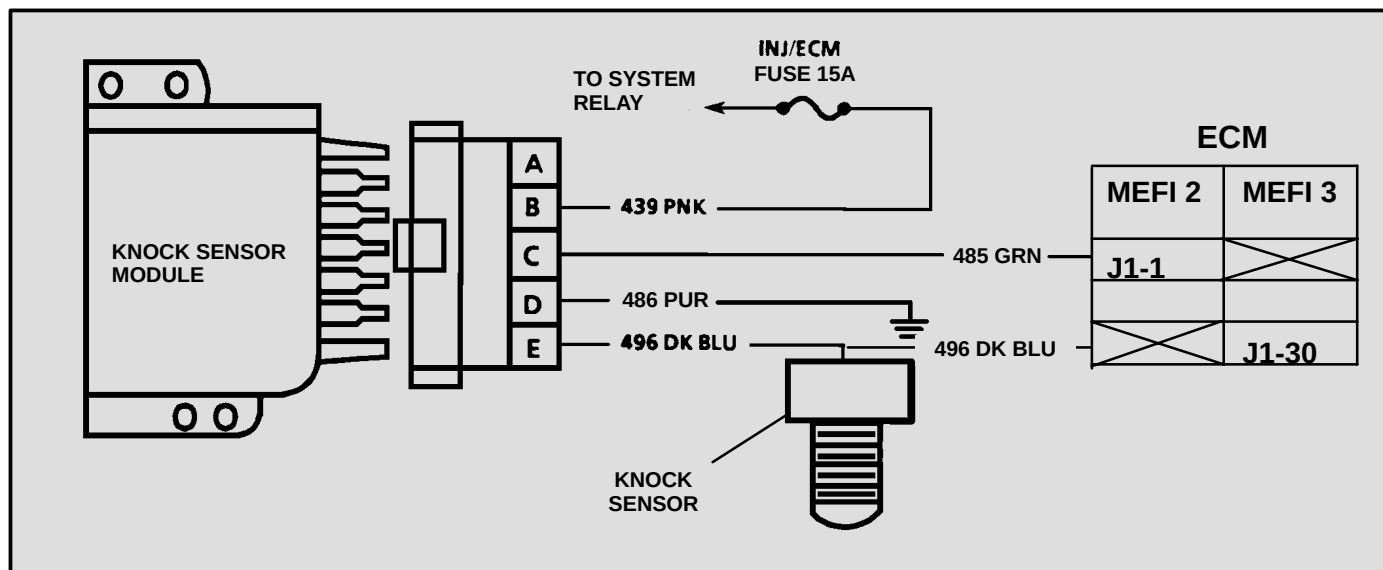
Code 43 (2 of 3): Knock Sensor (KS) Circuit

Step	Action	Yes	No
		PROCEED TO	
1.	<i>Was the "On-Board Diagnostic" (OBD) System Check Performed?</i>	Step 2.	OBD
2.	<i>Do you have a MEFI 3 ECM?</i>	Step 7.	Step 3.
3.	a. Disconnect 5-wire KS module connector b. Ignition ON, engine OFF. c. Using a test light connected to ground, probe KS module harness terminal "B" CKT 439. <i>Does test light illuminate?</i>	Step 4.	Step 9.
4.	a. Using a test light connected to battery positive (B+), probe KS module harness terminal "D" CKT 486. <i>Does test light illuminate?</i>	Step 5.	Step 10.
5.	a. Ignition OFF b. Reconnect KS module harness connector. c. Disconnect ECM J1 connector. d. Ignition ON, engine OFF. e. Connect DVOM from ECM CKT 485 to a known good ground. <i>Is the voltage within 8-10 volts?</i>	Step 6.	Step 11.
6.	a. Allow DVOM voltage to stabilize. b. Connect a test light to battery positive (B+). c. Touch test light to CKT 496. <i>Does voltage value change?</i>	Step 15.	Step 12.
7.	a. Disconnect ECM J1 connector b. Using DVOM, measure resistance between CKT 496 and ground. <i>Is resistance between 3000 - 5000 ohms?</i>	Step 15.	Step 8.
8.	a. Disconnect KS connector. b. Using DVOM, measure resistance between KS and ground. <i>Is resistance between 3000 - 5000 ohms?</i>	Step 12.	Step 14.
9.	Locate and repair open or short to ground in CKT 439.	Verify Repair	—
10.	Locate and repair open in CKT 486.		—
11.	a. Locate and repair open or short to ground in CKT 485. <i>Was a problem found?</i>		Step 13.
12.	a. CKT 496 open or shorted to ground.		—

Code 43 (3 of 3): Knock Sensor (KS) Circuit

Step	Action	Yes	No
		PROCEED TO	
13.	Replace faulty KS module.	Verify Repair	—
14.	Replace faulty KS.		
15.	Trouble code 43 is intermittent. Refer To "Diagnostic Aids" on facing page.		—

Code 44 (1 of 3): Knock Sensor (KS) Circuit



CIRCUIT DESCRIPTION:

MEFI 1 and MEFI 2

Engine detonation or spark knock is sensed with a module that sends a voltage signal to the ECM. As the knock sensor detects engine knock, the voltage from the KS module to the ECM drops, and this signals the ECM to start retarding timing. The ECM will retard timing when knock is detected and rpm and engine coolant temperature are above a certain value.

MEFI 3

Engine detonation or spark knock is detected with a sensor that sends a voltage signal to the ECM. As the knock sensor detects engine knock, the voltage output level increases and this signals the ECM to start retarding timing. The ECM will retard timing when knock is detected and rpm and engine coolant temperature are above a certain value.

NOTE: On MEFI 3 products do not have a knock module. The sensor connects directly to the ECM.

DIAGNOSTIC AIDS

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage.
- If CKT 496 is routed too close to secondary ignition wires, the KS module may see the interference as a knock signal, resulting in false timing retard.

After repairs, clear DTC following "Clearing Trouble Codes" procedure at the front of this section. Failure to do so may result in DTC not properly being cleared.

NOTE: if fuel octane is too high, a false DTC 44 may be set

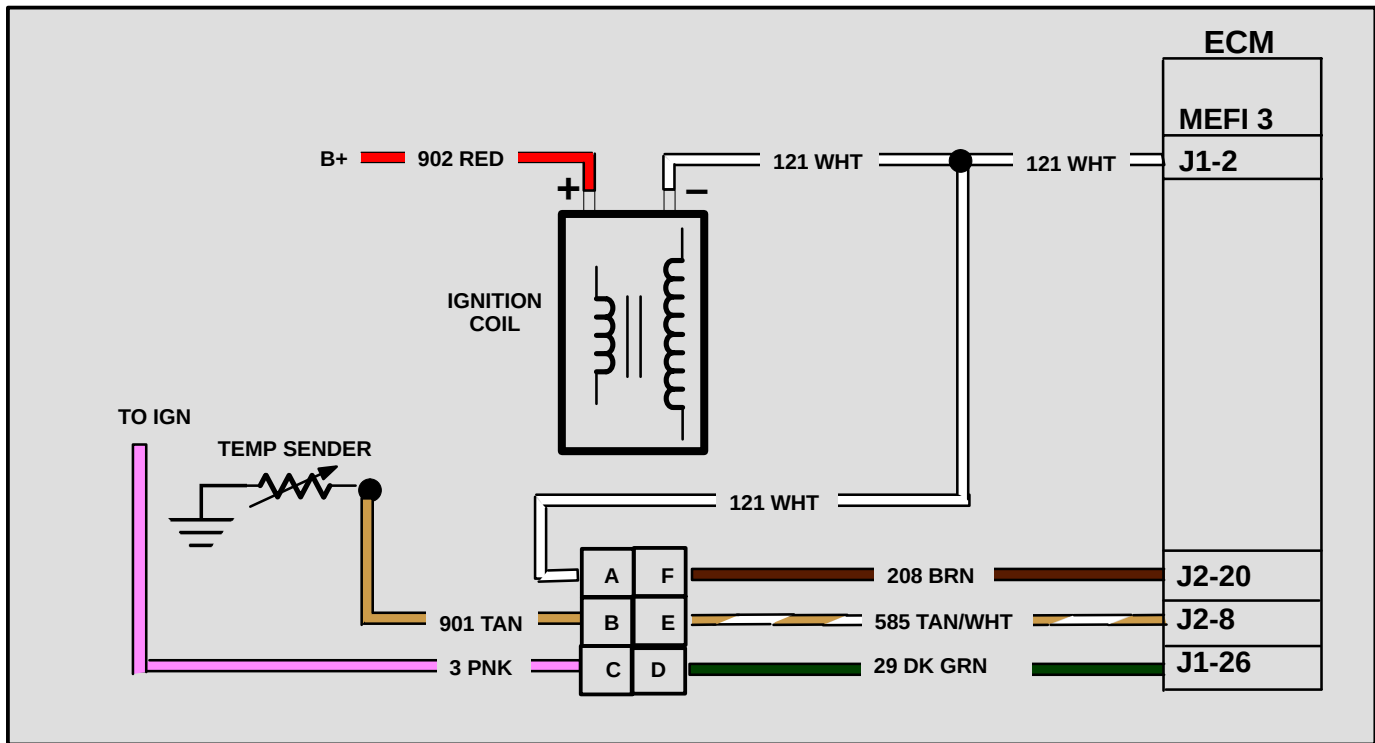
Code 44 (2 of 3): Knock Sensor (KS) Circuit

Step	Action	Yes	No
		PROCEED TO	
1.	Was the "On-Board Diagnostic" (OBD) System Check Performed?	Step 2.	OBD
2.	Do you have a MEFI 3 ECM?	Step 7.	Step 3.
3.	a. Disconnect 5-wire KS module connector b. Ignition ON, engine OFF. c. Using a test light connected to ground, probe KS module harness terminal "B" CKT 439. Does test light illuminate?	Step 4.	Step 9.
4.	a. Using a test light connected to battery positive (B+), probe KS module harness terminal "D" CKT 486. Does test light illuminate?	Step 5.	Step 10.
5.	a. Ignition OFF b. Reconnect KS module harness connector. c. Disconnect ECM J1 connector. d. Ignition ON, engine OFF. e. Connect DVOM from ECM CKT 485 to a known good ground. Is the voltage within 8-10 volts?	Step 6.	Step 11.
6.	a. Allow DVOM voltage to stabilize. b. Connect a test light to battery positive (B+). c. Touch test light to CKT 496. Does voltage value change?	Step 15.	Step 12.
7.	a. Disconnect ECM J1 connector b. Using DVOM, measure resistance between CKT 496 and ground. Is resistance between 3000 - 5000 ohms?	Step 15.	Step 8.
8.	a. Disconnect KS connector. b. Using DVOM, measure resistance between KS and ground. Is resistance between 3000 - 5000 ohms?	Step 12.	Step 14.
9.	Locate and repair open or short to ground in CKT 439.	Verify Repair	—
10.	Locate and repair open in CKT 486.		—
11.	a. Locate and repair open or short to ground in CKT 485. Was a problem found?		Step 13.
12.	a. CKT 496 open or shorted to ground.		—

Code 44 (3 of 3): Knock Sensor (KS) Circuit

Step	Action	Yes	No
		PROCEED TO	
13.	Replace faulty KS module.	Verify Repair	—
14.	Replace faulty KS.		
15.	Trouble code 44 is intermittent. Refer To “Diagnostic Aids” on facing page.		

Code 45 (1 of 2): Ignition Coil Driver Fault



CIRCUIT DESCRIPTION:

On MEFI 3 product, the coil driver circuitry is integrated into the ECM. When the engine is running, a diagnostic check of the coil drive circuitry is constantly taking place. If the diagnostic system detects excessive current to the coil through CKT 121, a fault code will set although the engine should continue to operate.

DIAGNOSTIC AIDS

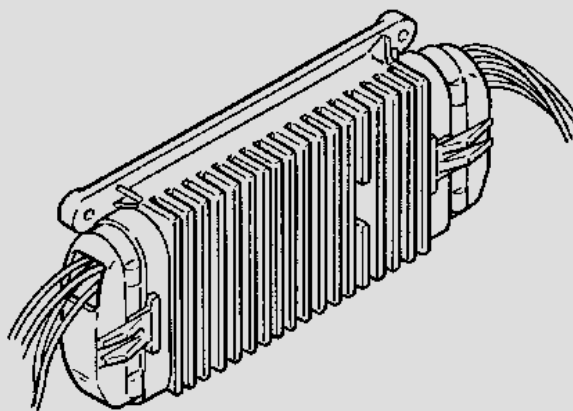
Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage.
- Shorted CKT 121 or tach lead in harness.
- Damaged ignition coil or improper coil. The ignition system is calibrated for Mercury approved coils only.

Code 45 (2 of 2):

Step	Action	Yes	No
		PROCEED TO	
1.	<i>Was the "On-Board Diagnostic" (OBD) System Check Performed?</i>	Step 2.	OBD
2.	a. Ignition ON, engine OFF. b. Using DVOM, measure voltage at coil positive (+) terminal. <i>Is Voltage Greater Than 12 Volts?</i>	Step 3.	Step 7.
3.	a. Ignition OFF. b. Disconnect ECM J1 connector. c. Check continuity from ECM CKT 121 to negative (-) terminal of coil. <i>Is Resistance Less Than 1 ohm?</i>	Step 4.	Step 8.
4.	a. Ignition OFF. b. Disconnect ECM J1 connector. c. Check resistance from ECM CKT 121 to ground. <i>Is Resistance Less Than 1 ohm?</i>	Step 9.	Step 5.
5.	a. Ignition OFF. b. Disconnect ECM J1 connector. c. Check resistance between positive (+) and negative (-) terminals of coil. <i>Is Resistance Less Than 2 ohms?</i>	Step 6.	Step 10.
6.	a. Ignition OFF. b. Disconnect ECM J1 connector. c. Remove secondary ignition wire from coil. d. Measure resistance between secondary coil tower and negative terminal of coil. <i>Is Resistance Greater Than 5 Ohms And Less Than 15 ohms?</i>	Step 11.	Step 10.
7.	Locate and repair open or short to ground in CKT 902.	Verify Repair	—
8.	Locate and repair open in CKT 121.		
9.	Locate and repair short to ground in CKT 121.		
10.	Replace ignition coil.		
11.	Trouble code 44 is intermittent. Check ignition wires and plugs.	—	

Code 51 (1 of 1): Calibration Memory Failure



72801

CIRCUIT DESCRIPTION:

This test allows the ECM to check for a calibration failure by comparing the calibration value to a known value stored in the EEPROM.

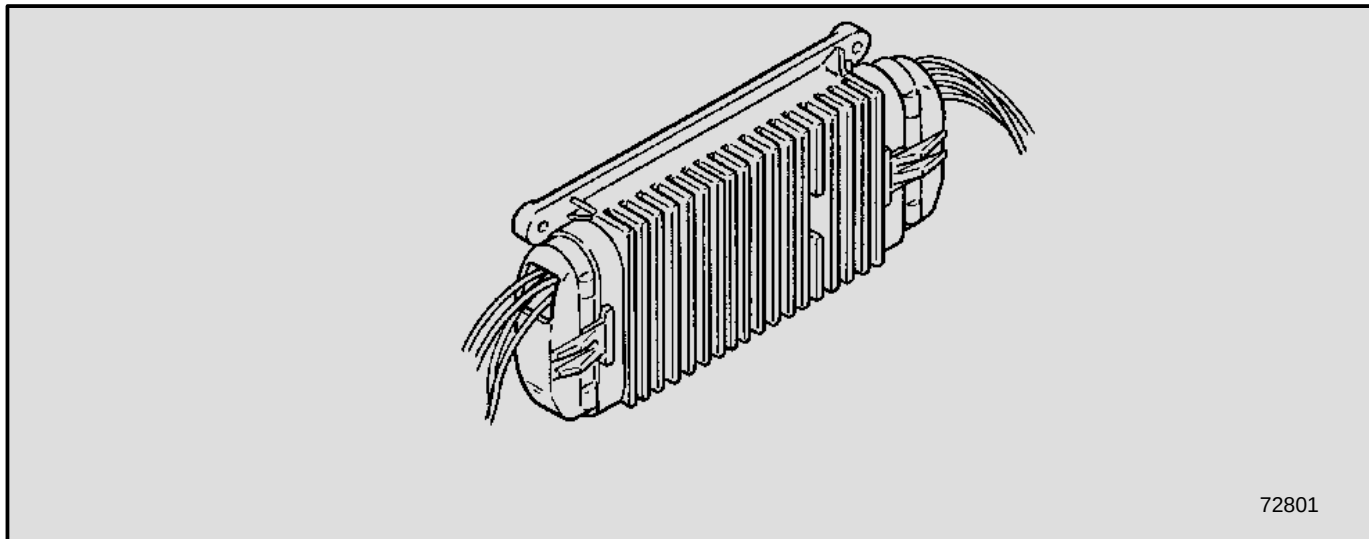
This test is also used as a security measure to prevent improper use of calibrations or changes to these calibrations that may alter the designed function of EFI.

DIAGNOSTIC AIDS:

If DTC 51 failed more than once, but is intermittent, replace the ECM.

Step	Action	VALUE	YES	NO
			PROCEED TO	
1.	Was the "On-Board Diagnostic" (OBD) System Check Performed?	—	Step 2.	OBD
2.	Ignition ON. Clear trouble code 51. Does Code 51 reset?	—	Step 4.	Refer to Diagnostic Aids
3.	Fault is not present at this time.	—	Refer to Diagnostic Aids	
4.	Replace faulty ECM and verify trouble code 51 does not reset.	—	Verify Repair	- —

Code 52 (1 of 1): EEPROM Failure



72801

CIRCUIT DESCRIPTION:

This test allows the ECM to check for a calibration failure by comparing the calibration value to a known value stored in the EEPROM.

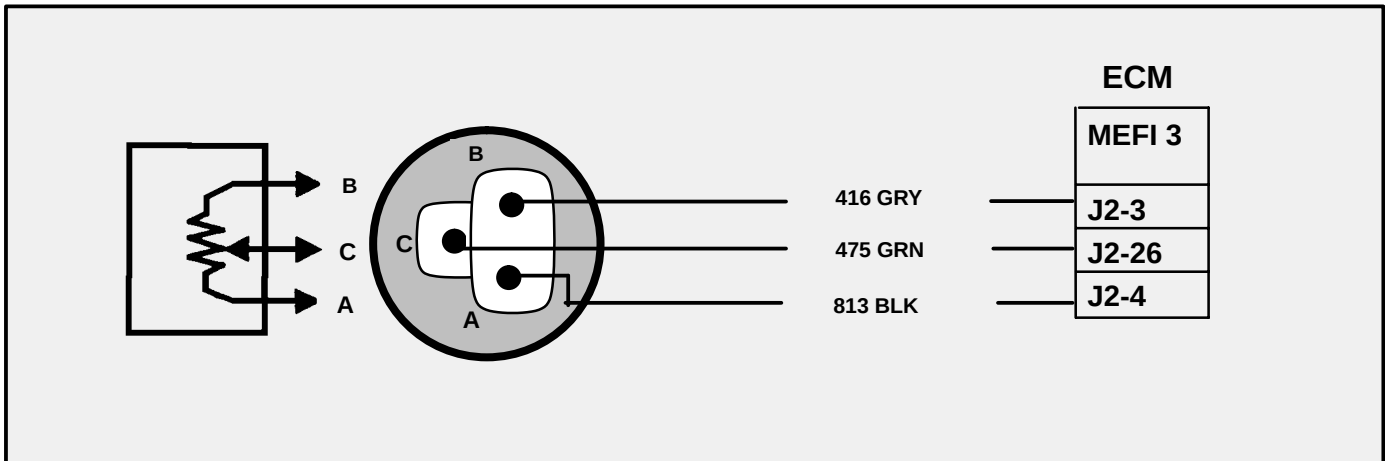
This test is also used as a security measure to prevent improper use of calibrations or changes to these calibrations that may alter the designed function of EFI.

DIAGNOSTIC AIDS:

If DTC 52 failed more than once, but is intermittent, replace the ECM.

Step	Action	Yes	No
		PROCEED TO	
1.	<i>Was the "On-Board Diagnostic" (OBD) System Check Performed?</i>	Step 2.	OBD
2.	a. Clear trouble code 52. b. Ignition ON. <i>Does trouble code 52 reset?</i>	Step 3.	Refer to Diagnostic Aids
3.	Replace faulty ECM and verify trouble code 52 does not reset.	Verify Repair	—

Code 61 (1 of 2) Fuel Pressure (FP) Circuit



CIRCUIT DESCRIPTION:

The fuel pressure (FP) Sensor provides a voltage signal that changes with measured fuel pressure. Signal voltage should be between 2.5 and 3.5 volts.

The FP signal provides inputs to the Electronic Control Module (ECM) for fuel control.

DIAGNOSTIC AIDS:

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage and test by moving the FP connector and harness.
- The scan tool reads fuel pressure in voltage relative to the pressure regulator setting. With ignition ON, engine OFF, the voltage should be 2.5-3.5 volts.
- If DTC 62 is also set, check for a short to ground in CKT 416.

After repairs, clear DTC following "Clearing Trouble Codes " procedure at the front of this section. Failure to do so may result in DTC not properly being cleared.

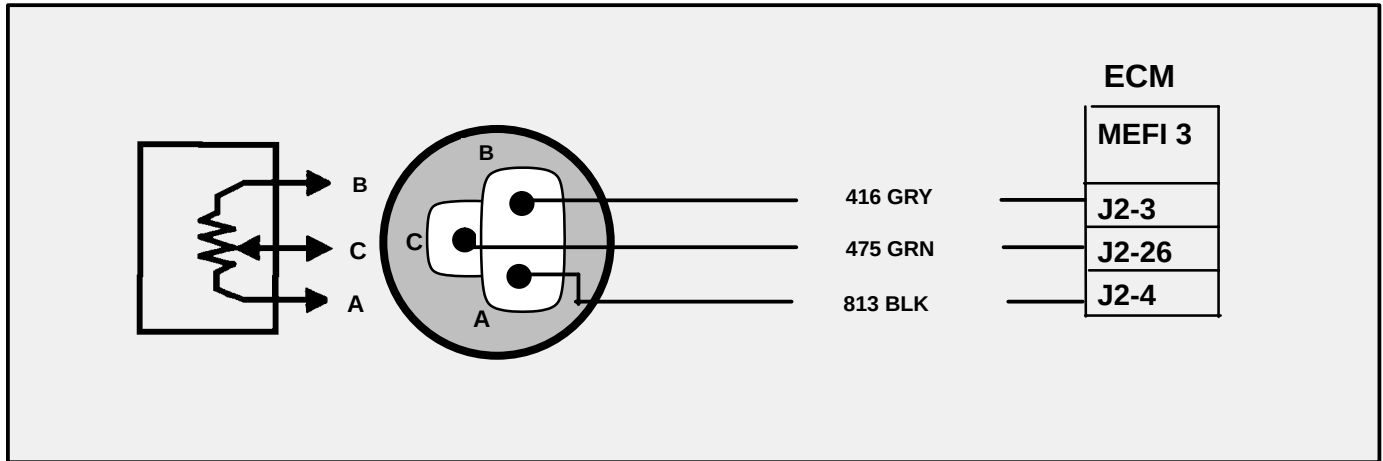
Code 61 (2 of 3) Fuel Pressure (FP) Circuit

Step	Action	Yes	No
		PROCEED TO	
1.	<i>Was the "On-Board Diagnostic" (OBD) System Check Performed?</i>	Step 2.	OBD
2.	<i>Are you using a Scan Tool?</i>	Step 3.	Step 7.
3.	a. Ignition ON. <i>Does scan tool indicate fuel pressure sensor voltage <u>greater</u> than 4 volts?</i>	Step 6.	Step 4.
	<i>Does scan tool indicate fuel pressure sensor voltage <u>less</u> than .3 volts?</i>	Step 5.	Step 4.
4.	Code 61 is intermittent, refer to "Diagnostic Aids" on facing page.	—	—
5.	a. Ignition OFF. b. Disconnect fuel pressure sensor electrical connector. Jumper fuel pressure sensor harness terminals "B" and "C" together. c. Ignition ON. <i>Does scan tool indicate fuel pressure sensor voltage <u>greater</u> than 4 volts?</i>	Step 15.	Step 7.
6.	a. Ignition OFF. b. Disconnect fuel pressure sensor connector. c. Ignition ON. <i>Does scan tool indicate voltage over 4 volts?</i>	Step 13.	Step 7.
7.	a. Ignition ON. b. Connect DVOM from harness terminal "B" (5 volt reference to harness terminal "A" (sensor ground). <i>Is voltage reading over 4 volts?</i>	Step 8.	Step 11.
8.	Connect DVOM from harness terminal "B" (CKT 416) to harness terminal "C" (fuel pressure sensor signal, CKT 475). <i>Is voltage reading over 4 volts?</i>	Step 9.	Step 10.

Code 61 (3 of 3) Fuel Pressure (FP) Circuit

Step	Action	Yes	No
		PROCEED TO	
9.	a. Ignition OFF. b. Connect a test light to battery positive (B+). c. Touch test light to harness terminal "C" (fuel pressure sensor signal). Is test light on?	Step 12.	Step 15.
10.	Connect DVOM between harness terminal "C" and engine ground (-). Is voltage reading over 4 volts?	Step 13.	Step 14.
11.	Connect DVOM from fuel pressure sensor harness terminal "B" to a good ground on engine. Is voltage reading over 4 volts?	Step 18.	Step 17.
12.	a. Disconnect ECM. b. Touch test light to harness terminal "C" (fuel pressure sensor signal). Is test light on?	Step 16.	Step 14.
13.	Check for CKT 475 shorted to voltage.	—	—
14.	Locate and repair open in CKT 475 or faulty connection at ECM.	—	—
15.	Replace fuel pressure sensor.	—	—
16.	Check for CKT 475 shorted to ground.	—	—
17.	CKT 416 open or shorted to ground or faulty connection at ECM.	—	—
18.	CKT 813 open or faulty connection at ECM.	—	—

Code 62 (1 of 3) Fuel Pressure (FP) Sensor Circuit



CIRCUIT DESCRIPTION:

The fuel pressure (FP) Sensor provides a voltage signal that changes with measured fuel pressure. Signal voltage should be between 2.5 and 3.5 volts.

The FP signal provides inputs to the Electronic Control Module (ECM) for fuel control.

DIAGNOSTIC AIDS:

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage and test by moving the FP connector and harness.
- The scan tool reads fuel pressure in voltage relative to the pressure regulator setting. With ignition ON, engine OFF, the voltage should be 2.5-3.5 volts.
- If DTC 61 is also set, check for a short to ground in CKT 416.

After repairs, clear DTC following "Clearing Trouble Codes" procedure at the front of this section. Failure to do so may result in DTC not properly being cleared.

Code 62 (2 of 3) Fuel Pressure (FP) Sensor Circuit

Step	Action	Yes	No
		PROCEED TO	
1.	Was the "On-Board Diagnostic" (OBD) System Check Performed?	Step 2.	OBD
2.	Are you using a Scan Tool?	Step 3.	Step 7.
3.	a. Ignition OFF. Does scan tool indicate fuel pressure sensor voltage less than .30 volt?	Step 4.	Step 6.
4.	a. Ignition OFF b. Disconnect fuel pressure sensor harness connector. c. Connect a jumper wire from harness terminal "B" CKT 416 to harness terminal "C" CKT 475. d. Ignition ON, engine OFF. Does scan tool indicate fuel pressure sensor voltage greater than 4 volts?	Step 9.	Step 5.
5.	a. Ignition OFF. b. Connect DVOM from harness terminal "B" (CKT 416) to a known good ground. Does DVOM indicate a voltage greater than 4 volts?	Step 10.	Step 11.
6.	Trouble code 62 is intermittent. Locate and repair intermittent faulty connections. Refer to "Diagnostic Aids."	—	—
7.	a. Switch CodeMate Tester to the normal mode. b. Ignition OFF. c. Disconnect fuel pressure sensor harness connector. d. Connect a jumper wire form harness terminal "B" CKT 416 to harness terminal "C" CKT 475. e. Start engine and idle for 2 minutes or until CodeMate Tester indicates a stored trouble code, whichever occurs first. f. Ignition ON, engine OFF. g. Switch CodeMate Tester to "Service Mode" and note trouble code. Is trouble code 61 present?	Step 9.	Step 10.
8.	a. Remove jumper wire from CKT 416 and CKT 475. b. Connect DVOM from harness terminal "B" CKT 416 to harness terminal "A" CKT 813. Is voltage reading above 4 volts?	Step 10.	Step 11.

Code 62 (3 of 3) Fuel Pressure (FP) Sensor Circuit

Step	Action	Yes	No
		PROCEED TO	
9.	Locate and repair intermittent faulty connections or replace faulty fuel pressure sensor.	Verify Repair	—
10.	Locate and repair open or short to ground in CKT 475 or faulty ECM connections.		—
11.	Locate and repair open or short to ground in CKT 416 or faulty ECM connections.		—

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COOLING SYSTEM

Section 6A - Seawater Cooled Models

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Torque Specifications

Description	lb-in.	lb-ft	Nm
Alternator Mounting Bracket		30	41
Power Steering Pump Bracket			
Seawater Pump Brace			
Seawater Pump Bracket To Block			
Seawater Pump Cover			
Thermostat Cover			
Thermostat Housing			
Thru-Hull Pickup Nut			
Alternator To Mounting Bracket		35	48
Water Circulating Pump			
Seawater Pump Clamping Screw On Casting Bracket		20	27
Water Temperature Sender			
Drain Plug (Note)	Securely		
Hose Clamps			
Petcocks			
Pulleys			

NOTE: Coat threads with Quicksilver Perfect Seal before installing.

Tools

Description	Part Number
Universal Puller Plate	91-37241
Quicksilver Flushing Attachment	44357A2

Special Tools

Description	Part Number
Kent-Moore Tools, Inc. 29784 Little Mack Roseville, MI 48066 Phone: (313) 574-2332	
Pulley Puller (Kent Moore)	J-25034-C

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Loctite 27131	92-809820
Quicksilver Perfect Seal	92-34227--1
Quicksilver 2-4-C Marine Lubricant With Teflon	92-825407A3
Quicksilver High Performance Gear Lube	92-816026A2
Quicksilver Liquid Neoprene	92-25711--3
Quicksilver Special Lubricant 101	92-13872A1
Silicone Sealant Or Equivalent	Obtain Locally
Shell Alvania No. 2 Grease	

Specifications

Cooling System Capacity

Engine	U.S. Quart (liter)
All	15 (14.1)

Thermostat

Engine	Specification
All	160°F (71°C)

Seawater Inlet Recommendations

Transom Mounted or Thru-Hull Seawater Pickups and Hose

Water pickup must be large enough to permit sufficient water flow to engine seawater pickup pump for adequate engine cooling [30 gal. per min. (114 L per min.) minimum]. Pickup also must supply a positive head while underway.

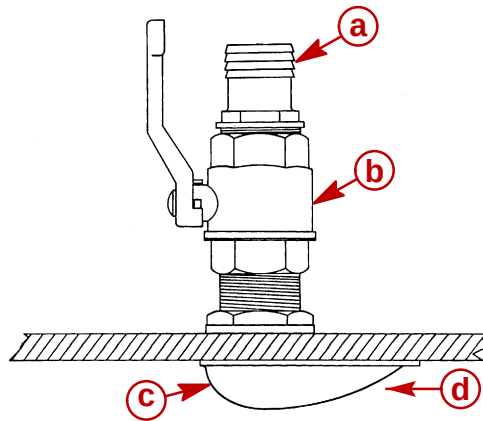
CAUTION

Do not install water pickup directly in line with propeller, as pickup may create turbulence and allow air to flow into the “propeller slipstream.” This will cause propeller ventilation and will adversely affect boat performance.

Water pickup should be located as close to seawater pickup pump inlet as possible and in an area where an uninterrupted, solid stream of water will flow past when boat is underway. Connect water pickup to seawater pickup pump inlet with 1-1/4 in. (32 mm) I.D. wire reinforced hose of adequate wall thickness to prevent it from collapsing from pump suction. Be sure to secure hose connections with hose clamps.

Seacock (Seawater Inlet Valve)

If a seacock is being used, it must be installed between water pickup and seawater pickup pump (or sea strainer), to allow operator to shut off the seawater in case of a leak or when boat is not in use. This will allow the operator to flush or drain the engine, or clean the sea strainer while boat is in the water. Seacock used must have an internal cross-sectional area equal to or greater than hose to prevent restricting water flow. Install seacock in an area where it will be easily accessible and self-supporting to prevent hose fatigue.



70355

Seacock (with Thru-Hull Pickup Shown)

- a** - Hose Connector 1-1/4 in. (32 mm) I.D. To Seawater Pump Inlet
- b** - Seacock 1-1/4 in. (32 mm) Brass Ball Or Gate Valve
- c** - Seawater Pickup
- d** - Direction Of Seawater Flow

Sea Strainer

If boat is equipped with a sea strainer, it must be of sufficient size to ensure that an adequate supply of water is maintained for engine cooling. Install seawater strainer in an area where it will be easily accessible for inspection and cleaning. Strainer should be installed in water inlet hose after water inlet valve to allow operator to shut off water when cleaning strainer.

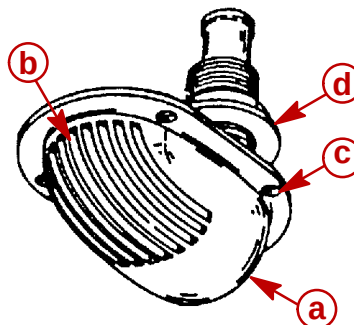
Seawater Pickups

NOTICE

Refer to manufacturer's instructions for information on removal and installation of other than Quicksilver Seawater Pickups.

IMPORTANT: Seal the inside edges of any hole made through the hull with a suitable sealant to prevent water absorption and deterioration.

Thru-Hull Mounted



72639

- a** - Seawater Pickup
- b** - Seawater Inlet Slots
- c** - Mounting Screw Holes (If Equipped)
- d** - Nut

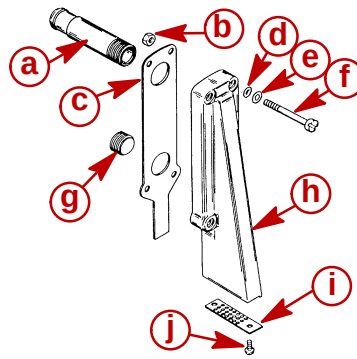
1. Seal inside edges of 1-3/4 in. (44 mm) hole in hull using a suitable sealer.
2. Apply marine caulking (sealer) to mounting surface on seawater pickup where hull contact will occur when installed.

IMPORTANT: Seawater inlet slots must face forward - parallel with the flow of water.

3. Ensure slots in seawater pickup are facing forward (toward bow of boat) and install seawater pickup through hull.
4. Fasten pickup with four appropriate mounting screws (if so designed).
5. Apply marine caulking as needed inside boat. Apply Loctite 27131 to threads of nut and install on pickup on inside of boat and torque nut to 35 lb-ft (42 Nm).

NOTE: If pickup being installed does not have mounting screws on underside where mounted to hull, be certain, after nut is torqued, that slots are still facing forward.

Transom Mounted



72640

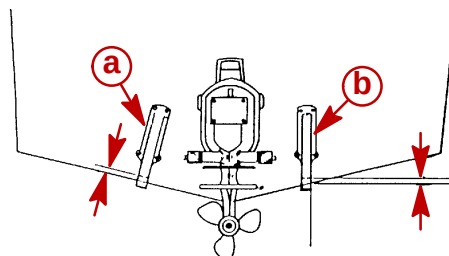
- a** - Hose Fitting
- b** - Nut (4)
- c** - Gasket - Between Pickup and Transom
- d** - O-Ring (4)
- e** - Washer (4)
- f** - Screw (4)
- g** - Plastic Pug
- h** - Pickup
- i** - Screen
- j** - Screw (2)

1. Seal the inside edges of the 1-1/2 in. (38 mm) hole hose fitting.
2. Be certain hose fitting and plastic plug are in place and threads have been sealed with Loctite Pipe Sealant with Teflon prior to tightening each securely.

NOTE: Use a sharp knife or wood chisel to remove excess plastic plug material so that plug is flush with pickup casting.

3. Position one flat washer and one rubber O-ring on each 5/16 in. x 4 in. (102 mm) long, round head screw as shown. Coat each screw shaft with silicone sealant or equivalent.
4. Place new gasket on pickup housing and hold pickup in place on transom. Install four round head screws (with washers and O-rings in place) into pickup mounting holes and through drilled 21/64 in. (8 mm) holes in transom.

NOTE: Some installations may have 7/32 in. (5 mm) holes drilled in transom using four 5/16 in. diameter stainless steel lag bolts in place of round head screws. In any case, flat washers and O-rings are required as outlined.



72641

Water Pickup Installed on Transom

- a** - Diagonal Mount - Leading Edge Of Pickup 1/8 in. (3.2 mm) From Boat Bottom.
- b** - Vertical Mount - Corner Of Leading Edge Of Pickup 1/8 in. (3.2 mm) From Boat Bottom

5. Secure water pickup from inside with locknuts and washers (unless using lag bolts).
6. Tighten fasteners securely.

Quicksilver Sea Strainer

NOTICE

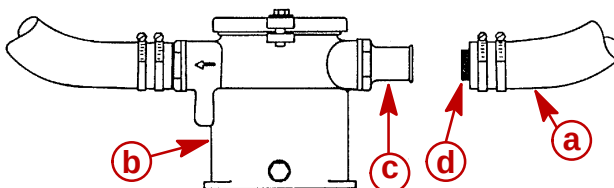
Refer to manufacturer's instructions for information on other than Quicksilver Sea Strainer.

Removal

CAUTION

If boat is in water while working on seawater strainer, close seacock, if so equipped. If boat is not equipped with a seacock, remove and plug seawater inlet hose to prevent a siphoning action that may occur, allowing seawater to flow from the drain holes or removed hoses and enter boat.

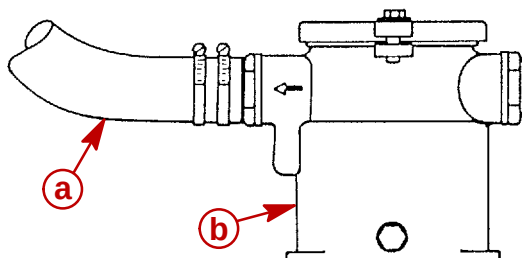
1. Follow "a" or "b" instructions:
 - a. **Models Equipped with Seacock:**
 - (1.) Close seacock (seawater inlet valve).
 - (2.) Disconnect seawater inlet hose from seawater strainer.
 - b. **Models without Seacock:**
 - (1.) Disconnect seawater inlet hose from seawater strainer inlet and plug seawater inlet hose.



70062

- a** - Seawater Inlet Hose
- b** - Seawater Strainer
- c** - Seawater Strainer Inlet
- d** - Plug

2. Remove outlet hose. Drain into a suitable container.



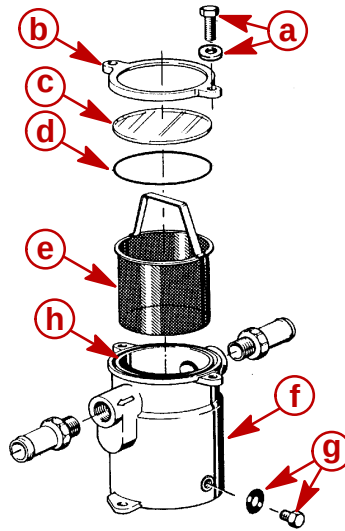
72643

- a** - Seawater Inlet Hose
- b** - Seawater Strainer

3. Remove mounting bolts. Remove strainer.

Cleaning and Inspection

1. Remove and clean filter element.
2. Remove drain plug



72673

Quicksilver Seawater Strainer Shown

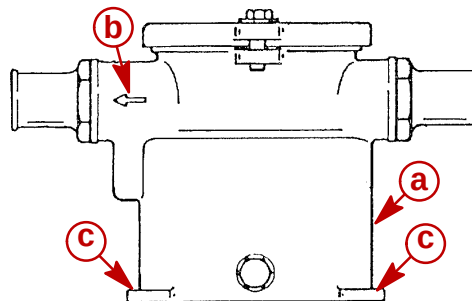
- a** - Screws and Washers
- b** - Cover
- c** - Glass
- d** - O-Ring
- e** - Strainer
- f** - Housing
- g** - Drain Plug and Sealing Washer
- h** - Gasket

3. Flush components with clean water.

Installation

IMPORTANT: Mount seawater strainer in a vibration-free location. Never mount it on the engine or transmission. Hoses must not be kinked or allowed to come in contact with hot or moving engine or transmission parts.

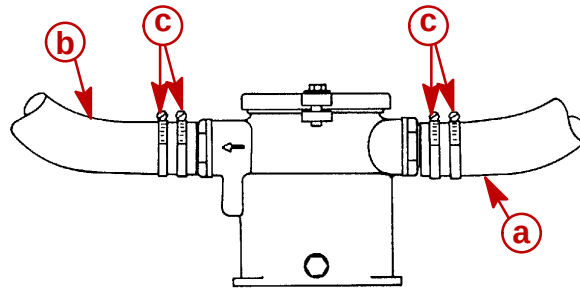
1. Mount seawater strainer. Arrow indicates required water flow direction and must point toward seawater pump. Tighten mounting bolts securely.



