MERCURY

40/50/60
40/50/60 SeaPro
40 Jet
FourStroke EFI

SERVICE MANUAL

Serial Numbers 1C453840 and Above

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40/50/60 - 40/50/60 SeaPro
40 Jet FourStroke EFI

SERVICE MANUAL

90-8M0105570
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Notice to Users of This Manual

Throughout this publication, warnings, cautions, and notices (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.

⚠ WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE

Indicates a situation which, if not avoided, could result in engine or major component failure.

IMPORTANT: Identifies information essential to the successful completion of the task.

NOTE: *Indicates information that helps in the understanding of a particular step or action.*

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

It is assumed that these personnel are familiar with marine product servicing procedures. Furthermore, it is assumed that they have been trained in the recommended service procedures of Mercury Marine power products, including 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 marine trade of all conceivable procedures and of the possible hazards and/or results of each method. Therefore, when using a service procedure and/or tool that is not recommended by the manufacturer, be completely satisfied that neither your personal or product safety is endangered.

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.

Refer to dealer service bulletins, operation maintenance and warranty manuals, and installation manuals for other pertinent information concerning the products described in this manual.

Precautions

It should be kept in mind, while working on the product, that the electrical and ignition systems 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 into the cylinders which could cause extensive internal damage when the engine is started.

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 reuse, care should be taken to select a replacement that matches the original.

Replacement Parts

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

⚠ WARNING

Avoid fire or explosion hazard. Electrical, ignition, and fuel system components on Mercury Marine products comply with federal and international standards to minimize risk of fire or explosion. Do not use replacement electrical or fuel system components that do not comply with these standards. When servicing the electrical and fuel systems, properly install and tighten all components.

Cleanliness and Care of Product

A Mercury Marine power product is a combination of many machined, honed, polished, and lapped surfaces with tolerances measured in the ten thousands of an inch/mm. When any product component is serviced, care and cleanliness are important. 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, they should be retained and marked for installation into their original locations. During the assembly process, the marked parts are quickly identified for installation into the same locations they were removed from.

Personnel should not work on or under an engine that is suspended. Engines should be secured to work stands, or lowered to the ground as soon as possible.

Copyright and Trademark Information

Manual Outline

Important Information

Section 1A - Specifications

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Table of Contents

40/50/60 FourStroke EFI Master Specifications

General Specifications

Model Specifications		
Horsepower at 5500 RPM		29.8 kW (40 hp) 37.7 kW (50 hp) 44.7 kW (60 hp)
WOT RPM range		5500–6000
Idle speed (in gear)		725 ± 25
Engine weight (50/60 ELPT)		112.7 kg (248 lb)
Engine weight (40/50/60 ELPT Command Thrust)		119.9 kg (264 lb)
Fuel		Automotive unleaded - minimum 87 octane
Oil type	All temperatures	NMMA FC-W certified synthetic blend SAE 25W-40 outboard oil
	Alternate viscosity below 4 °C (40 °F)	NMMA FC-W certified SAE 10W-30 outboard oil
Oil capacity - with oil filter replacement		3.0 L (3.0 US qt)

Fuel System Specifications

Fuel System Specifications		
Fuel lift pump type		Mechanical water-cooled (plunger/diaphragm)
Fuel pump pressure (maximum)		20–41 kPa (3–6 psi)
Plunger stroke		5.9 mm (0.232 in.)
Fuel tank capacity		Accessory
Fuel injection system		Sequential
Fuel injector resistance		10–13.5 ohms
Electric fuel pump	Pressure	290–303 kPa (42–44 psi)
	Engine running - after five minutes	295 kPa (43 psi)
Vapor separator float height - float needle seated		36.5–39.5 mm (1.437–1.555 in.)
Idle RPM (neutral) warm		750 ± 25 RPM
Idle RPM (forward gear) warm		750 ± 25 RPM

Ignition Specifications

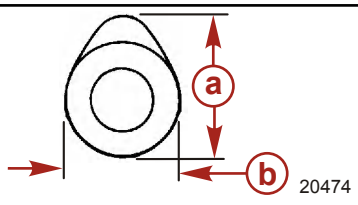
Ignition Specifications at 20 °C (68 °F)		
Ignition type		Capacitor discharge ignition
Spark plug type		Champion RA8HC
Spark plug gap		1.0 mm (0.040 in.)
Spark plug hex size		16 mm (5/8 in.)
Spark plug torque		17 Nm (150 lb-in.)
Spark plug hole size		12 mm
Firing order		1–3–4–2
Ignition timing	at Idle	Controlled by ECM
	at 1500–1800 RPM	14° BTDC
	at WOT	28° BTDC
Stator resistance		0.2–0.3 Ω (yellow - yellow)
Crankshaft position sensor resistance		300–350 Ω (red - white)
Ignition coil resistance		Refer to **Ignition Coil Resistance Test** chart

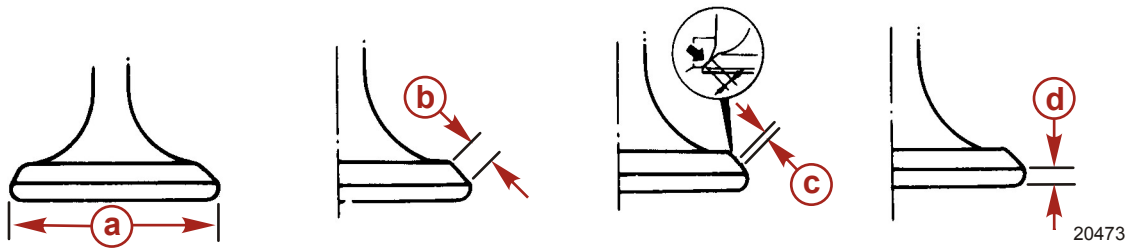
Ignition Specifications at 20 °C (68 °F)		
ECM engine speed limiter	Fuel/spark cutout on cylinders #2 and #3	6225 RPM
	Fuel/spark cutout on all cylinders	6350 RPM
ECM overheat speed control		Guardian System is activated. Power limit will vary with the level of overheat.
ECM low oil pressure speed control		Guardian System is activated. Engine power is limited to 10% of maximum (approximately 2000 RPM).
MAT/ECT temperature sensor		Refer to **Section 3B - Component Resistance Tests**
Manifold absolute pressure (MAP) sensor resistance		Refer to **Section 3B - Component Resistance Tests**
Fuel injector resistance		10.0–13.5 Ω
Main power relay		81–99 Ω (pin 85–pin 86)
Idle air control (IAC)		24–30 Ω (between pins)
Throttle position sensor (TPS) typical range	Output voltage at Idle	0.39–1.00 volts
	Output voltage at WOT (6000 RPM)	3.66–4.80 volts

Charging and Starting Specifications

Charging and Starting Specifications at 20 °C (68 °F)		
Alternator	Type	Single phase stator coil (12 pole)
	Output at 1000 RPM	12.5 A
	Output at 5000 RPM	17.5 A
Stator coil resistance		0.2–0.6 Ω
Fuse		20 A
Starter	Type	Sliding gear
	Model/manufacturer	Bendix
	Output	1.1 kW
	Ampere draw under load	174.0 A
	Ampere draw under no load	23.7 A
Battery rating	Minimum requirement	465 marine cranking amps (MCA) or 350 cold cranking amps (CCA)
	For operation below 0 °C (32 °F)	1000 marine cranking amps (MCA) or 775 cold cranking amps (CCA)
	Ampere hours (Ah) for operation above 0 °C (32 °F)	70
	Ampere hours (Ah) for operation below 0 °C (32 °F)	105
Quicksilver tachometer setting		6P or 4

Cylinder Head Specification

Cylinder Head Specifications		
Camshaft dimensions	Intake/exhaust "a"	30.83–31.03 mm (1.214–1.222 in.)
	Intake/exhaust "b"	25.90–26.10 mm (1.020–1.028 in.)
		
Intake/exhaust valve lift		4.73–5.13 mm (0.186–0.202 in.)

Cylinder Head Specifications		
Runout limit		0.1 mm (0.0039 in.)
Camshaft bearing diameter		36.935–36.955 mm (1.4541–1.4549 in.)
Camshaft bearing oil clearance		0.045–0.090 mm (0.0018–0.0035 in.)
Valve spring free length		37.85–39.85 mm (1.491–1.569 in.)
Tilt limit		Less than 1.7 mm (0.060 in.)
Cylinder head flatness		0.1 mm (0.0039 in.)
Camshaft bore diameter		37.000–37.025 mm (1.4567–1.4577 in.)
Valve clearance (cold)	Intake	0.15–0.25 mm (0.006–0.010 in.)
	Exhaust	0.25–0.35 mm (0.010–0.014 in.)
Valve dimensions	Valve seat angles	30°, 45°, 60°
	Intake valve head diameter "a"	31.90–32.1 mm (1.256–1.264 in.)
	Exhaust valve head diameter "a"	25.90–26.1 mm (1.020–1.028 in.)
	Intake/exhaust face width "b"	2.00–3.14 mm (0.079–0.124 in.)
	Intake/exhaust seat width "c"	0.90–1.10 mm (0.035–0.043 in.)
	Intake/exhaust margin thickness "d"	0.50–0.90 mm (0.020–0.035 in.)
		
Intake stem outside diameter		5.475–5.490 mm (0.2156–0.2161 in.)
Exhaust stem outside diameter		5.460–5.475 mm (0.2150–0.2156 in.)
Valve guide inside diameter (intake/exhaust)		5.500–5.512 mm (0.2165–0.2170 in.)
Stem to guide clearance (intake)		0.010–0.037 mm (0.0004–0.0015 in.)
Stem to guide clearance (exhaust)		0.025–0.052 mm (0.0010–0.0020 in.)
Stem runout limit (maximum)		0.016 mm (0.0006 in.)
Rocker shaft outside diameter		15.971–15.991 mm (0.6288–0.6296 in.)
Rocker arm inside diameter of bore		16.000–16.018 mm (0.6299–0.6306 in.)

Cylinder Block/Crankshaft Specifications

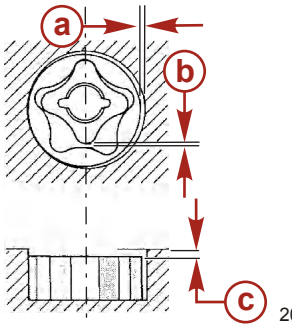
Cylinder Block Specifications		
Cylinder block type		In-line, 4-Stroke - OHC, 8 valves
Displacement		995 cc (60.8 in³)
Stroke length		75 mm (2.953 in.)
Number of cylinders		4
Cylinder bore diameter	Standard	65 mm (2.5591 in.)
	Oversize - 0.25 mm (0.010 in.)	65.25 mm (2.5689 in.)
	Oversize - 0.50 mm (0.020 in.)	65.50 mm (2.5787 in.)
	Taper/out of round maximum	0.08 mm (0.003 in.)
Bore type		Cast iron
Crankshaft Specifications		
Crankshaft journal diameter		47.985–48.000 mm (1.8892–1.8898 in.)
Crankshaft pin diameter		43.982–44.000 mm (1.7316–1.7323 in.)
Crankshaft pin width		21.00–21.07 mm (0.8268–0.8295 in.)
Crankshaft runout		0.046 mm (0.0018 in.)
Crankshaft main bearing clearance		0.012–0.044 mm (0.0005–0.0017 in.)

Piston Specifications

Piston Specifications		
Piston type		Aluminum
Skirt diameter	Measure point	13.0 mm (0.51 in.)
	Standard	64.950–64.965 mm (2.5570–2.5578 in.)
	Oversize - 0.25 mm (0.010 in.)	65.200–65.215 mm (2.5669–2.5675 in.)
	Oversize - 0.50 mm (0.020 in.)	65.450–65.465 mm (2.5768–2.5774 in.)
Piston to cylinder clearance		0.035–0.065 mm (0.0014–0.00261 in.)
Ring end gap (installed)	Top	0.15–0.30 mm (0.006–0.012 in.)
	Second	0.30–0.50 mm (0.012–0.020 in.)
	Bottom (oil ring)	0.20–0.70 mm (0.008–0.028 in.)
Ring side clearance	Top	0.02–0.06 mm (0.0008–0.0024 in.)
	Second	0.02–0.06 mm (0.0008–0.0024 in.)
Compression ratio		9.7:1
Cylinder compression (peak)		1240–1450 kPa (180–210 psi)
Piston pin diameter		15.965–15.970 mm (0.6285–0.6287 in.)

Piston Specifications		
Connecting rod	Small end inside diameter	15.985–15.998 mm (0.6293–0.6298 in.)
	Big end oil clearance	0.020–0.052 mm (0.0008–0.0020 in.)

Lubrication Specifications

Lubrication Specifications		
Pump type		Trochoid
3000 RPM with warm engine - 65 °C (149 °F)		207–276 kPa (30–40 psi) (reference only)
Oil pressure switch		20 kPa (2.9 psi)
Engine oil capacity		3 liters (3 US qts)
Oil pump dimensions	Outer rotor to housing "**a**"	0.11–0.23 mm (0.0045–0.0090 in.)
	Inner rotor to outer rotor "**b**"	0.12 mm (0.005 in.)
	Rotor to housing "**c**"	0.04–0.08 mm (0.0015–0.0031 in.)
 20467		

Mid-Section Specifications

Mid-Section Specifications		
Recommended transom height		
Long shaft		508 mm (20 in.)
XL shaft		635 mm (25 in.)
Steering pivot range	Tiller	90°
	Remote	60°
Full tilt up angle		71°
Trim angle (on 12° boat transom)		Negative 4° to positive 16°
Allowable transom thickness (maximum)		70 mm (2.75 in.)

Gear Housing Specifications (1.83:1)

Gear Housing Specifications	
Gear ratio	1.83:1
Gear shift positions	F–N–R
Reduction gear type	Spiral bevel gear
Clutch type	Dog clutch
Propeller shaft type	Spline
Propeller direction (rear view)	Clockwise
Gear housing capacity	340 ml (11.5 fl oz)
Lubricant type	High Performance Gear Lubricant or Premium Gear Lubricant
Forward gear - number of teeth	22
Pinion gear - number of teeth	12

Gear Housing Specifications		
Pinion height		0.64 mm (0.025 in.)
Pinion gear locating tool	Part number	91-817008A 2
	Flat number	
	Disc number	
Forward gear backlash		0.28–0.43 mm (0.011–0.017 in.)
Backlash indicating tool	Part number	91-19660 1
	Mark number	4
Water pressure	At 800 RPM	7–21 kPa (1–3 psi)
	At 6000 RPM	83–172 kPa (12–25 psi)
Leak test		69–83 kPa (10–12 psi) for five minutes

Gear Housing Specifications - Command Thrust (2.33:1) (S/N 0T625304 and Above)

Gear Housing Specifications		
Gear ratio		2.33:1
Gear shift positions		F–N–R
Reduction gear type		Spiral bevel gear
Clutch type		Dog clutch
Propeller shaft type		Spline
Propeller direction (rear view)		Clockwise
Gear housing capacity		710 ml (24 fl oz)
Lubricant type		High Performance Gear Lubricant or Premium Gear Lubricant
Forward gear - number of teeth		28 spiral/bevel
Pinion gear - number of teeth		12 spiral/bevel
Pinion height		0.64 mm (0.025 in.)
Pinion gear locating tool	Part number	91-12349A05
	Flat number	8
	Disc number	3
Forward gear backlash		0.30–0.48 mm (0.012–0.019 in.)
Backlash indicating tool	Part number	91-78473
	Mark number	4
Water pressure	At 800 RPM	14–41 kPa (2–6 psi)
	At 6000 RPM	83–172 kPa (12–25 psi)
Leak test		69–83 kPa (10–12 psi) for five minutes

Power Trim Specifications

Power Trim Specifications	
Trim up circuit pressure, minimum	19300 kPa (2800 psi)
Trim down circuit pressure	3450–5515 kPa (500–800 psi)
System fluid	Power Trim and Steering Fluid or automotive automatic transmission fluid (ATF) (Type Dexron III)

Propeller Information Charts

Stainless Steel Propellers

NOTE: *Using stainless steel propellers may create clutch rattle at idle speed.*

50 EFI FourStroke Non-Command Thrust

- Wide-open throttle RPM: 5000–6000

- Recommended transom heights: 50.8 cm (20 in.), 63.5 cm (25 in.)
- Right-hand rotation (RH)
- Gear reduction: 1.83:1

Diameter	Pitch	No. of Blades	Material	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
10	19	3	Aluminum	363 kg (800 lb)	Up to 4.3 m (14 ft)	79–93 km/h (49–58 mph)	48-73146A40
10	17	3	Aluminum	Up to 408 kg (900 lb)	Up to 4.6 m (15 ft)	69–80 km/h (43–50 mph)	48-73144A40
10	16	3	Steel	408–590 kg (900–1300 lb)	Up to 4.6 m (15 ft)	63–74 km/h (39–46 mph)	48-91818A5
10	16	3	Aluminum	408–590 kg (900–1300 lb)	4.6 m (15 ft)	63–74 km/h (39–46 mph)	48-73142A40
10-1/8	15	3	Steel	454–635 kg (1000–1400 lb)	4.0–4.6 m (13–15 ft)	58–69 km/h (36–43 mph)	48-855862A5
10-1/8	15	3	Aluminum	454–635 kg (1000–1400 lb)	4.0–4.6 m (13–15 ft)	58–69 km/h (36–43 mph)	48-73140A40
10-1/4	14	3	Steel	499–726 kg (1100–1600 lb)	4.3–4.9 m (14–16 ft)	53–63 km/h (33–39 mph)	48-855860A5
10-1/4	14	3	Aluminum	499–726 kg (1100–1600 lb)	4.3–4.9 m (14–16 ft)	53–63 km/h (33–39 mph)	48-73138A40
10-3/8	13	3	Steel	590–816 kg (1300–1800 lb)	4.3–5.2 m (14–17 ft)	48–58 km/h (30–35 mph)	48-855858A5
10-3/8	13	3	Aluminum	590–816 kg (1300–1800 lb)	4.3–5.2 m (14–17 ft)	48–58 km/h (30–35 mph)	48-73136A40
10-5/8	12	3	Steel	590–726 kg (1400–2000 lb)	4.6–5.2 m (15–17 ft)	43–51 km/h (27–32 mph)	48-855856A5
10-5/8	12	3	Aluminum	590–726 kg (1400–2000 lb)	4.6–5.2 m (15–17 ft)	43–51 km/h (27–32 mph)	48-73134A40
11-5/8	11	3	Steel	771–1089 kg (1700–2400 lb)	4.9–5.5 m (16–18 ft)	39–47 km/h (24–29 mph)	48-823478A5
10-7/8	11	3	Aluminum	771–1089 kg (1700–2400 lb)	4.9–5.5 m (16–18 ft)	39–47 km/h (24–29 mph)	48-85632A40
11-5/8	10-1/2	3	Aluminum	862–1225 kg (1900–2700 lb)	4.9+ m (16+ ft)	34–40 km/h (21–25 mph)	48-827312A10
11-1/4	10	3	Aluminum	771–998 kg (2100–3000 lb)	5.2+ m (17+ ft)	31–39 km/h (19–24 mph)	48-73132A40
12-1/4	9	3	Steel	1134+ kg (2500+ lb)	Pontoon	27–34 km/h (17–21 mph)	48-97868A10
12-1/4	9	3	Aluminum	1134+ kg (2500+ lb)	Pontoon	27–34 km/h (17–21 mph)	48-87818A10
12-1/2	8	3	Aluminum	1361+ kg (3000+ lb)	Pontoon/ houseboat	1–29 km/h (1–18 mph)	48-42738A10
12-1/2	8 cup	3	Aluminum		Pontoon		48-42738A12

60 EFI FourStroke Non-Command Thrust

- Wide-open throttle RPM: 5000–6000
- Recommended transom heights: 50.8 cm (20 in.), 63.5 cm (25 in.)
- Right-hand rotation (RH)
- Gear reduction: 1.83:1

Diameter	Pitch	No. of Blades	Material	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
10	19	3	Aluminum	454 kg (1000 lb)	Up to 4.3 m (14 ft)	79–93 km/h (49–58 mph)	48-73146A40

Diameter	Pitch	No. of Blades	Material	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
10	17	3	Aluminum	Up to 544 kg (1200 lb)	Up to 4.6 m (15 ft)	69–80 km/h (43–50 mph)	48-73144A40
10	16	3	Steel	544–726 kg (1200–1600 lb)	Up to 4.6 m (15 ft)	63–74 km/h (39–46 mph)	48-91818A5
10	16	3	Aluminum	544–726 kg (1200–1600 lb)	4.6 m (15 ft)	63–74 km/h (39–46 mph)	48-73142A40
10-1/8	15	3	Steel	590–771 kg (1300–1700 lb)	4.0–4.6 m (13–15 ft)	58–69 km/h (36–43 mph)	48-855862A5
10-1/8	15	3	Aluminum	590–771 kg (1000–1400 lb)	4.0–4.6 m (13–15 ft)	58–69 km/h (36–43 mph)	48-73140A40
10-1/4	14	3	Steel	635–907 kg (1400–2000 lb)	4.3–4.9 m (14–16 ft)	53–63 km/h (33–39 mph)	48-855860A5
10-1/4	14	3	Aluminum	635–907 kg (1400–2000 lb)	4.3–4.9 m (14–16 ft)	53–63 km/h (33–39 mph)	48-73138A40
10-3/8	13	3	Steel	726–998 kg (1600–2200 lb)	4.3–5.2 m (14–17 ft)	48–58 km/h (30–35 mph)	48-855858A5
10-3/8	13	3	Aluminum	726–998 kg (1600–2200 lb)	4.3–5.2 m (14–17 ft)	48–58 km/h (30–35 mph)	48-73136A40
10-5/8	12	3	Steel	816–1134 kg (1800–2500 lb)	4.6–5.2 m (15–17 ft)	43–51 km/h (27–32 mph)	48-855856A5
10-5/8	12	3	Aluminum	816–1134 kg (1800–2500 lb)	4.6–5.2 m (15–17 ft)	43–51 km/h (27–32 mph)	48-73134A40
11-5/8	11	3	Steel	1043–1361 kg (2300–3000 lb)	4.9–5.5 m (16–18 ft)	39–47 km/h (24–29 mph)	48-823478A5
10-7/8	11	3	Aluminum	1043–1361 kg (2300–3000 lb)	4.9–5.5 m (16–18 ft)	39–47 km/h (24–29 mph)	48-85632A40
11-5/8	10-1/2	3	Aluminum	1134–1497 kg (2500–3300 lb)	5.2+ m (16+ ft)	34–40 km/h (21–25 mph)	48-827312A10
11-1/4	10	3	Aluminum	1270–1633 kg (2800–3600 lb)	5.5+ m (17+ ft)	31–39 km/h (19–24 mph)	48-73132A40
12-1/4	9	3	Steel	1497+ kg (3300+ lb)	Pontoon	27–34 km/h (17–21 mph)	48-97868A10
12-1/4	9	3	Aluminum	1497+ kg (3300+ lb)	Pontoon	27–34 km/h (17–21 mph)	48-87818A10
12-1/2	8	3	Aluminum	1814+ kg (4000+ lb)	Pontoon/ houseboat	1–29 km/h (1–18 mph)	48-42738A10
12-1/2	8 cup	3	Aluminum		Pontoon		48-42738A12

40 EFI FourStroke Command Thrust

NOTE: *Special soft rubber hub propellers designed to reduce clutch rattle.*

- Wide-open throttle RPM: 5000–6000
- Recommended transom heights: 50.8 cm (20 in.), 63.5 cm (25 in.)
- Right-hand rotation (RH)
- Gear reduction: 2.31:1 or 2.33:1

IMPORTANT: These specially designed rubber hub propellers are rated for 44.7 kw (60 hp).

Diameter	Pitch	No. of Blades	Material	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
13.75	15	3	Aluminum	544–680 kg (1200–1500 lb)	4.3–4.9 m (14–16 ft)	43–52 km/h (27–32 mph)	48-77342A33
14	13	3	Aluminum	Up to 680–907 kg (1500–2000 lb)	Up to 5.5 m (16–18 ft)	35–43 km/h (22–27 mph)	48-77340A33
14	11	3	Aluminum	907–1360 kg (2000–3000 lb)	Pontoon	27–34 km/h (17–21 mph)	48-77338A33

Diameter	Pitch	No. of Blades	Material	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
14	10	3	Aluminum	1135 kg (2500+ lb)	Pontoon/work	23–31 km/h (14–19 mph)	48-854342A33
14	9	3	Aluminum	1588 kg (3500+ lb)	Houseboat/work	1–24 km/h (1–15 mph)	48-854340A33

50 EFI FourStroke Command Thrust

NOTE: *Special soft rubber hub propellers designed to reduce clutch rattle.*

- Wide-open throttle RPM: 5000–6000
- Recommended transom heights: 50.8 cm (20 in.), 63.5 cm (25 in.)
- Right-hand rotation (RH)
- Gear reduction: 2.31:1 or 2.33:1

IMPORTANT: These specially designed rubber hub propellers are rated for 44.7 kw (60 hp).

Diameter	Pitch	No. of Blades	Material	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
13.75	15	3	Aluminum	680–907 kg (1500–2000 lb)	4.3–4.9 m (14–16 ft)	40–51 km/h (25–32 mph)	48-77342A33
14	13	3	Aluminum	Up to 815–1180 kg (1800–2600 lb)	Up to 5.5 m (16–18 ft)	37–43 km/h (23–27 mph)	48-77340A33
14	11	3	Aluminum	1270–1815 kg (2800–4000 lb)	Pontoon	27–34 km/h (17–21 mph)	48-77338A33
14	10	3	Aluminum	1360 kg (3000+ lb)	Pontoon/work	23–31 km/h (14–19 mph)	48-854342A
14	9	3	Aluminum	2270 kg (5000+ lb)	Houseboat/work	1–26 km/h (1–16 mph)	48-854340A33

60 EFI FourStroke Command Thrust

NOTE: *Special soft rubber hub propellers designed to reduce clutch rattle.*

- Wide-open throttle RPM: 5000–6000
- Recommended transom heights: 50.8 cm (20 in.), 63.5 cm (25 in.)
- Right-hand rotation (RH)
- Gear reduction: 2.31:1 or 2.33:1

IMPORTANT: These specially designed rubber hub propellers are rated for 44.7 kw (60 hp).

Diameter	Pitch	No. of Blades	Material	Approx. Gross Boat Wgt.	Approx. Boat Length	Speed Range	Propeller Part Number
13.75	15	3	Aluminum	907–1135 kg (2000–2500 lb)	4.3–4.9 m (14–16 ft)	40–51 km/h (25–32 mph)	48-77342A33
14	13	3	Aluminum	Up to 1040–1450 kg (2300–3200 lb)	Up to 5.5 m (16–18 ft)	37–43 km/h (23–27 mph)	48-77340A33
14	11	3	Aluminum	1360–1950 kg (3000–4300 lb)	Pontoon	27–34 km/h (17–21 mph)	48-77338A33
14	10	3	Aluminum	1588 kg (3500+ lb)	Pontoon/work	23–31 km/h (14–19 mph)	48-854342A33
14	9	3	Aluminum	2500 kg (5500+ lb)	Houseboat/work	1–26 km/h (1–16 mph)	48-854340A33

Important Information

Section 1B - Maintenance

Table of Contents

Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
	Extreme Grease	Propeller shaft	8M0071842
94	Anti-Corrosion Grease	Flange surfaces on the water intake housing, liner, and pump housing	Obtain Locally
95	2-4-C with PTFE	Propeller shaft	92-802859A 1
		Tilt support lever, swivel bracket, tilt tube, copilot shaft, steering cable grease fitting	
		Driveshaft, drive key, and impeller bore	
		Driveshaft bearing	
		Tilt support lever, swivel bracket, tilt tube, copilot shaft, and steering cable grease fitting	
114	Power Trim and Steering Fluid	Power trim reservoir	92-858074K01
120	Corrosion Guard	External metal surfaces (except corrosion control anodes)	92-802878 55

Special Tools

Flushing Device	91-44357Q 2
 9192	Attaches to the water intakes; provides a fresh water connection when flushing the cooling system or operating the engine.

Inspection and Maintenance Schedule

Daily Checks

- Check the engine oil level
- Check the lanyard stop switch
- Inspect the fuel system for leaks
- Inspect the engine tightness on the transom
- Check the steering system for binding
- Check the propeller for damage
- Inspect the hydraulic steering fittings and hoses for leaks or signs of damage, if equipped
- Check the hydraulic steering fluid level, if equipped

After Each Use

- Wash the power package exterior with fresh water
- Flush the outboard cooling system, saltwater or brackish water only

Annually or 100 Hours

- Grease the engine, if applicable
- Change the engine oil and filter, if equipped
- Inspect the thermostat, saltwater or brackish water only
- Add Quickleen to the fuel tank, once per year, per engine
- Apply anti-seize to the spark plug threads
- Replace the gear lubricant
- Inspect the corrosion control anodes

- Replace all filters on the suction side of the fuel system—dealer item
- Lubricate the driveshaft splines—dealer item
- Lubricate the propeller shaft splines—dealer item
- Check the tightness on all the fasteners—dealer item
- Check the torque of the outboard mounting hardware—dealer item
- Check the battery condition and tightness of the battery cable connection—dealer item

Three years or 300 Hours

- Replace the spark plugs
- Replace the water pump impeller—dealer item
- Inspect the carbon fiber reeds—dealer item
- Inspect the wire harness connectors—dealer item
- Check the remote control cable adjustment, if applicable—dealer item
- Replace the high-pressure fuel filter—dealer item
- Replace the accessory drive belt—dealer item
- Check the power trim fluid level—dealer item
- Inspect the engine motor mounts—dealer item

Flushing the Cooling System

Flush the internal water passages of the outboard with fresh water after each use in salt, polluted, or muddy water. This will help prevent a buildup of deposits from clogging the internal water passages.

IMPORTANT: The engine must be run during flushing in order to open the thermostat and circulate water through the water passages.

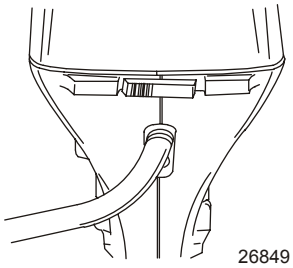
Outboard Models

⚠ WARNING

Rotating propellers can cause serious injury or death. Never operate the boat out of the water with a propeller installed. Before installing or removing a propeller, place the drive unit in neutral and engage the lanyard stop switch to prevent the engine from starting. Place a block of wood between the propeller blade and the anti-ventilation plate.

1. Place the outboard in either the operating position (vertical) or in a tilted position.
2. Remove the propeller. Refer to **Propeller Replacement**.
3. Thread a water hose into the rear fitting. Partially open the water tap (1/2 maximum). Do not open the water tap all the way, as this allows a high pressure flow of water.

   IMPORTANT: Do not run engine above idle when flushing.
4. Shift the outboard into neutral. Start the engine and flush the cooling system for at least five minutes. Keep engine speed at idle.
5. Stop the engine. Turn off the water and remove the hose. Install the propeller.

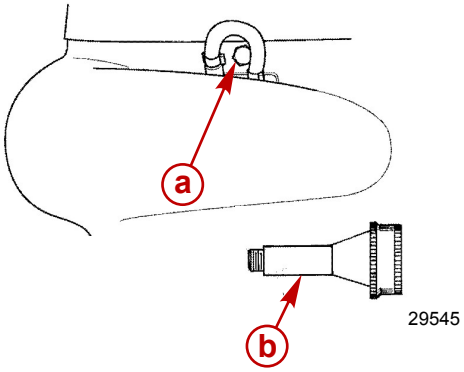


Jet Drive Models

Use a Mercury Precision Parts or Quicksilver accessory hose coupling.

1. Place the outboard in either the operating position (vertical) or in a tilted position.
2. Remove the plug and gasket.

3. Thread the hose coupling into the jet drive.

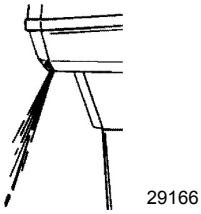


a - Plug and gasket
b - Hose coupling

4. Attach a water hose to the hose coupling. Partially open the water tap (1/2 maximum). Do not open the water tap all the way, as this allows a high pressure flow of water. Start the engine and run it at idle speed only.

   IMPORTANT: Do not run engine above idle when flushing.

5. Check for a steady stream of water flowing out of the water pump indicator hole. Continue flushing the outboard for three to five minutes, carefully monitoring water supply at all times.



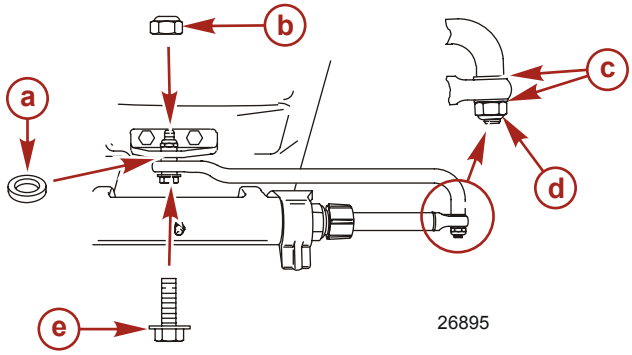
6. Stop the engine, turn off the water, and remove the hose coupling. Install plug and gasket.

Steering Link Rod Fasteners

IMPORTANT: The steering link rod that connects the steering cable to the engine must be fastened using special washer head bolt ("e" - Part Number 10-856680) and self-locking nylon insert locknuts ("b" and "d" - Part Number 11-826709113). These locknuts must never be replaced with common nuts (nonlocking) as they will work loose and vibrate off, freeing the link rod to disengage.

⚠ WARNING

Improper fasteners or improper installation procedures can result in loosening or disengagement of the steering link rod. This can cause a sudden, unexpected loss of boat control, resulting in serious injury or death due to occupants being thrown within or out of the boat. Always use required components and follow instructions and torque procedures.



a - Spacer (12-71970)
b - Nylon insert locknut (11-826709113)
c - Flat washer (2)
d - Nylon insert locknut (11-826709113)
e - Special washer head bolt (10-856680)

Description	Nm	lb-in.	lb-ft
Nylon insert locknut "b"	27		20
Nylon insert locknut "d"	Tighten until it seats, then back off 1/4 turn		
Special washer head bolt	27		20

Assemble steering link rod to steering cable with two flat washers and nylon insert locknut. Tighten locknut until it seats, then back nut off 1/4 turn.

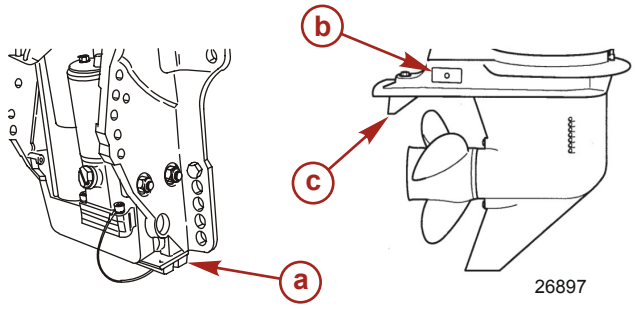
Assemble steering link rod to engine with special washer head bolt, locknut, and spacer. First torque bolt, then locknut to specification.

Corrosion Control Anode

Your outboard has corrosion control anodes at different locations. An anode helps protect the outboard against galvanic corrosion by sacrificing its metal to be slowly corroded instead of the outboard metals.

Each anode requires periodic inspection, especially in saltwater which will accelerate the erosion. To maintain this corrosion protection, always replace the anode before it is completely eroded. Never paint or apply a protective coating on the anode as this will reduce effectiveness of the anode.

One anode is installed on the bottom of the transom bracket assembly. The trim tab is also an anode on the 87.3 mm (3-7/16 in.) diameter gearcase. The 108 mm (4-1/4 in.) diameter gearcase has three anodes. One of the anodes is the trim tab, and the other two anodes are located on each side of the gearcase.



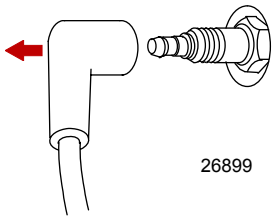
a - Anode on transom bracket assembly
b - Anode (2) on each side of gearcase
c - Trim tab

Spark Plug Inspection and Replacement

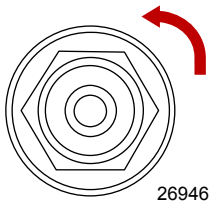
⚠ WARNING

Damaged spark plug boots may emit sparks that can ignite fuel vapors under the engine cowl, resulting in serious injury or death from a fire or explosion. To avoid damaging the spark plug boots, do not use any sharp object or metal tool to remove the spark plug boots.

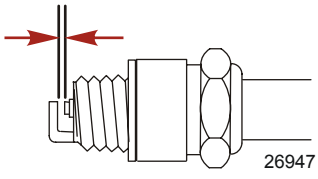
1. Remove the spark plug boot. Twist the rubber boot slightly and pull off.



2. Remove the spark plug to inspect. Replace spark plug if electrode is worn or the insulator is rough, cracked, broken, blistered, or fouled.



3. Set the spark plug gap to specification.



Spark Plug	
Spark plug gap	1.0 mm (0.040 in.)

4. Before installing the spark plug, clean off any dirt on the spark plug seat. Install the plug finger-tight, and then tighten 1/4 turn or tighten to the specified torque.

Description	Nm	lb-in.	lb-ft
Spark plug	17	150	

Battery Inspection

The battery should be inspected at periodic intervals to ensure proper engine starting capability.

IMPORTANT: Read the safety and maintenance instructions which accompany your battery.

1. Turn off the engine before servicing the battery.
2. Ensure the battery is secure against movement.
3. Battery cable terminals should be clean, tight, and correctly installed. Positive to positive and negative to negative.
4. Ensure the battery is equipped with a nonconductive shield to prevent accidental shorting of battery terminals.

Lubrication Points

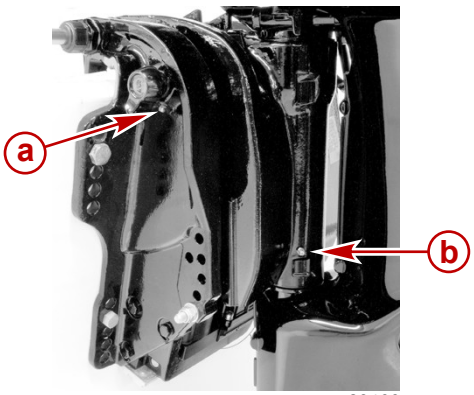
1. Lubricate the following with Quicksilver or Mercury Precision Lubricants Extreme Grease or 2-4-C with PTFE.

Tube Ref No.	Description	Where Used	Part No.
	Extreme Grease	Propeller shaft	8M0071842
95	2-4-C with PTFE	Propeller shaft	92-802859A 1

2. Lubricate the following with Quicksilver or Mercury Precision Lubricant 2-4-C with PTFE.

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Tilt support lever, swivel bracket, tilt tube, copilot shaft, steering cable grease fitting	92-802859A 1

- Tilt support lever - Lubricate through fitting.
- Swivel bracket - Lubricate through fitting.



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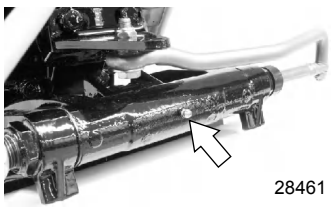
a - Tilt support lever
b - Swivel bracket

- Tilt tube - Lubricate through fitting.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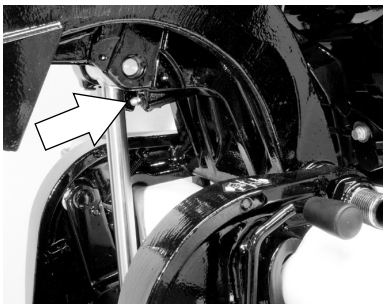
- Copilot shaft (tiller handle models) - Lubricate through fitting. Move the steering friction lever back and forth while lubricating.

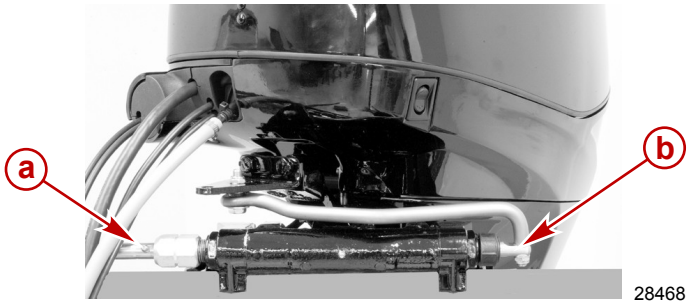


28823

⚠ WARNING

Incorrect cable lubrication can cause hydraulic lock, leading to serious injury or death from loss of boat control. Completely retract the end of the steering cable before applying lubricant.

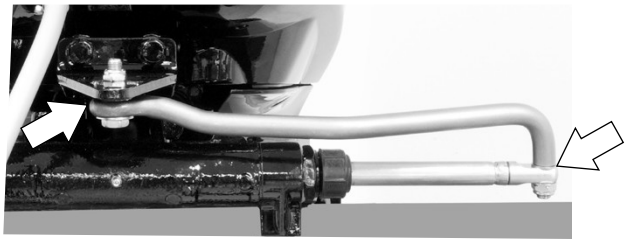
- Steering cable grease fitting (if equipped) - Rotate steering wheel to fully retract the steering cable end into the outboard tilt tube. Lubricate through fitting.



28468

a - Fitting
b - Steering cable end

3. Lubricate the following with lightweight oil.
   - Steering link rod pivot points - Lubricate points.



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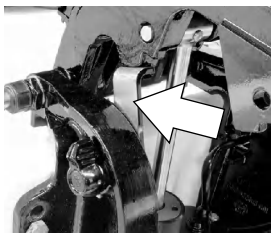
Checking Power Trim Fluid

1. Tilt the outboard to the full up position and engage the tilt support lock.



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2. Remove the fill cap and check the fluid level. The fluid level should be even with the bottom of the fill hole. Add Quicksilver or Mercury Precision Lubricants Power Trim and Steering Fluid. If not available, use automotive automatic transmission fluid (ATF).

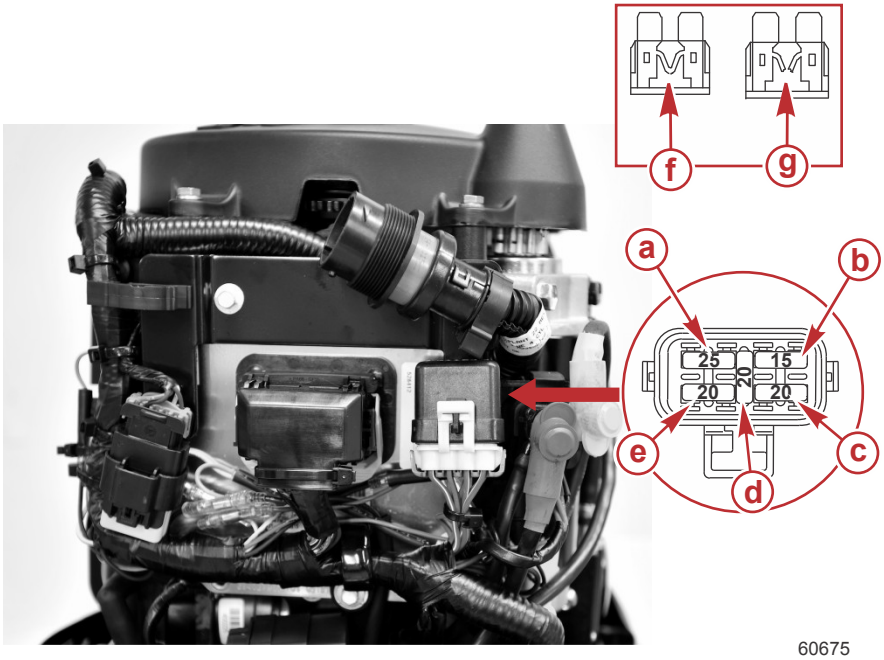
Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	Power trim reservoir	92-858074K01

Fuse Replacement

IMPORTANT: Always carry spare 20 amp fuses.

The electrical wiring circuits on the outboard are protected from overload by fuses in the wiring. If a fuse is blown, try to locate and correct the cause of the overload. If the cause is not found, the fuse may blow again.

Open the fuse holder and look at the silver colored band inside the fuse. If the band is broken, replace the fuse. Replace the fuse with a new fuse with the same rating.



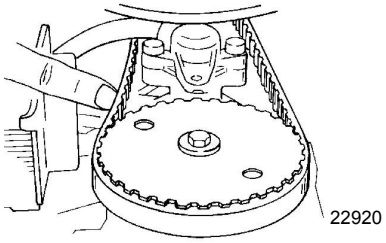
- **a -** Main circuit - 25 amp fuse (#1)
- **b -** Main relay/accessories - 15 amp fuse (#3)
- **c -** Ignition coil circuit - 20 amp fuse (#4)
- **d -** Spare 20 amp fuse
- **e -** Fuel pump/idle air control/fuel injector circuits - 20 amp fuse (#2)
- **f -** Good fuse
- **g -** Blown fuse

Timing Belt Inspection

Inspect the timing belt and have it replaced by an authorized dealer if any of the following conditions are found.

1. Cracks in the back of the belt or in the base of the belt teeth.
2. Excessive wear at the roots of the cogs.
3. Rubber portion swollen by oil.
4. Belt surfaces roughened.
5. Signs of wear on edges or outer surfaces of belt.

6. Stretching by 10 mm (0.39 in.) or more when belt is pushed in with your finger.



Fuel System

⚠ WARNING

Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

Before servicing any part of the fuel system, stop the engine and disconnect the battery. Drain the fuel system completely. Use an approved container to collect and store the fuel. Wipe up any spillage immediately. Material used to contain spillage must be disposed of in an approved receptacle. Any fuel system service must be performed in a well-ventilated area. Inspect any completed service work for sign of fuel leakage.

Fuel Line Inspection

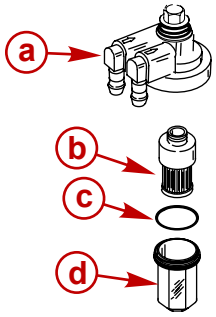
Visually inspect the fuel line and primer bulb for cracks, swelling, leaks, hardness, or other signs of deterioration or damage. If any of these conditions are found, the fuel line or primer bulb must be replaced.

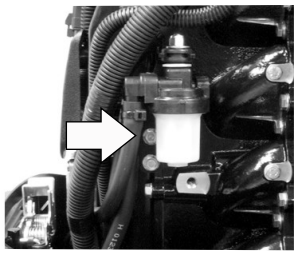
Engine Fuel Filter

Check the fuel filter for water accumulation or sediment. If water is in the fuel, remove the sight bowl and drain the water. If the filter appears to be contaminated, remove and replace.

Removal

1. Read the preceding fuel system servicing information and warning.
2. Pull out the filter assembly from the mount. Hold onto the cover to prevent it from turning and remove the sight bowl. Empty contents into an approved container.
3. Inspect the filter element. If replacement is necessary, replace the filter assembly.





a - Cover
b - Filter element
c - O-ring seal
d - Sight bowl

Installation

IMPORTANT: Visually inspect for fuel leakage from the filter by squeezing the primer bulb until firm, forcing fuel into the filter.

1. Push the filter element into the cover.
2. Place the O-ring seal into its proper position on the sight bowl and screw the sight bowl hand-tight into the cover.
3. Push the filter assembly back into the mount.

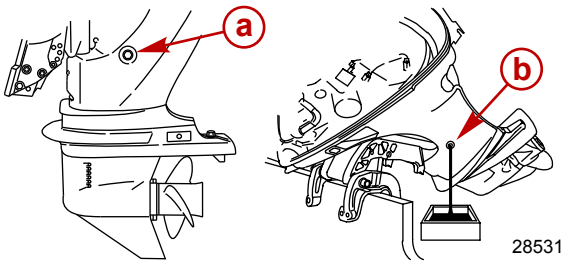
Changing Engine Oil

Engine Oil Capacity

	Capacity	Fluid Type
Engine oil	3.0 Liter (3 U.S. Quarts)	Mercury or Quicksilver SAE 25W-40 Synthetic Blend Marine 4-Stroke Engine Oil
		Mercury or Quicksilver SAE 10W-30 4-Stroke Marine Engine Oil

Oil Changing Procedure

1. Tilt the outboard up to the trailer position.
2. Turn the outboard so the drain hole is facing downward. Remove the drain plug and drain the engine oil into an appropriate container. Lubricate the seal on the drain plug with oil and reinstall.



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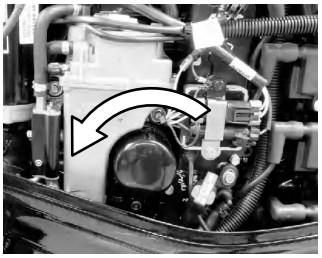
a - Drain plug
b - Drain hole

Changing Oil Filter

1. Place a rag or towel below the oil filter to absorb any spilled oil.
2. Unscrew the old filter by turning the filter to the left.
3. Clean the mounting base. Apply a film of clean oil to the filter gasket. Do not use grease. Screw the new filter on until the gasket contacts the base, then tighten 3/4 to 1 turn.



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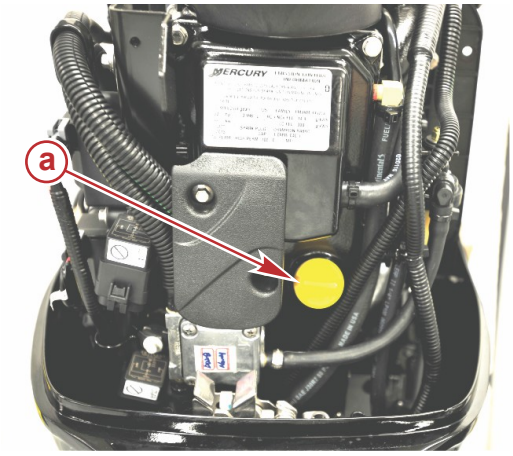
Oil Filling

1. Remove the oil fill cap and add oil to the proper operating level.
2. Idle the engine for five minutes and check for leaks. Stop the engine and check the oil level on the dipstick. Add oil if necessary.



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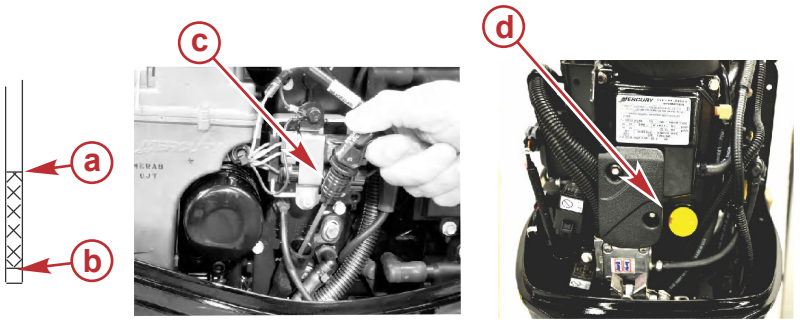
a - Oil fill cap

Checking and Adding Engine Oil

IMPORTANT: Do not overfill. Be sure that the outboard is upright (not tilted) when checking oil.

1. Turn the engine off. Have the outboard in a level operating position. Remove the top cowl.
2. Flip the handle up and pull out the dipstick. Wipe it with a clean rag or towel and push it back in all the way.
3. Pull the dipstick back out again and observe the oil level. If the oil level is low, remove the oil filler cap and fill to (but not over) the upper oil level with the recommended oil.

   IMPORTANT: Inspect oil for signs of contamination. Oil contaminated with water will have a milky color to it; oil contaminated with fuel will have a strong fuel smell. If contaminated oil is noticed, have the engine checked by your dealer.
4. Push the dipstick back in all the way, then flip the handle down to lock the dipstick in place. Install the oil filler cap and hand-tighten securely.



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a - Full mark
b - Add mark
c - Dipstick
d - Oil filler cap

Changing Gearcase Lubricant

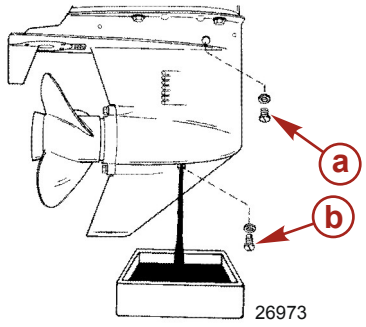
Standard Gearcase–Lubrication

When adding or changing gearcase lubricant, visually check for the presence of water in the lubricant. If water is present, it may have settled to the bottom and will drain out prior to the lubricant, or it may be mixed with the lubricant, giving it a milky colored appearance. If water is noticed, have the gearcase checked by your dealer. Water in the lubricant may result in premature bearing failure or, in freezing temperatures, will turn to ice and damage the gearcase.

Examine the drained gearcase lubricant for metal particles. A small amount of fine metal particles indicates normal gear wear. An excessive amount of metal filings or larger particles (chips) may indicate abnormal gear wear and should be checked by an authorized dealer.

Draining Gearcase

1. Place the outboard in a vertical operating position.
2. Place a drain pan below the outboard.
3. Remove the vent plug and fill/drain plug and drain the lubricant.



26973

a - Vent plug
b - Fill/drain plug

Gearcase Lubricant Capacity

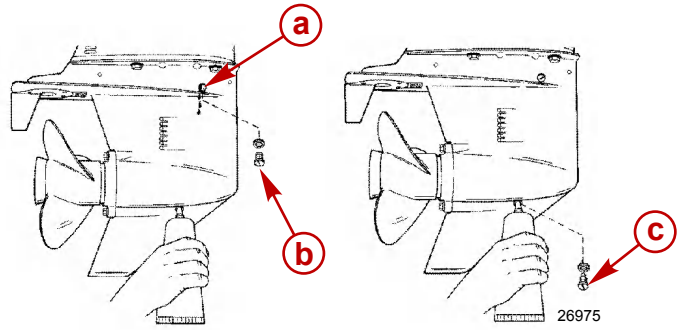
Gearcase lubricant capacity is approximately 340 ml (11.5 fl oz).

Checking Gearcase Lubricant Level and Filling Gearcase

1. Place the outboard in a vertical operating position.
2. Remove the vent plug.
3. Place the lubricant tube into the fill hole and add lubricant until it appears at the vent hole.

IMPORTANT: Replace sealing washers if damaged.

4. Stop adding lubricant. Install the vent plug and sealing washer before removing the lubricant tube.
5. Remove the lubricant tube and install a cleaned fill/drain plug and sealing washer.



a - Vent hole
b - Vent plug
c - Fill/drain plug

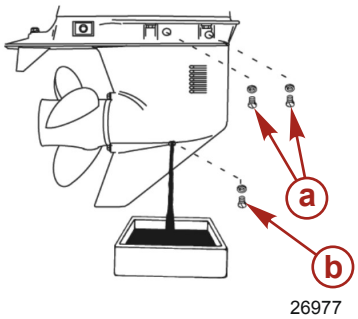
Command Thrust Gearcase–Lubrication

When adding or changing gearcase lubricant, visually check for the presence of water in the lubricant. If water is present, it may have settled to the bottom and will drain out prior to the lubricant, or it may be mixed with the lubricant, giving it a milky colored appearance. If water is noticed, have the gearcase checked by your dealer. Water in the lubricant may result in premature bearing failure or, in freezing temperatures, will turn to ice and damage the gearcase.

Examine the drained gearcase lubricant for metal particles. A small amount of fine metal particles indicates normal gear wear. An excessive amount of metal filings or larger particles (chips) may indicate abnormal gear wear and should be checked by an authorized dealer.

Draining Gearcase

1. Place the outboard in a vertical operating position.
2. Place a drain pan below the outboard.
3. Remove the vent plugs and fill/drain plug and drain the lubricant.



a - Vent plugs
b - Fill/drain plug

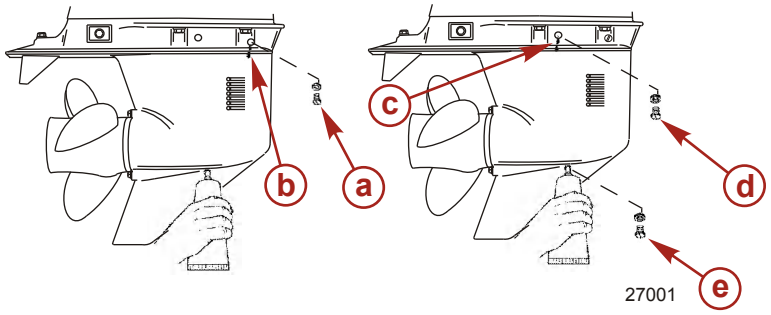
Gearcase Lubricant Capacity

Gearcase lubricant capacity is approximately 710 ml (24 fl oz).

Checking Lubricant Level and Filling Gearcase

1. Place the outboard in a vertical operating position.
2. Remove the front vent plug and rear vent plug.
3. Place the lubricant tube into the fill hole and add lubricant until it appears at the front vent hole. At this time install the front vent plug and sealing washer.
4. Continue adding lubricant until it appears at the rear vent hole.
5. Stop adding lubricant. Install the rear vent plug and sealing washer before removing the lubricant tube.

6. Remove the lubricant tube and install a cleaned fill/drain plug and sealing washer.

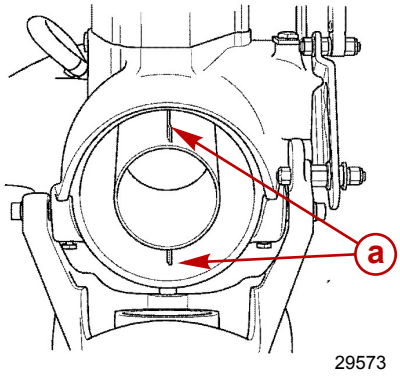


a - Front vent plug
b - Front vent hole
c - Rear vent hole
d - Rear vent plug
e - Fill/drain plug and sealing washer

Jet Maintenance

Steering Pull Adjustment

The steering on some boats will have the tendency to pull towards starboard. This pulling condition can be corrected by using a pliers and bending the ends of the exhaust fins 1.5 mm (1/16 in.) toward the starboard side of the outboard.



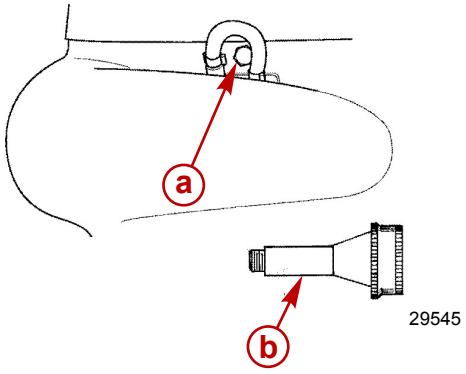
a - Exhaust fins

Flushing the Cooling System

Flush the internal water passages of the outboard with fresh water after each use in salt, polluted, or muddy water. This will help prevent a buildup of deposits from clogging the internal water passages.

Use a Mercury Precision Parts or Quicksilver accessory hose coupling.

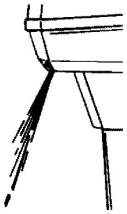
1. Remove plug and gasket.
2. Thread in hose coupling.



a - Plug and gasket
b - Hose coupling

3. Attach a water hose to the hose coupling. Slowly turn on water. Start the engine and run it at idle speed only.
   IMPORTANT: Do not run engine above idle when flushing.

4. Check for a steady stream of water flowing out of the water pump indicator hole. Continue flushing the outboard for 3 to 5 minutes, carefully monitoring water supply at all times.

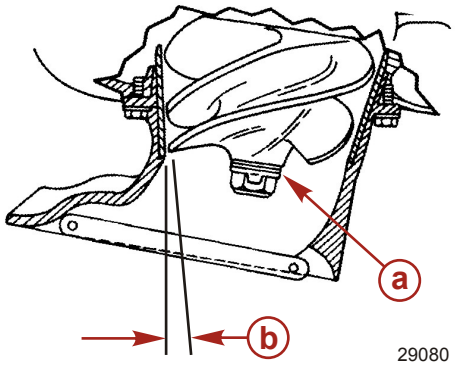

29166

5. Stop the engine, turn off the water, and remove the hose coupling. Reinstall plug and gasket.

Impeller Clearance Adjustment

The impeller should be adjusted so there is approximately 0.8 mm (0.03 in.) clearance between the impeller edge and liner. Operating the jet drive in waters that contain sand and gravel can cause wear to the impeller blades, and the clearance will start to exceed 0.8 mm (0.03 in.).

As the blades wear, shims located in the stack outside of the impeller can be transferred behind the impeller. This will move the impeller further down into the tapered liner to reduce the clearance.



29080

a - Shims
b - Clearance between impeller edge and liner

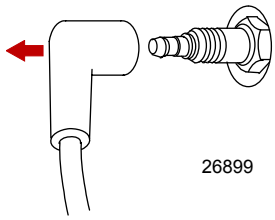
Check the impeller clearance by sliding a feeler gauge through the intake grate and measure the clearance between the impeller edge and liner. If adjustment is required, refer to **Impeller Removal and Installation.**

Impeller Removal and Installation

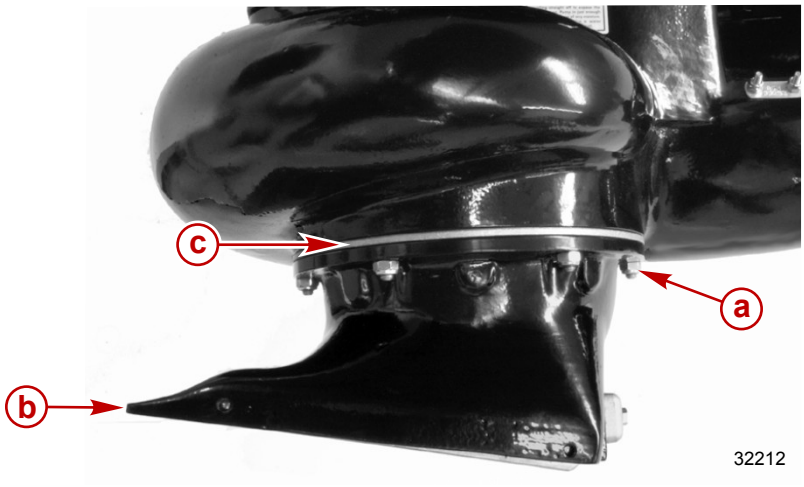
⚠ WARNING

Rotating the driveshaft may cause the engine to crank over and start. To prevent this type of accidental engine starting and possible serious injury caused from being struck by a rotating impeller, always turn the ignition key or lanyard stop switch to the "OFF" position and remove the spark plug leads from the spark plugs while servicing the impeller.