72644

- a** - Seawater Strainer
- b** - Arrow
- c** - Mounting Bolt Hole Location (Bolts Not Shown)

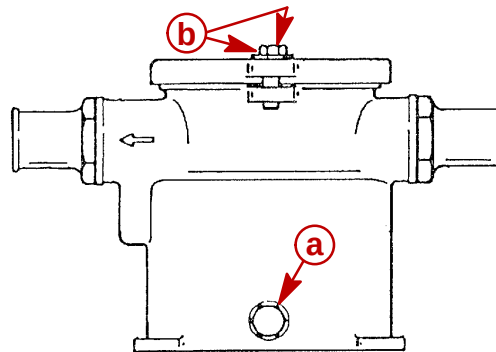
2. Remove plug from seawater inlet hose (if installed previously) and install hose on strainer. Install seawater outlet hose. Use two hose clamps on each hose connection. Tighten clamps securely.



72645

- a** - Seawater Inlet Hose
- b** - Seawater Outlet Hose
- c** - Double Hose Clamps

3. Check drain plug and lens cover bolts. Tighten securely. Do not overtighten cover bolts or cover may warp and leak water into boat.



72644

- a** - Drain Plug
- b** - Lens Cover Bolts (2, One Hidden In This View)

4. Open seacock, if equipped.

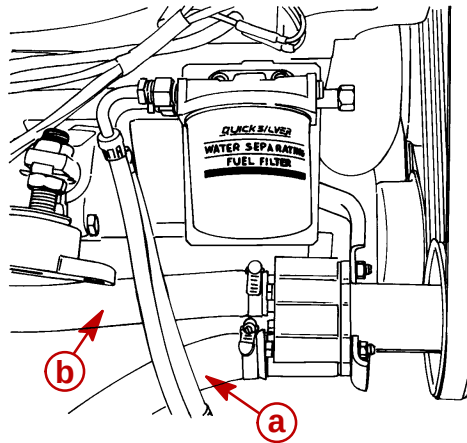
Seawater Pickup Pump

Output Test

If an overheating problem exists, use this test to determine if a sufficient amount of water is being supplied to cool the engine.

IMPORTANT: The following information should be observed before proceeding with test:

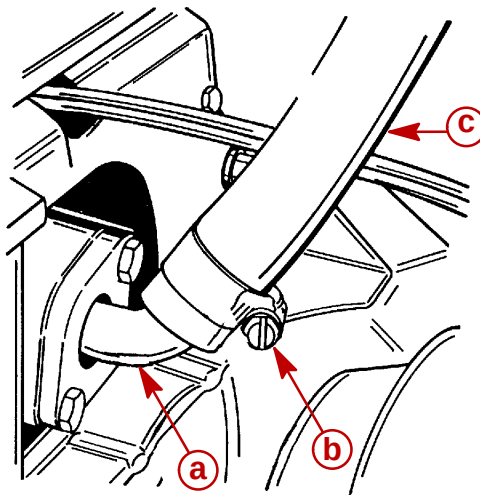
- **BOAT MUST BE IN THE WATER FOR THIS TEST.** This test **CANNOT BE** performed with a flush-test device and water hose.
 - The ability of this test to detect a problem is greatly dependent upon the accuracy with which it is performed. An error in setting the engine rpm, timing the test or measuring the water output will affect the overall accuracy of the test and may produce misleading results. To help ensure accurate results, a shop tachometer with an error of less than 5% should be used. The boat tachometer definitely should not be used as its accuracy is questionable. A stop watch should be used to time the duration of the test to help ensure that the accuracy is maintained within one second. An 8 U.S. qt. (7.6 L) or larger capacity container should be used to measure water output.
 - Due to the manner in which this test is performed, it may not be possible to detect a marginal condition or a high-speed water pump output problem.
1. **Models With Engine Mounted Seawater Pump** - remove water hose, which runs between pump outlet and engine, and replace with another hose of same diameter, but approximately 3 ft. (1 m) longer. Hose should be of adequate wall thickness to prevent it from kinking when performing test. Clamp hose at pump outlet only. Do not clamp hose at engine end.



75533

- a** - Seawater Inlet Hose
b - Hose To Cooler

2. **Models With Sterndrive (Alpha) Mounted Seawater Pump** - remove water inlet hose, which runs between gimbal housing water tube and engine, and replace with another hose of same diameter, but approximately 3 ft. (1 m) longer. Hose should be of adequate wall thickness to prevent it from kinking when performing test. Clamp hose at gimbal housing water tube only. Do not clamp hose at engine end.



72614

- a** - Water Tube
b - Hose Clamp
c - Water Hose

3. Place an 8 U.S. qt. (7.6 L) or larger container near unclamped end of hose.
4. With assistance of another person, start engine and adjust speed to exactly 1000 rpm while holding unclamped end of hose on connection on engine. Remove hose from connection on engine and direct water flow into container for exactly 15 seconds. At the end of 15 seconds, direct the water flow overboard, return engine to idle and stop engine. Reconnect hose to engine.
5. Measure quantity of water discharged into container and compare with specifications given in the following chart.
6. Repeat test four times to check repeatability of results.

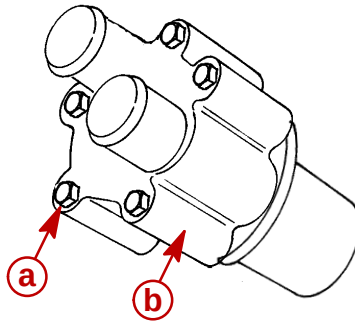
Engine Mounted Seawater Pump Output for a 15 Second Period	
7.5 U.S. Qt. (7.1 L) Minimum	

Alpha Sterndrive Seawater Pump Output for a 15 Second Period	
Drive Unit Gear Ratio	Minimum Quantity U.S. Qts.(L)
1.98:1	3.0 (2.8)
1.84:1	3.3 (3.1)
1.65:1	3.6 (3.4)
1.50:1	4.0 (3.8)
1.32:1	4.5 (4.3)

NOTE: Refer to Alpha Sterndrive Service Manual for repair of seawater pump.

Disassembly

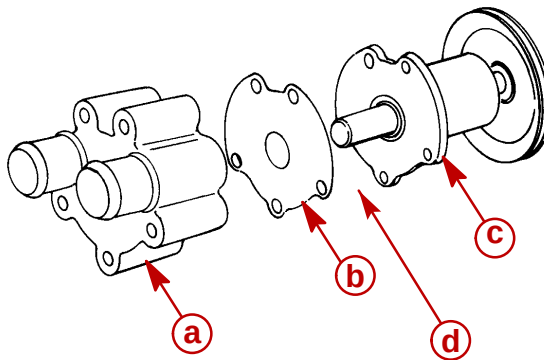
1. Remove the five screws from the seawater pump body.



75277

- a** - Screws (5)
- b** - Seawater Pump Body

2. Remove seawater pump body and wear plate from bearing housing.



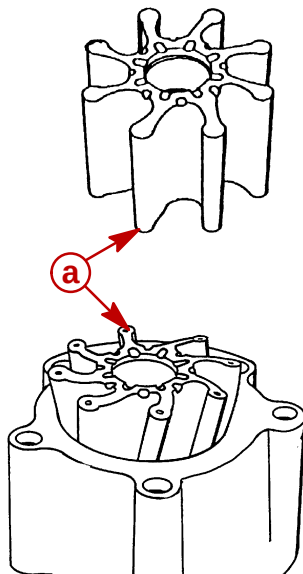
75275

- a** - Seawater Pump Body
- b** - Wear Plate
- c** - Bearing Housing

3. Remove the impeller from seawater pump body.

Reassembly

1. Lubricate seawater pump impeller with a water and soap solution. Install impeller into housing by rotating and pushing it into place. Push it down until flush with housing.

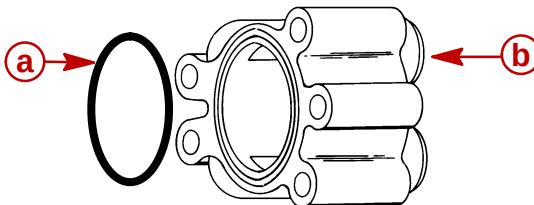


71118

71150

a - Impeller

2. Place wear plate over bearing housing shaft.
3. Place quad ring in groove in seawater pump body.



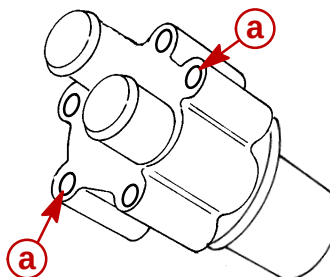
a - Quad Ring

b - Seawater Pump

4. Align flats on impeller and bearing housing shaft, slide seawater pump body on shaft.

NOTE: Reassembly of the pump requires the mounting bracket to be installed while performing the following step.

5. Install two screws in seawater pump body holes as shown. Use these two screws to align pump, then install the remaining screws.



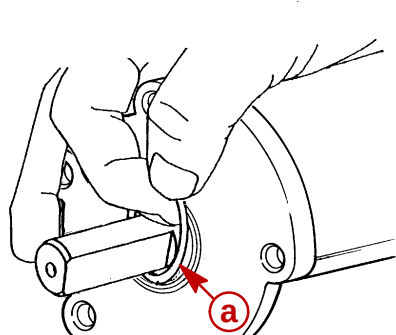
75277

a - Bolt Holes For Alignment

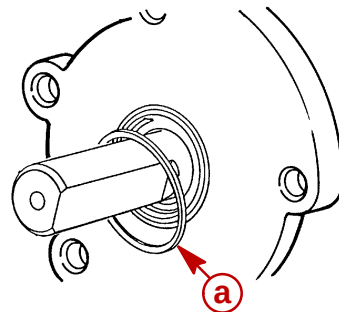
Seawater Pump Bearing Housing

Disassembly

1. Remove gasket, inner wear plate and quad ring seal. Discard gasket and quad ring seal.



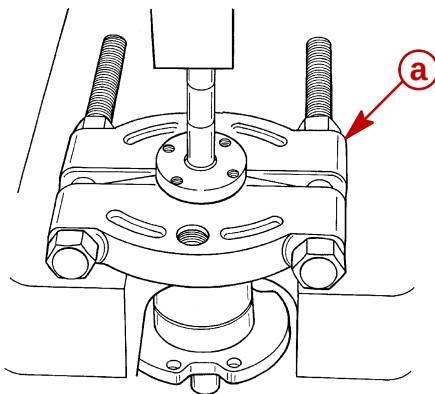
72655



72656

a - Quad Ring Seal

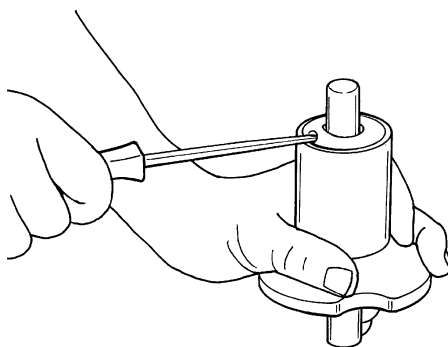
2. Press hub off shaft with Universal Puller Plate and an arbor press.



72648

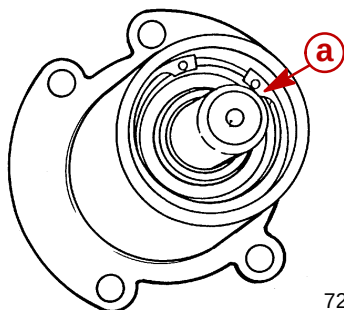
a - Universal Puller Plate (91-37241)

3. Puncture front oil seal with a tool and pry from bearing housing.

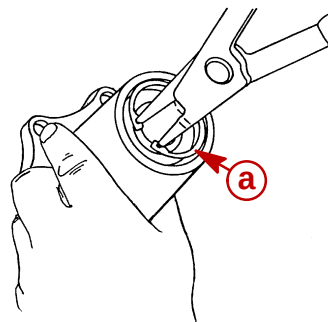


72649

4. Remove snap ring from bearing housing bore and press shaft and bearings out pulley end of housing. Bearings have a slip fit in housing; do not use excessive force.



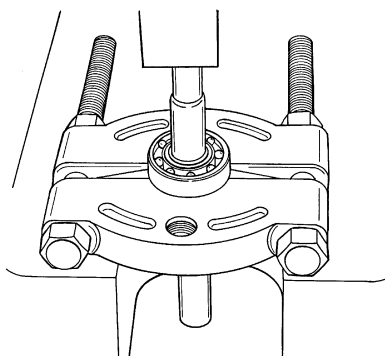
72657



72658

a - Snap Ring

5. If bearings require replacement, remove bearings from shaft with Universal Puller Plate and an arbor press. Bearings must be replaced, if removed.



72659

6. If rear seals require replacement, press seals from bearing housing with an appropriate tool.

Cleaning and Inspection

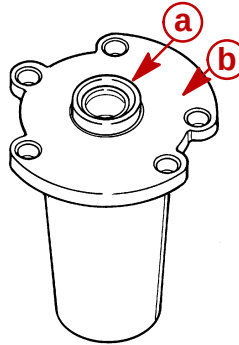
1. Clean metal parts in solvent and blow dry with compressed air.

IMPORTANT: Do not spin bearings at high speed when drying with compressed air, as bearings may be scored.

2. After cleaning, apply a coat of light engine oil to shaft and bearings to prevent rust.
3. Clean all gasket material and sealer from sealing surfaces.
4. Inspect bearing housing. Examine surfaces (where bearings contact housing) for evidence of bearing outer races turning in housing.
5. Inspect seals in bearing housing.
6. Inspect pump shaft bearings.
7. Inspect pump shaft for grooves in surface where seals contact shaft. Also inspect surface where bearings contact shaft for evidence of inner races turning on shaft.
8. Inspect pump body.
9. Inspect inner and outer wear plate.
10. Inspect pump impeller for wear on sides and tips of blades. Also inspect blades for cracks in area where blades flex. Replace impeller if blades have taken a set (remain in curved position).
11. Inspect pump pulley.
12. Check drive belt for excessive wear.

Reassembly

1. Apply a thin coat of Loctite 27131 to outside diameter of two new bearing housing rear seals; then install seals in housing with seal lips facing impeller end. Press first seal in until it bottoms out and second seal in until flush with housing.

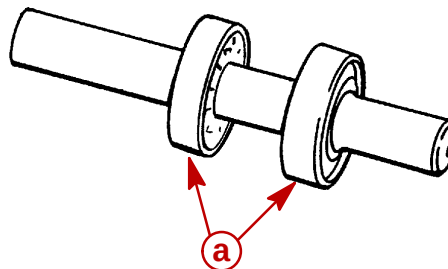


72660

- a** - Outer (Water) Seal
b - Face of Housing

IMPORTANT: It is recommended that Shell Alvania No. 2 Grease be used when packing seal and bearings in the following steps. If Shell Alvania No. 2 Grease is not available, it is permissible to use Quicksilver 2-4-C With Teflon. However, Quicksilver 2-4-C Marine Lubricant With Teflon is not recommended for applications where continuous high speed heavy-duty operation will be encountered.

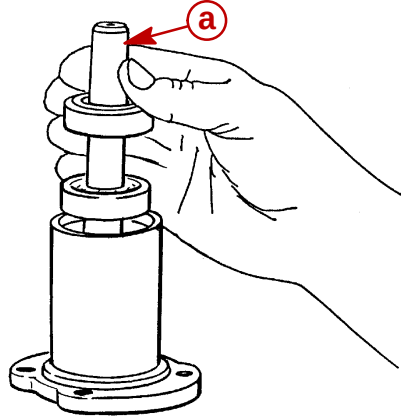
2. Pack cavity between seals with Shell Alvania No. 2 Grease or substitute.
3. Using an arbor press and suitable tool, press ball bearings onto shaft until they seat. Press on inner race of bearing only.



72663

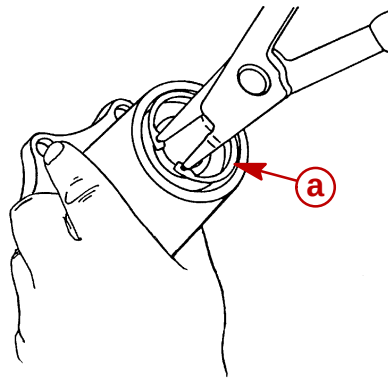
- a** - Bearings

4. Pack bearings and cavity between bearings with Shell Alvania No. 2 Grease or substitute. Slide bearings and shaft into bearing housing bore and install snap ring.



72661

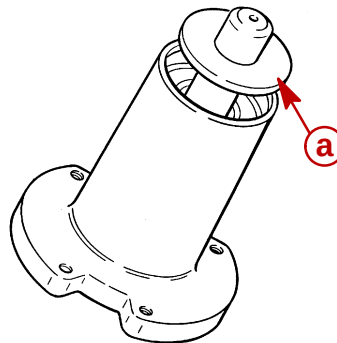
a - Shaft With Bearings



72658

a - Snap Ring

5. Apply a thin coat of Loctite 27131 to outside diameter of new bearing housing front oil seal and press seal into housing (with seal lip facing inward) until it bottoms out.

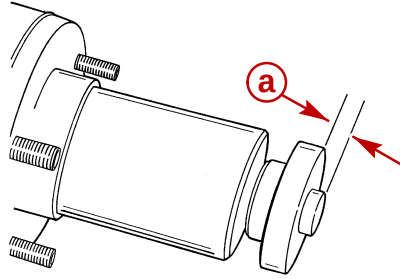


72662

a - Front Oil Seal

IMPORTANT: Be sure to support impeller end of pump shaft when installing pulley hub in next step to prevent placing a load on bearings.

6. Apply Quicksilver Special Lubricant 101 to pump shaft. Using an arbor press and appropriate tool, press pulley hub onto pump shaft to dimension shown.

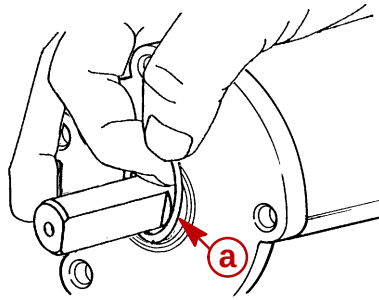


72664

a - .260 Inch (6.6 mm)

IMPORTANT: Pulley hub must be pressed onto shaft to exact dimension on pumps with stamped steel mounting bracket as this establishes proper drive belt alignment.

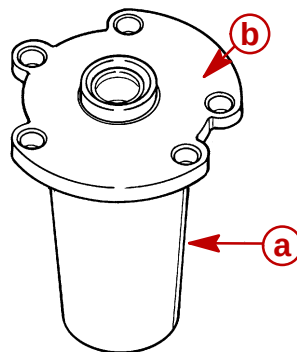
7. Clamp bearing housing in a soft jaw vise with flange end up.
8. Coat quad ring seal with Quicksilver 2-4-C Marine Lubricant With Teflon and install into groove in housing.



72655

a - Quad Ring Seal

9. Place the wear plate over the bearing housing.



72660

a - Bearing Housing
b - Wear Plate

Water Circulating Pump

Removal

1. Drain water from cylinder block.
2. Break loose circulating pump pulley attaching bolts. Do not remove bolts at this time.
3. Loosen alternator tensioner pulley, then pivot alternator inward and remove the serpentine drive belt.
4. Remove pump pulley attaching bolts, lockwashers, clamping ring (if equipped) and pulley.
5. Disconnect hose(s) from pump.
6. Remove bolts, which secure pump to cylinder block, and remove pump and old gaskets (discard gaskets).

Cleaning and Inspection

1. Clean gasket surfaces on water pump and cylinder block.
2. Inspect water pump for blockage, cracks, sand holes, corrosion or other damage. Inspect pump impeller for cracks and erosion. Replace complete pump if any damage exists.
3. Check impeller shaft and bearings for excessive side play. If play can be felt, replace complete pump.
4. Inspect pump pulley for bends, cracks, corrosion or other physical damage. Inspect pulley for rotational trueness. Replace pulley if damaged or untrue.

Installation

1. Coat both sides of new circulating pump gasket with Quicksilver Perfect Seal, then position gaskets and circulating pump on cylinder block. Coat threads of circulating pump attaching bolts with Quicksilver Perfect Seal and install bolts and alternator brace (if applicable). Torque bolts to specifications.
2. Reconnect hoses to pump.
3. Install pump pulley and clamping ring (if used) on pump hub and secure with bolts and lockwashers. Tighten bolts securely.
4. Install drive belts and adjust tension as outlined in "Drive Belt Tension Adjustment."
5. Start engine and check for leaks.

Drive Belt Tension Adjustment

NOTICE

Refer to SECTION 4B - "Ignition System"

Flushing Seawater Cooling System

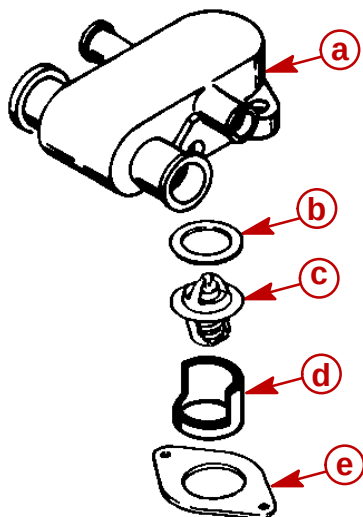
NOTICE

Refer to SECTION 1B - "Maintenance"

Thermostat

Removal

1. Drain water from cylinder block and exhaust manifolds.
2. Remove thermostat housing and related components.
3. Remove thermostat from thermostat housing or cover.

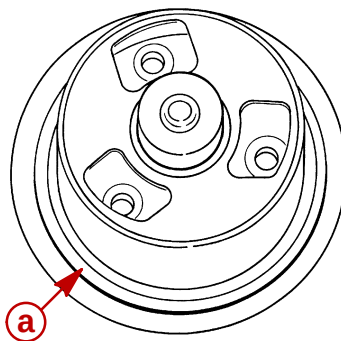


- a** - Housing
- b** - O-Ring
- c** - Thermostat (Stainless Steel)
- d** - Spacer
- e** - Gasket

71758

Testing

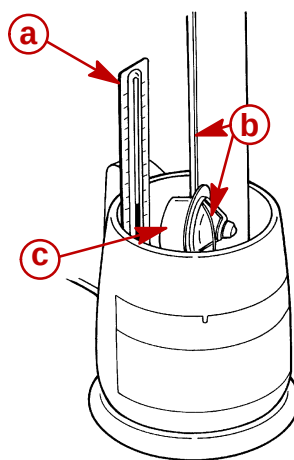
1. Clean thermostat in soap and water to remove any deposits or debris.
2. Inspect thermostat for corrosion or other visible damage.
3. If thermostat is suspected of producing insufficient engine temperature, check thermostat for leakage by holding it up to a lighted background. Light leakage around the thermostat valve indicates that thermostat is not closing completely and should be replaced. (A small amount of leakage at one or two points around the valve perimeter is acceptable.)



72717

a - Check For Light Leakage Around Perimeter Of Valve

4. Check opening and closing temperature of thermostat (using a tester similar to the one shown) as follows:
 - a. Fill tester to within 1 in. (25 mm) of top with tap water. Do not use distilled water.
 - b. Open thermostat valve and insert nylon string. Position thermostat on string so that it will be just below water level when suspended, then allow valve to close. Suspend thermostat in water.
 - c. Place thermometer in container and position so that bottom of thermometer is even with bottom of thermostat. Do not allow thermometer to touch container.



72675

- a - Thermometer**
b - Nylon String
c - Thermostat

IMPORTANT: When performing procedures d. - f. water must be agitated thoroughly to obtain accurate results.

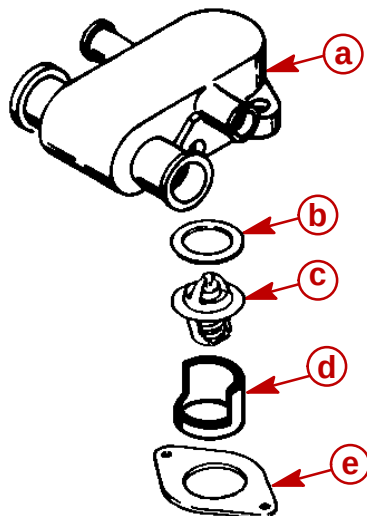
- d. Plug in tester and observe temperature at which thermostat opens (thermostat drops off thread). Thermostat must open at specified temperature stamped on thermostat.
- e. Continue to heat water until a temperature 25°F (14°C) above temperature specified on thermostat is obtained. Thermostat valve must be completely open at this temperature.
- f. Unplug tester and allow water to cool to a temperature 10°F (5°C) below specified temperature on thermostat. Thermostat must be completely closed at this temperature.
- g. Replace a thermostat that fails to meet all of the preceding tests.

Installation

1. Clean gasket surfaces on thermostat housing and intake manifold.

IMPORTANT: Gasket has continuity rivets. Do not coat with Quicksilver Perfect Seal, or Audio Warning Temperature Switch may not work properly.

2. Place O-ring in the thermostat housing. Be certain it is positioned properly in housing.
3. Place thermostat in thermostat housing with thermostatic element end toward housing bottom, as shown.
4. Align sleeve with groove in thermostat housing bore and install sleeve into housing.
5. Coat both sides of new thermostat housing gasket with Quicksilver Perfect Seal and position on intake manifold.
6. Reinstall thermostat housing and torque screws with lockwashers to 30 lb-ft (41 Nm).
7. Reconnect hose(s) to thermostat housing. Tighten hose clamps securely.
8. Start engine and inspect for leaks.



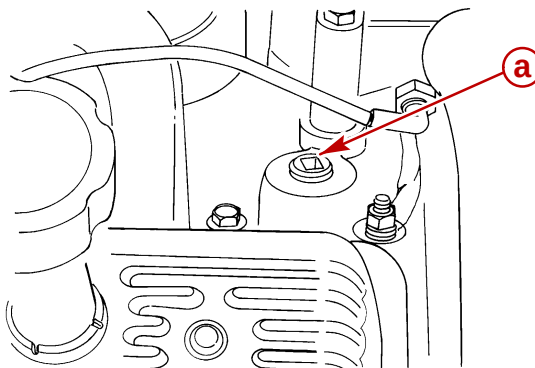
71758

- a** - Housing
- b** - O-Ring
- c** - Thermostat (Stainless Steel)
- d** - Spacer
- e** - Gasket

Auxiliary Hot Water Heater Installation

IMPORTANT: When connecting a cabin heater or hot water heater, certain requirements must be met:

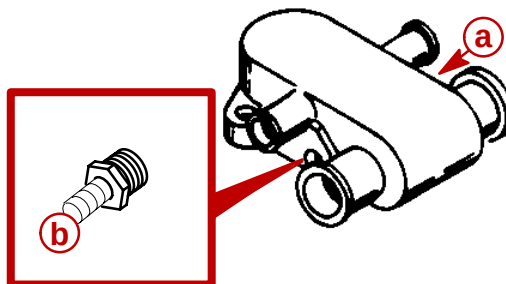
- Supply hose (from engine to heater) and return hose (from heater to engine) **MUST NOT EXCEED 5/8 in. (16 mm) I.D. (inside diameter).**
- Make heater connections **ONLY** at locations described in the following instructions.
- Check complete system for leaks after heater is connected into cooling system.
- Check for overheating condition (of engine) after heater is connected.



74973

Supply Hose Connection - If Location is Available

a - Location for Hot Water Supply

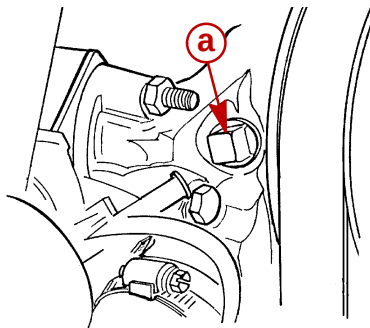


71758

Supply Hose Alternate Location

a - Thermostat Housing

b - Hose Connector



75480

Return Hose Connection

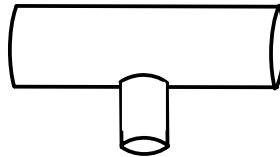
a - Location For Hot Water Return

Water Tap Locations For Propshaft Coolers

IMPORTANT: Tapping into the wrong location can cause the engine to vapor lock or run too cold.

MIE (Inboard) Models Only:

Splice into the port-side exhaust manifold water hose. This provides the temperatures and pressures required to cool the packing glands without damaging them.



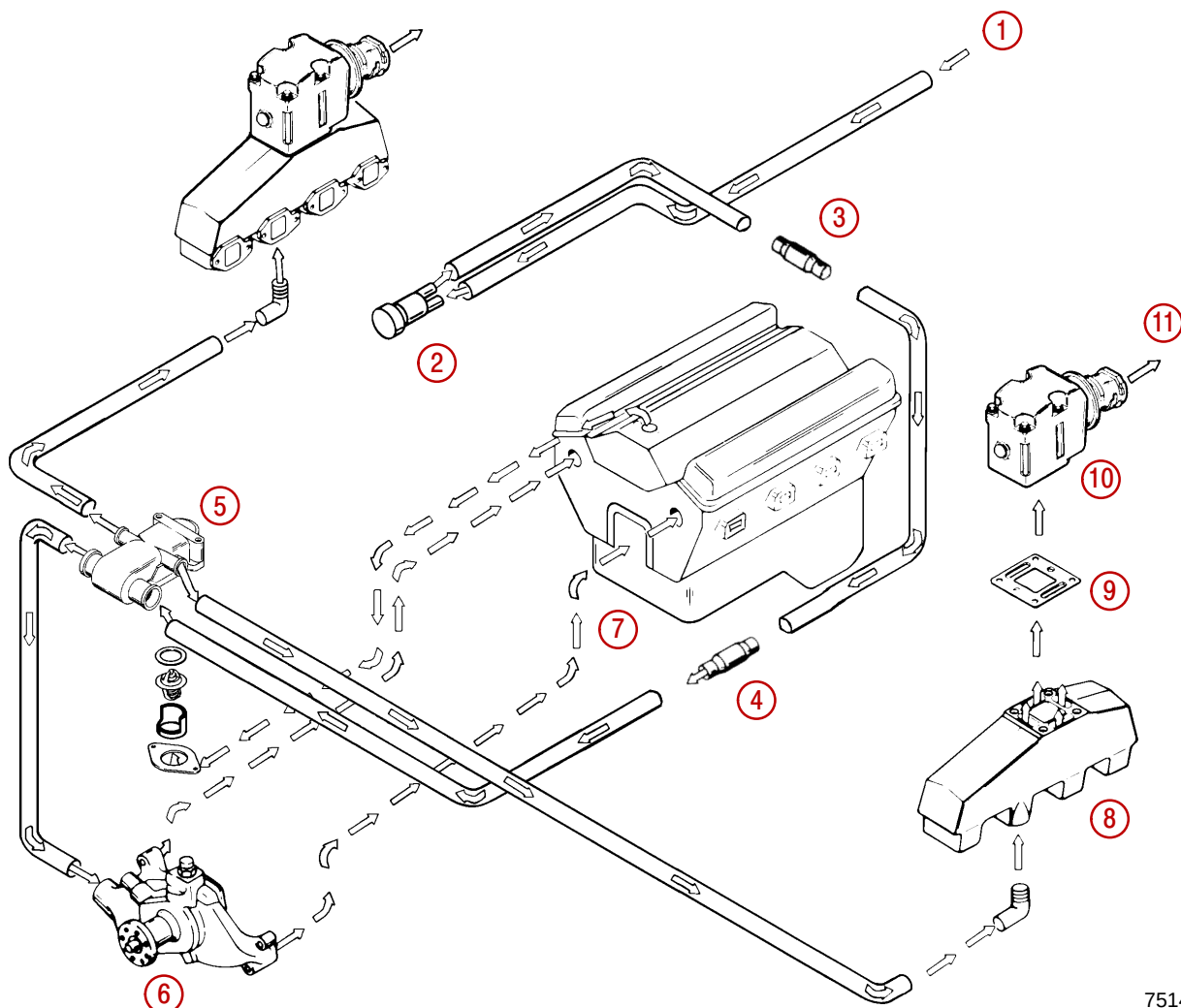
76254

T-Fitting

Water Flow Diagrams

305 cid and 350 cid Bravo, Inboard and Ski Engines

NOTE: Certain components in the following diagram may look different than on your particular power package, but the water flow paths remain similar on all engines.

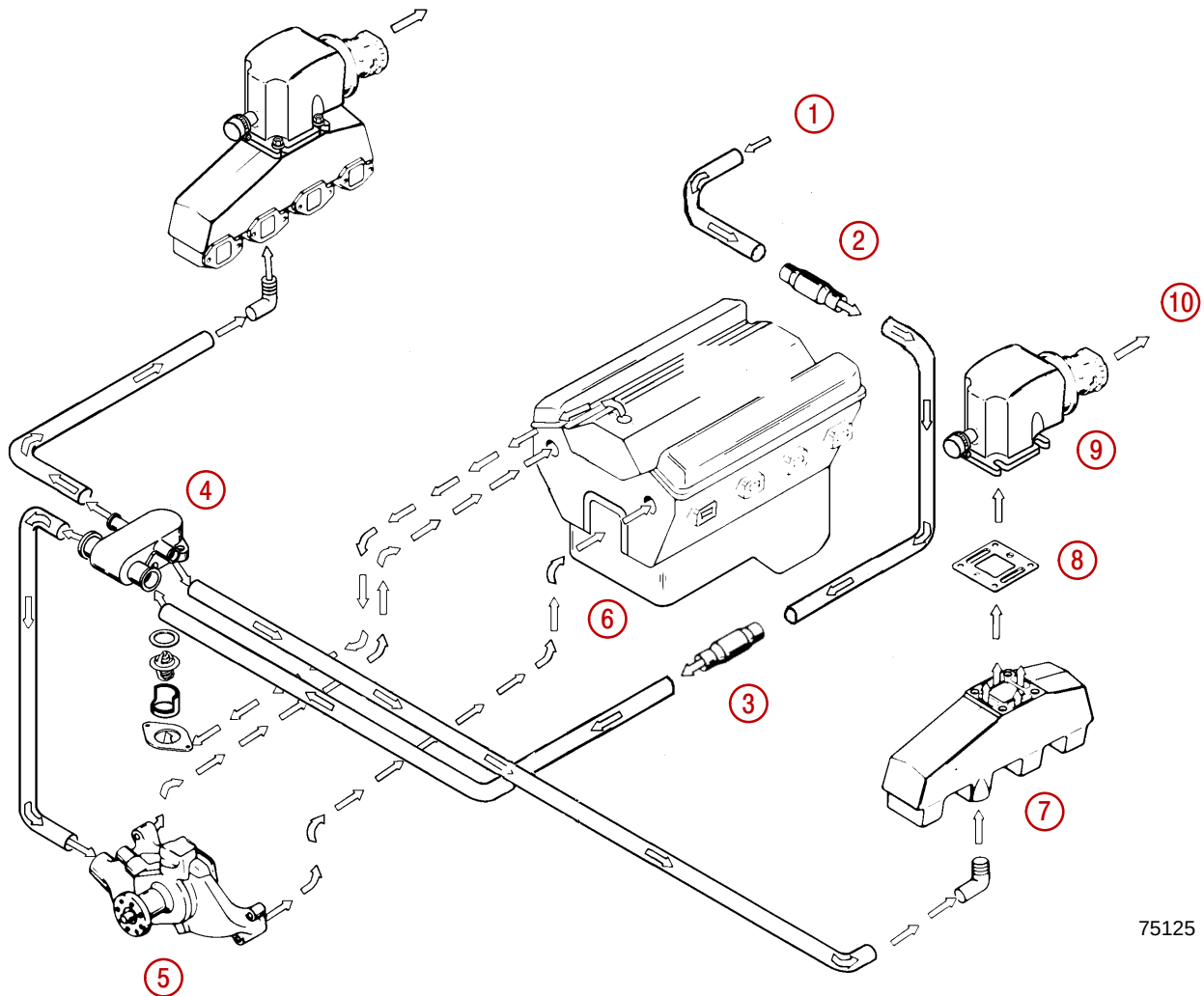


75149

- 1 - Seawater Intake (From Sterndrive)
- 2 - Seawater Pump
- 3 - Power Steering Fluid Cooler Or Transmission Fluid Cooler
- 4 - Fuel Cooler (EFI and MPI Models)
- 5 - Thermostat Housing and Cover Assembly
- 6 - Engine Water Circulating Pump
- 7 - Engine Block and Cylinder Head Assembly
- 8 - Exhaust Manifold, Typical
- 9 - Restrictor Gasket
- 10 - Exhaust Elbow Assembly, Typical
- 11 - Water Flow Overboard

305 cid and 350 cid Alpha Engines

NOTE: Certain components in the following diagram may look different than on your particular power package, but the water flow paths remain similar on all engines.



75125

- 1** - Seawater Intake (From Sterndrive)
- 2** - Power Steering Cooler
- 3** - Fuel Cooler (EFI and MPI Models)
- 4** - Thermostat Housing and Cover Assembly
- 5** - Engine Water Circulating Pump
- 6** - Engine Block and Cylinder Head Assembly
- 7** - Exhaust Manifold, Typical
- 8** - Restrictor Gasket
- 9** - Exhaust Elbow Assembly, Typical
- 10** - Water Flow Overboard

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COOLING SYSTEM

Section 6B - Closed Cooled Models

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Torque Specifications

Description	lb-in.	lb-ft	Nm
Heat Exchanger End Cap	36-72		4-8
Thermostat Cover		30	41
Heat Exchanger Mounting Brackets	Securely		
Hose Clamps			
Drain Plugs			

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver 2-4-C Marine Lubricant With Teflon	92-825407A3
Quicksilver Perfect Seal	92-34227--1
Quicksilver Liquid Neoprene	92-25711--3
Loctite Pipe Sealant With Teflon	Obtain Locally

Specifications

Closed Cooling System Capacity

NOTICE
Unit of Measurement: U.S. Quarts (Liters) All Capacities are approximate fluid measures.

Model	All Engines
Seawater Cooling System	15 (14.1)
Closed Cooling System	20 (19)

Coolant Specification

All Models
Extended Life Coolant 5/100 (Orange Color)

Thermostat

Engine	Specification
All Engines	160°F (71°C)

Pressure Cap Rating

Engine	Specifications
All Engines	16 psi (110 kPa)

Description

The cooling system is composed of two separate subsystems: the seawater system and the closed cooling system. The seawater system is similar in function to the fan used in an automobile because it absorbs heat from the closed cooling system as it passes through the heat exchanger. The closed cooling system is similar in function to the rest of the cooling system in an automobile.

The coolant recovery system keeps the reservoir full. Normal coolant overflow into recovery bottle is approximately 1/2 pint (230 mL) during warm-up. The coolant recovery system draws coolant back into the reservoir from the recovery bottle as the engine cools. As long as there is coolant in the recovery bottle, the reservoir should remain completely full. If not, there is a vacuum leak, usually at the hose leaving the reservoir or the gasket under the recovery filler cap.

IMPORTANT: The coolant (antifreeze) flows around the outside of the cooling tubes while seawater flows through the inside of the cooling tubes in the heat exchanger.

Coolant Recommendations

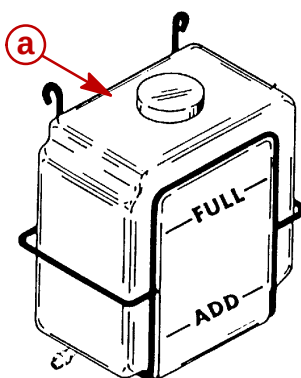
CAUTION

Alcohol or Methanol base antifreeze or plain water are not recommended for use in fresh water section of cooling system at any time.

NOTE: All factory installed closed cooling systems come filled with Extended Life Coolant. This antifreeze requires draining and replacing every five years or 1000 hours of operation, whichever comes first. For best results any "top-off" fluid used should be Extended Life Coolant. If Extended Life Coolant is unavailable, any type of ethylene glycol based antifreeze may be used, but it will require the draining and replacing of the coolant every two years or 400 hours of operation, whichever comes first.

In areas where the possibility of freezing DOES NOT exist, it is permissible to use solution of rust inhibitor and water (mixed to manufacturer's recommendations).

Maintaining Coolant Level



72520

Coolant Recovery Bottle

a - Fill Cap

Before starting engine each day, ensure that coolant is visible in coolant recovery bottle.

If coolant is not visible, check fresh water section of cooling system (including coolant recovery system) for leaks and repair. Refill fresh water section with recommended coolant solution as outlined under "Changing Coolant," following.

If coolant is visible, start engine and run until it reaches normal operating temperature, then recheck coolant level in coolant recovery bottle. Coolant level **MUST** be between the ADD and FULL marks (on front of bottle).

WARNING

Allow engine to cool before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and remove cap.

If level is low, remove fill cap from coolant recovery bottle and add required amount of coolant solution. Refer to "Coolant recommendations" in this section.

IMPORTANT: ALCOHOL OR METHANOL BASE ANTIFREEZE OR PLAIN WATER ARE NOT RECOMMENDED FOR USE IN COOLING SYSTEM AT ANY TIME. In areas where ethylene glycol is not available, and the possibility of freezing does not exist, it is permissible to use a solution of rust inhibitor and pure, soft water (mixed to manufacturer's recommendations).

Occasionally, ensure that coolant recovery system is functioning properly by removing pressure cap from heat exchanger and checking level. Coolant level should be up to bottom of heat exchanger filler neck. If low, examine entire fresh water section (especially coolant recovery system) for leaks and repair.

IMPORTANT: When reinstalling pressure cap, tighten it until it contacts stops on filler neck.

Pressure Cap Maintenance

Pressure cap should maintain pressure in fresh water section of closed cooling system at normal engine operating temperature. This raises the boiling point of the coolant, thereby increasing the efficiency of the cooling system. To help ensure proper operation, cap should be cleaned, inspected and pressure tested periodically as follows:

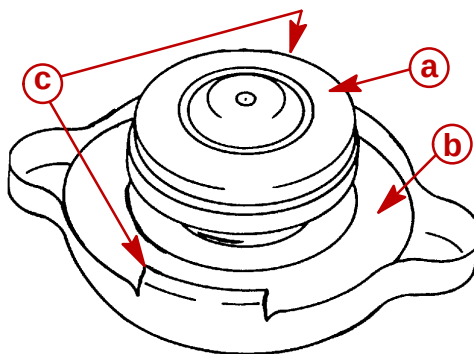
WARNING

Allow engine to cool before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

1. Remove pressure cap from heat exchanger.
2. Wash cap with clean water to remove any deposits or debris from sealing surfaces.
3. Inspect rubber seal on cap for cuts, cracks or other signs of deterioration. If seal is damaged, cap **MUST** be replaced.
4. Inspect coolant recovery gasket for deterioration and replace if bad.

5. Check condition of locking tabs on cap. Replace cap if tabs are bent or cracked.
6. Check gasket for cracks or other damage.

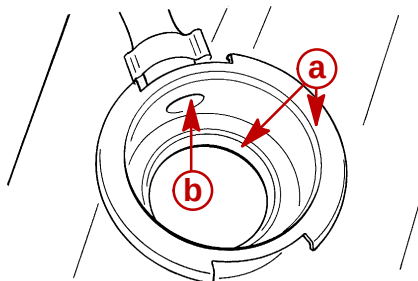
IMPORTANT: Cap MUST be replaced if damaged.



72714

- a** - Rubber Seal
- b** - Gasket
- c** - Locking Tabs (1 Hidden)

7. Refer to "Testing Pressure Cap" and test pressure cap as outlined.
8. Clean sealing surfaces on heat exchanger filler neck with a cloth. Inspect surfaces for any damage or deposits that may prevent cap from sealing properly.
9. Clean coolant recovery passage in heat exchanger filler neck with a wire and blow out with compressed air.



72715

- a** - Sealing Surfaces
- b** - Coolant Recovery Passages

10. Reinstall pressure cap. Tighten cap until it contacts filler neck.

Heat Exchanger Repair

IMPORTANT: Braze with BCUP 2 rod or silver solder. Care must be taken not to melt other joints during repair.

1. Internal leaks can be repaired by brazing shut the ends of the leaking tube. This is only a temporary fix because usually another tube will start leaking after a short period of time and this also causes a reduction in cooling capacity. Do not close more than three tubes.
2. Fittings and drains that have been broken off the heat exchanger can be reattached by brazing.

Testing Closed Cooling System

Testing Coolant for Alkalinity

WARNING

Allow engine to cool before removing pressure cap as sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

Coolant in fresh water section should be changed per Maintenance Schedule recommendations and should be checked for alkalinity at least once between change intervals. To check coolant for alkalinity, proceed as follows:

1. Obtain pink litmus paper from a local supplier (drug store, pet shop, etc.).
2. Remove pressure cap from heat exchanger and insert one end of litmus paper into coolant.
3. **If pink litmus paper turns blue**, coolant is alkaline and need not be replaced.
4. **If pink litmus paper remains pink**, coolant is not alkaline and **MUST BE REPLACED**, as explained under "Changing Coolant."

Pressure Testing System

WARNING

Allow engine to cool before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

If coolant section of closed cooling system is suspected of leaking or not holding sufficient pressure, and no visible signs of leakage can be found, perform the following test:

1. Remove pressure cap from heat exchanger or reservoir.
2. Clean, inspect and pressure test pressure cap, as outlined in "Testing Pressure Cap."
3. Clean inside of filler neck to remove any deposits or debris. Examine lower inside sealing surface for damage. Surface must be perfectly smooth to achieve a good seal between it and rubber seal on cap. Also check locking cams on sides of filler neck to be sure that they are not bent or damaged.
4. Adjust coolant level in fresh water section to 1 in. (25 mm) below filler neck.
5. Attach an automotive-type cooling system pressure tester to filler neck and pressurize closed cooling section to amount specified in following chart.

Pressure Cap Rating	Amount of Pressure Applied to Closed Cooling System
16 psi (110 kPa)	20 psi (138 kPa)

6. Observe gauge reading for approximately two minutes; pressure should not drop during this time. If pressure drops, proceed with the following steps until leakage is found.
7. While maintaining specified pressure on closed cooling section, visually inspect external portion of cooling system (hoses, gaskets, drain plugs, petcocks, core plugs, circulating pump seal, etc.) for leakage. Also listen closely for bubbling or hissing.
8. Refer to "Testing Heat Exchanger" in this section and test as outlined.

9. If no leakage could be found in above steps, engine is leaking internally. Leaking may be caused by one or more of the following: (1) loose cylinder head bolts or damaged gasket, (2) loose intake manifold bolts or damaged gasket, (3) loose exhaust elbow or distribution block retaining nuts or damaged gasket, (4) cracked or porous cylinder head or block, or (5) cracked or porous exhaust manifold. Proceed as follows until location of internal leak is found.
 - a. Start engine. Re-pressurize system to previously specified amount and observe pressure gauge on tester. If needle in gauge vibrates, compression or combustion is leaking into closed cooling section from a leak in the combustion chamber. Exact cylinders where leakage is taking place can sometimes be found by removing spark plug wires (one at a time) while observing pressure gauge. Vibration will decrease or stop when plug wire is removed from leaking cylinder. Stop engine.
 - b. Remove spark plugs (one at a time) from cylinders and examine for presence of coolant. A spark plug that is perfectly clean or milky appearing is a sure indication of a leak.
 - c. Drain oil from engine and examine for coolant. Oil will usually be milky if coolant is present. If coolant is present, remove engine from boat and drop the oil pan. With engine in the upright position, re-pressurize closed cooling section to previously specified amount and examine internal surfaces of engine to locate leak.
 - d. If no leakage can be found in above steps, entire engine must be disassembled and inspected for leakage.

Testing for Cylinder Head Gasket Leak

A leaking head gasket will cause combustion gas to be forced into the cooling system. The mixture of coolant and tiny air bubbles is a poor heat conductor and will overheat an engine quickly. Compression tests or cooling system pressure check normally will not detect the leak because the test pressure is far below the combustion pressures that cause the leak. An effective test is as follows:

IMPORTANT: Run boat in lake for this test. It is best to run the engine at or above cruising speed during this test. Usually a failed head gasket will not cause the engine to overheat below cruising speed.

1. Install a clear plastic hose between the reservoir and coolant recovery bottle. Use a 2-3 ft. (610-910 mm) long hose for this test.
2. Route this hose so a "U" is formed.
3. Put enough coolant into hose to fill the center 4 or 5 inches (100-130 mm) of the "U."
4. Observe the "U" while the engine is running.
 - a. **During Idle and Warm-Up:** Some coolant and/or air will leave the reservoir.
 - b. **During Cruising Speed (2500-3500 rpm):** Coolant and/or air leaving the reservoir should stop after approximately five minutes running at a given rpm. A leaking head gasket will produce air bubbling through the "U," going to the coolant recovery bottle. The frequency and size of the bubbles will depend on the size of the leak.
 - c. **At Higher Speeds (4000+ rpm):** Normal operation is the same as described in "b" above. A failed head gasket will cause the bubbles to come faster and may be accompanied by violent, intermittent bursts of coolant.

Do not confuse normal warm-up expansion with a failed head gasket. Normal warm-up produces an intermittent flow of coolant that will stop within approximately five minutes at a given rpm. A head gasket leak will not stop because the one thing that marks a failed head gasket is the continued passage of air. This may be accompanied by violent, intermittent bursts of coolant leaving the reservoir. If coolant flows evenly from the reservoir at cruising speed, something other than the head gasket is causing the engine to overheat.

Testing Heat Exchanger

FOR INTERNAL LEAK: An internal leak will cause coolant to go into the seawater circuit when pressure is put on the closed cooling circuit.

1. Remove a seawater hose from the exchanger. Do not drain the exchanger.
2. Pressurize the closed cooling circuit to 16-20 psi (110-138 kPa) with a radiator tester.
3. If seawater begins to flow from the nipple there is a leak.

FOR BLOCKAGE:

IMPORTANT: Seawater flows **THROUGH** the tubes in the exchanger. Closed cooling coolant flows **AROUND** the tubes.

1. Remove end caps and inspect for any blockage in the seawater circuit (broken impeller blades, weeds, etc.).
2. Remove closed cooling circuit hoses and inspect the tubes just inside the nipples. Because the complete exchanger cannot be inspected, the heat exchanger should be replaced if blockage is suspected.

Testing Pressure Cap

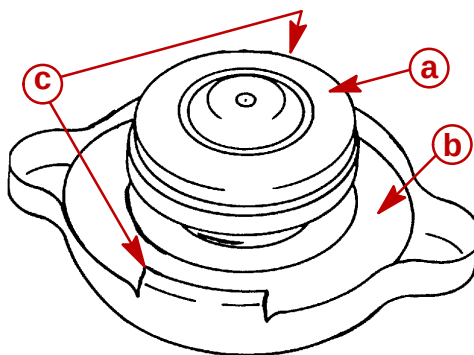
Pressure cap is designed to maintain a pressure of approximately its rated capacity (refer to "Specifications") in closed cooling section once engine has attained operating temperature. Cap should be cleaned, inspected and pressure-tested at regular tune-up intervals or whenever cap is suspected of maintaining improper pressure as follows:

WARNING

Allow engine to cool before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

1. Carefully remove pressure cap from reservoir or heat exchanger.
2. Wash cap with clean water to remove any deposits or debris from sealing surfaces.
3. Inspect gasket (if used) and rubber seal on cap for tears, cuts, cracks or other signs of deterioration. Replace gasket, if damaged, or entire cap if rubber seal is damaged.
4. Check condition of locking tabs on cap. Replace cap if tabs are bent or cracked.

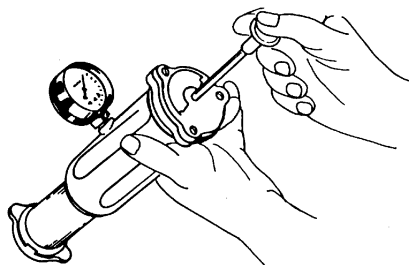
IMPORTANT: Cap MUST be replaced if damaged.



72714

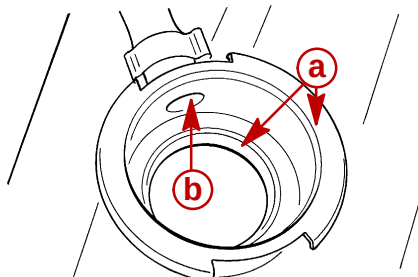
- a** - Rubber Seal
- b** - Gasket

5. Using a cooling system pressure tester (similar to one shown), test cap to be sure that it releases at proper pressure and does not leak. (Refer to instructions which accompany tester for correct test procedure.) Cap must relieve pressure at 16 psi (110 kPa), and must hold rated pressure for 30 seconds without going below 11 psi. Replace cap if it fails to fall within these limits.



72716

IMPORTANT: Before reinstalling cap in next step, examine lower inside sealing surface in filler neck to ensure that it is perfectly smooth and free of debris. Also, inspect cam lock flanges on sides of filler neck to be sure that they are not bent.



72715

- a** - Sealing Surfaces
- b** - Coolant Recovery Passages

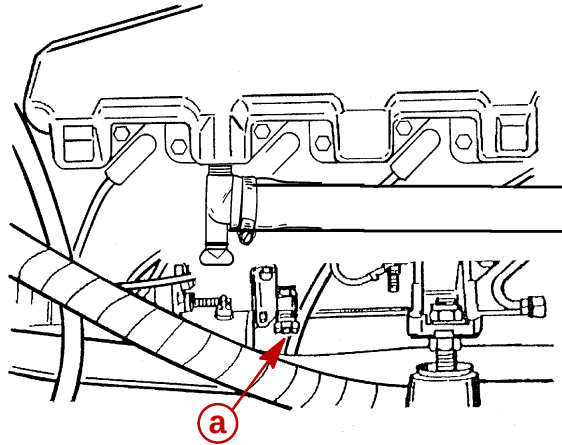
6. Reinstall cap on reservoir or heat exchanger.

Thermostat

Removal

NOTE: If coolant flow is restricted or fails to occur, a wire should be repeatedly inserted into all drain holes to ensure there are no obstructions in passages. Remove fitting, if necessary, to insert wire completely into drain hole.

1. Drain engine block by removing drain plugs. Be sure to drain port and starboard sides.

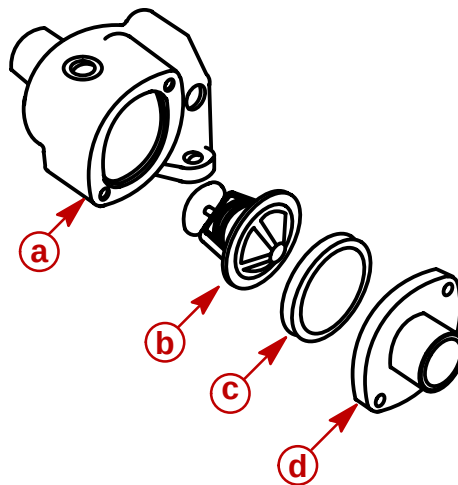


74130

Starboard Side Shown (Port Side Similar)

a - Hose

2. Disconnect hoses from thermostat cover.
3. Remove thermostat cover attaching bolts and lockwashers, then remove cover and gasket.
4. Remove thermostat from thermostat housing.

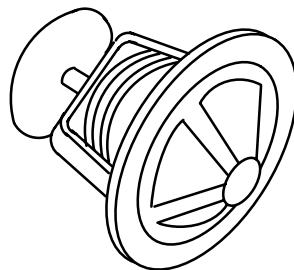


75746

- a** - Thermostat Housing
- b** - Thermostat
- c** - Gasket
- d** - Thermostat Housing Cover

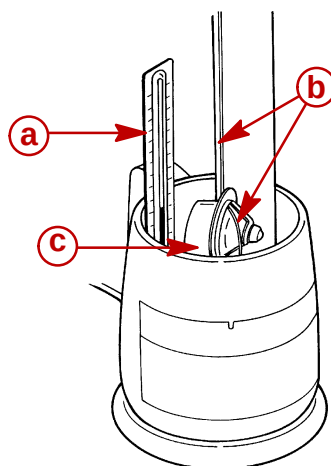
Testing

1. Clean thermostat in soap and water to remove any deposits or debris.
2. Inspect thermostat for corrosion or other visible damage.



75747

3. If thermostat is suspected of producing insufficient engine temperature, check thermostat for leakage by holding it up to lighted background. Light leakage around the thermostat valve indicates that thermostat is not closing completely and should be replaced. (A small amount of leakage at one or two points around the valve perimeter is acceptable.)
4. Check opening and closing temperature of thermostat (using a tester similar to the one shown), as follows:
 - a. Fill tester to within 1 in. (25 mm) of top with tap water. Do not use distilled water.
 - b. Open thermostat valve and insert thread. Position thermostat on nylon string so that it will be just below water level when suspended, then allow valve to close. Suspend thermostat in water.



72675

- a** - Thermometer
- b** - Nylon String
- c** - Thermostat (Typical)

- c. Place thermometer in container and position so that bottom of thermometer is even with bottom of thermostat. Do not allow thermometer to touch container.

IMPORTANT: When performing instructions d. and e. water must be agitated thoroughly to obtain accurate results.

- d. Plug in tester and observe temperature at which thermostat opens (thermostat drops off thread).
- e. Unplug tester and allow water to cool to a temperature 10°F (5°C) below specified temperature on thermostat. Thermostat must be completely closed at this temperature.
- f. Replace a thermostat that fails to meet all of the preceding tests.

Installation

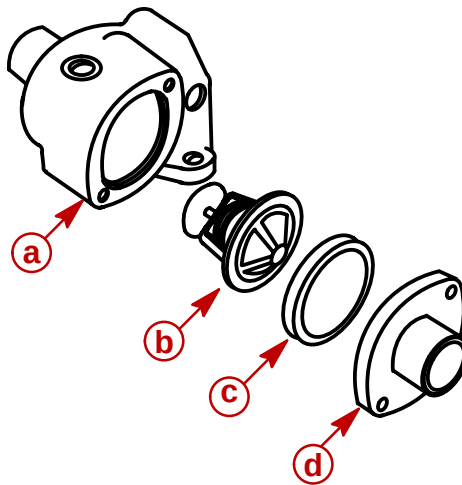
⚠ CAUTION

Avoid seawater pickup pump impeller damage. DO NOT operate engine without cooling water being supplied to seawater pickup pump.

1. Remove thermostat housing and gaskets. Discard gaskets.
2. Clean gasket surfaces on thermostat cover, thermostat housing and intake manifold.
3. Position gasket on intake manifold. Place thermostat housing on gasket.

IMPORTANT: If gasket has continuity rivets, do not coat with Quicksilver Perfect Seal, or audio warning temperature switch may not work properly.

4. Install thermostat, as previously shown, into thermostat housing.
5. Position gasket on thermostat and reinstall thermostat cover. Torque bolts to 30 lb-ft (41 Nm).



75746

- a** - Thermostat Housing
- b** - Thermostat
- c** - Gasket
- d** - Thermostat Housing Cover

6. Connect hoses to thermostat cover. Tighten hose clamps securely.
7. With boat in the water and/or cooling water properly supplied to seawater pickup pump, start engine and inspect for leaks.

Changing Coolant

NOTICE

For information and procedures on draining the seawater cooling system of Seawater Cooled (Raw-water) Models, refer to SECTION 6A. For information and procedures on draining the Seawater Section of Closed Cooling (Coolant) Models refer to SECTION 1B. For cold weather or extended storage, refer to SECTION 1B.

Closed Cooling Section

Closed cooling section of closed cooling system should be kept filled year-round with recommended coolant solution. Do not drain closed cooling section for storage, as this will promote rusting of internal surfaces. If engine will be exposed to freezing temperatures, make sure that closed cooling section is filled with Extended Life Coolant or an ethylene glycol antifreeze and water solution, mixed to manufacturer's recommended proportions, to protect engine to lowest temperature to which it will be exposed. If necessary, change coolant using coolant specified in "Coolant Recommendations."

Change Intervals

If the closed cooling system is factory installed, drain and flush coolant from the closed cooling system at least every five years or 1000 hours of operation, whichever comes first. It should also be changed whenever exhaust gases have entered the system.

If the system is not factory installed or has had anti-freeze other than Extended Life Coolant added, it must be changed every two years or 400 hours of operation, whichever comes first.

Draining Instructions

WARNING

Allow engine to cool before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

IMPORTANT: A wire should be inserted into drain holes to ensure that foreign material is not obstructing the drain holes. On some models with two piece petcock, removal of petcock may be required so that wire can be inserted completely into drain hole.

IMPORTANT: Engine must be as level as possible to ensure complete draining of cooling system.

IMPORTANT: Closed cooling section must be kept filled year round with recommended coolant. If engine will be exposed to freezing temperatures, make sure closed cooling section is filled with Extended Life Coolant or an ethylene glycol anti-freeze and water solution properly mixed to protect engine to lowest temperature to which it will be exposed.

The following draining instructions apply to all engines equipped with closed cooling. The location of petcocks that require opening and hoses that require removal are represented on the following pages for the individual engines.

IMPORTANT: Observe precautions previously outlined before proceeding.

1. Remove pressure cap from coolant tank.
2. Drain coolant from locations as shown in the "Draining Diagram."

3. After coolant has drained completely, reinstall petcocks and hoses. Tighten clamps and petcocks securely.
4. Remove coolant recovery bottle from mounting bracket and pour out coolant.
5. Clean system as outlined in "Cleaning System."
6. Fill system as outlined in "Filling Closed Cooling Section."

Cleaning System

Closed Cooling Section

Closed cooling section of closed cooling system should be cleaned at least once every two years or whenever decreased cooling efficiency is experienced.

A good grade automotive cooling system cleaning solution may be used to remove rust, scale or other foreign material. Always follow manufacturer's instructions for the cleaner.

If closed cooling section is extremely dirty, a pressure flushing device may be used to flush out remaining deposits. Flushing should be done in direction opposite normal coolant flow to allow water to get behind deposits and force them out. Refer to instructions that accompany flushing device for proper hookup and flushing procedure.

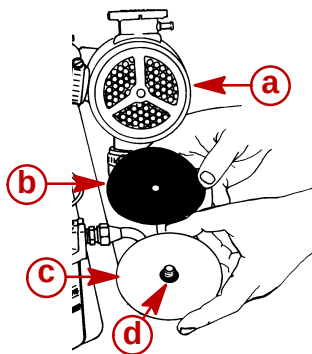
NOTICE
For information and procedures on draining and flushing Seawater Section of Closed Cooling (Coolant) Models, refer to SECTION 1B. For cold weather or extended storage, refer to SECTION 1B.

Seawater Section

Cooling efficiency of an engine with closed cooling is greatly dependent upon heat transfer through the tubes within the heat exchanger. During engine operation, contaminants within the seawater (such as salt, silt, lime, etc.) collect on the inside of the tubes, thus reducing heat transfer and greatly decreasing heat exchanger efficiency. It is, therefore, recommended that the seawater section of the heat exchanger be cleaned as specified in SECTION 1B - "Scheduled Maintenance" or whenever decreased cooling efficiency is suspected.

1. Remove bolts securing end plates to heat exchanger.
2. Then remove end plates, seal washers and gaskets.
3. Discard seal washers and gaskets.

4. Clean gasket material from end plates and heat exchanger.



71515

- a** - Heat Exchanger
- b** - Sealing Washer
- c** - End Cap
- d** - Gasket

5. Clean water passages in heat exchanger by inserting a suitable size wire brush into each passage. Use compressed air to blow loose particles out of water passages.
6. Apply Quicksilver Perfect Seal to both sides of new end plate gaskets.
7. Reinstall end plates, using new gaskets and seal washers. (Be sure to install seal washers between end plates and gaskets.)
8. Torque end plate bolts to specifications.

⚠ CAUTION

Avoid seawater pickup pump impeller damage. DO NOT operate engine without water being supplied to seawater pickup pump.

9. With boat in the water and/or cooling water properly supplied to seawater pickup pump, start engine and inspect for leaks.

Filling Closed Cooling Section

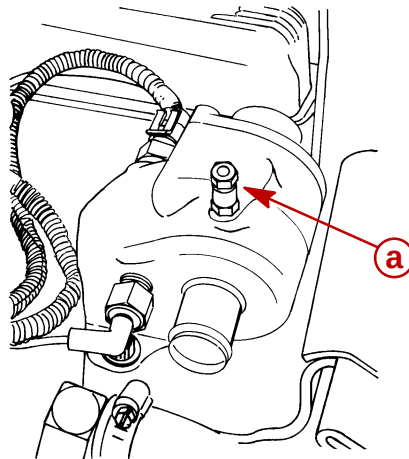
⚠ CAUTION

Alcohol or Methanol base antifreeze or plain water are not recommended for use in coolant section of Closed Cooling System at any time.

It is recommended that coolant section of Closed Cooling System be filled with a 50/50 mixture of Extended Life Coolant and pure, soft water. This coolant **MUST BE** used regardless of whether freezing temperatures are expected to provide adequate corrosion protection. In areas where Extended Life Coolant is not available and the possibility of freezing **DOES NOT** exist, it is permissible to use a solution of rust inhibitor and pure, soft water (mixed to manufacturer's recommendations).

NOTE: Coolant section capacity is approximately 18 U.S. Quarts (17 L).

1. Fill coolant section of Closed Cooling System with coolant mixture as follows:
 - a. Open bleeder valve on thermostat housing.



75598

a - Hex Head Bleeder Valve

- b. Fill with coolant mixture through heat exchanger fill neck until coolant appears at bleeder valve opening.
- c. Close bleeder valve securely.
- d. Continue filling until coolant level is into filler neck and begins to flow into coolant recovery bottle plastic tubing.

⚠ CAUTION

Avoid seawater pickup pump impeller damage. **DO NOT** operate engine without water being supplied to seawater pickup pump.

⚠ CAUTION

Front of engine should be higher than rear to purge trapped air out of the system during initial filling. This will minimize the possibility of air being trapped in the closed cooling section which can cause engine to overheat.

IMPORTANT: Coolant flows rapidly. Higher idle speeds increase dispersion of trapped air into system making it more difficult to purge trapped air. Operate at idle during filling and air purging when specified.

2. Start engine and run at IDLE.

3. Add coolant solution to heat exchanger, as required, to maintain coolant level at filler neck.
4. After engine has reached normal operating temperature thermostat is fully open and coolant level remains constant, fill heat exchanger until coolant level is into filler neck and begins to flow into coolant recovery bottle plastic tubing.
5. Remove cap from coolant recovery reservoir and fill to "FULL" mark with coolant solution.
6. Reinstall cap.
7. Lift recovery bottle and plastic tubing *above* heat exchanger filler neck. Allow coolant to flow down through tubing to purge air through filler neck fitting.
8. Install pressure cap on heat exchanger.
9. With engine still running, check hose connections, fittings and gaskets for leaks. Also observe engine temperature gauge to make sure that engine operating temperature is normal. If gauge indicates excessive temperature, stop engine immediately and examine for cause.

WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4-turn to allow any pressure to escape slowly, then push down and remove cap.

10. Recheck coolant level after first boat test and add coolant, if necessary.
11. Maintain coolant level in coolant recovery reservoir between "Add" and "Full" marks with engine at normal operating temperature.

Coolant section of Closed Cooling System should be kept filled year around with recommended coolant solution. DO NOT drain coolant from fresh water section for storage, as this will promote rusting of internal surfaces. If engine will be exposed to freezing temperatures, make sure that coolant section is filled with Extended Life Coolant and water solution, mixed to manufacturer's recommended proportion, to protect engine to lowest temperature to which it will be exposed.

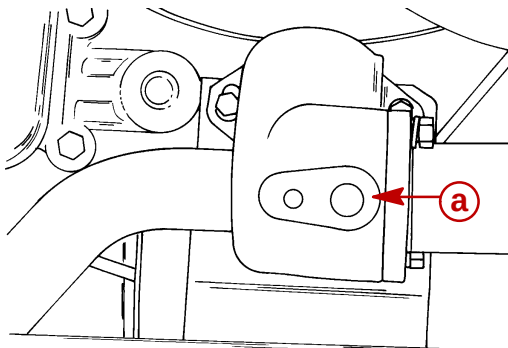
Auxiliary Hot Water Heater Installation

IMPORTANT: When connecting a cabin heater or hot water heater, certain requirements must be met:

- Supply hose (from engine to heater) and return hose (from heater to engine) **MUST NOT EXCEED 5/8 in. (16 mm) I.D. (inside diameter).**
- Make heater connections **ONLY** at locations described in the following instructions.
- Check complete system for leaks after heater is connected into cooling system.
- Check for overheating condition (of engine) after heater is connected.

⚠ CAUTION

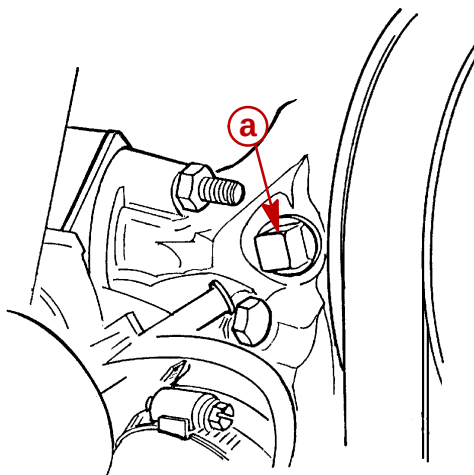
On closed cooling models, the heater must be mounted lower than the fill cap on the heat exchanger. If the heater is higher than the fill cap on the heat exchanger and some coolant is lost from system, an air pocket may form in the closed cooling system. This can cause the engine to overheat.



75503

Supply Hose Connection

a - Location For Hot Water Supply Hose (Thermostat Housing As Viewed From Above)

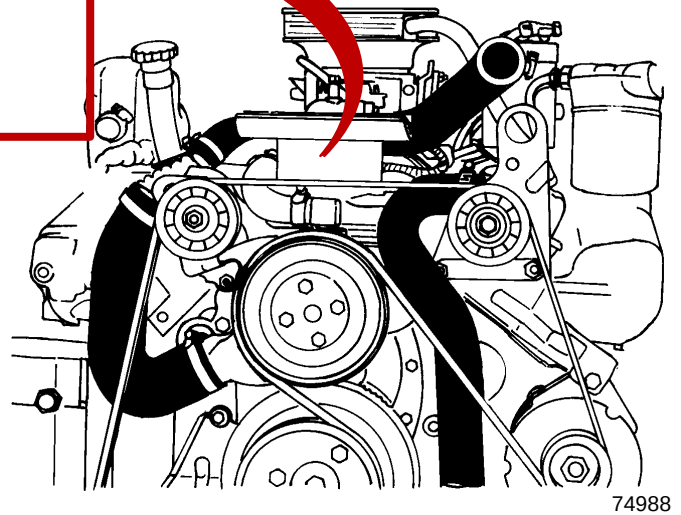
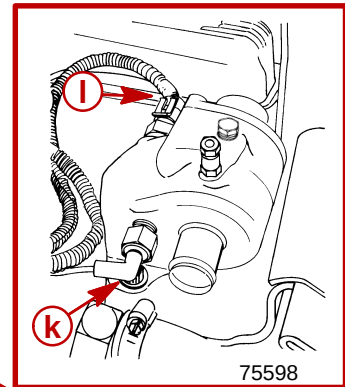
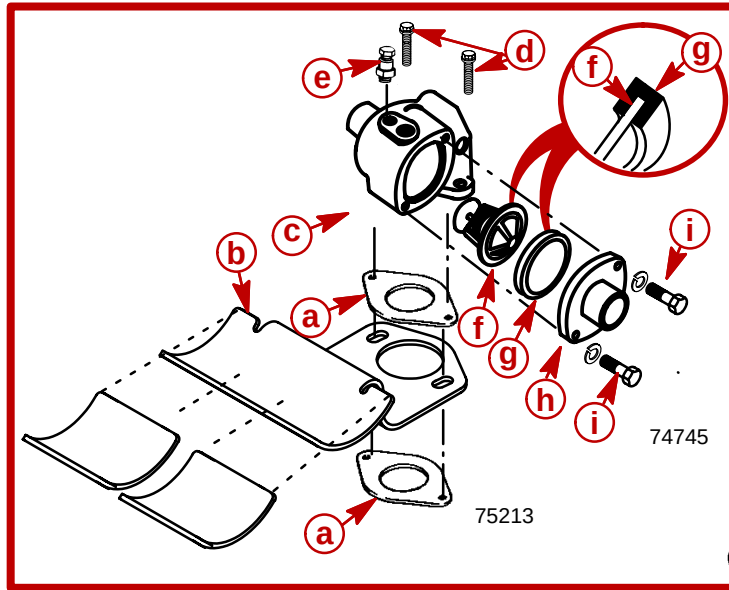


75480

Return Hose Connection

a - Location For Hot Water Return Hose

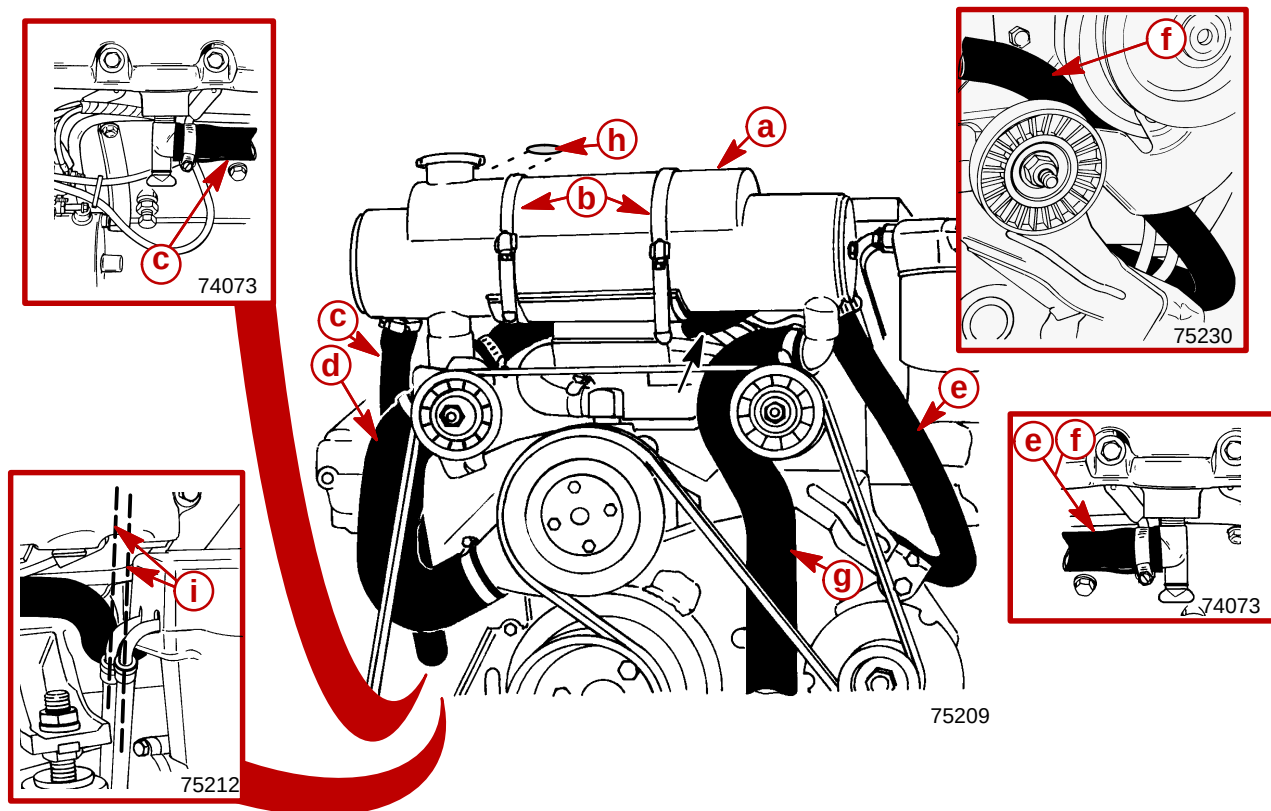
Heat Exchanger Bracket Hardware



Typical Engine Shown

- a** - Gasket
- b** - Heat Exchanger Bracket and Pads
- c** - Thermostat Housing
- d** - Screws, Stainless Steel
- e** - Bleeder Valve
- f** - Thermostat
- g** - Quad-Ring Seal
- h** - Outer Diameter of Thermostat
- i** - Thermostat Cover
- j** - Screws with Lockwashers
- k** - Engine Temperature Gauge Sender
- l** - ECT Sender

Heat Exchanger Hose Connections

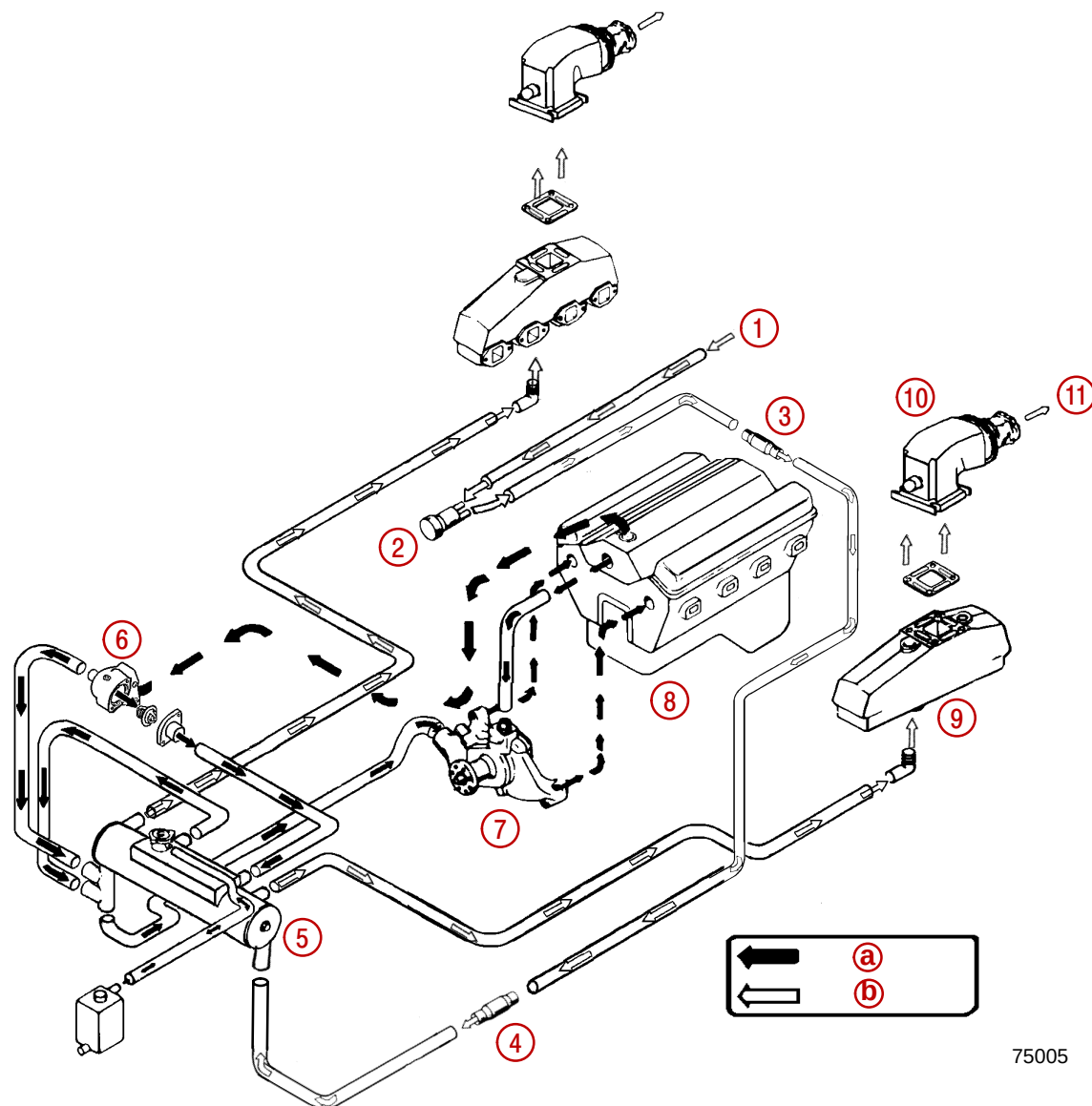


Typical Engine Shown

- a** - Heat Exchanger
- b** - Large Hose Clamps
- c** - Starboard Heat Exchanger-to-Exhaust Manifold Hose
- d** - Water Circulating Pump Hose
- e** - Port Heat Exchanger-to-Exhaust Manifold Hose (MIE)
- f** - Port Heat Exchanger-to-Exhaust Manifold Hose (MCM)
- g** - Cool Fuel System (or Seawater Pipe, if so equipped)-to-Heat Exchanger Hose
- h** - Coolant Identification Decal
- i** - Fuel Lines Aligned to Avoid Starboard Water Hose

Closed Cooling System Water Flow Diagram

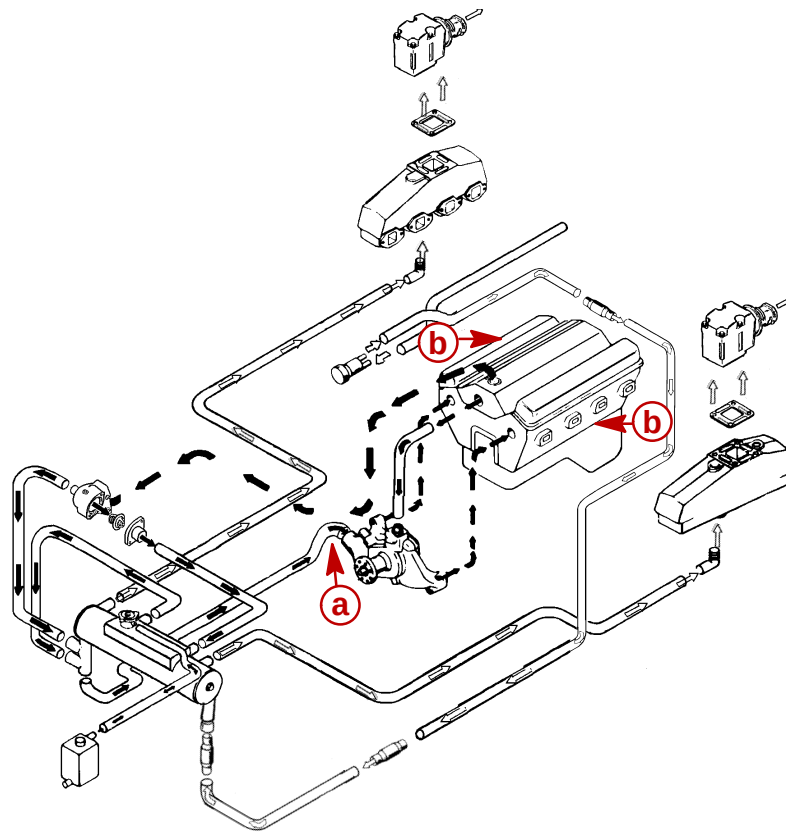
MCM / MIE Models



75005

- 1 - Seawater Inlet Hose
- 2 - Seawater Pump
- 3 - Transmission Fluid Cooler, or Power Steering Cooler
- 4 - Fuel Cooler
- 5 - Heat Exchanger, Typical
- 6 - Thermostat Housing and Cover Assembly
- 7 - Engine Water Circulating Pump
- 8 - Engine Block and Cylinder Head Assembly
- 9 - Exhaust Manifold, Typical
- 10 - Exhaust Elbow Assembly, Typical
- 11 - Overboard (Water and Exhaust Discharge)
- a - Freshwater (Coolant/Anti-Freeze) Flow
- b - Seawater (Raw Water) Flow

Draining Diagram (Coolant Section of System)



75005

- a** - Remove Hoses (Lift, Lower or Bend To Completely Drain).
- b** - Remove Block Plugs (Repeatedly Clean Out Holes Using A Stiff Wire Until Entire System Is Drained).