1. Shift the outboard to the neutral position.
2. Position the key switch or lanyard stop switch to the "OFF" position.
3. Remove the spark plug leads to prevent the engine from starting.

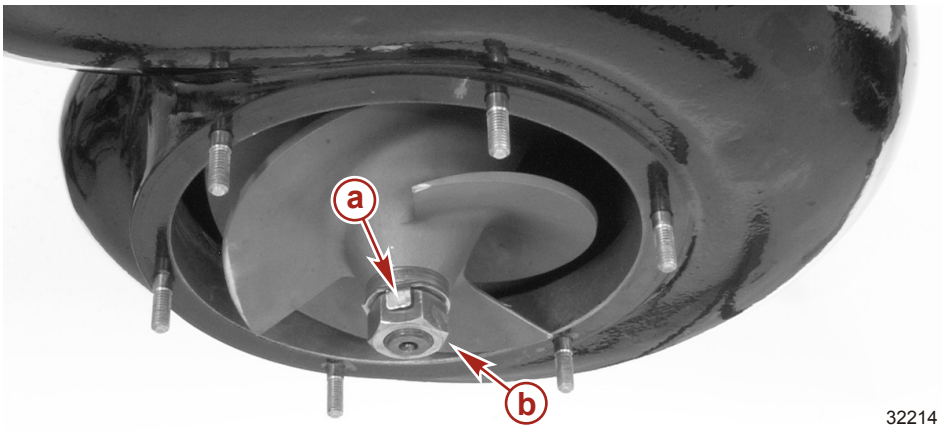

26899

4. Remove the six locknuts and washers securing the water intake housing. Remove the water intake housing and liner.



a - Locknut and washer (6)
b - Front of the water intake housing
c - Liner

5. Straighten the bent tabs on the tab washer and remove the impeller nut.



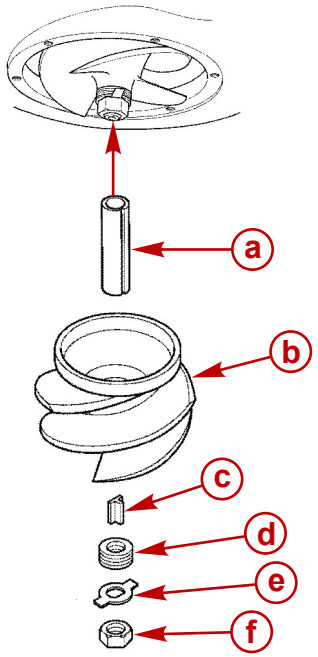
a - Tab
b - Impeller nut

6. Pull the impeller straight off the shaft. If the impeller is tight, use a hammer and a block of wood to rotate the impeller counterclockwise on the shaft until the keyway is directly above the flat on the shaft. This will free the jammed key and allow removal.

Installation

1. Lubricate the driveshaft, drive key, and impeller bore.
2. Place the plastic sleeve into the impeller bore.

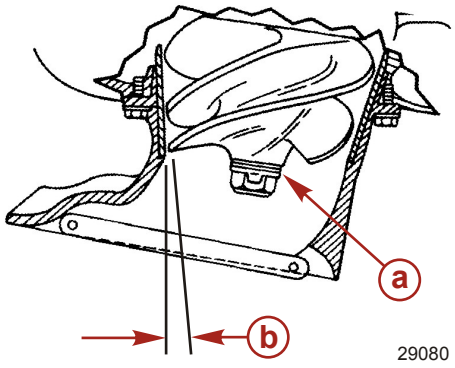
3. Install the drive key, impeller, shims, tab washer, and impeller nut.



a - Plastic sleeve
b - Impeller
c - Drive key
d - Shims
e - Tab washer
f - Impeller nut

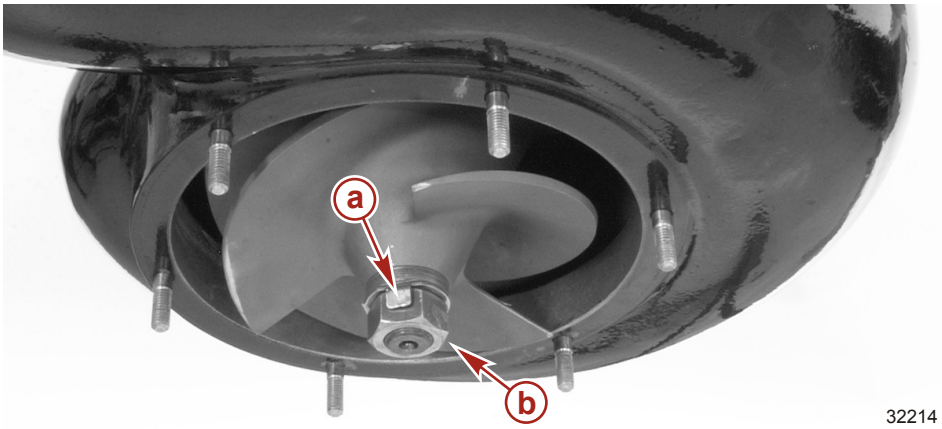
Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Driveshaft, drive key, and impeller bore	92-802859A 1

4. Turn the nut tight on the shaft to remove any play between the impeller and shaft. If the tabs on the tab washer do not line up with the flats on the nut, remove the nut and turn the tab washer over and tighten the nut again.
5. The impeller should be adjusted so there is approximately 0.8 mm (0.030 in.) clearance between the impeller edge and liner. Operating the jet drive in waters that contain sand and gravel can cause wear to the impeller blades, and the clearance will start to exceed 0.8 mm (0.030 in.). As the blades wear, shims located in the stack outside of the impeller can be transferred behind the impeller. This will move the impeller farther down into the tapered liner to reduce the clearance.
6. Check the impeller clearance by sliding a feeler gauge through the intake grate and measure the clearance between the impeller edge and liner.
7. Temporarily install the water intake housing in order to check for impeller clearance. Shim washers can be transferred to either side of the impeller to raise or lower the impeller to the correct clearance setting. The water intake housing can be shifted sideways a small amount in order to center the liner.



a - Shims
b - Impeller clearance

8. After setting the impeller height, install the tab washer and tighten the impeller nut to the specified torque. If the tabs do not align with a flat on the nut, remove the nut and tab washer. Turn the tab washer over and tighten the impeller nut to the specified torque. Secure the impeller nut by bending tabs against the flats on the impeller nut.



a - Tab
b - Impeller nut

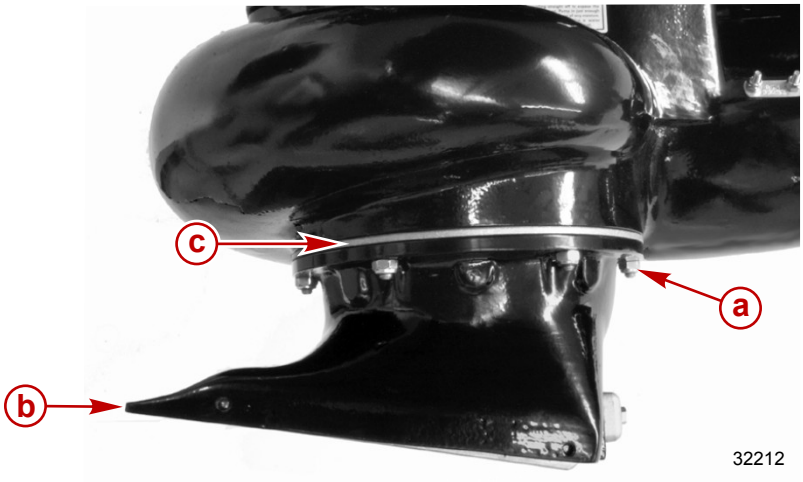
Description	Nm	lb-in.	lb-ft
Impeller nut	53		39

NOTE: *If the outboard is used in saltwater, apply Quicksilver or Mercury Precision Anti-Corrosion Grease around the entire flange surface on the water intake housing, liner, and pump housing.*

Tube Ref No.	Description	Where Used	Part No.
94	Anti-Corrosion Grease	Flange surfaces on the water intake housing, liner, and pump housing	Obtain Locally

9. Install the liner into the water intake housing.

10. Attach the water intake housing with the front of the housing facing the front of the outboard. Install a washer and locknut on each mounting stud. Torque the locknuts to specification.



a - Locknut and washer (6)
b - Front of the water intake housing
c - Liner

Description	Nm	lb-in.	lb-ft
Water intake housing mounting locknuts	16	142	

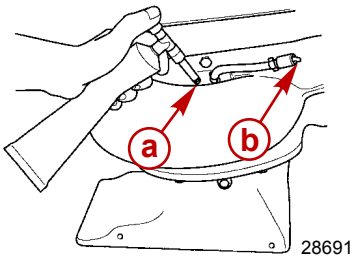
Lubrication Points

1. Lubricate the following with Quicksilver or Mercury Precision 2-4-C with PTFE.

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Driveshaft bearing	92-802859A 1

IMPORTANT: It is important not to use a general all-purpose grease for this bearing. The lubricant recommended is a water-resistant grease of the proper consistency for this application. If a substitute is used, be sure that it is water-resistant.

- Driveshaft bearing
  i. Pull vent hose off of the grease fitting.
  ii. Pump in grease through the grease fitting, using the grease gun provided, until excess grease starts to exit the vent hose.
  iii. Connect the vent hose onto the grease fitting after greasing.



a - Grease fitting
b - Vent hose

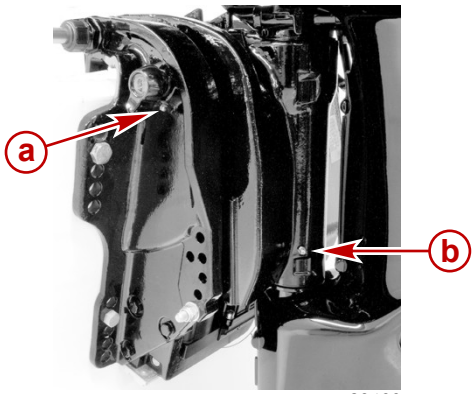
NOTE: *After 30 hours of operation, pump in extra grease to purge out any moisture. Visually inspecting the purged grease at this time will give an indication of conditions inside the bearing housing. A gradual increase in moisture content indicates seal wear. If the grease begins to turn a dark, dirty gray color, the driveshaft bearing and seals should be inspected and replaced if necessary. Some discoloration of the grease is normal during the break-in period on a new set of seals.*

2. Lubricate the following with Quicksilver or Mercury Precision Lubricant 2-4-C with PTFE.

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Tilt support lever, swivel bracket, tilt tube, copilot shaft, and steering cable grease fitting	92-802859A 1

- Tilt support lever - Lubricate through fitting.

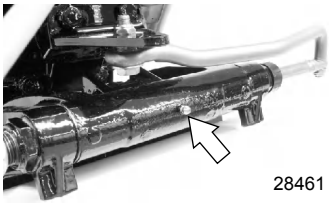
- Swivel bracket - Lubricate through fitting.



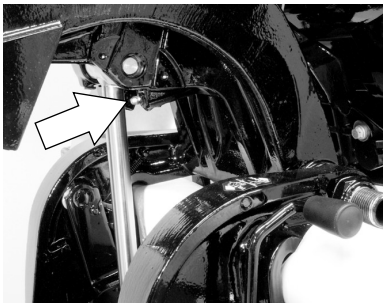
28466

a - Tilt support lever
b - Swivel bracket

- Tilt tube - Lubricate through fitting.


28461

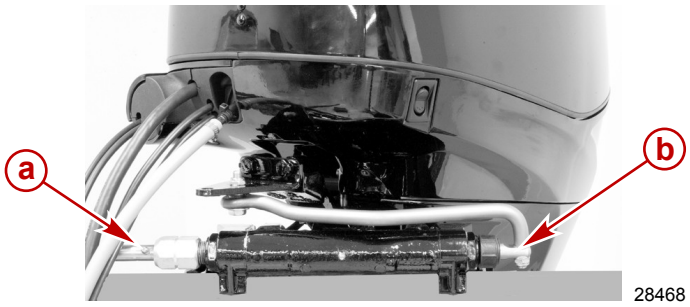
- Copilot shaft (tiller handle models) - Lubricate through fitting. Move the steering friction lever back and forth while lubricating.


28823

⚠ WARNING

Incorrect cable lubrication can cause hydraulic lock, leading to serious injury or death from loss of boat control. Completely retract the end of the steering cable before applying lubricant.

- Steering cable grease fitting (if equipped) - Rotate steering wheel to fully retract the steering cable end into the outboard tilt tube. Lubricate through fitting.

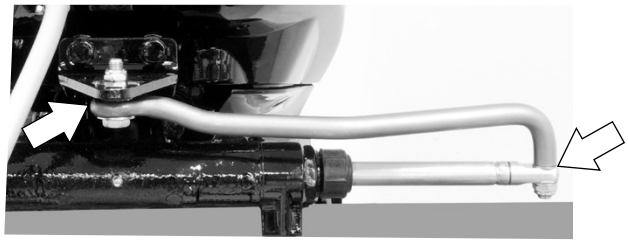


28468

a - Fitting
b - Steering cable end

3. Lubricate the following with lightweight oil.

- Steering link rod pivot points - Lubricate points.



28471

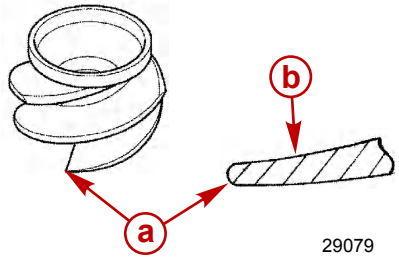
Worn/Dull Impeller

The intake of gravel through the pump can round off and wear the leading edges of the impeller. Some conditions that could be experienced from a worn/dull impeller are as follows:

- Noticeable performance loss, especially on acceleration
- Difficulty getting the boat on plane
- An increase in engine RPM at wide-open throttle

IMPORTANT: Do not sharpen or alter the top side lifting angle.

Check the impeller blades occasionally for damage. Use a flat file to sharpen the leading edges. Sharpen to a 0.8 mm (1/32 in.) radius by removing material from bottom side only.



29079

a - Leading edge
b - Top side lifting angle

Storage

Storage Preparation

The major consideration in preparing your outboard for storage is to protect it from rust, corrosion, and damage caused by freezing of trapped water.

The following storage procedures should be followed to prepare your outboard for out of season storage or prolonged storage (two months or longer).

NOTICE
Without sufficient cooling water, the engine, the water pump, and other components will overheat and suffer damage. Provide a sufficient supply of water to the water inlets during operation.

Fuel System

IMPORTANT: Gasoline containing alcohol (ethanol or methanol) can cause a formation of acid during storage and can damage the fuel system. If the gasoline being used contains alcohol, it is advisable to drain as much of the remaining gasoline as possible from the fuel tank, remote fuel line, and engine fuel system.

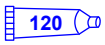
Fill the fuel tank and engine fuel system with treated (stabilized) fuel to help prevent formation of varnish and gum. Proceed with the following instructions.

- Portable fuel tank - Pour the required amount of gasoline stabilizer (follow instructions on container) into fuel tank. Tip fuel tank back and forth to mix stabilizer with the fuel.
- Permanently installed fuel tank - Pour the required amount of gasoline stabilizer (follow instructions on container) into a separate container and mix with approximately 1 liter (1 U.S. quart) of gasoline. Pour this mixture into fuel tank.
- Place the outboard in water or connect flushing attachment for circulating cooling water. Run the engine for ten minutes to fill the engine fuel system.

Flushing Device	91-44357Q 2

Protecting External Outboard Components

- Lubricate all outboard components listed in the **Inspection and Maintenance Schedule**, preceding.
- Touch-up any paint nicks.
- Spray Quicksilver or Mercury Precision Lubricants Corrosion Guard on external metal surfaces (except corrosion control anodes).

Tube Ref No.	Description	Where Used	Part No.
	Corrosion Guard	External metal surfaces (except corrosion control anodes)	92-802878 55

Protecting Internal Engine Components

- Remove the spark plugs and inject a small amount of engine oil inside of each cylinder.
- Rotate the flywheel manually several times to distribute the oil in the cylinders. Install the spark plugs.
- Change the engine oil.

Gearcase

- Drain and refill the gearcase lubricant (refer to **Gearcase Lubrication**).

Positioning Outboard for Storage

Store outboard in an upright (vertical) position to allow water to drain out of the outboard.

NOTICE

Storing the outboard in a tilted position can damage the outboard. Water trapped in the cooling passages or rain water collected in the propeller exhaust outlet in the gearcase can freeze. Store the outboard in the full down position.

Battery Storage

- Follow the battery manufacturer's instructions for storage and charging.
- Remove the battery from the boat and check water level. Charge if necessary.
- Store the battery in a cool, dry place.
- Periodically check the water level and charge the battery during storage.

Notes:

Important Information

Section 1C - General Information

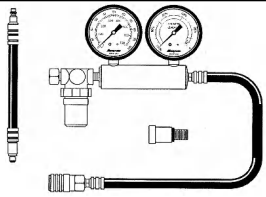
1
C

Table of Contents

Lubricant, Sealant, Adhesives

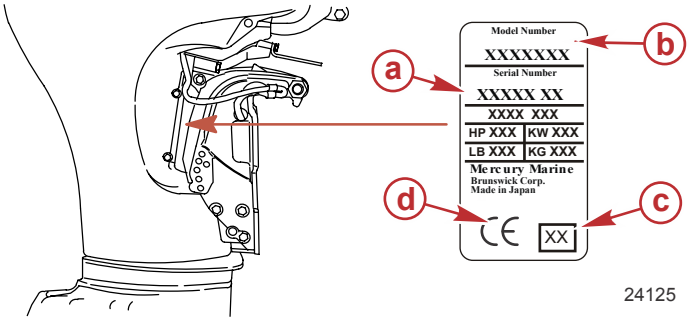
Tube Ref No.	Description	Where Used	Part No.
	Extreme Grease	Propeller shaft	8M0071842
95	2-4-C with PTFE	Propeller shaft	92-802859A 1
110	4-Stroke 10W-30 Outboard Oil	Cylinder head threads and compression gauge threads	92-8M0078625

Special Tools

Cylinder Leakage Tester	Snap-On EEPV309A
 11604	Aids in checking cylinder leakdown.

Recording Serial Number

It is important to record this number for future reference. The serial number is located on the outboard as shown.



a - Serial number
b - Model designation
c - Year manufactured
d - Certified Europe Insignia (as applicable)

Conditions Affecting Performance

Weather

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

Corporations internationally have settled on adoption of International Standards Organization (ISO) engine test standards, as set forth in ISO 3046 standardizing the computation of horsepower from data obtained on the dynamometer. All values are corrected to the power the engine will produce at sea level, at 30% relative humidity, at 25 °C (77 °F) temperature, and a barometric pressure of 29.61 inches of mercury.

Summer conditions of high temperature, low barometric pressure, and high humidity all combine to reduce the engine power. This, in turn, is reflected in decreased boat speeds as much as 3 to 5 km/h (2 to 3 MPH) in some cases. Nothing will regain this speed for the boater but cooler, dry weather.

Pointing out the consequences of weather effects, an engine running on a hot, humid day may encounter a loss of as much as 14% of the horsepower it would produce on a dry, brisk day. The horsepower that any internal combustion engine produces, depends upon the density of the air that it consumes. The density of air is dependent upon the ambient air temperature, the barometric pressure, and the humidity (water vapor) content.

Accompanying the effects of weather inspired loss of power is a second, but more subtle loss. Consider a boat rigged during cooler, less humid weather with a propeller that allowed the engine to turn within its recommended RPM range at full throttle. Higher temperatures with high humidity weather will consequently decrease the available horsepower. The propeller, in effect, is too large for the atmospheric conditions and the engine operates at less than its recommended RPM.

The engine-rated horsepower is a direct relation to the engine's RPM. An engine with too large of a propeller will have a further loss of horsepower and subsequent decrease in boat speed. This secondary loss of RPM and boat speed can be regained by switching to a smaller pitch propeller that allows the engine to run at recommended RPM.

For boaters to realize optimum engine performance under changing weather conditions, it is essential the engine has the proper propeller to allow it to operate at, or near, the top end of the recommended maximum RPM range at wide-open throttle with a normal boat load. Not only does this allow the engine to develop full power, but equally important, the engine will be operating in an RPM range that discourages damaging detonation. This enhances overall reliability and durability of the engine.

Weight Distribution (Passengers and Gear) Inside the Boat

Shifting weight to rear (stern):

- Generally increases speed and engine RPM
- Causes bow to bounce in choppy water
- Increases danger of following wave splashing into the boat when coming off plane
- At extremes, can cause the boat to porpoise

Shifting weight to front (bow):

- Improves ease of planing
- Improves rough water ride
- At extremes, can cause the boat to veer back and forth (bow steer)

Bottom of Boat

For maximum speed, a boat bottom should be nearly a flat plane where it contacts the water and particularly straight and smooth in fore and aft direction.

- **Hook:** Exists when bottom is concave in fore and aft direction when viewed from the side. When boat is planing, hook causes more lift on bottom near transom and allows bow to drop, thus greatly increasing wetted surface and reducing boat speed. Hook frequently is caused by supporting boat too far ahead of transom while hauling on a trailer or during storage.
- **Rocker:** The reverse of hook and much less common. Rocker exists if bottom is convex in fore and aft direction when viewed from the side, and boat has strong tendency to porpoise.
- **Surface roughness:** Moss, barnacles, etc., on boat or corrosion of outboard's gear housing increase skin friction and cause speed loss. Clean surfaces when necessary.

Water Absorption

It is imperative that all through-the-hull fasteners be coated with a quality marine sealer at time of installation. Water intrusion into the transom core and/or inner hull will result in additional boat weight (reduced boat performance), hull decay, and eventual structural failure.

Cavitation

Cavitation occurs when water flow cannot follow the contour of a fast-moving underwater object, such as a gear housing or a propeller. Cavitation increases propeller speed while reducing boat speed. Cavitation can seriously erode the surface of the gear housing or the propeller. Common causes of cavitation are:

- Weeds or other debris snagged on the propeller
- Bent propeller blade
- Raised burrs or sharp edges on the propeller

Detonation

Detonation in a 4-cycle engine resembles the pinging heard in an automobile engine. It can be otherwise described as a tin-like rattling or plinking sound.

Detonation is the explosion of the unburned fuel/air charge after the spark plug has fired. Detonation creates severe shock waves in the engine. These shock waves often find or create a weakness: the dome of a piston, cylinder head or gasket, piston rings or piston ring lands, piston pin, and roller bearings.

A few of the most common causes of detonation in a marine 4-cycle application are as follows:

- Over-advanced ignition timing
- Use of low octane gasoline
- Propeller pitch too high: engine RPM below recommended maximum range
- Lean fuel mixture at, or near, wide-open throttle
- Spark plugs: heat range too hot, incorrect reach, cross-firing
- Deteriorated or inadequate engine cooling system
- Combustion chamber deposits: result in higher compression ratio

Detonation usually can be prevented if:

- The engine is correctly set up

- Regular maintenance is scheduled

Following Complete Engine Submersion

Engine Submerged While Running (Special Instructions)

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

Saltwater Submersion (Special Instructions)

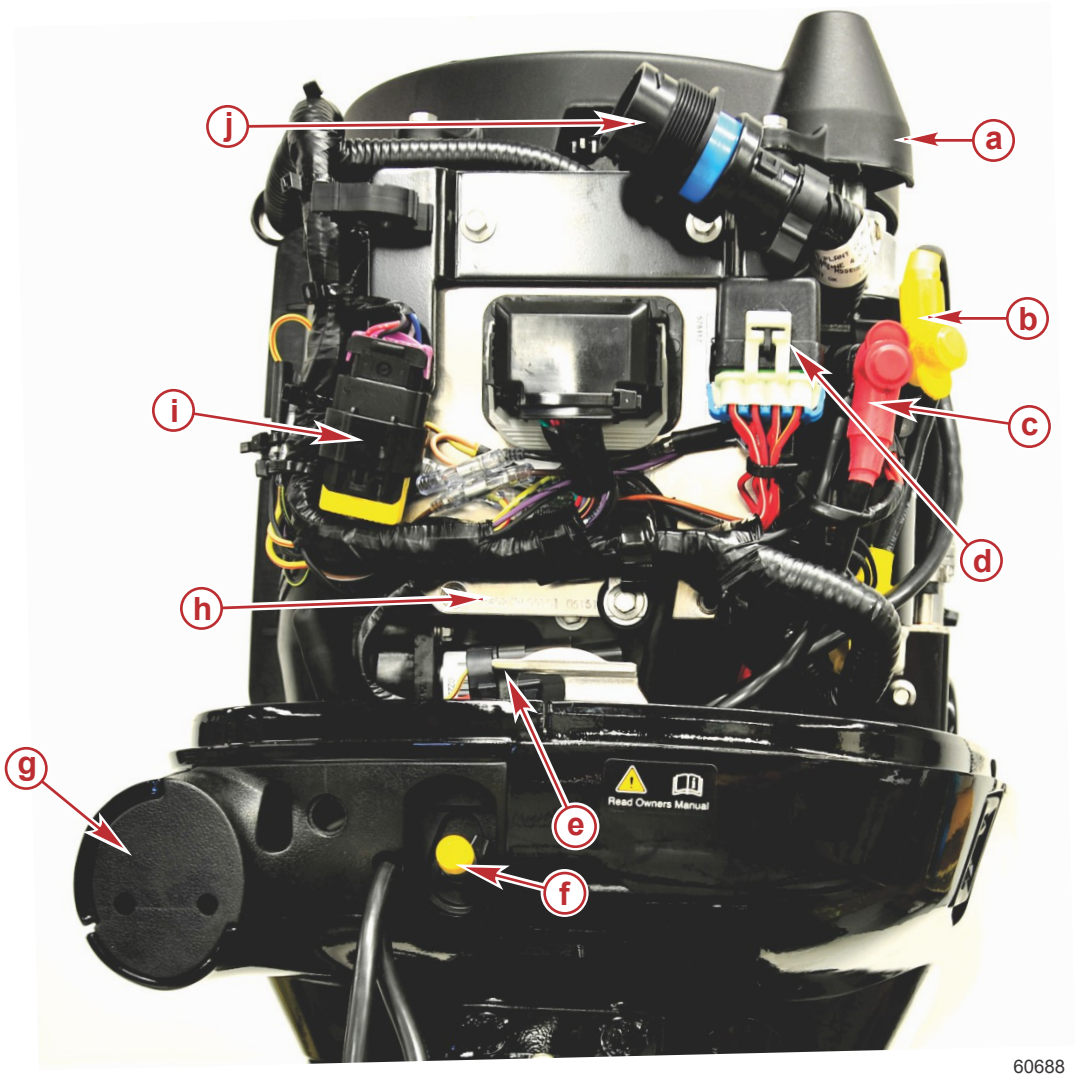
Due to the corrosive effect of saltwater on internal engine components, complete disassembly of the engine is necessary before any attempt is made to start the engine.

Freshwater Submersion (Special Instructions)

1. Recover the engine as quickly as possible.
2. Remove the cowling.
3. Flush the exterior of the outboard with fresh water to remove mud, weeds, etc. Do not attempt to start the engine if sand has entered the powerhead. Disassemble the powerhead, if necessary, to clean components.
4. Remove the spark plugs and get as much water as possible out of the powerhead. Most of the water can be eliminated with portable engines by placing the engine in a horizontal position (with spark plug holes down) and rotating the flywheel.
5. Drain the vapor separator.
6. Disassemble the engine starter motor and dry all the internal parts with compressed air. Be careful not to lose the brush springs.
7. Disassemble and clean the mechanical fuel pump.
8. Change the engine oil.
9. Pour alcohol into the spark plug openings and rotate the flywheel.
10. Turn the engine over and pour approximately one teaspoon of engine oil into each spark plug opening. Rotate the flywheel to distribute oil in the cylinders.
11. Dry all wiring and electrical components using compressed air.
12. Install the spark plugs, vapor separator, and fuel pump.
13. Attempt to start the engine, using a fresh fuel source. If the engine starts, it should be run for at least one hour to eliminate any water in the engine.
14. After running the engine, check for the presence of water in the oil. If water is present, the oil will appear milky. Drain and replace the oil as previously mentioned.
15. If the engine fails to start, determine if the cause is fuel, electrical, or mechanical. The engine should be run within two hours after recovery from the water, or serious internal damage will occur. If unable to start the engine within two hours of recovery, disassemble the engine and clean all parts. Apply oil to internal engine components as soon as possible.

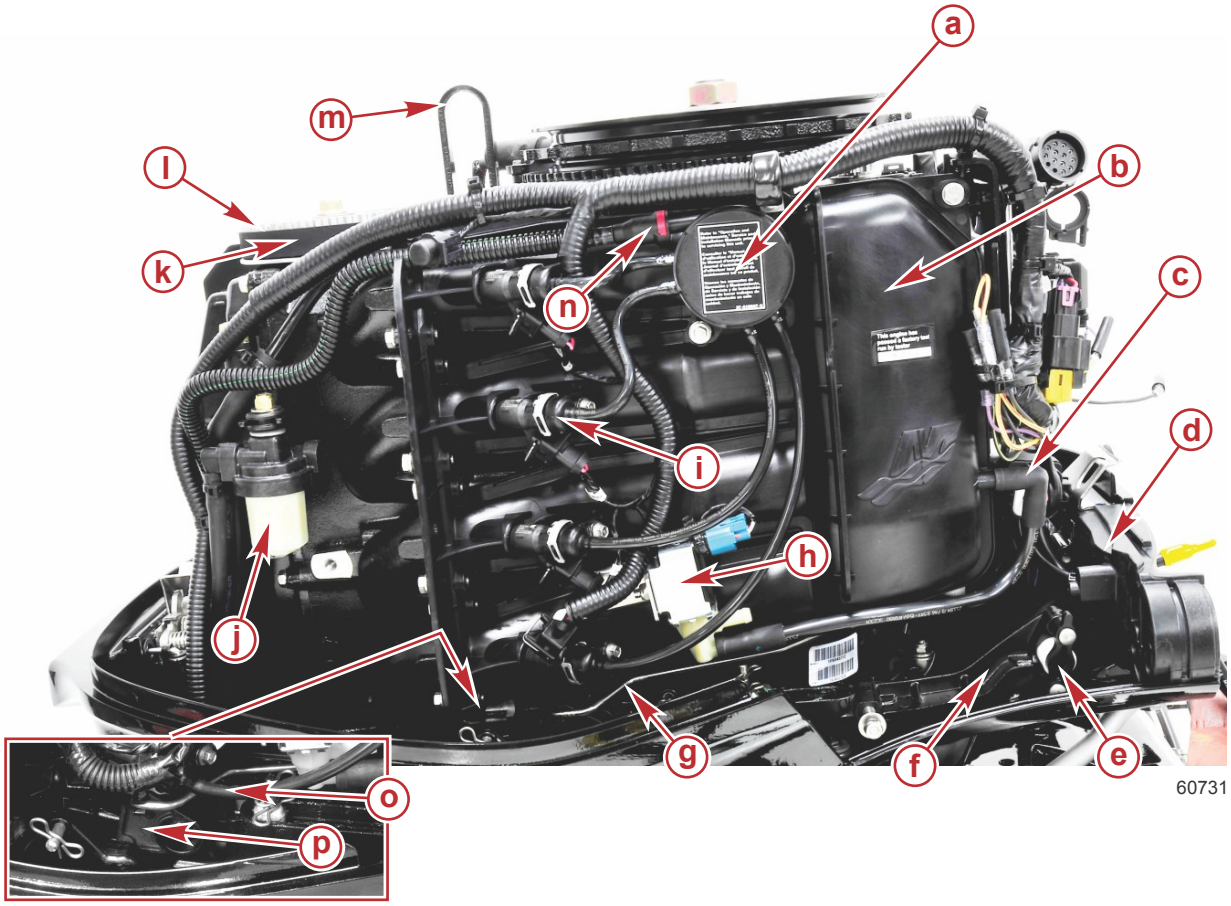
Powerhead Views

Model 40/50/60 EFI FourStroke Powerhead Front View



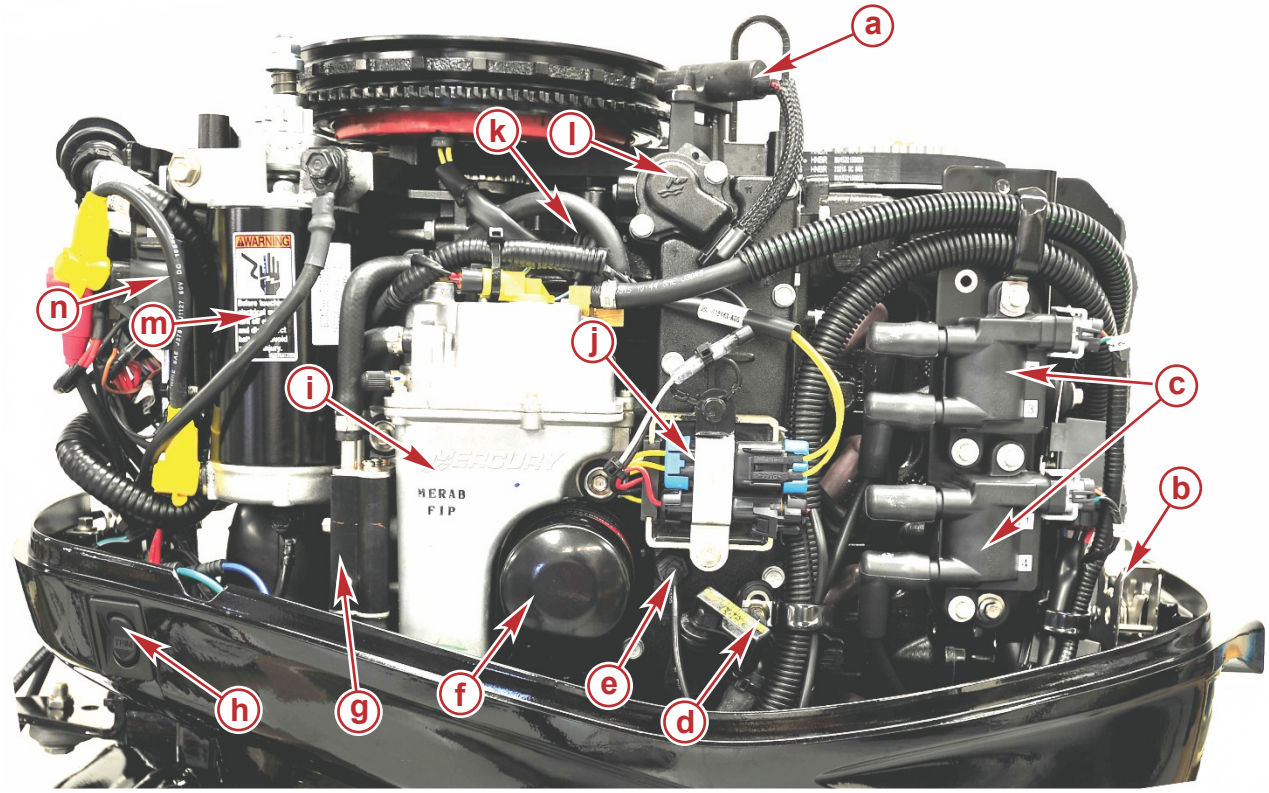
a - Flywheel cover
b - Starter lead
c - Positive (+) 12 volt battery connection
d - Fuses (2 - 25 amp, 1 - 20 amp, 1 - 15 amp)
e - Main power
f - Fuel connection
g - Rigging grommet
h - ECM
i - Diagnostic connector/SmartCraft termination resistor
j - 14-pin remote control and engine harness connection

Model 40/50/60 EFI FourStroke Powerhead Starboard View



- **a -** Fuel distribution manifold
- **b -** Intake manifold
- **c -** Throttle air bypass hose
- **d -** Rigging grommet
- **e -** Shift barrel cover
- **f -** Shift bracket
- **g -** Throttle linkage
- **h -** Idle air control (IAC)
- **i -** Fuel injectors (4)
- **j -** Fuel filter
- **k -** Timing belt
- **l -** Camshaft timing gear
- **m -** Lifting eye
- **n -** High-pressure fuel line from VST
- **o -** Cam follower
- **p -** Throttle cam

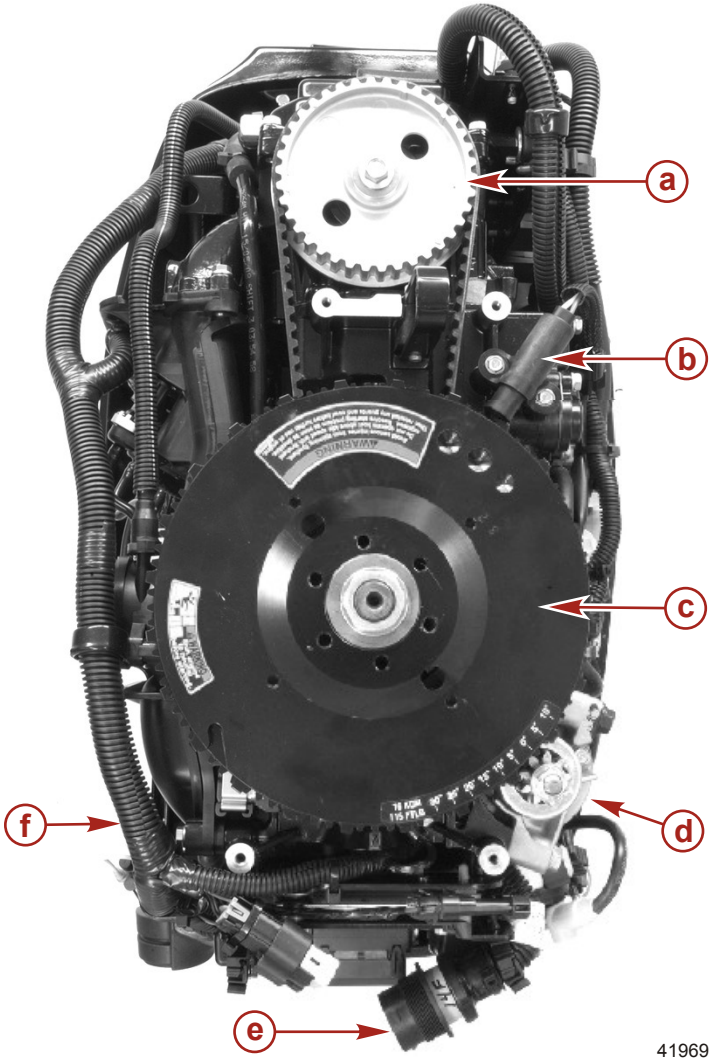
Model 40/50/60 EFI FourStroke Powerhead Port View



60693

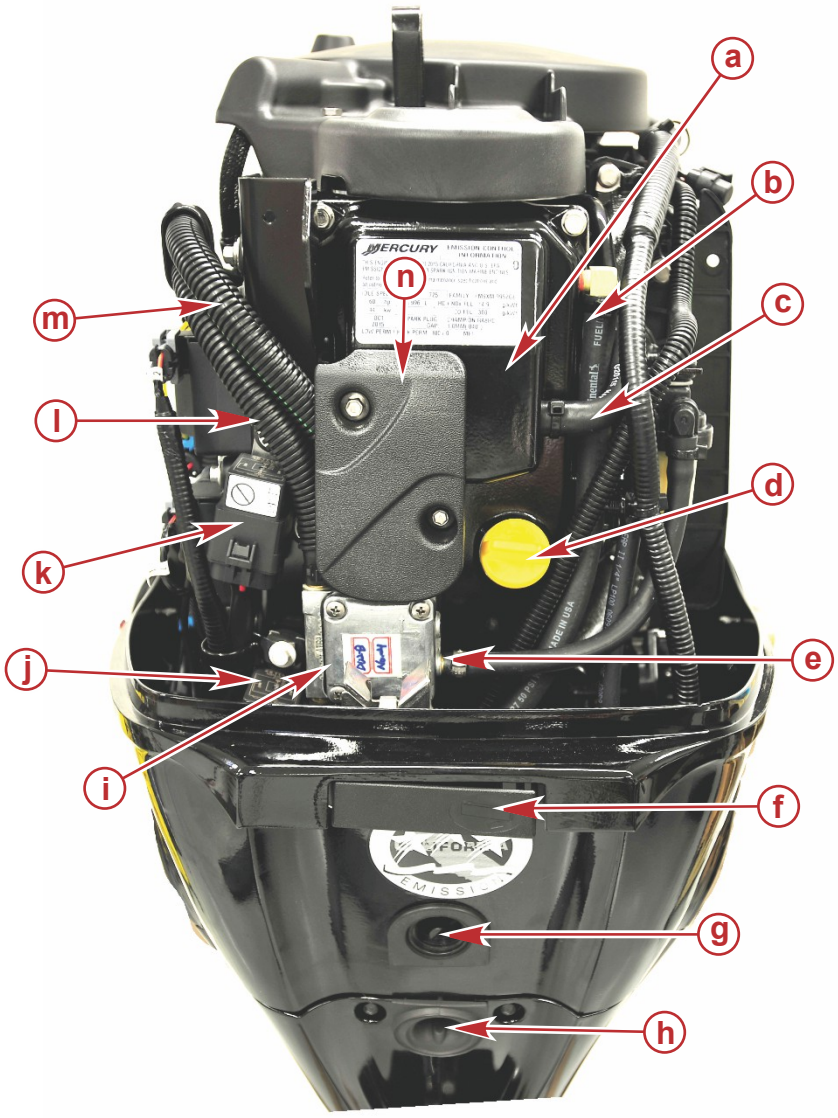
- **a -** Crankshaft position sensor
- **b -** Rear cowl latch
- **c -** Ignition coils (2)
- **d -** Engine oil dipstick
- **e -** Engine coolant temperature (ECT) sensor
- **f -** Oil filter
- **g -** Fuel cooler
- **h -** Power trim switch
- **i -** Vapor separator tank (VST)
- **j -** Voltage regulator
- **k -** Oil pressure switch
- **l -** Thermostat housing
- **m -** Starter motor
- **n -** Starter solenoid

Model 40/50/60 EFI FourStroke Powerhead Top View



- **a -** Camshaft timing gear
- **b -** Crankshaft position sensor
- **c -** Flywheel
- **d -** Starter motor
- **e -** 14 pin remote control and engine harness connector
- **f -** Engine harness

Model 40/50/60 EFI FourStroke Powerhead Aft View



- **a -** Valve cover
- **b -** Breather hose to throttle body attenuator
- **c -** Crankcase breather hose
- **d -** Oil fill plug
- **e -** Fuel pump inlet hose
- **f -** Bottom cowl latch
- **g -** Water pump indicator hole
- **h -** Idle relief port
- **i -** Fuel pump
- **j -** Trim up relay
- **k -** Trim down relay
- **l -** Water supply hose to fuel pump
- **m -** Fuel pump outlet hose
- **n -** Cowl deflector

Propeller Selection

IMPORTANT: The engines covered in this manual are equipped with an RPM rev-limiter that is set to an upper RPM limit. This limit, which is slightly above the normal operating range of the engine, helps prevent damage from excessive engine RPM. Once the RPM returns to the recommended operating RPM range, normal engine operation resumes.

The boat manufacturer and the selling dealer are responsible for equipping the power package with the correct propeller. Refer to Mercury Marine's web page **http://www.mercurymarine.com/propellers**.

Select a propeller that will allow the engine power package to operate at or near the top end of the recommended WOT operating RPM range with a normal load.

If full-throttle operation is below the recommended range, the propeller must be changed to prevent loss of performance and possible engine damage. On the other hand, operating an engine above the recommended operating RPM range will cause higher than normal wear and damage.

After initial propeller selection, the following common problems may require that the propeller be changed to a lower pitch.

- Warmer weather and greater humidity causes a loss of RPM.
- Operating in a higher elevation causes a loss of RPM.
- Operating with a dirty boat bottom causes a loss of RPM.
- Operating with increased load (additional passengers, pulling skiers) causes a loss of RPM.

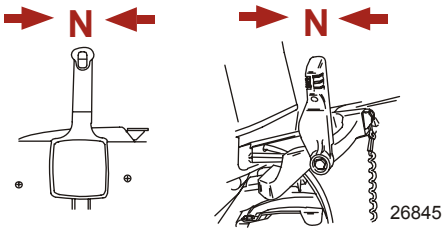
For better acceleration, such as is needed for waterskiing, use the next lower pitch propeller. When not pulling skiers, do not operate at full throttle when using the lower pitch propeller.

Propeller Replacement - 87.3 mm (3-7/16 in.) Diameter Gearcase

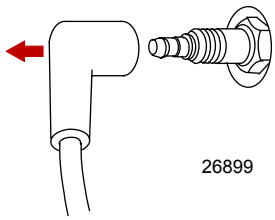
⚠ WARNING

Rotating propellers can cause serious injury or death. Never operate the boat out of the water with a propeller installed. Before installing or removing a propeller, place the drive unit in neutral and engage the lanyard stop switch to prevent the engine from starting. Place a block of wood between the propeller blade and the anti-ventilation plate.

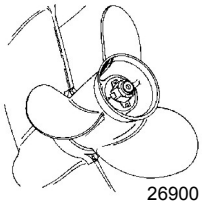
1. Shift the outboard to the neutral (N) position.



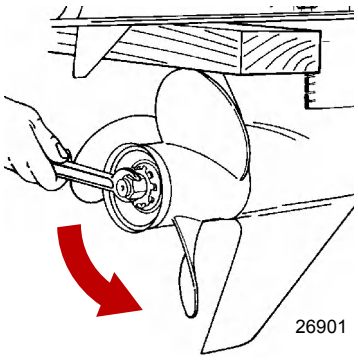
2. Remove the spark plug leads to prevent the engine from starting.



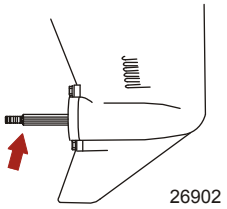
3. Straighten the bent tabs on the propeller nut retainer.



4. Place a block of wood between the gearcase and the propeller to hold the propeller and remove the propeller nut.
5. Pull the propeller straight off of the shaft. If the propeller is seized to the shaft and cannot be removed, have the propeller removed by an authorized dealer.



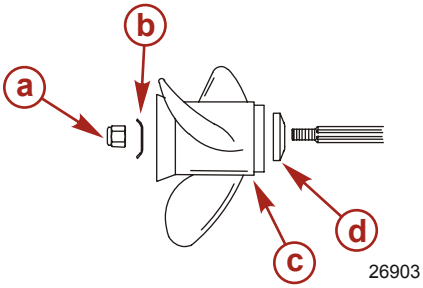
6. Coat the propeller shaft with Quicksilver or Mercury Precision Lubricants Extreme Grease or 2-4-C with PTFE.



Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Propeller shaft	92-802859A 1
	Extreme Grease	Propeller shaft	8M0071842

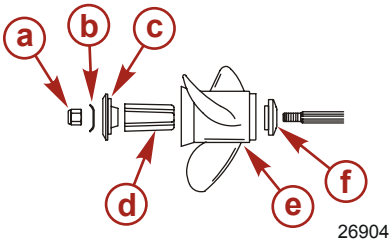
IMPORTANT: To prevent the propeller hub from corroding and seizing to the propeller shaft (especially in saltwater), always apply a coat of the recommended lubricant to the entire propeller shaft at the recommended maintenance intervals, and also each time the propeller is removed.

7. Flo-Torq I drive hub propellers - Install the forward thrust washer, propeller, propeller nut retainer, and propeller nut onto the shaft.



a - Propeller nut
b - Propeller nut retainer
c - Propeller
d - Forward thrust washer

8. Flo-Torq II drive hub propellers - Install the forward thrust washer, propeller, replaceable drive sleeve, rear thrust washer, propeller nut retainer, and propeller nut onto the shaft.

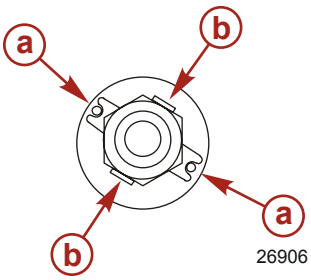


a - Propeller nut
b - Propeller nut retainer
c - Rear thrust washer
d - Replaceable drive sleeve
e - Propeller
f - Forward thrust washer

9. Place the propeller nut retainer over the pins. Place a block of wood between the gearcase and the propeller and tighten the propeller nut to the specified torque.

Description	Nm	lb-in.	lb-ft
Propeller nut	75	–	55.3

10. Align the flat sides of the propeller nut with the tabs on the propeller nut retainer. Secure the propeller nut by bending the tabs up and against the flats on the propeller nut.



a - Pins
b - Tabs

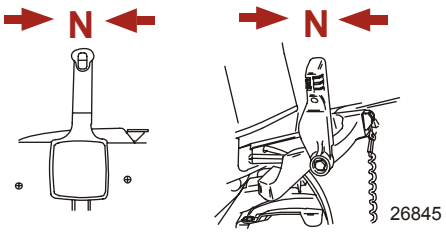
11. Install spark plug leads.

Propeller Replacement - 108 mm (4-1/4 in.) Diameter Gearcase

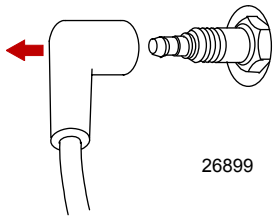
⚠ WARNING

Rotating propellers can cause serious injury or death. Never operate the boat out of the water with a propeller installed. Before installing or removing a propeller, place the drive unit in neutral and engage the lanyard stop switch to prevent the engine from starting. Place a block of wood between the propeller blade and the anti-ventilation plate.

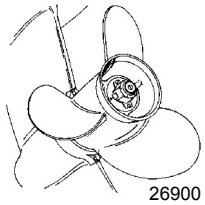
1. Shift the outboard to the neutral (N) position.



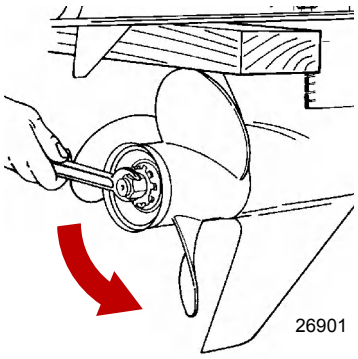
2. Remove the spark plug leads to prevent the engine from starting.



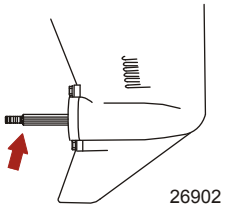
3. Straighten the bent tabs on the propeller nut retainer.



4. Place a block of wood between the gearcase and the propeller to hold the propeller and remove the propeller nut.
5. Pull the propeller straight off of the shaft. If the propeller is seized to the shaft and cannot be removed, have the propeller removed by an authorized dealer.



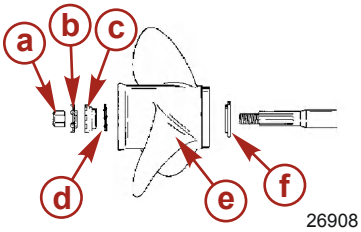
6. Coat the propeller shaft with Quicksilver or Mercury Precision Lubricants Extreme Grease or 2-4-C with PTFE.



Tube Ref No.	Description	Where Used	Part No.
	Extreme Grease	Propeller shaft	8M0071842
95	2-4-C with PTFE	Propeller shaft	92-802859A 1

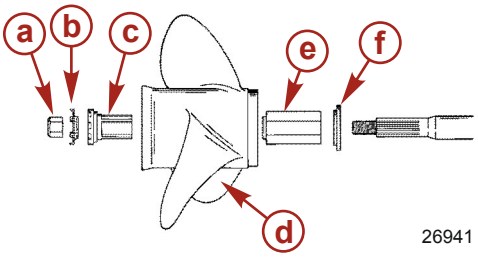
IMPORTANT: To prevent the propeller hub from corroding and seizing to the propeller shaft (especially in saltwater), always apply a coat of the recommended lubricant to the entire propeller shaft at the recommended maintenance intervals, and also each time the propeller is removed.

7. Flo-Torq I drive hub propellers - Install the thrust washer, propeller, continuity washer, thrust hub, propeller nut retainer, and propeller nut onto the shaft.



a - Propeller nut
b - Propeller nut retainer
c - Thrust hub
d - Continuity washer
e - Propeller
f - Thrust washer

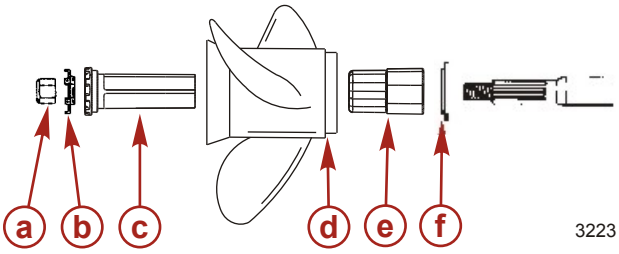
8. Flo-Torq II drive hub propellers - Install the forward thrust washer, replaceable drive sleeve, propeller, thrust hub, propeller nut retainer, and propeller nut onto the shaft.



a - Propeller nut
b - Propeller nut retainer
c - Thrust hub
d - Propeller
e - Replaceable drive sleeve
f - Forward thrust washer

NOTE: *Stainless steel applications - Installation of a Flo-Torq III drive hub propeller is recommended.*

9. Flo-Torq III drive hub propellers - Install the forward thrust washer, replaceable drive sleeve, propeller, rear thrust hub, propeller nut retainer, and propeller nut onto the shaft.

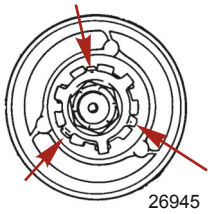


a - Propeller nut
b - Propeller nut retainer
c - Rear thrust hub
d - Propeller
e - Replaceable drive sleeve
f - Forward thrust washer

10. Place a block of wood between the gearcase and the propeller and tighten the propeller nut to the specified torque.

Description	Nm	lb-in.	lb-ft
Propeller nut	75	–	55.3

11. Secure the propeller nut by bending three of the tabs into the thrust hub grooves.



Power Trim System

General Information

The power trim system consists of an electric motor, pressurized fluid reservoir, pump, and trim cylinder.

Trim outboard through entire trim and tilt range several times to remove any air from the system.

The remote control or trim panel is equipped with a switch that is used for trimming the outboard up or down, for tilting the outboard for shallow water operation at slow speeds, or for trailering. The outboard can be trimmed up or down while engine is under power or when engine is not running.

Power Trim Operation

With most boats, operating around the middle of the trim range will give satisfactory results. However, to take full advantage of the trimming capability there may be times when you choose to trim your outboard all the way in or out. Along with an improvement in some performance aspects comes a greater responsibility for the operator, and this is being aware of some potential control hazards.

The most significant control hazard is a pull or torque that can be felt on the steering wheel or tiller handle. This steering torque results from the outboard being trimmed so the propeller shaft is not parallel to the water surface.

⚠ WARNING

Trimming the outboard beyond a neutral steering condition may result in a pull on the steering wheel or tiller handle and loss of boat control. Maintain control of the boat if trimming beyond a neutral steering condition.

Consider the following lists carefully.

1. Trimming in or down can:
   - Lower the bow.
   - Result in quicker planing off, especially with a heavy load or a stern heavy boat.
   - Generally improve the ride in choppy water.
   - Increase steering torque or pull to the right (with the normal right-hand rotation propeller.)
   - In excess, can lower the bow of some boats to a point where they begin to plow with their bow in the water while on plane. This can result in an unexpected turn in either direction (called bow steering or oversteering) if any turn is attempted, or if a significant wave is encountered.

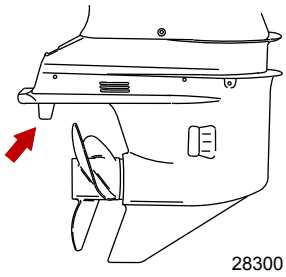
⚠ WARNING

Operating the boat at high speeds with the outboard trimmed too far under can create excessive bow steer, resulting in the operator losing control of the boat. Install the trim limit pin in a position that prevents excessive trim under and operate the boat in a safe manner.

   - In rare circumstances, the owner may decide to limit the trim in. This can be accomplished by purchasing a stainless steel tilt pin from your dealer and inserting it in whatever adjustment hole in the transom brackets is desired. The nonstainless steel shipping bolt should not be used in this application other than on a temporary basis.
2. Trimming out or up can:
   - Lift the bow higher out of the water.
   - Generally increase top speed.
   - Increase clearance over submerged objects or a shallow bottom.
   - Increase steering torque or pull to the left at a normal installation height (with the normal right-hand rotation propeller.)
   - In excess, can cause boat porpoising (bouncing) or propeller ventilation.
   - Cause engine overheating if any cooling water intake holes are above the waterline.

Trim Tab Adjustment

Propeller steering torque will cause the boat to pull in one direction. This steering torque is a normal result from the outboard not trimmed so the propeller shaft is parallel to the water surface. The trim tab can help compensate for this steering torque in many cases and can be adjusted within limits to reduce any unequal steering effort.



NOTE: *Trim tab adjustment will have little effect reducing steering torque if the outboard is installed with the anti-ventilation plate approximately 50 mm (2 inches) or more above the boat bottom.*

Operate your boat at normal cruising speed, trimmed to the desired position. Turn your boat left and right and note the direction the boat turns more easily.

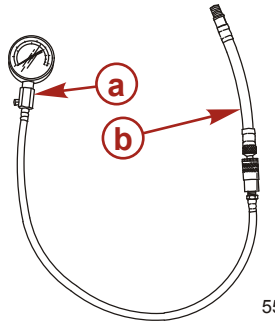
If adjustment is necessary, loosen trim tab bolt and make small adjustments at a time. If the boat turns more easily to the left, move the trailing edge of trim tab to the left. If the boat turns more easily to the right, move the trailing edge of trim tab to the right. Retighten bolt and retest.

Compression Check

NOTE: *Use Snap-on compression gauge with adapter (or equivalent) MT26J-MT26J300. Spark plug size is 14 mm.*

IMPORTANT: The compression check should be done with the throttle in the WOT position. Before removing the spark plugs, use compressed air to blow away dirt accumulated in the spark plug well.

1. Check the valve clearance (refer to **Section 4A - Valve Clearance Adjustment**), adjust if out of specification.
2. Warm up the engine.
3. Remove all spark plugs.
4. Lubricate the threads in the cylinder head and on the compression gauge. Install the compression gauge in the spark plug hole.



a - Compression gauge
b - Adapter

Tube Ref No.	Description	Where Used	Part No.
110	4-Stroke 10W-30 Outboard Oil	Cylinder head threads and compression gauge threads	92-8M0078625

5. Hold the throttle plate at wide-open throttle.
6. Crank the engine over until the compression reading peaks on the gauge. Record the reading.
7. Check and record the compression of each cylinder. The highest and lowest reading recorded should not differ by more than 15% (see example chart below). A reading below the specification might indicate a total engine wear problem.

Compression Pressure	
Minimum	950 kPa (138 psi)

Example of Compression Test Differences	
Maximum	Minimum
1240 kPa (180 psi)	1115 kPa (162 psi)
1035 kPa (150 psi)	880 kPa (127.5 psi)

8. Remove the compression gauge.
9. Install the spark plugs.

NOTE: *The compression check is important because an engine with low or uneven compression cannot be tuned successfully to give peak performance. It is essential, therefore, that improper compression be corrected before proceeding with an engine tune-up.*

Cylinder Leakage Testing

Engine Firing Order	
Cylinder sequence	1 - 3 - 4 - 2

NOTE: *Cylinder leakage testing, along with compression testing, can help the mechanic pinpoint the source of a mechanical failure by gauging the amount of leakage in an engine cylinder. Refer to the manufacturer's tester instructions for proper testing procedures.*

Cylinder Leakage Tester	Snap-On EEPV309A

1. Remove the spark plugs from cylinders 2, 3, and 4.
2. Rotate the engine clockwise until resistance is felt.
3. Continue to rotate flywheel so the timing marks on the flywheel and cylinder block are in alignment. This will be the compression stroke for cylinder #1.
4. Remove the spark plug from cylinder #1.
5. Complete the cylinder leak down test on the #1 spark plug hole. Refer to the manufacturer's tester instructions for proper testing procedures.
6. After testing cylinder #1, install a dial indicator on the next firing order sequence cylinder.
7. Rotate the flywheel so the piston is at TDC.
8. Complete the cylinder leak down test.
9. Proceed with the succeeding firing order cylinder TDC and complete the cylinder leak down test.
10. Complete the procedure in sequence on the remaining cylinders.

Analysis

Due to standard engine tolerances and engine wear, no cylinder will maintain a 0% of leakage. It is important only that cylinders have somewhat consistent reading between them. Differences of 15 to 30% indicate excessive leakage. Larger engines tend to have a larger percentage of cylinder leakage than smaller engines.

If excessive leakage is present, first check that the piston is at top dead center of its compression stroke. Leakage will naturally occur if the exhaust or intake valve is open.

To determine the cause of high percentage leaks, you must locate where the air is escaping from. Listen for air escaping through the intake, adjacent spark plug holes, exhaust pipe, and crankcase oil fill plug. Use the following table to aid in locating the source of cylinder leakage.

Air Escaping From	Possible Location
Air induction	Intake valve
Exhaust system	Exhaust valve
Oil fill plug	Piston/rings
Adjacent cylinder	Head gasket

Painting Procedures

⚠ WARNING
Continuous exposure to airborne particles such as chemical vapors, dust, or spray can cause serious injury or death. Ensure that the work area is properly ventilated and wear protective eyeware, clothing, and respirators.

Propellers

1. Sand the entire area to be painted with 3M 120 Regalite Polycut or coarse Scotch-Brite disc or belts.
2. Feather edges of all broken paint edges. Try not to sand through the primer.
3. Clean the surface to be painted using PPG Industries DX330 Wax and Grease Remover or equivalent (Xylene or M.E.K.).
4. If bare metal has been exposed, use Mercury/Quicksilver Light Gray Primer.
5. Allow a minimum of one hour dry time and no more than one week before applying the finish coat.
6. Apply the finish coat using Mercury/Quicksilver EDP Propeller Black.

Gear Housing

The following procedures should be used in refinishing gear housings. This procedure will provide the most durable paint system available in the field. The materials recommended are of high quality and approximate marine requirements. The following procedure will provide a repaint job that compares with a properly applied factory paint finish. It is recommended the listed materials be purchased from a local Ditzler Automotive Finish Supply Outlet. The minimum package quantity of each material shown following is sufficient to refinish several gear housings.