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EXHAUST SYSTEM

Section 7A - General

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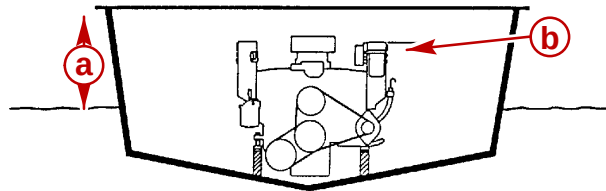
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Exhaust System Requirements

IMPORTANT: It is the responsibility of the boat manufacturer or installing dealer to properly locate the engine and install the exhaust system. Improper installation may allow water to enter the exhaust manifolds and combustion chambers and severely damage the engine. Damage caused by water in the engine will not be covered by MerCruiser Limited Warranty, unless this damage is the result of defective part(s).

Exhaust Elbow Risers

On all engines to determine if exhaust elbow risers are required, take measurements (a) and (b), with boat at rest in the water and maximum load aboard. Subtract (b) from (a). If (a) minus (b) is less than specified in chart, select appropriate size exhaust elbow riser kit and exhaust extension kit that will correctly position exhaust elbow.



72700

Exhaust Elbow Measurement

a - From Waterline To Top Of Transom

b - From Highest Point On Exhaust Elbow To Top Of Transom

Model	(a) Minus (b) Must Be at Least
All	13 In. (330 mm)

MCM (Sterndrive) Engines With Thru-Transom Exhaust

When designing and installing exhaust system, the following must be observed:

Minimum Hose Size		
Model	Single Outlet	Dual Outlet
All	4 in. (102 mm)	3 in. (76 mm)

- Exhaust flanges must be of proper size to accommodate 4 in. (102 mm) I.D. exhaust hoses. They must also be equipped with internal water shutters, and use an exhaust flapper over each outlet.
- The exhaust hoses and pipes must not be higher than exhaust elbows at any point.
- The exhaust outlet must be located so that a minimum of 1/2 in. (13 mm) drop per foot (305 mm) downward pitch exists in the exhaust hose from the engine exhaust elbow to the outlet. (This is an American Boat & Yacht Council recommendation.) The drop must be constant so that a low spot does not exist at any point in the exhaust hose.
- Exhaust outlet must be slightly above the waterline with boat at rest in the water and full load aboard.
- Back pressure must not exceed 4 in. (102 mm) of mercury when measured with a mercury manometer to exhaust elbow outlets.

MIE (Inboard) Engines

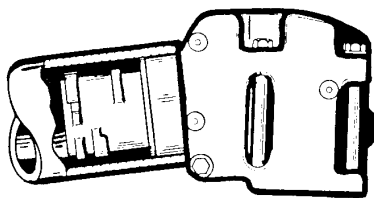
When designing and installing exhaust system, it is very important that the following additional points be taken into consideration:

1. System layout and construction must prevent cooling system discharge water from flowing back into engine and also must prevent seawater from entering engine via exhaust at any point.
2. The exhaust hoses and pipes must not be higher than exhaust elbows at any point.
3. The exhaust outlet (for routing exhaust to outside of boat) must be located so that a minimum of 1/2 in. (13 mm) per foot (305 mm) downward pitch (drop) exists in the exhaust hose or pipe from the engine exhaust elbow to the outlet, with a minimum drop of 4 in. (102 mm) overall. (This is an American Boat & Yacht Council recommendation.) The drop must be constant so that a low spot does not exist at any point in the exhaust hose or pipe.
4. Exhaust outlet must be slightly above the waterline with boat at rest in the water and full load aboard. Exhaust outlet should be equipped with an internal shutter to prevent seawater from running back into exhaust system. The use of an exhaust flapper on each outlet also is recommended.
5. System must not cause excessive back pressure. Back pressure **MUST NOT** exceed 4 in. (102 mm) of mercury when measured with a mercury manometer at exhaust elbow outlets. Minimum exhaust hose sizes are given in chart.

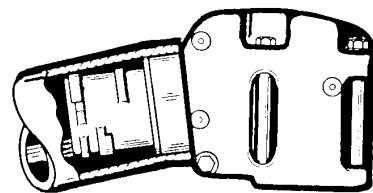
Minimum Hose Size		
Model	Single Outlet	Dual Outlet
All	4 in. (102 mm)	3 in. (76 mm)

Exhaust Hose Connection

1. Exhaust hoses must be connected to exhaust elbows so that they do not restrict the flow of discharge water from the elbow. If hoses are connected incorrectly, a hot spot in the hose can occur, and can eventually burn through.



Correct



Incorrect

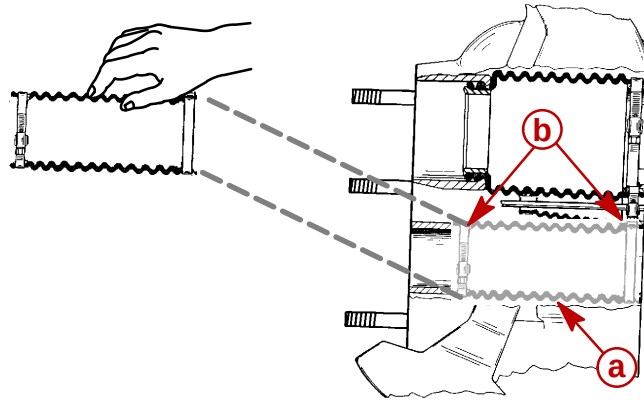
72538

2. Exhaust hoses must be secured at each connection with two hose clamps.

Exhaust Tube Requirements

IMPORTANT: When installing through-transom exhaust, it is recommended that the exhaust bellows on the transom assembly be removed. This is necessary to avoid creating a vacuum at the exhaust outlet in the propeller at higher boat speeds. This vacuum could degrade propeller performance on some boats.

1. If required, remove and discard clamps and bellows from gimbal housing.



22116

a - Exhaust Bellows

b - Clamps

IMPORTANT: When installing through-propeller exhaust:

- With any application, installation of an exhaust tube will increase exhaust noise.
 - With a Silent Choice Exhaust System the exhaust bellows must be removed and an exhaust tube **MUST BE INSTALLED**.
2. If required, install exhaust tube on gimbal housing as follows:
 - a. Remove and discard clamps and exhaust bellows.

⚠ CAUTION

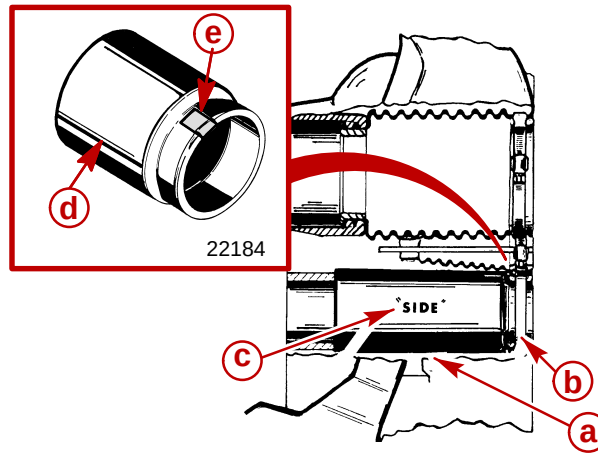
Exhaust tube clamp may corrode if grounding clip is not installed.

- b. Install grounding clip on tube.

NOTE: *Bellows adhesive is not used when installing an exhaust tube.*

- c. Position tube so that SIDE markings on tube are facing toward the right and left sides.
- d. Install clamp.

- e. Tighten clamp. Torque to 35 lb-in. (4 Nm).



22184

- a** - Exhaust Tube
- b** - Clamp
- c** - SIDE Marking
- d** - Exhaust Tube
- e** - Grounding Clip

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EXHAUST SYSTEM

Section 7B - Manifolds, Elbows And Risers

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Torque Specifications

Fastener Location	lb-in.	lb-ft	Nm
Hose Clamp		Securely	
Exhaust Elbow or Risers to Manifold		33	45
Exhaust Manifold to Cylinder Head		25	34

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Perfect Seal	92-34227--1
Quicksilver Loctite 510 Sealant	92-804874

Disassembly

WARNING

Avoid possible injury or damage to equipment should wires be accidentally shorted. Disconnect BOTH battery cables from battery before proceeding.

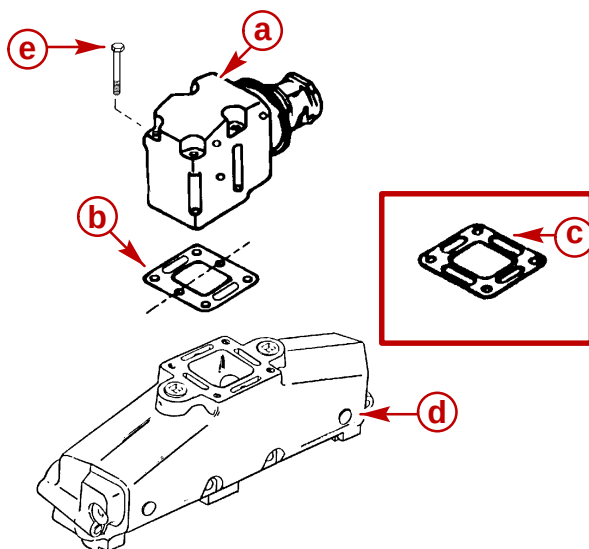
1. Disconnect battery cables from battery.

CAUTION

To avoid severe engine damage. Exhaust elbows and manifolds **MUST BE** drained to prevent water from entering combustion chambers when exhaust elbows are removed.

2. Drain water from manifold, elbow and riser, if equipped.
3. Disconnect exhaust and cooling hoses.
4. Remove any other components that are mounted to the manifold, elbow and riser, if equipped.
5. Remove elbow and riser, if equipped.

6. Remove exhaust manifold fasteners. Remove manifold assembly and discard gaskets.



75749

- a** - Exhaust Elbow
- b** - Restrictor Gasket
- c** - Open Gasket (Later Models and Service)
- d** - Exhaust Manifold
- e** - Bolts

Cleaning and Inspection

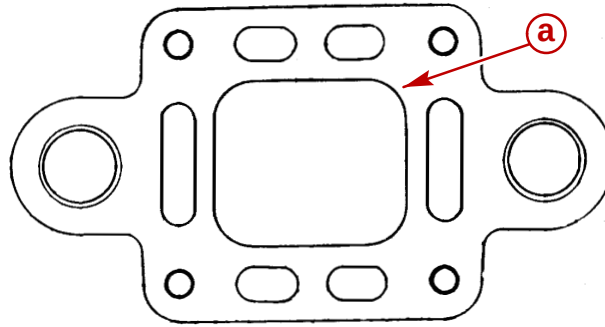
1. Clean gasket material from all surfaces and wash parts in solvent.
2. Check water passages for foreign material. Passages must be clean for efficient cooling.
3. If more thorough inspection is desired, pipe plugs may be removed from exhaust manifold and exhaust elbow.

IMPORTANT: If plugs are removed, coat threads with Quicksilver Perfect Seal before reinstalling.

4. Check for cracks.
5. To test manifold body for leaks, block-off plates, plugs or short hoses with plugged ends must be used. One block-off plate must have a threaded hole for attaching compressed air hose. Use new gaskets when installing block-off plate(s). Apply 40 psi (276 kPa) of air pressure and submerge manifold in water. Air bubbles will indicate a leak.
6. Inspect all parts carefully. Machined surfaces must be clean and free of all marks and deep scratches, or water and exhaust leaks may result.
7. Check the flatness of all gasket surfaces. Maximum overall is .003 in. (0.07 mm), with not more than a .001 in. (0.02 mm) difference within 1in. (25 mm).

NOTE: Maximum material that can be removed is .010 in. (0.25 mm) to true a gasket surface up. When torquing the attaching bolts, make sure that they are not bottoming out in the manifold's threaded hole.

8. Look at the condition of the metal around the exhaust outlet in the casting. Inspect for damaged metal caused by salt water or exhaust gas corrosion in the manifold, elbow and riser, if equipped. Replace all damaged parts.

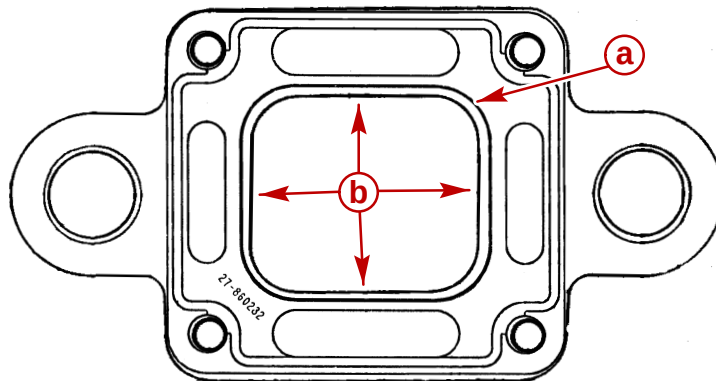


76341

a - Inspect Area Around Exhaust Outlet

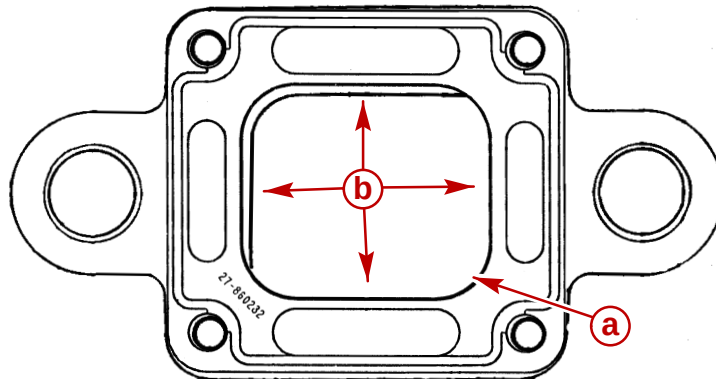
9. Check the fire ring gasket fit on the manifold gasket surface. Place a new gasket on the surface. Thread 4 short 3/8-16 bolts into the bolt holes. Move the gasket fore and aft, then side to side to make sure the gasket's fire ring has manifold gasket surface under it in all 4 positions.

NOTE: If the gasket's fire ring does not have a solid gasket surface in all 4 positions, the manifold should be replaced.



76355

a - Gasket's Fire Ring has Manifold Gasket Surface Under It in All 4 Positions
b - Manifold Gasket Surface



76359

a - Gasket's Fire Ring Does Not have Manifold Gasket Surface Under It in All 4 Positions
b - Manifold Gasket Surface

Installation

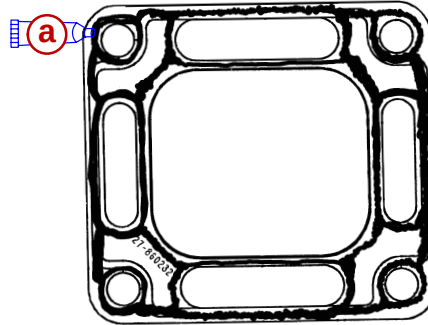
Gaskets

NOTE: The service replacement gasket may not be the same type of gasket that was used in production.

The fire ring gasket with 4 slots is used between all manifolds, risers and exhaust elbows.

IMPORTANT: After applying Loctite 510 to the gasket, assemble components immediately.

1. Apply a 1/8 in. (3 mm) bead of LOCTITE 510 Sealant P/N 92-804874 around all holes on both sides of a new fire ring gasket.

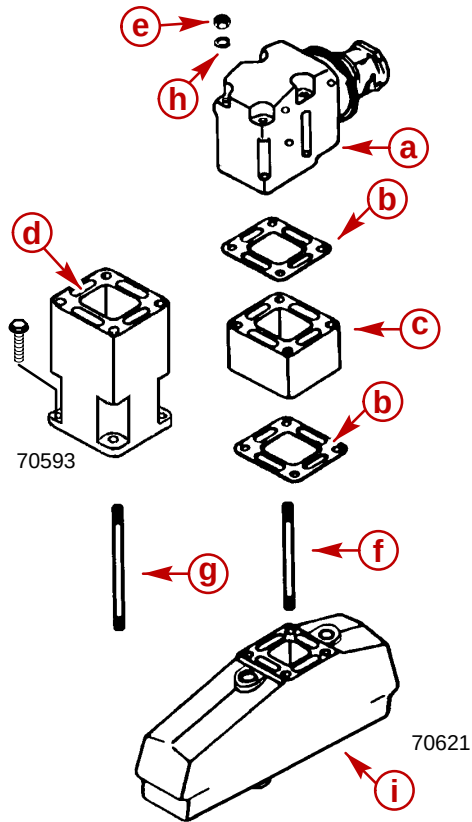


76360

- a** - 1/8 in. (3 mm) Bead of LOCTITE 510 Sealant
2. Assemble parts immediately and torque fasteners to specifications.
 3. Allow sealant to cure 2-3 hours before starting the engine.

Manifold

1. Using new gasket, install exhaust manifold to cylinder head. Torque fasteners to 25 lb-ft (34Nm).
2. Using a new gasket, install exhaust elbow to exhaust manifold. Torque fasteners to 25 lb-ft (34Nm).

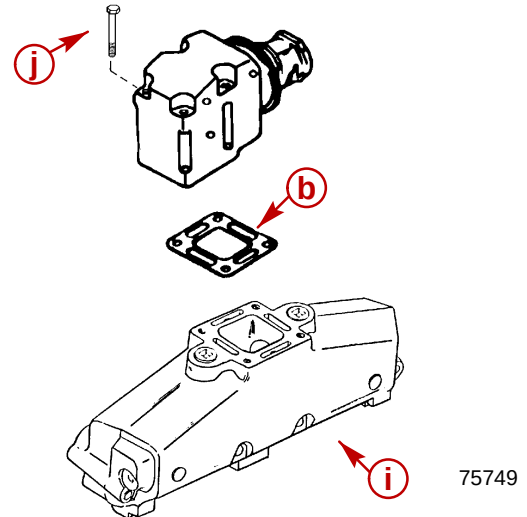


Elbows With Risers

- a** - Exhaust Elbow
- b** - 4 Slot Gasket
- c** - 3 in. (76 mm) Exhaust Riser
- d** - 6 in. (152 mm) Exhaust Riser
- e** - Nut (8)
- f** - Stud (8) 9-3/8 in. (238 mm)
- g** - Stud (8) 10-3/8 in. (264 mm) Used With Some MIE Remote Oil Filters
- h** - Washer (8)
- i** - Exhaust Manifold
- j** - Bolts

3. Port Manifold:

- a. Install remote oil filter and bracket.
- b. Install components on exhaust elbow (if necessary).



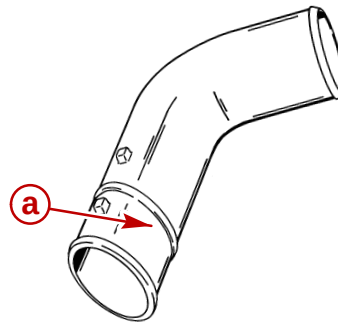
Elbows Without Risers

4. Starboard Manifold:

- a. Install bolt to secure water separating fuel filter bracket to exhaust manifold.
 - b. Install shift plate assembly on exhaust elbow (MCM only).
 - c. Connect instrument harness plug to engine harness, if disconnected previously.
 - d. Connect both shift cables (MCM only).
5. Install exhaust elbows and cooling hoses.
 6. **On Closed Cooled Models:** Refill closed cooling system to operating level with properly mixed coolant. Refer to SECTION 6B.
 7. Reconnect battery cables to battery. Tighten securely.
 8. Start engine and check for fuel, exhaust and water leaks.

Sterndrive Exhaust Extension

1. Install appropriate exhaust extension for MCM Models with thru prop exhaust, using two hose clamps at each end.
2. Cut along bottom edge of raised bead for 3 in. (76 mm) risers or use full length for 6 in. (152 mm) risers.



50930

Typical Exhaust Extension

a - Bottom Edge Of Raised Bead

3. Tighten hose clamps securely.
4. Upon first start-up of engine, check for leaks.

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EXHAUST SYSTEM

Section 7C - Collectors

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Torque Specifications

Fastener Location	lb-in.	lb-ft	Nm
Block-Off Plate		20-25	27-34
Exhaust Pipe to Gimbal Housing			
Exhaust Pipe to T-Pipe			
T-Pipe to Gimbal Housing			
Upper Exhaust Pipe to Lower Exhaust Pipe			
Exhaust Elbow			
Air Pump Mount	Securely		
Muffler End Plate			
Mode Switch			
Hose Clamps			
Water Shutter Bolt/Nut			

Lubricants / Sealants / Adhesives

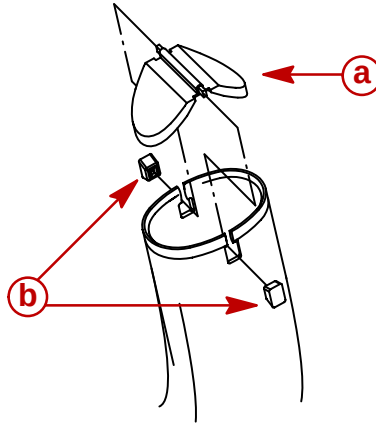
Description	Part Number
Quicksilver 2-4-C Marine Lubricant With Teflon	92-825407A3
Loctite 35	92-809833
Loctite Primer	92-809824
3M Brand Adhesive	92-86166--1
Quicksilver Perfect Seal	92-34227--1
Quicksilver Liquid Neoprene	92-25711--3
Quicksilver Sound Blanket Glue	92-25234

Bullhorn Exhaust

Shutter Replacement

IMPORTANT: Engine does not have to be removed to change shutters.

1. Loosen clamps and remove exhaust pipe, elbow and exhaust hose.
2. Replace water shutter.
3. Reinstall pipe, elbow and hose. Tighten clamps securely.



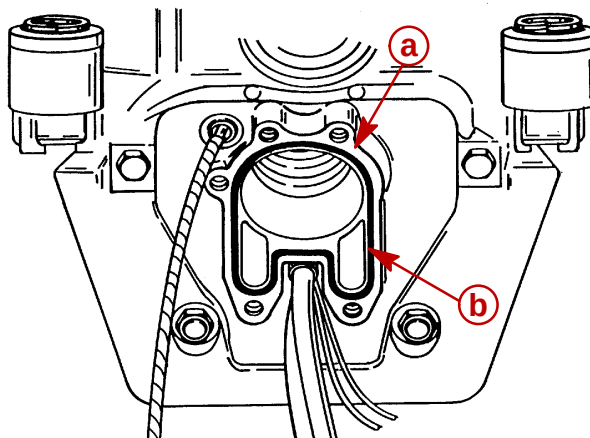
75760

- a** - Exhaust Flapper
b - Rubber Grommets

Component Replacement

To replace any components in exhaust system, the following must be adhered to:

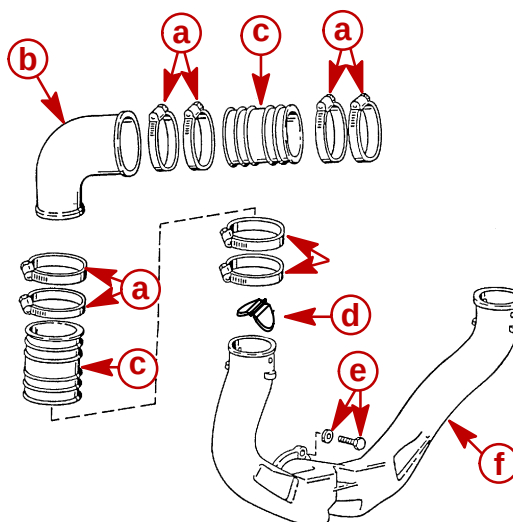
- All mating surfaces must be clean.
- O-ring must remain in groove to properly seal joints to prevent leakage.
- Torque all bolts to 20-25 lb-ft (27-34 Nm).
- Tighten all clamps securely.



72736

a - Mating Surface

b - O-Ring



72737

a - Clamps

b - Exhaust Pipe Elbow

c - Exhaust Hose

d - Water Shutters

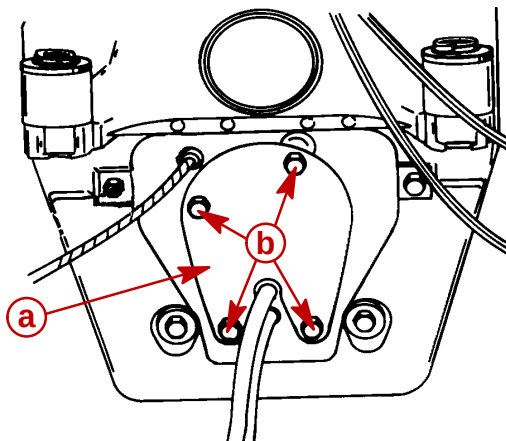
e - Bolts and Lockwashers

f - Exhaust Pipe

Thru-Transom Exhaust

Shutter Replacement

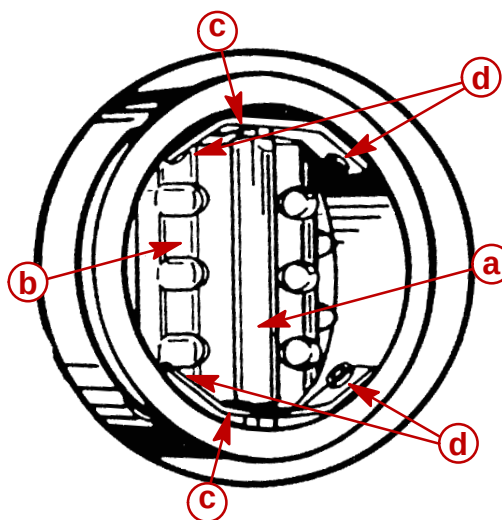
IMPORTANT: A block off plate must be installed when using thru-transom exhaust or below swim platform kits.



22057

- a** - Block Off Plate
- b** - Bolts (4)

1. Remove exhaust hose clamps, then hose.
2. Chisel rivets away from both support members.

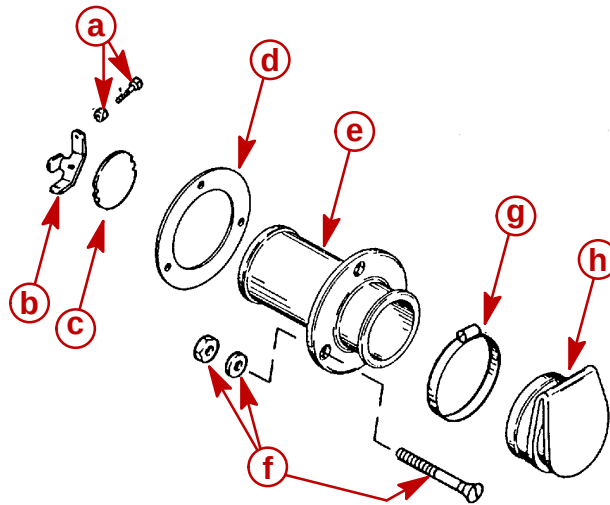


27761

- a** - Shutter Hinge
- b** - Water Shutter - Opens Toward Outside Of Boat
- c** - Support Member
- d** - Rivets (4)

3. Install new shutter as shown in "Component Replacement" following. Tighten screws and nut securely.
4. Reinstall exhaust hose. Tighten clamps securely.

Component Replacement



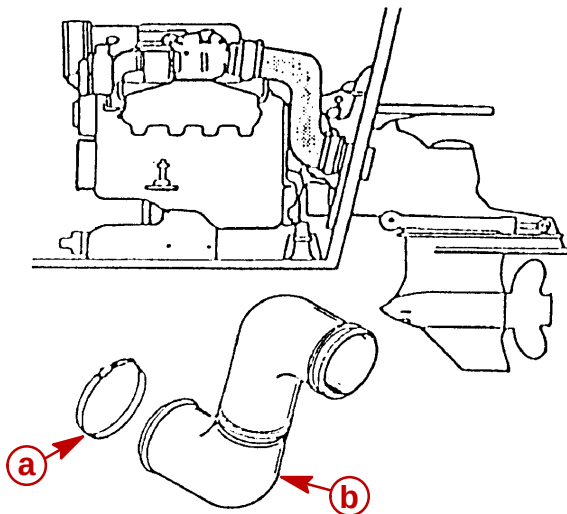
72740

Transom Exhaust Kit

- a** - Screw And Nut (4)
- b** - Support Member
- c** - Water Shutter (Hinge Must Be Vertical)
- d** - Gasket
- e** - Exhaust Flange
- f** - Bolts, Washers and Nuts (3)
- g** - Clamp
- h** - Cover (Flapper)

Below Swim Platform Exhaust Pipe

This exhaust kit may be used on any MerCruiser installation having a 4 in. (102 mm) exhaust elbow.

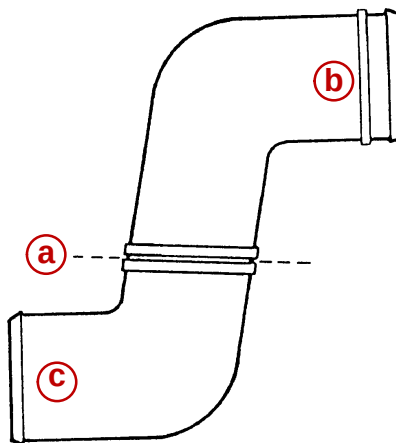


72742

a - 8 Per Kit

b - 2 Per Kit

The below swim platform exhaust pipe can be modified for specific height applications by cutting pipe at location shown.



72743

a - Cut Line (See Notes)

b - To Engine

c - To Transom

NOTE: If riser kits are installed, or if more vertical drop is required, cut "a" must be made, and the upper and lower sections of the pipe rejoined with a 4 in. (102 mm) I.D. exhaust hose of the required length. Secure with hose clamps.

NOTE: Prime and paint any raw (cut) aluminum surface.

IMPORTANT: Each exhaust bellows must be double clamped at each connection. The hose clamps are torqued to 30-40 lb-in. (3-5 Nm).

Silent Choice Exhaust System

If engine is equipped with thru-prop exhaust, a thru-transom kit [4 in. (102 mm)], two exhaust bellows and eight bellows hose clamps are required.

If engine is equipped with thru-transom exhaust, an exhaust pipe kit (P/N 44266A6) is required, containing the exhaust pipe and necessary parts.

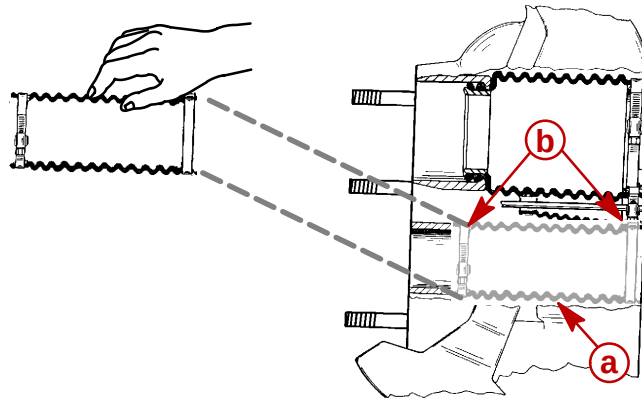
IMPORTANT: When installing Silent Choice exhaust, it is recommended that the exhaust bellows on the transom assembly be removed. This is necessary to avoid creating a vacuum at the exhaust outlet in the propeller at higher boat speeds. This vacuum could degrade propeller performance on some boats.

⚠ CAUTION

It is the responsibility of the boat manufacturer or installing dealer to properly locate the engine and install exhaust system. Improper installation may allow water to enter the exhaust manifolds and combustion chambers, and severely damage the engine. Damage caused by water in the engine will not be covered by Mercury MerCruiser Warranty, unless this damage is the result of defective part(s).

Exhaust Tube Installation

1. If required, remove and discard clamps and bellows from gimbal housing.



22116

2. If required, install exhaust tube on gimbal housing as follows:
3. Remove and discard clamps and exhaust bellows.

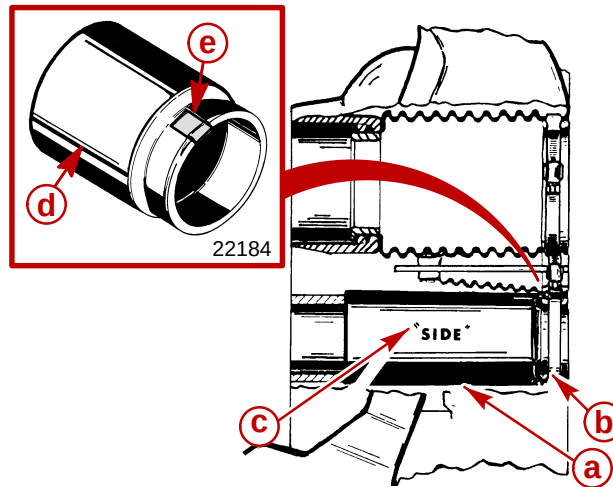
⚠ CAUTION

Exhaust tube clamp may corrode if grounding clip is not installed.

- a. Install grounding clip on tube.

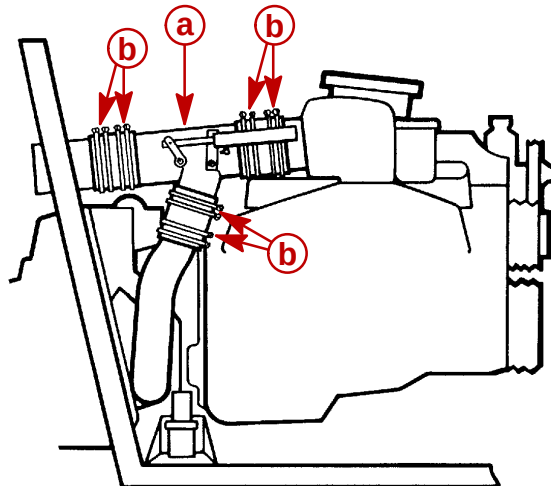
NOTE: Bellows adhesive is not used when installing an exhaust tube.

- (1.) Position tube so that SIDE markings on tube are facing toward the right and left sides.
- (2.) Install clamp.
- (3.) Tighten clamp securely.



22184

- a** - Exhaust Tube
- b** - Clamp
- c** - Side Marking
- d** - Exhaust Tube
- e** - Grounding Clip

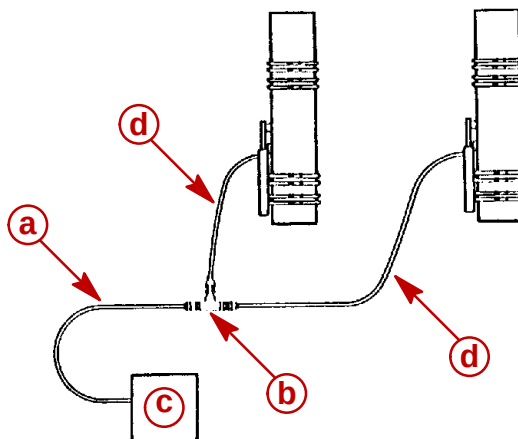


72539

- a** - Silencer Valve Assembly
- b** - Hose Clamps

Air Tube Routing

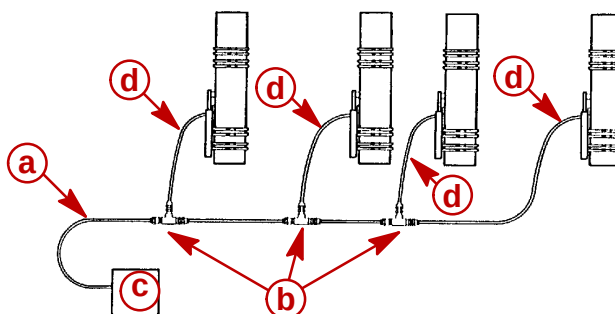
1. Route air tubing from air pump to silencer valve cylinders. Do not route air tubing close to hot surfaces. Excessive heat will damage air tubes.



72775

Single Engine

- a** - Air Tube
- b** - T-Fittings
- c** - Air Pump Assembly
- d** - Air Tube To Air Cylinder - On Each Silencer Valve



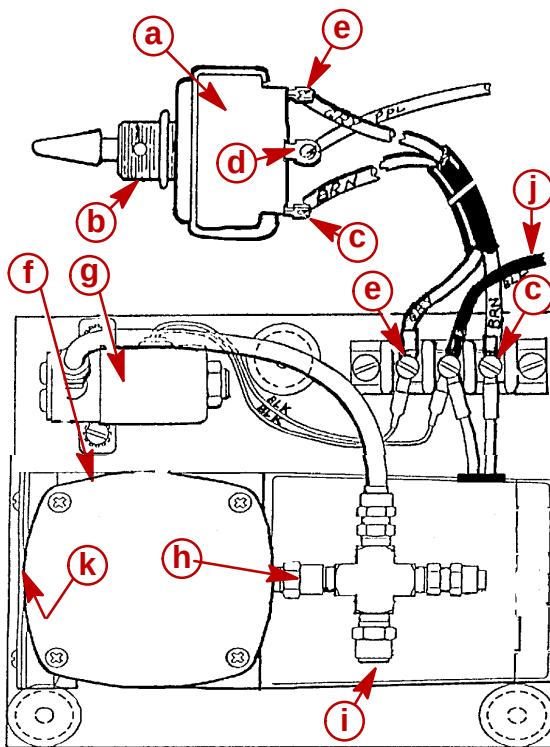
72776

Dual Engine

- a** - Air Tube
- b** - T-Fittings
- c** - Air Pump Assembly
- d** - Air Tube To Air Cylinder - On Each Silencer Valve

Maintenance

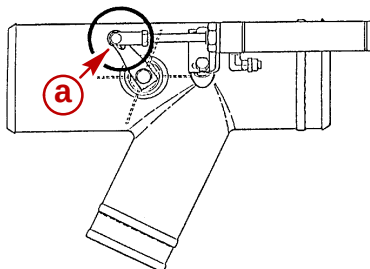
1. Air Intake Filter (32-17272) must be checked once each year. If filter is clogged or partially clogged, replace. The filter pad is glued in and may be removed with needle-nose pliers. Clean surface in casting, apply a single dot of Quicksilver Sound Blanket Glue to center of casting, and install new filter. Be careful not to coat filter or clog air intake holes with adhesive.



72534

- a** - Mode Switch
- b** - Keyway - Install In DOWN Position
- c** - BROWN Wire To Terminal 3 - Activates Compressor
- d** - PURPLE Wire - 12 Volt; Connect To 12 Volt Source In Control Panel Area
- e** - GRAY Wire To Terminal 1 - Activates Solenoid
- f** - Air Pump
- g** - Solenoid
- h** - Check Valve
- i** - Relief Valve - 30 PSI
- j** - 2 Ft. (610 mm) Ground Wire - Connect To Terminal - Must Be Grounded To Engine
- k** - Air Intake Filter

2. Lubricate air cylinder-to-silencer pipe flapper at clevis and pin, as needed, with Quicksilver 2-4-C Marine Lubricant.



72778

- a** - Lubricate Clevis And Pin With Quicksilver 2-4-C Marine Lubricant

Exhaust Muffler Kit

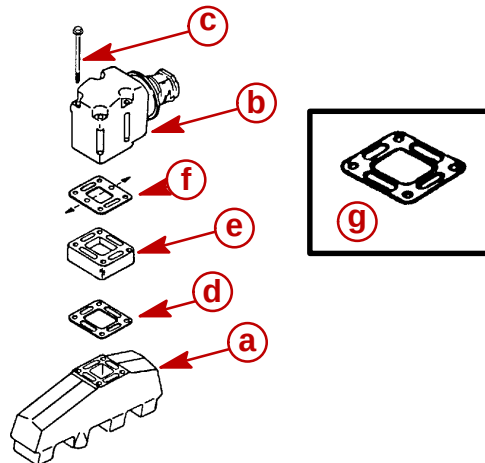
This muffler, designed for use on all V-8 engines with Plus Power™ exhaust systems (4 in., 7 degrees downward outlets), requires the installation of 1-1/4 in. (32 mm) exhaust elbow risers, which are included in the kit.

IMPORTANT: If a thru-transom exhaust kit other than the one from Mercury Marine is used, the exhaust kit must be equipped with internal shutters and external flappers.

⚠ CAUTION

It is the responsibility of the boat manufacturer or installing dealer to properly locate the engine and install exhaust system. Improper installation may allow water to enter the exhaust manifolds and combustion chambers, and severely damage the engine. Damage caused by water in the engine will not be covered by Mercury MerCruiser Warranty, unless this damage is the result of defective part(s).

IMPORTANT: Restrictor gaskets (if equipped) must be installed in order shown.



72780

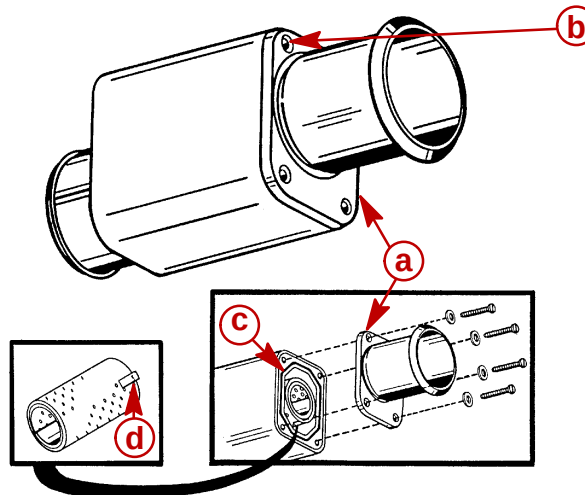
1-1/4 Inch Muffler Riser Installation

- a** - Exhaust Manifold
- b** - Exhaust Elbow
- c** - Bolt (4 Each Manifold)
- d** - Gasket - Lightly Coat Both Sides With Quicksilver Perfect Seal
- e** - Riser 1-1/4 Inch (32 mm) Height
- f** - Restrictor Gasket (Open Gasket on Later Models)
- g** - Refer To Note Following

NOTE: Later models will have an open gasket (four slots) instead of a restrictor gasket (two slots and two holes). If replacing gaskets, it is acceptable to replace the old gaskets with the open gaskets. Be sure that the same type of gasket is used on both manifolds.

Cleaning and Inspection

1. Disassemble muffler as shown.



72782

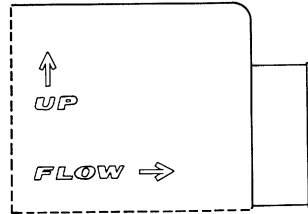
- a** - Removable End Plate
- b** - 4 Screws Secure End Plate
- c** - O-Ring Seal
- d** - Element - When Reassembling, Seat Tab In Slot In Casting

2. Clean (using pressurized water) and inspect parts, including filter element and O-ring seal. If required, replace O-ring, securing in place with Quicksilver Sound Blanket Glue.
3. Reassemble as shown above. Tighten end plate screws securely.

Installation

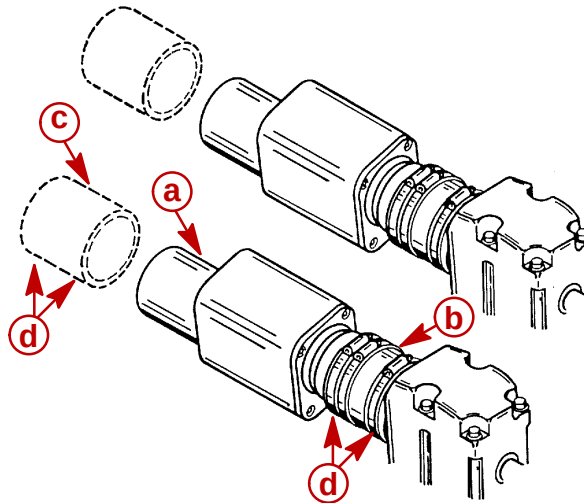
1. Install muffler, as shown, into exhaust hose and molded tube. Fabricate muffler to transom using 4-in. I.D. exhaust hose, cut to required length.

NOTE: Removable end of muffler ALWAYS goes toward exhaust elbow. This places direction marks on muffler body casting at the upper rear corner on the port side.



72783

IMPORTANT: A MOLDED exhaust tube MUST be used at exhaust elbow connection to maintain positive separation of exhaust outlet and muffler inlet.



72781

- a** - Muffler
- b** - Molded Exhaust Tube - Muffler To Elbow
- c** - Exhaust Hose - Muffler To Thru-Transom Fitting - Cut To Length
- d** - Double Clamp Each Connection (Not Shown On Hose C)

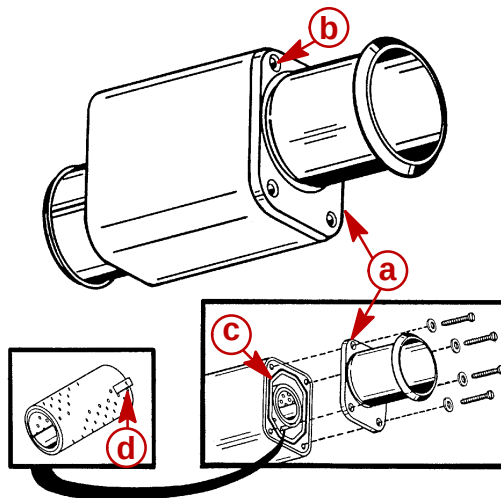
2. Double clamp each connection. Tighten each clamp securely.

IMPORTANT: After starting engine, check installation for leaks.

Maintenance Instructions

Maintenance inspection is owner's responsibility and must be performed at intervals specified in owner's Operation and Maintenance Manual.

1. Check exhaust elbow attaching nuts for adequate tightness [20-25 lb-ft (27-34 Nm)].
2. Check hose clamps for adequate tightness.
3. Periodically check tubes/hoses for soft spots, brittleness, cracks, and general condition. Replace as necessary.
4. As needed, depending on use conditions, remove mufflers, then remove four screws securing forward end plate, and remove end plate and element and interior of muffler. Clean thoroughly, at least once each year, using pressurized water.



72782

- a** - Removable End Plate
- b** - 4 Screws Secure End Plate
- c** - O-Ring Seal
- d** - Element - When Reassembling, Seat Tab In Slot In Casting

- a. Check condition of O-ring seal; if dried out or shrunk below mating surface, remove and replace. Clean groove thoroughly.
 - b. Glue new O-ring seal in groove, using Sound Blanket Glue. Wipe off excess glue immediately.
5. Reinstall muffler end plate with four screws. Tighten securely.
 6. Reinstall muffler into tubes/hoses. Double clamp. Tighten securely.
 7. Check area around exhaust elbow and riser gaskets for leakage. Replace gaskets, if necessary.

CAUTION

Water must be completely drained from exhaust elbow riser during freezing temperatures, or water may freeze and cause severe damage to riser.

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DRIVES

Section 8A - Velvet Drive In-Line And V-Drive Transmission

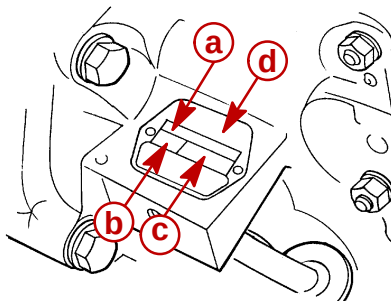
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Specifications

Identification

The transmission identification plate is located on the top left side of the transmission. Refer to charts following to determine engine and transmission combinations.



72839

Transmission Identification Plate

- a** - Model Number
- b** - Ratio (In Forward Gear)
- c** - Serial Number
- d** - Identification Plate Model Color Code

Ratio

Ratio in Forward Gear (Note 1 & 2)
1:1

NOTE: 1. This ratio is shown on identification plate.

NOTE: 2: These transmissions are for LH (standard) rotation engines and the propeller shaft rotation is LH (standard) when in forward gear.

Torque Specifications

Description	lb-in.	lb-ft	Nm
Drain Plug (Bushing)		25	34
Fluid Hose to Bushing		25	34
Pump Housing to Adapter		17-22	23-29
Rear Mounts to Transmission		45	61
Shift Lever to Valve		8-11	11-15
Transmission to Flywheel Housing		50	68
Neutral Start Switch		8-11	11-14
Propeller Shaft Coupler To Output Flange		50	68
Shift Lever Nut	96-132		11-15

Fluid Specifications

Make and Model	Capacity	Fluid Type
Velvet Drive 71C In-Line	1-1/2 (1.33) ¹	Mobil 424 <u>or</u> Dexron III Automatic Transmission Fluid Do Not Mix!
Velvet Drive 72 Series V-Drive	3 (2.75) ¹	Mobil 424 <u>or</u> Dexron III Automatic Transmission Fluid Do Not Mix!

NOTE: ¹ Use dipstick to determine fluid exact level.

Warm Fluid Level Check: The transmission should be at operating temperature [190° F (90° C) maximum] to receive an accurate oil level reading.

Cold Fluid Level Check: To ease checking fluid level, the dipstick can be marked or scribed. First the procedure for warm fluid level must be performed, then allow boat to sit overnight. Remove and wipe clean the dipstick. Insert clean dipstick and mark the cold fluid level.

Pressure Specifications

Engine rpm	Neutral Gear PSI (kPa)		Forward Gear PSI (kPa)		Reverse Gear PSI (kPa)	
	Min.	Max.	Min.	Max.	Min.	Max.
250	—	—	70 (483)	—	70 (483)	—
600	115 (793)	135 (931)	115 (793)	140 (965)	120 (827)	140 (965)
2000	—	—	125 (862)	160 (1103)	125 (862)	160 (1103)
3000	—	—	135 (931)	180 (1241)	—	—

Important Information

Shift Control and Cables

CAUTION

Shift control and shift cable must position transmission shift lever exactly as stated in this manual, or transmission, as a result of improper shift lever positioning, will not be covered by Velvet Drive Warranty.

IMPORTANT: Velvet Drive Warranty is jeopardized if the shift lever poppet ball or spring is permanently removed or if shift lever is repositioned or changed in any manner.

Remote control used must position transmission shift lever over the letter "F" embossed on transmission case when remote control is placed in FORWARD gear position. Transmission failure will occur if transmission shift lever is positioned over the letter "R" and the wrong rotation propeller is used to propel boat forward.

Remote control must provide shift cable travel (at transmission) of at least 2-3/4 in. (70 mm) to position transmission shift lever fully in the FORWARD and REVERSE gear positions. Insufficient shift cable travel will cause transmission to slip and eventually fail.

Engine

Engine rotation is indicated on engine specifications and serial number decal on flame arrestor cover. Engine rotation is described when observed from the rear of the engine (transmission end) looking forward (water pump end).

Installed angle of MIE inboard transmission and engine should not exceed a maximum of 18° of the water line.

Transmission

Transmission gear ratio (in forward gear) is marked on transmission identification plate, which is located on the port (left) side of transmission. Transmission output shaft rotation and propeller rotation required is indicated on a decal on transmission case. Transmission rotation is described when viewed from the rear of transmission with transmission in forward gear selector position.

On MIE engines equipped with in-line transmissions having 1:1 gear ratio, transmission output shaft rotation is the same as engine rotation with transmission in forward gear. Engine rotation is LH (CCW), so a LH propeller is required.

1. DO NOT start or crank engine without fluid in transmission.
2. Use only recommended fluid in transmission.
3. Except in an emergency, never shift transmission at engine speeds above 1000 rpm.
4. Free wheeling of one propeller (in a twin engine boat) at trolling speeds will not cause damage to the transmission. However, boat operation above trolling speed should be avoided. Be sure proper fluid level exists before free wheeling propeller.
5. DO NOT paint shift lever poppet ball and spring. An accumulation of paint will prevent proper action of the detent.
6. Always replace oil cooler and hoses after a transmission failure or prior to installing a new or rebuilt transmission. Metallic particles from a failure tend to collect in the cooler and hoses and will gradually flow back into the fluid system and damage transmission.

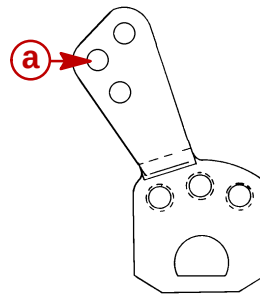
7. Always use specified oil cooler, hoses and fittings. Hoses must be at least 13/32 in. (10.5 mm) I.D. Oil cooler, hoses and fittings must be sufficient size to maintain transmission fluid (in sump) at 140-190°F (60-88°C).

Propeller

Propeller rotation is described when observed from the rear of the boat (stern) looking forward (bow end). The term "left-hand" (LH) refers to rotation in the counterclockwise (CCW) direction. The term "right-hand" (RH) refers to rotation in the clockwise (CW) direction. A LH propeller will move the boat forward when rotated counterclockwise. A RH propeller will move the boat forward when rotated clockwise. Propeller rotation is not necessarily the same as engine rotation.

Transmission Shift Lever

The lever has three holes as illustrated following. The shift lever stud is placed in the forward hole when using Quicksilver remote control cables.



71301

a - Stud In This Hole

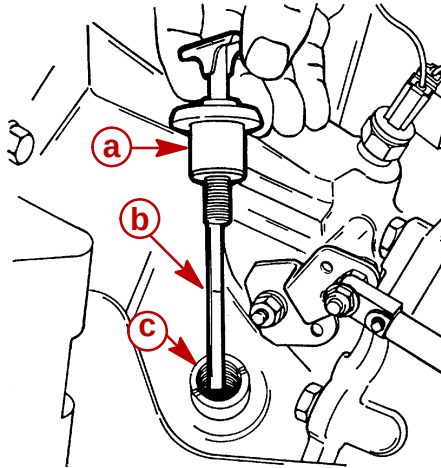
Shift Cable Adjustment

Refer to SECTION 2C - "MIE Models - Velvet Drive Transmissions" for installation and adjustment.

Checking Transmission Fluid Level

IMPORTANT: Use only specified transmission fluid. Refer to “Specifications.”

IMPORTANT: To accurately check fluid level, engine must be run at 1500 rpm for 2 minutes immediately prior to checking level.



72526

- a** - Dipstick
- b** - Full Mark
- c** - Dipstick Tube

1. Start engine and run at 1500 rpm for 2 minutes to fill all hydraulic circuits.

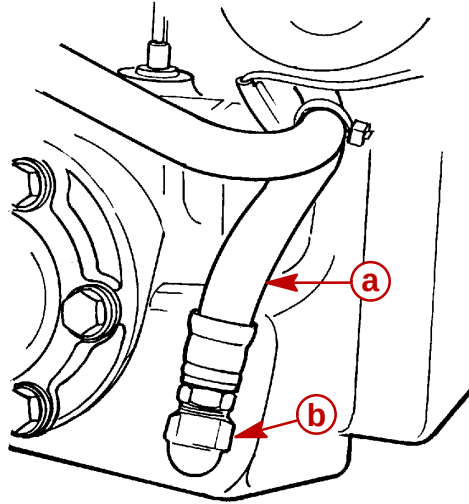
IMPORTANT: Be sure to push dipstick all the way down into dipstick tube when checking fluid level.

2. Stop engine and check fluid level. Add transmission fluid, if necessary, to bring level up to full mark on dipstick.
3. Reinstall dipstick. Be sure to tighten T-handle securely. DO NOT overtighten.
4. If transmission fluid level was extremely low, carefully check transmission, fluid cooler and hoses for leaks.

Changing Transmission Fluid

Draining Transmission

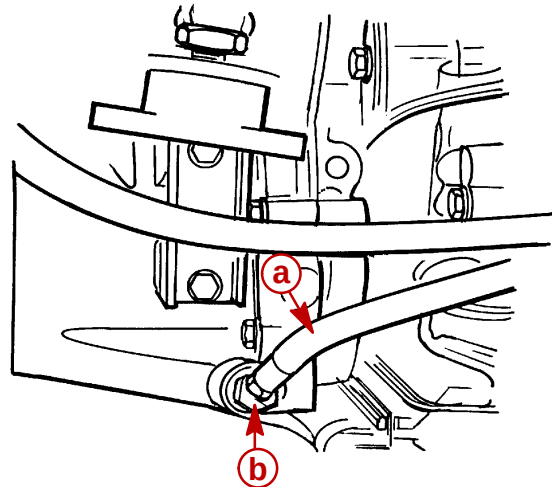
1. Clean area around cooler hose shown and proceed as follows:
 - a. Disconnect hose from elbow fitting.
 - b. Remove elbow fitting from bushing.
 - c. Drain oil from transmission, cooler and cooler hoses into a suitable container.



72840

Transmission With 1:1 Ratio

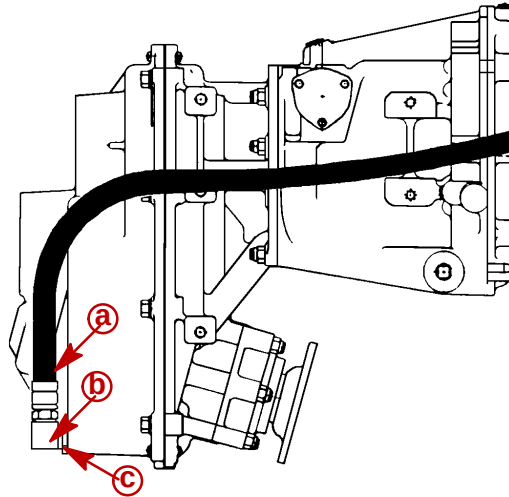
- a** - Hose
- b** - Elbow Fitting



72841

Transmission with Reduction Ratios

- a** - Hose
- b** - Bushing

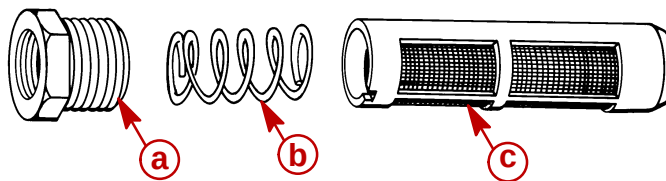


71305

V-Drive Transmission

- a** - Hose
- b** - Elbow Fitting
- c** - Bushing

2. Remove bushing, spring and strainer tube from transmission case. Allow transmission to drain completely.
3. Clean strainer tube in suitable solvent.



71307

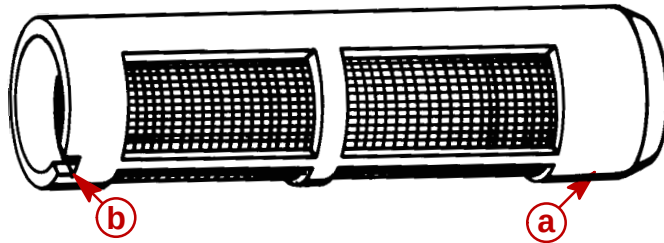
- a** - Bushing
- b** - Spring
- c** - Plastic Strainer Tube

4. Check oil for the following foreign matter:
 - **Metal Particles** - A few small particles are normal. Larger metal chips are an early sign of transmission failure which may mean transmission should be disassembled and inspected for internal damage.
 - **Rubber Particles** - Indication of cooler hose wear. Hoses should be inspected for cracks or fraying. Replace damaged hoses.

⚠ CAUTION

Avoid severe transmission damage or possible failure of transmission. Strainer must be properly installed as follows.

5. Install plastic strainer tube with the notch DOWN and OUT toward the side of the case.



71306

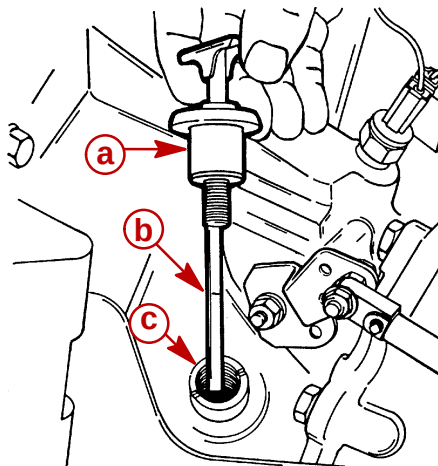
- a** - Plastic Strainer Tube
b - Notch

6. Install spring.
7. Coat bushing threads with Quicksilver Perfect Seal. Install and torque bushing to 25 lb-ft (34 Nm).
8. Coat elbow fitting threads with Quicksilver Perfect Seal and install in bushing. Tighten securely.
9. Reconnect hose and tighten securely.

Filling Transmission

IMPORTANT: Use only specified transmission fluid. Refer to “Specifications.”

1. Remove dipstick. Fill transmission with fluid, through dipstick hole, to bring up to full mark.



72526

- a** - Dipstick
b - Full Mark
c - Dipstick Tube

IMPORTANT: To accurately check fluid level, run engine at 1500 rpm for 2 minutes immediately prior to checking level.

2. Start engine and run at 1500 rpm for 2 minutes to fill all hydraulic circuits.

NOTE: Be sure to push dipstick all the way down into dipstick tube when checking fluid level.

3. Stop engine and quickly check fluid level. Add transmission fluid, if necessary, to bring level up to full mark on dipstick.
4. Reinstall dipstick. Be sure to tighten T-handle securely.

Removal

NOTICE
The following procedure describes removal of transmission without removing engine. If engine must be removed, refer to SECTION 2 (see "Table of Contents").

1. Drain transmission fluid.
2. Disconnect fluid cooler hoses.
3. Disconnect shift cable.
4. Disconnect wires from neutral start safety switch.
5. Disconnect wires from fluid temperature switch.
6. Disconnect propeller shaft coupling.
7. Remove four rear mount (to engine bed) bolts.
8. Support rear part of engine with either a hoist or by using wooden blocks under flywheel housing.
9. Remove two center transmission-to-flywheel housing attaching bolts and install two long studs.

IMPORTANT: These two long studs will help support weight of transmission during removal and installation.

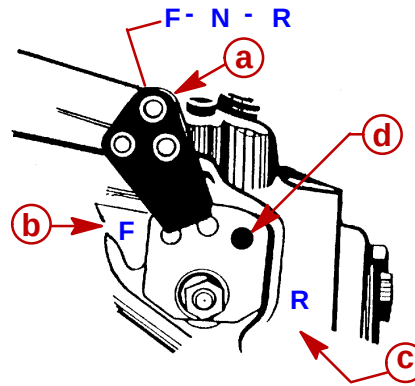
10. Remove remaining transmission attaching bolts.
11. Pull transmission straight back and off engine.

Installation

1. Check transmission output shaft rolling torque. Refer to "Specifications."
2. Apply Quicksilver Engine Coupler Spline Grease to transmission input shaft splines and engine drive plate splines.
3. If removed, install rear engine mounting brackets. Torque to 45 lb-ft (61 Nm).
4. Align transmission splines with drive plate splines.
5. Slide transmission into place and secure with bolts.
6. Remove two long studs (installed in Step 9) and install remaining two bolts. Torque all bolts to 50 lb-ft (68 Nm).
7. Relieve hoist tension and fasten rear engine mounts to engine bed. Tighten bolts securely.
8. Connect wires to neutral start safety switch.
9. Connect wires to fluid temperature switch.
10. Connect fluid cooler hoses to transmission.

11. Connect and adjust shift cable(s) as outlined in SECTION 2C, "MIE Models - Velvet Drive Transmissions".

IMPORTANT: Velvet Drive Transmission Warranty is jeopardized if the shift lever poppet ball or spring is permanently removed, if the shift lever is repositioned or changed in any manner, or if remote control and shift cable do not position shift lever exactly as shown.



72601

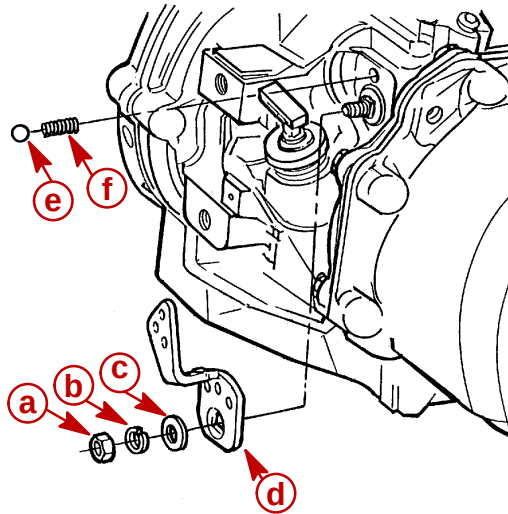
- a** - Transmission Shift Lever
 - b** - Shift Lever Must Be Over This Letter when Propelling Boat FORWARD
 - c** - Shift Lever Must Be Over This Letter when Propelling Boat in REVERSE
 - d** - Poppet Ball Must Be Centered in Detent Hole for Each F-N-R Position (Forward Gear Shown)
12. Refer to SECTION 2C "MIE Models - Velvet Drive Transmissions" and check engine final alignment as outlined.
 13. After engine has been properly aligned, connect propeller shaft coupler to transmission output flange. Attach couplers together with bolts, lockwashers and nuts. Torque to 50 lb-ft (68 Nm).
 14. Refill transmission with specified fluid. Refer to "Filling Transmission."
 15. Check for leaks and check fluid level after first engine start-up.

Shift Lever Installation

IMPORTANT: Velvet Drive Warranty is jeopardized if the shift lever poppet spring and/or ball is permanently removed, or if the shift lever is changed, repositioned or if the linkage between the remote control and the transmission shift lever does not have sufficient travel in both directions.

Shift lever and related parts must be assembled as shown.

1. Lubricate poppet ball, spring, and holes in shift lever with Quicksilver 2-4-C Marine Lubricant.
2. Install poppet spring and ball. Retain ball by placing shift lever on shaft.
3. Install flat washer, lockwasher and nut on shaft.
4. Torque nut to 96-132 lb-in. (11-15 Nm).



72844

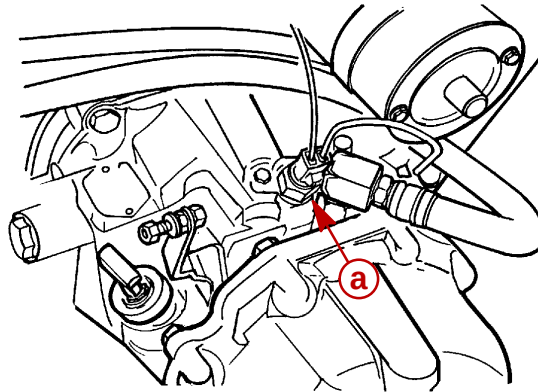
Typical Shift Lever

- a** - Nut
- b** - Lockwasher
- c** - Flat Washer
- d** - Shift Lever
- e** - Poppet Ball
- f** - Poppet Spring

5. After installation, move shift lever through forward, neutral and reverse positions. No more than finger-tip effort should be required. If valve binds, cause for binding must be found and corrected.

Pressure Test

1. Install pressure gauge.



72845

a - Main Line Pressure Tap - Remove Temperature Switch

2. With boat in water, start engine and run until normal operating temperature is reached.
3. Refer to "Specifications" for pressure readings.

Transmission Repair

Mercury Marine does not stock or sell replacement parts for the in-line transmission. Velvet Drive has a network of distributors throughout the world to service their product. These distributors, in turn, have a dealer network to service the transmissions. Also, service manuals (for each transmission) can be obtained from Velvet Drive.

For the location of your closest distributor or service literature contact:

Velvet Drive Transmissions
Division of Regal Beloit
Theodore Rice Boulevard
Industrial Park
New Bedford, MA 02745
Phone: (508) 995-2616

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DRIVES

Section 8B - Velvet Drive 5000 Series Transmission

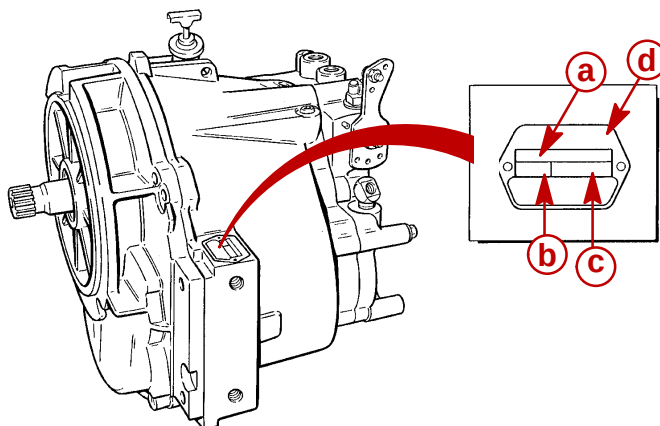
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Velvet Drive 5000A Down Angle Specifications

Identification

The transmission identification plate is located on the top left side of the transmission. Refer to charts following to determine engine and transmission combinations.



73247

Transmission Identification Plate

- a** - Model Number
- b** - Ratio (In Forward)
- c** - Serial Number
- d** - Identification Plate Model Color Code

Transmission Ratios and Part Numbers

Ratio in Forward Gear ¹	Identification Plate Color Code	Velvet Drive Model Number	Mercury Marine Part Number
1.5:1	Black	20-01-003	805495A6
2:1		20-01-004	805495A4
2.5:1		20-01-005	805495A5
2.8:1		20-01-006	805495A7

¹This ratio is shown on identification plate. Ratio may be rounded off in some cases.

Transmission Fluid Capacity

Model	U.S. Quarts (Liters)
5000A Down Angle (All Ratios)	3 (2.75) ¹

¹: Always use dipstick to determine exact quantity of fluid required.

Transmission Fluid Specification

Model	Fluid Type
5000A Down Angle (All Ratios)	Automatic Transmission Fluid (Dexron III) or Equivalent

Transmission Pressure Specifications

Engine rpm	Neutral Gear psi (kPa)		Forward Gear or Reverse Gear psi (kPa)	
	Min.	Max.	Min.	Max.
900	10 (69)	50 (344)	200 (1379)	400 (2757)
2400	50 (344)	70 (483)		

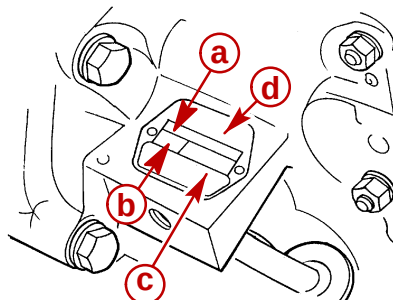
Torque Specifications

Fastener Location	lb-in.	lb-ft	Nm
Drain Plug		25	34
Fluid Hose-to-Cooler			
Fluid Hose-to-Housing			
Rear Mounts-to-Transmission		45	61
Shift Lever-to-Valve	96-132		11-15
Transmission-to-Flywheel Housing		50	68
Neutral Start Safety Switch	120		13
Propeller Shaft Coupler To Output Flange		50	68

Velvet Drive 5000V V-Drive Specifications

Identification

The transmission identification plate is located on the top left side of the transmission. Refer to charts following to determine engine and transmission combinations.



72839

Transmission Identification Plate

- a** - Model Number
- b** - Ratio (In Forward Gear)
- c** - Serial Number
- d** - Identification Plate Model Color Code

Transmission Ratios and Part Numbers

Ratio in Forward Gear ¹	Identification Plate Color Code	Velvet Drive Model Number	Mercury Marine Part Number
1.5:1	Blue	20-02-003	807481A5
2:1		20-02-004	807481A6
2.5:1		20-02-005	807481A7

¹This ratio is shown on identification plate. Ratio may be rounded off in some cases.

Transmission Fluid Capacities

Model	U.S. Quarts. (Liters)
5000V	3 (2-3/4) ¹

NOTE: ¹ Use dipstick to determine exact fluid level.

Warm Fluid Level Check: The transmission should be at operating temperature [190°F(90° C)] maximum to receive an accurate oil level reading.

Cold Fluid Level Check: To ease checking fluid level, the dipstick can be marked or scribed. First the procedure for warm fluid level must be performed, then allow boat to sit overnight. Remove and wipe clean the dipstick. Insert clean dipstick and mark the cold fluid level.

Transmission Fluid Specification

Model	U.S. Quarts (Liters)
5000V	Automatic Transmission Fluid Dexron III or Equivalent

Transmission Pressure Specifications

Engine rpm	Neutral Gear psi (kPa)		Forward Gear psi (kPa)		Reverse Gear psi (kPa)	
	Min.	Max.	Min.	Max.	Min.	Max.
250	—	—	70 (483)	—	70 (483)	—
600	115 (793)	135 (931)	115 (793)	140 (965)	120 (827)	140 (965)
2000	—	—	125 (862)	160 (1103)	125 (862)	160 (1103)
3000	—	—	135 (931)	180 (1241)	—	—

Torque Specifications

Description	lb-in	lb-ft	Nm
Drain Plug (Bushing)		25	34
Fluid Hose to Bushing		25	34
Pump Housing to Adapter		17-22	23-29
Rear Mounts to Transmission		45	61
Shift Lever to Valve		8-11	11-15
Transmission to Flywheel Housing		50	68
Neutral Start Switch		8-11	11-14

Shift Control and Cables

CAUTION

Shift control and shift cable must position transmission shift lever exactly as stated in this manual, or transmission, as a result of improper shift lever positioning, will not be covered by Velvet Drive Warranty.

IMPORTANT: Velvet Drive Warranty is jeopardized if the shift lever poppet ball or spring is permanently removed, or if shift lever is repositioned or changed in any manner.

Remote control also must provide a total shift cable travel (at transmission end) of at least 2-3/4 in. (70 mm). This is necessary to position transmission shift lever fully in the forward and reverse gear positions. Insufficient shift cable travel will cause transmission to slip and eventually fail.

Important Information

Engine

Engine rotation is indicated on engine specifications and serial number decal on the engine. Engine rotation is described when observed from the rear of the engine (transmission end) looking forward (water pump end).

Installed angle of MIE inboard transmission and engine should not exceed a maximum of 12° of the water line.

Transmission

Transmission gear ratio is marked on transmission identification plate, which is located on the port (left) side of transmission. Transmission rotation is described when viewed from the rear of transmission with transmission in forward gear selector position.

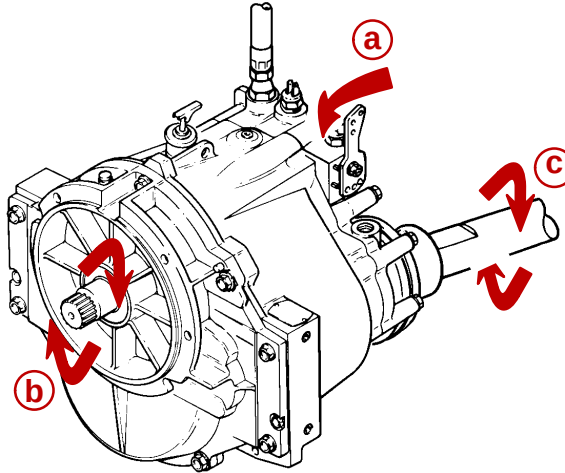
1. DO NOT start or crank engine without fluid in transmission.
2. Use only recommended fluid in transmission.
3. Except in an emergency, never shift transmission at engine speeds above 1000 rpm.
4. Free wheeling of one propeller (in a twin engine boat), at trolling speeds, will not cause damage to the transmission; however, boat operation above trolling speed should be avoided. Be sure proper fluid level exists before free wheeling propeller.
5. DO NOT paint shift lever poppet ball and spring. An accumulation of paint here will prevent proper action of the detent.
6. Always replace oil cooler and hoses after a transmission failure or prior to installing a new or rebuilt transmission. Metallic particles from a failure tend to collect in the cooler and hoses and will gradually flow back into the fluid system and damage transmission.
7. Always use specified oil cooler, hoses and fittings. Hoses must be at least 13/32 in. (10.5 mm) I.D. Oil cooler, hoses and fittings must be sufficient size to maintain transmission fluid (in sump) at 140-190°F (60-88°C).

Propeller

Propeller rotation is described when observed from the rear of the boat (stern) looking forward (bow end). The term "left-hand" (LH) refers to rotation in the counterclockwise (CCW) direction. The term "right-hand" (RH) refers to rotation in the clockwise (CW) direction. A LH propeller will move the boat forward when rotated counterclockwise. A RH propeller will move the boat forward when rotated clockwise. Propeller rotation is not necessarily the same as engine rotation.

Transmission / Propeller Rotation

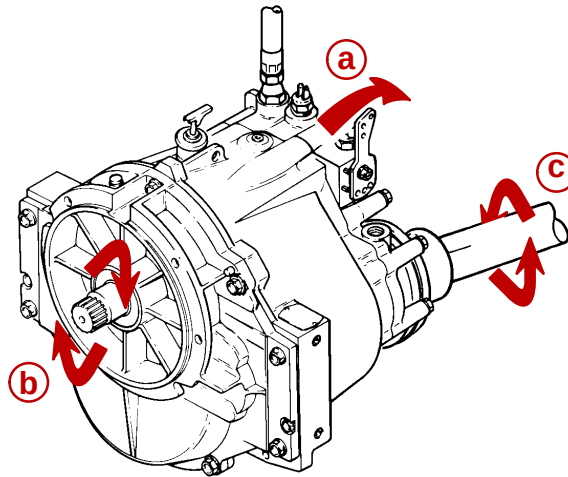
These transmissions are full power reversing transmissions, allowing a standard (LH rotation) engine to be used for both propeller rotations. Propeller rotation (output shaft rotation) is determined by shift cable attachment at the remote control. Be sure to use correct rotation propeller and shift cable hook up for direction desired.



71888

Typical

- a** - Direction Of Shift Lever Engagement (Toward Flywheel)
- b** - Engine/Transmission Input Shaft Shaft Rotation Direction (LH)
- c** - Transmission Output/Propeller Shaft Rotation Direction (LH)



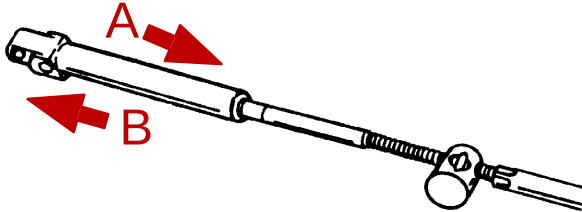
71888

Typical

- a** - Direction Of Shift Lever Engagement (Away From Flywheel)
- b** - Engine/Transmission Input Shaft Rotation Direction (LH)
- c** - Transmission Output/Propeller Shaft Rotation Direction (RH)

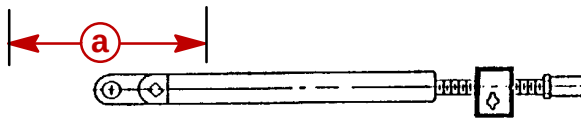
For Left-Hand Propeller Shaft Rotation: Shift cable hookup at remote control must result in shift cable end guide moving in direction "A" when remote control handle is placed in forward position.

For Right-Hand Propeller Shaft Rotation: Shift cable hookup at remote control must result in shift cable end guide moving in direction "B" when remote control handle is placed in forward position.



23242

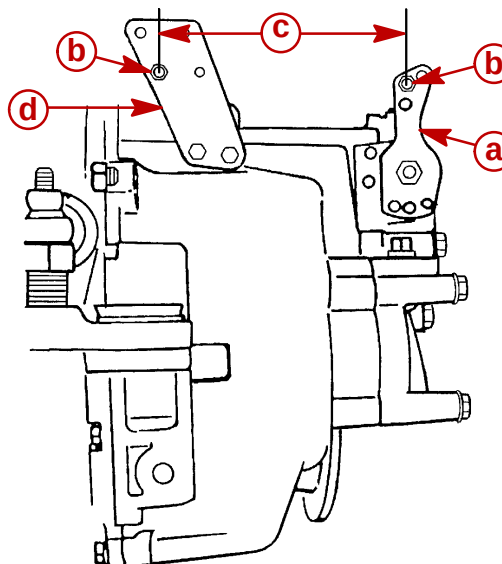
Remote control must provide a total shift cable travel (at transmission end) of at least 2-3/4 in. (70 mm). This is necessary to position transmission shift lever fully in the forward and reverse gear positions. Insufficient shift cable travel will cause transmission to slip and eventually fail.



72602

a - 2-3/4 Inch (70 mm) Minimum

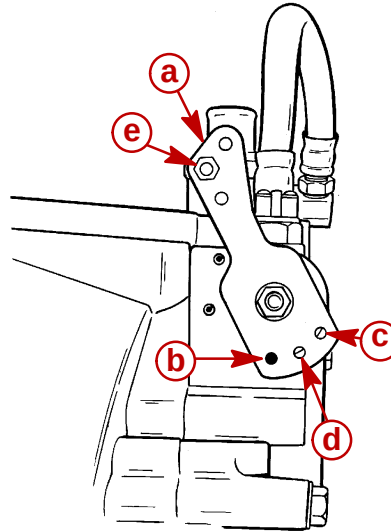
IMPORTANT: The distance between studs (Dimension "C") shown in the following illustration, is set at 7-1/8 in. (318 mm).



73284

- a** - Shift Lever
- b** - Anchor Stud
- c** - Dimension Between Studs - 7-1/8 Inch (318 mm)
- d** - Shift Cable Bracket

IMPORTANT: Velvet Drive Transmission Warranty is jeopardized if the shift lever poppet ball or spring is permanently removed, if the shift lever is repositioned or changed in any manner, or if remote control and shift cable do not position shift lever exactly as shown.



73248

- a** - Transmission Shift Lever
- b** - Poppet Ball Must Be Centered In This Detent Hole When Left-Hand Propeller Shaft Rotation Is Desired
- c** - Poppet Ball Must Be Centered In This Detent Hole When Right-Hand Propeller Shaft Rotation Is Desired
- d** - Poppet Ball Must Be Centered In This Detent Hole For Neutral Position
- e** - Install Shift Lever Stud In This Hole When Using Quicksilver Shift Cables

Shift Control and Cables

CAUTION

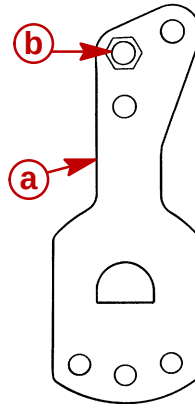
Shift control and shift cable must position transmission shift lever exactly as stated in this manual, or transmission, as a result of improper shift lever positioning, will not be covered by Velvet Drive Warranty.

IMPORTANT: Velvet Drive Warranty is jeopardized if the shift lever poppet ball or spring is permanently removed, or if shift lever is repositioned or changed in any manner.

Remote control also must provide a total shift cable travel (at transmission end) of at least 2-15/16 in. (75 mm). This is necessary to position transmission shift lever fully in the forward and reverse gear positions. Insufficient shift cable travel will cause transmission to slip and eventually fail.

Transmission Shift Lever and Shift Cable Bracket

1. The lever has three holes as illustrated following. For use with Quicksilver shift cables, the anchor stud is located in the middle hole.