1. Wash the gear housing with a muriatic acid base cleaner to remove any type of marine growth, and rinse with water.
2. Wash the gear housing with soap and water. Rinse with clean water.
3. Sand blistered area with 3M 180 grit sandpaper or P180 Gold Film Disc to remove paint blisters only. Feather edge all broken paint edges.
4. Clean gear housing thoroughly with DX-330 Wax and Grease Remover.
5. Spot repair surfaces where bare metal is exposed with DX-503 Alodine Treatment.

   IMPORTANT: Do not use aerosol spray paints as the paint will not properly adhere to the surface, nor will the coating be sufficiently thick to resist future paint blistering.
6. Mix Epoxy Chromate Primer DP-90LF with equal part catalyst DP-402LF per the manufacturer's instructions. Allow proper induction period for permeation of the epoxy primer and catalyst.
7. Allow a minimum of one hour drying time and no more than one week before the top coat application.
8. Use Ditzler Urethane DU9300 for Mercury Black, DU34334 for Mariner Grey, DU35466 for Force Charcoal, DU33414M for Sea Ray White, and DFHS 37372H for Verado Silver. Catalyze all five colors with Ditzler DU5 catalyst mixed 1:1 ratio. Reduce with solvents per Ditzler label.

⚠ WARNING

Continuous exposure to airborne particles such as chemical vapors, dust, or spray can cause serious injury or death. Ensure that the work area is properly ventilated and wear protective eyeware, clothing, and respirators.

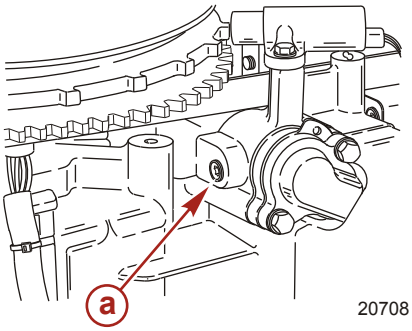
NOTE: *Apply one half to one mil even film thickness with a spray gun. Allow the paint to flash off for five minutes before applying the second even coat of one half to one mil film thickness. Urethane paint will dry to the touch in a matter of hours, but will remain sensitive to scratches and abrasions for a few days.*

9. The type of spray gun used will determine the proper reduction ratio of the paint.

   IMPORTANT: Do not paint the sacrificial anode.
10. Cut out a cardboard plug for trim tab pocket to keep paint off of mating surface to maintain good continuity circuitry between trim tab and gear housing.

Water Pressure Measurement

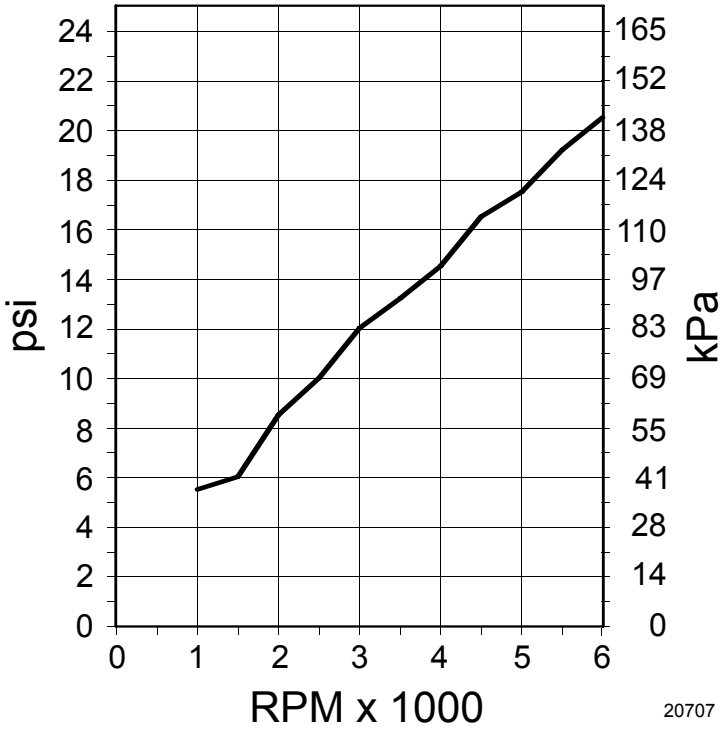
1. Warm the engine to operating temperature.
2. Shut the engine off and remove the water pressure access plug.
3. Attach the hose fitting and water pressure gauge to the access port.



a - Water pressure access plug

NOTE: *The water pressure should be measured on a warm engine with the thermostat operating at 60 °C (140 °F).*

4. Run the engine and record water pump pressure versus engine RPM.



Water pump pressure vs. engine RPM

Decal Removal

1. Mark decal location before removal to assure proper alignment of new decal.
2. Carefully soften decal and decal adhesive with a heat gun or heat blower while removing old decal.
3. Clean decal contact area with a 1:1 mixture of isopropyl alcohol and water.
4. Thoroughly dry decal contact area and check for a completely cleaned surface.

Decal Application

1. Mix 16 ml (1/2 oz) of dishwashing liquid in 4 liter (1 US gal) of cool water to use as a wetting solution.

   NOTE: *Leave protective masking on the face of the decal until final steps of decal installation. This will ensure the vinyl decal keeps its shape during installation.*
2. Place the decal face down on a clean work surface and remove the paper backing from adhesive side of decal.
3. Using a spray bottle, flood the entire adhesive side of the decal with the premixed wetting solution.
4. Flood area where the decal will be positioned with wetting solution.
5. Position prewetted decal on wetted surface and slide into position.
6. Starting at the center of the decal, lightly squeegee out the air bubbles and wetting solution with overlapping strokes to the outer edge of the decal. Continue going over the decal surface until all wrinkles are gone and adhesive bonds to the cowl surface.
7. Wipe decal surface with a soft paper towel or cloth.
8. Wait 10–15 minutes.
9. Starting at one corner, carefully and slowly pull the masking off the decal surface at a 180° angle.

NOTE: *To remove any remaining bubbles, pierce the decal at one end of the bubble with a stick pin and press out the entrapped air or wetting solution with your thumb, moving toward the puncture.*

Shipping of Hazardous Material (HazMat) and Engine/Components Containing Hazardous Material

Outboard Service Bulletin 2008-07

There are a number of United States regulations regarding the shipment of hazardous material. These regulations apply not only to shipments within the United States, but to import and export shipments as well. It is important to comply with all of these regulations. This bulletin is intended to provide you with some basic information about some of these regulations, and provide you with information about resources from which you can obtain additional information. It is also intended to draw your attention to the importance of proper packaging, labeling, and shipping of hazardous material; as well as any engine or engine component that contains hazardous material like gasoline or other fluids such as crankcase oil, gearcase oil, and hydraulic fluid. There are also requirements for training personnel that deal with the shipment of hazardous material. This bulletin is intended to draw your attention to some of the shipping regulations that we are aware of that might apply to your business, it is not a complete review of all of the laws and regulations that apply to the shipment of hazardous materials. Please do not treat it as such.

NOTE: *You, as the shipper of record, are responsible for classification, packaging, hazard communication, incident reporting, handling, and transportation of hazardous materials.*

Overview of Regulations

The Hazardous Materials Regulations (HMR) specify requirements for the safe transportation of hazardous materials in commerce by rail car, aircraft, vessel, and motor vehicle. These comprehensive regulations govern transportation-related activities. In general, the HMR prescribe requirements for classification, packaging, hazard communication, incident reporting, handling, and transportation of hazardous materials. The HMR are enforced by Pipeline Hazardous Material Safety Administration (PHMSA), Department of Transportation (DOT), Federal Aviation Administration (FAA), Federal Highway Administration (FHWA), Federal Railroad Administration (FRA), and the United States Coast Guard (USCG).

Overview of Training Requirements

Current U.S. Department of Transportation (DOT) regulations require initial training (and recurrent training) of all employees who perform work functions covered by the Hazardous Materials Regulations. Any employee who works in a shipping, receiving, or material handling area; or who may be involved in preparing or transporting hazardous materials, is required to have training. Hazardous materials transportation training is available from ShipMate, Inc. The training modules on CD-ROM or online contain an interactive training program which satisfies the DOT requirement for general awareness, general safety, and HazMat security training. A comprehensive exam is offered and Certificates of Completion are generated upon successful completion of the program. The CD-ROM and online Web-Based Training may be purchased from ShipMate, Inc. This also includes an electronic version of the 49 CFR Hazardous Materials Regulations, the current Emergency Response Guidebook, and full access to ShipMate's technical staff to assist you in properly preparing hazardous materials for transport. ShipMate, Inc. may be reached at 1-310-370-3600 or on the web at http://www.shipmate.com.

NOTE: *The DOT training program does* ***NOT*** *include a test of any type and contains a lot of material which is not relevant (e.g. cargo tanks). In addition, you would have to purchase the 49 CFR and the Emergency Response Guidebook separately. Further, the DOT program provides no support – technical or otherwise. For further information, view the DOT website at http://www.dot.gov.*

Shipping of Complete Engines and Major Assemblies

Complete engines cannot be transported without going through additional preparation first. Electronic fuel injection (EFI) and direct fuel injection (DFI) engines must have the fuel system drained of fuel, not run dry because of possible damage to electric fuel pumps. Carbureted engines must be completely run dry and have stalled due to lack of fuel. All engines must have any remaining fluids/oils drained (including engine and gearcase oil) and hydraulic fluids (including power trim fluid) and disconnected fluid pipes that previously contained fluid must be sealed with leakproof caps that are positively retained. Major assemblies such as gearcases, dressed powerheads, or other components containing any fluids must be also drained prior to shipping.

More Information on Hazardous Material

More information on hazardous material, regulations, packaging, training, etc. can be found by going to the ShipMate website: http://www.shipmate.com or by calling:

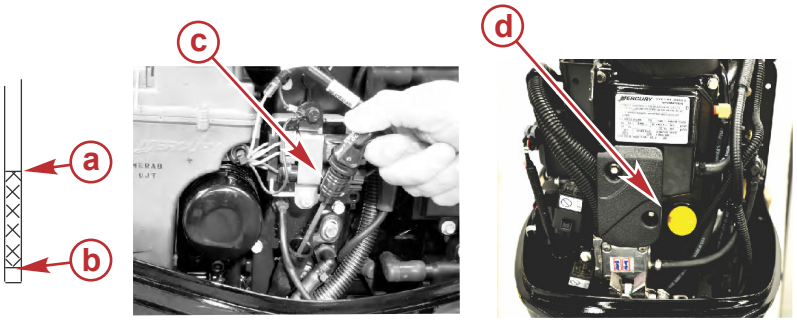
ShipMate Inc.	
Telephone	+ 1 (310) 370-3600
Fax	+ 1 (310) 370-5700
E-mail	shipmate@shipmate.com

Checking and Adding Engine Oil

IMPORTANT: Do not overfill. Be sure that the outboard is upright (not tilted) when checking oil.

1. Turn the engine off. Have the outboard in a level operating position. Remove the top cowl.
2. Flip the handle up and pull out the dipstick. Wipe it with a clean rag or towel and push it back in all the way.
3. Pull the dipstick back out again and observe the oil level. If the oil level is low, remove the oil filler cap and fill to (but not over) the upper oil level with the recommended oil.

   IMPORTANT: Inspect oil for signs of contamination. Oil contaminated with water will have a milky color to it; oil contaminated with fuel will have a strong fuel smell. If contaminated oil is noticed, have the engine checked by your dealer.
4. Push the dipstick back in all the way, then flip the handle down to lock the dipstick in place. Install the oil filler cap and hand-tighten securely.



60679

a - Full mark
b - Add mark
c - Dipstick
d - Oil filler cap

Important Information

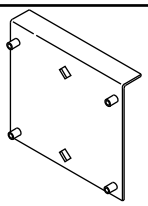
Section 1D - Outboard Motor Installation

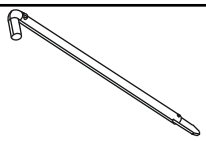
Table of Contents

Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	The entire cable end	92-802859A 1

Special Tools

Transom Drilling Fixture	91- 98234A 2
 5489	Aids in engine installation by acting as a template for engine mounting holes.

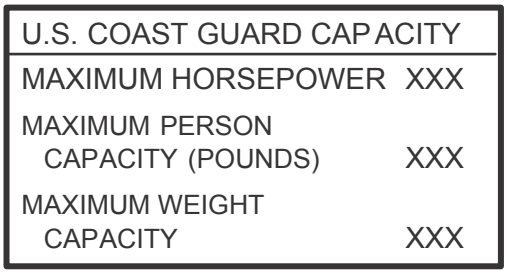
Stainless Steel Tilt Pin	17- 49930A 1
 2749	Limits the down trim angle of the power trim equipped engines, or aids in determining the trim out angle on non-power trim engines.

Boat Horsepower Capacity

⚠ WARNING

Exceeding the boat's maximum horsepower rating can cause serious injury or death. Overpowering the boat can affect boat control and flotation characteristics or break the transom. Do not install an engine that exceeds the boat's maximum power rating.

Do not overpower or overload your boat. Most boats will carry a required capacity plate indicating the maximum acceptable power and load as determined by the manufacturer following certain federal guidelines. If in doubt, contact your dealer or the boat manufacturer.



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Start in Gear Protection

⚠ WARNING

Starting the engine with the drive in gear can cause serious injury or death. Never operate a boat that does not have a neutral-safety-protection device.

The remote control connected to the outboard must be equipped with a start in neutral only protection device. This prevents the engine from starting in gear.

Selecting Accessories for Your Outboard

Genuine Mercury Precision or Quicksilver Accessories have been specifically designed and tested for your outboard. These accessories are available from Mercury Marine dealers.

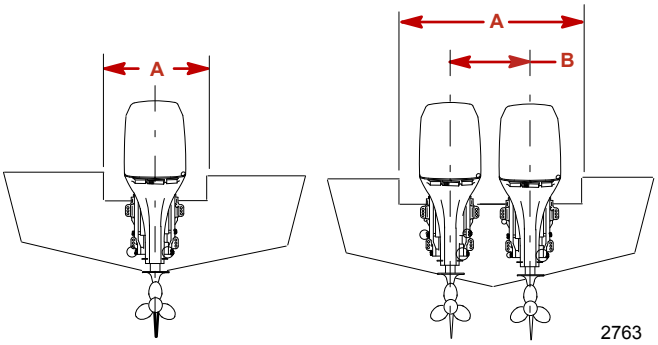
IMPORTANT: Check with your dealer before installing accessories. The misuse of approved accessories or the use of nonapproved accessories can damage the product.

Some accessories not manufactured or sold by Mercury Marine are not designed to be safely used with your outboard or outboard operating system. Acquire and read the installation, operation and maintenance manuals for all your selected accessories.

Electric Fuel Pump

If an electric fuel pump is used, the fuel pressure must not exceed 27.58 kPa (4 psi) at the engine. If necessary, install a pressure regulator to regulate the pressure.

Installation Specifications



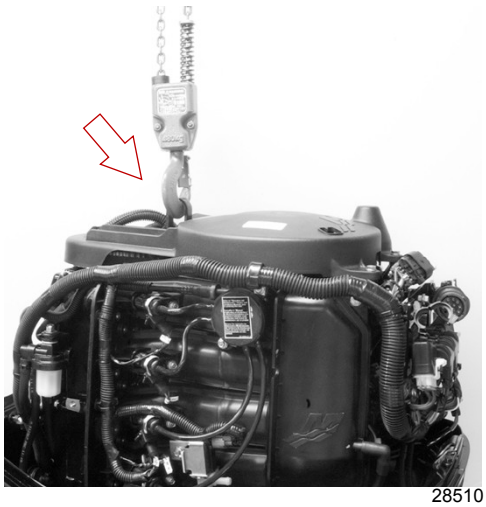
a - Minimum transom opening
b - Engine centerline for dual engines

Minimum Transom Opening	
Single engine (remote)	48.3 cm (19 in.)
Single engine (tiller)	76.2 cm (30 in.)
Dual engines	101.6 cm (40 in.)

Engine Centerline	
Minimum	66 cm (26 in.)

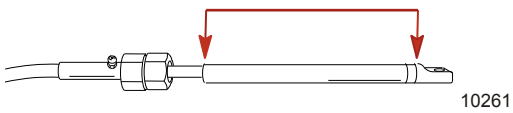
Lifting Outboard

Use the lifting eye on the engine.



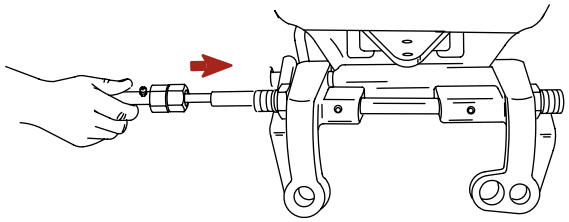
Steering Cable - Starboard Side Routed Cable

1. Lubricate the entire cable end.



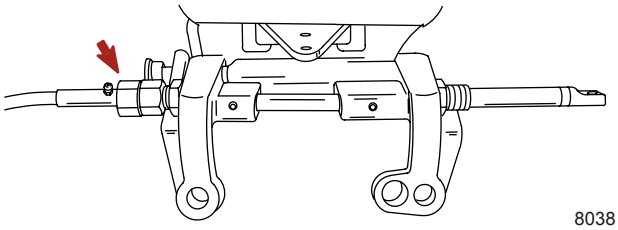
Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	The entire cable end	92-802859A 1

2. Insert steering cable into tilt tube.



8037

3. Torque nut to specification.

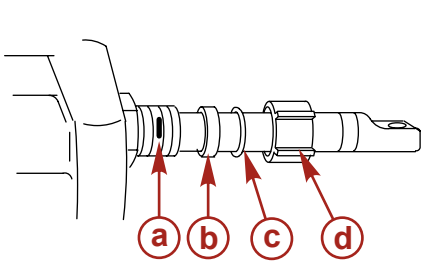


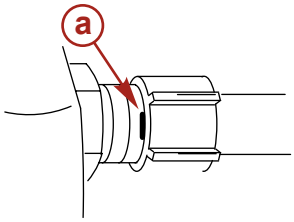
8038

Description	Nm	lb-in.	lb-ft
Nut	47.5		35

Steering Cable Seal

1. Mark tilt tube 6.4 mm (0.25 in.) from end. Install seal components.
2. Thread cap to the mark.





a - 6.4 mm (1/4 in.)
b - Plastic spacer
c - O-ring seal
d - Cap

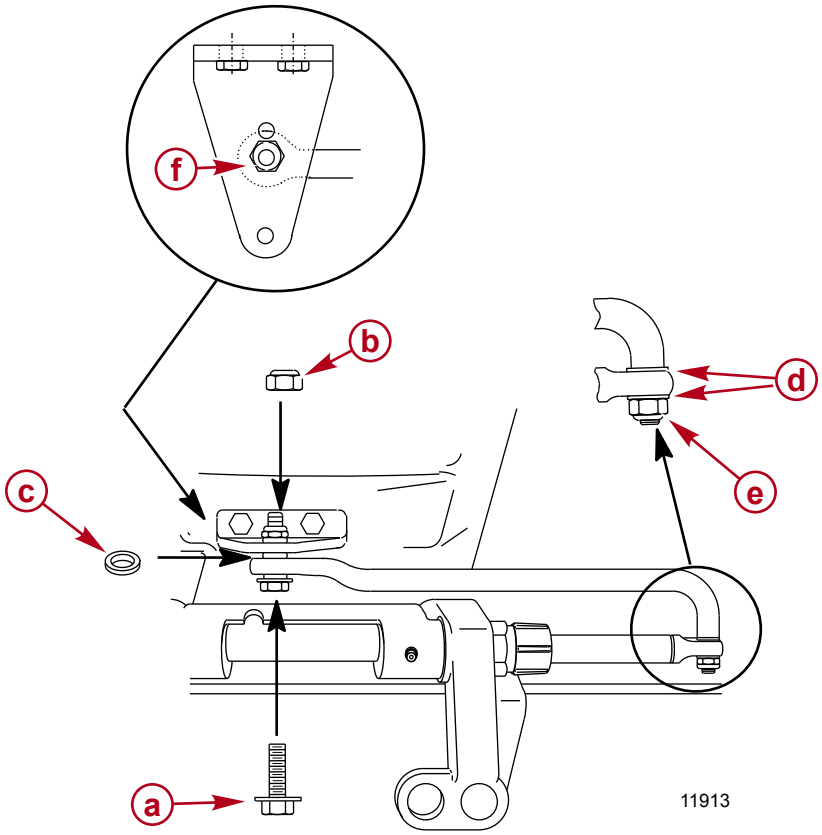
8041

Steering Link Rod Fasteners

IMPORTANT: The steering link rod that connects the steering cable to the engine must be fastened using special washer head bolt ("a" - Part Number 10-856680) and self-locking nylon insert locknuts ("b" and "e" - Part Number 11-826709113). These locknuts must never be replaced with common nuts (nonlocking) as they will work loose and vibrate off, freeing the link rod to disengage.

⚠ WARNING

Improper fasteners or improper installation procedures can result in loosening or disengagement of the steering link rod. This can cause a sudden, unexpected loss of boat control, resulting in serious injury or death due to occupants being thrown within or out of the boat. Always use required components and follow instructions and torque procedures.



- **a -** Special washer head bolt (10-856680)
- **b -** Nylon insert locknut (11-826709113)
- **c -** Spacer (12-71970)
- **d -** Flat washer (2)
- **e -** Nylon insert locknut (11-826709113)
- **f -** Use middle hole - steer outboard to the side to gain hole access

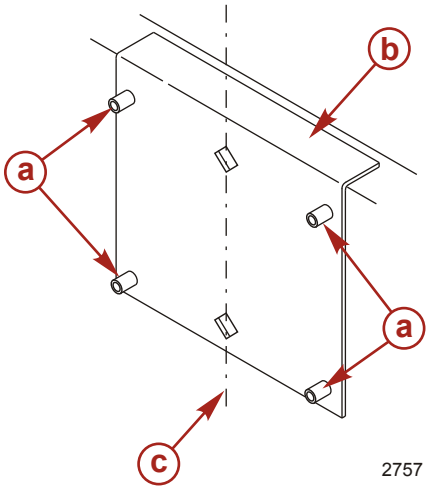
Description	Nm	lb-in.	lb-ft
Special washer head bolt	27		20
Nylon insert locknut "b"	27		20
Nylon insert locknut "e"	Tighten until it seats, then back off 1/4 turn		

Assemble steering link rod to steering cable with two flat washers and nylon insert locknut. Tighten locknut until it seats, then back nut off 1/4 turn.

Assemble steering link rod to engine with special washer head bolt, locknut, and spacer. First torque bolt, then torque locknut to specifications.

Installing Outboard - Non Thumb Screw Models

1. Mark four mounting holes on the transom using the transom drilling fixture.

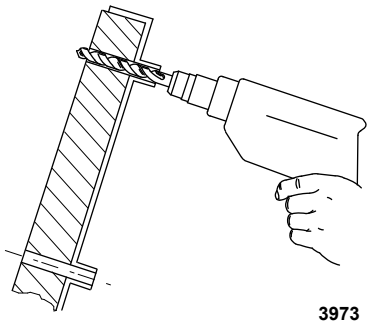


2757

a - Drill guide holes
b - Transom drilling fixture
c - Transom centerline

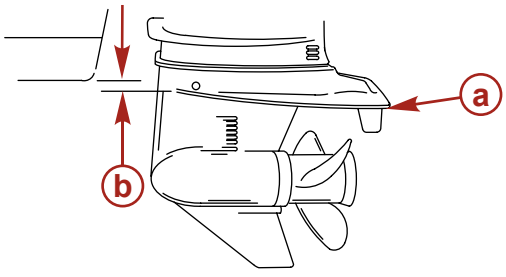
Transom Drilling Fixture	91- 98234A 2

2. Drill four 13.5 mm (17/32 in.) mounting holes.



3973

3. Install the outboard so the anti-ventilation plate is in line or within 25 mm (1 in.) below the bottom of the boat.

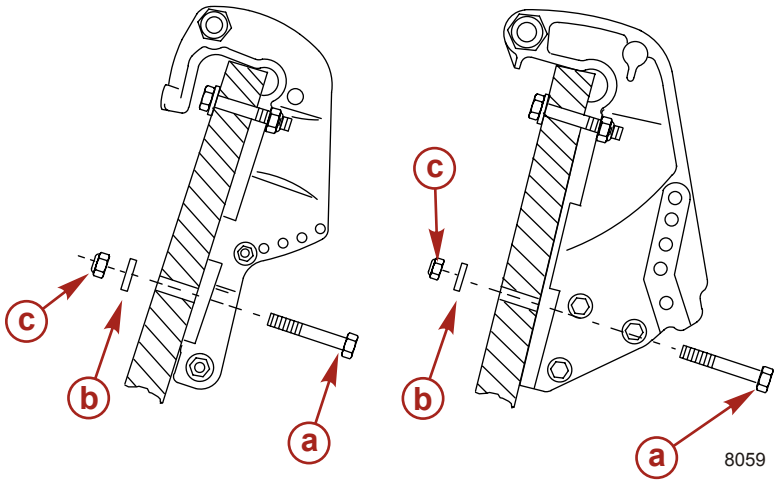


8045

a - Anti-ventilation plate
b - 25 mm (1 in.)

4. Apply marine sealer to the shanks of bolts, not the threads.

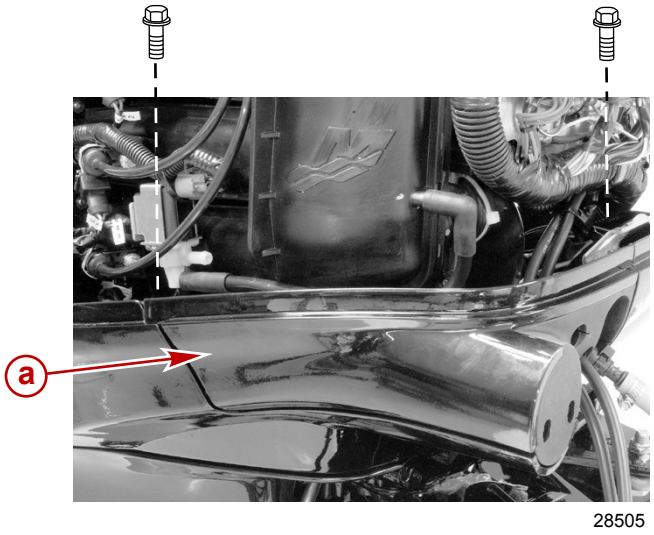
5. Fasten the outboard with provided mounting hardware.



a - 1/2 in. diameter bolt (4)
b - Flat washer (4)
c - Locknut (4)

Remote Wiring Harness

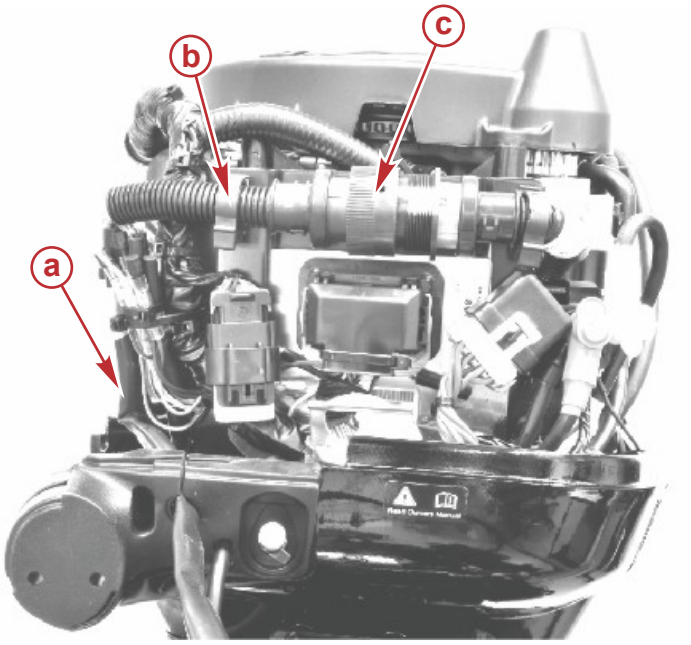
Remove the access cover.



a - Access cover

Route the remote wiring harness through the rubber grommet.

Connect the 14-pin connector to the engine harness and fasten the harness with the retainer.



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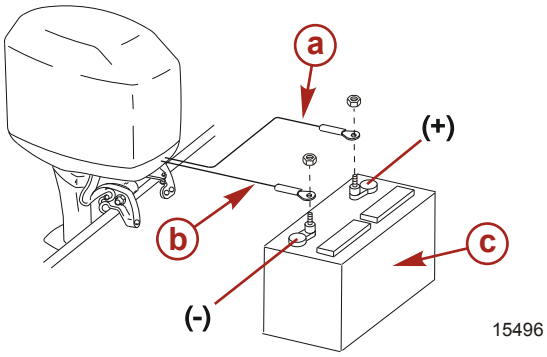
a - Remote wiring harness
b - Retainer
c - 14-pin connector

Battery Cable Connections

Single Outboard

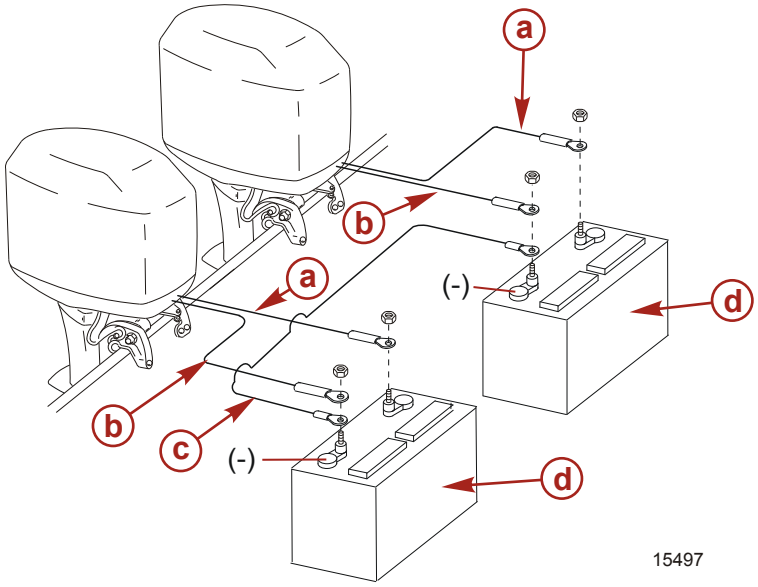


15496

a - Red sleeve - Positive (+)
b - Black sleeve - Negative (–)
c - Cranking battery

Dual Outboards

Connect a common ground cable (wire size same as engine battery cables) between negative (–) terminals on starting batteries.



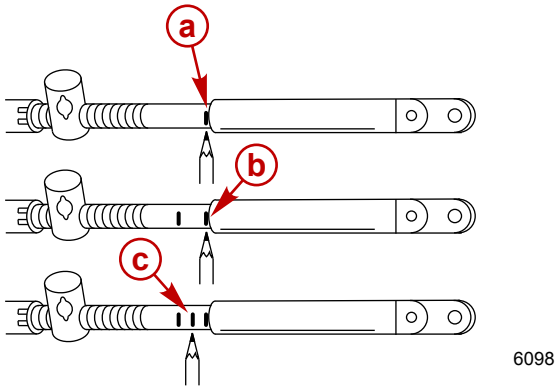
- **a -** Red sleeve - Positive (+)
- **b -** Black sleeve - Negative (–)
- **c -** Ground cable
- **d -** Cranking battery

Shift and Throttle Cable Installation

Shift Cable Installation

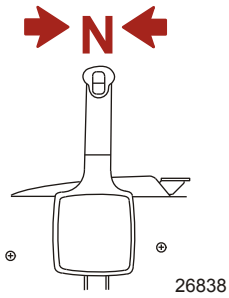
Install the cables into the remote control following the instructions provided with the remote control.

1. Locate the center point of the slack or lost motion that exists in the shift cable as follows:
   a. Move the remote control handle from neutral into forward and advance the handle to full speed position. Slowly return the handle back to neutral. Place a mark ("a") on the cable next to the cable end guide.
   b. Move the remote control handle from neutral into reverse and advance the handle to full speed position. Slowly return the handle back to neutral. Place a mark ("b") on the cable next to the cable end guide.
   c. Make a center mark ("c"), midway between marks ("a" and "b"). Align the cable end guide with this center mark when installing cable to the engine.

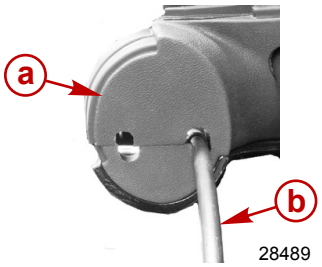


2. Manually shift the outboard into neutral. The propeller will rotate freely.

3. Position the remote control handle into neutral.

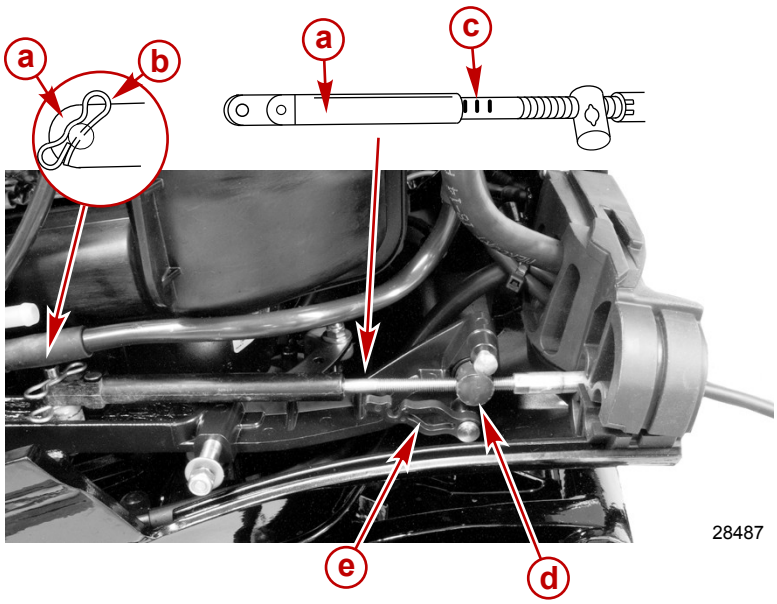


4. Fit the shift cable through the rubber grommet.



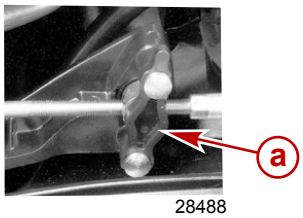
a - Rubber grommet
b - Shift cable

5. Attach the shift cable to the shift lever with a bow tie clip retainer.
6. Adjust the cable barrel so the center mark on the cable is aligned with the end guide when the cable barrel is placed in the barrel receptacle.



a - Cable end guide
b - Bow tie clip retainer
c - Center mark
d - Cable barrel
e - Barrel latch

7. Place the cable barrel into the barrel receptacle.
8. Lock barrel in place with the barrel latch.



a - Barrel latch

9. Check shift cable adjustments as follows:
   a. Shift remote control into forward. The propeller shaft should be locked in gear. If not, adjust the barrel closer to the cable end guide.

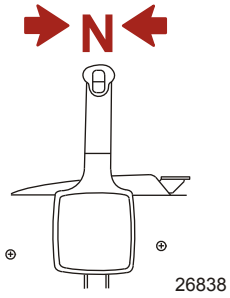
b. Shift remote control into reverse while turning propeller. The propeller shaft should be locked in gear. If not, adjust the barrel away from the cable end guide. Repeat steps a through c.

c. Shift remote control back to neutral. The propeller shaft should turn freely without drag. If not, adjust the barrel closer to the cable end guide. Repeat steps a through c.

Throttle Cable Installation

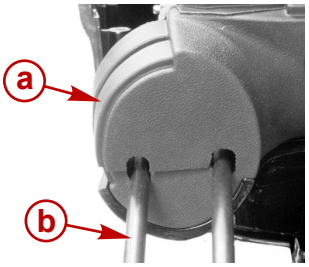
Install the cables into the remote control following the instructions provided with the remote control.

1. Position the remote control into neutral.



26838

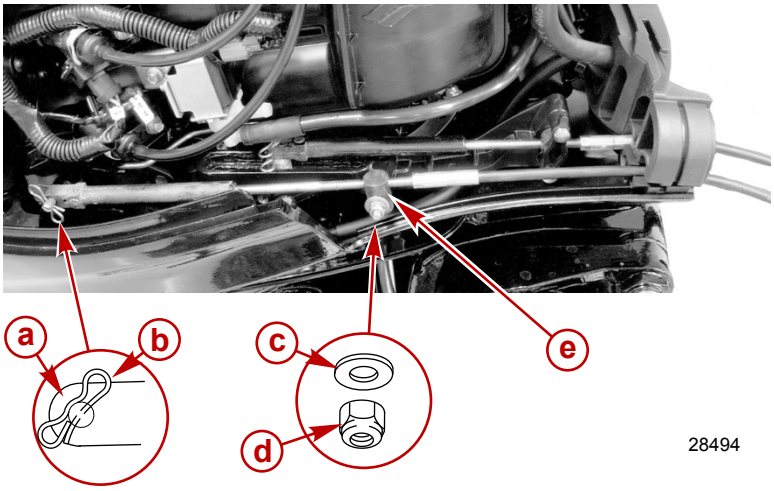
2. Fit the throttle cable through the rubber grommet.



28491

a - Rubber grommet
b - Throttle cable

3. Attach the throttle cable to the throttle lever with a bow tie clip retainer.
4. Adjust cable barrel until the barrel slips onto the mounting stud.
5. Fasten the throttle cable to the mounting stud with a flat washer and locknut. Tighten the locknut to the specified torque.

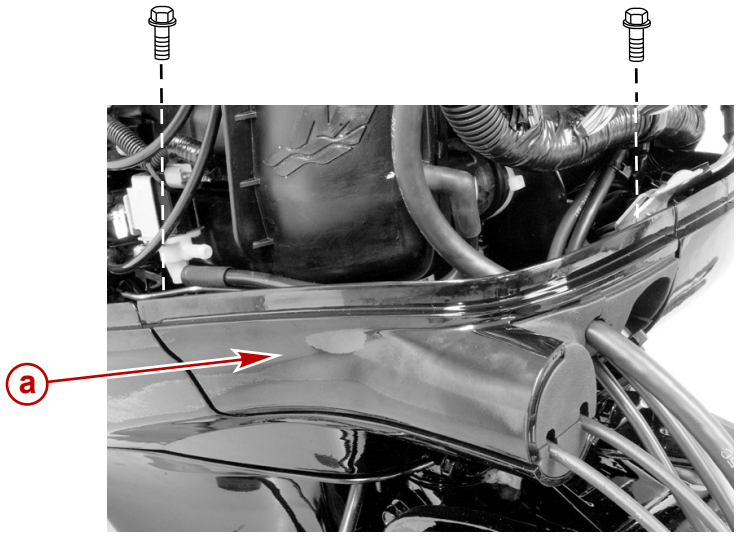


28494

a - Cable end guide
b - Bow tie clip retainer
c - Flat washer
d - Locknut
e - Cable barrel

Description	Nm	lb-in.	lb-ft
Throttle cable locknut	6	53	

6. Install the access cover with two bolts. Tighten the bolts to the specified torque.



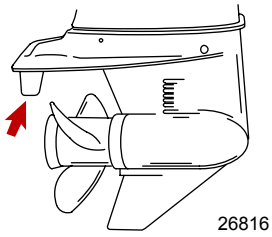
28500

a - Access cover

Description	Nm	lb-in.	lb-ft
Access cover bolt	10	89	

Trim Tab Adjustment

Propeller steering torque will cause your boat to pull in one direction. This steering torque is a normal thing that results from your outboard not being trimmed so the propeller shaft is parallel to the water surface. The trim tab can help compensate for this steering torque in many cases and can be adjusted within limits to reduce any unequal steering effort.



26816

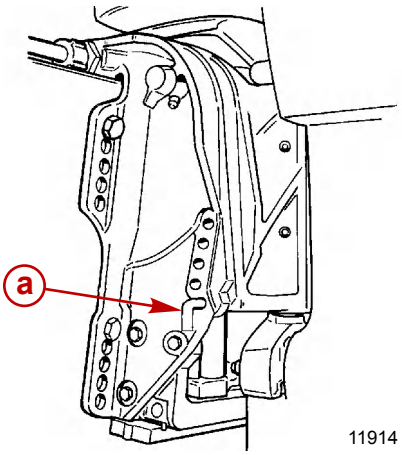
NOTE: *Trim tab adjustment will have little effect reducing steering torque if the outboard is installed with the anti-ventilation plate approximately 50 mm (2 inches) or more above the boat bottom.*

Operate your boat at normal cruising speed, trimmed to the desired position. Turn your boat left and right and note the direction the boat turns more easily.

If adjustment is necessary, loosen trim tab bolt and make small adjustments at a time. If the boat turns more easily to the left, move the trailing edge of trim tab to the left. If the boat turns more easily to the right, move the trailing edge of trim tab to the right. Tighten bolt and retest.

Trim-In Stop Adjustment - Power Trim Models

If an adjustment is required, purchase a stainless tilt pin (17-49930A1) and insert it through whatever pin hole is desired. The nonstainless steel shipping bolt should not be used in this application other than on a temporary basis.



11914

a - Tilt pin (not included with engine)

Stainless Steel Tilt Pin	17- 49930A 1

Jet Drive Installation

Boat Horsepower Capacity

⚠ WARNING

Exceeding the boat's maximum horsepower rating can cause serious injury or death. Overpowering the boat can affect boat control and flotation characteristics or break the transom. Do not install an engine that exceeds the boat's maximum power rating.

Do not overpower or overload your boat. Most boats will carry a required capacity plate indicating the maximum acceptable power and load as determined by the manufacturer following certain federal guidelines. If in doubt, contact your dealer or the boat manufacturer.

U.S. COAST GUARD CAPACITY	
MAXIMUM HORSEPOWER	XXX
MAXIMUM PERSON CAPACITY (POUNDS)	XXX
MAXIMUM WEIGHT CAPACITY	XXX

26777

Start in Gear Protection

⚠ WARNING

Starting the engine with the drive in gear can cause serious injury or death. Never operate a boat that does not have a neutral-safety-protection device.

The remote control connected to the outboard must be equipped with a start in neutral only protection device. This prevents the engine from starting in gear.

Selecting Accessories for Your Outboard

Genuine Mercury Precision or Quicksilver Accessories have been specifically designed and tested for your outboard. These accessories are available from Mercury Marine dealers.

IMPORTANT: Check with your dealer before installing accessories. The misuse of approved accessories or the use of nonapproved accessories can damage the product.

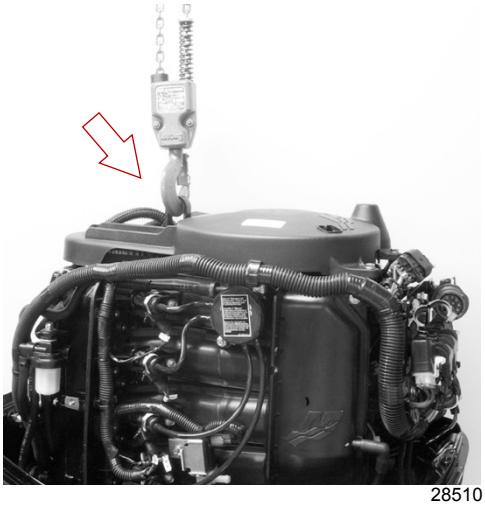
Some accessories not manufactured or sold by Mercury Marine are not designed to be safely used with your outboard or outboard operating system. Acquire and read the installation, operation and maintenance manuals for all your selected accessories.

Electric Fuel Pump

If an electric fuel pump is used, the fuel pressure must not exceed 27.58 kPa (4 psi) at the engine. If necessary, install a pressure regulator to regulate the pressure.

Lifting Outboard

Use the lifting eye on the engine.



28510

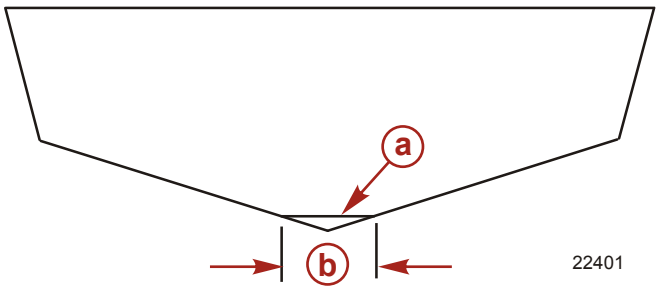
Determining the Mounting Height of the Outboard Jet

The following outboard mounting height settings will work good for most applications, however, because of different boat/hull designs, the setting should be checked by test running the boat. Refer to **Water Testing**.

- Installing the outboard too high on the transom will allow the water intake to suck in air and cause cavitation. (Cavitation will cause the engine to overspeed in spurts and reduce thrust.) This condition should be avoided by proper height setting.
- Installing the outboard too low on the transom will allow excessive drag.

Boats with a "V" Bottom Hull

1. Measure the width of the leading edge on the water intake housing. Make a horizontal line on the transom up from the "V" bottom the same length as the width of the water intake housing.

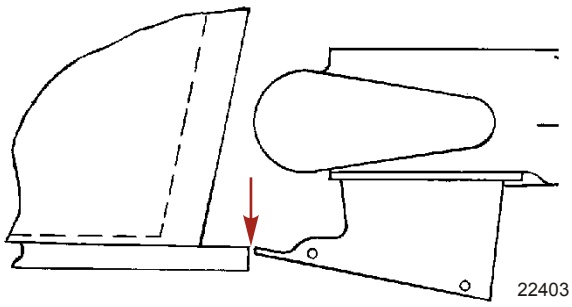


22401

a - Horizontal line
b - Width of the leading edge on the water intake housing

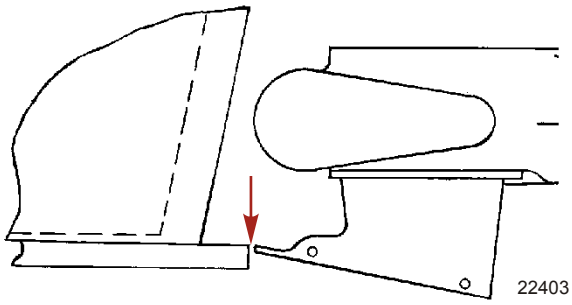
2. Place (center) the outboard on the boat transom. Set the height of the outboard on the boat transom so that the front edge of the water intake housing is in line with the horizontal line made in step 1. Temporarily clamp the outboard to the transom at this position.

3. Fasten the outboard to the transom at this height. Refer to **Fastening the Outboard**.



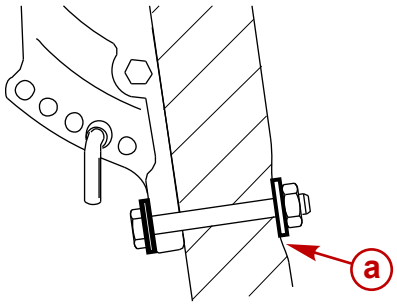
Boats with a Flat Bottom Hull

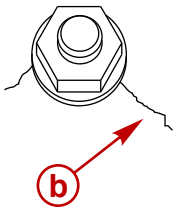
1. Place (center) the outboard on the boat transom. Set the height of the outboard on the boat transom so that the front edge of the water intake housing is in line with the bottom of the boat as shown. Temporarily clamp the outboard to the transom at this position.
2. Fasten outboard to the transom at this height. Refer to **Fastening the Outboard**.



Checking Boat Transom Construction

IMPORTANT: Determine the strength of the boat transom. The outboard mounting locknuts and bolts should be able to hold 75 Nm (55 lb-ft) of torque without the boat transom yielding or cracking. If the boat transom yields or cracks under this torque, the construction of the transom may not be adequate. The boat transom must be strengthened or the load carrying area increased.

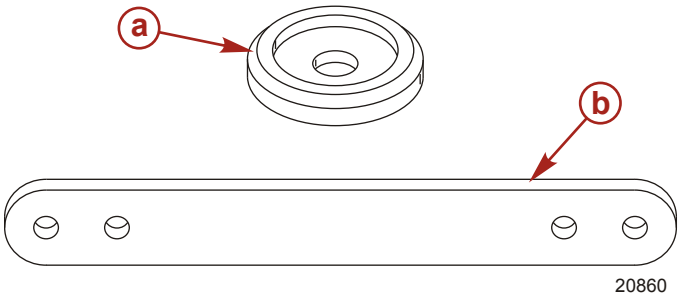




a - Transom yielding under bolt torque
b - Transom cracking under bolt torque

When first determining transom strength, use a dial torque wrench. If the bolt or nut continues to turn without the torque reading on the dial increasing, it is an indication that the transom is yielding. The load area can be increased by using a larger washer or a transom reinforcement plate.

NOTE: The inside holes on the transom reinforcement plate are for the lower transom bolts and the outside holes are for the upper transom bolts.



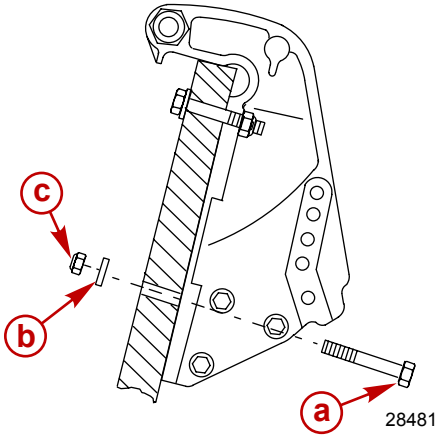
a - Large transom washer
b - Transom reinforcement plate

Description	Part Number
Large transom washer	67-896392
Transom reinforcement plate	67-896305

Fastening the Outboard

1. Drill four 13.5 mm (17/32 in.) mounting holes.
2. Install the outboard so that the water intake housing is set at the correct height. Refer to **Determining Outboard Mounting Height**.
3. Apply marine sealer to shanks of bolts. Do not apply marine sealer to the threads of the bolts.
4. Fasten the outboard with provided mounting hardware shown. Tighten locknuts to the specifed torque.

The outboard must be secured to the transom with the four 13 mm (1/2 in.) diameter mounting bolts and locknuts provided. Install two bolts through the upper set of mounting holes and two bolts through the lower set of mounting holes.

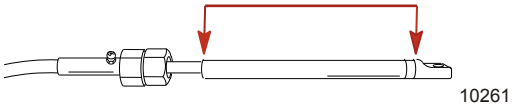


a - 1/2 in. diameter bolt (4)
b - Flat washer (4)
c - Locknut (4)

Description	Nm	lb-in.	lb-ft
Outboard mounting locknuts and bolts	75		55

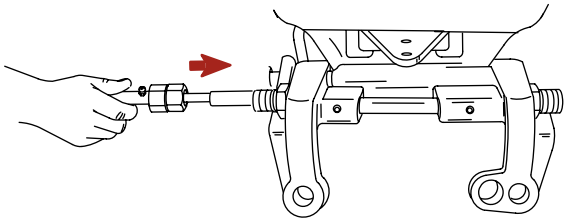
Steering Cable - Starboard Side Routed Cable

1. Lubricate the entire cable end.



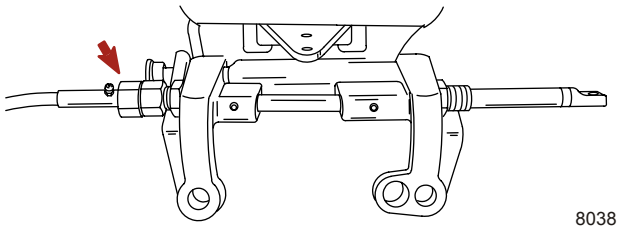
Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	The entire cable end	92-802859A 1

2. Insert steering cable into tilt tube.



8037

3. Torque nut to specification.



8038

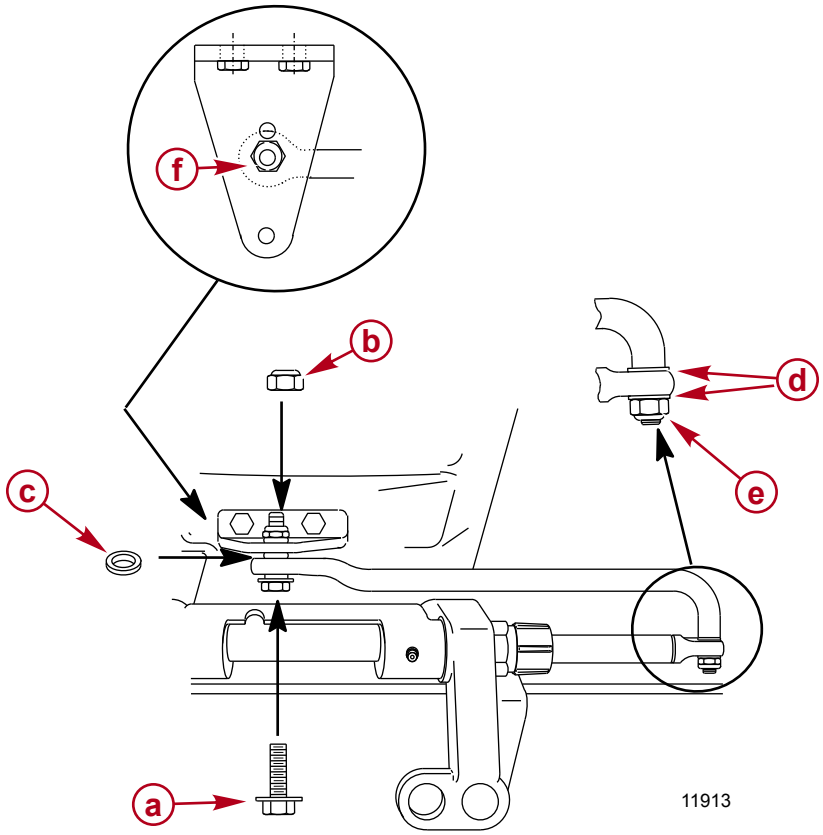
Description	Nm	lb-in.	lb-ft
Nut	47.5		35

Steering Link Rod Fasteners

IMPORTANT: The steering link rod that connects the steering cable to the engine must be fastened using special washer head bolt ("a" - Part Number 10-856680) and self-locking nylon insert locknuts ("b" and "e" - Part Number 11-826709113). These locknuts must never be replaced with common nuts (nonlocking) as they will work loose and vibrate off, freeing the link rod to disengage.

⚠ WARNING

Improper fasteners or improper installation procedures can result in loosening or disengagement of the steering link rod. This can cause a sudden, unexpected loss of boat control, resulting in serious injury or death due to occupants being thrown within or out of the boat. Always use required components and follow instructions and torque procedures.



- **a -** Special washer head bolt (10-856680)
- **b -** Nylon insert locknut (11-826709113)
- **c -** Spacer (12-71970)
- **d -** Flat washer (2)
- **e -** Nylon insert locknut (11-826709113)
- **f -** Use middle hole - steer outboard to the side to gain hole access

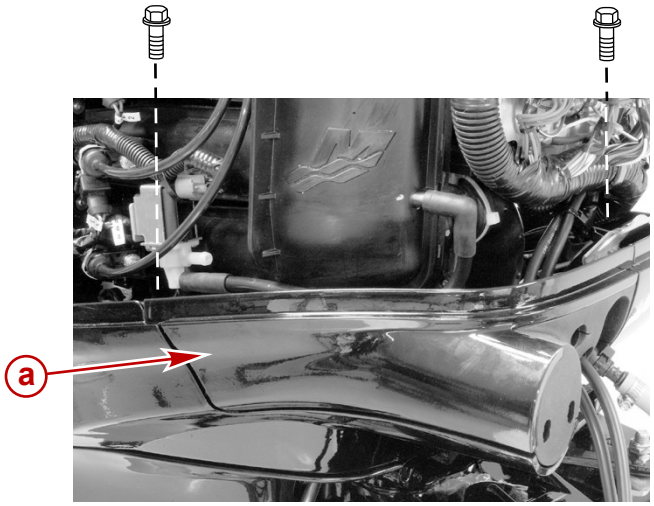
Description	Nm	lb-in.	lb-ft
Special washer head bolt	27		20
Nylon insert locknut "b"	27		20
Nylon insert locknut "e"	Tighten until it seats, then back off 1/4 turn		

Assemble steering link rod to steering cable with two flat washers and nylon insert locknut. Tighten locknut until it seats, then back nut off 1/4 turn.

Assemble steering link rod to engine with special washer head bolt, locknut, and spacer. First torque bolt, then torque locknut to specifications.

Remote Wiring Harness

Remove the access cover.

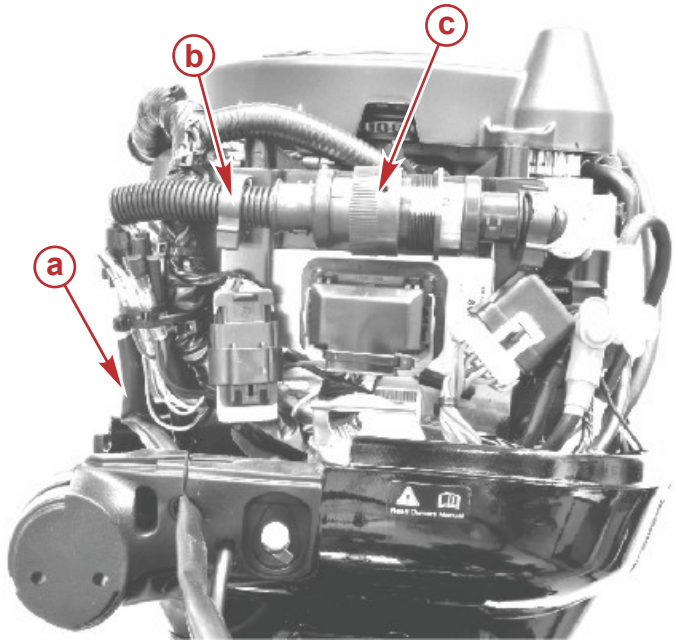


28505

a - Access cover

Route the remote wiring harness through the rubber grommet.

Connect the 14-pin connector to the engine harness and fasten the harness with the retainer.

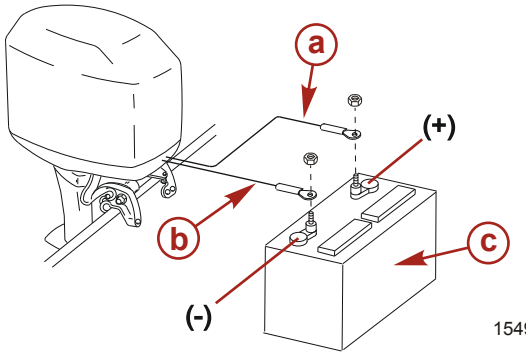


60874

a - Remote wiring harness
b - Retainer
c - 14-pin connector

Battery Cable Connections

Single Outboard

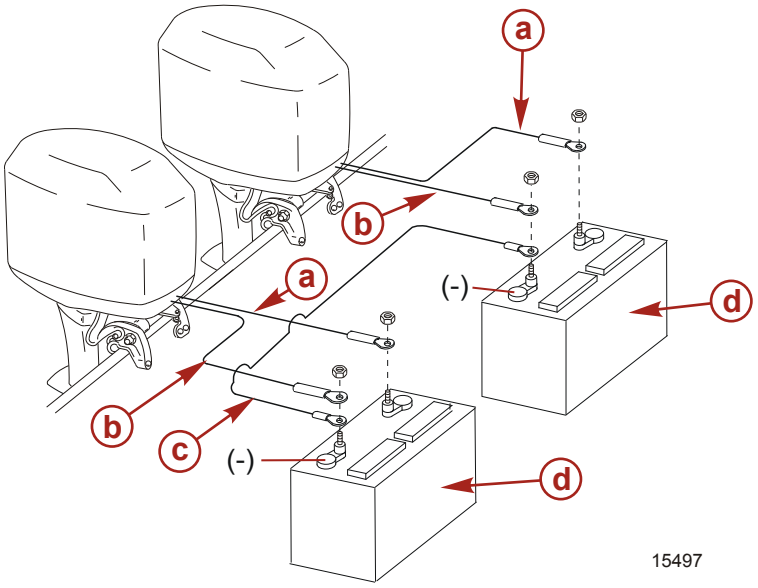


15496

a - Red sleeve - Positive (+)
b - Black sleeve - Negative (–)
c - Cranking battery

Dual Outboards

Connect a common ground cable (wire size same as engine battery cables) between negative (–) terminals on starting batteries.

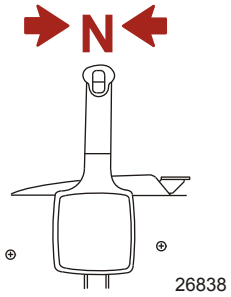


a - Red sleeve - Positive (+)
b - Black sleeve - Negative (–)
c - Ground cable
d - Cranking battery

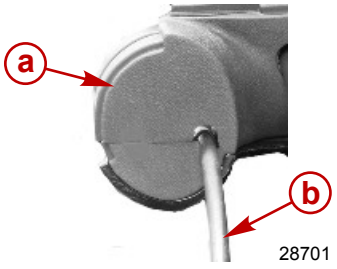
Throttle Cable Installation

Install the cables into the remote control following the instructions provided with the remote control.

1. Place the throttle cable on the throttle lever pin and lock in place with the retainer.
2. Center the roller with the alignment mark on the cam. Adjust the cable barrel so that it fits into the anchor pocket.