73249

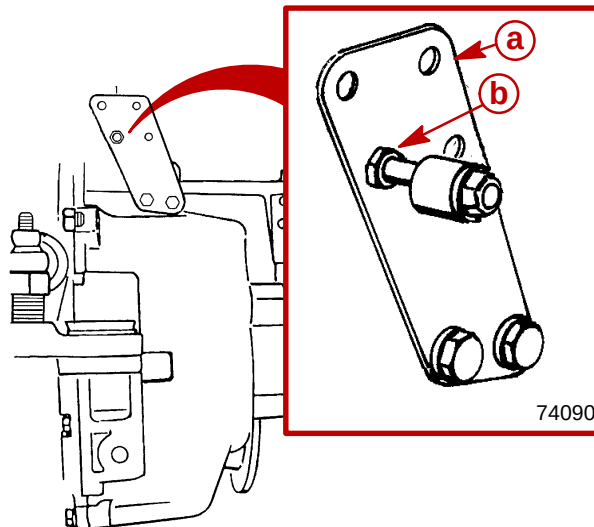
a - Shift Lever

b - Shift Cable Anchor Stud Location (For Quicksilver Shift Cables)

⚠ WARNING

Avoid serious personal injury or property damage caused by improper shifting. Anchor stud for shift cable must be installed in the correct hole when using bracket with four anchor location holes.

2. Be certain anchor stud is installed in the lower, front hole as shown in the illustration following.

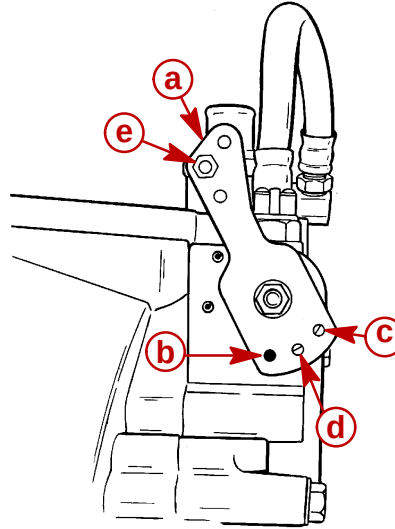


a - Cable Bracket

b - Shift Cable Anchor Stud Location (For Quicksilver Shift Cables)

Shift Cable Adjustment

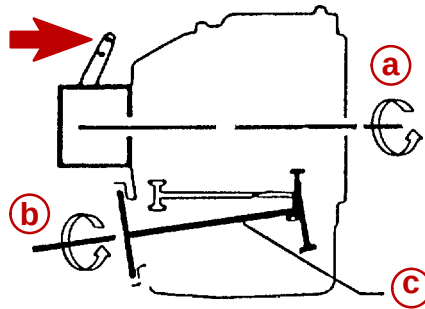
IMPORTANT: Velvet Drive Transmission Warranty is jeopardized if the shift lever poppet ball or spring is permanently removed, if the shift lever is repositioned or changed in any manner or if remote control and shift cable do not position shift lever exactly as shown.



73248

- a** - Transmission Shift Lever
- b** - Poppet Ball Must Be Centered In This Detent Hole When Left-hand Propeller Shaft Rotation Is Desired
- c** - Poppet Ball Must Be Centered In This Detent Hole When Right-hand Propeller Shaft Rotation Is Desired
- d** - Poppet Ball Must Be Centered In This Detent Hole For Neutral Position
- e** - Install Shift Lever Stud In This Hole When Using Quicksilver Shift Cables

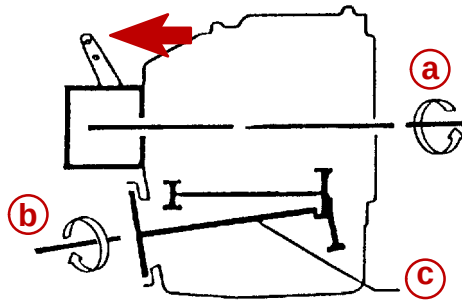
IMPORTANT: The Velvet Drive 5000 Series transmissions are full reversing transmission. Direction of output/propeller rotation is determined by hookup of shift cable at remote control.



73291

Position Is Forward Gear For LH Rotation Propeller

- a** - Input
- b** - Output
- c** - Output Shaft



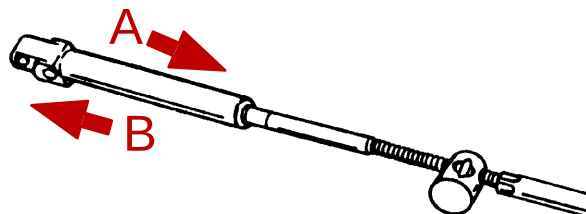
73285

Position Is Forward Gear For LH Rotation Propeller

- a** - Input
- b** - Output
- c** - Output Shaft

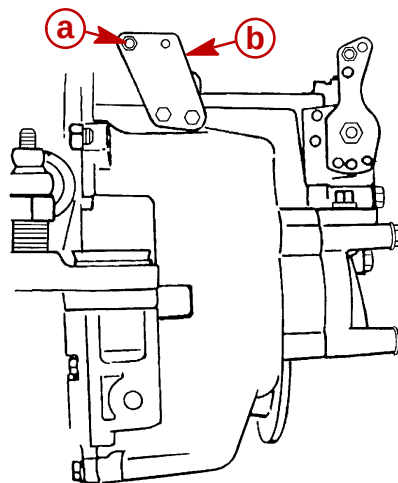
For Left-Hand Propeller Shaft Rotation: Shift cable hookup at remote control must result in shift cable end guide moving in direction "A" when remote control handle is placed in forward position.

For Right-Hand Propeller Shaft Rotation: Shift cable hookup at remote control must result in shift cable end guide moving in direction "B" when remote control handle is placed in forward position.



23242

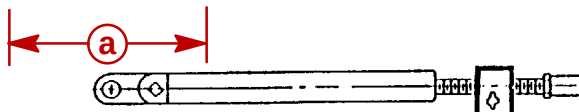
IMPORTANT: Be certain anchor stud is installed in the front hole as shown in the illustration following.



73284

- a** - Anchor Stud In Front Hole
- b** - Shift Cable Bracket

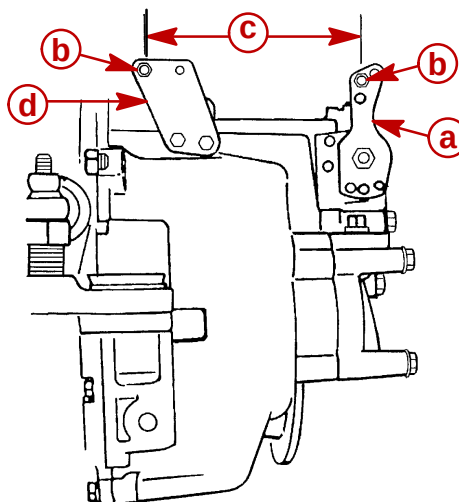
Remote control must provide a total shift cable travel (at transmission end) of at least 2-3/4 in. (70 mm). This is necessary to position transmission shift lever fully in the forward and reverse gear positions. Insufficient shift cable travel will cause transmission to slip and eventually fail.



72602

- a** - 2-3/4 In. (70 mm) Minimum

IMPORTANT: The distance between studs (Dimension C) shown in the following illustration is set at 7-1/8 in. (318 mm).

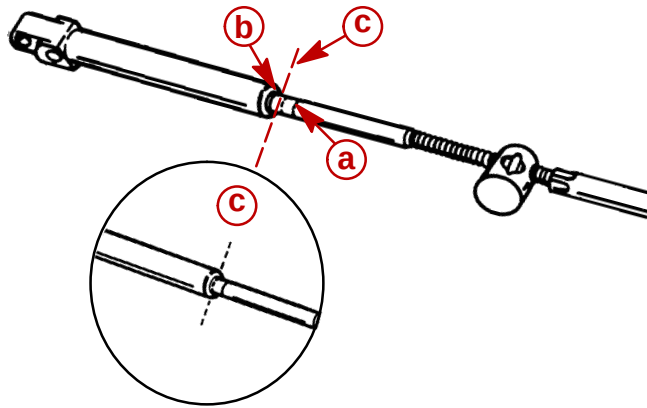


73284

- a** - Shift Lever
- b** - Anchor Stud
- c** - Dimension Between Studs - 7-1/8 Inch (318 mm)
- d** - Shift Lever Bracket

IMPORTANT: When installing shift cables, be sure that cables are routed in such a way as to avoid sharp bends and/or contact with moving parts. DO NOT fasten any items to shift cables.

1. Place remote control shift lever and transmission shift lever in neutral position.
2. Remove nuts and washers from shift cable attaching studs.
3. Locate center of remote control and control shift cable play (backlash) as follows:
 - a. Check that remote control is in neutral position.
 - b. Push in on control cable end with enough pressure to remove play; mark position "a" on tube.
 - c. Pull out on control cable end with enough effort to remove play; mark position "b" on tube.
 - d. Measure distance between marks "a" and "b;" mark position "c" half-way between marks "a" and "b."



72603

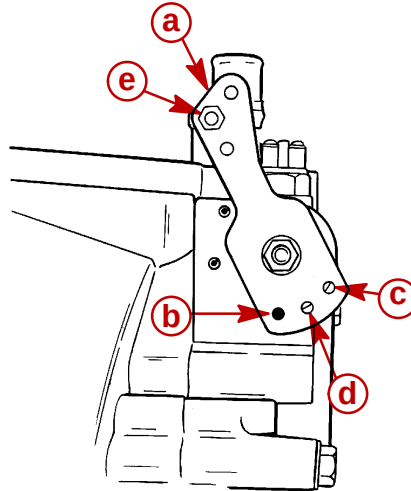
4. Center cable-end play, then adjust cable barrel to align holes in barrel and in cable end guide, with attaching points on transmission.
5. Temporarily install shift cable. Do not secure at this time.

IMPORTANT: Transmission is "fully" in gear when shift lever comes to a stop, in either direction.

6. Place remote control shift lever in gear and check position of transmission shift lever. Shift lever must be positioned as shown.

⚠ CAUTION

Remote control and shift cable must position transmission shift lever exactly as shown, or transmission failure may occur. Do not remove poppet ball or spring.

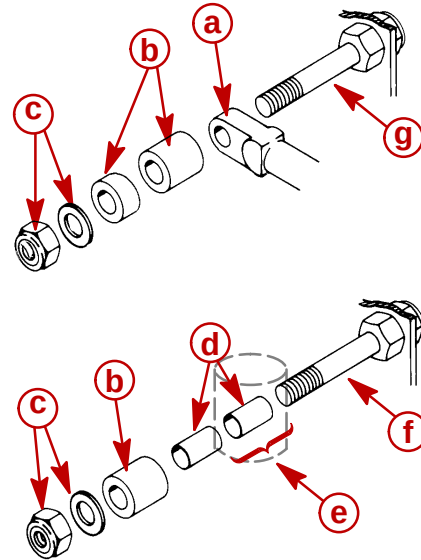
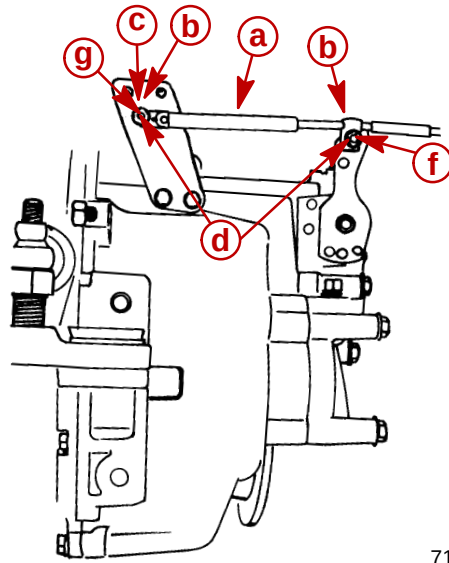


73248

- a** - Transmission Shift Lever
- b** - Poppet Ball Must Be Centered in This Detent Hole when Left-Hand Propeller Shaft Rotation Is Desired
- c** - Poppet Ball Must Be Centered in This Detent Hole when Right-Hand Propeller Shaft Rotation Is Desired
- d** - Poppet Ball Must Be Centered in This Detent Hole for Neutral Position
- e** - Install Shift Lever Stud in This Hole when Using Quicksilver Shift Cables

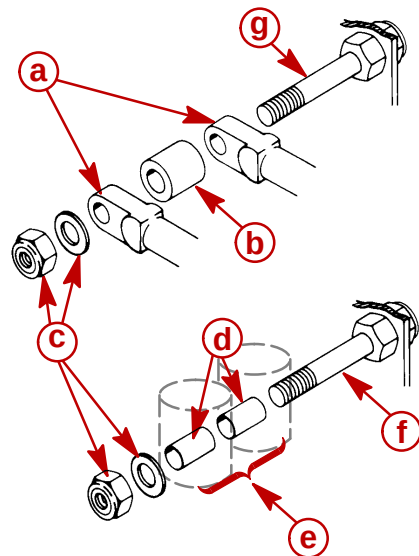
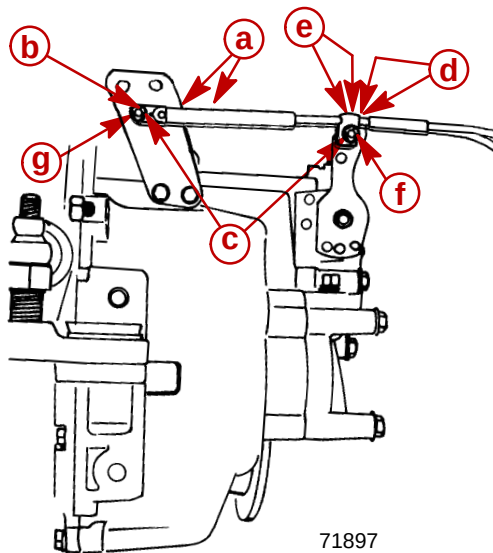
7. Place remote control shift lever in opposite gear position and again check transmission shift lever position. Lever must be positioned as shown by "c."
8. If transmission shift lever will not position properly in one gear or both gears, recheck shift cable adjustment and travel as previously instructed in "a"-"h." If proper positioning is still not obtained, remote control does not provide sufficient shift cable travel and must be repaired or replaced.
9. Install nut and washer to cable end guide stud. Tighten until snug, then back off one full turn.

10. Install nut and washer to cable barrel stud. Tighten until they contact. Tighten securely, but DO NOT OVERTIGHTEN.



Typical Single Cable Installation - Rear Approach

- a** - Cable End Guide
- b** - Spacer (As Required)
- c** - Elastic Stop Nut And Washer
- d** - Bushing(s)
- e** - Cable Barrel (s) [Position (s) Only Indicated In Right Drawing]
- f** - Cable Barrel Stud
- g** - Cable End Guide Stud



Typical Dual Cable Installation - Rear Approach

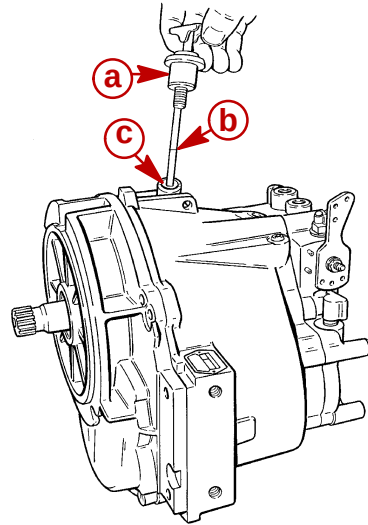
- a** - Cable End Guide
- b** - Spacer (As Required)
- c** - Elastic Stop Nut and Washer
- d** - Bushing(s)
- e** - Cable Barrel (s) [Position(s) Only Indicated In Right Drawing]
- f** - Cable Barrel Stud
- g** - Cable End Guide Stud

Checking Transmission Fluid Level

IMPORTANT: Use only specified transmission fluid. Refer to “Specifications.”

Check transmission fluid before running engine each day, as follows:

1. Remove dipstick. Check fluid level as indicated on dipstick. Fluid level may be somewhat over full mark, as some of the fluid from transmission fluid cooler and hoses may have drained back into transmission. If low, add specified transmission fluid to bring level up to full mark on dipstick.



73250

- a** - Dipstick
- b** - Full Mark
- c** - Dipstick Tube

IMPORTANT: To accurately check fluid level, engine must be run at 1500 rpm for 2 minutes immediately prior to checking level.

2. Start engine and run at 1500 rpm for 2 minutes to fill all hydraulic circuits.

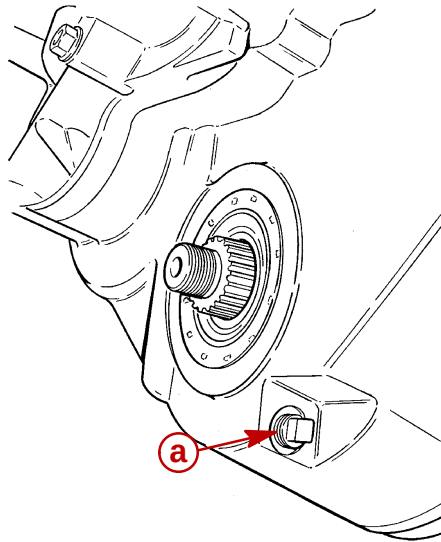
IMPORTANT: Be sure to push dipstick all the way down into dipstick tube when checking fluid level.

3. Stop engine and quickly check fluid level. Add transmission fluid, if necessary, to bring level up to full mark on dipstick.
4. Reinstall dipstick.
5. If transmission fluid level was extremely low, carefully check transmission, fluid cooler and hoses for leaks.

Changing Transmission Fluid

Draining Transmission

1. Clean area around drain plug shown.
2. Remove dipstick and then remove drain plug. Drain oil from transmission into a suitable container.



73252

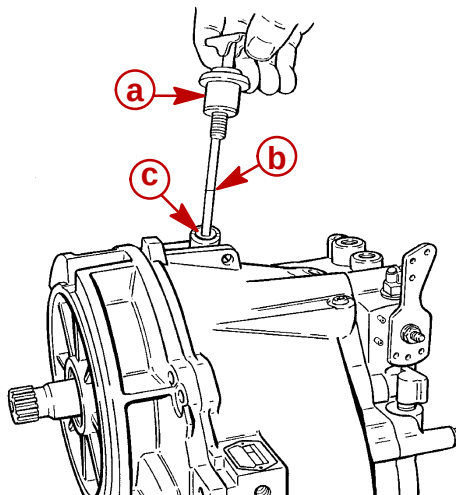
a - Drain Plug

3. Check oil for the following foreign matter:
 - **Metal Particles** - A few small particles are normal. Larger metal chips are an early sign of transmission failure which may mean transmission should be disassembled and inspected for internal damage.
 - **Rubber Particles** - Indication of cooler hose wear. Hoses should be inspected for cracks or fraying. Replace damaged hoses.
4. Coat drain plug threads with Quicksilver Perfect Seal. Install and torque drain plug to 25 lb-ft (34 Nm).
5. Reconnect hose and tighten securely.
6. Refill transmission with specified fluid. Refer to "Filling Transmission."

Filling Transmission

IMPORTANT: Use only specified transmission fluid. Refer to “Specifications.”

1. Remove dipstick. Fill transmission with fluid, through dipstick hole, to bring up to full mark.



73250

- a** - Dipstick
- b** - Full Mark
- c** - Dipstick Tube

IMPORTANT: To accurately check fluid level, run engine at 1500 rpm for 2 minutes immediately prior to checking level.

2. Start engine and run at 1500 rpm for 2 minutes to fill all hydraulic circuits.

NOTE: Be sure to push dipstick all the way down into dipstick tube when checking fluid level.

3. Stop engine and quickly check fluid level. Add transmission fluid as needed to bring level up to full mark on dipstick.
4. Reinstall dipstick. Be sure to tighten T-handle securely.

Removal

NOTICE

The following procedure describes removal of transmission without removing engine. If engine must be removed, refer to SECTION 2.

1. Disconnect negative battery cable.
2. If required, drain transmission fluid and disconnect fluid cooler hoses.
3. Disconnect shift cable from transmission.
4. Disconnect wires from neutral start safety switch.
5. Disconnect wires from transmission fluid temperature switch.
6. Loosen trunnion clamping fasteners on engine mounts (port and starboard).
7. Remove coupling nuts and bolts and separate propeller shaft flange from transmission output flange.
8. Remove the four rear engine mount-to-engine bed fasteners and hardware.

9. Support rear part of engine using a suitable hoist or wooden blocks under flywheel housing.
10. Support transmission with hoist or by other suitable means through the lifting eye on the transmission case.
11. Remove port and starboard rear mount brackets (with base and trunnion) from transmission.

⚠ CAUTION

Avoid damage to transmission input shaft or engine coupler. Make sure transmission is completely supported before removing hardware attaching transmission to flywheel housing.

12. Remove all hardware attaching transmission to flywheel housing.
13. Move transmission straight back and away from engine to completely disengage splines on input shaft.
14. Carefully lift out transmission.

Installation

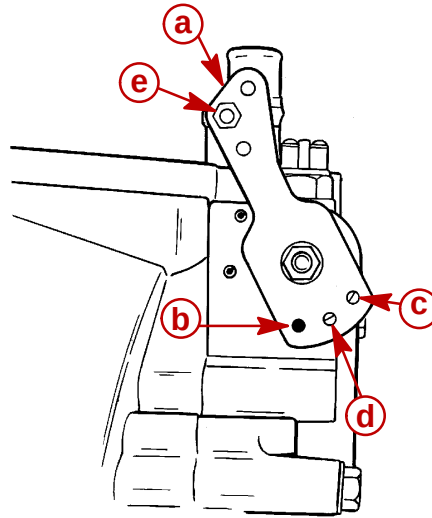
1. Apply Quicksilver Engine Coupler Spline Grease to transmission input shaft splines and engine drive plate splines.
2. Using a suitable hoist, position transmission in boat and align transmission splines with drive plate splines.
3. Slide transmission into place and secure with attaching hardware. Torque transmission to flywheel housing fasteners to 55 lb-ft (75 Nm). Remove hoist.
4. Install rear mount brackets to transmission. Torque fasteners and hardware to 45 lb-ft (61 Nm).
5. Using hoist, raise engine and transmission to remove blocks (if employed). Lower assembly to engine bed. Securely tighten the four rear engine mount-to-engine bed fasteners with hardware. Relieve hoist tension.
6. Connect wires to neutral start safety switch.
7. Connect wires to transmission fluid temperature switch.

⚠ CAUTION

Improper shift cable connection and adjustment can cause premature clutch failure.

8. Connect and adjust shift cable(s).

IMPORTANT: Velvet Drive Transmission Warranty is jeopardized if the shift lever poppet ball or spring is permanently removed, if the shift lever is repositioned or changed in any manner, or if remote control and shift cable do not position shift lever exactly as shown.



73248

- a** - Transmission Shift Lever
- b** - Poppet Ball Must Be Centered In This Detent Hole When Left-hand Propeller Shaft Rotation Is Desired
- c** - Poppet Ball Must Be Centered In This Detent Hole When Right-hand Propeller Shaft Rotation Is Desired
- d** - Poppet Ball Must Be Centered In This Detent Hole For Neutral Position
- e** - Install Shift Lever Stud In This Hole When Using Quicksilver Shift Cables

9. Refer to SECTION 2C and check engine final alignment as outlined.

10. After final engine and coupler alignment has been properly set (with boat in the water), connect propeller shaft coupler to transmission output flange. Attach couplers together with bolts, lockwashers and nuts. Torque to 50 lb-ft (68 Nm).

IMPORTANT: Be certain to torque trunnion clamping fasteners on engine mounts (port and starboard) which were loosened during removal.

IMPORTANT: All coupler bolts must be SAE Grade 8 (Metric Grade 10.9) or better, with a shoulder (grip length) long enough to pass through the face mating plane of couplers.

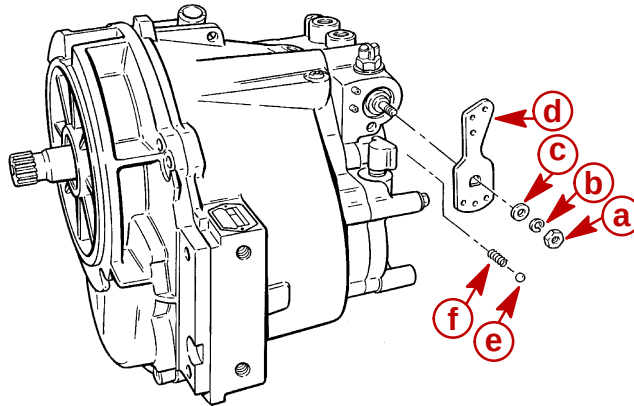
11. If previously removed, install transmission fluid cooler and hoses. Torque hose fittings at cooler and transmission housing to 25 lb-ft (34 Nm).
12. Refill transmission with specified fluid. Refer to "Filling Transmission."
13. Connect negative battery cable. Tighten clamp securely.
14. Check for leaks and check fluid level after first engine start-up.

Shift Lever Installation

IMPORTANT: Velvet Drive Warranty is jeopardized if the shift lever poppet spring and/or ball is permanently removed, or if the shift lever is changed in any manner, or repositioned, or if the linkage between the remote control and the transmission shift lever does not have sufficient travel in both directions.

Shift lever and related parts must be assembled as shown.

1. Lubricate poppet ball, spring and holes in shift lever with Quicksilver 2-4-C Marine Lubricant.
2. Install poppet spring and ball. Retain ball by placing shift lever on shaft.
3. Install flat washer, lockwasher and nut on shaft.
4. Torque nut to 96-132 lb-in. (11-15 Nm).



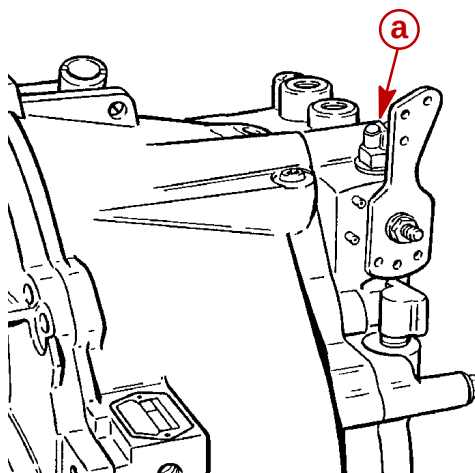
73251

- a - Nut
- b - Lockwasher
- c - Flat Washer
- d - Shift Lever
- e - Poppet Ball
- f - Poppet Spring

5. After installation, move shift lever through forward, neutral and reverse positions. No more than finger-tip effort should be required. If valve binds, cause for binding must be found and corrected.

Pressure Test

1. Remove transmission temperature switch and install a suitable pressure gauge.



73247

a - Main Line Pressure Tap - Remove Temperature Switch

2. With boat in water, start engine and run until normal operating temperature is reached.
3. Refer to "Operating Specifications" for test rpms and respective pressure readings.

Transmission Repair

Mercury Marine does not stock or sell replacement parts for the down angle transmission. Velvet Drive has a network of distributors throughout the world to service their product. These distributors, in turn, have a dealer network to service the transmissions. Also, service manuals (for each transmission) can be obtained from Velvet Drive.

For the location of your closest distributor or service literature contact:

Velvet Drive Transmissions
Division of Regal Beloit
Theodore Rice Boulevard
Industrial Park
New Bedford, MA 02745
Phone: (508) 995-2616

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DRIVES

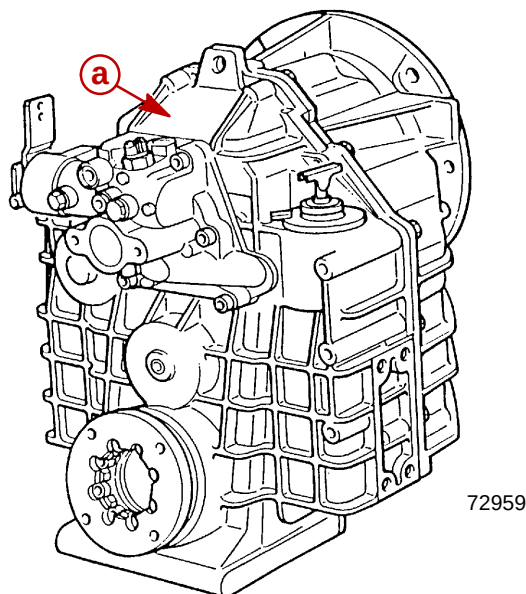
Section 8C - Hurth Transmissions

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Fluid Specifications	8C-3	Transmission Removal	8C-14
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Lubricants / Sealants / Adhesives	8C-3	Functional Tests	8C-17
Rotation	8C-4		

Identification

The transmission identification plate is located on the top rear of the transmission.



Late Style Identification Plate

a - Serial Number and Gear Ratio

Specifications

Torque Specifications

Item / Fastener Location	lb-in.	lb-ft	Nm
Transmission Housing Halves Bolts and Nuts		36	49
Control Block To Housing		18	25
Output Flange		14	18
Mounts		50	68
Transmission To Flywheel Housing			

Operating Specifications

Description	Specification
Shifting Pressure	312-377 PSI (2151-2599 kPa)
Operating Temperature	130°-200°F (54°-94°C)

Fluid Specifications

Make and Model	Capacity	Fluid Type
ZF (Hurth)		
630V	4.2 (4.0)	Dexron III Automatic Transmission Fluid
630A	3.2 (3.0)	
800A	5.8 (5.5)	

NOTE: ¹ Use dipstick to determine fluid exact level.

Warm Fluid Level Check: The transmission should be at operating temperature [190° F (90° C) maximum] to receive an accurate oil level reading.

Cold Fluid Level Check: To ease checking fluid level, the dipstick can be marked or scribed. First the procedure for warm fluid level must be performed, then allow boat to sit overnight. Remove and wipe clean the dipstick. Insert clean dipstick and mark the cold fluid level.

Tools

Description	Part Number
Thermometer [(3/8 In, Thread 0-270°F (-18 to -132°C))]	Obtain Locally
Pressure Gauge (M10x1 Thread)	

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Engine Coupler Spline Grease	92-816391A4
Quicksilver Liquid Neoprene	92-25711--3
Loctite Type A	Obtain Locally
Loctite 515	

Rotation

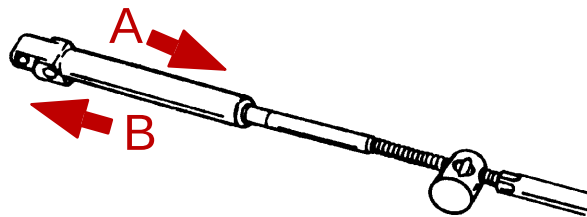
The Hurth transmissions are full power reversing transmissions, allowing a standard (LH rotation) engine to be used for both rotations. Propeller rotation is determined by shift cable attachment at the remote control.

⚠ CAUTION

Avoid severe transmission damage. All Hurth Transmissions require Standard Left-Hand rotation engines. NEVER connect a Hurth Transmission to a Right-Hand rotation engine.

IMPORTANT: Transmission propeller rotation is determined by the shift cable installation in the remote control.

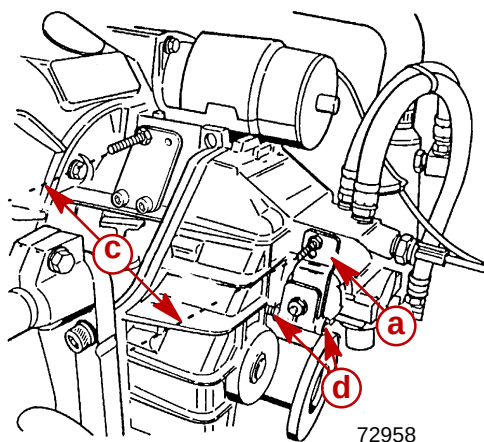
- **RIGHT-HAND PROPELLER ROTATION** - Control cable will have to be installed in remote control so that cable end will move in direction "A" when shift handle is placed in the forward position.
- **LEFT-HAND PROPELLER ROTATION** - Control cable will have to be installed in remote control so that cable end will move in direction "B" when shift handle is placed in the forward position.



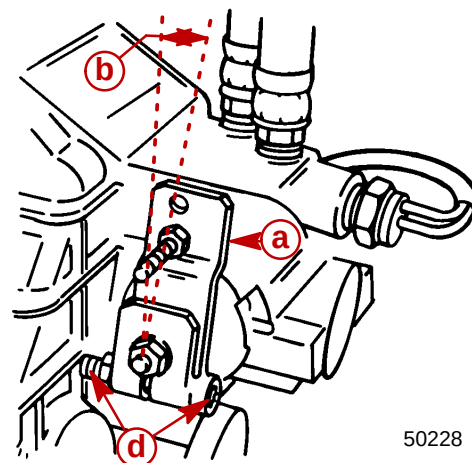
23242

Shift Cable Installation and Adjustment

IMPORTANT: Check that shift lever is positioned approximately 10° aft of vertical as shown when in the neutral detent position. Also, ensure that the distance between studs in the following is set at 7-1/8 in. (181 mm). If necessary, loosen clamping bolt and position lever so that dimension “c” is as shown when in the neutral detent position, and retighten clamping bolt.



72958



50228

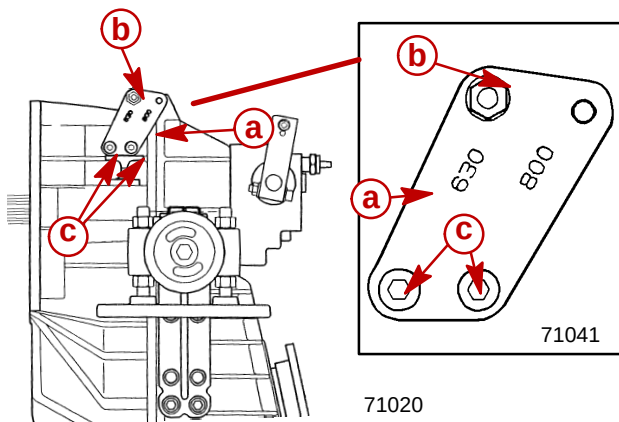
Typical Hurth Transmission Shown

- a** - Shift Lever
- b** - Lever, In Neutral Detent, Must Be Approximately 10 Degrees Aft Of Vertical
- c** - Dimension Between Studs - 7-1/8 In. (181 mm)
- d** - Clamping Bolt

1. **On bracket with two anchor location holes:** Be certain anchor stud is installed in the hole marked “630.”

⚠ WARNING

Avoid serious personal injury or property damage caused by improper shifting. Anchor stud for shift cable must be installed in the correct hole when using bracket with two anchor location holes.

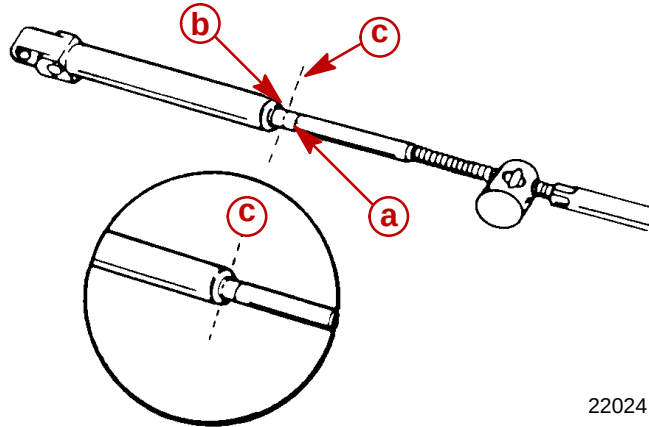


71020

Shift Cable Bracket - Anchor Stud Position Shown for 630 Transmission

- a** - Shift Cable Bracket
- b** - Shift Cable Anchor Stud
- c** - Bracket To Transmission Fasteners

2. Place remote control shift lever and transmission shift lever in neutral position.
3. Remove nuts and washers from shift cable attaching studs.
4. Locate center of remote control and control shift cable play (backlash), as follows:
 - a. Check that remote control is in neutral position.
 - b. Push in on control cable end with enough pressure to remove play and mark position "a" on tube.
 - c. Pull out on control cable end with enough effort to remove play and mark position "b" on tube.
 - d. Measure distance between marks "a" and "b," and mark position "c," halfway between marks "a" and "b."



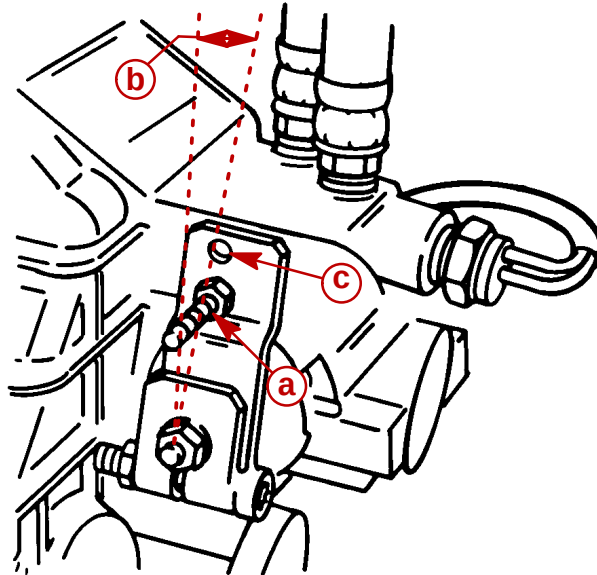
22024

5. Center cable-end play, then adjust cable barrel to align holes in barrel and in cable end guide with attaching points on transmission.
6. Temporarily install shift cable. Do not secure at this time.

IMPORTANT: Transmission is fully in gear when shift lever comes to a stop, in either direction.

7. Place remote control shift lever in forward gear position. Ensure transmission is fully in gear, as follows:
 - a. Hold shift lever in position.
 - b. Carefully slide shift cable off of anchor points.
 - c. Attempt to move shift lever further.
8. Place remote control shift lever in reverse gear position. Again ensure transmission is fully in gear as follows:
 - a. Hold shift lever in position.
 - b. Carefully slide shift cable off of anchor points.
 - c. Attempt to move shift lever further.

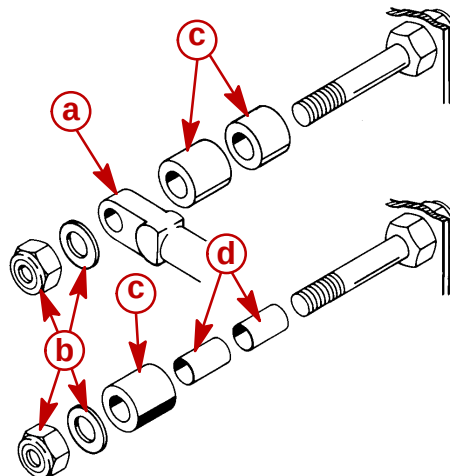
9. If transmission shift lever will position properly in one gear, but not in the other, recheck shift cable adjustment. If transmission shift lever will not position properly in both gears, move transmission shift lever stud from top hole in shift lever to bottom hole and recheck for proper positioning. If proper positioning is still not obtained, remote control does not provide sufficient shift cable travel and must be replaced.



50228

- a** - Shift Lever Stud (In Bottom Hole, If Required)
- b** - Lever, In Neutral Detent, Must Be Approximately 10 Degrees Of Vertical
- c** - Shift Lever Top Hole

10. Install nut and washer to cable end guide stud. Tighten until contacts, then loosen one full turn.
11. Install nut and washer to cable barrel stud. Tighten until they contact. Then loosen 1/2 turn.



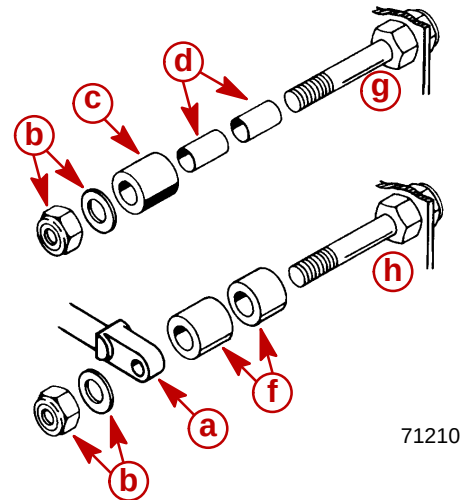
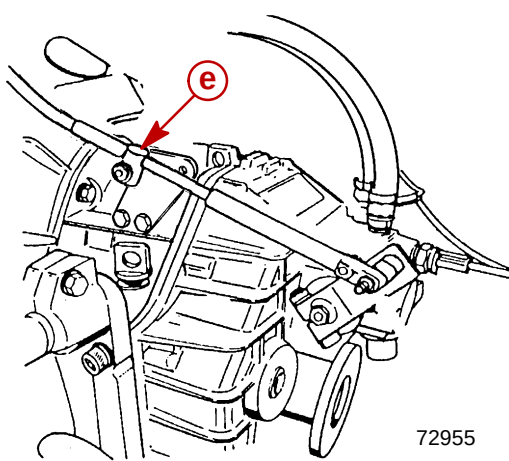
50229

- a** - Cable End Guide
- b** - Locknut and Washer
- c** - Spacer
- d** - Bushings
- e** - Cable Barrel

12. Once shift cable adjustment is correct, secure shift cable(s) with hardware as shown, referring to appropriate configuration following:

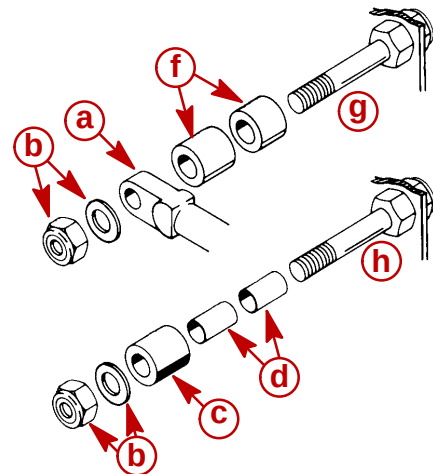
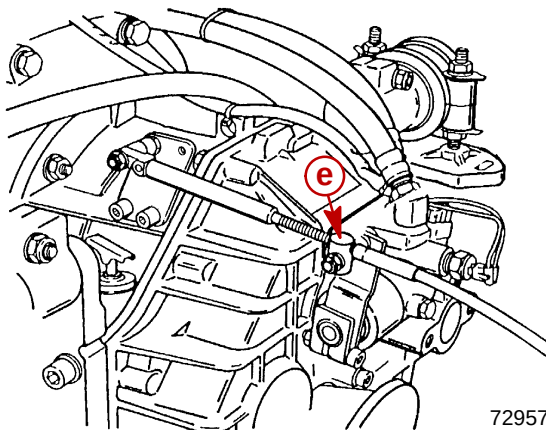
NOTE: To change cable approach direction on single or dual station installations, only the spacer/bushings have to be switched to the opposite stud. The studs are identical.

IMPORTANT: Tighten locknut until it contacts and then loosen 1/2 turn.



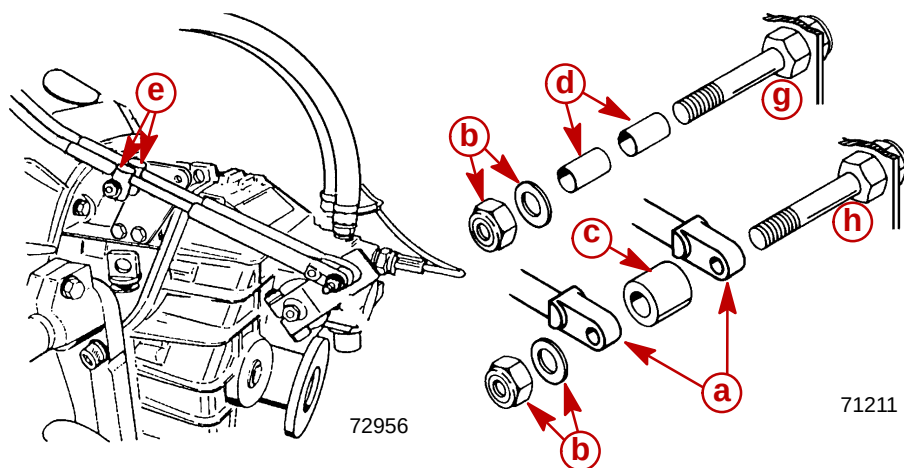
Typical Single Cable - Forward Approach

- a - Cable End Guide
- b - Locknut and Washer
- c - Spacer (Fits Over Bushings)
- d - Bushing
- e - Cable Barrel
- f - Spacers (Fits Over Stud)
- g - Cable Barrel Stud
- h - Cable End Guide Stud



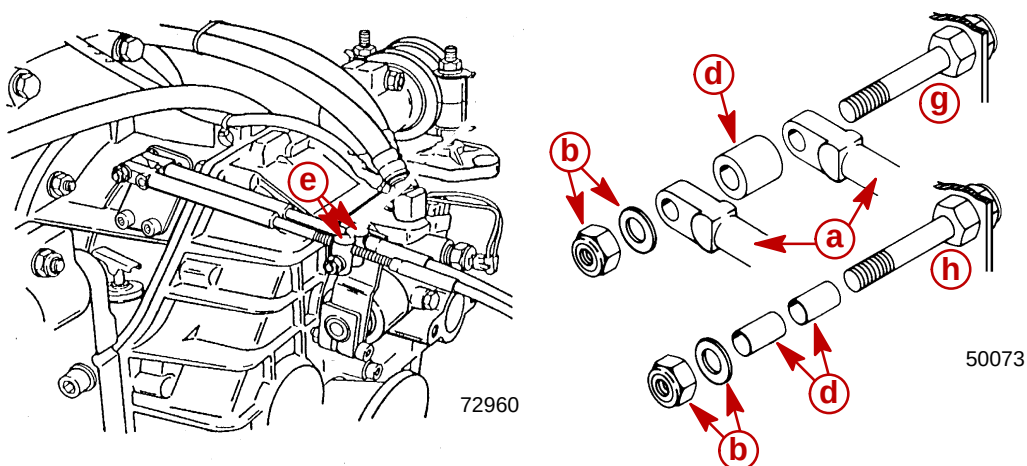
Typical Single Cable - Rear Approach

- a - Cable End Guide
- b - Locknut And Washer
- c - Spacer (Fits Over Bushings)
- d - Bushing
- e - Cable Barrel
- f - Cable Barrel Stud
- g - Cable End Guide Stud



Typical Dual Cable - Forward Approach

- a** - Cable End Guide
- a** - Cable End Guide
- b** - Locknut And Washer
- c** - Spacer (Fits Over Bushings)
- d** - Bushing
- e** - Cable Barrel
- f** - Spacers (Fits Over Stud)
- g** - Cable Barrel Stud
- h** - Cable End Guide Stud



Typical Dual Cable - Rear Approach

- a** - Cable End Guide
- b** - Locknut And Washer
- c** - Spacer (Fits Over Bushings)
- d** - Bushing
- e** - Cable Barrel
- f** - Spacers (Fits Over Stud)
- g** - Cable Barrel Stud
- h** - Cable End Guide Stud

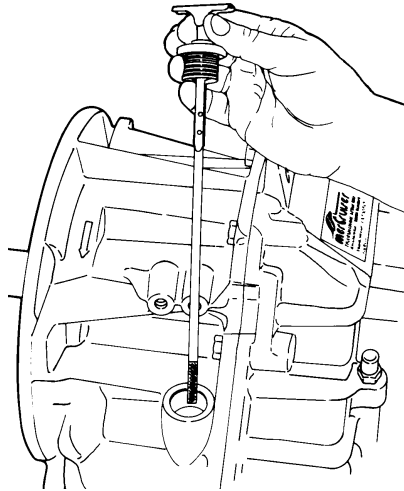
Checking Transmission Fluid Level

IMPORTANT: Use only specified transmission fluid; refer to “Transmission Fluid Specifications.”

IMPORTANT: The fluid level dipstick is located on the port side of transmission. **DO NOT** remove T-handle on starboard side of transmission.

Check transmission fluid before starting engine each day, as follows:

1. Remove dipstick. Check fluid level as indicated on dipstick. Fluid level may be somewhat over full mark, as some of the fluid from transmission fluid cooler and hoses may have drained back into transmission. If low, add transmission fluid to bring level up to full mark on dipstick.



27661

Typical Hurth Transmission

IMPORTANT: To accurately check fluid level, engine must be operated at 1500 RPM for two minutes immediately prior to checking level.

2. Start engine and operate at 1500 RPM for two minutes to fill all hydraulic circuits.

IMPORTANT: Be sure to push dipstick all the way down into dipstick tube when checking fluid level.

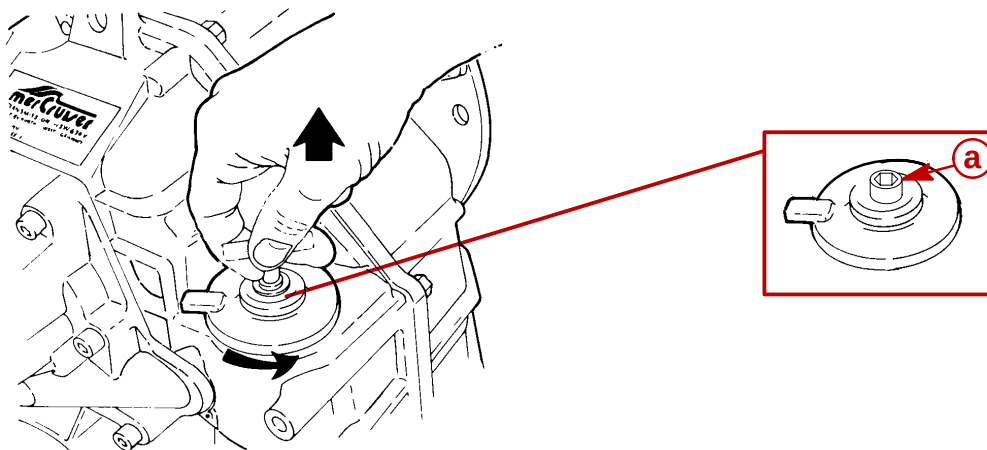
3. Stop engine and quickly check fluid level. Add automatic transmission fluid, if necessary, to bring level up to full mark on dipstick.
4. Reinstall dipstick.
5. If transmission fluid level was extremely low, carefully check transmission, fluid cooler and hoses for leaks.

Draining Transmission

1. Clean the exterior of transmission before disassembly.

NOTE: Later model Hurth transmissions will be equipped with an allen head socket screw on the oil filter cover.

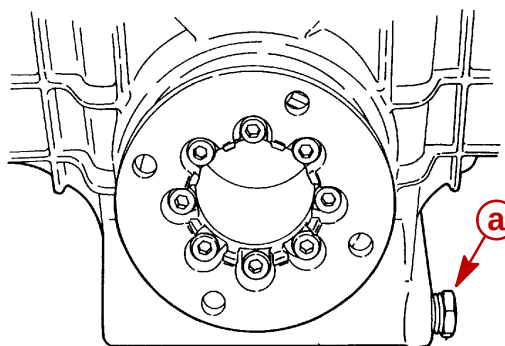
2. Remove oil filter from housing by turning (counterclockwise) and pulling at the same time.



27666

a - Set Screw (Later Models)

3. Remove drain plug from transmission and allow fluid to drain. Reinstall drain plug and tighten securely.



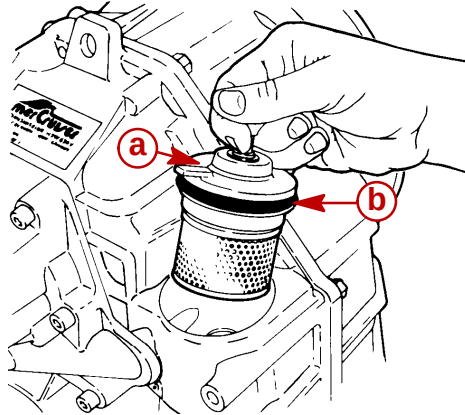
73013

a - Drain Plug

Filling Transmission

IMPORTANT: Use only fluid recommended in “Fluid Specifications.”

1. Fill transmission to proper level, through oil filter cavity. Capacities are listed in “Fluid Specifications.”
2. Install filter as follows:
 - a. Coat O-ring on filter cover with transmission fluid.



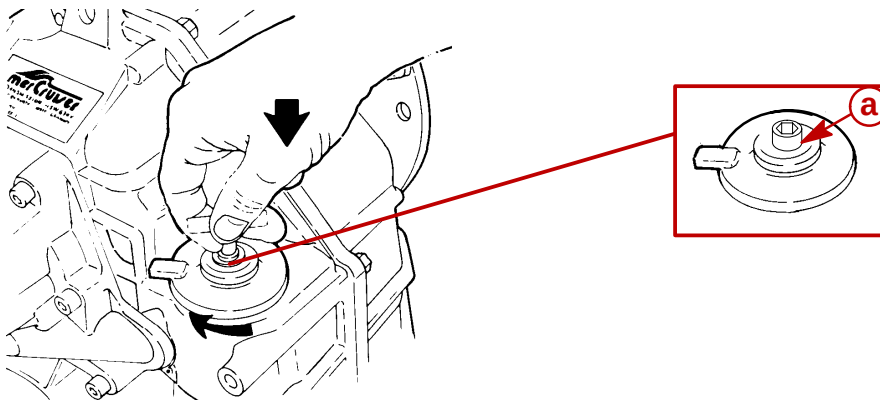
27662

- a** - Filter Cover
b - O-Ring

⚠ CAUTION

Transmission fluid filter and cover must be properly seated to avoid fluid foaming and/or loss of fluid, thus resulting in decreased efficiency and/or damage to transmission.

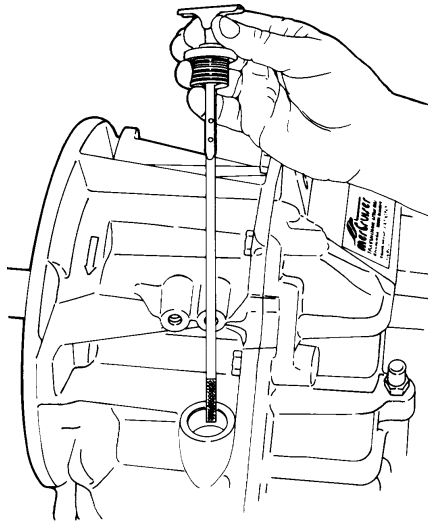
- b. Push down until cover is fully seated (top of cover flush with housing), then, Turn T-handle clockwise until tight.



27666

- a** - Set Screw (Later Models)

3. Start engine and run for two minutes to fill system with fluid.
4. Stop engine and check fluid level. Fluid should be between minimum and maximum lines on dipstick.

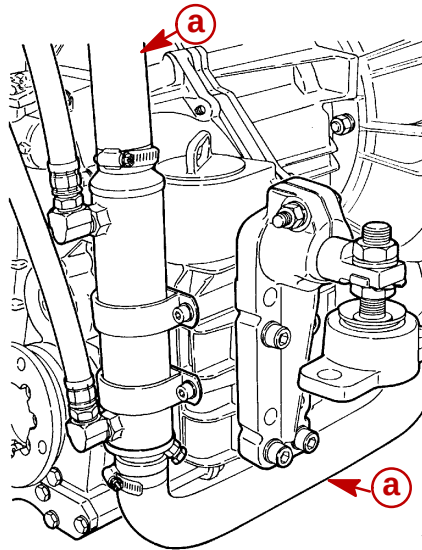


27661

Typical Hurth Transmission

Transmission Removal

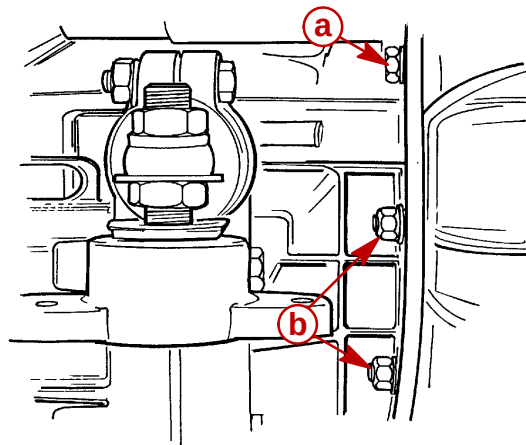
1. Disconnect wires from neutral safety switch and audio warning temperature switch.
2. Disconnect seawater hoses from transmission fluid cooler.



72711

a - Seawater Hoses

3. Remove bolts and locknuts and remove transmission.



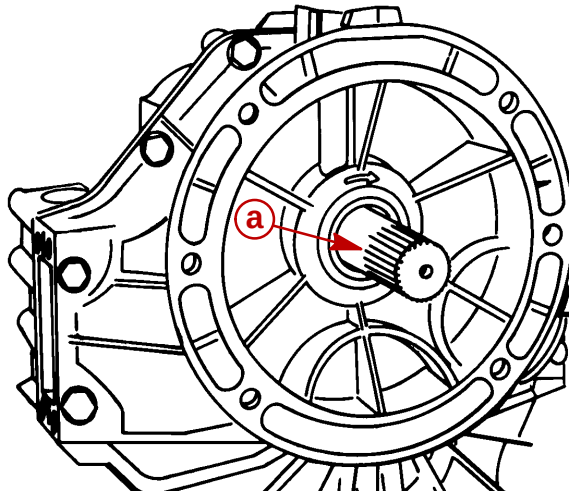
72720

a - Bolts (2), One On Each Side

b - Locknuts (4), Two On Each Side

Transmission Installation

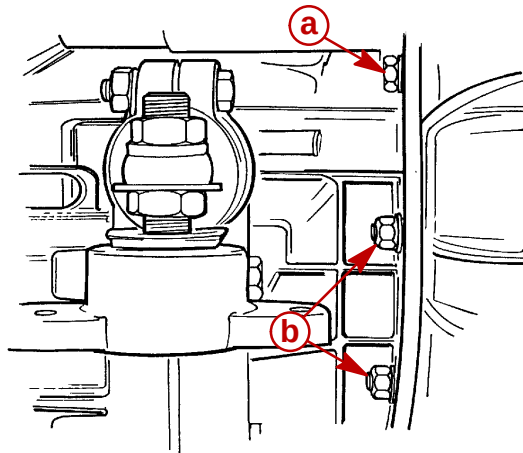
1. Coat splines on input shaft with Quicksilver Engine Coupler Spline Grease.



71044

a - Input Shaft

2. Install transmission on flywheel housing and secure with hardware shown. Torque fasteners to 50 lb-ft (68 Nm).

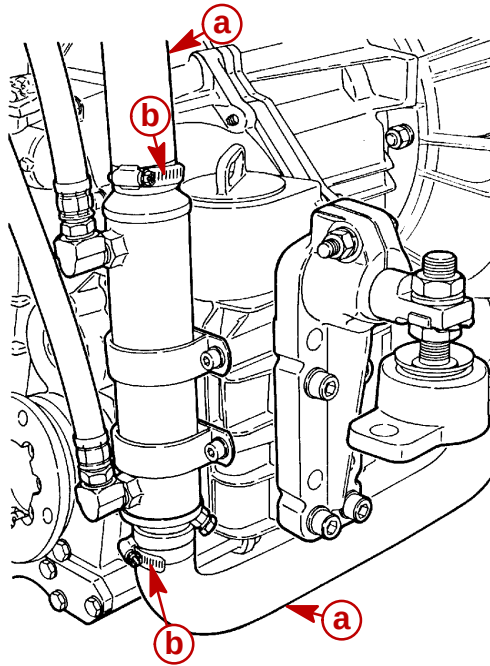


72720

a - Bolts (2), One On Each Side

b - Locknuts (4), Two On Each Side

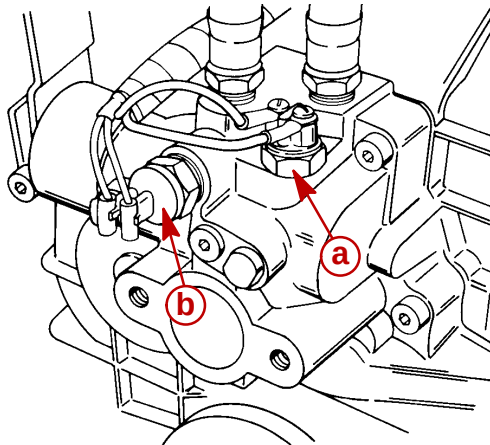
3. Connect seawater hoses to transmission fluid cooler and tighten hose clamps securely.



72711

- a** - Seawater Hoses
- b** - Hose Clamps

4. Connect wires to neutral safety switch and to audio warning temperature switch. Coat connections on neutral safety switch with Quicksilver Liquid Neoprene.

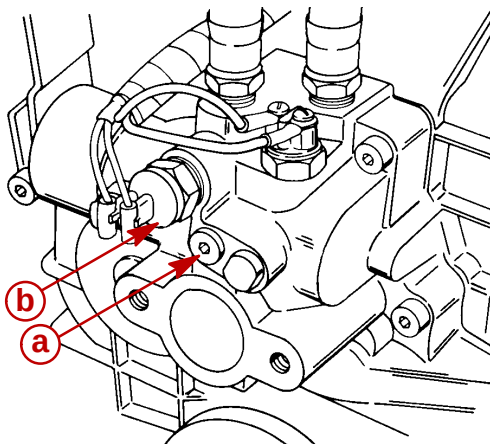


50686

- a** - Neutral Safety Switch
- b** - Audio Warning Temperature Switch

Functional Tests

1. Connect a pressure gauge and thermometer to fluid pump at locations shown.



50686

- a** - Pressure Gauge (m10x1 Thread - Remove Plug)
b - Thermometer (3/8 In. Thread) - Remove Temperature Sender

2. Perform functional tests as shown in chart following. Refer to "Operating Specifications" for correct readings.

Tests to Be Carried Out:

1. Leakages
2. Noise emission
3. Direction of rotation, LH/RH
4. Fluid temperature
5. Shifting pressure

Motor Speed RPM	Shift Lever Position	Duration Minutes	Tests
800-1000	Neutral	5	1 2
600-800 (Idling Speed)	A↔B Position Repeatedly	—	1 2 3
1500-2500	B Position	1	1 2 4
600-800 (Idling Speed)	A↔B Position Repeatedly	—	1 2 3
Idling Maximum Speed	A Position	—	1 2 5 ²
600 -800	From A → B Position	—	1 2
Idling Maximum Speed	B Position	—	1 2 5 ²

¹Until fluid temperature of 167-176°F (75-80°C) has been reached

²At different speeds

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DRIVES

Section 8D - Drive Shaft / Propeller Shaft Models

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Torque Specifications

Fastener Location	lb-in.	lb-ft	Nm
Drive Shaft To Bearing Support Flange (MCM Models)		50	68
Drive Shaft To Output Shaft (MCM Models)			
Propeller Shaft Coupling To Transmission Coupling (MIE Models)			
Flywheel Housing To Block (MCM Models)		30	41
Output Shaft Housing To Flywheel Housing (MCM Models)			
Engine Coupling		35	48
Bearing Support Housing Attaching Bolts		35-54	47-73
Coupling Set Screws (If Equipped)		Securely (See Note)	

NOTE: Safety wire set screws.

Tools

Description	Part Number
Quicksilver Alignment Tool	91-805475A1
Quicksilver Slide Hammer Puller	91-34569A1

Lubricants / Sealants / Adhesives

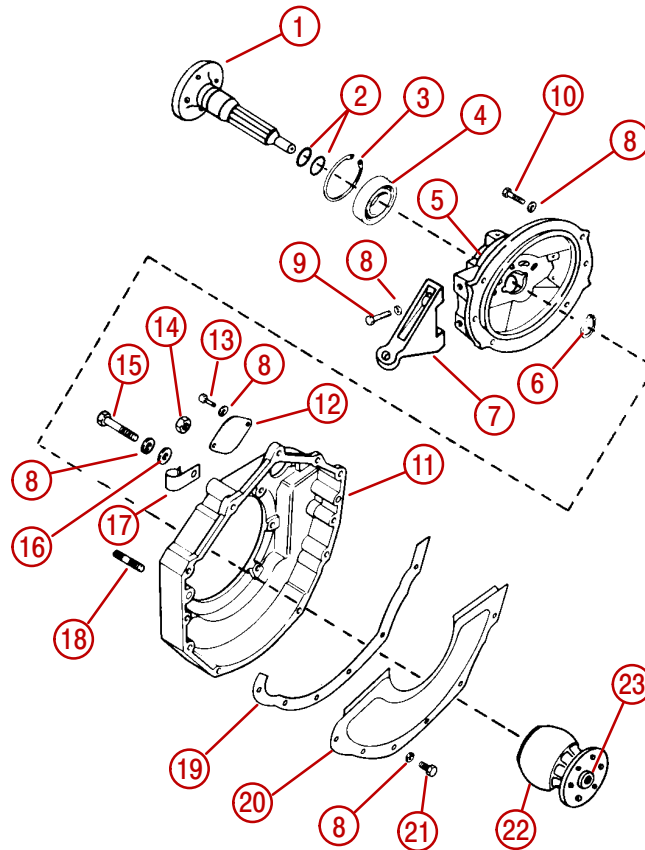
Description	Part Number
2-4-C Marine Lubricant With Teflon	92-825407A3
U-Joint and Gimbal Bearing Grease	92-828052A2
Quicksilver Engine Coupler Spline Grease	91-816391A4
Quicksilver Loctite 27131	92-809820
Loctite 290	Obtain Locally

Flywheel Housing / Output Shaft Housing Repair (MCM Sterndrive Models)

NOTICE

The following procedure requires removal of the drive shaft. In most cases, because of engine compartment space limitations, the engine also must be removed.

Exploded View



Flywheel Housing/Output Shaft Housing

- | | |
|-----------------------------------|-----------------------------|
| 1 - Output Shaft | 13 - Screw (2) |
| 2 - O-Rings | 14 - Nut (1) |
| 3 - Ball Bearing Snap Ring | 15 - Bolt (4) |
| 4 - Ball Bearing | 16 - Washer (1) |
| 5 - Shaft Bearing | 17 - Clamp (1) |
| 6 - Output Shaft Snap Ring | 18 - Stud (1) |
| 7 - Rear Engine Mount | 19 - Gasket |
| 8 - Lockwasher | 20 - Flywheel Cover |
| 9 - Screw (4) | 21 - Screw (7) |
| 10 - Screw (6) | 22 - Engine Coupling |
| 11 - Flywheel Housing | 23 - Bushing |
| 12 - Plate | |

Removal and Installation

1. Remove drive shaft as outlined following in this section.
2. If engine must be removed, refer to appropriate instructions in SECTION 2 - "Removal and Installation."

Disassembly

IMPORTANT: This disassembly procedure, beginning with Step 1, assumes that engine does not require removal from boat. If engine removal is required, refer to SECTION 2 for removal and installation instructions. With engine removed from boat, proceed with disassembly, beginning with Step 3.

1. **If Engine Is Removed From Boat, Go To Step 3. If Engine Is In Boat:** Support rear of engine with overhead hoist or wooden blocks under the rear of the engine.
2. Remove stringer bolts (rear engine mounts).
3. Remove output shaft housing attaching screws, then remove housing.
4. Remove snap ring, then pull output shaft out of housing.
5. Remove snap ring from housing.
6. Using Quicksilver Slide Hammer Puller, remove bearing from housing.
7. Remove flywheel cover.
8. Remove flywheel housing.
9. Remove engine coupling.
10. Clean and inspect all parts. Replace any damaged parts.

Reassembly

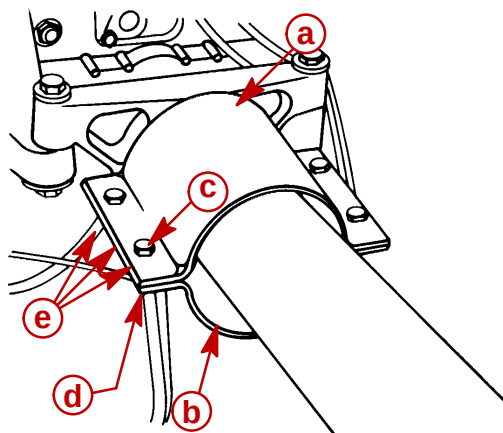
1. Install engine coupling. Torque to 35 lb-ft (48 Nm).
 2. Install flywheel housing. Torque to 30 lb-ft (41 Nm).
 3. Using new gasket, install flywheel cover. Tighten screws securely.
- IMPORTANT: Groove in outside diameter of ball bearing must align with grease fitting hole.**
4. Install ball bearing into output shaft housing, then install snap ring.
 5. Apply Quicksilver 2-4-C Marine Lubricant With Teflon to O-rings (on output shaft), then slide shaft through bearing. Secure shaft with snap ring.
 6. Apply Quicksilver Engine Coupler Spline Grease to splines on output shaft.
 7. Install output shaft housing to flywheel housing. Torque screws to 30 lb-ft (48 Nm).
 8. Secure rear engine mounts to stringer with bolts. Tighten securely.
 9. Remove hoist (or wooden blocks).
 10. Install drive shaft and check alignment. (Refer to SECTION 2B for engine and drive shaft alignment if engine was removed.)
 11. Using Quicksilver U-Joint and Gimbal Bearing Grease, grease ball bearing through grease fitting.

Drive Shaft Repair (MCM Sterndrive Models)

Removal

IMPORTANT: It is not necessary to remove the engine to service the drive shaft.

1. Remove top and bottom drive shaft shields around transom end and engine end of drive shaft.

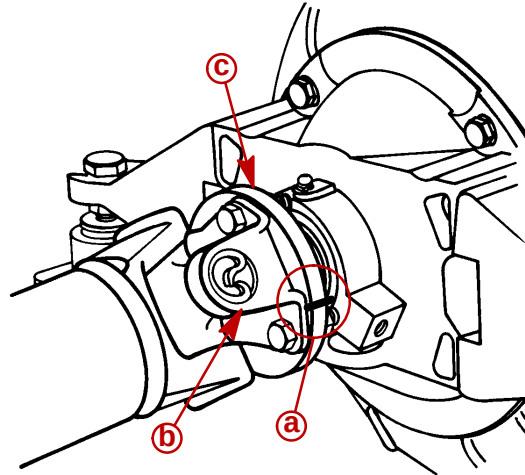


70245

Top Shield and Bottom Shield at Transom End (Engine End Similar)

- a** - Top Shield
- b** - Bottom Shield
- c** - Bolt 3/3-16 x 7/8 In. (22.2 mm); 4 Used
- d** - Nut 3/8 16: 4 Used
- e** - Screws (3 Used Hidden In This View)

2. Suitably mark drive shaft U-joint yokes / flange connections (engine output and drive unit input) to assist in exact same positioning during assembly at engine and transom end.

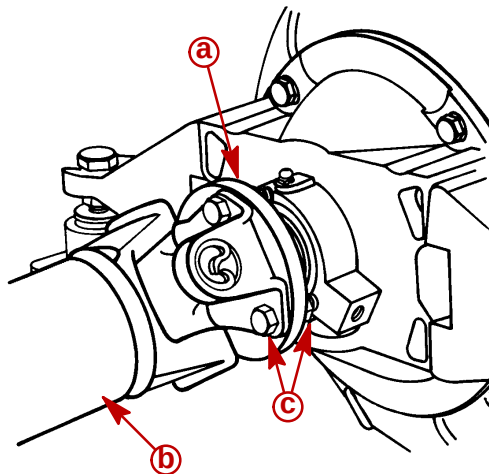


70237

Engine End Shown (Transom End Similar)

- a** - Suitable Mark On Flange and Drive Shaft Connection
- b** - Extension Drive Shaft U-Joint Yoke
- c** - Flange

3. Remove drive shaft fasteners and drive shaft.



70237

Engine End Shown (Transom End Similar)

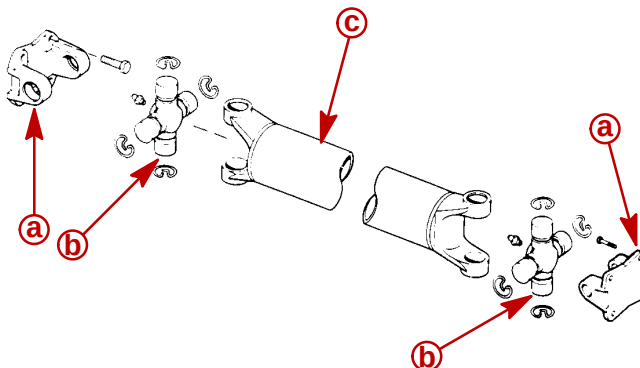
- a** - Output Shaft Flange
- b** - Drive Shaft
- c** - Bolt With Nut (4 Total)

Repair

⚠ CAUTION

Be sure U-joint locking rings are seated properly after replacing U-joints.

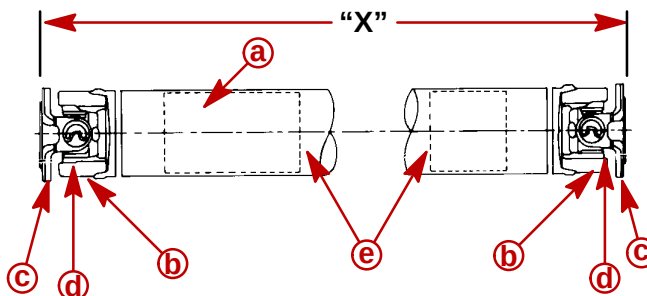
1. Replace U-joints, if required.
2. Replace flange, if required.



- a** - Flange
- b** - U-Joint
- c** - Drive Shaft

Replacement Drive Shafts

MerCruiser furnishes a 58 in. (1473 mm) or 34-1/2 in. (876 mm) long drive shaft with extension shaft models. Some boat manufacturers modify the drive shafts to a shorter length. Because of this, use the following procedure to obtain replacement drive shafts.



- a** - Tube
- b** - Yoke - Tube
- c** - Flange
- d** - Universal Joint
- e** - Sound Deadener (Cardboard Tube)

The complete drive shaft can be ordered from Mercury Marine.

Drive Shafts Modified to Shorter Lengths

The complete modified (shortened) drive shaft has to be ordered from the boat manufacturer that installed the MerCruiser Power Package.

IMPORTANT: Dana Corporation - Spicer Regional Drive Shaft Centers will not shorten replacement drive shafts for dealers or consumers.

If a boat manufacturer is currently having extension drive shafts modified, they must be modified by one of Dana Corporation - Spicer Regional Drive Shaft Centers to maintain MerCruiser warranty. The modified drive shaft must meet the following specifications.

- U-joints aligned radially within $0^\circ (\pm 1/2^\circ)$.
- U-joints greased, after welding, with Quicksilver U-Joint and Gimbal Bearing Grease.
- Assembly balanced to within 1.5 oz-in. (0.01 Nm) to 4500 rpm.
- Tube to have .005 in. (0.127 mm) to .010 in. (0.254 mm) interference fit with tube yoke.
- Tube must be straight and round within .015 in. (0.381 mm).

Installation

IMPORTANT: The following instructions are to be used if ONLY the drive shaft was removed for service. Refer to appropriate sections for installation of other components which require special alignment.

1. Grease both drive shaft universal joints with Quicksilver U-Joint and Gimbal Bearing Grease.

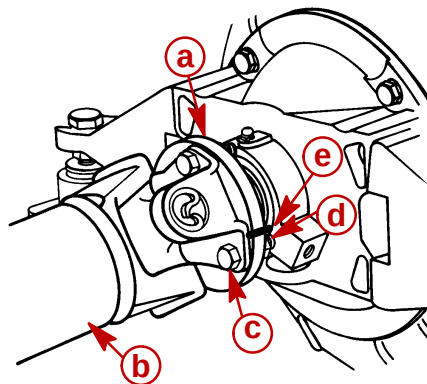
CAUTION

When attaching shaft in next step, BE SURE that the pilot on drive shaft flanges are engaged in input shaft and output shaft flanges. Flanges MUST BE flush with each other prior to tightening screws or screws may come loose during operation.

CAUTION

Failure to properly align shaft flanges with matching marks made on disassembly may cause improperly aligned drive unit and extension drive shaft U-joint center-lines resulting in a severe vibration problem.

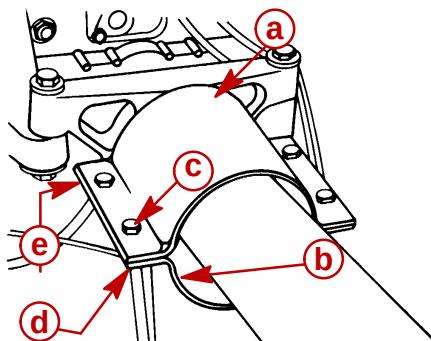
2. As shown, attach drive shaft output flange and input shaft flange exactly as marked upon disassembly. Torque fasteners to 50 lb-ft (68 Nm).



70237

Engine End Shown (Transom End Similar)

- a** - Output Shaft Flange
 - b** - Drive Shaft
 - c** - Bolt 7/16-20 x 1-1/2 In. (38 mm) Long (4 Used)
 - d** - Nut 7/16-20 (4 Used)
 - e** - Suitable Matching Marks Made Upon Disassembly - Aligned
3. Apply Loctite 27131 to threads of bottom drive shaft shield retaining screws and install bottom shields on engine and transom end. Then install both top shields as shown. Torque all fasteners to 30 lb-ft (41 Nm).



70245

Top Shield and Bottom Shield at Transom End (Engine End Similar)

- a** - Top Shield
- b** - Bottom Shield
- c** - Bolt 3/8-16 x 7/8 in. (22 mm); 4 Used
- d** - Nut 3/8-16; 4 Used
- e** - Screws (3 Used - Hidden In This View)

Bearing Support Repair (MCM Sterndrive Models)

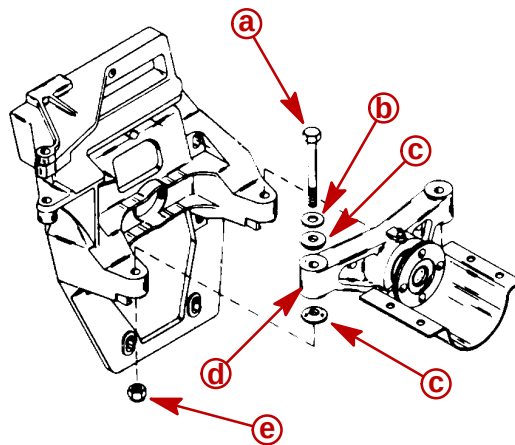
Removal

IMPORTANT: It is not necessary to remove the engine to service the drive shaft and/or bearing support.

⚠ CAUTION

If bearing support is removed, you must remove the sterndrive unit so you can properly align drive unit U-joint centerline with extension drive shaft U-joint centerline. Lack of alignment will cause a severe vibration problem.

1. Remove drive shaft as previously outlined.
2. Remove sterndrive unit. Refer to appropriate Sterndrive Service Manual.
3. Remove bearing support and retain hardware.



75279

- a** - Bolt, Bearing Support (2)
- b** - Flat Washer (2)
- c** - Spherical Washer (4)
- d** - Bearing Support (Tailstock)
- e** - Nut (2)

Disassembly

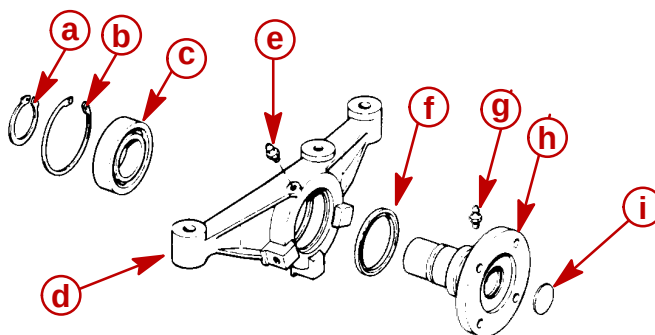
1. Remove snap ring, then remove input shaft.
2. Remove larger snap ring.
3. Using Quicksilver Slide Hammer Puller, remove ball bearing.
4. Remove oil seal.
5. If required, remove plug from end of input shaft.
6. Clean and inspect all parts.
7. Replace any damaged parts.

Reassembly

1. If removed, install new plug in end of input shaft.
2. Apply Quicksilver Loctite 27131 to outer diameter of new oil seal.
3. Press oil seal into bearing support. Lip of seal faces away from ball bearing.
4. Apply Loctite 290 to outer diameter of ball bearing and inner diameter of bearing support.
5. Install bearing (with sealed side toward snap ring) by using a press. After installation, wipe up excessive Loctite. Install snap ring.
6. Apply Loctite 290 to outer diameter of input shaft (bearing area) and inside diameter of bearing race.
7. Install input shaft, then install snap ring. Wipe up excessive Loctite.

IMPORTANT: Do not let Loctite get into ball bearing.

8. Fill bearing area with Quicksilver U-Joint and Gimbal Bearing Grease through grease fitting.
9. Apply Quicksilver Engine Coupler Spline Grease to splines of input shaft before installing drive unit.



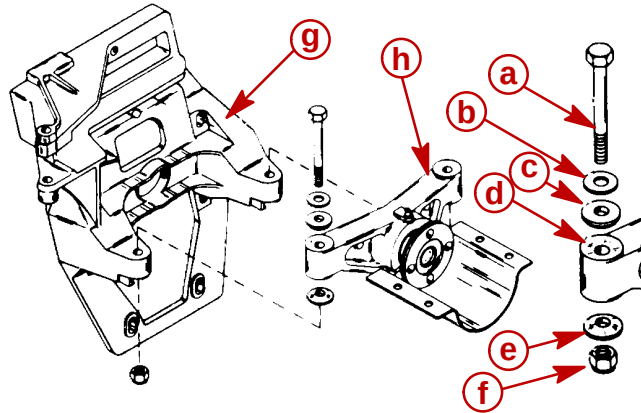
75281

- a** - Snap Ring - Input Shaft
- b** - Snap Ring - Ball Bearing
- c** - Ball Bearing
- d** - Bearing Support
- e** - Grease Fitting
- f** - Oil Seal
- g** - Grease Fitting
- h** - Input Shaft
- i** - Plug - Input Shaft

Installation

1. Install bearing support assembly (tailstock) on transom plate using hardware as shown. Tighten bolts until they contact. **DO NOT TORQUE BOLTS AT THIS TIME.**

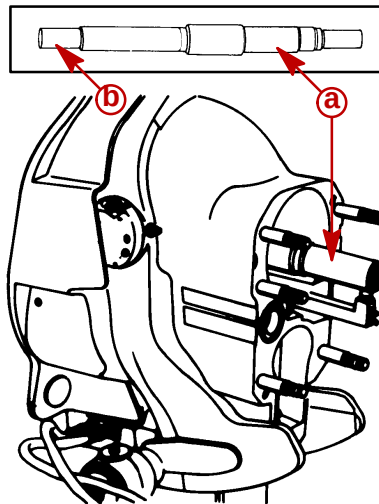
IMPORTANT: The spherical washers **MUST** be positioned so that the rounded side of the washers are toward the bearing support assembly as shown.



75279

- a** - Bolts 1/2-20 x 4 In. (102 mm)
- b** - Steel Washer (Flat)
- c** - Spherical Washer (Rounded On One Side)
- d** - Bearing Support
- e** - Spherical Washer (Rounded On One Side)
- f** - Nut 1/2-20
- g** - Transom Plate
- h** - Bearing Support (Tailstock)

2. Insert solid end of Quicksilver Alignment Tool through bearing in gimbal housing and into input shaft splines of bearing support.