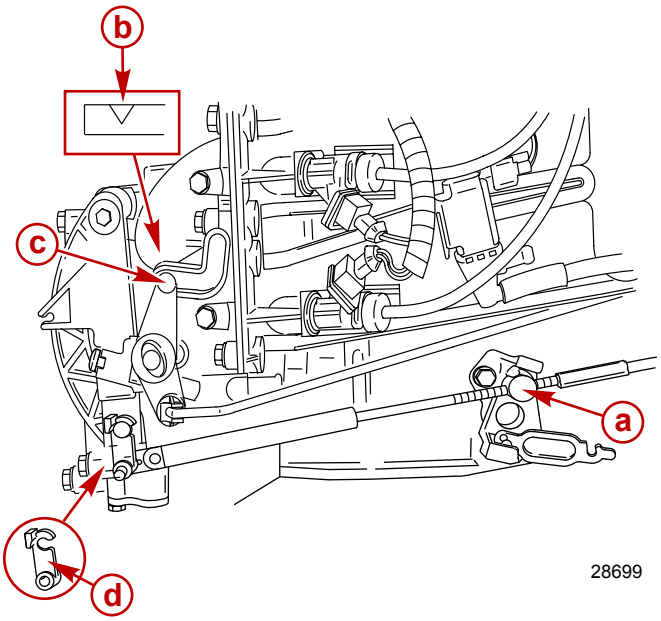
3. Fit the throttle cable through the rubber grommet.



a - Rubber grommet
b - Throttle cable

4. Place the throttle cable on the throttle lever pin. Lock in place with the retainer.

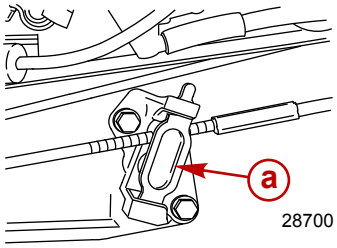
5. Adjust the cable barrel so the center of the roller is lined up with the alignment mark on the cam when the cable barrel is placed in the barrel receptacle.



28699

a - Cable barrel
b - Alignment mark
c - Roller
d - Retainer

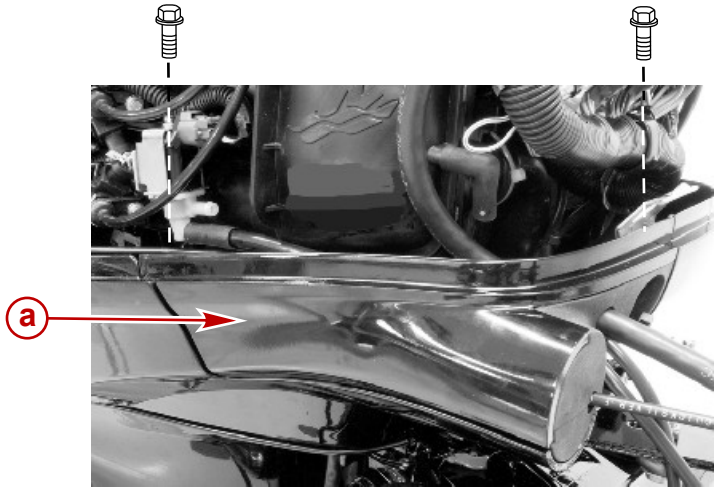
6. Place the cable barrel into the barrel receptacle.
7. Lock in barrel in place with the barrel latch.



28700

a - Barrel latch

8. Install the access cover with two bolts. Tighten the bolts to the specified torque.



28702

a - Access cover

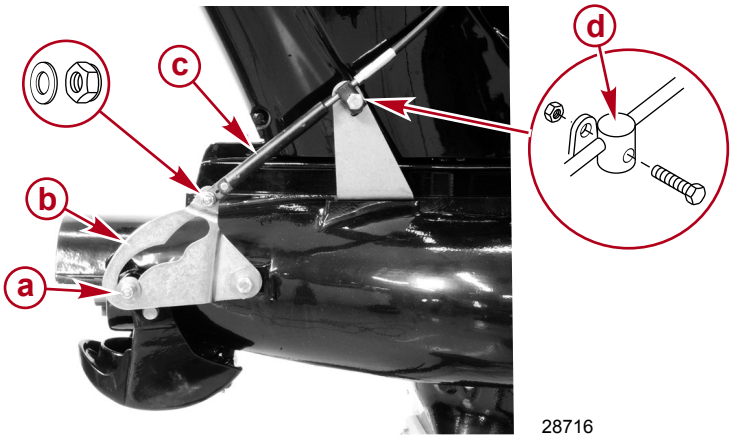
Description	Nm	lb-in.	lb-ft
Access cover bolt	6	53	

Shift Cable Installation—Outboard Jet

⚠ WARNING

If not properly installed, the reverse gate can interfere with water coming off the rudder, suddenly and unexpectedly slowing the boat. This can cause serious injury or death from occupants being thrown within or out of the boat. Adjust the shift cable to prevent the reverse gate from interfering with water flow off the rudder.

1. Attach the shift cable to the shift cam with a flat washer and a self-locking nylon insert locknut as shown. Tighten the locknut against the flatwasher, then back-off the locknut 1/4 turn.
2. Place the remote control handle into full forward position.
3. Adjust the shift cable adjustment barrel so that the roller is at the full end of travel (bottom) in the shift cam.
4. Attach the shift cable adjustment barrel to the bracket with a bolt and locknut. Tighten the bolt until it seats against the adjustment barrel, then back-off the bolt 1/4 turn. Hold the bolt from turning, and tighten the locknut on the bolt. The adjustment barrel must be free to pivot.



28716

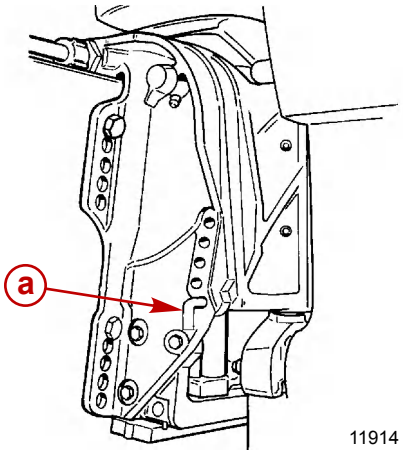
a - Roller
b - Shift cam
c - Shift cable
d - Shift cable adjustment barrel

5. Check the shift cable adjustment in forward shift position. The correct shift adjustment will position the cam far enough on the roller to lock the reverse gate into forward position. Push on the reverse gate by hand to verify it is locked into position. The reverse gate should not move when pushed toward the neutral position.

IMPORTANT: The forward locking of the reverse gate must be met. If not, readjust the shift cable.

Trim-In Stop Adjustment - Power Trim Models

If an adjustment is required, purchase a stainless tilt pin (17-49930A1) and insert it through whatever pin hole is desired. The nonstainless steel shipping bolt should not be used in this application other than on a temporary basis.



11914

a - Tilt pin (not included with engine)

Stainless Steel Tilt Pin	17- 49930A 1

Water Testing

Checking for Cavitation

The initial outboard height setting should be close to the optimum setting for the outboard. However, because of the hull design of some boats, obstructions, or imperfections in the hull ahead of the water intake, adjustments may be required to prevent cavitation at running speeds.

When operating the boat, the outboard driveshaft housing should be vertical, or tilted toward the boat, when planing to provide a scooping angle on the water intake. Tilting the outboard out beyond a vertical position reduces the scoop angle and can cause impeller slippage and cavitation.

IMPORTANT: If the angle of the boat transom does not allow the driveshaft housing to be positioned vertical, a wedge kit should be installed behind the transom brackets to increase the tilt-in angle.

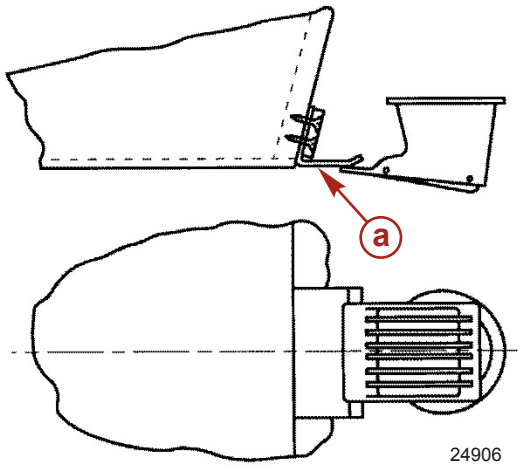
NOTE: *Slight cavitation in sharp turns and rough water is acceptable, but excessive cavitation is harmful to the outboard and should be avoided.*

Test run the boat. If cavitation occurs (air enters the pump), the first thing to try is lowering the outboard mounting height.

If cavitation still exists after lowering the outboard, it may be helpful to seek advice from the boat manufacturer.

Another option to further reduce cavitation is a rough water plate.

A rough water plate may be helpful in reducing cavitation when running in windy, rough water conditions where air is sucked into the water intake when jumping waves. Install a 0.8 mm (1/32 in.) metal plate that extends from the hull bottom to the top of the water intake housing. This plate tends to reduce air intake as well as reduce spray.



a - Rough water plate

Notes:

Electrical

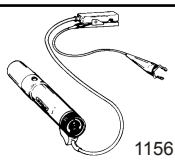
Section 2A - Ignition

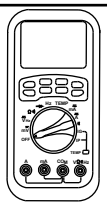
Table of Contents

Ignition Specifications

Ignition Specifications at 20 °C (68 °F)		
Ignition type		Capacitor discharge ignition
Spark plug type		Champion RA8HC
Spark plug gap		1.0 mm (0.040 in.)
Spark plug hex size		16 mm (5/8 in.)
Spark plug torque		17 Nm (150 lb-in.)
Spark plug hole size		12 mm
Firing order		1–3–4–2
Ignition timing	at Idle	Controlled by ECM
	at 1500–1800 RPM	14° BTDC
	at WOT	28° BTDC
Stator resistance		0.2–0.3 Ω (yellow - yellow)
Crankshaft position sensor resistance		300–350 Ω (red - white)
Ignition coil resistance		Refer to **Ignition Coil Resistance Test** chart
ECM engine speed limiter	Fuel/spark cutout on cylinders #2 and #3	6225 RPM
	Fuel/spark cutout on all cylinders	6350 RPM
ECM overheat speed control		Guardian System is activated. Power limit will vary with the level of overheat.
ECM low oil pressure speed control		Guardian System is activated. Engine power is limited to 10% of maximum (approximately 2000 RPM).
MAT/ECT temperature sensor		Refer to **Section 3B - Component Resistance Tests**
Manifold absolute pressure (MAP) sensor resistance		Refer to **Section 3B - Component Resistance Tests**
Fuel injector resistance		10.0–13.5 Ω
Main power relay		81–99 Ω (pin 85–pin 86)
Idle air control (IAC)		24–30 Ω (between pins)
Throttle position sensor (TPS) typical range	Output voltage at Idle	0.39–1.00 volts
	Output voltage at WOT (6000 RPM)	3.66–4.80 volts

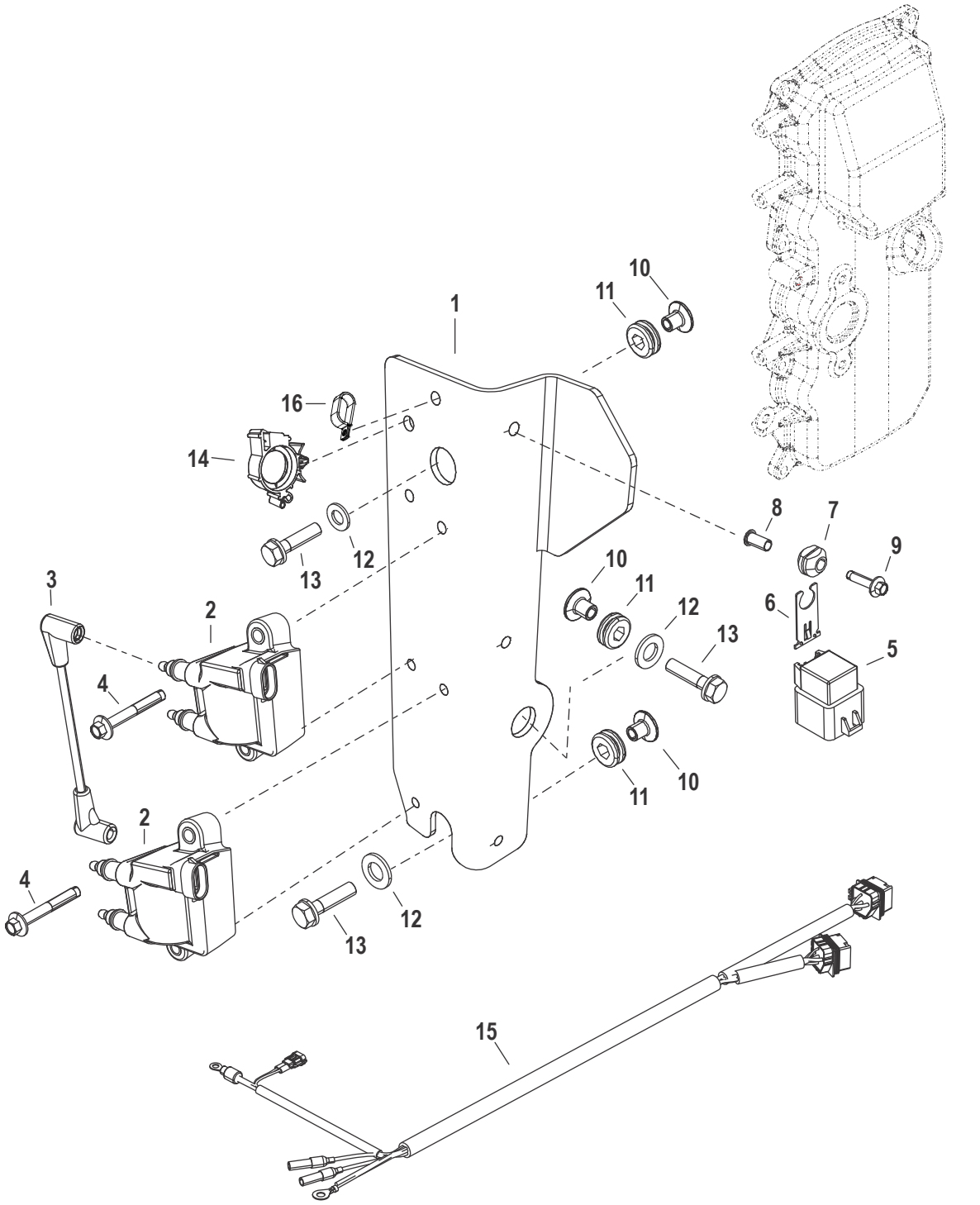
Special Tools

Timing Light	91- 99379
 11561	Allows a technician to check ignition timing.

DMT 2004 Digital Multimeter	91-892647A01
 4516	Measures RPM on spark ignition (SI) engines, ohms, amperes, AC and DC voltages; records maximums and minimums simultaneously, and accurately reads in high RFI environments.

Notes:

Ignition Coil Mounting Components



Ignition Coil Mounting Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Coil plate			
2	2	Dual output ignition coil			
3	4	Spark plug lead			
4	8	Bolt (M6 x 45)	6	53	–
5	3	Relay assembly			
6	3	Bracket			
7	1	Grommet			
8	3	Bushing			
9	1	Bolt (M6 x 25)	6	53	–
10	3	Bushing			
11	2	Grommet			
12	3	Bolt (M6 x 10)	6	53	–
13	3	Washer			
14	3	Clip (19 mm)			
15	1	Trim harness			
16	1	Clip			

Wire Color Code Abbreviations

Wire Color Abbreviations				
BLK	Black		BLU	Blue
BRN	Brown		GRY	Gray
GRN	Green		ORN or ORG	Orange
PNK	Pink		PPL or PUR	Purple
RED	Red		TAN	Tan
WHT	White		YEL	Yellow
LT or LIT	Light		DK or DRK	Dark

Ignition Description

When the ignition key switch is turned to the "RUN" position, battery voltage is applied to both the ECM through the purple wire and the MPR through the red/purple wire. As the ECM receives the "RUN" signal, it internally completes the ground circuit of the main relay for a period of two seconds, energizing the ignition/injection systems for start-up. As the engine is cranked with the starter motor, the ECM receives the output signal from the crankshaft position sensor (CPS) and completes the ground circuit to the main relay for engine operation.

With the main relay closed (completed circuit), DC current from the battery/charging system is transferred through the 20 amp main relay fuse to the positive terminal of all ignition coil primary windings. The negative terminals of the ignition coil primaries are connected to the engine ground through the coils internal driver, which is triggered by the ECM. With the coil drivers closed, an electric magnetic field is allowed to build-up within the ignition coil.

As the flywheel rotates, the CPS senses the location of the 54 teeth on the flywheel and supplies the trigger signal information to the ECM. The ECM utilizes the CPS information and determines when to adjust the trigger signal to the coil driver of each ignition coil. The coil driver then opens the coil primary ground circuit which allows its magnetic field to rapidly collapse across the coil secondary winding which induces a high voltage charge (approximately 10,000 volts) that fires the spark plug.

Ignition Diagnostic Procedures

NOTE: *With engine running, use inductive timing light to check spark advance of each cylinder as throttle is opened and closed. If timing advances and retards on each cylinder, ignition system is most likely functioning properly.*

Timing Light	91- 99379

If outboard appears to have an ignition system failure, it is recommended that before beginning in-depth troubleshooting:

- Ensure that the engine is mechanically sound in the fuel system, cylinder compression, etc.
- Check all engine ground leads for loose or corroded connections.
- Disconnect and reconnect ignition harness connectors to verify proper continuity.

Ignition Test Procedures

Direct Voltage Adapter (DVA)

⚠ WARNING

High voltage is present any time the key is turned on, especially when starting or operating the engine. Do not touch ignition components or metal test probes and stay clear of spark plug leads when performing live tests.

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

- **Do not reverse the battery cable connections. The battery negative (–) cable is ground.**
- **Do not spark the battery terminals with the battery cable connections to check polarity.**
- **Do not disconnect the battery cables while the engine is running.**
- **Do not crank the engine with the ECM or the ignition coils not grounded.**

To protect against meter and/or component damage, observe the following precautions:

- 400 VDC test position or higher must be used for all tests.
- Ensure the positive (+) lead/terminal of the DVA is connected to the positive (+) receptacle of the meter.
- Do not change the meter selector switch position while the engine is running and/or being cranked.
- All components must be grounded during the tests. Running or cranking the engine with the ECM or the ignition coils ungrounded may damage the components.

NOTE: *If using a meter with a built-in DVA, the DVA/400 or DVA/500 VDC test position should be used.*

Test procedures and specifications are provided for checking the primary ignition voltage while the engine is running and/or cranked with all the harnesses connected.

Suggested Ignition Testing Procedures

NOTE: *The following recommended tests and probable causes are not listed in any specific order. The technician should use this table as a guide to help isolate and test the specific problem/condition. Always perform the DVA tests first (if applicable), then perform resistance test to validate suspected component failure.*

Recommended tests:

1. DVA test (direct voltage adapter)
2. Ohm test (resistance testing)
3. Replace component and retest
4. Mechanical test/repair

No Spark Condition (All Cylinders)	
Probable Cause	**Recommended Test**
Crankshaft position sensor	2
Stator	1, 2
ECM	3
Stop circuit short to ground	
Stop circuit lead	2
Lanyard stop switch	2
Tiller handle stop button (if supplied)	2
Remote control harness	2
Ignition coil	2
Primary circuit shorted to ground	2
Spark plugs	3
Open ground condition	
Ignition coil	2
Stator ground	3
ECM	3
Rectifier/regulator	1, 2

No Spark Condition (One Cylinder)	
Probable Cause	**Recommended Test**
High tension lead (resistance lead)	2
Spark plug cap (resistor)	2
Spark plug	3

Weak Spark Condition	
Probable Cause	**Recommended Test**
Ground connection at:	
Ignition coil primary leads	2
Stator	2
ECM primary coil supply leads	3
High resistance to ground at:	
Stop/lanyard switch (water/corrosion)	2
Weak charge coil (stator)	1, 2
Ignition coil high tension leads	1, 2, 3
Spark plugs	2
Spark plug cap (resistor)	3
Spark plug cap leak	3
ECM failure	3

Weak Spark Condition	
Probable Cause	**Recommended Test**
Rectifier/regulator	1, 2

Timing Fluctuations[1]	
Probable Cause	**Recommended Test**
Loss of oil pressure - overheating	
Timing retards and fluctuates; RPM will drop below 2000	4
Flywheel key sheared	4
ECM	3

Timing Will Not Advance	
Probable Cause	**Recommended Test**
Low oil pressure - engine overheating	
Timing retards and fluctuates; RPM remains below 2000	4
ECM	3

Engine Misfires at High RPM	
Probable Cause	**Recommended Test**
Low oil pressure - engine overheating	
Timing retards and fluctuates; RPM will remain below 2000 (cylinders #1 and #4)	4
Ignition coil - high tension leads	2
Spark plug cap (resistor)	2
Spark plug	3
ECM	3
Ground connection	
ECM	3
Ignition coil	2
Stator	2

Engine Hard to Start Cold	
Probable Cause	**Recommended Test**
Debris in fuel circuit	4
Weak spark condition	1
Throttle plate in open position	4

Engine Hard to Start Hot	
Probable Cause	**Recommended Test**
Weak spark condition	4
Vapor lock	4

Engine Will Not Run Over 2000 RPM	
Probable Cause	**Recommended Test**
Charge coil	1, 2
Low oil pressure - engine overheating	
Timing retards and fluctuates; RPM will remain below 2000	4
Ignition coil - high tension leads	2
ECM	3
Spark plugs	3

1. It is considered normal for the timing to fluctuate approximately 1°–2° within the designated timing window.

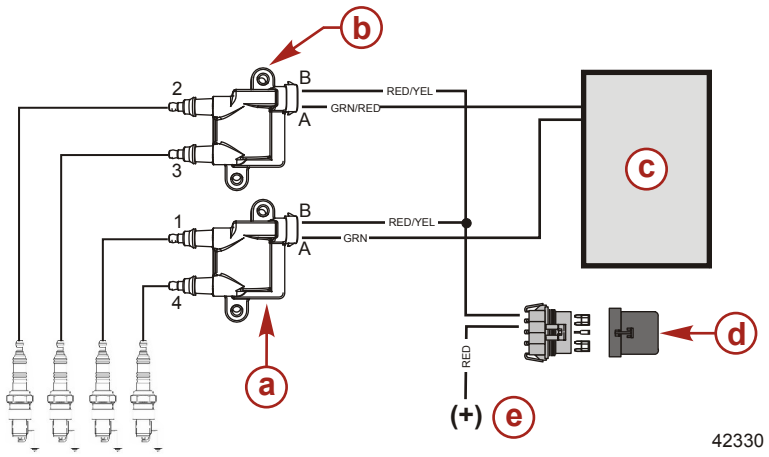
Engine Occasionally Misfires	
Probable Cause	**Recommended Test**
Ignition coil - high tension leads	2
Spark plug cap (resistor)	2
Spark plug	3
Ground connection at:	
Ignition coil	2
ECM	3
High resistance to ground at:	
Lanyard stop switch (water/corrosion)	2
ECM	3

Engine Surges Over 6200 RPM While Under Load[2].	
Probable Cause	**Recommended Test**
Boat underpropped	4
Propeller hub spun	4

Ignition Coils

The ignition coils are inductive type coils. A 12 volt DC current is supplied to the coils at all times from the boat battery. For a predetermined length of time (dwell), the primary circuit of the coil is completed by closing the electrical circuit within the coil driver. When the coil driver circuit opens, the primary field of the coil collapses inducing high voltage in the secondary windings which produces up to 10,000 volts at the spark plugs.

The ignition coils are a wasted spark design where the spark plugs fire twice per complete engine cycle, one coil fires two cylinders simultaneously. One spark plug fires on the compression stroke, the other spark plug fires on the exhaust stroke where there is no combustible material, which is wasted. The lower coil (coil 1) fires cylinders 1 and 4; the upper coil (coil 2) fires cylinders 2 and 3.



a - Coil 1
b - Coil 2
c - ECM
d - 20 amp fuse
e - Starter solenoid

Ignition Coil Removal and Installation

Removal

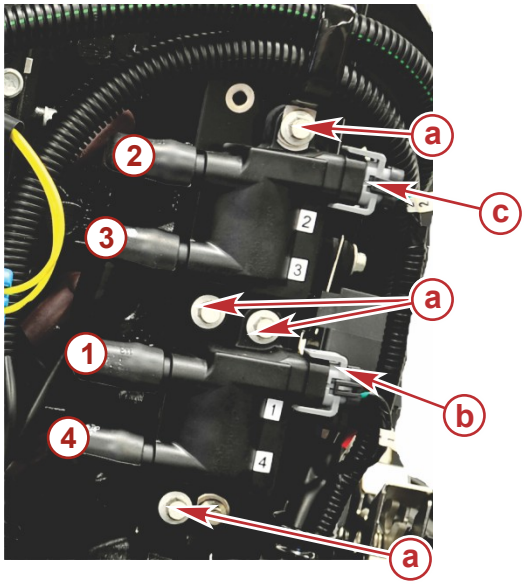
⚠ WARNING

Damaged spark plug boots may emit sparks that can ignite fuel vapors under the engine cowl, resulting in serious injury or death from a fire or explosion. To avoid damaging the spark plug boots, do not use any sharp object or metal tool to remove the spark plug boots.

1. Disconnect the harness connector from each ignition coil.
2. Remove the mounting bolts and remove the ignition coils from the coil plate.

2. The engine ECM will retard timing and reduce RPM above 6200 RPM.

3. Remove the spark plug leads from the spark plugs.

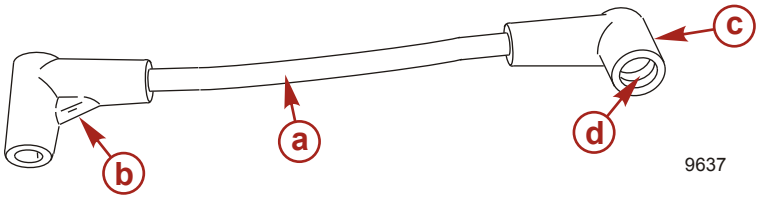


60741

a - Bolt (M6 x 30 flange head) (4)
b - Harness connector 1
c - Harness connector 2

Installation

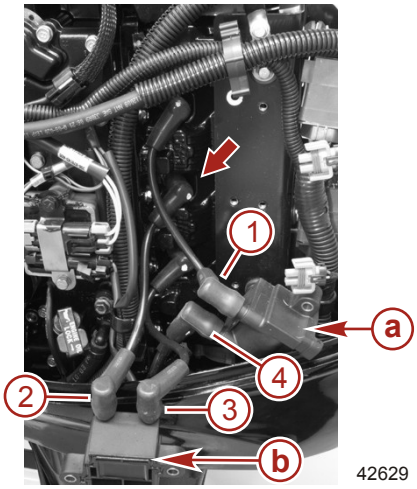
1. If removed, install the spark plug lead onto each ignition coil.



9637

a - Spark plug lead
b - Support webbing - spark plug boot
c - Ignition coil boot
d - Retention ribs

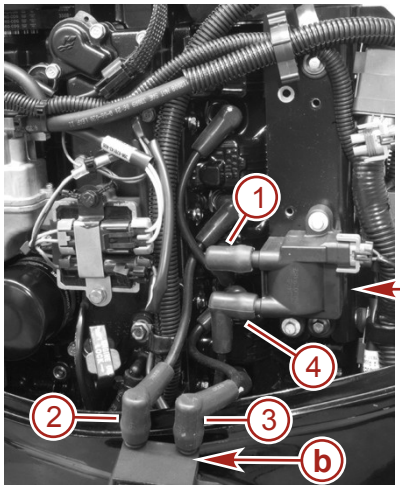
2. Install the spark plug leads onto the spark plugs with the spark plug boot angled as shown.
3. Route the spark plug leads as shown—number 1 lead routed over number 2.



42629

a - Coil 1
b - Coil 2

4. Attach coil 1 to the coil plate using two mounting bolts.

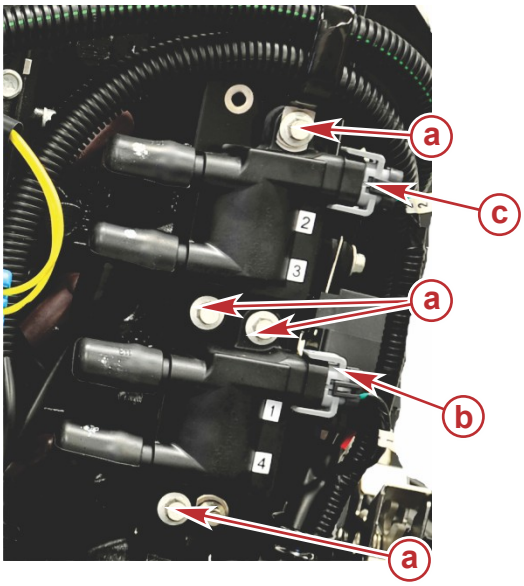


42630

a - Coil 1
b - Coil 2

IMPORTANT: Ensure the spark plug leads are routed as shown.

5. Attach coil 2 to the coil plate using two mounting bolts.
6. Tighten the mounting bolts to the specified torque.
7. Connect the harness connectors to the ignition coils.



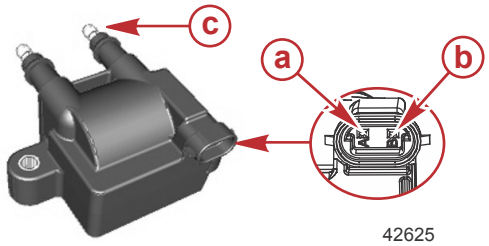
60743

a - Bolt (M6 x 30 flange head) (4)
b - Harness connector 1
c - Harness connector 2

Description	Nm	lb-in.	lb-ft
Ignition coil mounting bolts (M6 x 30 flange head) (4)	6	53	–

Ignition Coil Resistance Test

1. Remove the spark plug lead from the ignition coil. Twist the ignition coil boot slightly while removing.
2. Use a DMT 2004 digital multimeter and perform the following test.



a - Pin A
b - Pin B
c - Coil towers

Ignition Coil Resistance Test (Ω)				
	Black Meter Lead			
Red Meter Lead	X	Coil tower	Pin A	Pin B
	Coil tower	7200–8800	No continuity	7200–8800
	Pin A	No continuity	X	0.3–0.5
	Pin B	7200–8800	0.3–0.5	X

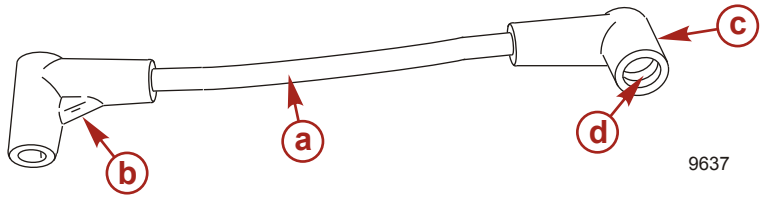
DMT 2004 Digital Multimeter	91-892647A01

Spark Plug Lead Resistance Test

Spark plug leads are directional. The boot with the support webbing is to be installed on the spark plug only. The other boot has a slightly larger internal diameter and there are ribs inside the boot to help with retention when installed on the ignition coil tower.

Use a DMT 2004 digital multimeter and perform the following test.

Spark Plug Lead Resistance Test



a - Spark plug lead
b - Support webbing - Spark plug boot
c - Ignition coil boot
d - Retention ribs

Meter Test Leads		Meter Scale	Reading (Ω)
Red	Black		
Coil end	Spark plug end	Ω	0.6–1.1 K

DMT 2004 Digital Multimeter	91-892647A01

Electrical

Section 2B - Charging and Starting System

Table of Contents

Charging and Starting Specifications

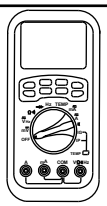
Charging and Starting Specifications at 20 °C (68 °F)		
Alternator	Type	Single phase stator coil (12 pole)
	Output at 1000 RPM	12.5 A
	Output at 5000 RPM	17.5 A
Stator coil resistance		0.2–0.6 Ω
Fuse		20 A
Starter	Type	Sliding gear
	Model/manufacturer	Bendix
	Output	1.1 kW
	Ampere draw under load	174.0 A
	Ampere draw under no load	23.7 A
Battery rating	Minimum requirement	465 marine cranking amps (MCA) or 350 cold cranking amps (CCA)
	For operation below 0 °C (32 °F)	1000 marine cranking amps (MCA) or 775 cold cranking amps (CCA)
	Ampere hours (Ah) for operation above 0 °C (32 °F)	70
	Ampere hours (Ah) for operation below 0 °C (32 °F)	105
Quicksilver tachometer setting		6P or 4

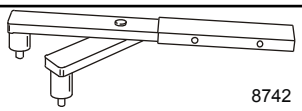
Lubricant, Sealant, Adhesives

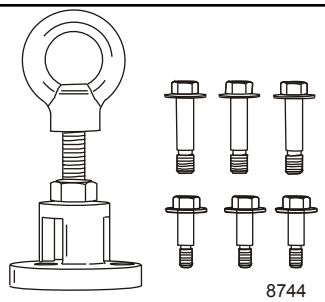
Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Seal ground wire connection Battery cable and wire connections	92- 25711 3
51	Loctite 222 Threadlocker	Stator mounting screw threads	92-809818
95	2-4-C with PTFE	Battery terminal bolts	92-802859A 1

Special Tools

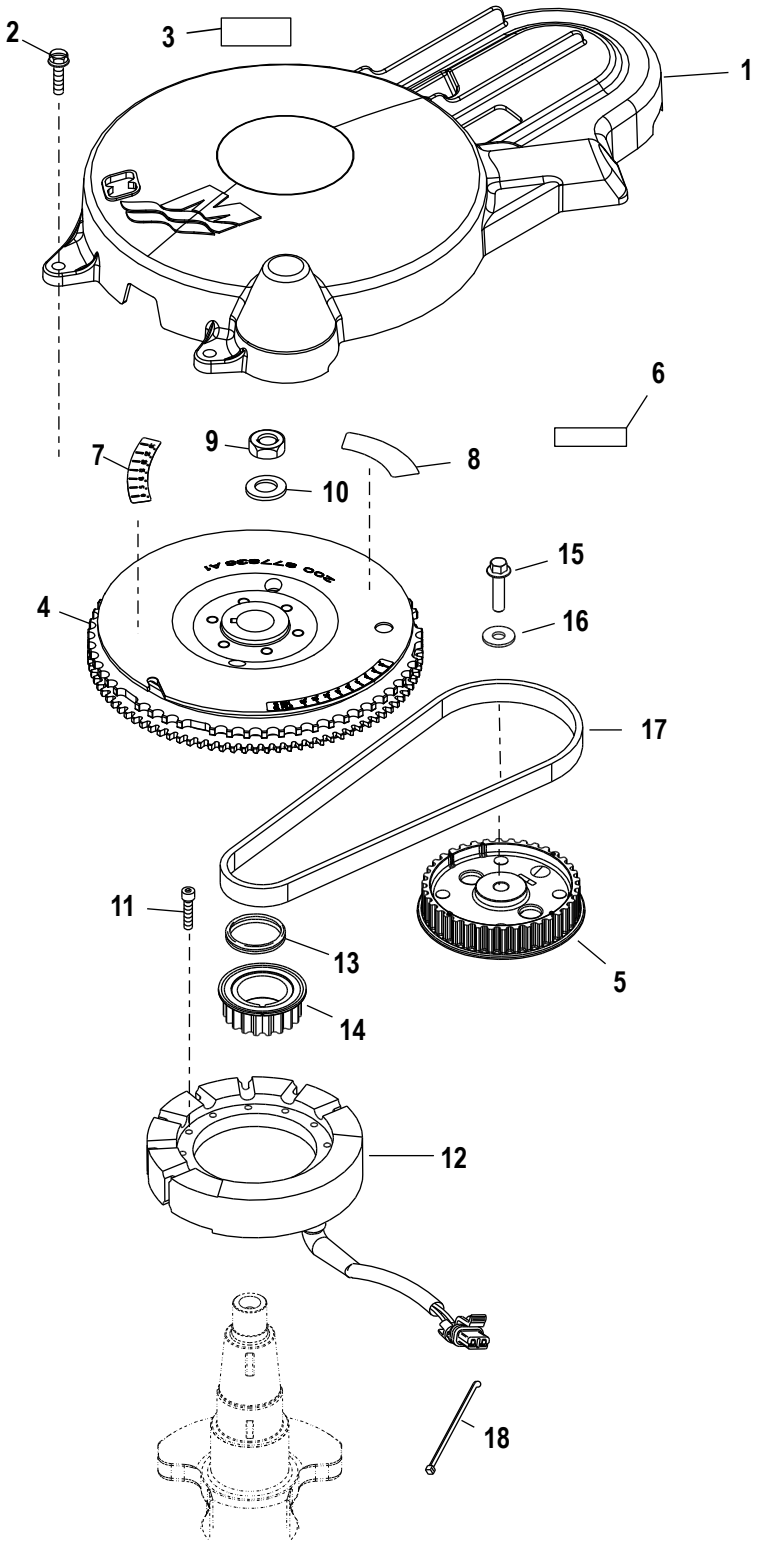
Clamp-on Current Probe	91-802650
 4006	Measures the current output of battery charging systems or current draw of electric motors.

DMT 2004 Digital Multimeter	91-892647A01
 4516	Measures RPM, ohms, amperes, AC and DC voltages; records maximums and minimums simultaneously, and accurately reads in high RFI environments.

Flywheel Holder	91- 83163M
 8742	Holds and/or turns the flywheel while making engine repairs, also used to torque the flywheel or the engine coupler.

Flywheel Puller/Lifting Ring	91- 83164M
 8744	Removes flywheel from engine. Used for lifting powerhead/engine.

Flywheel Components

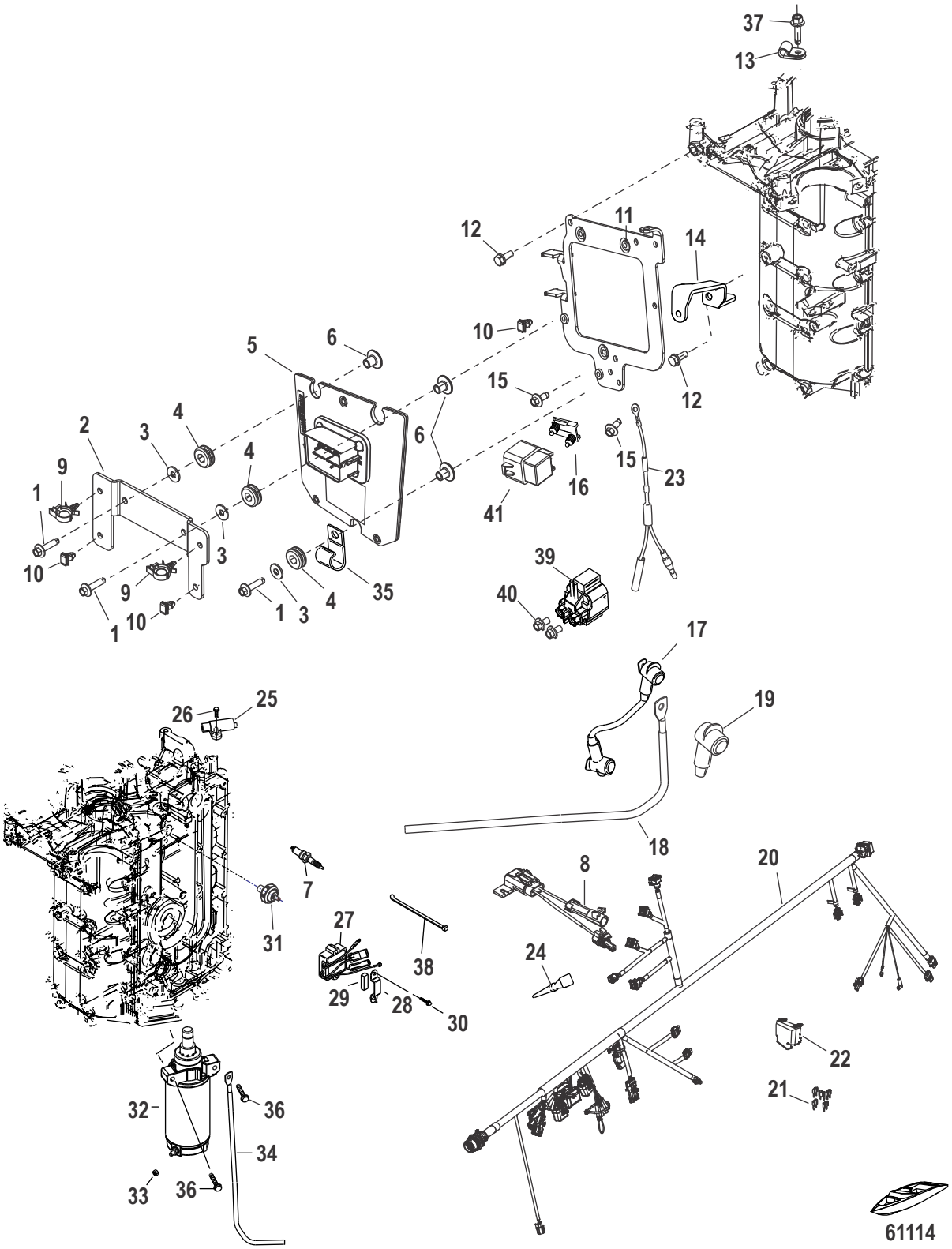


1748

Flywheel Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Flywheel cover			
2	4	Bolt (M6 x 25)	8.5	75	
3	1	EPA information decal			
4	1	Flywheel			
5	1	Driven gear			
6	1	Warning - Spinning flywheel decal			
7	1	Timing marks decal			
8	1	Warning - Neutral decal			
9	1	Nut	156		115
10	1	Washer			
11	3	Screw (M5 x 30)	9.6	85	
12	1	Stator			
13	1	Load ring			
14	1	Drive gear			
15	1	Bolt (M10 x 40)	38		28
16	1	Washer			
17	1	Timing belt			
18	1	Cable tie			

Electrical Components



Electrical Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	3	Bolt (M6 x 25)	8	70	–
2	1	Bracket			
3	3	Washer			
4	3	Grommet			
5	1	ECM			
6	3	Bushing			
7	4	Spark plug	27	–	20
8	1	Fuse harness assembly			
9	2	Clip			
10	3	Clip			
11	1	Plate			
12	3	Screw (M6 x 16)	8	70	–
13	1	Clip			
14	1	Brace			
15	2	Bolt (M6 x 14)	5	45	—
16	1	Relay clip			
17	1	Cable assembly			
18	1	Positive battery cable			
19	1	Red insulator boot			
20	1	Engine harness			
21	3	Fuse (Yellow 20 A)			
	1	Fuse (Clear 25 A)			
	1	Fuse (Tan 5 A)			
	1	Fuse (Blue 15 A)			
22	1	Cover			
23	1	Diode cable			
24	1	Male plug			
25	1	Crankshaft position sensor (CPS)			
26	1	Screw (M5 x 16)	5	45	–
27	1	Voltage regulator			
28	1	Bracket			
29	1	Foam pad			
30	1	Bolt (M6 x 40)	8.5	75	–
31	1	Pressure switch			
32	1	Starter motor			
33	1	Nut (1/4-20) brass			
34	1	Negative battery cable			
35	1	J-clip			
36	1	Bolt (M8 x 45) strainless	30	–	22
37	1	Screw (M5 X 12)	5	45	–
38	AR	Cable tie			
39	1	Relay			
40	2	Screw			
41	1	Relay assembly			

Wire Color Code Abbreviations

Wire Color Abbreviations				
BLK	Black		BLU	Blue
BRN	Brown		GRY	Gray
GRN	Green		ORN or ORG	Orange
PNK	Pink		PPL or PUR	Purple
RED	Red		TAN	Tan
WHT	White		YEL	Yellow
LT or LIT	Light		DK or DRK	Dark

Battery

Battery Cable Test

This test is used to determine if there is excessive resistance in the battery's positive or negative cables, or if the cable is sized properly to carry the necessary current needed to crank the engine at the proper RPM.

IMPORTANT: This test must be performed while the key switch is in the "START" position. Ignore any voltage readings taken without the circuit under load.

⚠ WARNING

Moving parts can cause serious injury or death. Wear eye protection and keep hands, hair, and clothing away from moving parts when performing tests or checking adjustments on an operating engine.

1. Perform a load test on the battery following the instructions supplied with the load tester. Ensure the battery is brought to a full charge after being tested.
2. With the key switch in the "START" position, measure the voltage across the battery posts, not the cable clamps. Record the voltage reading. If the voltage is less than 10 VDC, replace the battery.

   NOTE: *The voltage reading in step 2 is the base voltage. The base voltage reading will be compared to the voltage readings obtained in the following steps.*
3. With the key switch in the "START" position, measure the voltage from the battery positive post (not the cable clamp) to the starter post (the stud where the battery positive cable is connected). Record the voltage reading.
4. With the key switch in the "START" position, measure the voltage from the starter case to the battery negative post (not the cable clamp). Record the voltage reading.
5. If the voltage reading in step 3 was more than 1.0 VDC:
   a. Check the cable connections for tightness and corrosion.
   b. If the cable is tight and not corroded, replace the cable with a larger diameter cable.
6. If the voltage reading in step 4 was more than 1.0 VDC:
   a. Check the cable connections for tightness and corrosion.
   b. If the cable is tight and not corroded, replace the cable with a larger diameter cable.

Resistance in the cables can cause a voltage drop and limit current to the starter. If corrosion is present, or if the starter is worn, there may not be enough amperage to turn the starter motor.

NOTE: *If the voltage at the starter is less than 11 VDC, the engine may not start.*

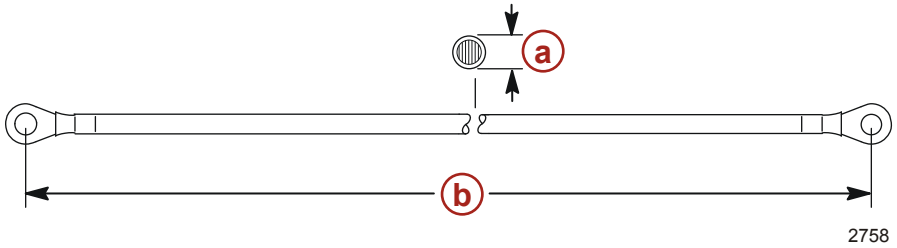
Original Battery Cable Length and Gauge Shipped with Engine

Original Equipment Battery Cable Length/Wire Gauge Size Shipped with Engine		
Models (HP)	**Cable Length**	**Wire Gauge Size**
6–25 (2 and 4-Stroke 400 cc [24.4 in³] or less)	2.4 m (8 ft)	8
25–115 (except OptiMax)	2.4 m (8 ft)	6
125–250 (except OptiMax)	3.0 m (10 ft)	6
OptiMax/Verado	3.7 m (12 ft)	4
75/80/90/100/115 EFI FourStroke (2006 and newer)	3.7 m (12 ft)	4

Battery Cable Size for Outboard Models

IMPORTANT: Only use copper battery cables. Do not use aluminum cables for any outboard marine installations.

- If longer battery cables are required, the wire gauge size must increase. See chart following for correct wire gauge size.



a - Wire gauge size
b - Battery cable length

Copper Battery Cable Wire Gauge Size					
Wire Gauge Size Number SAE					
Models		6–25 hp (2 and 4-Stroke 400 cc [24.4 in³] or less)	25–115 hp (except OptiMax)	125–250 hp (except OptiMax)	OptiMax, Verado, 75–115 EFI FourStroke (2006 and newer)
Cable Length	2.4 m (8 ft)	8	6	-	-
	2.7 m (9 ft)	6	4	-	-
	3.0 m (10 ft)	6	4	6	-
	3.4 m (11 ft)	6	4	4	-
	3.7 m (12 ft)	6	4	4	4
	4.0 m (13 ft)	6	2	4	2
	4.3 m (14 ft)	4	2	4	2
	4.6 m (15 ft)	4	2	4	2
	4.9 m (16 ft)	4	2	2	2
	5.2 m (17 ft)	4	2	2	2
	5.5 m (18 ft)	4	2	2	2
	5.8 m (19 ft)	4	2	2	2
	6.1 m (20 ft)	4	2	2	2
	6.4 m (21 ft)	2	1	2	1
	6.7 m (22 ft)	2	1	2	1
	7.0 m (23 ft)	2	1	2	1
	7.3 m (24 ft)	2	1	2	1
	7.6 m (25 ft)	2	1	2	1
	7.9 m (26 ft)	2	1/0	1	1/0
	8.2 m (27 ft)	2	1/0	1	1/0
	8.5 m (28 ft)	2	1/0	1	1/0
	8.8 m (29 ft)	2	1/0	1	1/0
	9.1 m (30 ft)	2	1/0	1	1/0
	9.4 m (31 ft)	2	1/0	1	1/0
	9.8 m (32 ft)	2	1/0	1	1/0
	10.1 m (33 ft)	2	2/0	1/0	2/0
	10.4 m (34 ft)	2	2/0	1/0	2/0
	10.7 m (35 ft)	1	2/0	1/0	2/0
	11.0 m (36 ft)	1	2/0	1/0	2/0
	11.3 m (37 ft)	1	2/0	1/0	2/0
	11.6 m (38 ft)	1	2/0	1/0	2/0
	11.9 m (39 ft)	1	2/0	1/0	2/0
	12.2 m (40 ft)	1	2/0	1/0	2/0

Replacement Parts

⚠ WARNING

Avoid fire or explosion hazard. Electrical, ignition, and fuel system components on Mercury Marine products comply with federal and international standards to minimize risk of fire or explosion. Do not use replacement electrical or fuel system components that do not comply with these standards. When servicing the electrical and fuel systems, properly install and tighten all components.

IMPORTANT: Deep-cycle batteries are not suitable for use as engine starting batteries.

Recommended Battery

A 12 volt battery with a minimum rating of 465 marine cranking amps (MCA) or 350 cold cranking amps (CCA) is recommended. For operation below 0 °C (32 °F), a rating of 1000 marine cranking amps (MCA) or 775 cold cranking amps (CCA) is recommended.

Battery Precautions

⚠ WARNING

An operating or charging battery produces gas that can ignite and explode, spraying out sulfuric acid, which can cause severe burns. Ventilate the area around the battery and wear protective equipment when handling or servicing batteries.

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

The following precautions should be observed to prevent an explosion:

1. Do not smoke near batteries being charged or which have been charged very recently.
2. Do not break live circuits at terminals of batteries, because a spark usually occurs at the point where a live circuit is broken. Always be careful when connecting or disconnecting cable clamps on chargers. Poor connections are a common cause of electrical arcs which cause explosions.
3. Do not reverse polarity of battery terminal to cable connections.

Charging a Discharged Battery

⚠ WARNING

An operating or charging battery produces gas that can ignite and explode, spraying out sulfuric acid, which can cause severe burns. Ventilate the area around the battery and wear protective equipment when handling or servicing batteries.

The following basic rules apply to any battery charging situation:

1. Any battery may be charged at any rate (in amperes), or as long as spewing of electrolyte (from violent gassing) does not occur, and for as long as electrolyte temperature does not exceed 52 °C (125 °F). If spewing of electrolyte occurs, or if electrolyte temperature exceeds 52 °C (125 °F), charging rate (in amperes) must be reduced or temporarily halted to avoid damage to the battery.
2. Battery is fully charged when, over a 2 hour period at a low charging rate (in amperes), all cells are gassing freely (not spewing liquid electrolyte), and no change in specific gravity occurs. Full charge specific gravity is 1.260–1.275, corrected for electrolyte temperature with electrolyte level at 4.8 mm (3/16 in.) over plate, unless electrolyte loss has occurred (from age or overfilling), in which case, specific gravity reading will be lower. For most satisfactory charging, lower charging rates in amperes are recommended.
3. If, after prolonged charging, specific gravity of at least 1.230 on all cells cannot be reached, battery is not in optimum condition and will not provide optimum performance; however, it may continue to provide additional service, if it has performed satisfactorily in the past.
4. To check the battery voltage while cranking the engine with an electric starting motor at ambient air temperature of 23.8 °C (75 °F), place the red (+) lead of the tester on the positive (+) battery terminal and the black (–) lead of the tester on the negative (–) battery terminal. If the voltage drops below 10-1/2 volts while cranking, the battery is weak and should be recharged or replaced.

Winter Storage of Batteries

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

1. Remove battery from its installation as soon as possible and remove all grease, sulfate, and dirt from the top surface by running water over top of the battery. Be sure, however, the vent caps are tight beforehand and blow off all excess water thoroughly with compressed air. Check water level, making sure the plates are covered.
2. When adding distilled water to the battery, be extremely careful not to fill more than 4.8 mm (3/16 in.) above perforated baffles inside the battery. Battery solution or electrolyte expands from heat caused by charging. Overfilling the battery will cause the electrolyte to overflow (if filled beyond 4.8 mm [3/16 in.] above baffles).
3. Grease terminal bolts with 2-4-C with PTFE and store the battery in a cool-dry place. Remove the battery from storage every 30–45 days, check the water level, and put on charge for 5 or 6 amps. Do not fast charge.

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Battery terminal bolts	92-802859A 1

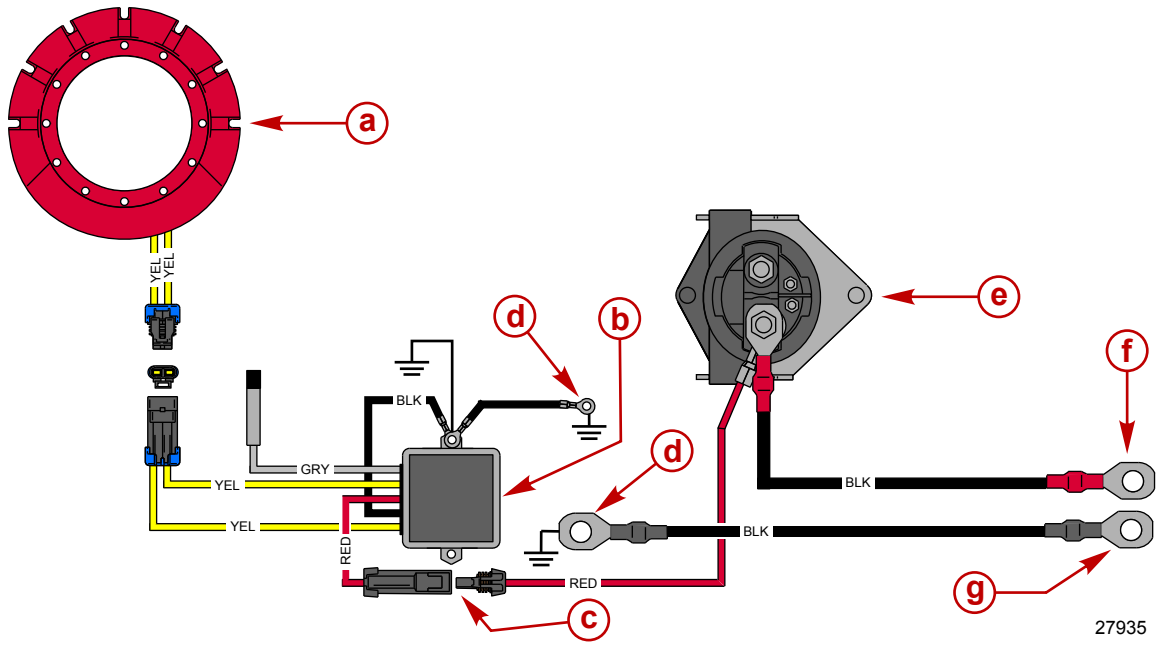
4. If specific gravity drops below 1.240, check battery for reason and recharge. When gravity reaches 1.260, discontinue charging. To check specific gravity, use a hydrometer, which can be purchased locally.
5. Repeat preceding charging procedure every 30–45 days, as long as the battery is in storage, for best possible maintenance during inactive periods to ensure a good serviceable battery in spring. When ready to place the battery back in service, remove excess grease from the terminals (a small amount is desirable on terminals at all times), recharge again, as necessary, and reinstall the battery.

Battery Charging System

Description

The battery charging system components are the flywheel, stator, regulator/rectifier, and the battery. Alternating current (AC) is generated in the stator assembly and flows to the regulator/rectifier which changes the AC to a regulated direct current (DC) for charging the battery.

Wiring Diagram



a - Stator
b - Voltage regulator/rectifier
c - Connector
d - To engine ground
e - Starter solenoid
f - To battery positive terminal
g - To battery negative terminal

Flywheel

The flywheel assembly contains six permanently charged magnet segments which are bonded and retained to the inner wall of the flywheel. Each magnet contains a north and a south pole providing a 12 pole system.

Stator

The stator assembly, located under the flywheel, contains 12 "T" poles wound in series which provides single phase AC voltage to the voltage regulator.

As the flywheel permanent magnets pass the stator windings, an AC current is produced at each winding as the magnet polarity changes across them.

Battery

A 12 volt battery with a minimum rating of 465 marine cranking amps (MCA) or 350 cold cranking amps (CCA) is recommended. For operation below 0 °C (32 °F), a rating of 1000 marine cranking amps (MCA) or 775 cold cranking amps (CCA) is recommended.

Voltage Regulator/Recifier

The voltage regulator is an electronic device that regulates alternator output according to the accessory loads and state of the battery. The voltage regulator manages the alternator output according to operating conditions. The voltage regulator must balance the needs of a fully charged battery, long battery life, and accessory loads.

Symptoms of a faulty voltage regulator may include a discharged battery, short battery life, poor accessory and lighting operation, frequent bulb replacement, lower than normal voltmeter readings, or frequent topping off of the battery's electrolyte.

Troubleshooting the Battery Charging System

IMPORTANT: The charging system may be damaged by:

- **Reversed battery cables**
- **Running the engine with the battery cables disconnected and stator leads connected to the rectifier**
- **An open circuit, such as a broken wire or loose connection**

A fault in the battery charging system will cause the battery to become undercharged or overcharged. Check the battery electrolyte level. Charge the battery, if necessary.

If the battery will not accept a satisfactory charge, replace the battery.

If the battery accepts a satisfactory charge, determine the cause of the charging system problem as follows.

- Check for correct battery polarity: red cable to positive (+) battery terminal. If the polarity was incorrect, check for a damaged voltage regulator/rectifier and/or main fuse. Refer to **Voltage Regulator/Rectifier Test**.
- Check for loose or corroded battery cable connections.
- Visually inspect the wiring between the stator and the battery for cuts, chafing, loose, corroded, or disconnected connection.
- Excessive electrical load from too many accessories will cause battery to run down.

Battery Charging System Test		
Test Number	**Procedure**	**Test Result**
Test 1	Check the voltage of the starting battery while the engine is running.	**Battery voltage above 15.0 volts:** Replace the voltage regulator/rectifier.
		Battery voltage below 12.5 volts: Charge the battery. If the battery cannot be satisfactorily charged, replace the battery.
		Battery voltage 12.6 volts to 15.0 volts: Proceed to Test 2.
Test 2	Check the voltage of the starting battery while cranking the engine with the starter motor.	**Battery voltage below 9.0 volts:** Replace the battery.
		Battery voltage above 9.0 volts: Proceed to Test 3.
Test 3	Perform the stator output current test	**Stator output current test is within specification:** The charging system is functioning properly.
		Stator output current test not within specification: Proceed to Test 4.

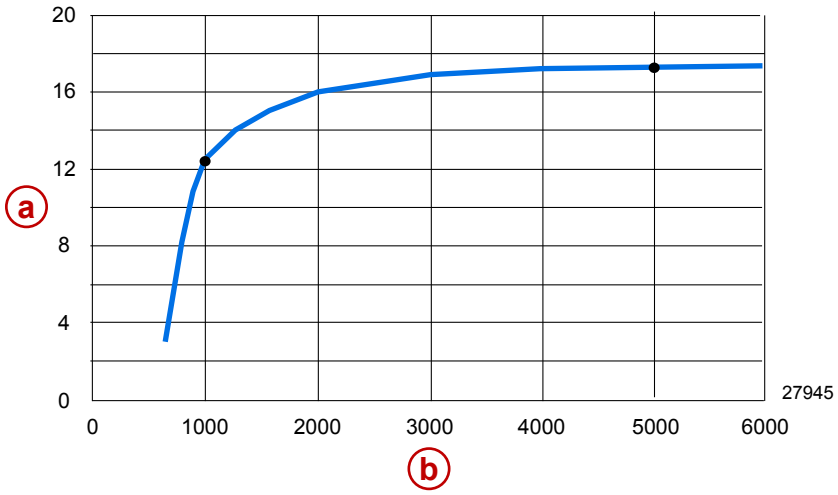
Battery Charging System Test		
Test Number	**Procedure**	**Test Result**
Test 4	Perform the stator resistance test	**Stator resistance test is within specification:** The charging system is functioning properly.
		Stator resistance test not within specification: Replace the stator.

Alternator System Test

1. Check the battery voltage at the battery with the engine running.
2. Check stator wire for a short to ground.
3. If the battery voltage is above 15.0 volts, replace the voltage regulator/rectifier. Check the condition of the battery as overcharging may have damaged the battery.
4. If the battery voltage is below 12.5 volts, charge the battery. If the battery cannot be satisfactorily charged, replace the battery.
5. If the battery accepts a satisfactory charge, check the battery voltage while cranking the engine. If cranking voltage is not acceptable, replace the battery.
6. If cranking voltage is acceptable, install a clamp-on current probe around the red voltage regulator/rectifier wire.

Clamp-on Current Probe	91-802650
DMT 2004 Digital Multimeter	91-892647A01

7. Ensure the stator wires are secured away from the flywheel.
8. With engine running at the indicated RPM, the multimeter should indicate the following appropriate amps:



a - Output current (amps)
b - Engine RPM x 1000

Alternator output	
At 1000 RPM	12.5 A
At 5000 RPM	17.5 A

9. A reading in excess of 17.5 amps at 5000 RPM and the battery at 12.6 volts indicates the charging system is functioning properly.
10. If the ammeter reads less than the required amps at 5000 RPM, test the stator. Refer to **Stator Resistance Test**. If the stator tests within specification, replace the voltage regulator/rectifier.

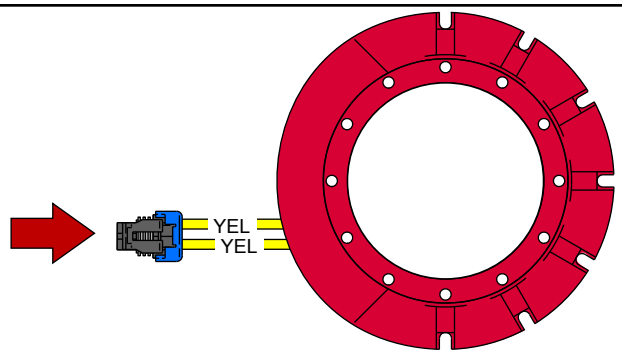
NOTE: *The voltage regulator reduces the charging current as the battery voltage increases. Maximum current is produced with the battery voltage at 12.6 volts.*

Stator Resistance Test

NOTE: *Resistance readings may vary slightly due to temperature changes. The test readings listed were taken at 20 °C (68 °F). The multimeters should be zeroed before making measurements.*

1. With the engine turned off, disconnect the stator harness connector.
2. Use the DMT 2004 digital multimeter and perform the following test.

Test



Meter Test Leads		Meter Scale	Reading
Red	Black		
Stator connector yellow lead	Stator connector yellow lead	Ω	0.2–0.6
Either stator connector yellow lead	Engine ground	Ω	∞, OUCH, or OL

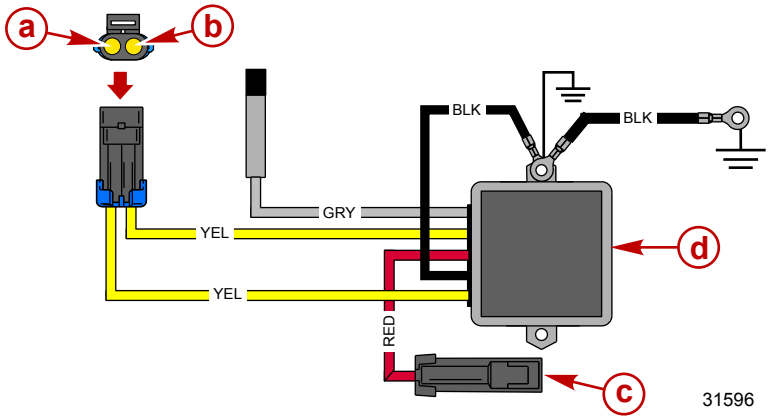
DMT 2004 Digital Multimeter	91-892647A01

Voltage Regulator/Rectifier Test

NOTE: *Voltage regulator/rectifier specifications are given for informational purposes only. Use the appropriate troubleshooting techniques previously mentioned to find the faulty component in the charging system.*

1. Disconnect the stator harness connector and the red wire connector.
2. Use the DMT 2004 digital multimeter. Set the meter to diode check and perform the following test.

Test



a - Test point - Yel (1)
b - Test point - Yel (2)
c - Test point - Red
d - Metal case

Meter Test Leads		Meter Scale	Reading
Red	Black		
Yel (1)	Red	Diode check	0.4–0.8 V
Yel (2)	Red	Diode check	0.4–0.8 V
Red	Yel (1)	Diode check	∞, OUCH, or OL
Red	Yel (2)	Diode check	∞, OUCH, or OL
Yel (1)	Metal case	Diode check	1.5 V, ∞, OUCH, or OL
Yel (2)	Metal case	Diode check	1.5 V, ∞, OUCH, or OL

DMT 2004 Digital Multimeter	91-892647A01

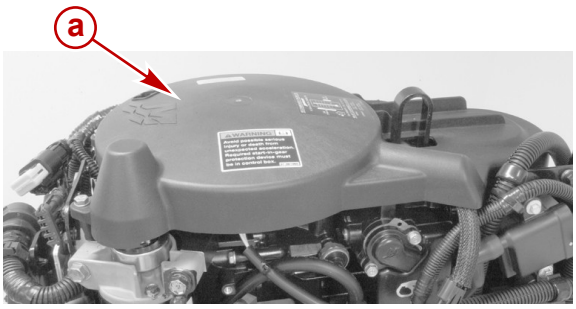
Flywheel Removal and Installation

Removal

⚠ WARNING

An unexpected engine start due to rotation of the flywheel may cause serious injury. During removal, installation, or adjustment of the flywheel, always remove the spark plug leads and isolate the leads to the engine ground.

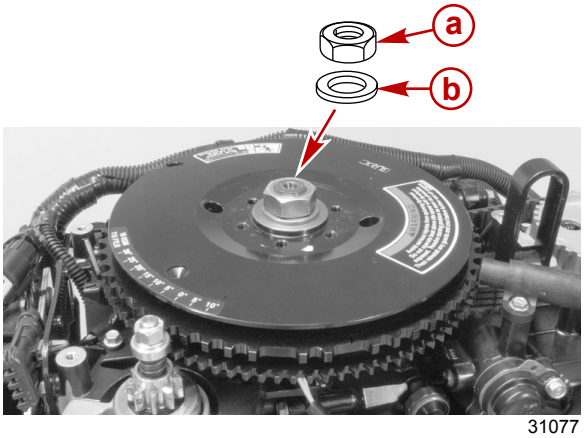
1. Remove the four bolts securing the flywheel cover. Remove the flywheel cover.



31061

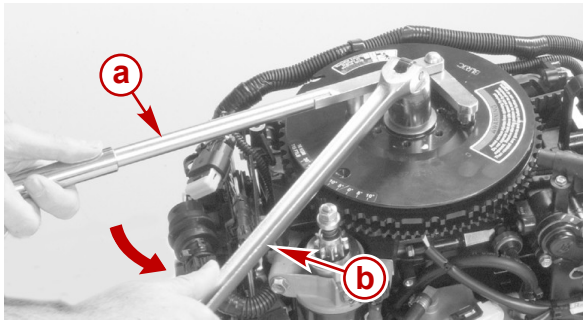
a - Flywheel cover

2. Hold the flywheel from turning by using the flywheel holder tool and remove the nut and washer.



31077

a - Nut
b - Flat washer



31083

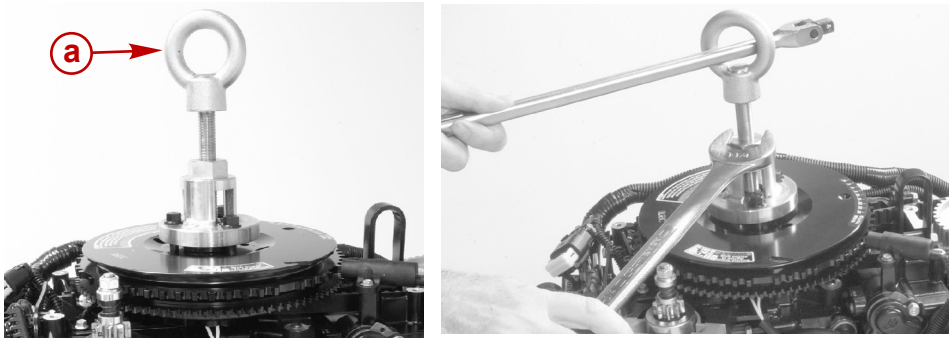
a - Flywheel holder
b - Breaker bar with 30 mm socket

Flywheel Holder	91- 83163M

NOTE: *Do not use heat or strike the flywheel to aid in the flywheel removal process.*

3. Apply a small amount of grease to the end of the crankshaft before installing the flywheel puller.
4. Fasten the flywheel puller onto the flywheel with three of the shoulder bolts that are provided with the puller.

5. Loosen the flywheel using the puller.



31090

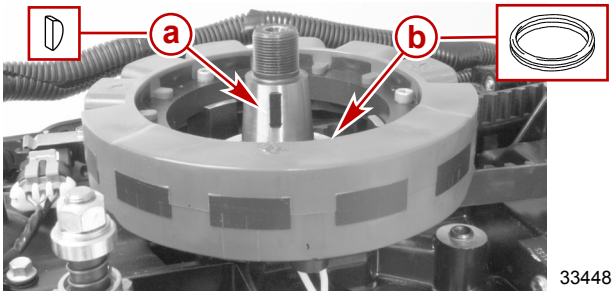
a - Flywheel puller

Flywheel Puller/Lifting Ring	91- 83164M

6. Remove the flywheel and retain the flywheel key. Discard the load ring.

Installation

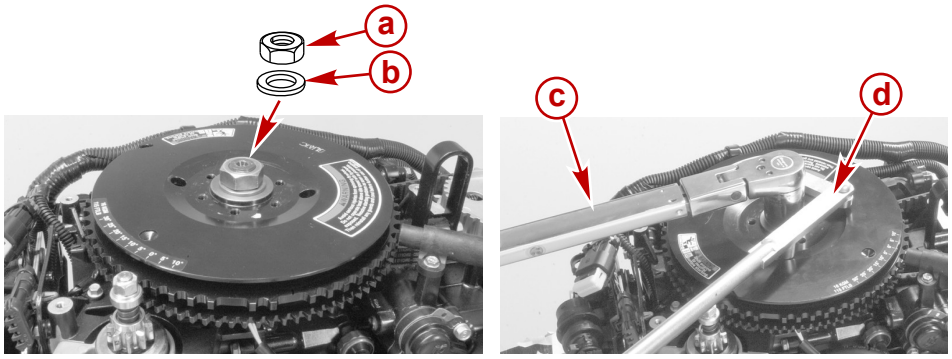
1. Place the flywheel key into the crankshaft keyway.
2. Place a new load ring over the crankshaft.



33448

a - Flywheel key
b - Load ring

3. Apply oil to the threads on the crankshaft.
4. Install the flywheel onto the crankshaft and secure with a flat washer and hex nut. Use the flywheel holder to hold the flywheel and tighten the nut to the specified torque.



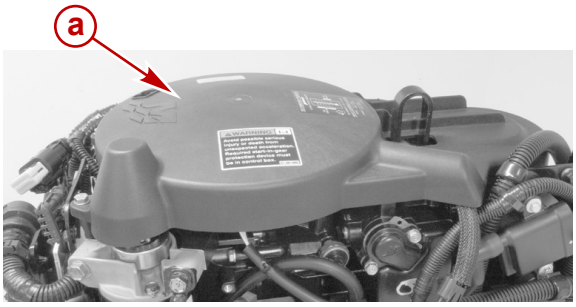
31099

a - Nut
b - Washer
c - Torque wrench with 30 mm socket
d - Flywheel holder

Flywheel Holder	91- 83163M

Description	Nm	lb-in.	lb-ft
Flywheel nut	156		115

5. Install the flywheel cover and tighten the bolts to the specified torque.



31061

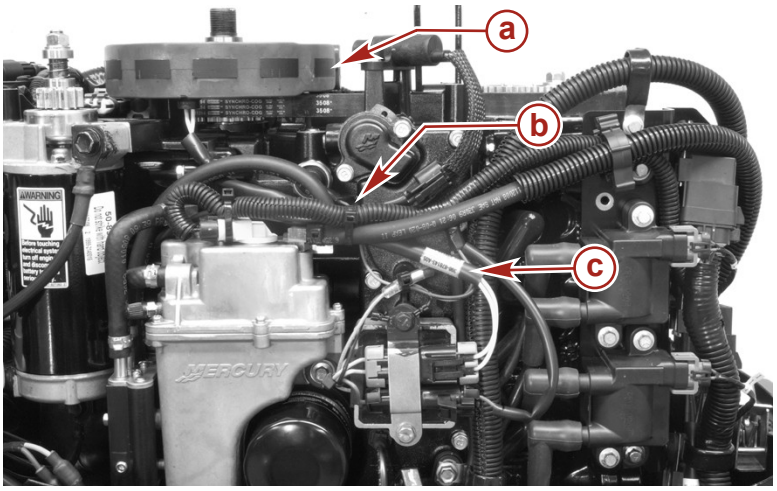
a - Flywheel cover

Description	Nm	lb-in.	lb-ft
Flywheel cover bolts (M6 x 25) (4)	8.5	75	

Stator Removal and Installation

Removal

1. Remove the flywheel. Refer to **Flywheel Removal**.
2. Disconnect the stator harness from the voltage regulator/rectifer.
3. Remove the three stator mounting screws. Cut the cable tie fastening the stator harness and remove the stator.



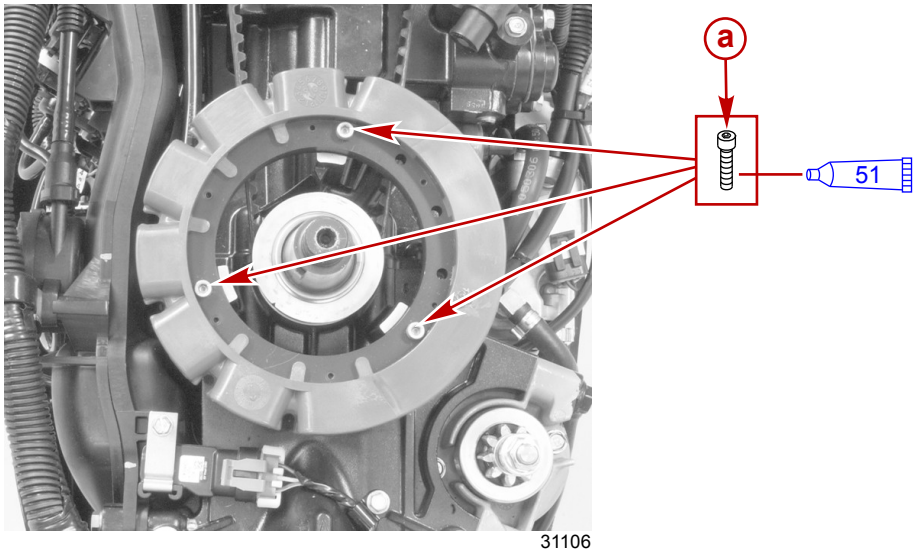
42735

a - Stator
b - Cable tie
c - Stator harness

Installation

1. Position the stator onto the top of the engine.
2. Apply Loctite 222 to the threads of the three stator mounting screws.

3. Secure the stator with the three stator mounting screws. Tighten the screws to the specified torque.



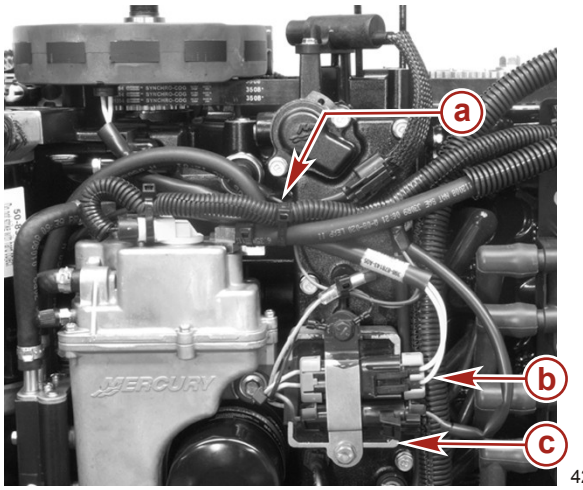
31106

a - Stator mounting screws

Tube Ref No.	Description	Where Used	Part No.
51	Loctite 222 Threadlocker	Stator mounting screw threads	92-809818

Description	Nm	lb-in.	lb-ft
Stator mounting screws (M5 x 30) (3)	9.5	85	

4. Route the stator harness, as shown, and connect the stator harness to the voltage regulator/rectifer.
5. Secure the stator harness to the VST harness, VST fuel hose, and CPS engine harness with a cable tie.



42737

a - Cable tie
b - Stator harness
c - Voltage regulator/rectifer

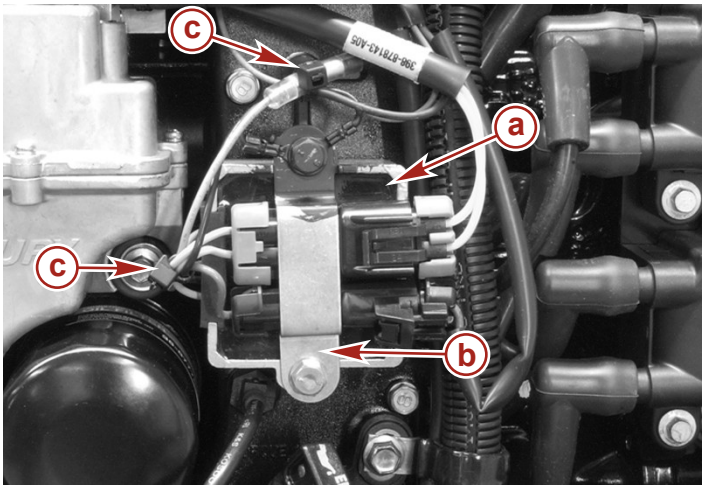
6. Install the flywheel. Refer to **Flywheel Installation**.

Voltage Regulator/Rectifier Removal and Installation

Removal

1. Cut the cable ties securing the voltage regulator/rectifier wires.
2. Disconnect the wiring connectors from the voltage regulator/rectifier.

3. Remove the two bolts securing the bracket and voltage regulator/rectifier to the engine.

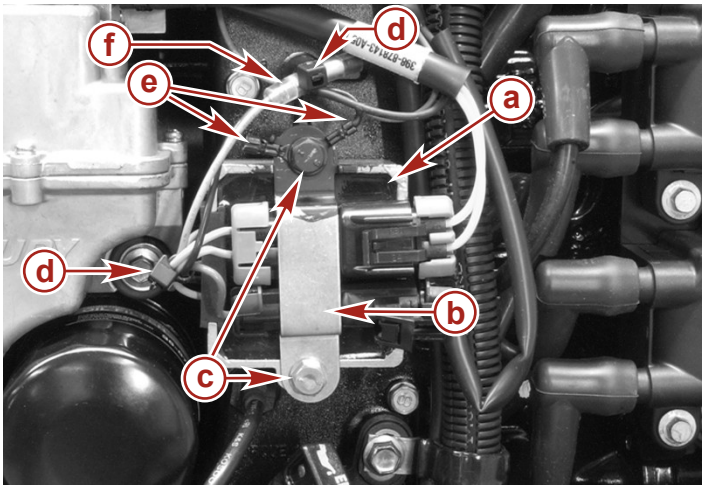


42270

a - Voltage regulator/rectifier
b - Bracket
c - Cable tie

Installation

1. Secure the voltage regulator/rectifier, two wiring connectors, and two ground wires with the bracket. Tighten the bolts securing the bracket to the specified torque.
2. Connect the wiring to the voltage regulator/rectifier.
3. Secure the wire with cable ties, as shown.
4. Seal the engine ground wire connection with Liquid Neoprene.



42271

a - Voltage regulator/rectifier
b - Bracket
c - Bolt (M6 x 40) (2)
d - Cable tie
e - Engine ground wires
f - Bullet connector

Description	Nm	lb-in.	lb-ft
Voltage regulator/rectifier mounting bolts (M6 x 40) (2)	8.5	75	

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Seal ground wire connection	92- 25711 3

Cranking System

Description

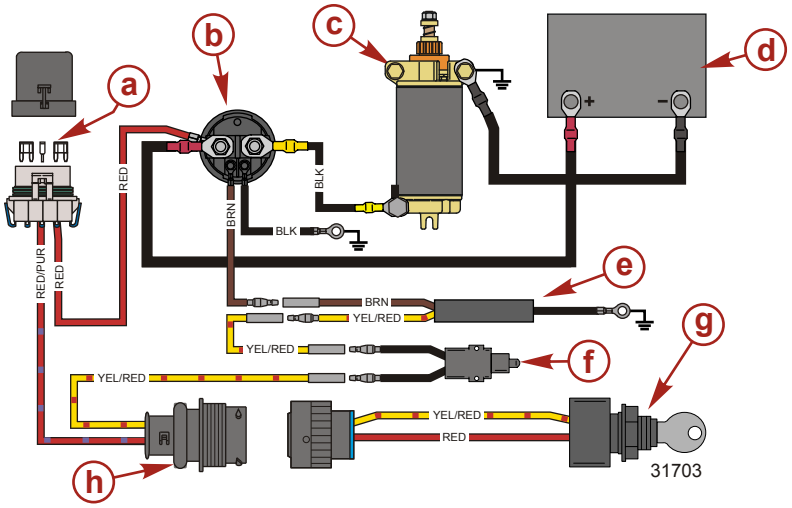
The function of the cranking system is to crank the engine. The battery supplies electrical energy to crank the starter motor. When the ignition switch is turned to the "START" position, the starter solenoid is activated and completes the starting circuit between the battery and starter.

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

The purpose of the suppression diode is to eliminate the inductive spike created as the start solenoid is de-energized (key switch turned from "Start" to "Run"). The suppression diode is located between the brown lead from the starter solenoid and the yellow/red lead from the engine harness. The third lead from the suppression diode connects to the engine ground.

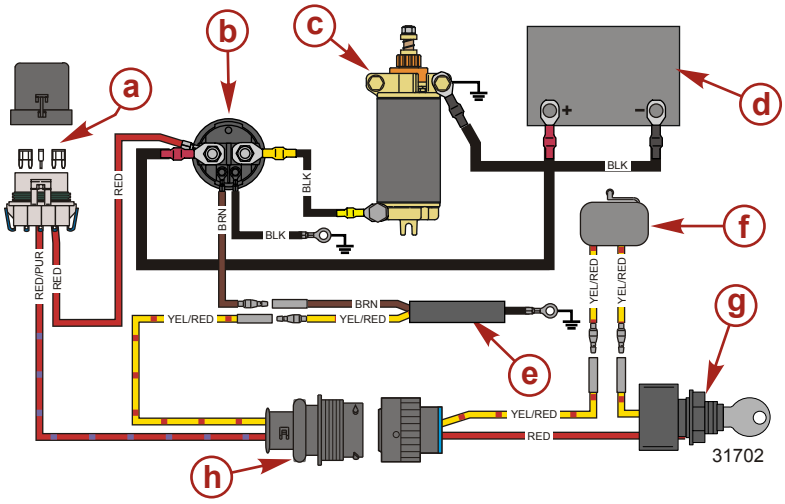
The starting system consists of the following components:

Starting System Wiring Diagram



Tiller handle models

- **a -** 15 amp fuse
- **b -** Starter solenoid
- **c -** Starter motor
- **d -** Battery
- **e -** Suppression diode
- **f -** Neutral start switch
- **g -** Ignition key switch
- **h -** 14 pin connector



Remote control models

- **a -** 15 amp fuse
- **b -** Starter solenoid
- **c -** Starter motor
- **d -** Battery
- **e -** Suppression diode
- **f -** Neutral start switch
- **g -** Ignition key switch
- **h -** 14 pin connector

Troubleshooting the Starting System

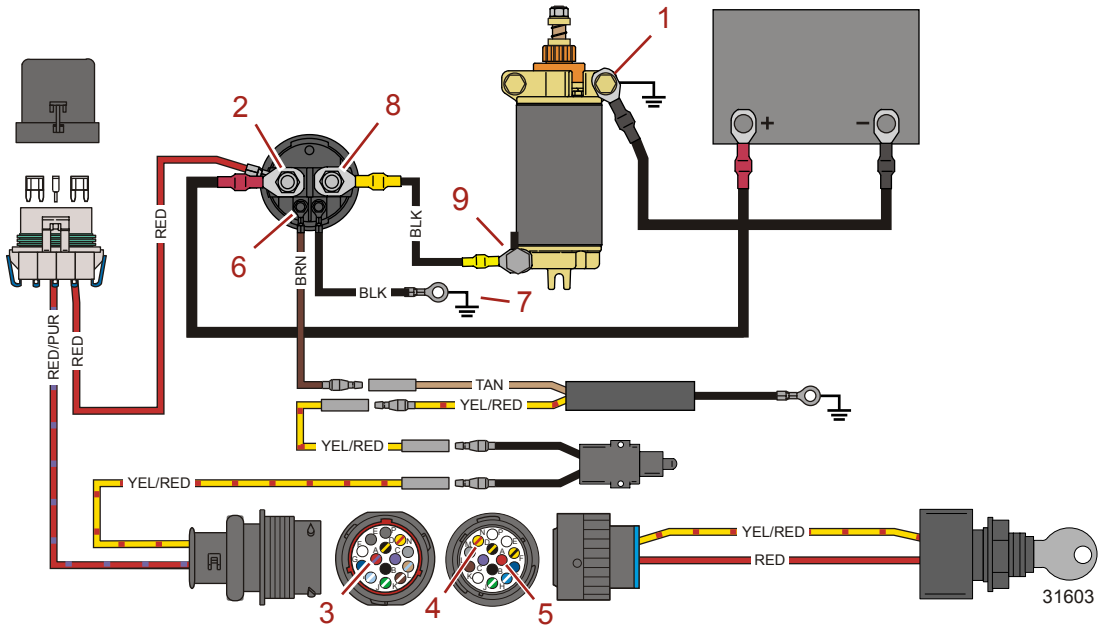
The following starting circuit troubleshooting chart will locate any malfunction. Location of test points called out in the chart are numbered in the diagrams.

Before beginning the starting system troubleshooting flowchart, first check for the following conditions:

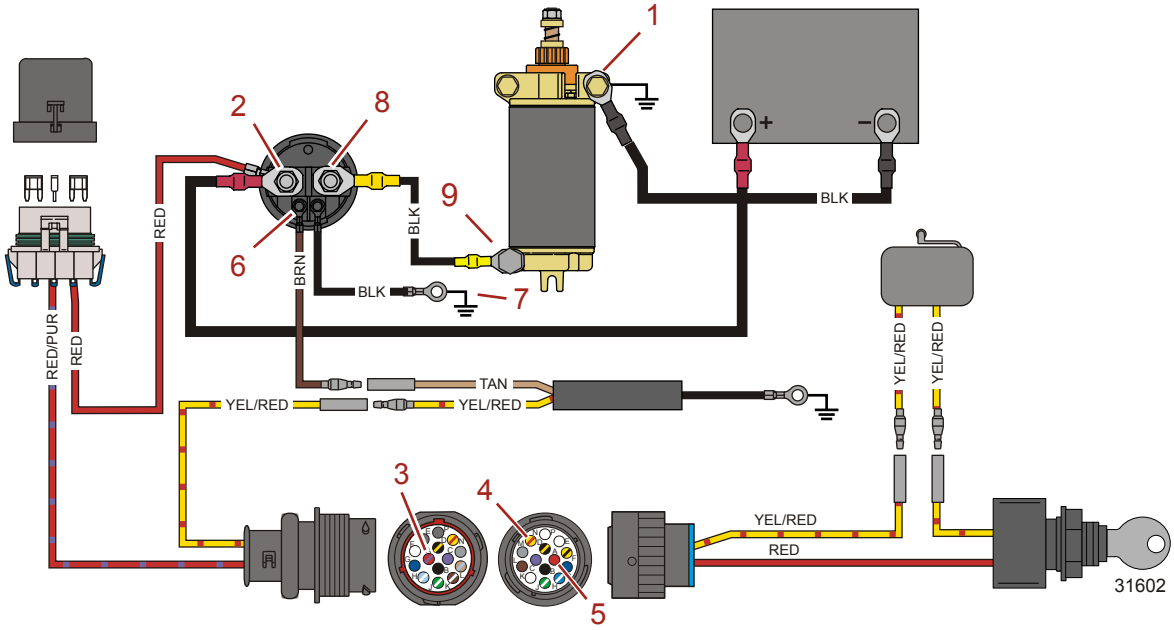
- Ensure that the battery is fully charged.
- Ensure the engine is shifted into neutral position.
- Check the battery terminals for corrosion and loose connections.
- Check the cables and wiring for frayed and worn insulation.
- Check the in-line fuse.

Use the DMT 2004 digital multimeter and perform the following test.

NOTE: *Disconnect the starter motor lead from the starter solenoid at test point 8 before making tests 5 through 7 to prevent unexpected engine cranking.*



Tiller handle models



Remote control models

Starter Does Not Work		
Test Number	**Procedure**	**Test Result**
Test 1	Check continuity between test point 1 and the negative (–) battery terminal.	**Continuity indicated:** Proceed to Test 2.
		No continuity indicated: There is an open circuit in the negative (–) battery cable between the battery and the engine. • Check the cable for a loose or corroded connection. • Check the cable for an open circuit.

Starter Does Not Work		
Test Number	**Procedure**	**Test Result**
Test 2	Check voltage between test point 2 and engine ground.	**Reading battery voltage:** Proceed to Test 3. **No voltage reading:** There is an open circuit in the positive (+) battery cable between the battery and the engine. • Check cable for loose or corroded connections. • Check cable for open.
Test 3	1. Disconnect the boat wiring harness from the 14 pin connector. 2. Check voltage between test point 3 (pin A) and engine ground.	**Reading battery voltage:** Proceed to Test 4. **No voltage reading:** Check for open lead or open fuse between test points 2 and 3.
Test 4	1. Set the shift control to neutral. 2. Turn the ignition key to "START" position and check continuity between test points 4 and 5 (pins N and A).	**Continuity indicated:** Proceed to Test 5. **No continuity indicated:** • The ignition key switch may be defective. • On remote control models, the neutral start switch is open. • Lead is open between test points 4 and 5.
Test 5	1. Reconnect the boat wiring harness to the 14 pin connector. 2. Disconnect the starter motor lead from the starter solenoid at test point 8. 3. Turn the ignition key to "START" position and check voltage between test point 6 and engine ground.	**Reading battery voltage:** Proceed to Test 6. **No voltage reading:** • Lead is open between test points 5 and 6. • On tiller handle models, the neutral start switch is open.
Test 6	1. Disconnect the black ground wire from test point 7. 2. Turn the ignition key to "START" position and check voltage between the black ground wire and engine ground at test point 7.	**Reading battery voltage:** Reconnect the black ground wire and proceed to Test 7. **No voltage reading:** Defective starter solenoid.
Test 7	Turn the ignition key to "START" position and check voltage between test point 8 and engine ground.	**Reading battery voltage:** Proceed to Test 8. **No voltage reading:** Defective starter solenoid.
Test 8	1. Reconnect the starter motor lead to the starter solenoid at test point 8. 2. Turn the ignition key to "START" position and check voltage between test point 9 and engine ground.	**Reading battery voltage:** Check the starter for a corroded ground to the engine. If OK, check the starter motor. **No voltage reading:** Lead is open between test points 8 and 9.

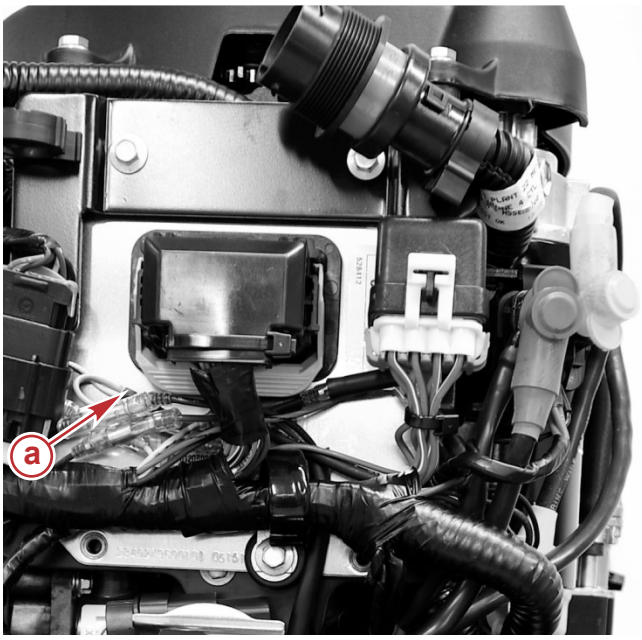
Suppression Diode

When turning the key to the "START" position, if the 15 amp main relay/accessories fuse blows, check the suppression diode. If the battery is connected backwards, the diode will fail, providing a direct short to ground each time the starter is engaged.

Symptoms of a failed suppression diode:

1. Open circuit - The warning horn will sound while cranking the engine for start up.

2. Short circuit - Blown fuse (main relay/accessories).



60748

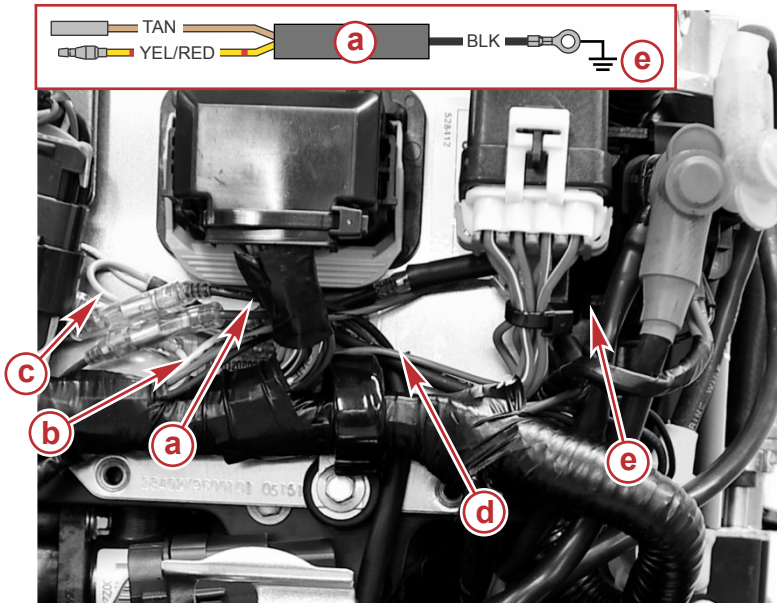
Four cylinder model shown

a - Suppression diode

Suppression Diode Replacement

Attach the ground lead to engine ground with the ground bolt, as shown. Tighten the bolt to the specified torque and seal the ground connection with Liquid Neoprene.

Refer to the **Starting System Wiring Diagram** and connect the brown and yellow/red leads.



60750

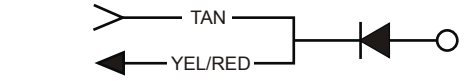
a - Suppression diode
b - Yellow/red wire
c - Tan wire
d - Brown wire to starter solenoid
e - Ground bolt

Description	Nm	lb-in.	lb-ft
Ground bolt (M6 x 14)	5	45	–

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Seal ground wire connection	92- 25711 3

Suppression Diode Test

Use the DMT 2004 digital multimeter and perform the following test.



43353

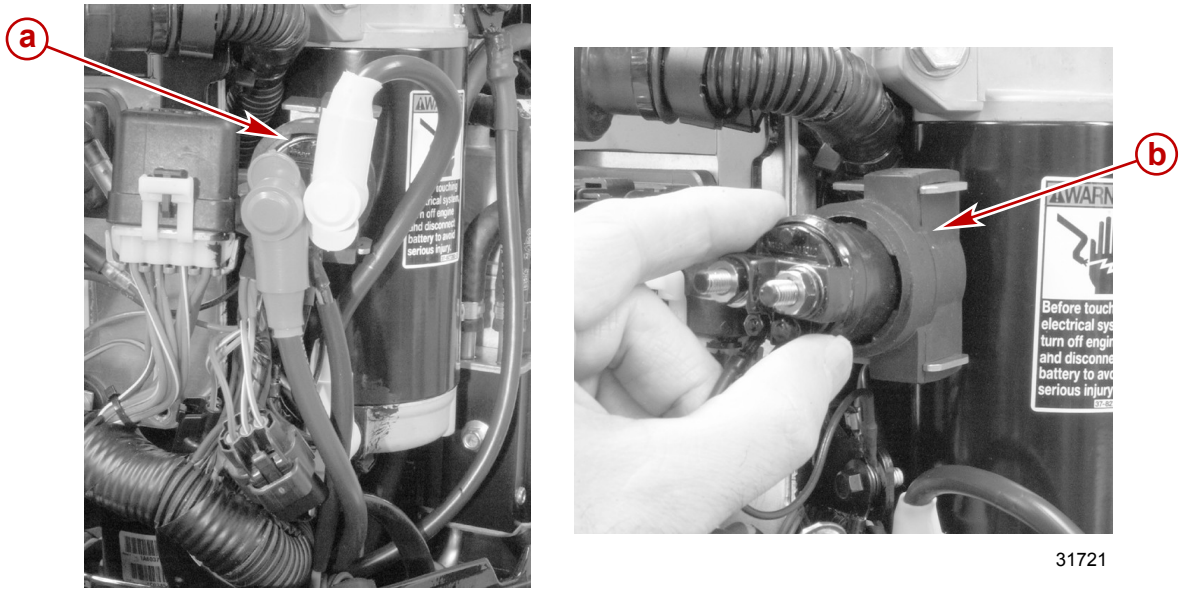
41971

Meter Test Leads		Meter Scale	Reading
Red	Black		
YEL/RED	TAN	DCV	0 or Short
YEL/RED	BLK	DCV	0.4–0.8
TAN	YEL/RED	DCV	0 or Short
TAN	BLK	DCV	0.4–0.8
BLK	YEL/RED	DCV	OUCH, OL, ∞
BLK	TAN	DCV	OUCH, OL, ∞
YEL/RED	TAN	Ω	< 0.5
YEL/RED	BLK	Ω	1–3 M
TAN	YEL/RED	Ω	< 0.5
TAN	BLK	Ω	1–3 M
BLK	YEL/RED	Ω	OUCH, OL, ∞
BLK	TAN	Ω	OUCH, OL, ∞

Starter Solenoid

Starter Solenoid Removal

1. Remove the engine battery leads from the battery.
2. Remove the wiring from the solenoid terminals.
3. Disconnect the brown lead and remove the black ground lead from the engine ground.
4. Pull the solenoid out of the rubber mount.



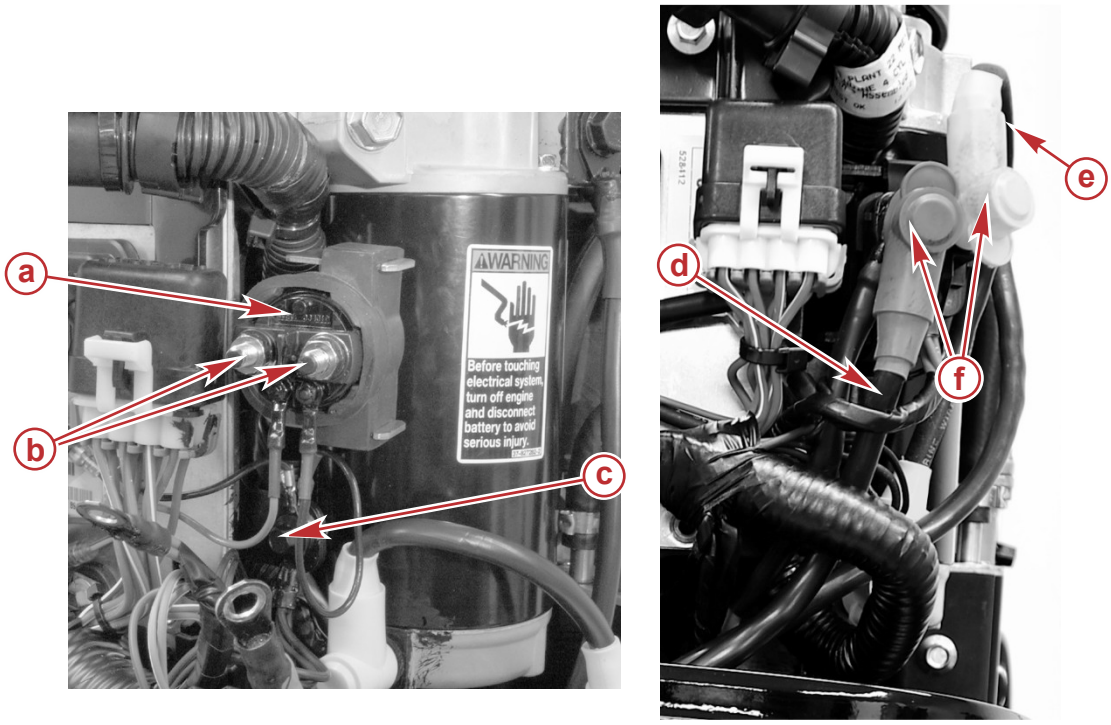
31721

a - Starter solenoid
b - Rubber mount

Starter Solenoid Installation

1. Insert the starter solenoid into the rubber mount. Push in the solenoid until its outer flange is seated inside the rubber mount.

2. Fasten the black lead to the engine ground with the ground bolt, as shown. Tighten the bolt to the specified torque and seal the ground connection with Liquid Neoprene.
3. Attach the wiring to the main terminals with hex nuts. Position the wiring connections, as shown. Tighten the hex nuts to the specified torque and seal the connections with Liquid Neoprene.
4. Place a rubber insulator boot over each terminal.



60755

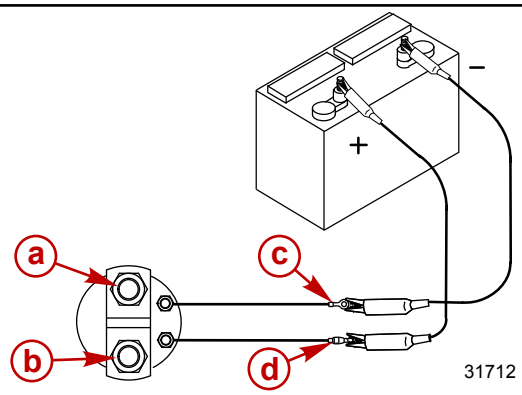
a - Starter solenoid
b - Main terminals
c - Ground bolt
d - +12 volt battery cable
e - Starter motor cable
f - Insulator boot (2)

Description	Nm	lb-in.	lb-ft
Ground bolt (M6 x 14)	5	45	–
Main terminal hex nuts	5	45	–

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Seal ground wire connection	92- 25711 3

Starter Solenoid Test

1. Disconnect the wires from the solenoid.
2. Use the DMT 2004 digital multimeter and perform the following test.
3. Connect the meter test leads to the listed terminals.
4. Connect the black and brown leads to a 12 volt power supply. The solenoid should click and the meter should read 0 ohms (full continuity). Replace the solenoid if the meter does not read 0 ohms (full continuity).



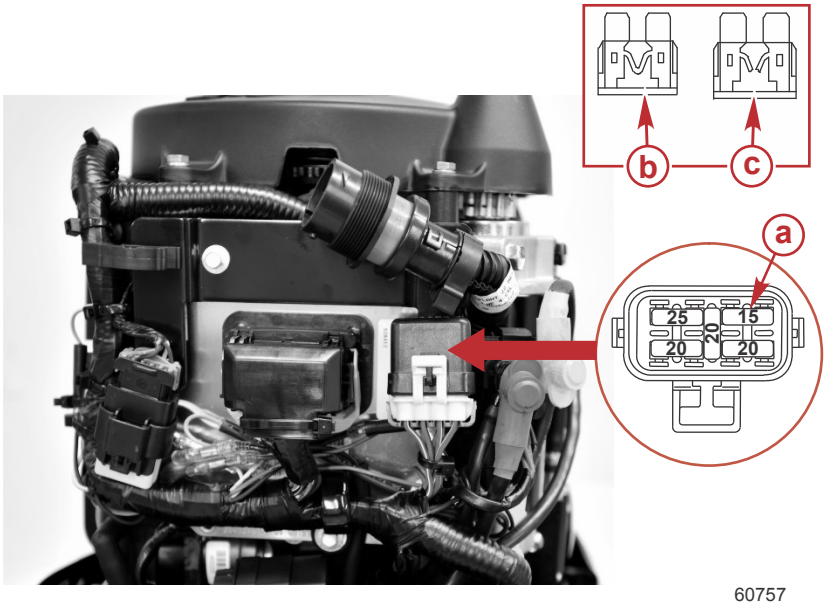
a - Terminal 1
b - Terminal 2
c - Black lead
d - Brown lead

Meter Test Leads		Meter Scale	Reading
Red	Black		
Terminal 2	Terminal 1	Ω	0

DMT 2004 Digital Multimeter	91-892647A01

Starting Circuit Fuse

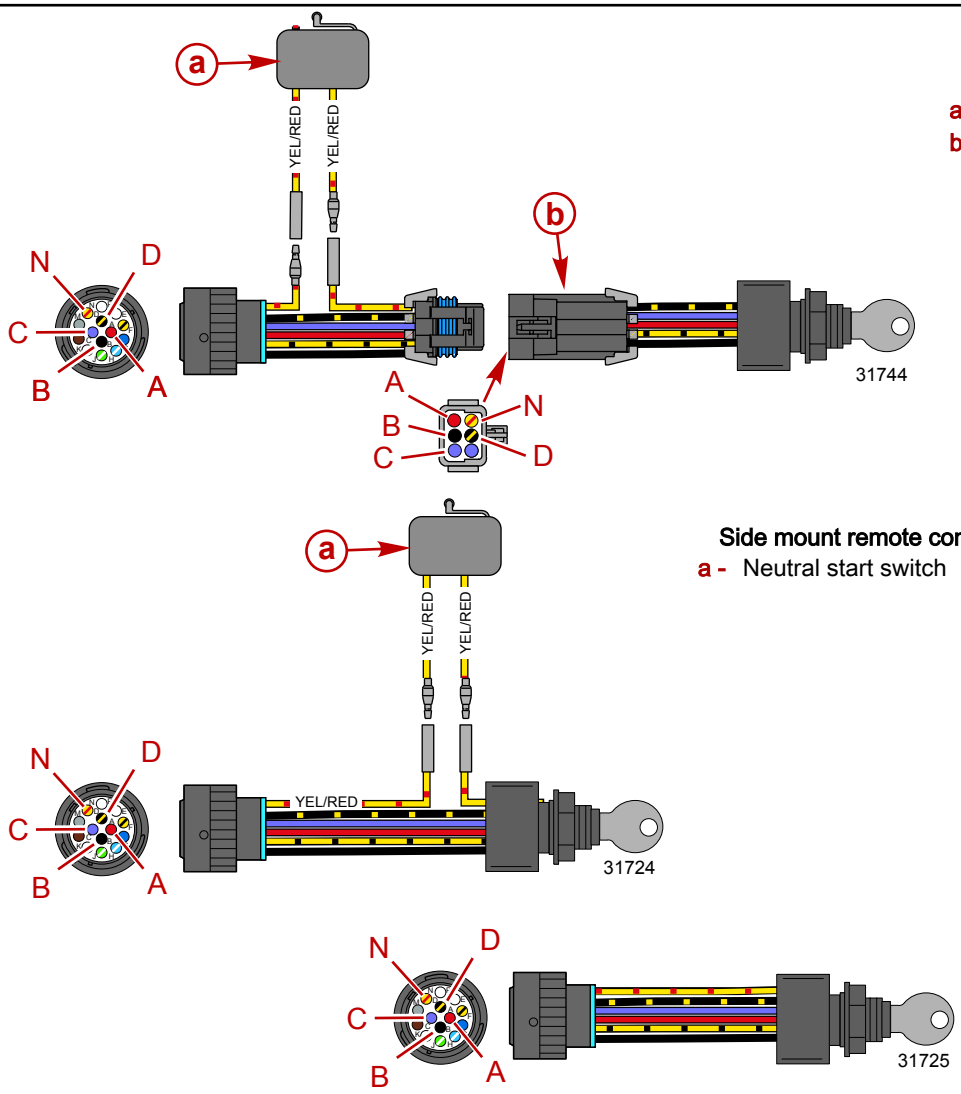
The starting circuit is protected from overload by the 15 amp fuse that is located in the fuse holder near the starter motor. Open the fuse holder and look at the silver colored band inside the fuse. If the band is broken, replace the fuse with a new fuse with the same rating.



a - 15 amp fuse
b - Good fuse
c - Blown fuse

Ignition Key Switch Test

1. Disconnect the 14 pin connector. If the boat is equipped with a panel or console remote control, the ignition key switch can be tested at the 6 pin connector.
2. Remote control models - Position the shift level into neutral.
3. Use the DMT 2004 Digital Multimeter and perform the following test.
4. Connect the meter test leads to the listed connector pins and check for full continuity.
5. If the meter reading on remote control models are other than specified, verify that the ignition key switch is faulty and not the neutral start switch.



Panel and console mount remote control models

a - Neutral start switch

b - 6 pin connector

Side mount remote control models

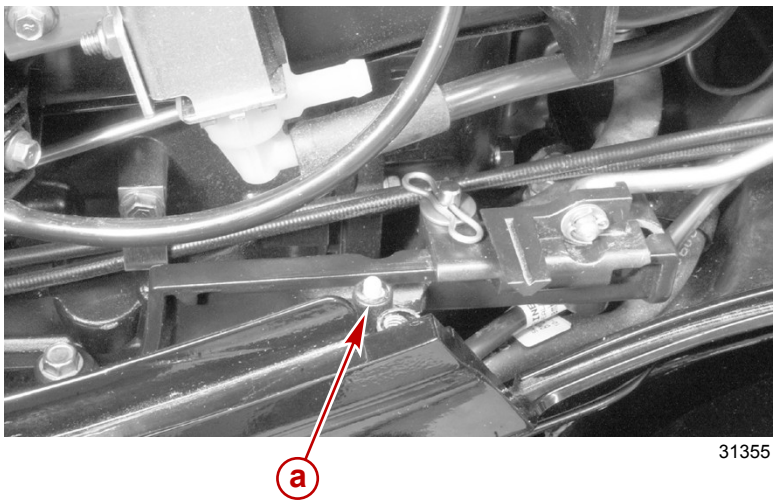
a - Neutral start switch

Tiller handle models

Meter Test Leads		Key Switch Position	Meter Scale	Reading (Ω)
Red	Black			
Pin B	Pin N	"'OFF"	Ω	0
Pin A	Pin C	"ON"	Ω	0
Pin A	Pin N	"START"	Ω	0
Pin A	Pin C	"START"	Ω	0
Pin N	Pin C	"START"	Ω	0

DMT 2004 Digital Multimeter	91-892647A01

Neutral Start Switch Test (Tiller Handle Model)



a - Neutral start switch

Refer to **Section 7B - Tiller Handle** for replacement instructions for the switch.

Continuity Test - Neutral (Switch Depressed)

Meter Test Leads		Meter Scale	Reading (Ω)
Red	Black		
Black	Black	Ω	0 or SHORT

Continuity Test - In Gear (Switch Not Depressed)

Meter Test Leads		Meter Scale	Reading (Ω)
Red	Black		
Black	Black	Ω	OUCH, OL, or ∞

Starter Motor Removal and Installation

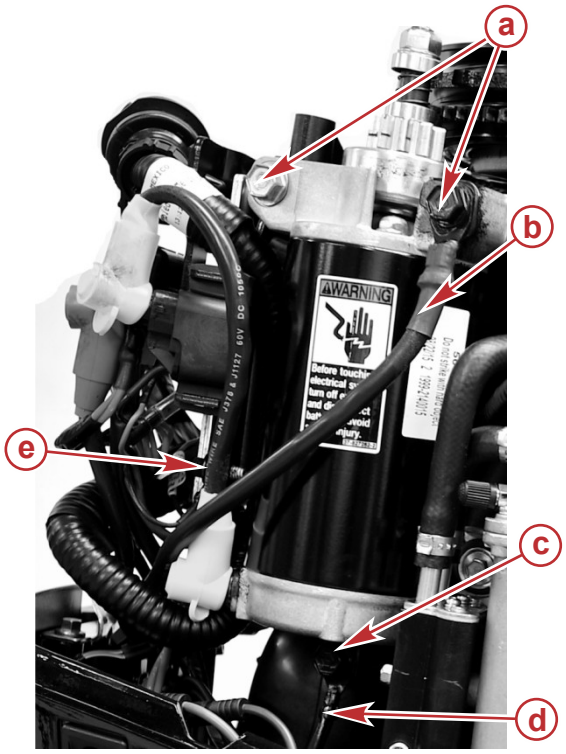
Removal

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

1. Disconnect the battery leads from the battery.
2. Disconnect the positive 12 volt wire from the terminal on the starter motor.

3. Remove the two upper mounting bolts and loosen the lower mounting bolt. Lift up on the starter motor and remove.



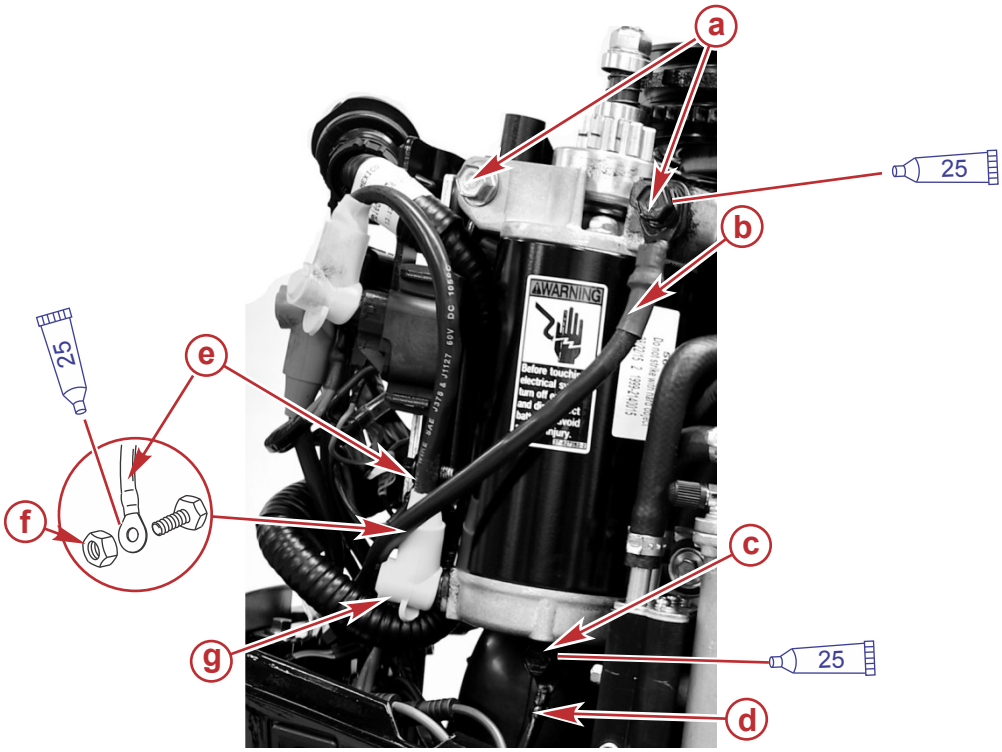
60759

a - Upper mounting bolts
b - Negative battery cable
c - Lower mounting bolt
d - Black ground wires
e - Positive 12 volt wire

Installation

1. Install the starter motor to the engine with three mounting bolts. Fasten the negative battery cable along with the upper mounting bolt, as shown, and connect the ground wires with the lower mounting bolt. Tighten the bolts to the specified torque.
2. Attach the positive 12 volt wire to the terminal on the starter motor with a hex nut. Tighten the hex nut to the specified torque.
3. Seal all the wire connections with Liquid Neoprene.

4. Place the insulator boot over the terminal.



60762

a - Upper mounting bolts
b - Negative battery cable
c - Lower mounting bolt
d - Black ground wires
e - Positive 12 volt wire
f - Hex nut
g - Insulator boot

Description	Nm	lb-in.	lb-ft
Starter motor mounting bolts (M8 x 45) (3)	29.4	–	22
Positive 12 volt wire hex nut (1/4-20)	6.8	60	–

Tube Ref No.	Description	Where Used	Part No.
25	Liquid Neoprene	Battery cable and wire connections	92- 25711 3

Electrical

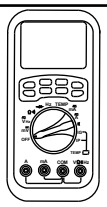
Section 2C - Timing, Synchronizing, and Adjusting

Table of Contents

Ignition Specifications

Ignition Specifications at 20 °C (68 °F)		
Ignition type		Capacitor discharge ignition
Spark plug type		Champion RA8HC
Spark plug gap		1.0 mm (0.040 in.)
Spark plug hex size		16 mm (5/8 in.)
Spark plug torque		17 Nm (150 lb-in.)
Spark plug hole size		12 mm
Firing order		1–3–4–2
Ignition timing	at Idle	Controlled by ECM
	at 1500–1800 RPM	14° BTDC
	at WOT	28° BTDC
Stator resistance		0.2–0.3 Ω (yellow - yellow)
Crankshaft position sensor resistance		300–350 Ω (red - white)
Ignition coil resistance		Refer to **Ignition Coil Resistance Test** chart
ECM engine speed limiter	Fuel/spark cutout on cylinders #2 and #3	6225 RPM
	Fuel/spark cutout on all cylinders	6350 RPM
ECM overheat speed control		Guardian System is activated. Power limit will vary with the level of overheat.
ECM low oil pressure speed control		Guardian System is activated. Engine power is limited to 10% of maximum (approximately 2000 RPM).
MAT/ECT temperature sensor		Refer to **Section 3B - Component Resistance Tests**
Manifold absolute pressure (MAP) sensor resistance		Refer to **Section 3B - Component Resistance Tests**
Fuel injector resistance		10.0–13.5 Ω
Main power relay		81–99 Ω (pin 85–pin 86)
Idle air control (IAC)		24–30 Ω (between pins)
Throttle position sensor (TPS) typical range	Output voltage at Idle	0.39–1.00 volts
	Output voltage at WOT (6000 RPM)	3.66–4.80 volts

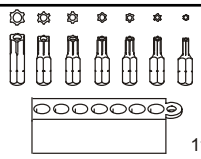
Special Tools

DMT 2004 Digital Multimeter	91-892647A01
 4516	Measures RPM on spark ignition (SI) engines, ohms, amperes, AC and DC voltages; records maximums and minimums simultaneously, and accurately reads in high RFI environments.

Timing Light	91- 99379
 11561	Allows a technician to check ignition timing.

CDS G3 Harness	84-8M0045065
 43351	Connects the engine harness to the CDS G3 diagnostic interface tool.

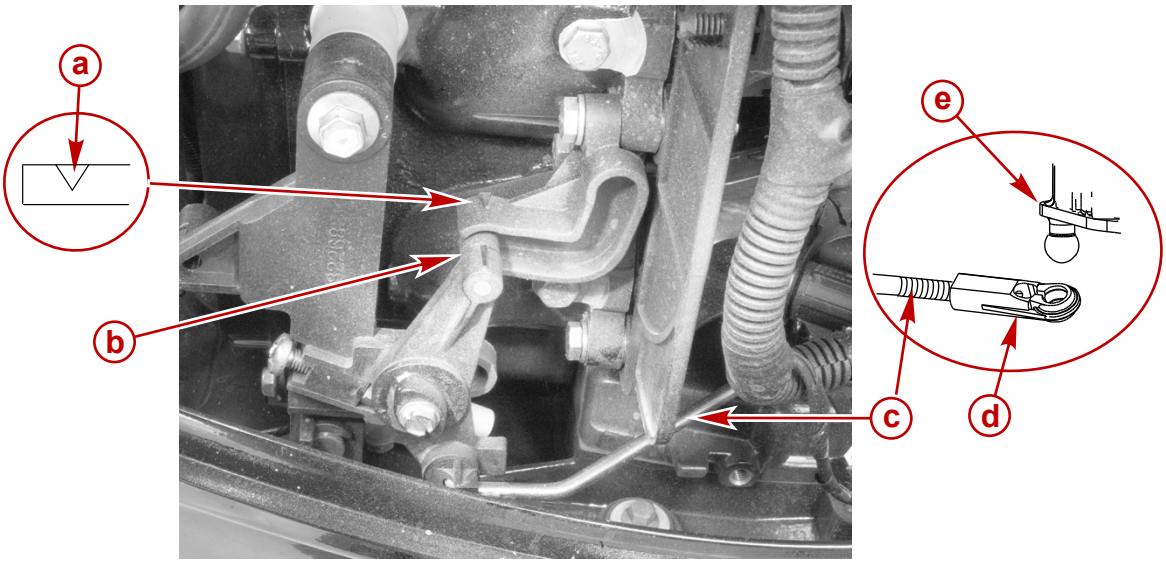
CDS G3 Diagnostic Tool Kit	8M0114141
 60575	Interfaces CDS G3 software to SmartCraft network. NOTE: This kit includes download instructions and a license key.

Tamper-Proof Screw Torx Bit Set	91-881828
 11782	Aids in the removal of tamper-proof fasteners.

Throttle Link Setting - Tiller Handle Models and 40 HP Jet Models

Idle

1. For 40 hp Jet models, remove the remote control cable from the throttle arm. For tiller handle models, use the throttle twist grip to advance the throttle arm.
2. Position the throttle body so that the idle speed screw is resting against the stop.
3. Remove the link rod ball socket from the throttle body. Adjust the length of the link rod so that the center of the throttle arm roller lines up with the alignment mark. Attach the link rod ball socket.

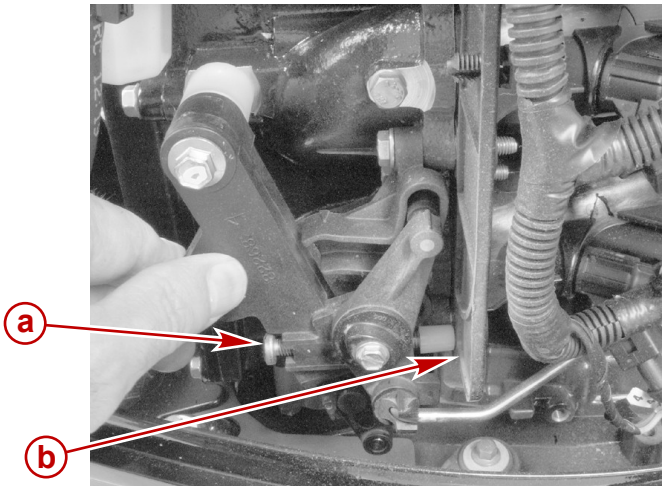


31472

a - Alignment mark
b - Throttle arm roller
c - Link rod
d - Link rod ball socket
e - Throttle body

Full Throttle Setting

Advance the throttle body to full throttle position. Adjust the full throttle stop screw so when the screw contacts the throttle stop there will be a small amount of free play in the throttle linkage at full throttle. Do not allow the throttle body to act as a throttle stop.

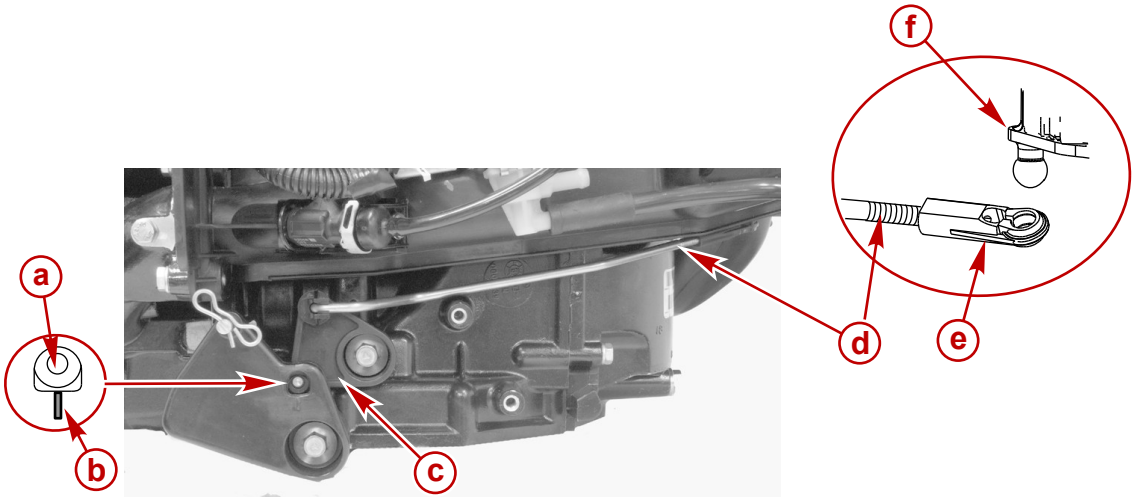


31477

- **a -** Full throttle stop screw
- **b -** Throttle stop

Throttle Link Setting - Remote Control Models

1. Remove the remote control throttle cable from the throttle cam.
2. Position the throttle body so that the idle speed screw is resting against the stop.
3. Remove the link rod ball socket from the throttle body. Adjust the length of the link rod so that the center of the cam follower roller lines up with the alignment mark. Attach the link rod ball socket.