71401

Typical Sterndrive Unit Shown

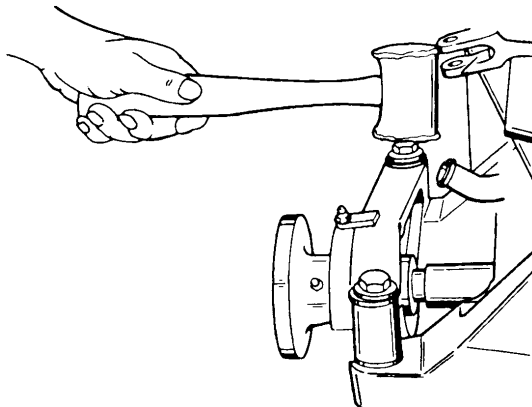
- a** - Quicksilver Alignment Tool
- b** - Insert This End Of Alignment Tool Through Gimbal Housing Assembly

3. **DO NOT** remove alignment tool from gimbal housing.

⚠ CAUTION

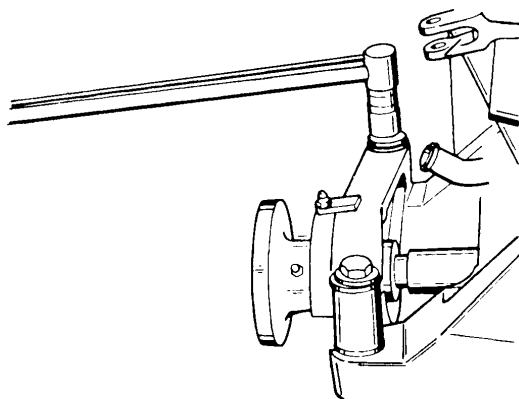
Both attaching bolts **MUST** be struck firmly in the following step to properly seat spherical washers. If procedure is not followed, difficulty in the installation of the sterndrive unit may be experienced and subsequent damage to the input bearing may result.

4. Strike the head of BOTH bearing support attaching bolts firmly with a hammer.



71098

5. Torque bolts to 35-54 lb-ft (47-73 Nm).



71099

6. Refer to appropriate Sterndrive Service Manual and install drive unit.
7. Refer to appropriate SECTION 2 - "Removal and Installation – Engine Installation/Alignment," if engine was removed.

Propeller Shaft (MIE Inboard Models)

NOTICE
The following information can be used as a guide for determining vibration problems on boats powered by inboard engines (MIE models). For installation, alignment and repairs to shafts, struts, shaft logs and rudders, refer to boat manufacturer's service manual. If boat is equipped with V-drive, refer to SECTION 8B or boat manufacturer's service manual for all servicing and troubleshooting. For MIE engine installation and alignment, refer to SECTIONS 2E and 2F.

Checks Made With Boat In Water

1. Disconnect propeller shaft coupling from transmission coupling.
2. Check fit of coupling to propeller shaft.

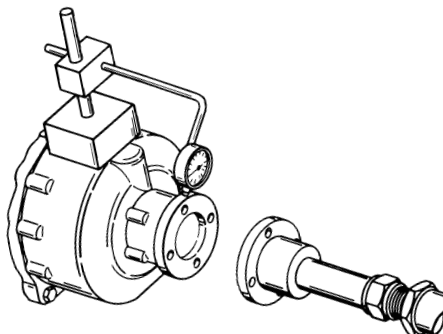
Straight Bore Type:

- a. Loosen set screws.
- b. Try to move coupling by hand. The bore of the coupling should be a semi-press fit to shaft.
- c. Check shaft for wear. If worn, replacement of shaft may be necessary.
- d. If shaft is not worn, try another coupling.

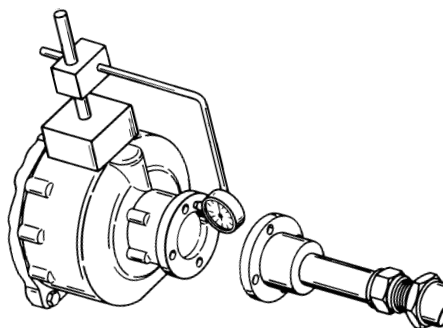
Tapered Bore Type:

- a. Check nut on shaft for tightness.
- b. If nut was loose, remove coupling and check for damage to taper on shaft or in coupling.
- c. Replace worn parts.
- d. Always make sure key is not sticking out of coupling.
- e. Install coupling on shaft without the key.
- f. Mark the shaft (behind the coupling), then remove the coupling.
- g. Now install the key and coupling. Make sure coupling still lines up with the mark. This ensures that key is not oversize and holding the tapers apart.

3. Check output coupling flange of transmission.



Checking Coupling Outside Diameter - Rotate One Complete Turn



Checking Coupling Face - Rotate One Complete Turn

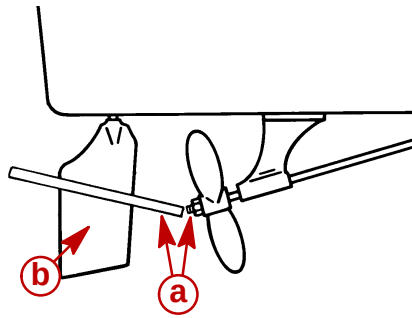
4. If there is movement in Step 3. replace output coupling.
5. Replace damaged parts and realign engine as outlined.
6. Torque propeller shaft coupling and transmission coupling (output flange) to 50 lb-ft (68 Nm). Tighten set-screws securely, if equipped. Safety wire set screws (if equipped).

Checks Made With Boat Out Of Water And Shaft Installed

Possible causes for vibration may be propeller shaft, propeller to shaft fit or propeller. All three can be checked by using the rudder, a strong metal straight edge and a C- clamp.

1. Check installation of propeller to shaft.
 - a. Remove propeller.
 - b. Check for chipped or cracked keyway in propeller on shaft without key.
 - c. Install propeller on shaft without key.
 - d. Mark the shaft (behind the propeller), then remove propeller.
 - e. Install the key and propeller. Make sure propeller still lines up with mark. This ensures that key is not oversize and holding the tapers apart. Retighten propeller nut.
 - f. Be sure key is not sticking out of propeller.

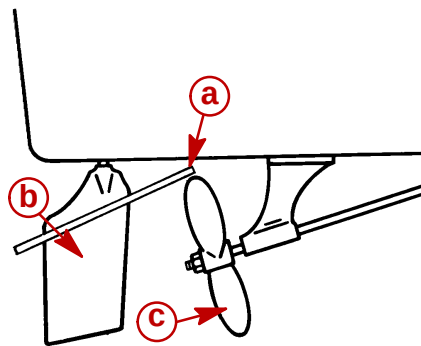
2. Check for propeller shaft being bent behind the strut.



a - Metal Straight Edge (Held To Rudder With C-Clamp) - Position Corner Of Straight Edge At Center Of Shaft. Rotate Shaft One Complete Turn. If Shaft Wobbles, Replace Shaft.

b - Rudder

3. Check the diameter of all propeller blades. If not the same, repair propeller.

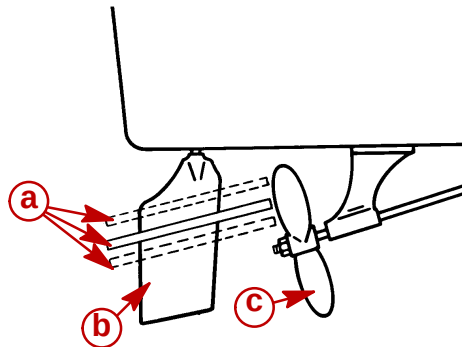


a - Metal Straight Edge (Held To Rudder With C-Clamp)

b - Rudder

c - Rotate Propeller One Complete Turn

4. Check that all propeller blades are the same pitch and that propeller is properly seated on shaft. Repair or replace if necessary.



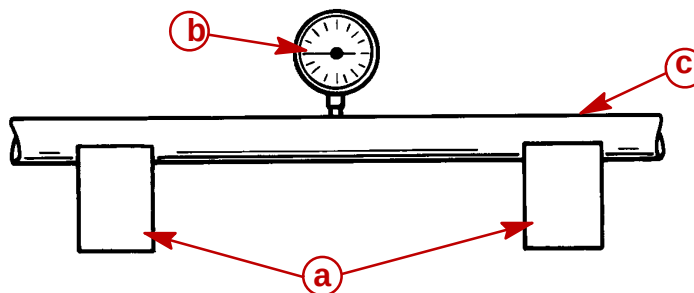
a - Metal Straight Edge (Held To Rudder With C-Clamp)

b - Rudder

c - Rotate Propeller One Complete Turn. Check At Three Different Points On Blades

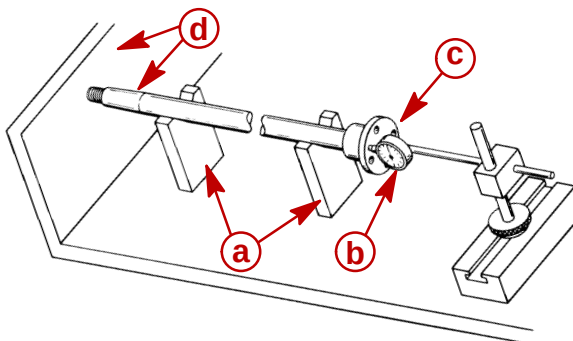
Checks Made With Propeller Shaft Removed From Boat

1. Check propeller shaft for straightness. Check at three or four places. If dial indicator deflects over .004 in. (0.1 mm), replace shaft.



- a** - V-Blocks
- b** - Dial Indicator
- c** - Shaft - Rotate One Complete Turn

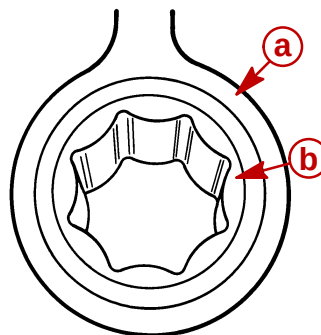
2. Check that bore of coupling is 90 degrees from coupling flange. Replace coupling if needle moves.



- a** - V-Blocks
- b** - Dial Indicator
- c** - Coupling Flange - Rotate One Complete Turn
- d** - Shaft Against Block To Prevent Fore And Aft Movement

Strut

Refer to boat manufacturer's service manual for alignment and replacement. Normally, the shaft should be centered in the cutlass bearing. Shims (placed between the strut and hull) are used to align the strut to the shaft.



- a** - Strut
- b** - Cutlass Bearing

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POWER STEERING SYSTEM

Section 9A - Pump And Related Components

Table of Contents

Torque Specifications	9A-2	Important Service Information	9A-7
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Serpentine Belt Routing	9A-4	Pump Assembly	9A-8
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Removal	9A-6	Installation	9A-10
Installation	9A-6	Hydraulic Hoses and Fluid Cooler	9A-11

Torque Specifications

Fastener Location	lb-in.	lb-ft	Nm
Crankshaft Pulley To Torsional Damper		35	42
Torsional Damper To Crankshaft		60	81
Pump Mounting Bracket To Engine		30	41
Power Steering Hose Fittings		23	31

Tools

Description	Part Number
Pulley Installer	91-93656A1

Special Tools

Description	Part Number
Kent-Moore Special Tools 29784 Little Mack Roseville, MI 48066 (313) 574-2332	
Pulley Removal Tool	J-25034

Description	Part Number
Snap-On Special Puller Tool	CJ124A

Lubricants / Sealants / Adhesives

Description	Part Number
Quicksilver Perfect Seal	92-34227--1
Transmission Fluid Dexron III or Equivalent	Obtain Locally

Precautions

⚠ CAUTION

Do not operate engine without cooling water being supplied to water pickup pump or water pump impeller will be damaged and subsequent overheating damage to engine may result.

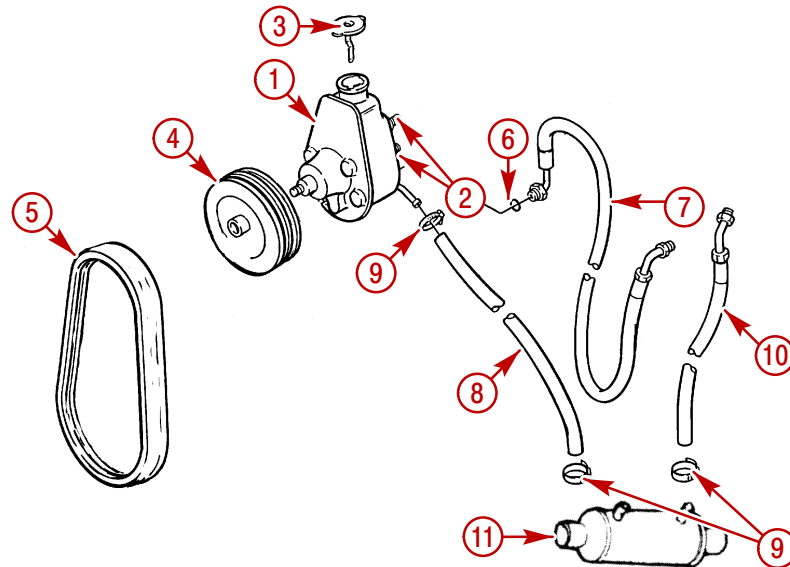
⚠ WARNING

Always disconnect battery cables from battery before working on engine to prevent fire or explosion.

⚠ CAUTION

Do not pry on power steering pump or alternator when adjusting belt tension. Serious damage may result.

Power Steering Pump and Components (Exploded View)

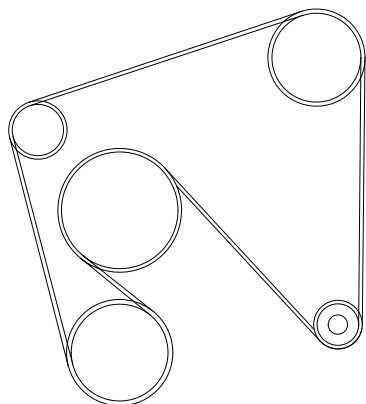


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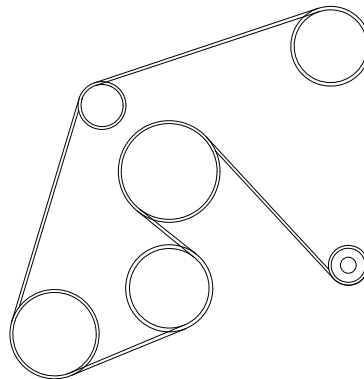
- 1 - Power Steering Pump Assembly
- 2 - Stud
- 3 - Cap
- 4 - Pulley
- 5 - Serpentine Belt
- 6 - O-Ring, High Pressure Hose Fitting
- 7 - Hose, High Pressure (Fittings on Both Ends)
- 8 - Hose, Low Pressure
- 9 - Clamp
- 10 - Hose, Control Valve To Fluid Cooler (Fitting On One End)
- 11 - Power Steering Cooler

Serpentine Belt Routing

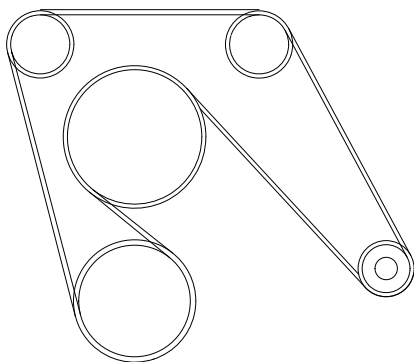
S/N 0L618999 and Below



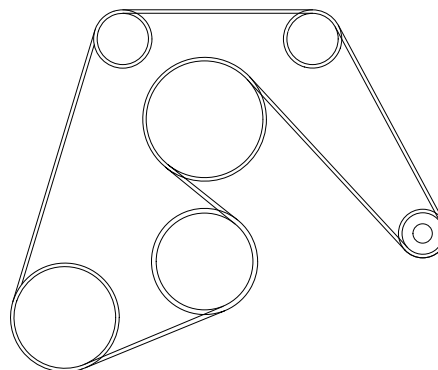
Alpha With Power Steering



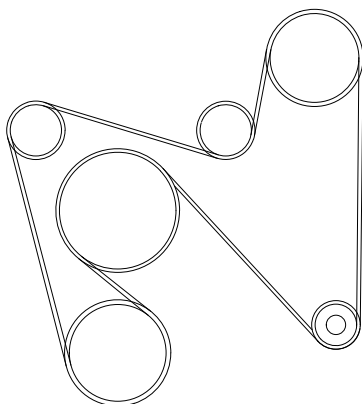
Bravo With Power Steering



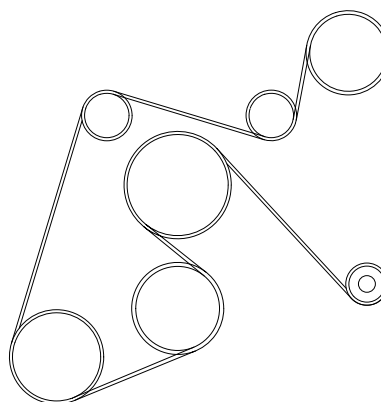
**Alpha With Closed Cooling
Without Power Steering**



Bravo Without Power Steering



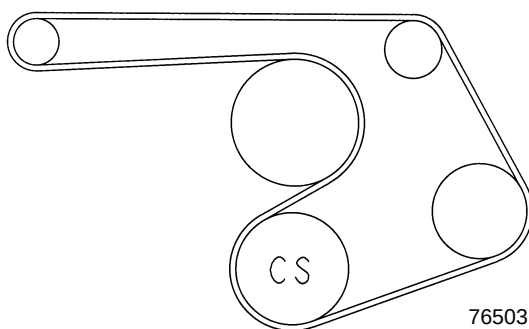
**Alpha With Closed Cooling
and Power Steering**



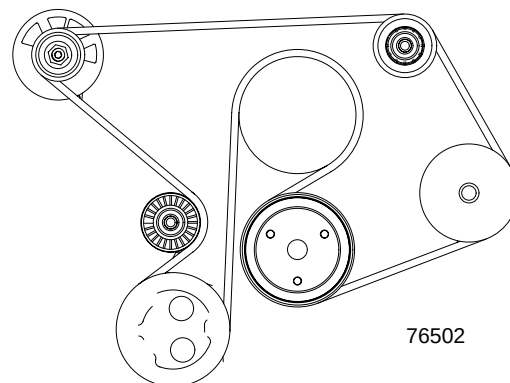
**Bravo With Closed Cooling
and Power Steering**

Serpentine Belt Routing (Continued)

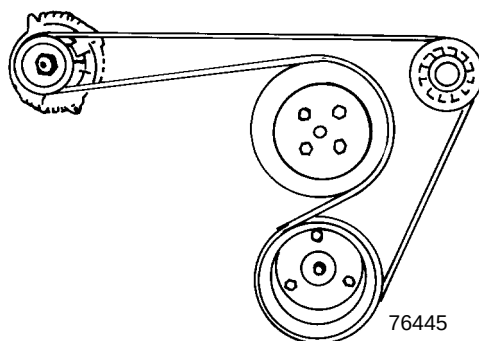
S/N 0L619000 and Above



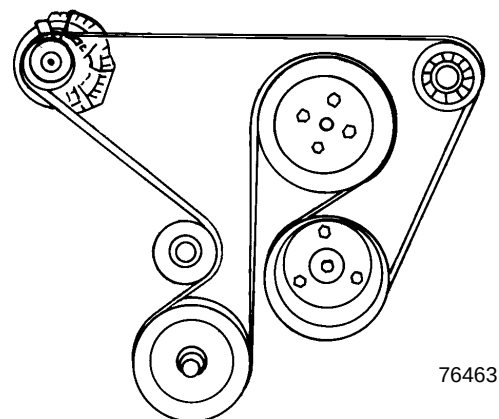
Alpha With Power Steering



Bravo With Power Steering



Alpha Without Power Steering



Bravo Without Power Steering

Serpentine Belt Adjustment

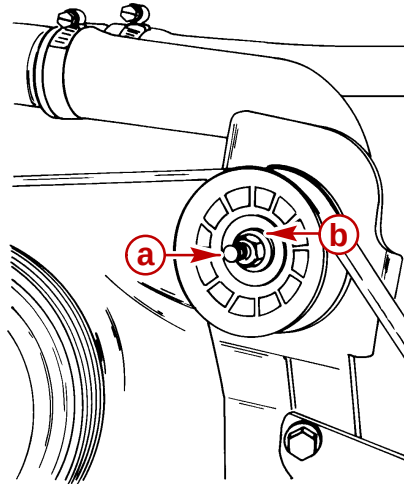
IMPORTANT: If a belt is to be reused, it should be installed in the same direction of rotation as before.

Removal

1. Remove drive belt as follows:

NOTE: The upper, starboard idler pulley is the belt adjustment pulley.

- a. Loosen 5/8 in. locking nut on adjustment stud.
- b. Turn adjustment stud and loosen belt. Remove belt.



75483

- a** - Adjustment Stud
b - Locking Nut

Installation

2. Install drive belt on pulleys.
3. Adjust tension as follows:
 - a. Loosen 5/8 in. locking nut on adjustment stud. Leave wrench on adjustment stud locking nut.

NOTE: Belt deflection is to be measured on the belt at the location that has the longest distance between two (2) pulleys. Normally this location is between the power steering pump and the belt adjustment pulley. This location will be different on engines with closed cooling or models without power steering.

- b. Use 5/16 in. socket and tighten adjusting stud until the correct deflection of the belt is obtained at location specified above.
- c. While holding adjustment stud at the correct belt tension, tighten 5/8 in. locking nut.

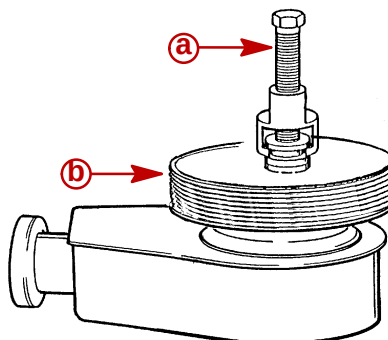
Important Service Information

Pump Pulley Replacement

REMOVAL

NOTE: Serpentine belt pulley requires a special puller tool. See your local automotive repair dealer for appropriate tool or use Snap-On P/N CJ124A.

1. Install appropriate puller on end of pulley and shaft as shown.
2. While holding tool with suitable wrench, turn threaded screw until pulley is removed.



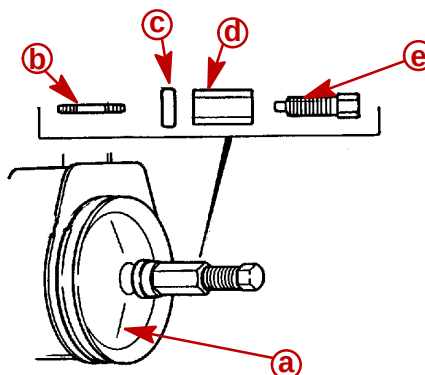
72821

- a** - Typical Puller
b - Serpentine Pulley

INSTALLATION

Install pulley, using appropriate pulley installation tool as follows:

1. Place pulley on pump shaft.
2. Thread stud all the way into pump shaft. Place bearing over stud.
3. Thread nut onto shaft. Thread tool shaft (and nut) all the way onto stud (threaded into pump shaft).
4. Turn large pusher nut until face of pulley is even with edge of shaft.



75751

Typical Installation Tool Shown

- a** - Power Steering Pump Pulley
b - Stud
c - Bearing
d - Nut
e - Tool Shaft

Testing and Repair

Refer to appropriate MerCruiser Sterndrive Service Manual.

Checking Pump Fluid Level

Refer to SECTION 1B "Maintenance."

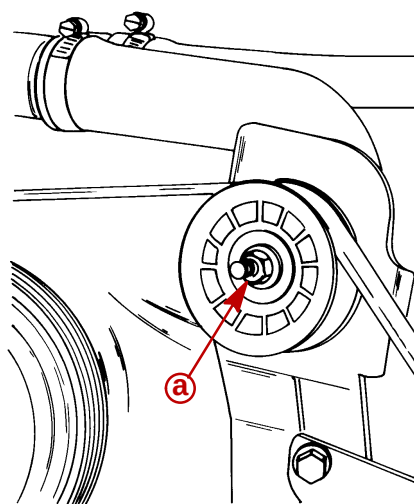
Filling and Air Bleeding System

Refer to SECTION 1B "Maintenance."

Pump Assembly

Removal

1. Loosen the adjusting stud and remove the serpentine belt from the power steering pulley.

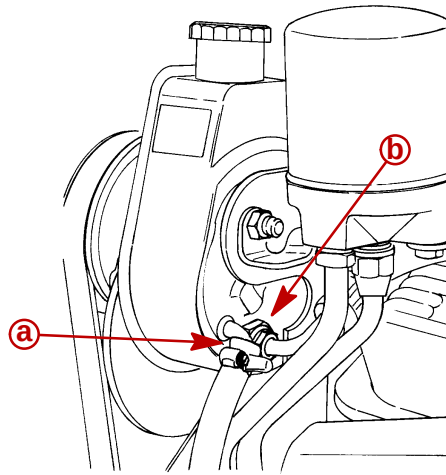


75483

a - Adjusting Nut

NOTE: Use a suitable container catch ant power steering fluid when removing the power steering hoses.

2. Remove the high pressure hose and return hose from the power steering pump.



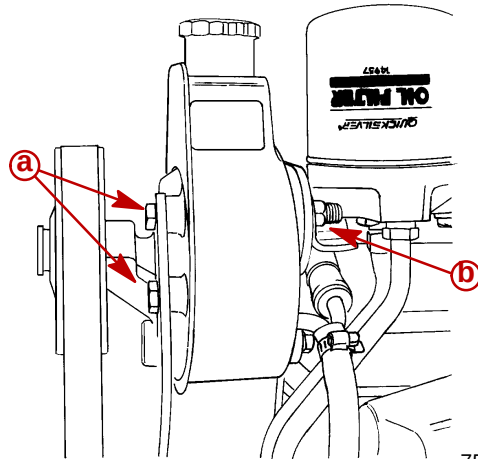
75228

Power Steering Pump Typical Location

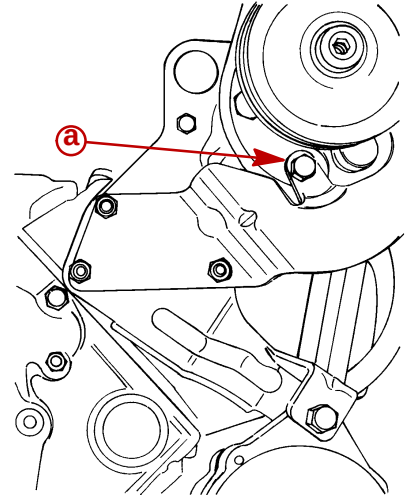
a - Return Hose

b - High Pressure Hose

3. Remove mounting fasteners from pump.



75798



75228

Power Steering Pump Typical Location

a - Nut

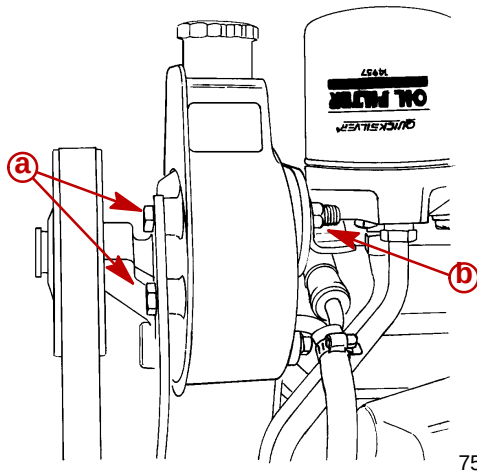
b - Bolts

4. Remove the power steering pump from the bracket.
5. Refer to appropriate Sterndrive Service Manual for power steering pump repair procedures.

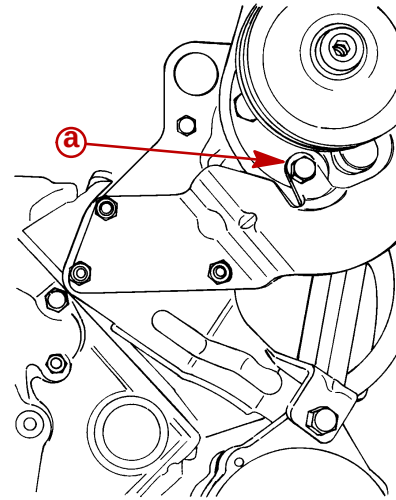
Installation

IMPORTANT: Be careful to not cross-thread or overtighten hose fittings.

1. Place the power steering pump on the bracket and install the screws and nut. Torque to 30 lb-ft (41 Nm).



75798

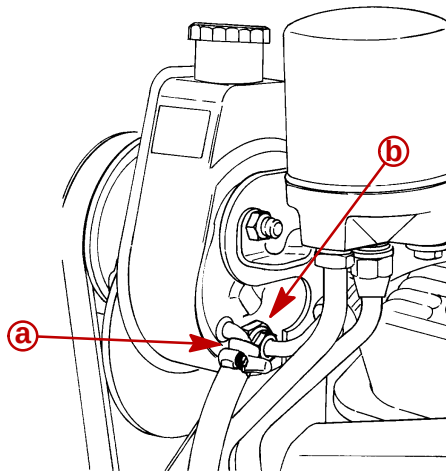


75228

Power Steering Pump Typical Location

- a** - Nut
b - Bolts

2. Be certain a new high pressure hose O-ring is present. Install threaded fitting in back of pump assembly. Tighten fitting securely. Connect low pressure hose on back of pump. Tighten hose clamp securely.



75228

Power Steering Pump Typical Location

- a** - Return Hose
b - High Pressure Hose

3. Install mounting hardware and fasteners to retain pump to bracket. (Refer to "Exploded View" for specific details on your engine.)
4. Install drive belt and adjust tension. Refer to "Pump Drive Belt Adjustment" as previously outlined.
5. Fill and air bleed system. Refer to SECTION 1B - "Maintenance."

Hydraulic Hoses and Fluid Cooler

The following information is provided to assist in replacement of power steering fluid hoses and to assure proper routing and connection to the cooler.

Replace high or low pressure hoses following:

IMPORTANT: Make hydraulic connections as quickly as possible to prevent fluid leakage.

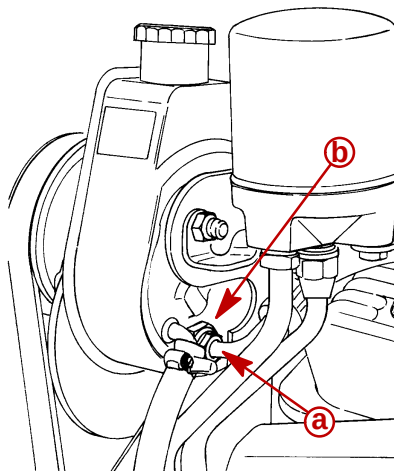
IMPORTANT: Be careful to not cross-thread or overtighten hose fittings.

High Pressure Hose (Pump-to-Control Valve)

REMOVAL

NOTE: Catch fluid that drains from pump and hoses in a suitable container.

1. Remove high pressure hose fitting with O-ring seal from pump fitting on rear of pump.



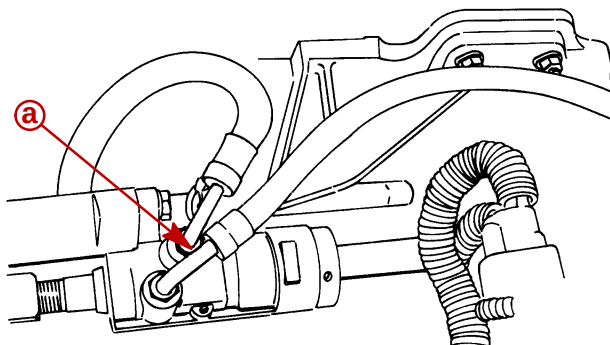
75228

Power Steering Pump Typical Location

a - High Pressure Hose Fitting (With O-Ring - Not Visible In This View)

b - Pump Fitting

2. Remove hose where routed and secured (port or starboard side), across top of engine, near valve cover.
3. Remove fitting from control valve at transom. Remove hose.



73860

a - Power Steering Hose Fitting

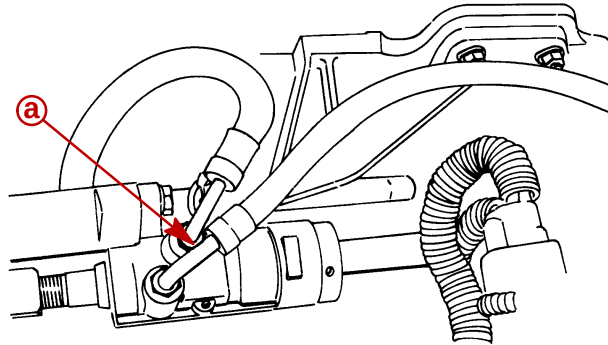
INSTALLATION

⚠ CAUTION

Route hoses exactly as shown below. This will help avoid stress on the hose fittings and will help avoid kinks in the hoses.

IMPORTANT: Be careful to not cross-thread or overtighten hose fittings.

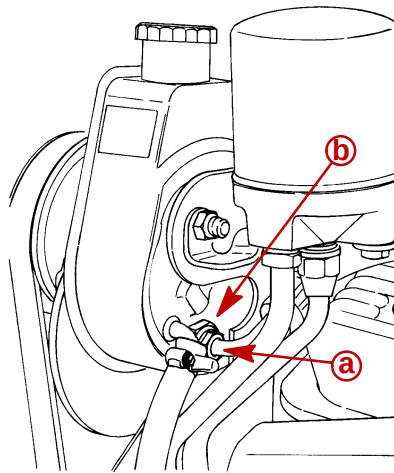
1. Position hose properly (as it was prior to removal). Install fitting and torque to 23 lb-ft (31 Nm). Do not cross-thread or overtighten.



73860

a - Power Steering Hose Fitting

2. Route hose along valve cover and secure with J-clamp(s) provided.
3. Be certain a new high pressure hose O-ring is present. Install threaded hose fitting in back of pump assembly fitting. Tighten hose fitting securely. Do not cross-thread or overtighten.



75228

Power Steering Pump Typical Location

a - High Pressure Hose Fitting (With O-Ring - Not Visible In This View)

b - Pump Fitting

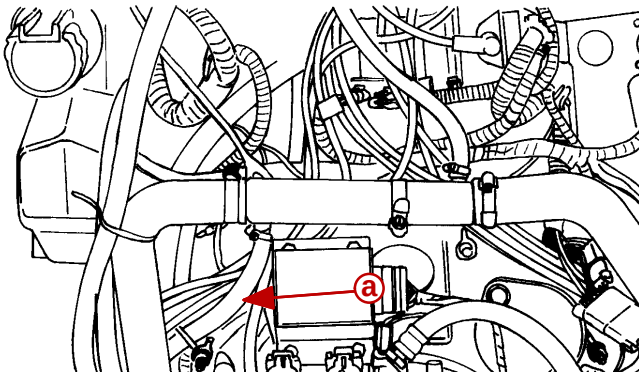
4. Fill and air bleed system. Refer to SECTION 1B.

Low Pressure Hose (Cooler-to-Pump)

REMOVAL

NOTE: Catch fluid that drains from hose, cooler and pump in a suitable container.

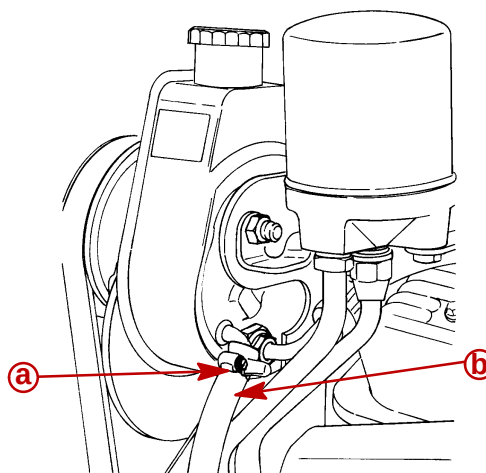
1. Loosen hose clamp and remove hose from fluid cooler.



75595

a - Hose

2. Loosen hose clamp and remove hose from back of pump.



75228

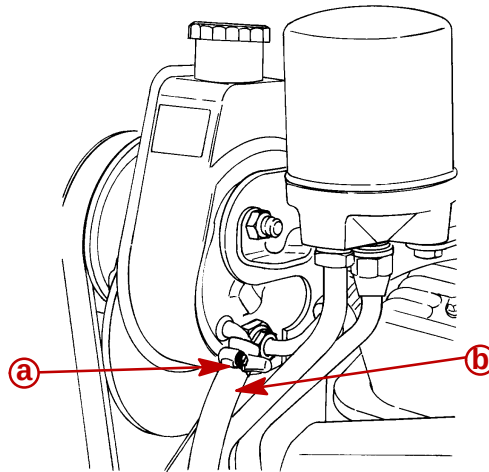
Power Steering Pump Typical Location

a - Hose Clamp

b - Hose

INSTALLATION

1. Using hose clamp, install new hose on back of pump. Tighten clamp securely.



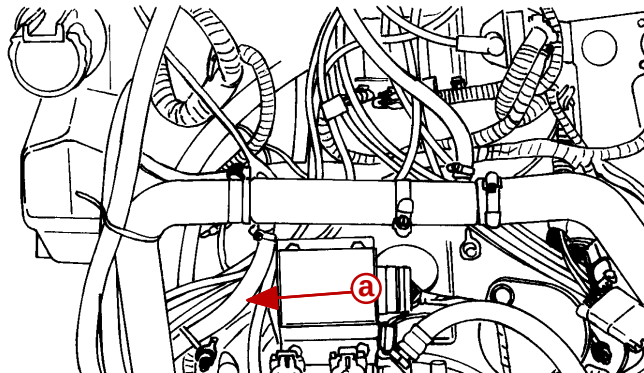
75228

Power Steering Pump Typical Location

a - Hose Clamp

b - Hose

2. Using hose clamp, install hose on fluid cooler. Tighten clamp securely.



75595

a - Hose

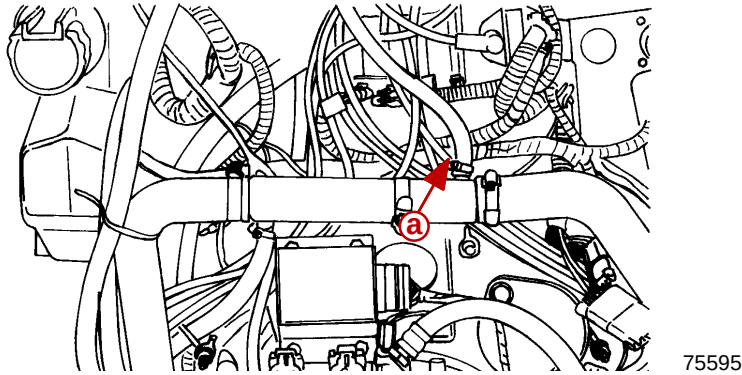
3. Fill and air bleed system. Refer to SECTION 1B.

Low Pressure Hose (Control Valve-to-Cooler)

REMOVAL

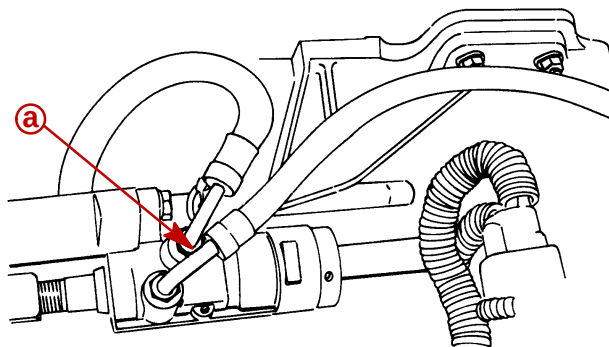
NOTE: Catch fluid that drains from hose, cooler and pump in a suitable container.

1. Loosen hose clamp and remove hose from fluid cooler.



a - Hose

2. Remove fitting from control valve at transom. Remove hose.



a - Power Steering Hose Fitting

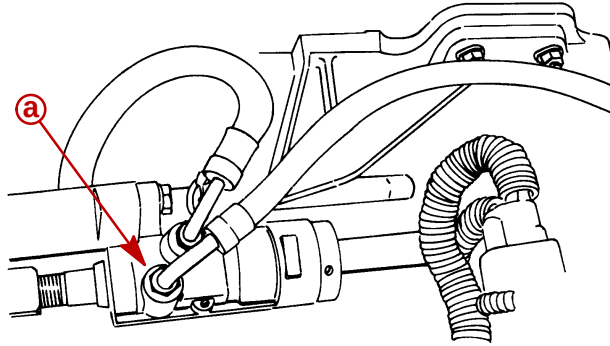
INSTALLATION

⚠ CAUTION

Route hoses exactly as shown below. This will help avoid stress on the hose fittings and will help avoid kinks in the hoses.

IMPORTANT: Be careful to not cross-thread or overtighten hose fittings.

1. Position hose properly (as prior to removal). Install fitting and torque to 23 ft in. (31 Nm). Do not cross-thread or overtighten.

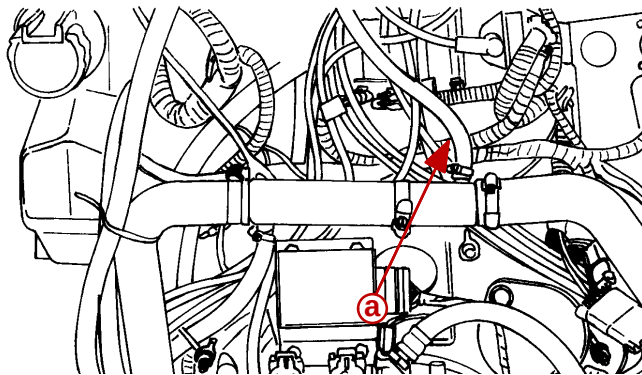


73860

a - Power Steering Hose Fitting

IMPORTANT: Be careful to not cross-thread or overtighten hose fittings.

2. Route hose along flywheel housing and secure with J-clamp(s) provided.
3. Using hose clamp, install hose on fluid cooler. Tighten clamp securely.



75595

a - Hose

4. Fill and air bleed system. Refer to SECTION 1B.

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