31478

- **a -** Cam follower roller
- **b -** Alignment mark
- **c -** Cam follower
- **d -** Link rod
- **e -** Link rod ball socket
- **f -** Throttle body

Timing

Ignition timing is not adjustable. The engine control module (ECM) unit electronically controls the ignition timing.

When initially running the outboard, use a timing light to verify that the ignition timing falls within the timing windows as described within the following tests.

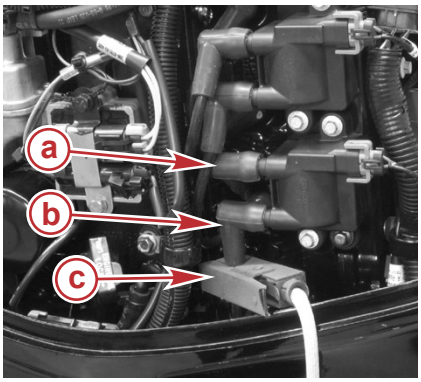
Check maximum timing per specification while running the outboard.

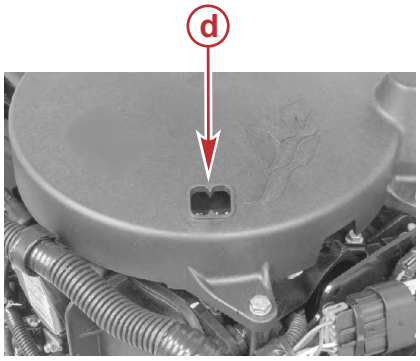
IMPORTANT: When checking the timing with the engine running, one of the following test procedures must be followed:

- **In a test tank**
- **On a dynamometer**
- **On a boat secured on a trailer backed in water**

1. Attach a timing light to the #4 spark plug lead.

   NOTE: *The lower coil fires the #1 and #4 spark plug leads simultaneously.*



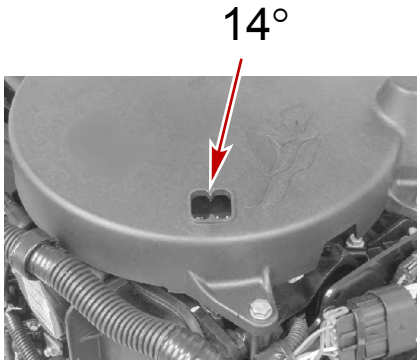


60763

a - #1 spark plug lead
b - #4 spark plug lead
c - Timing light clamp
d - Timing window (electric start models)

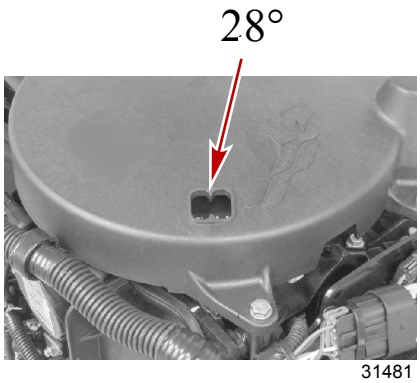
NOTE: *Idle timing is controlled by the ECM and will vary for idle speed control. Checking the ignition timing marks using a timing light will not be stable until 1500–1800 RPM.*

2. Start the engine and place the outboard in forward gear. Check timing at 1500–1800 RPM, timing should be 14° BTDC. If timing is not within specification, refer to **Section 3B - Diagnostics and Troubleshooting**.



31480

3. Slowly increase the engine RPM while watching the ignition timing marks. The timing should increase to 28° BTDC at approximately 6000 RPM. If timing is not within specification, refer to **Section 3B - Diagnostics and Troubleshooting**.



31481

DMT 2004 Digital Multimeter	91-892647A01
Timing Light	91- 99379
CDS G3 Harness	84-8M0045065

CDS G3 Diagnostic Tool Kit	8M0114141

Engine Timing	
1500–1800 RPM	14° BTDC
WOT (6000 RPM)	28° BTDC

Idle Speed

Engine idle speed is maintained by the ECM and is, therefore, not adjustable. The parameters affecting idle speed can be checked and monitored using the computer diagnostic system (CDS) G3. Refer to **Section 3B - Diagnostics and Troubleshooting**.

Throttle Position Sensor (TPS)

The throttle position sensor (TPS) is not adjustable. TPS voltage reading can be monitored with the CDS G3 through the ECM. If readings are not within specifications, refer to **Section 3B - Diagnostics and Troubleshooting**.

Idle Air Control (IAC)

The IAC maintains an optimum idling engine speed depending on the temperature of the air and engine block.

The idle air control (IAC) is an electrically operated, spring-loaded solenoid valve, which controls the amount of air bypassing the closed throttle shutter. Signals from the ECM regulate the duty cycle that the IAC valve remains open, or closed. The IAC controls three operating functions:

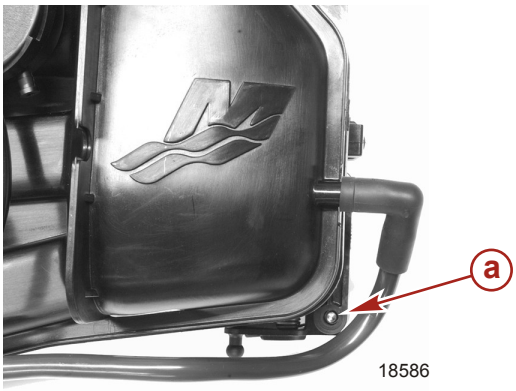
- Provides additional intake air for engine during start-up, and allows increased idle RPM during engine warm-up.
- Controls idle speed according to the varying engine loads, and running conditions.
- Functions as an electronic dashpot by providing additional bypass air as the throttle quickly closes during a rapid deceleration, preventing engine stalling.

Setup Procedure

1. Connect a computer diagnostic system (CDS) G3 to the engine.
2. Place the engine in water.
3. Start the engine. Shift the engine into forward gear and allow the engine to warm-up by running the engine for five minutes at 2500–3000 RPM.
4. Return engine speed to idle. Shift the engine into neutral and wait one minute for the engine RPM to stabilize.

CDS G3 Harness	84-8M0045065
CDS G3 Diagnostic Tool Kit	8M0114141

5. The IAC PWM % or idle air control valve reading should be between 20–40%. If the reading is not within 20–40%, use a T10 Torx bit and adjust the idle adjustment screw until the reading is between 20–40%.



a - Idle adjustment screw

Tamper-Proof Screw Torx Bit Set	91-881828

6. The setup is complete. Stop the engine and remove the CDS.

Electronic Fuel Injection

Section 3A - Theory of Operation

Table of Contents

Special Tools

CDS G3 Harness	84-8M0045065
 43351	Connects the engine harness to the CDS G3 diagnostic interface tool.

CDS G3 Diagnostic Tool Kit	8M0114141
 60575	Interfaces CDS G3 software to SmartCraft network. NOTE: This kit includes download instructions and a license key.

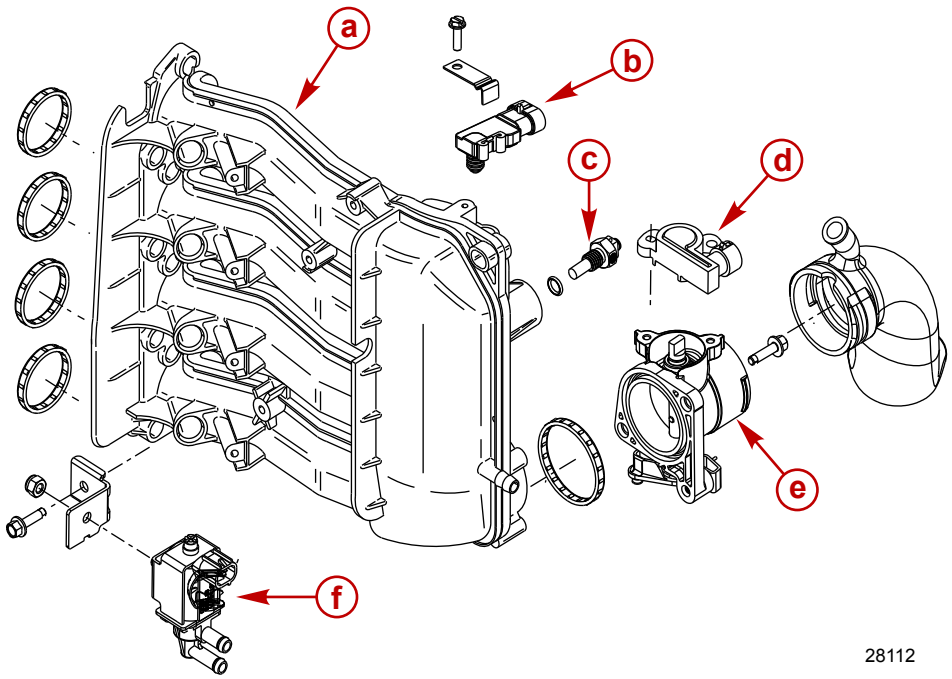
Wire Color Code Abbreviations

Wire Color Abbreviations				
BLK	Black		BLU	Blue
BRN	Brown		GRY	Gray
GRN	Green		ORN or ORG	Orange
PNK	Pink		PPL or PUR	Purple
RED	Red		TAN	Tan
WHT	White		YEL	Yellow
LT or LIT	Light		DK or DRK	Dark

Electronic Fuel Injection System

Air Induction System

The air induction system consists of an intake manifold (an intake runner for each cylinder joined to a common air box), a single throttle body/shutter with attached throttle position sensor (TPS), an idle air control (IAC), a manifold absolute pressure (MAP) sensor, and a manifold air temperature (MAT) sensor. The intake manifold also mounts the fuel distribution manifold and the fuel injectors.

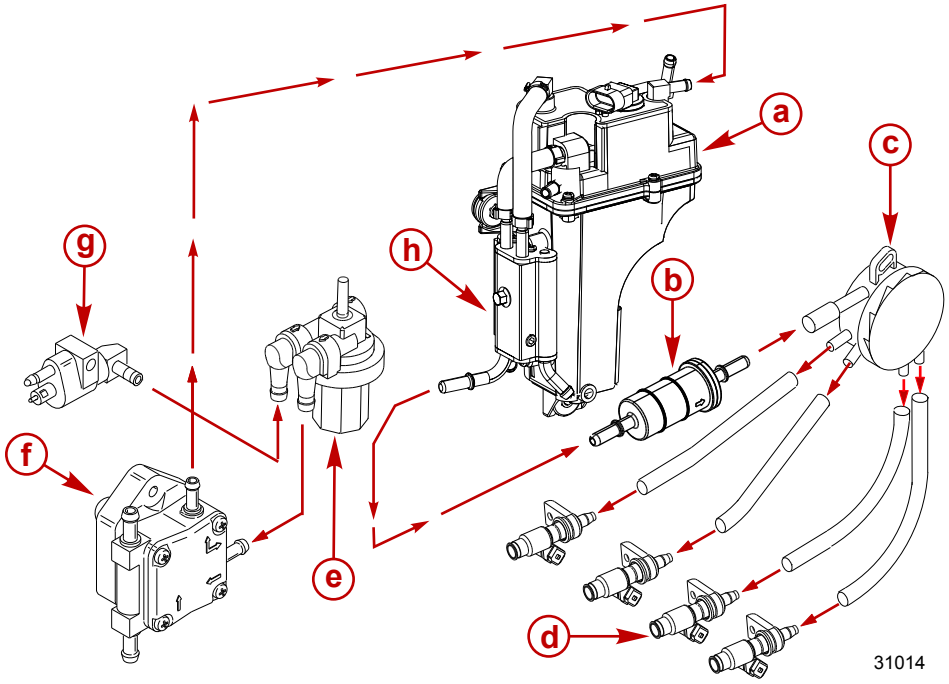


28112

- **a -** Intake manifold
- **b -** Manifold absolute pressure (MAP) sensor
- **c -** Manifold air temperature (MAT) sensor
- **d -** Throttle position sensor (TPS)
- **e -** Throttle body/shutter
- **f -** Idle air control (IAC)

Fuel System

The fuel system consists of a fuel line connector, a water separating fuel filter, a low-pressure mechanical fuel pump, a high-pressure electric fuel pump, a fuel distribution manifold, fuel injectors, a fuel cooler, and a fuel pressure regulator. The low-pressure mechanical fuel pump draws fuel from the fuel tank, through the fuel line connector and fuel filter, then delivers it to the high-pressure fuel pump within the vapor separator tank. High-pressure fuel is circulated through the fuel cooler and supplied to the fuel distribution manifold and fuel injectors to be sprayed into the intake manifold. Fuel not used by the fuel injectors (fuel not entering the high-pressure fuel line to the fuel distribution manifold) circulates through the fuel cooler, then flows through the pressure regulator, and returns to the vapor separator tank.



- **a -** Vapor separator tank/ high-pressure electric fuel pump
- **b -** High-pressure fuel filter
- **c -** Fuel distribution manifold
- **d -** Fuel injectors (4)
- **e -** Water separating fuel filter
- **f -** Low-pressure mechanical fuel pump
- **g -** Fuel line connector
- **h -** Fuel cooler

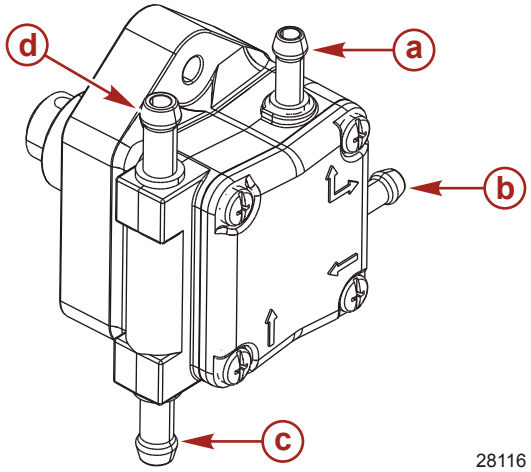
Fuel System Components

Fuel Pump

The fuel pump is a diaphragm pump which is mechanically driven off of the rocker arm.

The pump base insulates the fuel pump from the heat of the engine block. The fuel pump is water-cooled to help prevent vapor lock by cooling the fuel.

If the engine runs out of fuel, or has a restriction (on the inlet side of the pump) preventing adequate fuel flow, the pump will make a clicking noise.

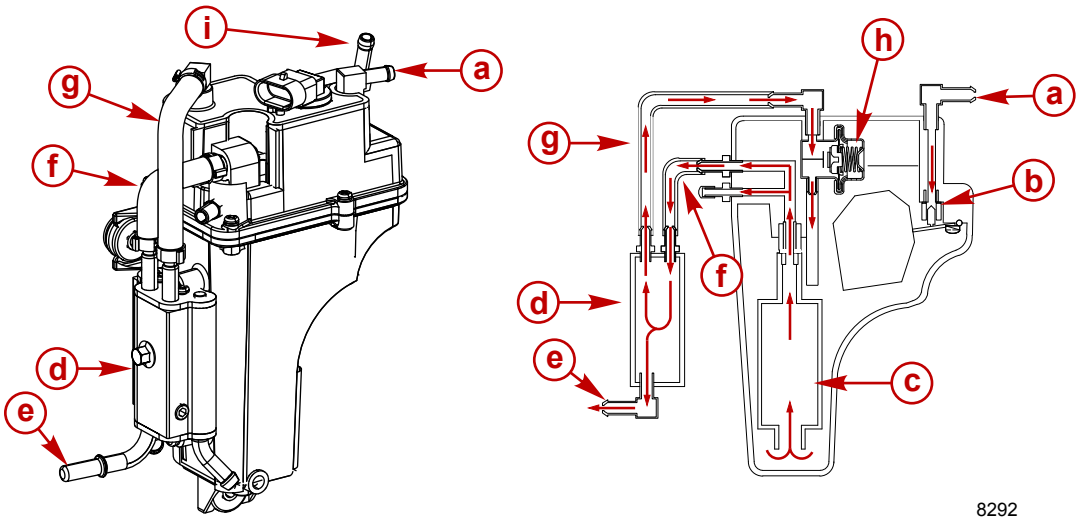


- **a -** Fuel outlet to VST
- **b -** Fuel inlet from filter/tank
- **c -** Water outlet to water pump indicator hole
- **d -** Water inlet from VST fuel cooler

Vapor Separator and Fuel Regulator

Vapor Separator

The vapor separator maintains a liquid fuel supply for the high-pressure fuel pump located in the vapor separator tank. Fuel delivered from the mechanical low-pressure fuel pump is supplied to the top of the vapor separator and is controlled by the inlet needle/float assembly. Pressurized fuel from the high-pressure pump circulates through the fuel cooler, to the fuel distribution manifold and injectors. Excess fuel flows through the pressure regulator back to the vapor separator tank.



- **a -** Fuel inlet from mechanical fuel pump
- **b -** Inlet needle
- **c -** High-pressure fuel pump
- **d -** Fuel cooler
- **e -** High-pressure fuel to fuel distribution manifold
- **f -** Fuel line from high-pressure pump to fuel cooler
- **g -** Fuel line from fuel cooler to fuel pressure regulator
- **h -** Fuel pressure regulator
- **i -** VST vent to intake manifold

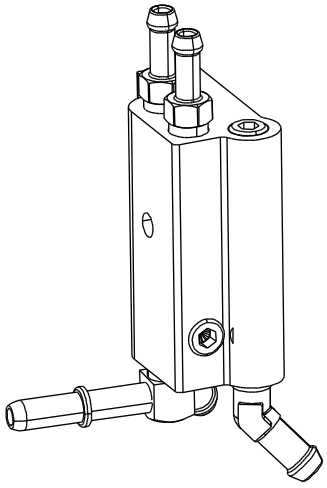
Fuel Regulator

The fuel pressure regulator is mounted inside the VST on the vapor separator cover. It maintains a stable fuel pressure between the high-pressure fuel pump and the fuel injectors. The pressure regulator consists of a spring-loaded diaphragm which actuates a valve/seat assembly. Excess fuel pressure unseats the valve returning fuel to the vapor separator tank. The excess fuel is channeled below the fuel level in the vapor separator tank through an internal pipe to prevent fuel vaporization.

The spring side of the diaphragm is vented inside the VST. The VST is vented to atmosphere pressure allowing barometric pressure changes to act on the diaphragm in addition to spring pressure.

Fuel Cooler

A fuel cooler (heat exchanger) is attached to the vapor separator and uses engine cooling water to cool the high-pressure fuel supply to the fuel injectors as well as a return circuit to the VST. Removing heat from the circulating high-pressure fuel prevents the formation of fuel vapors.



28127

Sensors

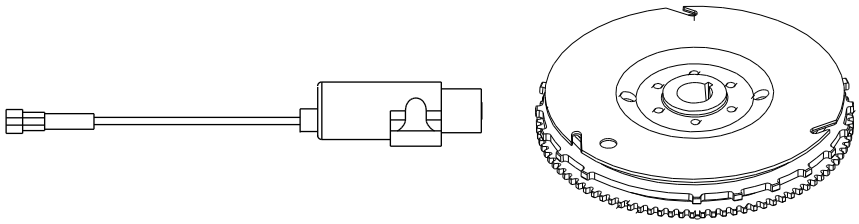
Function of Sensors

The sensors are some of the key components for controlling optimum fuel efficiency, horsepower, and emissions for internal combustion engines. Each sensor is designed to monitor for a specific condition or identify a location. These condition and location sensors supply vital information to the ECM. The sensors, in conjunction with the ECM, manage the fuel system, the ignition system, and the warning system, based on the information received from these condition and location sensors.

Crankshaft Position Sensor (CPS)

As the flywheel rotates, the CPS senses the location of the teeth on the flywheel and supplies the trigger signal information to the ECM. The ECM utilizes the CPS information and determines when to trigger each ignition coil and fuel injector.

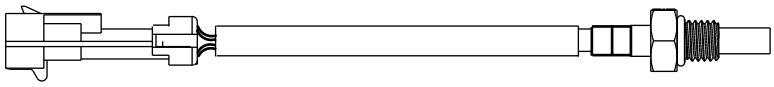
The CPS provides the ECM with the crankshaft angle position and engine speed information, which the ECM uses in determining fuel delivery and spark timing.



28128

Engine Coolant Temperature (ECT) Sensor

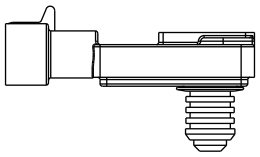
The ECT sensor is located on the engine's exhaust cover and protrudes into the return water passage. The sensor monitors the temperature of the cooling water that has passed through the engine as controlled by the thermostat and sends signals to the ECM for processing.



28129

Manifold Absolute Pressure (MAP) Sensor

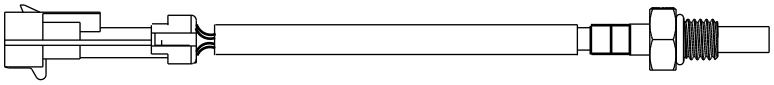
The MAP sensor is mounted into the intake manifold and measures the absolute pressure within the intake manifold. This information is then used to calculate fuel delivery and spark timing.



28130

Manifold Air Temperature (MAT) Sensor

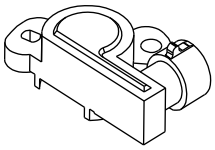
The MAT sensor is mounted into the intake manifold and measures the charge air temperature. This information is then conducted to the ECM for processing.



28129

Throttle Position Sensor (TPS)

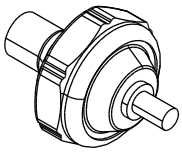
The TPS is located on the throttle body and connected to the throttle shaft. It provides the ECM with throttle angle information.



28131

Oil Pressure Switch

The oil pressure switch is located on the port side of the engine and protrudes into the pressurized oil galley between the oil pump and the oil filter. The sensor sends a low oil pressure signal to the ECM, which activates ignition/injection cutoff/warning horn.



28132

Actuators

Function of Actuators

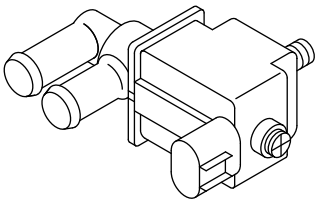
Actuators receive output signals from the ECM, and perform functions which control air-fuel ratios, spark advance, and idle RPM. The actuators maintain optimal fuel economy as a direct relation to the engine horsepower.

Idle Air Control (IAC)

The idle air control (IAC) is an electrically operated spring-loaded solenoid valve which controls the amount of air bypassing the closed throttle shutter. Signals from the ECM regulate the duty cycle that the IAC valve remains open, or closed. The IAC controls three operating functions:

- Provides additional intake air for engine during start-up, and allows increased idle RPM during engine warm-up.
- Controls idle speed according to the varying engine loads, and running conditions.

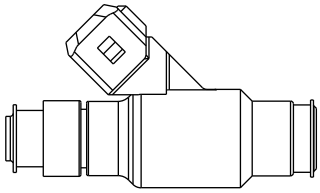
- Functions as an electronic dashpot by providing additional bypass air as the throttle quickly closes during a rapid deceleration, preventing engine stalling.



21101

Fuel Injector

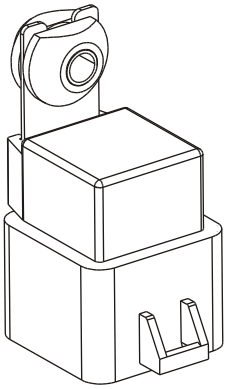
The fuel injector is an electrically operated spring-loaded solenoid, which delivers a metered amount of fuel into the intake manifold runner, just ahead of the intake valve. The injectors are electrically charged as the key switch is set to the run position. The ECM controls the injection by completing the ground circuit, lifting the solenoid, which allows high-pressure fuel to flow. The ECM then opens the ground circuit allowing the spring to close the injector and stop the fuel flow.



28126

Main Power Relay (MPR)

The MPR is controlled by the ECM. It provides power to the ignition coils, idle air control, injectors, and high-pressure fuel pump.



22713

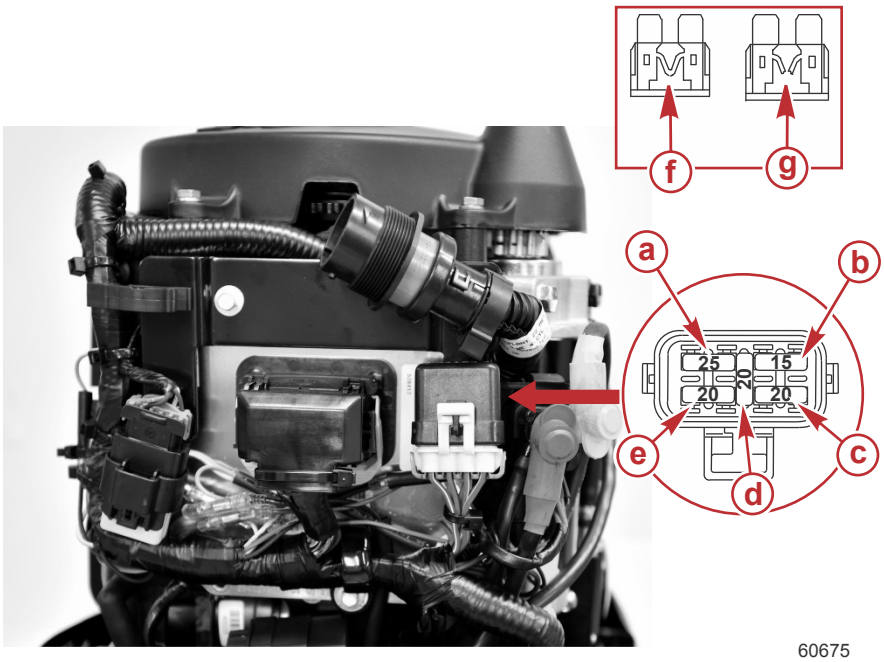
Fuses

The electrical circuits and components are protected from overload by fuses in the wiring harness. If a fuse is blown, locate and correct the cause of the overload. If the cause is not corrected, the fuse may blow again.

The wiring harness has two fuse holders that hold four function fuses, one spare fuse, and a slot for another spare fuse.

1. Remove the suspected blown fuse to determine if the silver colored band is broken.

2. Replace the blown fuse with a new fuse of the same amperage rating.

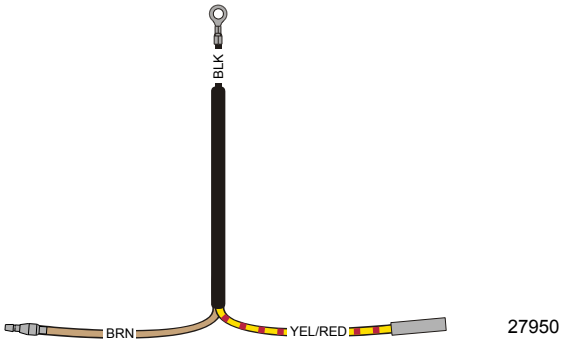


60675

- **a -** Main circuit - 25 amp fuse (#1)
- **b -** Main relay/accessories - 15 amp fuse (#3)
- **c -** Ignition coil circuit - 20 amp fuse (#4)
- **d -** Spare 20 amp fuse
- **e -** Fuel pump/idle air control/fuel injector circuits - 20 amp fuse (#2)
- **f -** Good fuse
- **g -** Blown fuse

Suppression Diode

The suppression diode is located between the brown start solenoid lead and the yellow/red key switch lead (within the engine harness), and connects to the engine ground. The purpose of the suppression diode is to eliminate the inductive spike created as the start solenoid is de-energized (key switch turned from start to run).



27950

Engine Control Module

The ECM requires 5 volts to operate. If the ECM should fail, the engine will stop running. Inputs to the ECM can be monitored and tested with the computer diagnostic system (CDS) G3.

CDS G3 Harness	84-8M0045065
CDS G3 Diagnostic Tool Kit	8M0114141

The ECM performs the following functions:

- Calculates precise fuel and ignition timing requirements based on engine speed, throttle position, manifold absolute pressure, manifold air temperature, and engine coolant temperature.
- Directly controls the ground circuit of fuel injectors, ignition coils, high-pressure fuel pump, and idle air control.
- Indirectly controls the positive circuit of fuel injectors, ignition coils, and idle air control.
- Controls alarm horn and warning functions.
- Controls RPM limit function.
- Records engine running information.

ECM Systems Control Matrix

ECM Control Item	Description Parameter
Ignition timing	Controls the optimum ignition timing according to the current operating conditions
Fuel injection	Controls the fuel injection pulse width (duration) for optimum efficiency according to current operating condition
Idle air control (IAC)	Stabilizes the engine RPM when idling and during quick engine RPM deceleration by managing the duty cycle driving the IAC in order to control bypass air entering the intake manifold
Tachometer	Sends out six tachometer pulses per engine revolution (12 pole)
Warning horn	**After starting:** Short beep for two seconds after the engine is initially started indicating all sensors are functioning **Continuous sound:** During engine over RPM, engine coolant temperature is over 90 °C (194 °F), engine oil pressure is 24.5 kPa (3.6 psi) **Intermittent sound:** MAP sensor or engine coolant temperature sensor is defective or is disconnected
Warning lamp	**After starting:** Illuminated for five seconds after the engine is initially started indicating all sensors are functioning **Continuous illumination:** During engine over RPM, engine coolant temperature is over 90 °C (194 °F), engine oil pressure is 24.5 kPa (3.6 psi) **Intermittent illumination:** MAP sensor or engine coolant temperature sensor is defective or is disconnected
Memorizes operation data	Engine running time Over temperature and time of occurrence Engine Guardian (over RPM, and RPM reduction to 2800 or less) Sensor failures

Outline of the Engine Control System

Ignition Timing Control

ECM	Sensors
Engine load and engine speed map	Manifold absolute pressure (MAP) sensor
	Crankshaft position sensor (CPS)
	Manifold air temperature (MAT) sensor
Engine temperature correction	Engine coolant temperature (ECT) sensor
Starting correction	Engine coolant temperature (ECT) sensor
	Crankshaft position sensor (CPS)
Ignition cutoff for decreased engine speed	Crankshaft position sensor (CPS)
	Engine coolant temperature (ECT) sensor
	Oil pressure switch
Overrevolution prevention	Crankshaft position sensor (CPS)
Engine cutoff	Ignition key switch
	Stop switch
Idling stabilizer	Crankshaft position sensor (CPS)
Safety control	Sensors and switches

Fuel System

ECM	Sensors
Engine load and engine speed map	Manifold absolute pressure (MAP) sensor
	Manifold air temperature (MAT) sensor
Engine temperature correction	Engine coolant temperature (ECT) sensor
Starting correction	Engine coolant temperature (ECT) sensor
Rapid acceleration correction	Throttle position sensor (TPS)
	Crankshaft position sensor (CPS)
Rapid deceleration correction	Throttle position sensor (TPS)
	Crankshaft position sensor (CPS)
Fuel cutoff for decreased engine speed	Crankshaft position sensor (CPS)
	Oil pressure switch
	Engine coolant temperature (ECT) sensor
	Battery voltage
Overrevolution prevention	Crankshaft position sensor (CPS)
Safety control	Sensors and switches

IAC Control

ECM	Sensors
Engine speed	Crankshaft position sensor (CPS)
Engine temperature correction	Engine coolant temperature (ECT) sensor
	Crankshaft position sensor (CPS)
	Throttle position sensor (TPS)
Starting correction	Engine coolant temperature (ECT) sensor
Rapid deceleration correction	Throttle position sensor (TPS)
	Crankshaft position sensor (CPS)
Idling speed feedback	Crankshaft position sensor (CPS)
	Engine coolant temperature (ECT) sensor
Variable idling speed control	Throttle position sensor (TPS)
	Crankshaft position sensor (CPS)
Starting preparation	Engine coolant temperature (ECT) sensor
Safety control	Sensors and switches

Control and Function

	Ignition	Fuel	IAC	Function
Crankshaft position sensor (CPS)	X	X	X	Detects the crankshaft position and engine speed
Throttle position sensor (TPS)	X	X	X	Detects the open angle of the throttle valve
Engine coolant temperature (ECT) sensor	X	X	X	Detects engine coolant temperature
Manifold absolute pressure (MAP) sensor	X	X		Detects intake air pressure of the intake manifold
Manifold air temperature (MAT) sensor	X	X		Detects intake air temperature
Oil pressure switch	X	X		Detects oil pressure

Electronic Fuel Injection

Section 3B - Diagnostics and Troubleshooting

Table of Contents

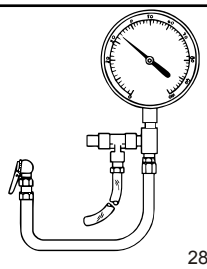
Fuel System Specifications

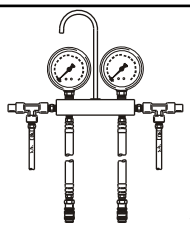
Fuel System Specifications		
Fuel lift pump type		Mechanical water-cooled (plunger/ diaphragm)
Fuel pump pressure (maximum)		20–41 kPa (3–6 psi)
Plunger stroke		5.9 mm (0.232 in.)
Fuel tank capacity		Accessory
Fuel injection system		Sequential
Fuel injector resistance		10–13.5 ohms
Electric fuel pump	Pressure	290–303 kPa (42–44 psi)
	Engine running - after five minutes	295 kPa (43 psi)
Vapor separator float height - float needle seated		36.5–39.5 mm (1.437–1.555 in.)
Idle RPM (neutral) warm		750 ± 25 RPM
Idle RPM (forward gear) warm		750 ± 25 RPM

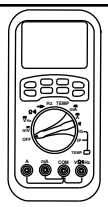
Special Tools

CDS G3 Harness	84-8M0045065
 43351	Connects the engine harness to the CDS G3 diagnostic interface tool.

CDS G3 Diagnostic Tool Kit	8M0114141
 60575	Interfaces CDS G3 software to SmartCraft network. NOTE: This kit includes download instructions and a license key.

Fuel Pressure Gauge Kit	91-881833A03
 2807	Tests the fuel pump pressure; can be used to relieve fuel pressure.

Dual Fuel/Air Pressure Gauge Kit	91-881834A 1
 5822	Tests fuel and air pressure; the dual gauges allow the viewing of both pressures simultaneously.

DMT 2004 Digital Multimeter	91-892647A01
 4516	Measures RPM on spark ignition (SI) engines, ohms, amperes, AC and DC voltages; records maximums and minimums simultaneously, and accurately reads in high RFI environments.

Wire Color Code Abbreviations

Wire Color Abbreviations				
BLK	Black		BLU	Blue
BRN	Brown		GRY	Gray
GRN	Green		ORN or ORG	Orange
PNK	Pink		PPL or PUR	Purple
RED	Red		TAN	Tan
WHT	White		YEL	Yellow
LT or LIT	Light		DK or DRK	Dark

40/50/60 EFI ECM Pin Identification

Pin	ECM	Color Code
1	Empty	Empty
2	Empty	Empty
3	Idle air control (IAC) valve driver	wht/orn
4	Analog tach signal out or tach link configuration[1.]	gry
5	Empty	Empty
6	Empty	Empty
7	Empty	Empty
8	Main power relay (MPR) driver (pin that controls MPR)	yel/ppl
9	Empty	Empty
10	Empty	Empty
11	Oil pressure signal	lt blu
12	Empty	Empty
13	Crankshaft position sensor (CPS) signal (–)	wht
14	Crankshaft position sensor (CPS) signal (+)	red
15	Empty	Empty
16	Empty	Empty
17	Empty	Empty
18	Empty	Empty
19	Empty	Empty
20	Manifold air temperature (MAT) signal	tan
21	Engine coolant temperature (ECT) signal	tan/blk
22	Manifold absolute pressure (MAP) signal	yel
23	CAN 1 (+) signal for SmartCraft gauges	wht
24	CAN 1 (–) signal for SmartCraft gauges	dk blu
25	Empty	Empty
26	Empty	Empty
27	Empty	Empty
28	CDS communication (+) to data link connector (DLC)	blu/wht

1. May be switchable with the CDS.

Pin	ECM	Color Code
29	CDS communication (–) to data link connector (DLC)	wht/blu
30	Empty	Empty
31	Empty	Empty
32	EST coil #1 driver (controls smart coil)	grn/blk
33	EST coil #2 driver	grn/red
34	Sensor power (power 1) 5 V (+) from ECM to sensors	ppl/yel
35	Empty	Empty
36	Empty	Empty
37	Empty	Empty
38	Empty	Empty
39	Empty	Empty
40	Empty	Empty
41	Emergency stop (through 10-pin CAN connector)	blk/yel
42	Sensor ground (5 V [–]), sometimes called filtered ground	blk/orn
43	Empty	Empty
44	Empty	Empty
45	Empty	Empty
46	Empty	Empty
47	Empty	Empty
48	Fuel injector #4 driver (controls negative side of injector)	pnk/yel
49	Fuel injector #1 driver (controls negative side of injector)	pnk/brn
50	Fuel injector #2 driver (controls negative side of injector)	pnk/red
51	Empty	Empty
52	Wake up (key switch +)	ppl
53	Throttle position sensor (TPS) signal	lt blu/wht
54	Empty	Empty
55	Empty	Empty
56	Empty	Empty
57	Driver power (12 V [+]) (from MPR into the ECM)	red/blu
58	Driver power (12 V [+]) (from MPR into the ECM)	red/blu
59	Empty	Empty
60	Empty	Empty
61	Empty	Empty
62	Empty	Empty
63	Warning horn driver (controls negative side of horn)	tan/lt blu
64	Empty	Empty
65	Fuel injector #3 driver (controls negative side of injector)	pnk/orn
66	Empty	Empty
67	Starter solenoid power/cowl trim switch power	red/ppl
68	Ground (to engine block/negative battery terminal)	blk
69	Fuel pump driver (controls fuel pump or its relay)	blk/blu
70	Ground (to engine block/negative battery terminal)	blk

Troubleshooting with the CDS G3 Diagnostic System

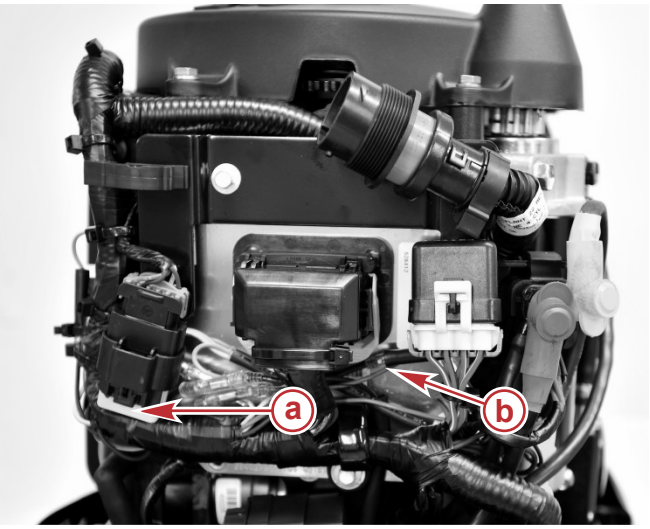
Accessing ECM Information

1. Connect the USB cable end into one of the computer USB ports.
   IMPORTANT: Always connect to the same USB port when acquiring data.
2. Connect the G3 cable to the SmartCraft diagnostic port.
3. Key-up the engine.

4. Open the G3 software program.

NOTE: *The following lights on the G3 interface should be lit:*

- *Pwr*
- *Bus I*
- *Bus II (flashing)*



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a - SmartCraft diagnostic port
b - ECM

The ECM is designed so that if a sensor fails, the ECM will compensate so that the engine does not go into an overrich condition. Because of this, disconnecting a sensor for troubleshooting purposes may have no noticeable effect.

The CDS G3 system was developed specifically to help technicians diagnose and repair Mercury Marine 2 and 4 cycle engines.

The CDS G3 will monitor sensors and ECM data values including status switches. The ECM program can help diagnose intermittent engine problems.

CDS G3 Harness	84-8M0045065
CDS G3 Diagnostic Tool Kit	8M0114141

System Information

The **Module Data** screen will display an alpha-numeric code identifying a specific calibration in the ECM.

- Fault codes can be displayed active or historic.
- An **active fault** is a fault that is present right now. It is occurring at this instant. Active faults affect how the engine is running right now. On the engines in this manual, active faults will activate the Guardian program, which will reduce engine power based on the severity of the problem. Refer to **Guardian Protection System**.
- An **occurred fault** is a fault that was active during this key switch cycle, but is not active right now. Occurred faults do not affect how the engine is running right now. They are valuable for diagnosing intermittent faults (faults that come and go, but do not stay active permanently). Without the intermittent/historic fault, we would not know that a problem occurred in the past.
- The **View Fault** displays active and inactive faults, the code number, description, and the source of the faults. When the status column shows YES, they are active, when the status shows NO, they are inactive/historic, which also means intermittent (a fault that comes and goes, but does not stay active indefinitely).
- **Freeze Frame (FF) Occurrence** is the length of time in seconds that each of the first 23 faults have been active. The longer the time active, the more serious the fault and more likely you are to find an actual problem. A fault that has only occurred for a second or two may be difficult to diagnose and may have been caused by a loose or poor connection or rough water. This does not tell us when the fault has last occurred, just how long it has been active. If the fault that is occurring is a number higher than 23, it will not show up in **FF Occurrence**.

- **Freeze Frame** are captures of selected data stream items at the time a fault occurs. A buffer can be created for each fault that is enabled on a particular calibration. When a fault becomes active, the ECM will store the data items (listed below) in the first buffer using the values the instant the fault went active. There are ten available buffers and they will fill up in chronological order until the tenth and final buffer is full. The next buffer that occurs, will erase the first buffer and all of the buffers will move one frame closer to zero. This technique is called first in, first out (FIFO). The buffer listed first in CDS is always the oldest buffer (as far as when each fault first occurred). If any fault reoccurs, then the original data is discarded and replaced with the current data and the frequency counter counts up one. Look at the engine hours in each buffer to determine which of the faults are the most recent. Faults at the top occurred first, since the faults were last cleared, regardless of the engine hour displayed in the buffer. Try to fix faults from top to bottom.

The freeze frame buffers contain the following data items.

1. The fault number and name (refer to the CDS G3 Master Fault list displaying the CDS G3 text for each fault).
2. FF Occurrence Counter - the number of times the fault has occurred. This is in computer counts, so 0 = 1, 1 = 2, and so on. The higher the number of occurrences, the more likely you have a true intermittent condition. The frequency counter can read many hundred, it just depends on how often the fault occurs; imagine a loose connection on a vibrating engine, it is easy to see how the frequency counter can be very high in some instances.
3. Run time (in hours) - the total run time on the engine that the fault occurred at. The longer ago a fault occurred, the less we should be worried about it.
4. Engine State - run, crank, or stall at the time of the fault.
5. Engine Speed - crankshaft RPM at the time of the fault.
6. Baro Pressure - the barometric pressure at the time of the fault.
7. MAP Pressure - the manifold absolute pressure at the time of the fault.
8. Power Limit (available power) - the available power (in %) at the time of the fault.
9. Demand - how much power the operator was demanding. On mechanical shift engines, this mirrors the TPS signal.
10. TPS - the throttle position sensor position expressed in % open at the time of the fault.
11. Load - a calculation of how hard the engine is working at the time of the fault. This data item must be ignored if the engine is not running. It is only accurate when the engine is running.
12. Block Pressure - the water pressure in the cylinder block at the time of the fault.
13. ECT - the engine coolant temperature at the time of the fault.
14. Charge Temp - the intake air temperature at the time of the fault.
15. FPC (fuel per cylinder) Total - a relative reading of the amount of fuel being injected into the engine. It can be loosely related to injector pulse width. Bigger numbers mean richer mixtures, smaller numbers mean leaner mixtures. it is best measured in grams. The number in the buffer will be the FPC at the time of the fault.
16. Gear Position - if a neutral switch is present, it will show the gear position (neutral or in-gear) at the time of the fault.
17. Trim Position - not applicable to this engine family. There are no trim sensors on the 40–60 EFI FourStroke.

Default Sensor Information

Default sensor values are preprogrammed amounts used by the PCM to calculate fuel and ignition values when the sensor in question has exceeded its preprogrammed diagnostic limits. Default sensor values are typically used when the sensor has a circuit high or circuit low fault. For example, all 2 wire sensors operate the same. When you unplug the sensor, a circuit high fault occurs and when you short the two wires together, a circuit low fault occurs.

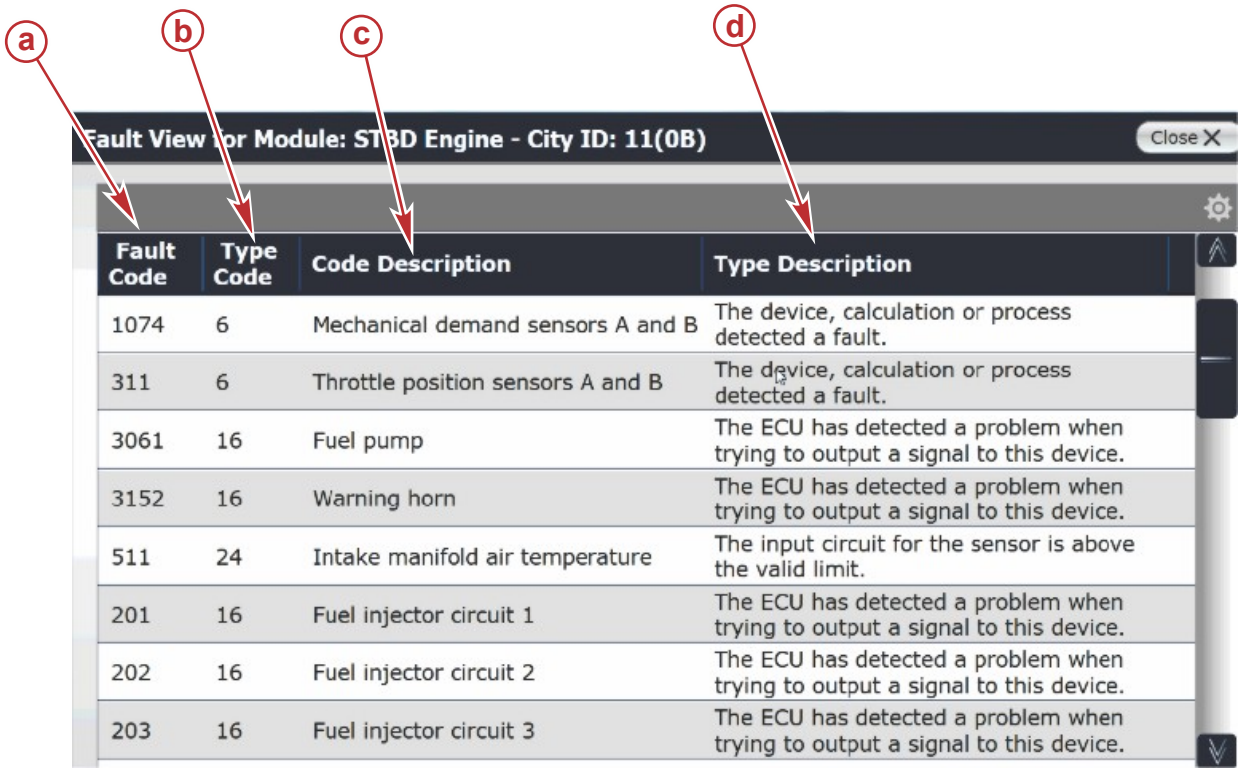
Most temperature sensors default to 0 °C (32 °F). This can be verified by unplugging the sensor in question and watching the data stream value with the CDS.

Most pressure sensors default to a preprogrammed number also. The MAP sensor is an exception. A failed MAP sensor will display a value that is near the actual value, but diagnosed with displayed fault codes. Refer to **Fault Information**.

Mercury Universal Fault Codes

Mercury universal fault codes help ensure uniformity in fault reporting in control modules. It also ensures that boat operators receive consistent information and instruction, such as **Service Engine Soon**, **Reduce Engine Speed**, and others in response to specific faults.

For CDS G3 users this means that instead of seeing a fault such as INJ1_OutputFault, the fault will now appear as **201 (Fuel injector circuit 1), 16 (The ECU has detected a problem when trying to output a signal to this device.).**



Fault Code	Type Code	Code Description	Type Description
1074	6	Mechanical demand sensors A and B	The device, calculation or process detected a fault.
311	6	Throttle position sensors A and B	The device, calculation or process detected a fault.
3061	16	Fuel pump	The ECU has detected a problem when trying to output a signal to this device.
3152	16	Warning horn	The ECU has detected a problem when trying to output a signal to this device.
511	24	Intake manifold air temperature	The input circuit for the sensor is above the valid limit.
201	16	Fuel injector circuit 1	The ECU has detected a problem when trying to output a signal to this device.
202	16	Fuel injector circuit 2	The ECU has detected a problem when trying to output a signal to this device.
203	16	Fuel injector circuit 3	The ECU has detected a problem when trying to output a signal to this device.

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An active fault list example (actual screen appearance may vary)

a - Fault code (the affected component)
b - Fault type code (how it was affected)
c - Code description
d - Fault code type description

In the last line of this example, component **203**, **Fuel injector circuit 3**, had a fault type **16**, meaning that the ECM/PCM is unable to output a signal to the device. This could indicate a faulty fuel injector, or in this case, where the same fault is affecting multiple injector and other components, likely indicates a more widespread fault, such as an unplugged harness, issues with a power supply, or some other systemic issue.

Mercury Universal Fault Code Table—40/50/60 4-Cylinder

Refer to the following table for an explanation of faults and possible solutions when using the CDS G3 diagnostic interface tool.

CDS G3 Diagnostic Tool Kit	8M0114141

Fault Code	Type Code	Code Description	Type Description	Possible Root Cause
0	0	Fault system	The system has no active faults.	–
101	16	Ignition circuit 1	The ECU has detected a problem when trying to output a signal to this device.	Ignition coil, wire harness, or ECM failure
102	16	Ignition circuit 2	The ECU has detected a problem when trying to output a signal to this device.	Ignition coil, wire harness, or ECM failure
201	16	Fuel injector circuit 1	The ECU has detected a problem when trying to output a signal to this device.	Failed injector or wire harness

Fault Code	Type Code	Code Description	Type Description	Possible Root Cause
202	16	Fuel injector circuit 2	The ECU has detected a problem when trying to output a signal to this device.	Failed injector or wire harness
203	16	Fuel injector circuit 3	The ECU has detected a problem when trying to output a signal to this device.	Failed injector or wire harness
204	16	Fuel injector circuit 4	The ECU has detected a problem when trying to output a signal to this device.	Failed injector or wire harness
301	24	Throttle position sensor A	The input circuit for the sensor is above the valid limit.	Shorted TPS or engine harness
	25	Throttle position sensor A	The input circuit for the sensor is below the valid limit.	Failed TPS, open engine harness, or 0 volts on sensor power
351	6	Throttle position sensor A on mechanical throttle adapt	The device, calculation, or process detected a fault.	The throttle is moved prior to turning the key on, or the TPS has been tampered with
401	24	Manifold pressure sensor using time sampling	The input circuit for the sensor is above the valid limit.	Internally shorted sensor or harness
	25	Manifold pressure sensor using time sampling	The input circuit for the sensor is below the valid limit.	MAP sensor is open, engine harness has an open, or 5 V sensor power is 0.
404	6	Manifold pressure sensor and throttle position sensor A rationality	The device, calculation, or process detected a fault.	Failed MAP sensor
407	17	Manifold pressure sensor barometer reading	The signal or result is outside the expected range.	Bad MAP sensor or sensor circuit
431	21	Oil pressure	Relative to a specified threshold, the value is too low.	Bad oil pressure sensor/switch, low engine oil pressure, failed oil pump, oil dilution
511	24	Intake manifold air temperature	The input circuit for the sensor is above the valid limit.	Failed intake air temperature sensor or open in the wire harness
	25	Intake manifold air temperature	The input circuit for the sensor is below the valid limit.	Failed intake air temperature sensor or short in the wire harness
523	24	Engine coolant temperature S1	The input circuit for the sensor is above the valid limit.	Possible sensor or wire failure
	25	Engine coolant temperature S1	The input circuit for the sensor is below the valid limit.	Possible sensor or wire failure to ground
	20	Engine coolant temperature S1	A temperature sensor value is higher than normal.	Water pump failure, debris in cooling system, or failed thermostat
601	4	Sensor supply voltage A	The signal received is valid but is higher than the expected range.	Failed ECM
	5	Sensor supply voltage A	The signal received is valid but is lower than the expected range.	Shorted out sensor power due possibly from bad 3 wire sensor, harness, or ECM
621	24	System voltage	The input circuit for the sensor is above the valid limit.	Alternator sense lead shorted or bad alternator
	25	System voltage	The input circuit for the sensor is below the valid limit.	Bad battery connections, weak battery, too much electrical load, failed alternator
1052	6	Crankshaft or camshaft trigger	The device, calculation, or process detected a fault.	Failure to the sensor or wire harness. Could also be a poor connection that is creating too much resistance/load on the circuit.

Fault Code	Type Code	Code Description	Type Description	Possible Root Cause
1106	3	Oil pressure switch	The signal is unsteady or intermittent such that a single value cannot be determined.	Bad connection at oil pressure switch, shorted wire leading to oil pressure switch, or engine oil pressure unstable
	21	Oil pressure switch	Relative to a specified threshold, the value is too low.	Bad connection at oil pressure switch, shorted wire leading to oil pressure switch, or engine oil pressure unstable
1109	23	Emergency stop	A particular state or condition exists.	Lanyard is pulled, failed switch, or harness
2011	23	Guardian	A particular state or condition exists.	Refer to active fault
2051	23	Guardian due to oil pressure	A particular state or condition exists.	Low on oil, bad oil pump, or pressure relief valve
2081	23	Guardian due to overheat	A particular state or condition exists.	Failed water pump, thermostat, or debris causing water restrictions
2091	23	Guardian due to overspeed	A particular state or condition exists.	Engine is incorrectly propped
2111	23	Guardian due to voltage	A particular state or condition exists.	Refer to universal fault code 621-24 or 621-25.
2152	22	Manifold airflow	Relative to a specified threshold, the value is too high.	Throttle restrictor has been removed
3061	1	Fuel pump	The output signal from the ECU to the device is open circuit or has too much resistance.	Fuel pump circuit has failed open due to a bad harness or pump
	2	Fuel pump	The output signal from the ECU to the device is short circuit or has too little resistance.	Contamination in the electric fuel pumps or failure of the pumps
3152	16	Warning horn	The ECU has detected a problem when trying to output a signal to this device.	Horn is disconnected or bad wire harness
3161	16	Idle air control valve	The ECU has detected a problem when trying to output a signal to this device.	IAC has electrically failed, wire harness is open or shorted
4005	6	CAN P Doc 02 state of health	The device, calculation or process detected a fault.	Boat harness failed open or gauge failure
4501	23	Security device missing	A particular state or condition exists.	Theft Deterrent System harness disconnected, failed open, or module failure
4502	23	Security locked	A particular state or condition exists.	No key fob or the incorrect key fob is installed. Possible open in the harness.
4503	23	Security setup	A particular state or condition exists.	The set up procedure was not correctly followed
4601	23	Test fault	A particular state or condition exists.	–

Descriptive Fault List

Fault Name	Warning Horn Type	Fault Explanation	Possible Root Cause
BaroRange	No horn	Barometer reading out of specification	Bad MAP sensor or sensor circuit
Cold_Engine	No horn	Engine is running below specified running temperature for 8 minutes	Possible thermostat failure from excessive debris or corrosion
DRVPInputHigh	Critical 6 second beep	Fault is calibrated to trigger fault at 15 V or 550 ADC	Alternator sense lead shorted or bad alternator
DRVPInputLow	Critical 6 second beep	Low battery voltage	Bad battery connections, weak battery, too much electrical load, failed alternator

Fault Name	Warning Horn Type	Fault Explanation	Possible Root Cause
ECTInputHigh	Noncritical 6 beeps	ECT circuit has failed electrically open	Possible sensor or wire failure
ECTInputLow	Noncritical 6 beeps	ECT circuit has failed electrically shorted	Possible sensor or wire failure to ground
ECT_Overtemp	Critical 6 second beep	ECT circuit exceeded maximum allowable operating temperature	Water pump failure, debris in cooling system, or failed thermostat
EST1_OutputFault	Noncritical 6 beeps	Ignition circuit failed open while the engine was running	Ignition coil, wire harness, or ECM failure
EST2_OutputFault	Noncritical 6 beeps	Ignition circuit failed open while the engine was running	Ignition coil, wire harness, or ECM failure
ESTOP_Active	No horn	ESTOP was activated	Lanyard is pulled, failed switch, or harness
EncoderFaultCrank CamTrigger	Critical 6 second beep	Crankshaft position sensor circuit failure	Failure to the sensor or wire harness. Could also be a poor connection that is creating too much resistance/load on the circuit.
FuelPumpCurrentHigh	Critical 6 second beep	Current draw from the fuel pumps is over specification	Contamination in the electric fuel pumps or failure of the pumps
FuelPumpCurrentLow	Critical 6 second beep	Current draw from the fuel pumps is below specification	Fuel pump circuit has failed open due to a bad harness or pump
Guardian_Active_Fault	No horn	Refer to active fault	Refer to active fault
Guardian_OilPressure	Noncritical 6 beeps	Oil pressure is below specification for engine's speed	Low on oil, bad oil pump, or pressure relief valve
Guardian_Overheat	Noncritical 6 beeps	Engine is running above specified overheat temperature	Failed water pump, thermostat, or debris causing water restrictions
Guardian_Overspeed	No horn	Maximum RPM exceeded	Engine is incorrectly propped
Guardian_Voltage	Critical No horn	Battery voltage is out of specification. This fault should accompany DRVPInputHigh or DRVPInputLow.	See DRVPInputHigh or DRVPInputLow fault explanations
HORN_OutputFault	Noncritical No horn	ECM sensed the horn circuit is open	Horn is disconnected or bad wire harness
IATInputHigh	Noncritical 6 beeps	Intake air temperature circuit is electrically open	Failed intake air temperature sensor or open in the wire harness
IATInputLow	Noncritical 6 beeps	Intake air temperature circuit is electrically shorted	Failed intake air temperature sensor or short in the wire harness
INJ1_OutputFault	Noncritical 6 beeps	Shorted injector 1 circuit	Failed injector or wire harness
INJ2_OutputFault	Noncritical 6 beeps	Shorted injector 2 circuit	Failed injector or wire harness
INJ3_OutputFault	Noncritical 6 beeps	Shorted injector 3 circuit	Failed injector or wire harness
INJ4_OutputFault	Noncritical 6 beeps	Shorted injector 4 circuit	Failed injector or wire harness
KeySw_Dirty	Noncritical 6 beeps	Detects if a key switch has a faulty crank terminal	If the crank request signal is 2 V lower than the wake input into the PCM the fault will become active
KeySw_Leaky	Noncritical 6 beeps	Detects if there is current leaking from the power terminal of the key switch to the crank terminal	If the key is turned on (not cranking) and the voltage on the crank request line is between 3 V and 9.5 V (crank request threshold) the fault will be activated
LIAC_OutputFault	Noncritical 6 beeps	IAC circuit has experienced an open or short electrical failure	IAC has electrically failed, wire harness is open or shorted
MAF_Too_High	Noncritical 6 beeps	Airflow calculation too high (75 hp model only)	Throttle restrictor has been removed
MAPInputHigh	Noncritical 6 beeps	MAP circuit is electrically shorting the sense lead to 5 V power	Internally shorted sensor or harness

Fault Name	Warning Horn Type	Fault Explanation	Possible Root Cause
MAPInputLow	Noncritical 6 beeps	MAP circuit has 0 V present on the sense lead	MAP sensor is open, engine harness has an open, or 5 V sensor power is 0
MAPR_TPS1Rationality	Noncritical 6 beeps	Fault only occurs at idle. MAP must be greater than baro pressure.	Failed MAP sensor
MAP_Rationality	Noncritical 6 beeps	MAP pressure reading does not agree with TPS reading	Plugged MAP sensor, faulty connection, or sensor. Check that both the MAP sensor and TPS sensor are reading properly.
Neutral_Overspeed	No horn	Engine RPM exceeds the neutral overspeed setting	Engine running in neutral above 2500 RPM, or bad shift position sensor
OilPress_Low	Critical 6 second beep	Engine running with oil pressure below calibration set points	Bad oil pressure sensor/switch, low engine oil pressure, failed oil pump, oil dilution
OilPressureInputHigh	Noncritical 6 beeps	Oil pressure sense lead has 5 V present	Failed sensor or engine harness
OilPressureInputLow	Noncritical 6 beeps	Oil pressure sensor has an open circuit	Failed oil pressure sensor or engine harness
RxDoc2_SOH	Noncritical 6 beeps	Troll control cannot detect the controlling gauge or device	Boat harness failed open or gauge failure
STRT_OutputFault	Critical 6 second beep	A shorted coil detected on the start relay	Faulty engine harness, solenoid, or switch. Check relay coil and wiring for a short circuit.
Security_Device_ Missing	Critical 6 beeps	Security Theft Deterrent System error or component missing	Theft Deterrent System harness disconnected, failed open, or module failure
Security_Locked	Noncritical 6 beeps	The engine has been started without recognizing a key fob	No key fob or the incorrect key fob is installed. Possible open in the harness.
Security_Setup	Noncritical 6 beeps	Theft Deterrent System installed but not correctly recognized by the system	The set up procedure was not correctly followed
ShiftPosInputHigh	Noncritical 6 beeps	Shift position sensor has 5 V present on the sense lead	Shorted sensor, engine harness, or ECM
ShiftPosInputLow	Noncritical 6 beeps	Shift position sensor has 0 V present on the sense lead	Failed sensor, ECM or open in the engine harness
Shift_Potentiometer	Noncritical 6 beeps	The shift potentiometer is indicating neutral when the engine is running over a calibrated speed and load	Faulty shift position sensor or wiring. Check that the shift potentiometer is reading properly (reads in gear while engine is in gear).
TPS1_RangeHigh	Noncritical 6 beeps	TPS has 5 V present on the sense lead	Shorted TPS or engine harness
TPS1_RangeLow	Noncritical 6 beeps	TPS has 0 V present on the sense lead	Failed TPS, open engine harness, or 0 V on sensor power
TPS_AdaptMech	Noncritical 6 beeps	TPS voltage is out of specified range when the key switch is turned on	The throttle is moved prior to turning the key on, or the TPS has been tampered with
TPS_Rationality	Noncritical 6 beeps	TPS value falls below minimum specification while running at or above the RPM threshold	Bad TPS or linkage problem
WaterInFuelInputLow	Noncritical 6 beeps	Water in fuel has 0 V on the sense lead	Water is present in filter, failed sensor, or harness
XDRPaInputHigh	Critical 6 second beep	Sensor power (XDRPa) is above specification	Failed ECM
XDRPaInputLow	Critical 6 second beep	Sensor power (XDRPa) is below specification - this is engine sensor power	Shorted out sensor power due possibly from bad 3 wire sensor, harness, or ECM
XDRPbInputHigh	Noncritical 6 beeps	Sensor power (XDRPb) is above specification - this is boat sensor power	Failed ECM
XDRPbInputLow	Noncritical 6 beeps	Sensor power (XDRPb) is below specification - this is boat sensor power	Shorted out sensor power due possibly from bad 3 wire sensor, harness, or ECM

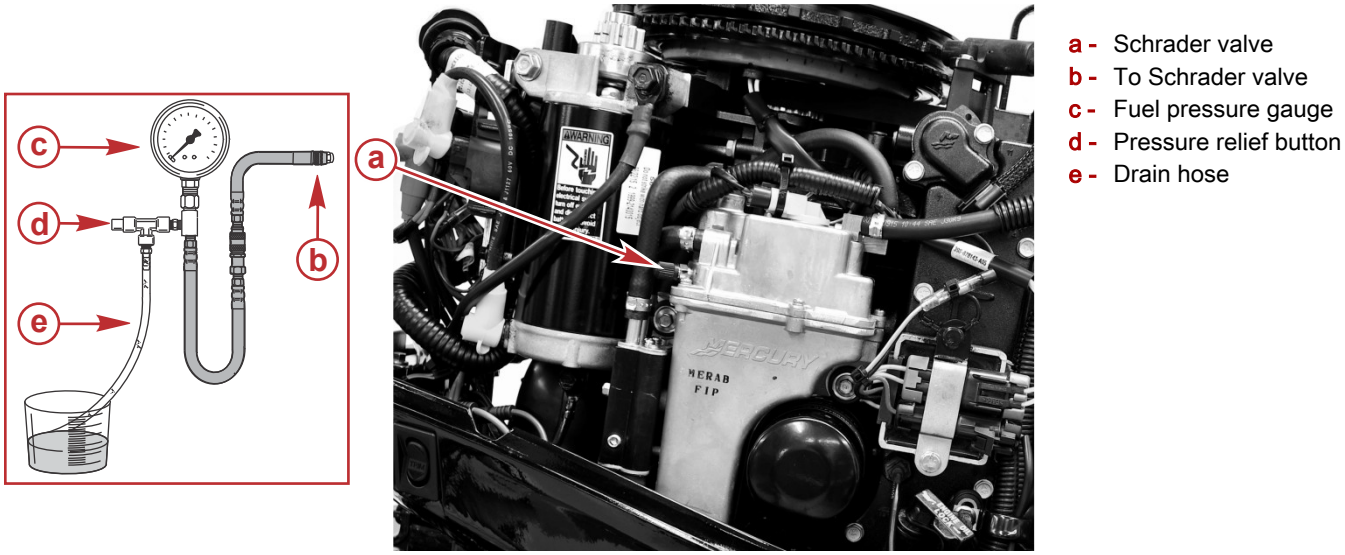
CDS G3 Text - Guardian Cause

CDS G3 Text for Data Stream item "Guardian Cause"	
Text	**Probable Cause**
None	Guardian is not currently active. You are operating within the Guardian limits or no faults right now.
Coolant Temperature Hot	ECT (or similar coolant temperature sensor) is hot. Diagnose the cooling system.
Battery Voltage	Battery voltage is too low or high. Diagnose the charging system.
Sensor Faults	A circuit high or circuit low sensor failure has occurred. Check fault status.
Forced Idle	Major component or system failure is causing forced idle (5% available power). Low oil pressure, ECT sticking, or loss of control, ESC faults, or other critical component faults.
Oil Pressure Low	4-stroke mechanical oil pump pressure is low.

Mechanical Fuel Pump

Pressure Regulator Test

1. Install the fuel pressure gauge onto the Schrader valve located on the VST.
2. Start the engine. The fuel pressure should be within specification.



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a - Schrader valve
b - To Schrader valve
c - Fuel pressure gauge
d - Pressure relief button
e - Drain hose

Fuel Pump Pressure	
At idle	290–303 kPa (42–44 psi)

Fuel Pressure Gauge Kit	91-881833A03
Dual Fuel/Air Pressure Gauge Kit	91-881834A 1

Antisiphon Valves

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

- Severe fuel rail pressure fluctuation
- Loss of fuel pump pressure
- High speed surging
- Outboard cuts out or hesitates upon acceleration
- Outboard runs rough
- Outboard quits and cannot be restarted
- Outboard will not start
- Vapor lock

Since any type of antisiphon device must be located between the outboard fuel inlet and fuel tank outlet, a simple method of checking if such a device (or bad fuel) is a problem source, is to operate the outboard with a separate fuel supply which is known to be good, such as a remote fuel tank.

If, after using a separate fuel supply, it is found that the antisiphon valve is the cause of the problem, there are two solutions to the problem; either 1) replace the antisiphon valve with one that has a lighter spring tension, or 2) replace it with a solenoid-operated fuel shut off valve.

Mechanical Fuel Pump Test (Vacuum)

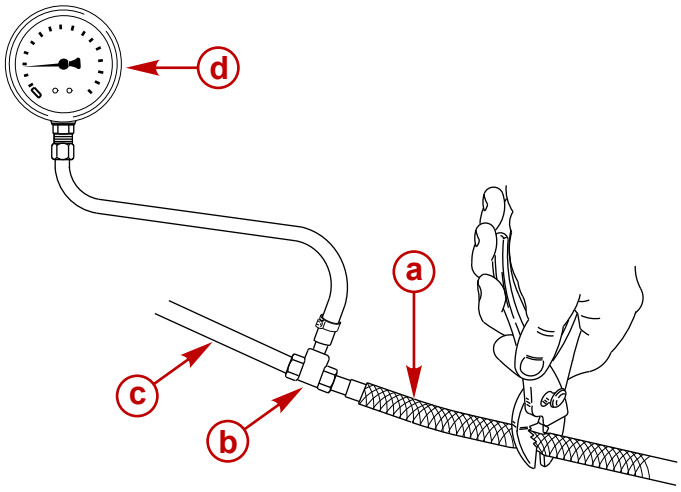
Fuel system vacuum can be checked by using a short piece of extra fuel hose, vacuum gauge, and a T-fitting.

1. Conduct the test with water to the engine cooling system using one of the following methods:
   a. In a test tank
   b. With the boat/outboard lower unit in water
2. Disconnect the fuel hose from the inlet fitting of the mechanical fuel pump.
3. Connect an extra fuel hose onto the outlet fitting of the pump.
4. Install a T-fitting into the extra hose making the connection as close to the pump as possible.
5. Connect a vacuum gauge and the fuel inlet hose onto the T-fitting.
6. Start the engine and run at 1000 RPM, normal fuel system vacuum (lift) should be to specifications.

   NOTE: *The system vacuum test is normally performed at 1000 RPM. As engine RPM is increased, there will be a slight increase in vacuum; this increase should not exceed normal readings.*

Mechanical Fuel Pump Vacuum (Lift)	
Vacuum at 1000 RPM	25–50 mm Hg (1–2 in. Hg)

7. To isolate the mechanical fuel pump from the rest of the fuel system:
   a. Pinch off/restrict the fuel supply hose between the vacuum gauge and the fuel tank.
   b. The mechanical fuel pump vacuum (lift) should be to specifications.
   c. If the vacuum reading for the pump is below specifications, the pump needs rebuilding.



- **a -** Fuel supply hose from fuel tank
- **b -** T-fitting
- **c -** Extra hose to inlet fitting of the mechanical fuel pump
- **d -** Vacuum gauge

Mechanical Fuel Pump Vacuum (Lift)	
Minimum vacuum at 1000 RPM with fuel line pinched	102 mm Hg (4 in. Hg)minimum

8. If the fuel pressure reading is not within specifications, refer to **Fuel Pump Pressure Troubleshooting** table.
9. Stop the engine, remove the gauge, and reconnect the fuel line to the inlet fitting of the fuel pump.

   NOTE: *The fuel pump is designed to lift fuel (vertically) approximately 152 cm (60 in.) if there are no other restrictions in the system using a fuel hose that is 8 mm (5/16 in.) minimum diameter. As restrictions are added, such as filters, fittings, valves, etc., the amount of fuel pump lift decreases.*

Fuel Pump (Vacuum) Troubleshooting		
Condition	**Cause**	**Correction**
Fuel system vacuum (lift) above specification	Restricted anti-siphon valve	Refer to **Anti-Siphon Valves**, preceding
	Plugged fuel tank pickup screen	Clean/replace fuel pickup screen
	Pinched/collapsed fuel hose	Inspect/replace fuel hoses
	Dirty/plugged water separating fuel filter	Clean/replace water separating fuel filter
	Restriction in fuel line thru-hull fitting	Clean/replace fitting
	Restriction in fuel tank switching valve	Clean/replace valve
	Restriction within primer bulb	Rebuild/replace primer bulb
Fuel system vacuum (lift) below specification	Low fuel level in fuel tank	Fill tank with fuel
	Hole/cut in pickup tube of fuel tank	Replace fuel pickup tube
	Loose fuel line connection	Check/tighten all connections
	Hole/cut in fuel line	Inspect/replace fuel hoses
	Loose fuel pump screws	Torque screws to specification
	Fuel pump gaskets worn or leaking	Rebuild/replace fuel pump
	Fuel pump check valves/seals leaking	Rebuild/replace fuel pump
	Leaky fuel pump diaphragm	Rebuild/replace fuel pump
	Worn/broken fuel pump springs	Rebuild/replace fuel pump
	Leaky fuel pump seals	Rebuild/replace fuel pump
	Fuel filter bowl loose	Tighten fuel filter bowl
	Fuel filter gasket cut/worn	Replace gasket
	Fuel vaporization	Check for plugged fuel pump water-cooling circuit

Mechanical Fuel Pump Test (Pressure)

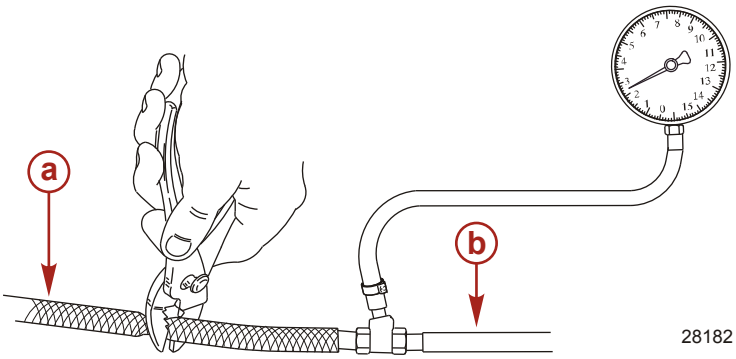
Fuel system pressure troubleshooting can be performed by using a piece of clear fuel hose 10 cm (4 in.) long, a pressure gauge, and a T-fitting.

1. Conduct the test with water to the engine cooling system using one of the following methods:
   - In a test tank
   - With the boat/outboard lower unit in water
2. Disconnect the fuel hose from the outlet fitting of the mechanical fuel pump.
3. Connect the clear fuel hose onto the outlet fitting of the pump.
4. Install the T-fitting onto the clear fuel hose.
5. Connect the pressure gauge and fuel outlet hose (to VST) onto the T-fitting.
6. Start the engine and run at 1000 RPM, normal fuel system pressure should be to specifications.

Normal Mechanical Fuel System Pressure	
Pressure at 1000 RPM	13.8 kPa (2 psi)

7. To isolate the mechanical fuel pump from the rest of the fuel system:
   a. Pinch off/restrict the fuel hose between the T-fitting and the VST.
   b. The mechanical fuel pump pressure should be to specifications.
   c. If pressure reading for the pump is below specifications, the pump needs rebuilding.
8. If the fuel pressure reading is below specifications, refer to **Fuel Pump Pressure Troubleshooting** table.

9. Stop the engine, remove the gauge, and clear hoses. Reconnect the fuel line to the outlet fitting of the fuel pump.



a - Fuel hose (to VST)
b - Clear hose (from mechanical fuel pump outlet to T-fitting)

Mechanical Fuel Pump Pressure	
Pressure at 1000 RPM with pinched fuel line	20.7 kPa (3 psi)

Fuel Pressure Gauge Kit	91-881833A03
Dual Fuel/Air Pressure Gauge Kit	91-881834A 1

Fuel Pump Pressure Troubleshooting

Mechanical Fuel Pump (Pressure) Troubleshooting		
Condition	**Cause**	**Correction**
Fuel system pressure below specification	Restricted anti-siphon valve	Refer to **Anti-Siphon Valves**, preceding
	Low fuel level in fuel tank[1.]	Fill tank with fuel
	Plugged fuel tank pickup screen	Clean/replace fuel pickup screen
	Hole/cut in pickup tube of fuel tank[1.]	Replace fuel pickup tube
	Loose fuel line connection[1.]	Check/tighten all connections
	Hole/cut in fuel line[1.]	Inspect/replace fuel hoses
	Fuel line primer bulb check valves not opening	Replace fuel line primer bulb
	Fuel hose/line internal diameter too small	Use 8 mm (5/16 in.) fuel hose
	Restriction in fuel line thru-hull fitting	Clean/replace fitting
	Restriction in fuel tank switching valve	Clean/replace valve
	Restriction within primer bulb	Rebuild/replace primer bulb
	Pinched/collapsed fuel hose	Inspect/replace fuel hoses
	Dirty/plugged water separating fuel filter	Clean/replace water separating fuel filter
	Fuel filter bowl loose[1.]	Tighten fuel filter bowl
	Fuel filter gasket cut/worn[1.]	Replace gasket
	Loose fuel pump screws[1.]	Tighten screws to specification
	Fuel pump gaskets worn or leaking[1.]	Rebuild/replace fuel pump
	Fuel pump check valves/seals leaking	Rebuild/replace fuel pump
	Leaky fuel pump diaphragm[1.]	Rebuild/replace fuel pump
	Worn/broken fuel pump springs	Rebuild/replace fuel pump
	Leaky fuel pump seals	Rebuild/replace fuel pump
	Fuel vaporization	Check for plugged fuel pump water-cooling circuit

Guardian Protection System

The Guardian Protection System monitors critical engine functions and will reduce engine power accordingly in an attempt to keep the engine running within safe operating parameters.

IMPORTANT: The Guardian Protection System cannot guarantee that powerhead damage will not occur when adverse operating conditions are encountered. The Guardian Protection System is designed to 1) warn the boat operator that the engine is operating under adverse conditions and 2) reduce power by limiting maximum RPM in an attempt to avoid or reduce the possibility of engine damage. The boat operator is ultimately responsible for proper engine operation.

Warning Horn/Guardian System Operation		
Sound	**Condition**	**Description**
One beep on key up	Normal	System test.
Six beeps on key up, or during a running failure	Failure detected with MAP, MAT, TPS, or Flash Check Sum (ECM)	Engine should run well, however, service will be required.

1. Air bubbles may also be visible as fuel passes through the clear fuel (test) hose installed between the mechanical fuel pump outlet fitting and the VST.

Warning Horn/Guardian System Operation		
Sound	**Condition**	**Description**
Three beeps every four minutes	Failure detected with: • Battery voltage • EST - Open detected at key up. Short detected with engine running. • Fuel injector - Detected while cranking/running • Coolant sensor • IAC	Engine will start hard, run rough, and/or stall. Utilizing the neutral fast idle feature may assist starting. Service is required.
Intermittent beeps failure detected with:	Failure detected with: • Fuel pump - May start momentarily • Main Power Relay (MPR) - No start • ECM reference voltage to MAP/TPS - Starts but stalls under load	Engine may or may not start. If engine starts, it easily stalls. Service is required.
Continuous	Engine overheat	Engine Guardian Protection System is activated. Power limit will vary with level of overheat. Stop engine and check water intake for obstruction. Advancing throttle above idle may provide additional cooling.
	Low oil pressure	Guardian Protection System is activated. Engine power is limited to 10% of maximum. Stop engine and check oil level. Add oil if necessary.
	Battery voltage less than 10 V or more than 16 V	Engine Guardian Protection System is activated. Engine power is limited to 75% of maximum.
	Coolant sensor failure	Engine Guardian Protection System is activated. Engine power is limited to 50% of maximum. Engine overheat protection is compromised.
	Engine speed limiter	Exceeding 6200 RPM cuts spark/injection on cylinders #2 and #3 to reduce engine speed. Exceeding 6350 RPM cuts spark/injection on all cylinders to reduce engine speed.

Overheat Temperature Parameters

40/50/60 EFI FourStroke

When troubleshooting these models of engines, questions often arise as to what the actual engine overheat parameters are for Guardian. Please see the table below as a reference point for this information:

Engine Temperature	Percent of Available Power
Below 77 °C (170 °F)	100%
77–79 °C (170–174 °F)	60%
79–82 °C (174–180 °F)	40%
85–87 °C (185–189 °F)	30%
Above 87 °C (189 °F)	20%

NOTE: *These models of engines are able to run at idle speed with temperatures up to 90 °C (194 °F) before any Guardian or horn is activated.*
Keep in mind that the operator must attempt to operate the engine above the available power limit to activate the Guardian system. If the engine is operating at one of the above temperatures, but below the available power limit, no reduction in speed or warning horn will be noticed.

IMPORTANT: One of the many causes of an overheat condition can be a damaged or plugged thermostat. If the engine has a thermostat that allows the engine to reach temperatures between 71–77 °C (160–170 °F) the Guardian system may activate due to engine load as part of the calibration not covered in the above chart. In these scenarios the fault will be recorded as a RPM Limit fault.

EFI System Troubleshooting Guide

Condition	Cause/First	Warning Mode	Check
Engine cranks, but will not start	Lanyard stop switch is in the "OFF" position	None	Set lanyard stop switch to "RUN."
	Weak battery or bad starter motor. Battery voltage drops below 8 V while cranking (ECM cuts out below 6 V) (fuel pump requires 8 V)	Three beeps every four minutes for low battery voltage	Check condition of battery/starter solenoid terminals and cables. Charge/replace battery. Inspect condition of starter motor.
	Blown fuse	None	Replace fuse (located in the port fuse holder). Inspect engine wiring harness and electrical components. Fuse #2 - fuel injectors/IAC/fuel pump Fuse #3 - main power relay/accessory Fuse #4 - ignition coils
	Main power relay	Intermittent beeps	Listen for relay to click when key switch is turned to "ON" 81–99 ohms between pin 8 (yel/ppl) of the ECM connector and (red/blu) wire of fuse #3 (fuse removed) - or - between pin 85 and pin 86 of relay - or - Test suppression diode. Refer to **Section 2B - Suppression Diode Test.**
	Crankshaft position sensor (CPS)	None ***NOTE:*** *No RPM reading at tachometer*	300–350 ohms between pin 29 (red) and pin 13 (wht) of the ECM connector - or - between pin 1 (red) and pin 2 (wht) of CPS connector.
	Electric fuel pump	Intermittent beeps	Listen for pump. Fuel pump should run two seconds after key switch is turned to "RUN" position. 32–41 ohms between pin 69 (blk/blu) and pin 57 or 58 (red/blu) - or - between pins of fuel pump connector.
	Flywheel misaligned	None	Remove flywheel and inspect flywheel key/keyway.
	Engine coolant temperature (ECT) sensor	Three beeps every four minutes	Refer to **Component Resistance Tests**. Advancing the remote control fast idle feature or advancing the tiller handle throttle grip halfway may assist starting.

Condition	Cause/First	Warning Mode	Check
Engine cranks, starts, and stalls	Remote control to engine wiring harness connection is poor	None	Clean and inspect male and female connections.
	Air in fuel system/lines	None	Crank and start engine several times.
	Manifold absolute pressure (MAP) sensor	Six beeps at key-up or failure	Refer to **Component Resistance Tests**.
	Throttle position sensor (TPS)	Six beeps at key-up or failure	Typical TPI range with CDS: Idle 0.39–1.0 volts, WOT 3.66–4.80 volts.
	Idle air control (IAC)	Three beeps every four minutes	20–24 ohms between pin 3 (wht/org) and pin 57 or 58 (red/blu) of the ECM connector - or - between pin A and pin B of IAC.
	ECM reference voltage to MAP/TPS	Intermittent beeps	5 V between ppl/yel pin of MAP sensor wiring harness connector and engine ground (key switch to "RUN").
	Fuel pressure at VST fitting	None	Refer to **Mechanical Fuel Pump Test (Pressure)**.
	Flywheel misaligned	None	Remove flywheel and inspect flywheel key and keyway.
Engine idles fast after warm-up (900–1100 RPM)	Engine coolant temperature (ECT) sensor	Three beeps every four minutes	Refer to **Component Resistance Tests**.
Poor off idle or WOT running quality	Fuel injector	Three beeps every four minutes	10.0–13.5 ohms between fuel injector pin 1 and pin 2 - or - between (removed) fuse #2 (red/blu) wire and the ECM connector: pin 49 (pnk/brn) fuel injector #1 pin 50 (pnk/red) fuel injector #2 pin 65 (pnk/org) fuel injector #3 pin 48 (pnk/yel) fuel injector #4
	Ignition coil (EST)[1.]	Three beeps every four minutes	Refer to **Ignition Coil Resistance Test** chart in **Section 2A - Ignition**.
	Fuel pressure at VST fitting	None	Refer to **Mechanical Fuel Pump Test (Pressure)**.
	Fuel filter plugged	None	Replace fuel filter.
	Improper spark plugs	None	Use recommended resistor spark plugs.
	Loose grounds	None	Check all ground connections.
	Flywheel timing tooth pattern	None	Check tooth pattern for partially missing or damaged teeth.
	Fouled spark plug	None	Replace spark plug.

1. The ECM will only monitor the EST connection to the ignition coil, use resistance tests and/or spark gap test to confirm an ignition coil failure.

Condition	Cause/First	Warning Mode	Check
Poor idle quality	Crankshaft position sensor	None	300–350 ohms between pin 14 (red) and pin 13 (wht) of the ECM connector - or - between pin 1 (red) and pin 2 (wht) of CPS connector.
	Manifold absolute pressure (MAP) sensor	Six beeps at key-up or failure	Refer to **Component Resistance Tests**.
	Throttle position sensor (TPS)	Six beeps at key-up or failure	Typical TPI range with CDS: Idle 0.39–1.0 volts, WOT 3.66–4.80 volts.
	Engine coolant temperature (ECT) sensor	Three beeps every four minutes	Refer to **Component Resistance Tests**.
	Manifold air temperature (MAT) sensor	Six beeps at key-up or failure	Refer to **Component Resistance Tests**.
	Fuel injector	Three beeps every four minutes.	10.0–13.5 ohms between fuel injector pin 1 and pin 2 - or - between (removed) fuse #2 (red/blu) wire and the ECM connector: pin 49 (pnk/brn) fuel injector #1 pin 50 (pnk/red) fuel injector #2 pin 65 (pnk/org) fuel injector #3 pin 48 (pnk/yel) fuel injector #4
	Ignition coil (EST)[1.]	Three beeps every four minutes	Refer to **Ignition Coil Resistance Test** chart in **Section 2A - Ignition**.
	Idle air control (IAC)	Three beeps every four minutes	20–24 ohms between pin 3 (wht/org) and pin 57 or 58 (red/blu) of the ECM connector - or - between pin A and pin B of IAC.
	Fuel pressure at VST fitting	None	Refer to **Mechanical Fuel Pump Test (Pressure)**.
	Loose grounds	None	Check all ground connections.
	Fouled spark plug	None	Replace spark plug.
Engine runs rich	Fuel pressure regulator	None	290–303 kPa (42–44 psi) at VST fitting.
	Engine coolant temperature (ECT) sensor	Three beeps every four minutes	Refer to **Component Resistance Tests**.
	Thermostat stuck open	None	Remove and inspect thermostat - **Section 4B - Cylinder Block/Crankcase.**
Speed reduction Engine RPM limited to 2000	Low oil pressure or grounded oil pressure switch lead	Continuous horn above 10% power setting	Check engine oil level and add oil as needed. Remove oil pressure switch and install oil pressure gauge, (warm engine) oil pressure should be: above 20.0 kPa (2.9 psi) at idle, 207–278 kPa (30–40 psi) at 3000 RPM. Refer to **Oil Pressure Switch Test** in **Section 4B - Cylinder Block/Crankcase.** Check for short between pin 11 (lt blu) of the ECM connector and open connector of oil pressure switch.

Condition	Cause/First	Warning Mode	Check
Speed reduction Engine RPM limited	Engine overheat	Continuous	Engine Guardian System is activated. Power limit will vary with level of overheat. Stop engine and check water intake for obstruction. Advancing throttle above idle may provide additional cooling.
	Battery voltage less than 10 V or more than 16 V	Continuous horn above 75% power setting	Engine Guardian System is activated. Engine power is limited to 75% of maximum.
	Engine coolant temperature (ECT) sensor failure	Continuous horn above 50% power setting	Engine Guardian System is activated. Engine power is limited to 50% of maximum. Engine overheat protection is compromised.

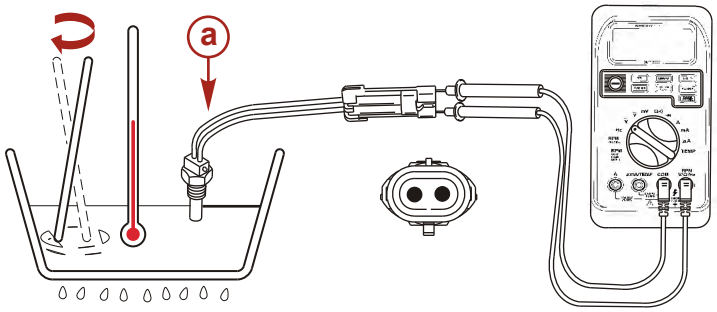
IMPORTANT: In all instances check wiring harness integrity (especially ground connections) in boat and on engine.

Component Resistance Tests

Engine Coolant Temperature (ECT) Sensor and Manifold Air Temperature (MAT) Sensor

The ECT and MAT sensors are thermistors (a resistor that changes value based on temperature). Low temperature produces a high resistance. High temperature causes low resistance.

1. Place the temperature sensor in a container filled with water.
2. Place a thermometer in the water and slowly heat the water.
3. Measure the resistance when the specified temperature is reached. If the reading is out of specification, replace the sensor.

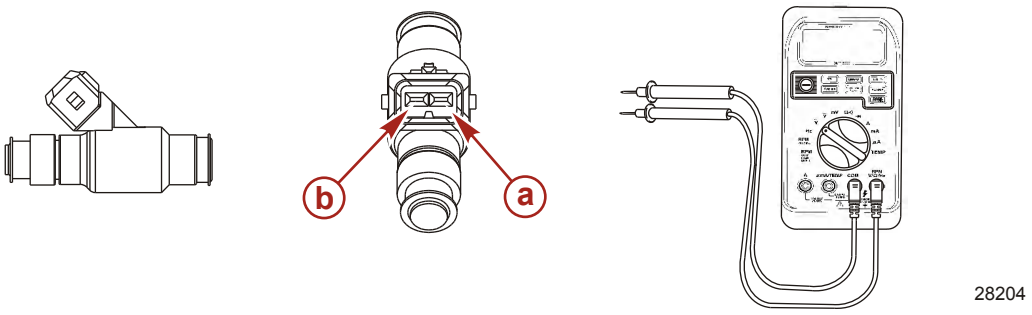


a - Temperature sensor

DMT 2004 Digital Multimeter	91-892647A01

Approximate Temperature-to-Resistance Values		
°F	**°C**	**ohms**
210	100	680
160	70	1,752
104	40	5,327
70	20	12,493
41	5	25,396
32	0	32,654
23	-5	42,324
-4	-20	97,060
-40	-40	336,000

Fuel Injector

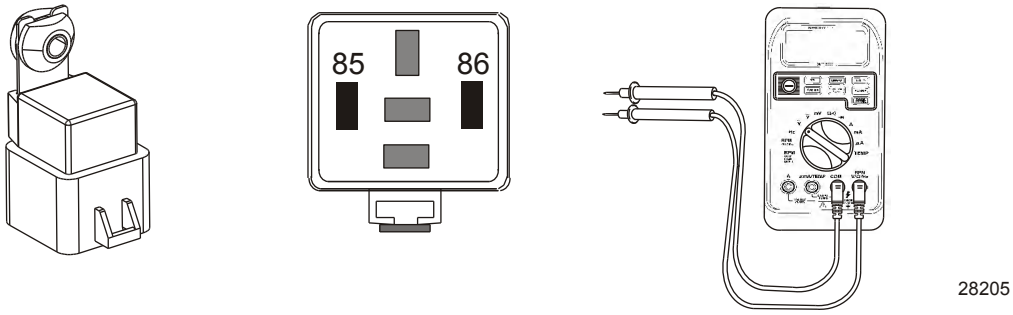


a - Pin A
b - Pin B

DMT 2004 Digital Multimeter	91-892647A01

Meter Test Leads		Meter Scale	Reading (Ω)
Red	Black		
Pin A	Pin B	Ω	10.0–13.5

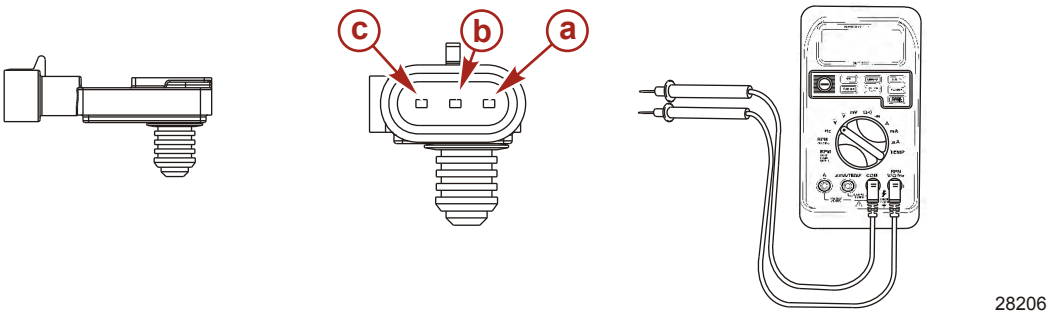
Main Power Relay



DMT 2004 Digital Multimeter	91-892647A01

Meter Test Leads		Meter Scale	Reading (Ω)
Red	Black		
Terminal 85	Terminal 86	Ω	81–91

Manifold Absolute Pressure (MAP) Sensor

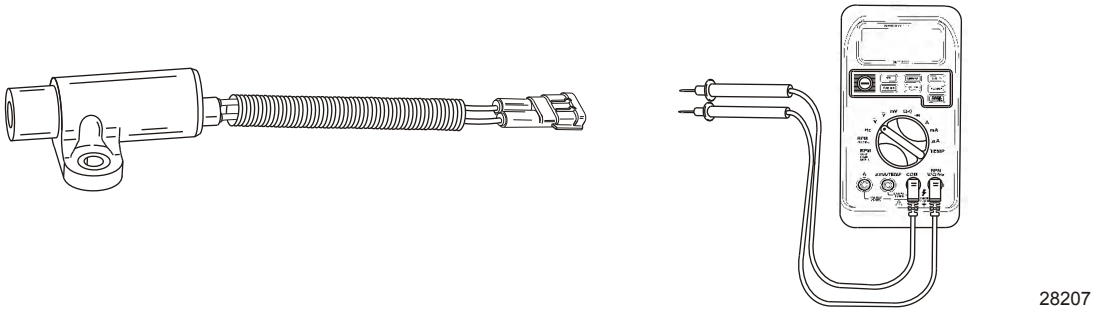


a - Pin A (blk/org)
b - Pin B (yel)
c - Pin C (pur/yel)

DMT 2004 Digital Multimeter	91-892647A01

Meter Test Leads		Meter Scale	Reading (Ω)
Red	Black		
Pin A	Pin B	Ω	95–105 k
Pin A	Pin C	Ω	3.9–4.3 k
Pin B	Pin C	Ω	95–105 k

Crankshaft Position Sensor (CPS)



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Meter Test Leads		Meter Scale	Reading (Ω)
Red	Black		
Red	White	Ω	300–350

DMT 2004 Digital Multimeter	91-892647A01

Notes:

Electronic Fuel Injection

Section 3C - Service Procedures

Table of Contents

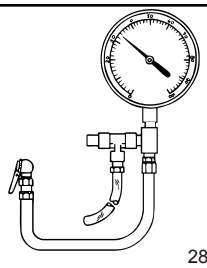
Fuel System Specifications

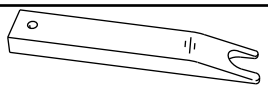
Fuel System Specifications		
Fuel lift pump type		Mechanical water-cooled (plunger/ diaphragm)
Fuel pump pressure (maximum)		20–41 kPa (3–6 psi)
Plunger stroke		5.9 mm (0.232 in.)
Fuel tank capacity		Accessory
Fuel injection system		Sequential
Fuel injector resistance		10–13.5 ohms
Electric fuel pump	Pressure	290–303 kPa (42–44 psi)
	Engine running - after five minutes	295 kPa (43 psi)
Vapor separator float height - float needle seated		36.5–39.5 mm (1.437–1.555 in.)
Idle RPM (neutral) warm		750 ± 25 RPM
Idle RPM (forward gear) warm		750 ± 25 RPM

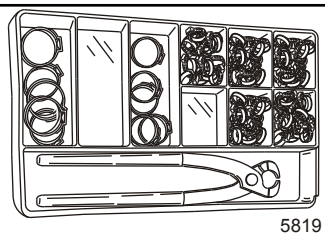
Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
36	P80 Rubber Lubricant	Breather hose	Obtain Locally
66	Loctite 242 Threadlocker	Cowl deflector mounting bolts	92-809821
		Pressure regulator retaining screw and baffle plate screws (3)	
95	2-4-C with PTFE	Throttle body gasket	92-802859A 1
		Manifold air temperature (MAT) sensor O-ring	
		ECT sensor O-ring	

Special Tools

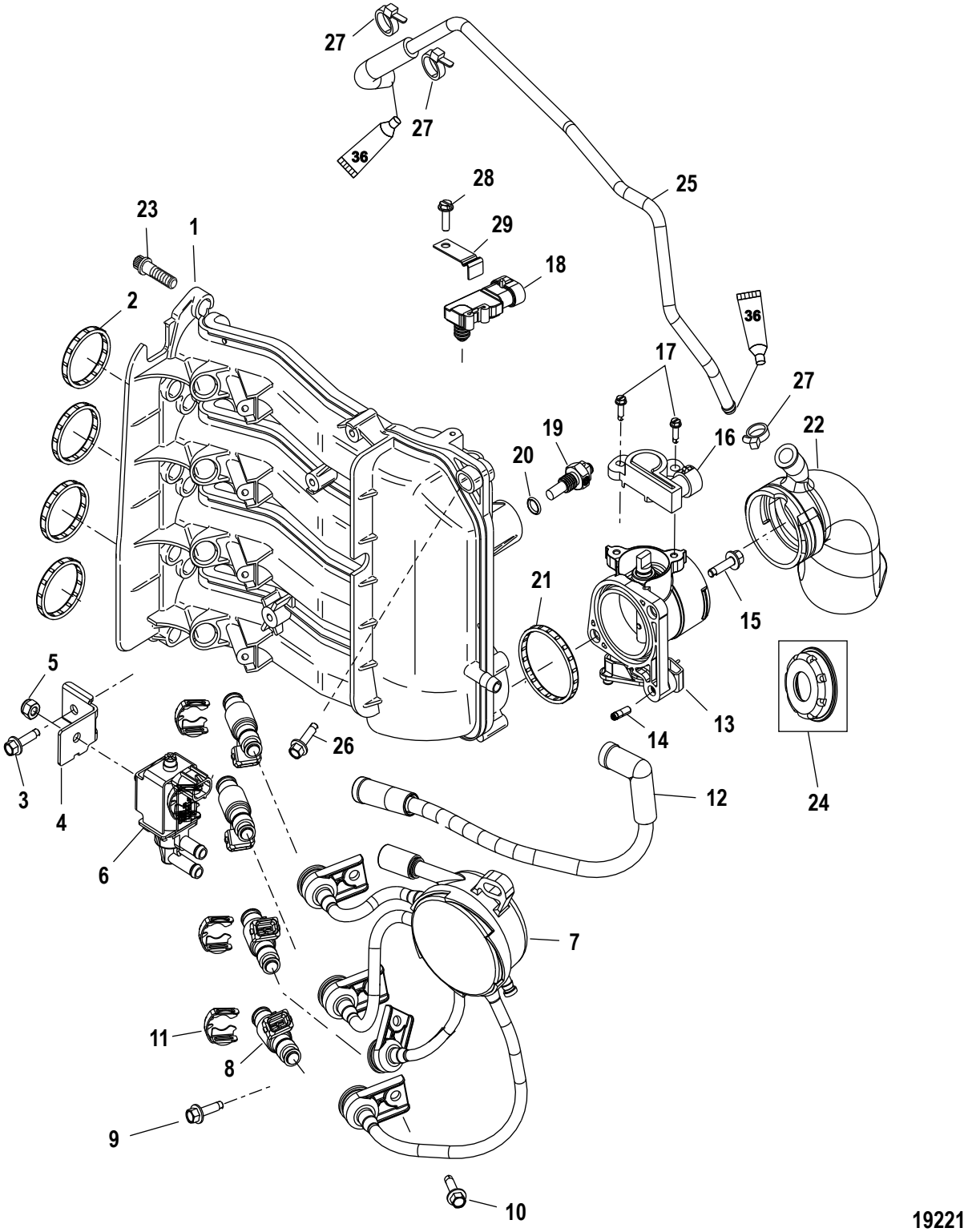
Fuel Pressure Gauge Kit	91-881833A03
 2807	Tests the fuel pump pressure; can be used to relieve fuel pressure.

Fuel Injector Cap Tool	883877A1
 28261	Aids in the removal of the fuel injector cap.

Hose Clamp Tool Kit	91-803146A04
 5819	Aids in the installation of high pressure (Oetiker ®) hose clamps.

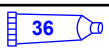
Notes:

Intake Manifold Components

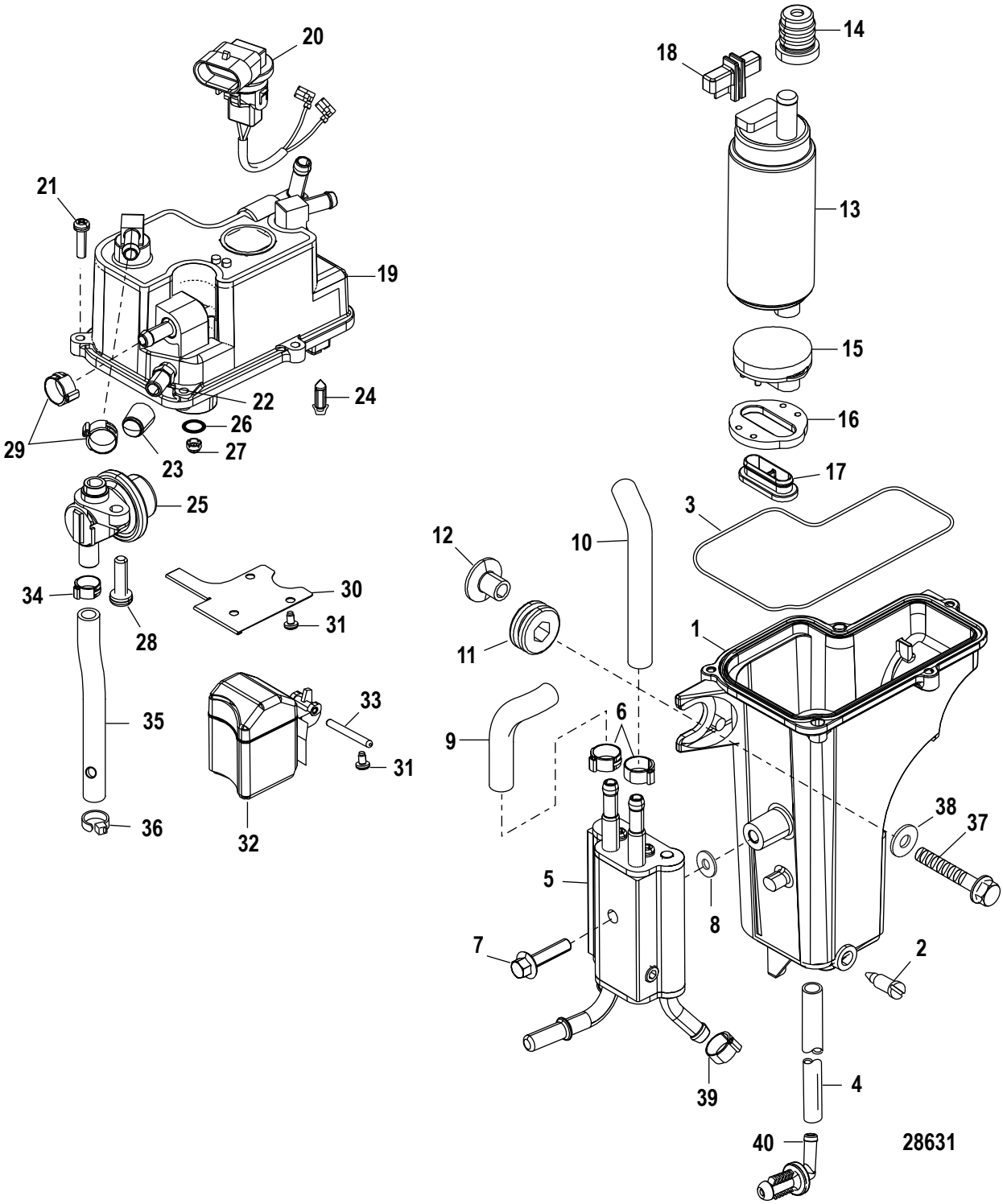


Intake Manifold Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Intake manifold			
2	4	Gasket			
3	4	Bolt	3.5	31	
4	1	Bracket			
5	1	Nut (M6)	8.5	75	
6	1	Solenoid valve			
7	1	TFI system			
8	4	Injector			
9	2	Screw	3.5	31	
10	4	Screw	3.5	31	
11	4	Clip			
12	1	Hose			
13	1	Throttle body			
14	1	Adjustment screw			
15	2	Bolt	3.5	31	
16	1	Throttle position sensor			
17	2	Bolt	2	18	
18	1	MAP sensor			
19	1	MAT sensor	1.4	12.5	
20	1	O-ring			
21	1	Gasket			
22	1	Attenuator			
23	8	Bolt (M6 x 25)	8.5	75	
24	1	Restrictor			
25	1	Breather hose			
26	1	Bolt (M6 x 30)	8.5	75	
27	3	Cable tie			
28	1	Screw (#10-16 x 0.625)	Drive tight		
29	1	Retainer			

Tube Ref No.	Description	Where Used	Part No.
	P80 Rubber Lubricant	Breather hose	Obtain Locally

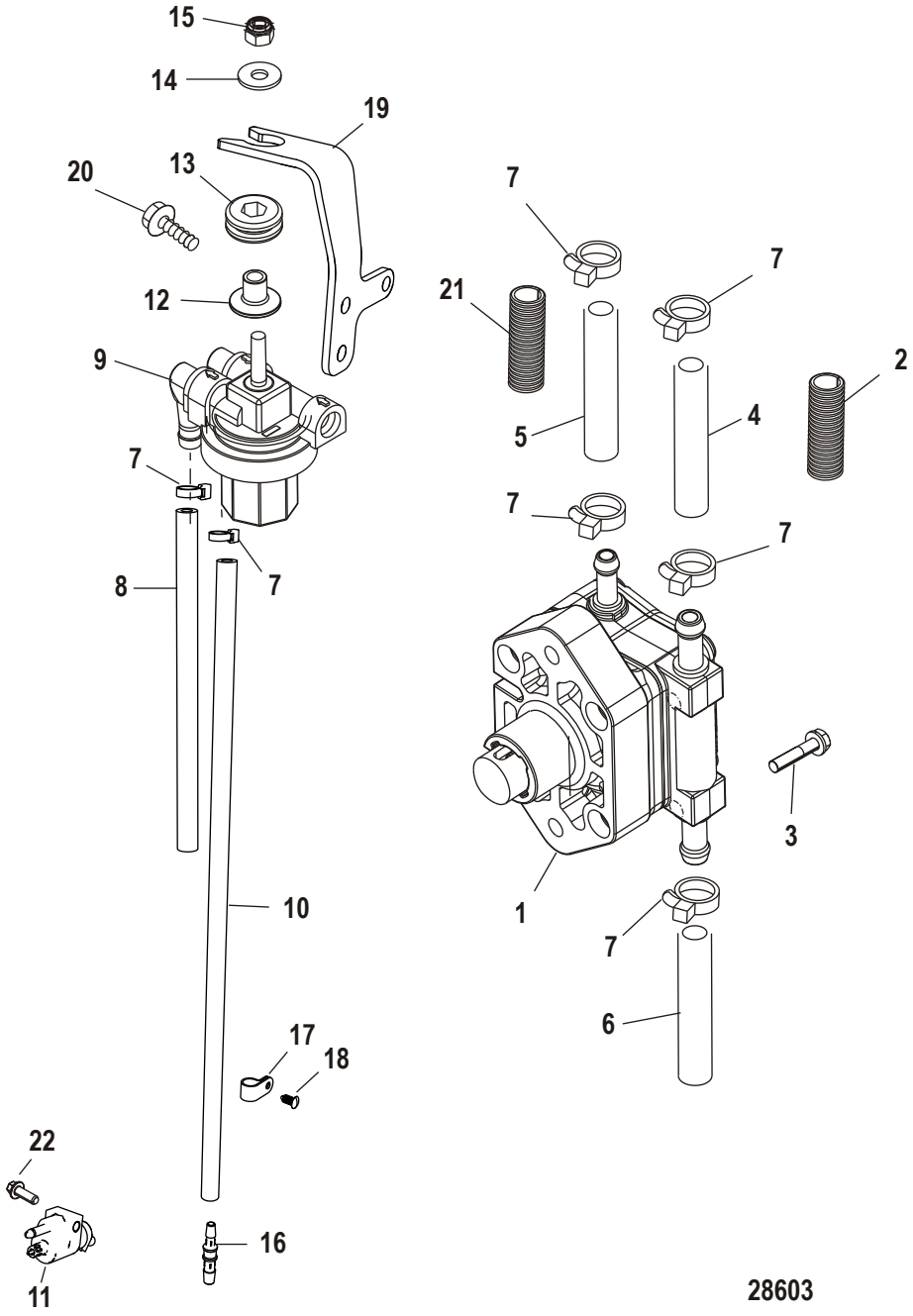
VST Components



VST Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Body assembly			
2	1	Drain screw	8.5	75	
3	1	O-ring			
4	1	Hose			
5	1	Fuel cooler			
6	2	Clamp			
7	1	Bolt (M6 x 25)	5.6	50	
8	1	Washer			
9	1	Hose			
10	1	Hose			
11	3	Grommet			
12	3	Bushing			
13	1	Fuel pump kit			
14	1	Insulator			
15	1	Isolator			
16	1	Insulator			
17	1	Fuel strainer			
18	1	Cover			
19	1	Cover assembly			
20	1	Electrical connector			
21	5	Screw (M4 x 16)	4.3	38	
22	1	Schrader valve	5.6	50	
23	1	Cap	5.6	50	
24	1	Float valve kit			
25	1	Pressure regulator kit			
26	1	O-ring			
27	1	Screen			
28	1	Screw (M5 x 15)			
29	2	Clamp			
30	1	Plate			
31	5	Screw (M4 x 8)	2.5	22	
32	1	Float			
33	1	Float pin			
34	1	Clamp			
35	1	Hose			
36	1	Cable tie			
37	3	Bolt (M6 x 25)	12	106	
38	3	Washer			
39	1	Clamp			
40	1	Fitting			

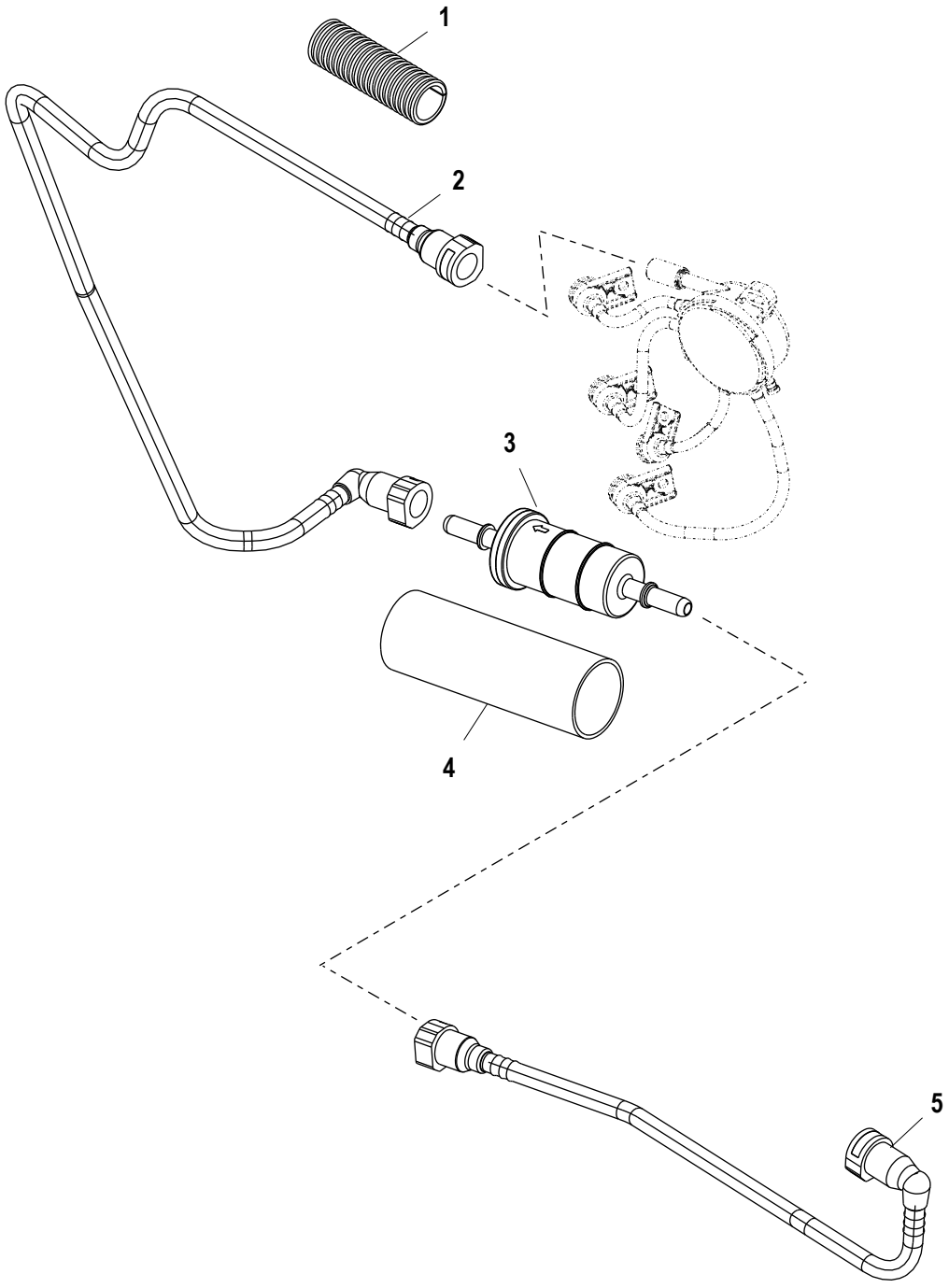
Fuel Pump Components



Fuel Pump Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Fuel pump assembly			
2	1	Conduit (66 cm [26 in.])			
3	2	Bolt (M6 x 30)	8.5	75	
4	1	Tubing (94 cm [37 in.])			
5	1	Hose (42 cm [16.5 in.])			
6	1	Tubing (15 cm [6 in.])			
7	AR	Cable tie			
8	1	Hose (20 cm [8 in.])			
9	1	Fuel filter			
10	1	Hose (86 cm [34 in.]) (remote)			
	1	Conduit (80 cm [31.5 in.]) (handle)			
11	1	Fuel connector (handle)			
12	1	Bushing			
13	1	Grommet			
14	1	Washer			
15	1	Nut (M6)	5.1	45	
16	1	Reducer fitting (remote)			
17	4	Clamp			
18	4	Screw			
19	1	Bracket			
20	2	Bolt (M6 x 13)	8.5	75	
21	1	Conduit			
22	1	Screw			

Fuel Line Components



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Fuel Line Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Conduit (61 cm [24 in.])			
2	1	Fuel line			
3	1	Fuel filter			
4	1	Protective sleeve			
5	1	Fuel line			

Intake Manifold

Releasing Fuel Pressure in the High-Pressure Fuel Line

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

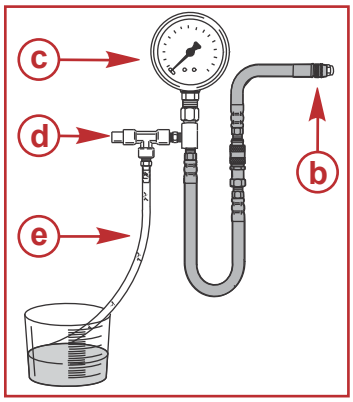
⚠ WARNING

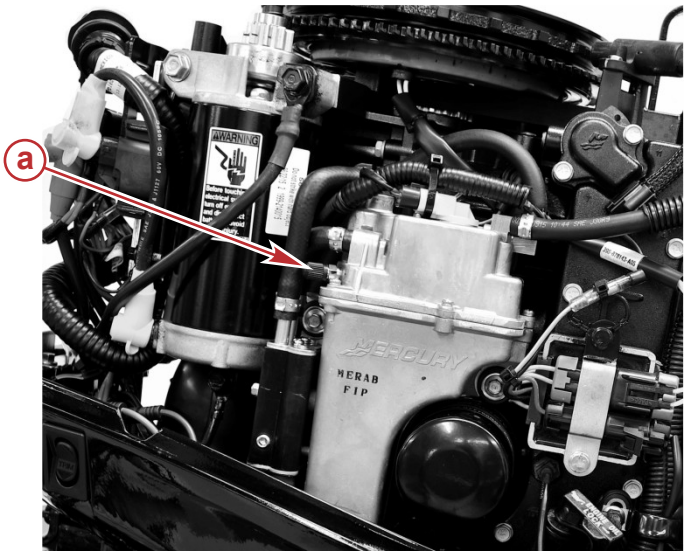
Fuel is flammable and explosive. Ensure that the key switch is off and the lanyard is positioned so that the engine cannot start. Do not smoke or allow sources of spark or open flame in the area while servicing. Keep the work area well ventilated and avoid prolonged exposure to vapors. Always check for leaks before attempting to start the engine, and wipe up any spilled fuel immediately.

⚠ CAUTION

Failure to release pressure from the fuel system will result in fuel spraying out, which can cause a fire or explosion. Allow the engine to cool completely and release all fuel pressure before servicing any part of the fuel system. Always protect eyes and skin from pressurized fuel and vapors.

1. Install the fuel pressure gauge onto the Schrader valve.
2. Place the drain hose into a container.
3. Push the relief button and release the pressure.





60765

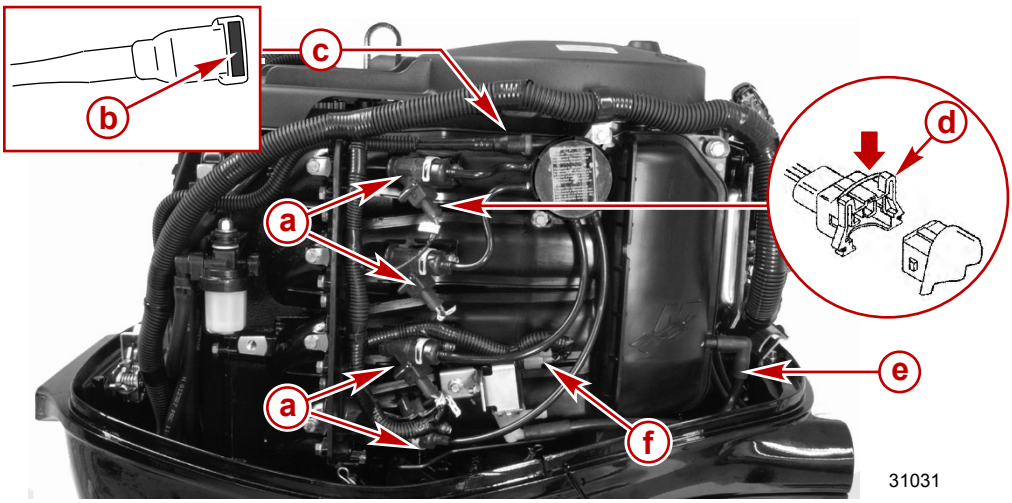
a - Schrader valve
b - To Schrader valve
c - Fuel pressure gauge
d - Pressure relief button
e - Drain hose

Fuel Pressure Gauge Kit	91-881833A03

Intake Manifold Removal

1. Release the pressure in the high-pressure fuel line.
2. Push the fuel injector harness connector retaining clip in and unplug the harness from each fuel injector. It is not necessary to remove the retaining clip from the connector.
3. Unplug the idle air control (IAC) connector.

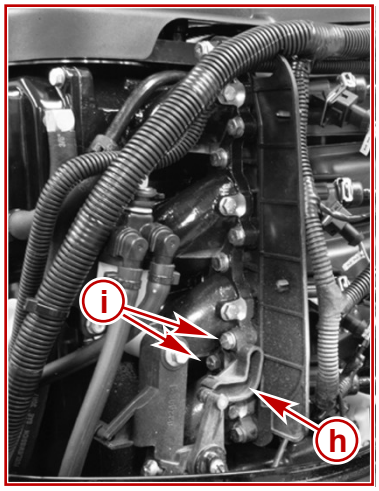
4. Depress the locking tab on the high-pressure fuel line and remove the line from the fuel distribution manifold.

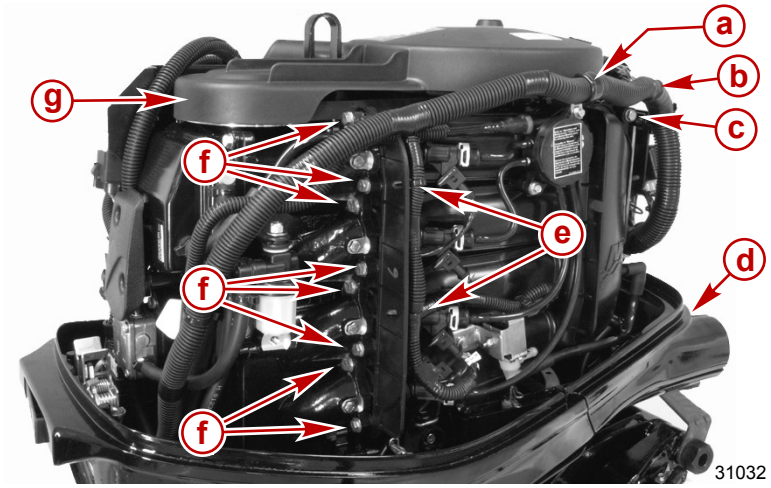


a - Fuel injector (4)
b - Locking tab
c - High-pressure fuel line
d - Harness connector retaining clip (4)
e - Throttle air bypass hose
f - Idle air control (IAC) connector

5. Remove the flywheel cover.
6. Remove the access cover.
7. Cut and remove the two cable ties on the fuel injector harness.
8. Cut and remove the cable tie on the engine harness.
9. Remove the engine harness from the J-clamp.

10. Remove the intake manifold mounting bolts and remove the intake manifold assembly.

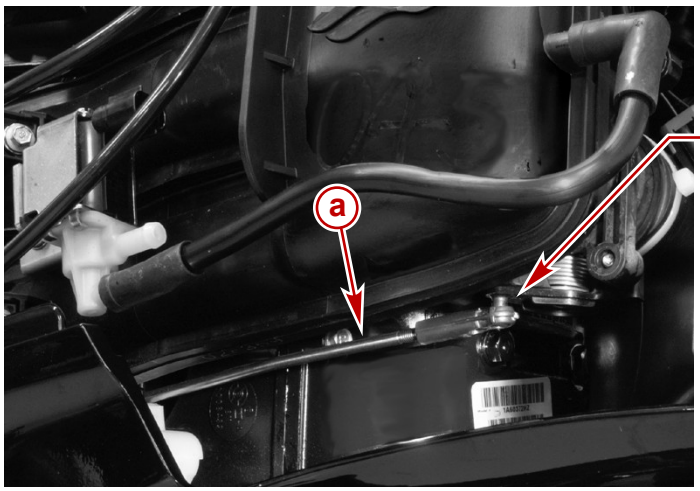




Jet models **Remote/tiller models**

- **a -** J-clamp
- **b -** Engine harness
- **c -** Intake manifold mounting bolts (M6 x 30) (1)
- **d -** Access cover
- **e -** Cable tie
- **f -** Intake manifold mounting bolts (M6 x 25) (8 or 6)
- **g -** Flywheel cover
- **h -** Throttle cam
- **i -** Intake manifold mounting bolts (M6 x 40) (2)

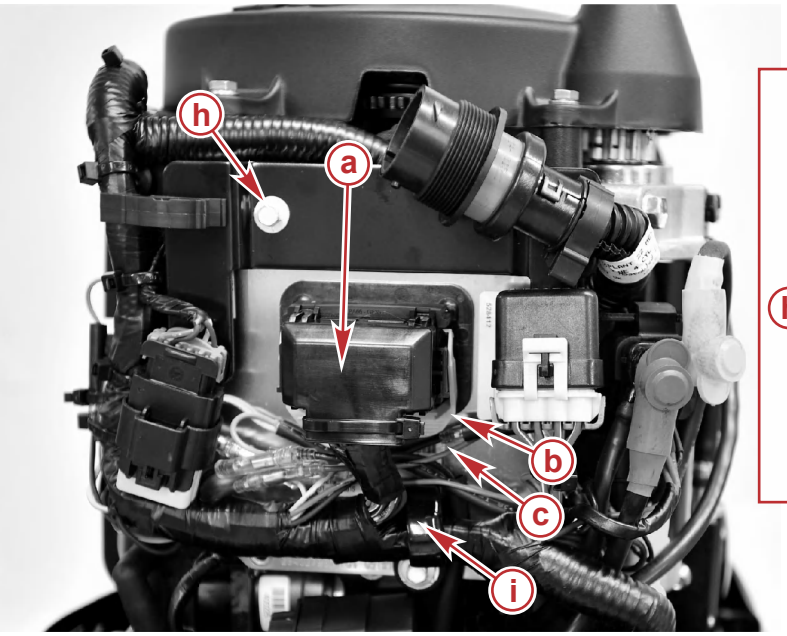
11. Disconnect the throttle link rod from the throttle body ball socket.

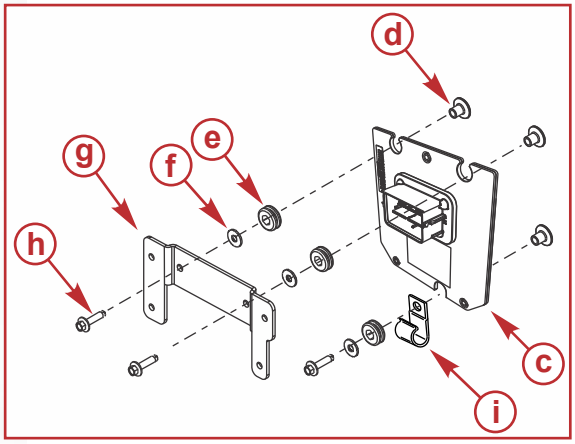


- **a -** Throttle link rod
- **b -** Throttle body ball socket

12. Release the locking bar on the ECM connector and remove the ECM harness connector.

13. Remove the ECM mounting bolts and washers. Remove the ECM from the mounting plate.

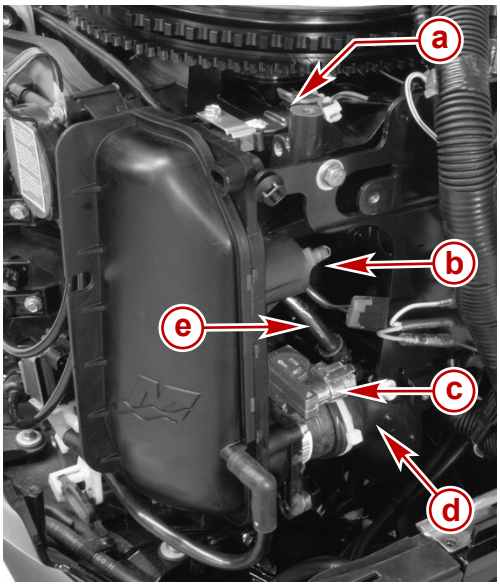




60770

a - ECM harness connector (2)
b - Locking bar
c - ECM
d - Bushing (3)
e - Grommet (3)
f - Washer (3)
g - Bracket
h - ECM mounting bolt (M6 x 25) (3)
i - J-clip

14. Disconnect the following sensors:
    - Manifold absolute pressure (MAP)
    - Manifold air temperature (MAT)
    - Throttle position sensor (TPS)
15. Cut the cable tie and remove the crankcase breather hose from the sound attenuator. Remove the intake manifold assembly from the engine.

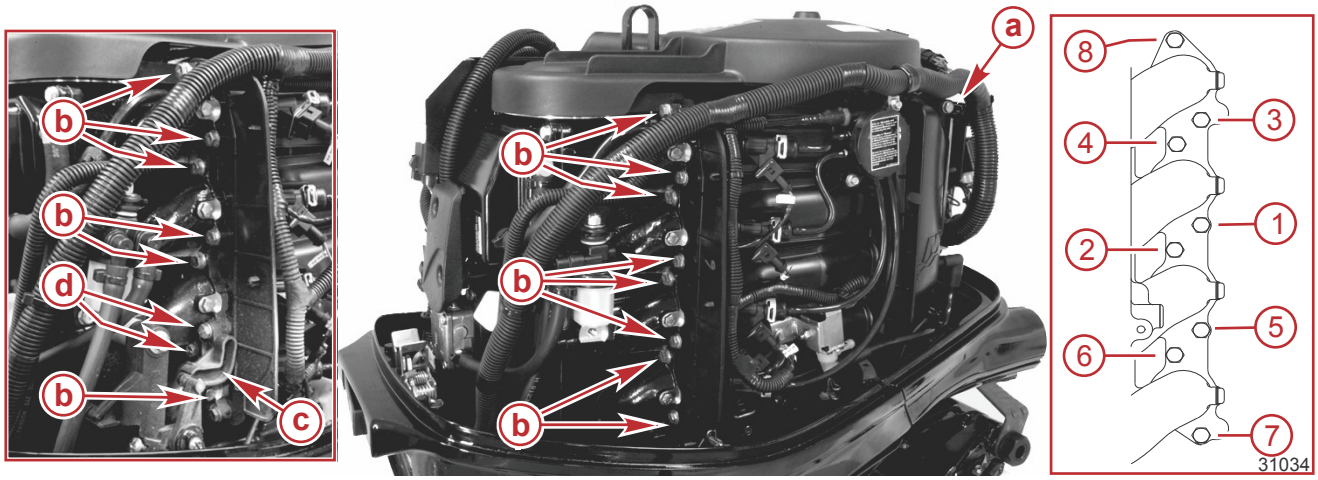


31079

a - Manifold absolute pressure (MAP) sensor
b - Manifold air temperature (MAT) sensor
c - Throttle position sensor (TPS)
d - Sound attenuator
e - Crankcase breather hose

Intake Manifold Installation

1. Install the gaskets into the grooves on the intake manifold.
2. Install the intake manifold assembly to the engine. Tighten the bolts in sequence to the specified torque.



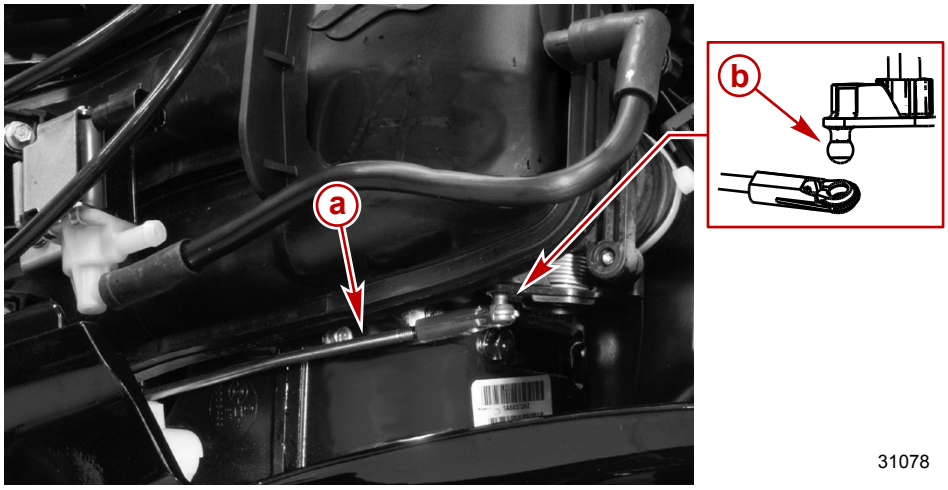
Jet models **Remote/tiller models**

a - Intake manifold mounting bolt (M6 x 30) (1)
b - Intake manifold mounting bolts (M6 x 25) (8 or 6)
c - Throttle cam
d - Intake manifold mounting bolts (M6 x 40) (2)

Description	Nm	lb-in.	lb-ft
Intake manifold mounting bolts	8.5	75.2	–

3. Connect the throttle link rod to the throttle body ball socket.

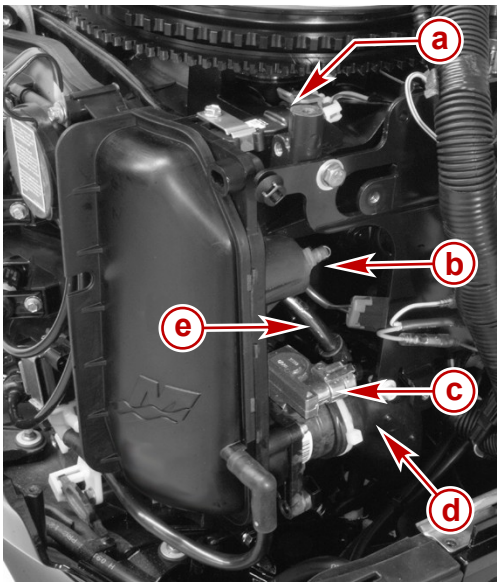
IMPORTANT: Check for proper throttle link rod adjustment. Refer to Section 7A.



a - Throttle link rod
b - Throttle body ball socket

4. Connect the following sensors:
   - Manifold absolute pressure (MAP)
   - Manifold air temperature (MAT)
   - Throttle position sensor (TPS)
5. Install the MAP sensor retaining clip. Tighten the screw to the specified torque.

6. Install the crankcase breather hose into the sound attenuator. Secure with a cable tie.

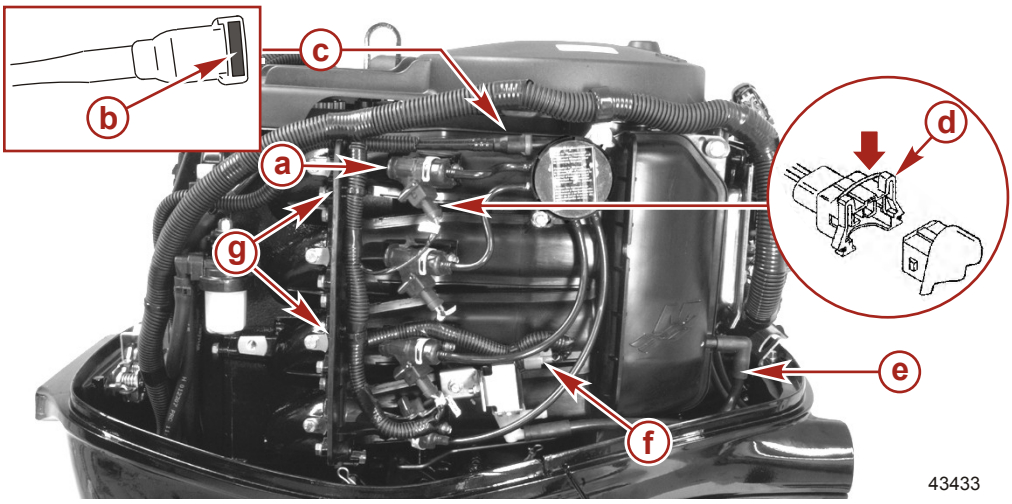


31079

- **a -** Manifold absolute pressure (MAP) sensor
- **b -** Manifold air temperature (MAT) sensor
- **c -** Throttle position sensor (TPS)
- **d -** Sound attenuator
- **e -** Crankcase breather hose

Description	Nm	lb-in.	lb-ft
MAP sensor retaining clip screw	Drive tight		

7. Connect the fuel line to the fuel distribution manifold. Push in until locked into place.
8. Route the injector harness as shown. Secure the harness to the intake manifold with two cable ties.
9. Connect the fuel injector and IAC connectors.
10. Install the flywheel cover. Tighten the bolts to the specified torque.



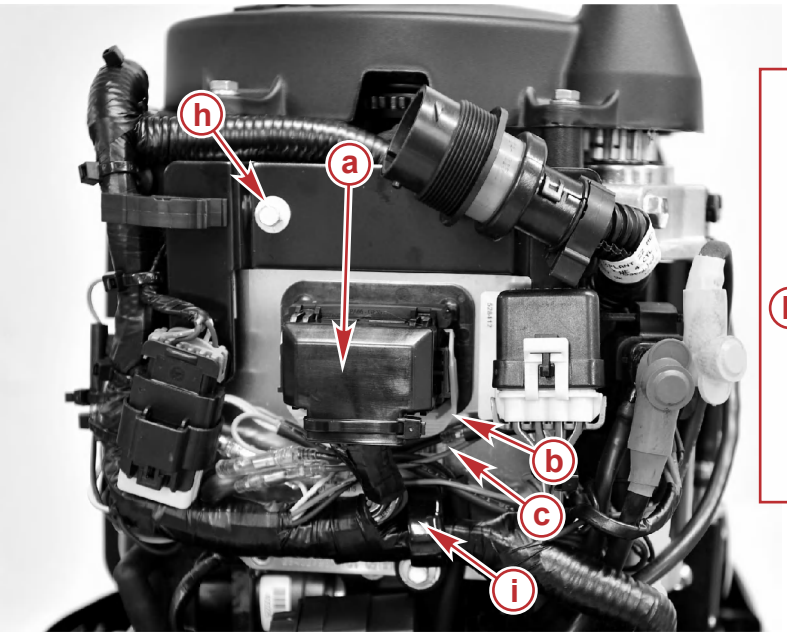
43433

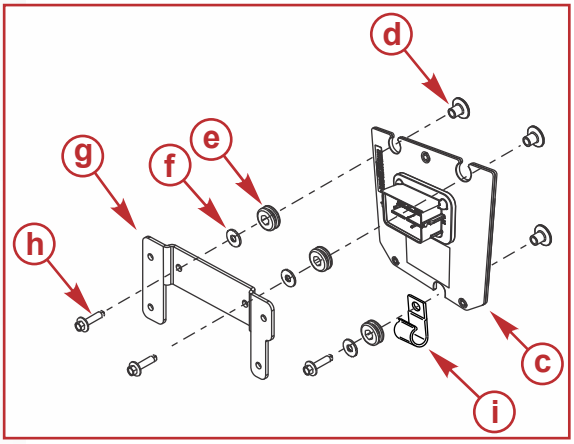
- **a -** Fuel injector (4)
- **b -** Locking tab
- **c -** High-pressure fuel line
- **d -** Harness connector retaining clip (4)
- **e -** Throttle air bypass hose
- **f -** Idle air control (IAC) connector
- **g -** Cable tie

Description	Nm	lb-in.	lb-ft
Flywheel cover bolts (M6 x 25) (4)	8.5	75.2	–

11. Install the ECM to the mounting plate. Tighten the mounting bolts to the specified torque.

12. Connect the ECM harness connector. Push the locking bar to secure.





60770

- **a -** ECM harness connector
- **b -** Locking bar
- **c -** ECM
- **d -** Bushing (3)
- **e -** Grommet (3)
- **f -** Washer (3)
- **g -** Bracket
- **h -** ECM mounting bolt (M6 x 25) (3)
- **i -** J-clip

Description	Nm	lb-in.	lb-ft
ECM mounting bolts	8.5	75.2	–

Throttle Body

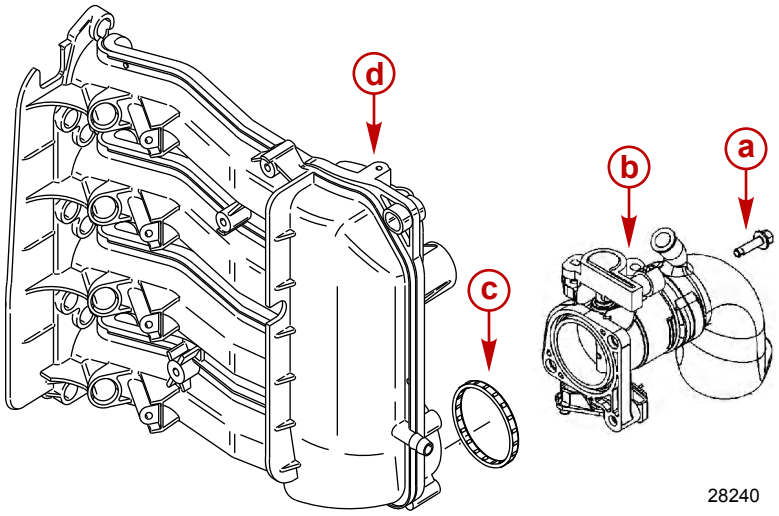
Removal

1. Remove the intake manifold assembly. Refer to **Intake Manifold Removal**.
2. Remove the throttle body mounting bolts. Remove the throttle body assembly from the intake manifold.

Installation

1. Lubricate the gasket and install the throttle body to the intake assembly. Tighten the bolts to the specified torque.

2. Install the intake manifold. Refer to **Intake Manifold Installation**.



a - Throttle body mounting bolts (M6 x 25) (2)
b - Throttle body assembly
c - Gasket
d - Intake manifold assembly

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Throttle body gasket	92-802859A 1

Description	Nm	lb-in.	lb-ft
Throttle body mounting bolts (M6 x 25) (2)	3.5	31	

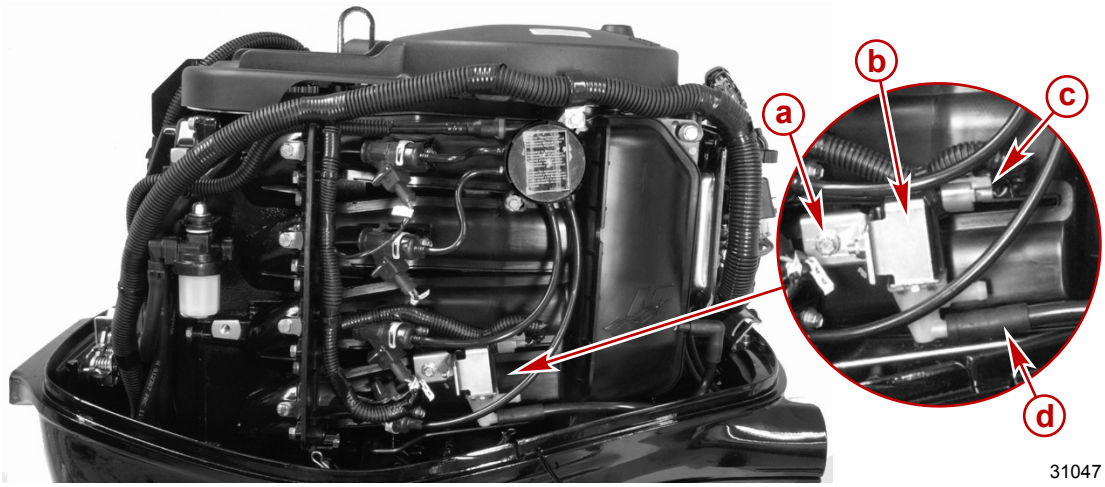
Idle Air Control (IAC)

Removal

1. Disconnect the IAC harness connector.
2. Remove the IAC mounting screw.
3. Disconnect the throttle air bypass hose and remove the IAC valve.

Installation

1. Install the IAC. Tighten the mounting screw to the specified torque.
2. Connect the IAC harness connector and bypass hose.



a - IAC mounting screw
b - IAC valve
c - IAC harness connector
d - Throttle air bypass hose

Description	Nm	lb-in.	lb-ft
IAC mounting screw	3.5	31	

3. Refer to **Section 2C - Timing, Synchronizing, and Adjusting** for adjustments.

Fuel Injectors

⚠ CAUTION

Failure to release pressure from the fuel system will result in fuel spraying out, which can cause a fire or explosion. Allow the engine to cool completely and release all fuel pressure before servicing any part of the fuel system. Always protect eyes and skin from pressurized fuel and vapors.

Removal

1. Remove the fuel injector cap retaining clips and screws.
2. Push in on the harness connector retaining clip and unplug the harness from each fuel injector.
3. Using the fuel injector cap tool, pry the injector cap from the injector.
4. Remove the fuel injectors from the intake manifold.

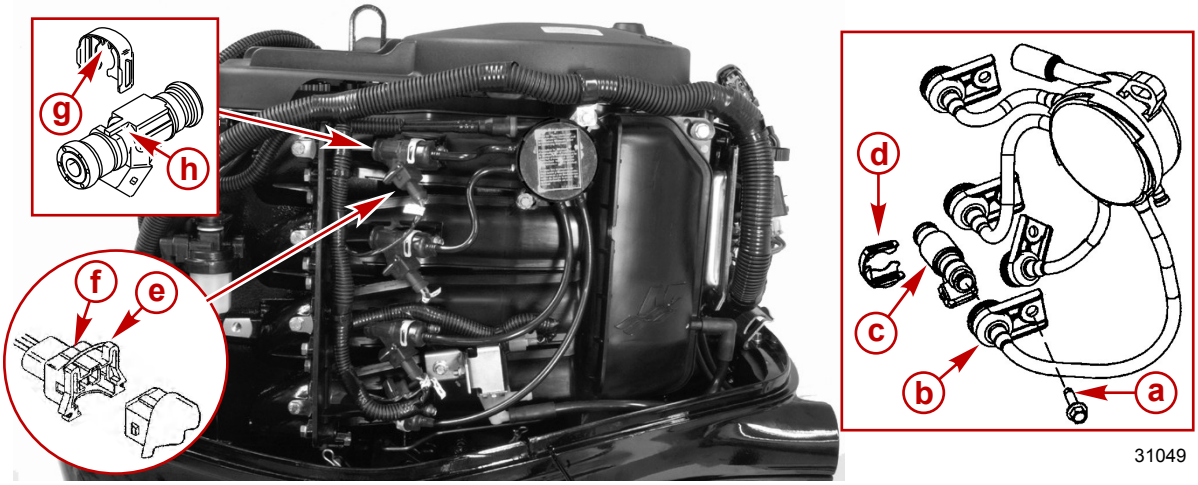
a - Screw (4)
b - Fuel injector cap
c - Fuel injector
d - Fuel injector cap retainer clip
e - Harness connector retaining clip

Fuel Injector Cap Tool	883877A1

Installation

1. Install the fuel injector cap by pushing it on the fuel injector until it bottoms out.
2. Lubricate the O-rings and install the fuel injectors into the intake manifold.
3. Install the fuel injector cap retaining screws and tighten to the specified torque. Install the fuel injector cap retaining clips so that the locking teeth line up with the locking rib on the fuel injector, as shown.

4. Connect the harness connectors to each fuel injector. Push the connector on until the retaining clip locks in place.



a - Screw (4)
b - Fuel injector cap
c - Fuel injector
d - Fuel injector cap retainer clip
e - Harness connector retaining clip
f - Harness connector
g - Locking teeth
h - Locking rib

Description	Nm	lb-in.	lb-ft
Fuel injector cap retaining screw (4)	3.5	31	

Manifold Absolute Pressure (MAP) Sensor

Removal

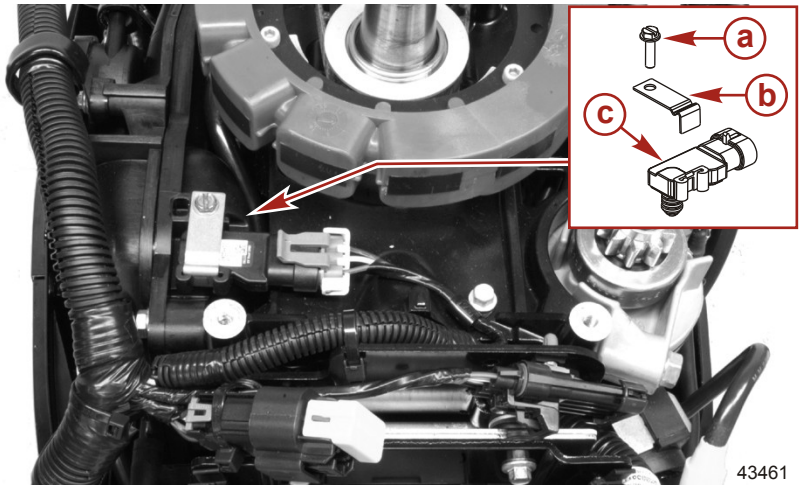
1. Remove the flywheel cover.
2. Remove the flywheel. Refer to **Section 2B - Flywheel Removal**.
3. Remove the MAP sensor retaining screw and retainer. Remove the MAP sensor from the intake manifold by pulling and twisting simultaneously (pulls out hard).

Installation

1. Lubricate the seal and push MAP sensor into the intake assembly.
2. Install the retainer and screw. Tighten the screw securely.
3. Install the flywheel.

   IMPORTANT: Always install a new load ring when installing the flywheel.

4. Install the flywheel cover. Refer to **Section 2B - Flywheel Installation**.



a - Screw (10-16 x 5/8)
b - MAP sensor retainer
c - Manifold absolute pressure (MAP) sensor

Fuel Distribution Manifold

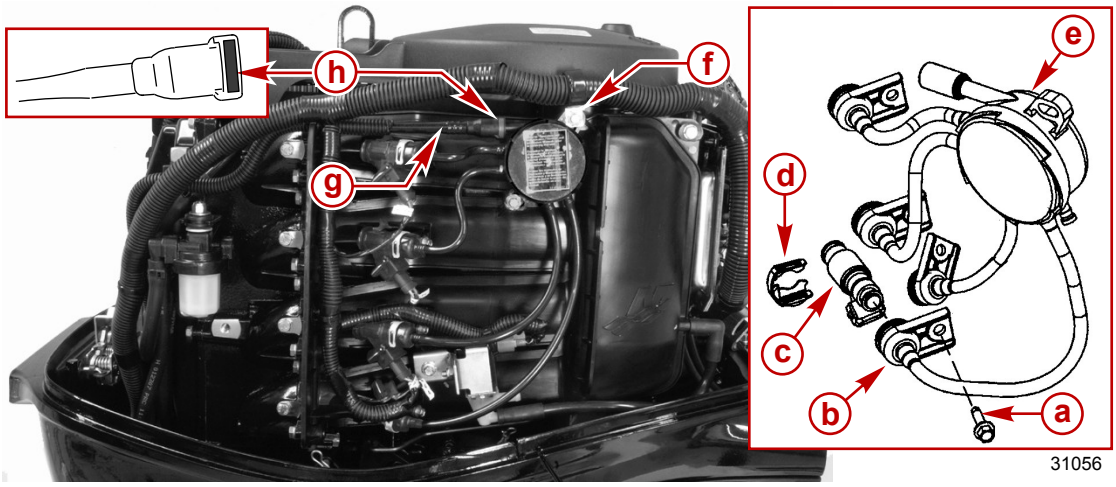
⚠ CAUTION

Failure to release pressure from the fuel system will result in fuel spraying out, which can cause a fire or explosion. Allow the engine to cool completely and release all fuel pressure before servicing any part of the fuel system. Always protect eyes and skin from pressurized fuel and vapors.

Removal

1. Release the pressure in the high-pressure line. Refer to **Releasing Fuel Pressure in the High-Pressure Fuel Line**.
2. Remove the fuel injector cap retaining screws.
3. Remove the fuel injector cap retaining clips.
4. Using the fuel injector cap tool, pry the fuel injector cap off of each fuel injector.
5. Remove the fuel distribution manifold mounting screws.

6. Disconnect the high-pressure fuel line by depressing the locking tab and pulling back. Remove the fuel distribution manifold.



a - Screw (4)
b - Fuel injector cap
c - Fuel injector
d - Fuel injector cap retainer clip
e - Fuel distribution manifold
f - Fuel distribution manifold mounting screws
g - High-pressure fuel line
h - High-pressure fuel line locking tab

Fuel Injector Cap Tool	883877A1

Installation

1. Install the fuel distribution manifold and tighten the screws to the specified torque.

Description	Nm	lb-in.	lb-ft
Fuel distribution manifold mounting screws	3.5	31	

2. Push the fuel injector cap onto the fuel injector until the cap bottoms out on the injector.
3. Install the fuel injector cap retaining screws and tighten to the specified torque. Install the fuel injector cap retaining clips so the locking teeth line up with the locking rib on the fuel injector.
4. Connect the high-pressure fuel line. Push on until the locking tab snaps in place.

Description	Nm	lb-in.	lb-ft
Fuel injector cap retaining screws	3.5	31	

Manifold Air Temperature (MAT) Sensor

Removal

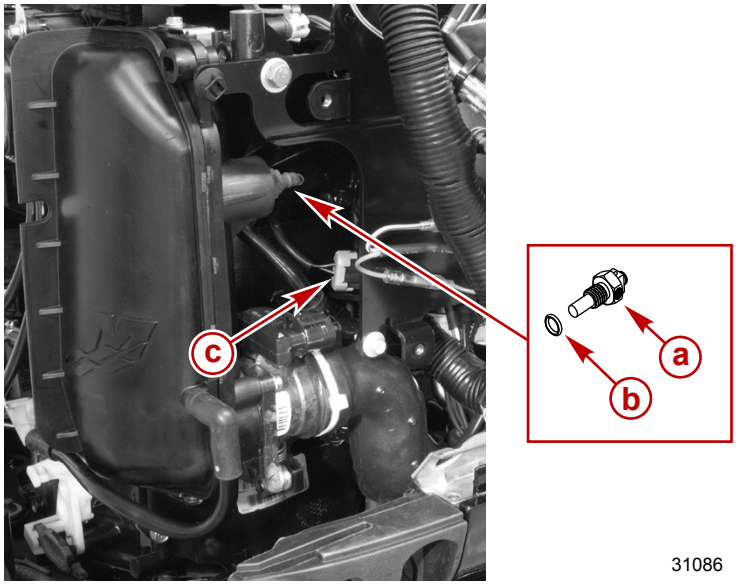
1. Remove the intake engine control module (ECM). Refer to **Engine Control Module (ECM)**.
2. Disconnect the manifold air temperature (MAT) sensor connector.
3. Remove the MAT sensor from the intake manifold assembly.

Installation

IMPORTANT: Overtightening the manifold air temperature (MAT) sensor can damage the plastic threads. Tighten to the specified torque.

1. Inspect the O-ring and replace if necessary. Lubricate the O-ring with 2-4-C with PTFE and install the manifold air temperature sensor. Tighten to the specified torque.
2. Connect the MAT sensor connector.

3. Install the intake engine control module (ECM). Refer to **Engine Control Module (ECM)**.



31086

- **a -** Manifold air temperature (MAT) sensor
- **b -** O-ring
- **c -** MAT sensor harness connector

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Manifold air temperature (MAT) sensor O-ring	92-802859A 1

Description	Nm	lb-in.	lb-ft
Manifold air temperature (MAT) sensor	1.4	12.5	

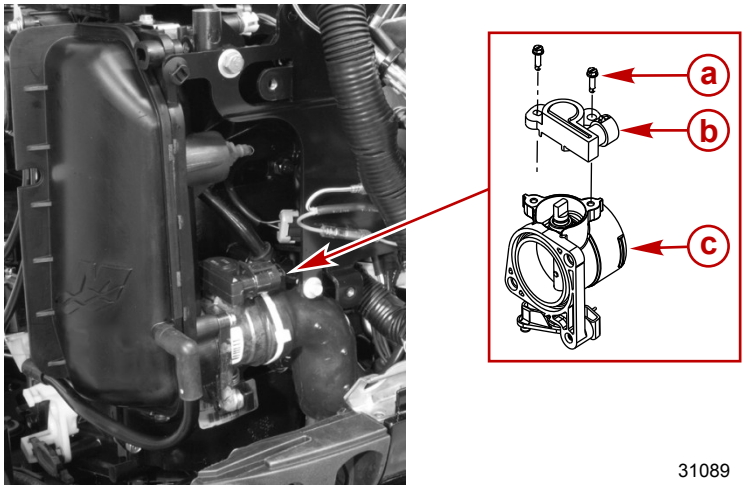
Throttle Position Sensor (TPS)

Removal

1. Remove the engine control module (ECM). Refer to **Engine Control Module (ECM)**.
2. Disconnect the throttle position sensor (TPS) connector.
3. Remove the mounting screws and remove the throttle position sensor.

Installation

1. Install the throttle position sensor. Tighten the screws to the specified torque.
2. Connect the throttle position sensor connector.
3. Install the intake engine control module (ECM). Refer to **Engine Control Module (ECM)**.



31089

- **a -** Mounting screws (15 mm long) (2)
- **b -** TPS connector
- **c -** Throttle body

Description	Nm	lb-in.	lb-ft
TPS mounting screws	2	18	

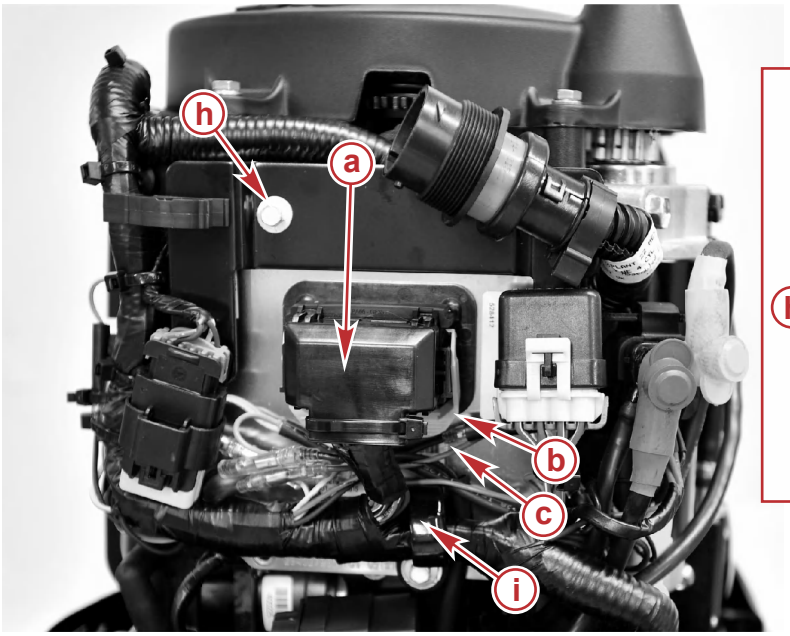
Engine Control Module (ECM)

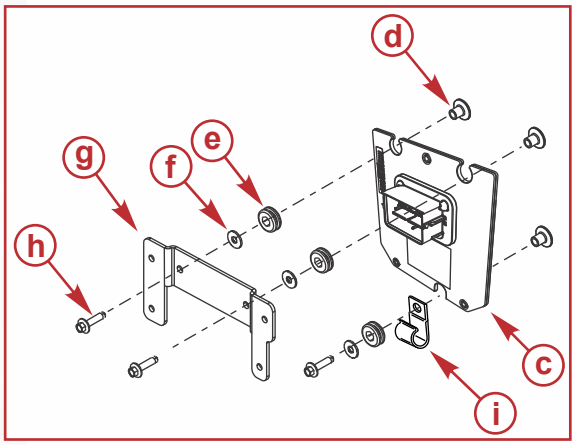
Removal

1. Pull the ECM connector locking bar to unlock the connector from the ECM.
2. Remove the engine harness connector from the ECM.
3. Remove the two bolts securing the ECM and bracket to the powerhead.
4. Remove the ECM from the powerhead.

Installation

1. Install the grommets and bushings onto the ECM.
2. Install the ECM onto the lower grommet attached to the powerhead.
3. Install the two bolts through the bracket and install washers onto the bolts.
4. Install the ECM and bracket to the powerhead. Tighten the bolts to the specified torque.
5. Connect the engine harness connector to the ECM.
6. Push the locking bar to secure the connector to the ECM.





60770

a - ECM harness connector
b - Locking bar
c - ECM
d - Bushing (3)
e - Grommet (3)
f - Washer (3)
g - Bracket
h - ECM mounting bolt (M6 x 25) (3)
i - J-clip

Description	Nm	lb-in.	lb-ft
ECM mounting bolt (M6 x 25) (3)	5.1	45	–

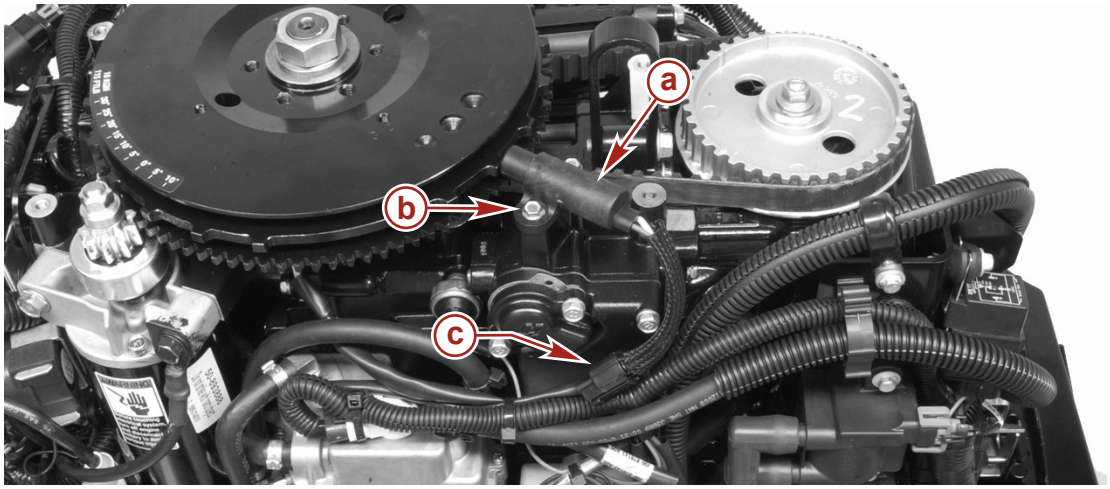
Crankshaft Position Sensor (CPS)

Removal

1. Remove the flywheel cover. Refer to **Section 4A - Valve Cover Removal**.
2. Disconnect the sensor from the engine harness.
3. Remove the sensor mounting screws.
4. Remove the crankshaft position sensor.

Installation

1. Install the crankshaft position sensor.
2. Install the mounting screws. Tighten the screws to the specified torque.
3. Connect the sensor to the engine harness.



42001

a - Crankshaft position sensor (CPS)
b - Mounting screw (M5 x 16) (2)
c - Connector

Description	Nm	lb-in.	lb-ft
Crankshaft position sensor mounting screw (M5 x 16) (2)	5.1	45	

4. Install the flywheel cover. Refer to **Section 4A - Valve Cover Installation**.

Engine Coolant Temperature (ECT) Sensor

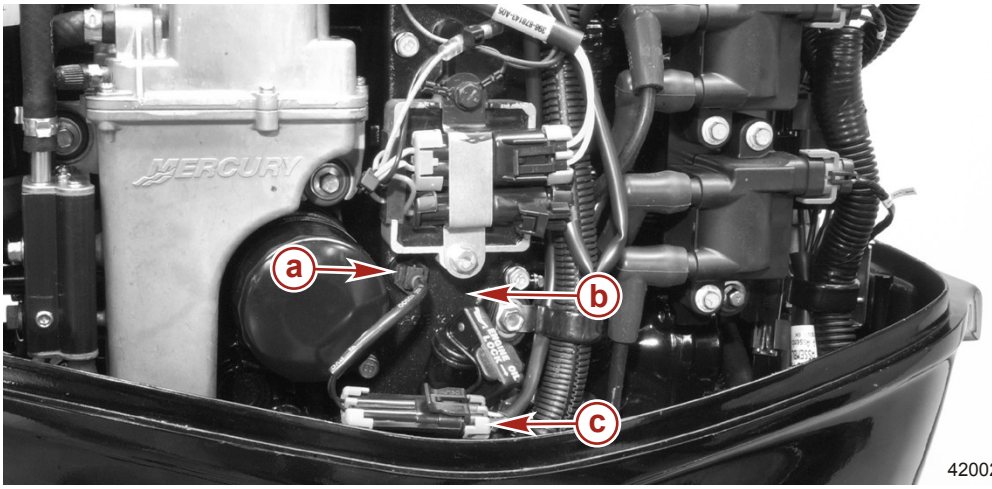
Removal

1. Disconnect the sensor from the engine harness.
2. Remove the sensor from the exhaust cover.

Installation

1. Inspect the O-ring and replace if necessary.
2. Lubricate the O-ring with 2-4-C with PTFE and install the sensor into the exhaust cover. Tighten the sensor to the specified torque.

3. Connect the sensor connector to the engine harness.



a - Engine coolant temperature (ECT) sensor
b - Exhaust cover
c - Harness connector

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	ECT sensor O-ring	92-802859A 1

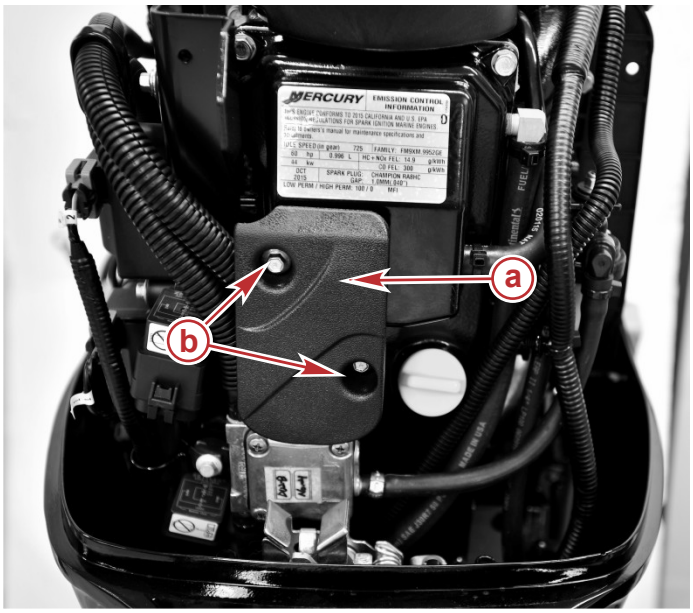
Description	Nm	lb-in.	lb-ft
ECT sensor	1.7	15	

Low-Pressure Fuel Pump

Low-Pressure Fuel Pump Removal and Disassembly

Removal

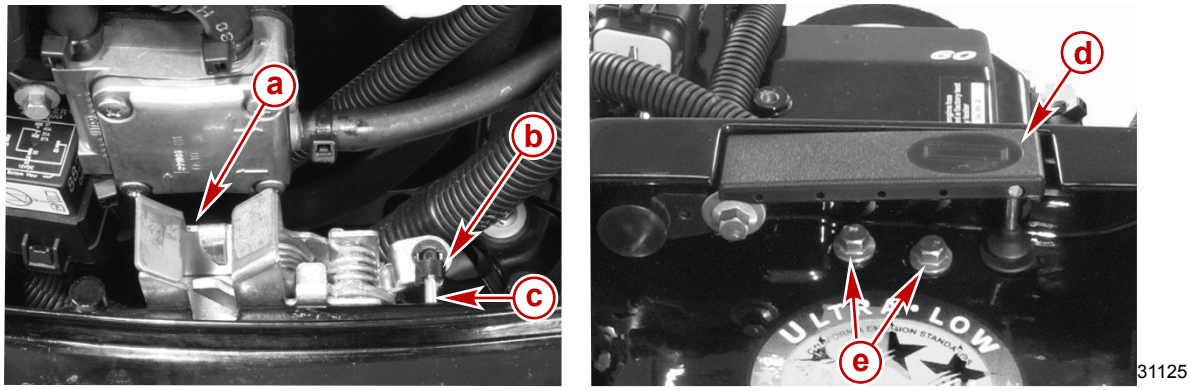
1. Remove the two cowl deflector mounting bolts and the cowl deflector.



a - Cowl deflector
b - Mounting bolts (M6 special flange head)

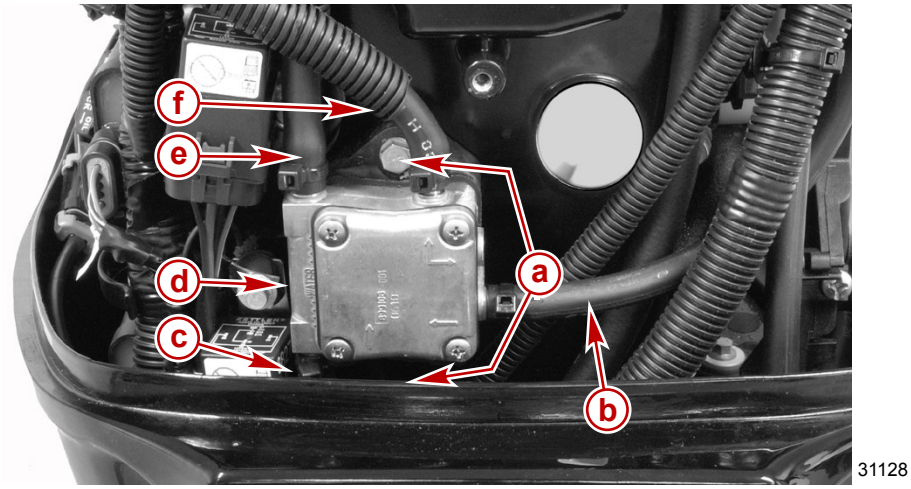
2. Remove the rear latch link retainer from the link.
3. Remove the two rear latch mounting bolts.

4. Remove the rear latch assembly and link.



a - Rear latch assembly
b - Rear latch link retainer
c - Link
d - Rear latch handle
e - Rear latch mounting bolts (M6 x 20)

5. Cut the cable ties. Remove the fuel pump inlet/outlet hoses and fuel cooler water inlet/outlet hoses.
6. Remove the fuel pump mounting bolts.
7. Remove the fuel pump from the valve cover.



a - Mounting bolt (M6 x 30) (2)
b - Fuel inlet line
c - Fuel cooler water outlet hose (to water pump indicator hole)
d - Fuel pump
e - Fuel cooler water inlet hose (from VST fuel cooler)
f - Fuel outlet hose (to VST)

Disassembly

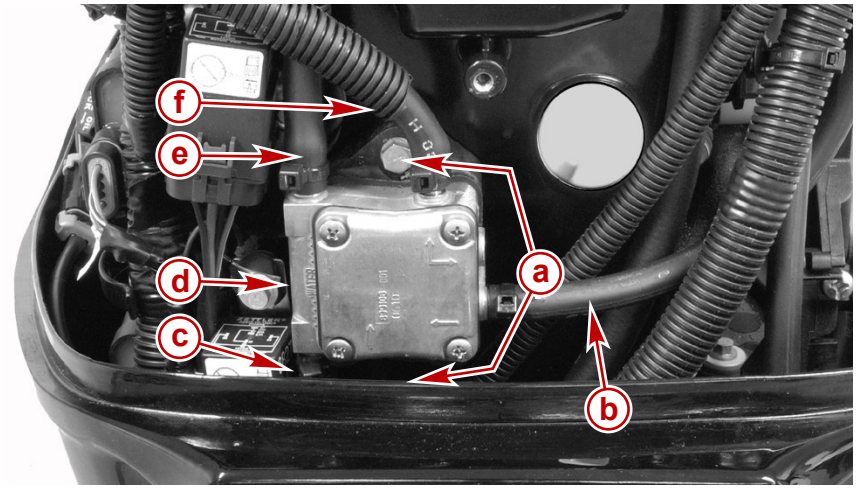
NOTE: *Replacement parts are not available. Complete pump must be replaced.*

Low-Pressure Fuel Pump Installation

Installation

1. Connect the fuel lines to the pump and secure with new cable ties.

2. Install the fuel pump onto the cylinder head cover. Secure with two bolts. Tighten to the specified torque.

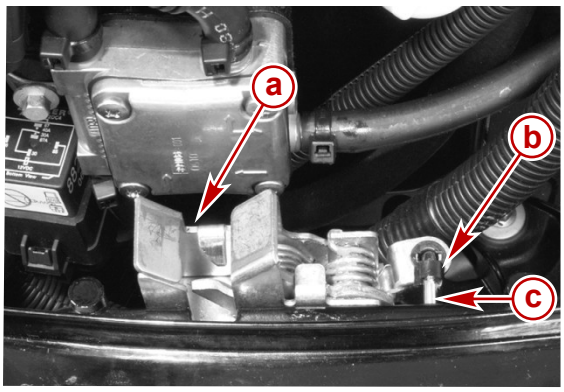


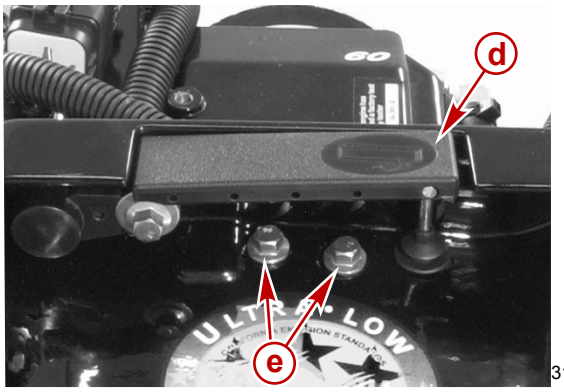
31128

- **a -** Mounting bolt (M6 x 30) (2)
- **b -** Fuel inlet line
- **c -** Fuel cooler water outlet hose (to water pump indicator outlet)
- **d -** Fuel pump
- **e -** Fuel cooler water inlet hose (from VST fuel cooler)
- **f -** Fuel outlet hose (to VST)

Description	Nm	lb-in.	lb-ft
Fuel pump mounting bolts (2)	8.5	75.2	–

3. Install the rear latch.
4. Install the two rear latch mounting bolts. Tighten the bolts to the specified torque.
5. Install the link into the rear latch assembly.
6. Fasten the rear latch link retainer over the link.





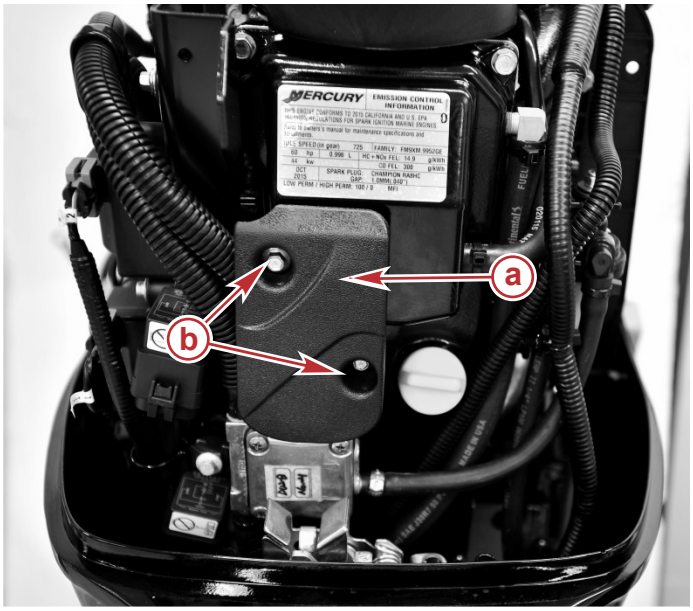
31125

- **a -** Rear latch assembly
- **b -** Rear latch link retainer
- **c -** Link
- **d -** Rear latch handle
- **e -** Rear latch mounting bolts (M6 x 20)

Description	Nm	lb-in.	lb-ft
Rear latch mounting bolts (M6 x 20) (2)	10	88.5	–

7. Apply Loctite 242 Threadlocker to the cowl deflector special flange head bolt threads.

8. Install the cowl deflector. Tighten the bolts to the specified torque.



60826

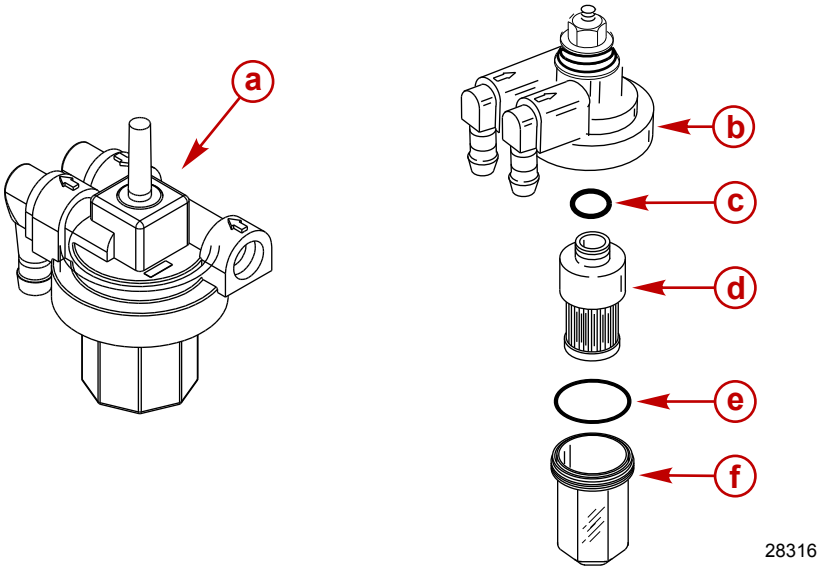
a - Cowl deflector
b - Mounting bolts (M6 special flange head)

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Cowl deflector mounting bolts	92-809821

Description	Nm	lb-in.	lb-ft
Mounting bolts (M6 special flange head)	10	88.5	–

Fuel Filter Replacement

1. Unscrew the fuel filter cup and remove the fuel filter element and O-rings.
2. Inspect the O-rings; replace if necessary.
3. Clean the fuel filter cup and replace the fuel filter element, if needed.
4. Lubricate the O-rings with engine oil and install the fuel filter element.
5. Install the fuel filter cup and hand-tighten.



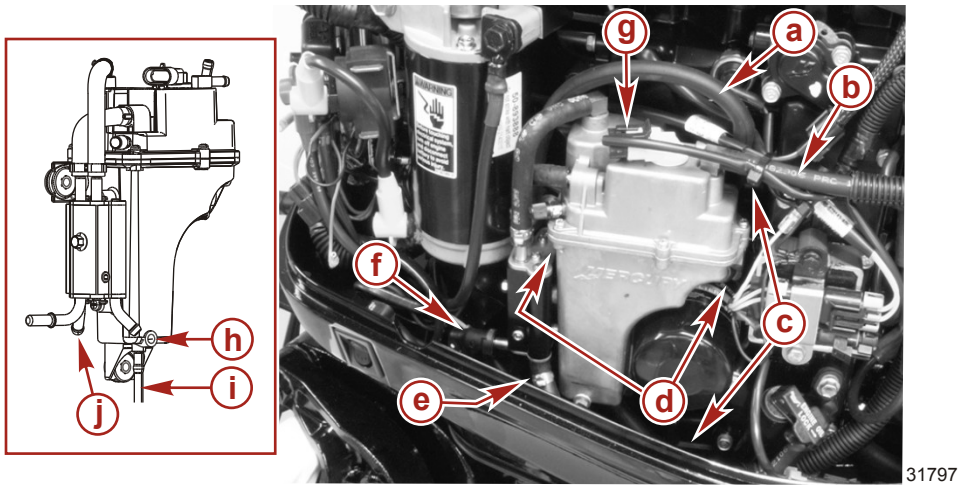
28316

a - Fuel filter assembly
b - Fuel filter cap
c - O-ring
d - Element
e - O-ring
f - Fuel filter cup

Vapor Separator Tank (VST)

Removal

1. Release the fuel pressure. Refer to **Releasing Fuel Pressure in the High-Pressure Fuel Line**.
2. Drain the fuel from the VST into a suitable container.
3. Cut the cable ties securing the fuel hoses.
4. Disconnect the VST fuel hose (from the mechanical fuel pump), vent hose, and the pump harness connector.
5. Remove the two uppermost VST mounting bolts. Leave the lower bolt in place.
6. Disconnect the high-pressure fuel hose and the water hose on the VST fuel cooler.
7. Remove the VST drain hose.
8. Remove the VST from the engine.



- **a -** VST vent hose
- **b -** Fuel hose (mechanical fuel pump to VST)
- **c -** Cable ties
- **d -** Upper VST mounting bolts (M6 x 25)
- **e -** Water hose (exhaust cover to fuel cooler)
- **f -** High-pressure fuel hose (fuel cooler to fuel distribution manifold)
- **g -** High-pressure fuel pump harness connector
- **h -** VST drain valve
- **i -** VST drain hose
- **j -** Water hose (VST fuel cooler to mechanical fuel pump fuel cooler)

Installation

1. Tighten the drain valve to the specified torque.
2. Connect the drain line, water hose (VST fuel cooler to mechanical fuel pump fuel cooler), and the water hose (exhaust cover to fuel cooler). Secure the water hose (VST fuel cooler to mechanical fuel pump fuel cooler) with a cable tie. Secure the water hose (exhaust cover to fuel cooler) with an Oetiker clamp.

Hose Clamp Tool Kit	91-803146A04

3. Install the grommets and bushings onto the VST. Install the VST onto the engine. Tighten the mounting bolts to the specified torque.
4. Connect the VST fuel hose (from the mechanical fuel pump) and vent hose. Secure both hoses with cable ties.
5. Connect the high-pressure fuel pump harness connector.
6. Secure the hoses and wire harnesses with cable ties.

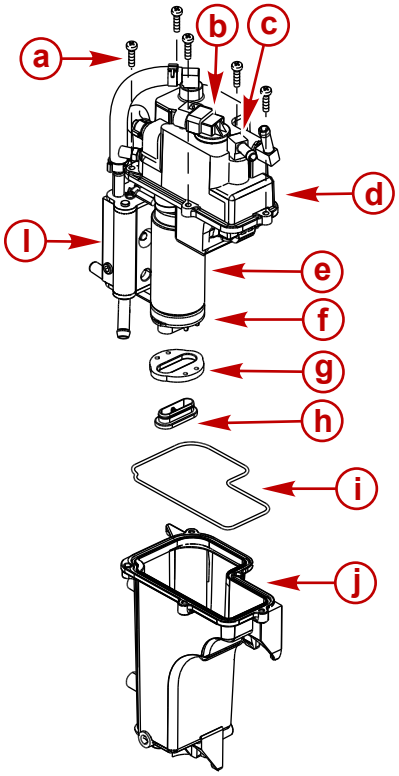
Description	Nm	lb-in.	lb-ft
Drain valve	8.5	75	
VST mounting bolts (M6 x 25)	12	106	

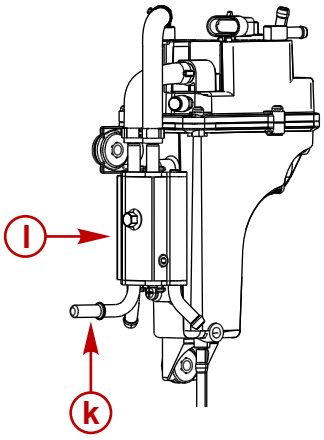
Vapor Separator Tank (VST) (S/N 1B036614 and Above)

Disassembly

1. Remove the fuel cooler mounting bolt.
2. If removal of the fuel cooler is required, cut the metal hose clamps and remove the fuel hoses from the VST cover. Remove the fuel cooler.

3. Remove the VST cover screws; remove the cover assembly.

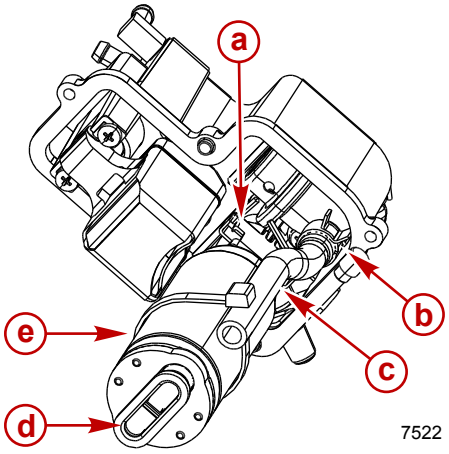




7624

- **a -** VST cover screws (5)
- **b -** Electrical connector
- **c -** Fuel inlet
- **d -** VST cover assembly
- **e -** High-pressure fuel pump
- **f -** Isolator
- **g -** Insulator
- **h -** Screen
- **i -** O-ring
- **j -** VST float chamber
- **k -** Fuel outlet
- **l -** Fuel cooler

4. Disconnect the high-pressure fuel pump connectors; remove the high-pressure fuel pump.
5. Inspect and clean the high-pressure fuel pump screen.

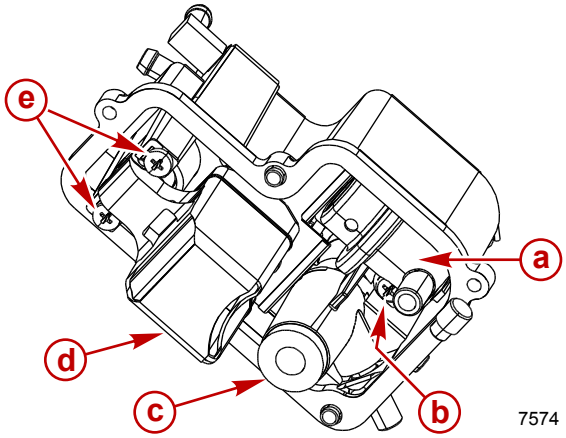


7522

- **a -** Connector insulator (connectors underneath)
- **b -** Hose clamp
- **c -** Fuel pressure regulator hose
- **d -** Screen
- **e -** High-pressure fuel pump

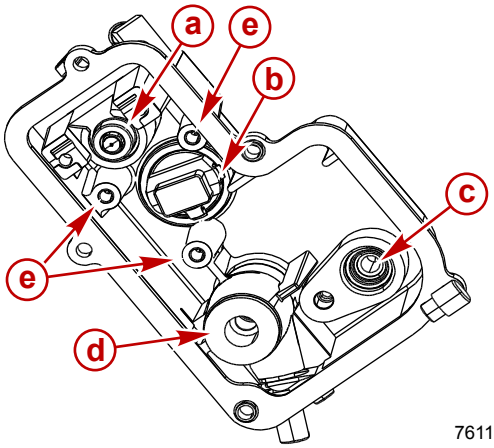
6. Loosen the float pin retaining screw and remove the float assembly.
7. Remove the fuel pressure regulator retaining screw.

8. Remove the fuel pressure regulator.



- **a -** Fuel pressure regulator
- **b -** Fuel pressure regulator retaining screw
- **c -** Insulator
- **d -** Float
- **e -** Float pin retaining screws

9. Inspect and clean the VST float chamber.
10. Inspect the fuel inlet seat for damage.
    NOTE: *The fuel inlet seat is not serviceable.*
11. Remove the three screws securing the baffle plate; remove the baffle plate.
12. Inspect and clean the regulator screen.
13. Remove the electrical connector. Depress the three locking tabs and push the connector out of the VST cover.

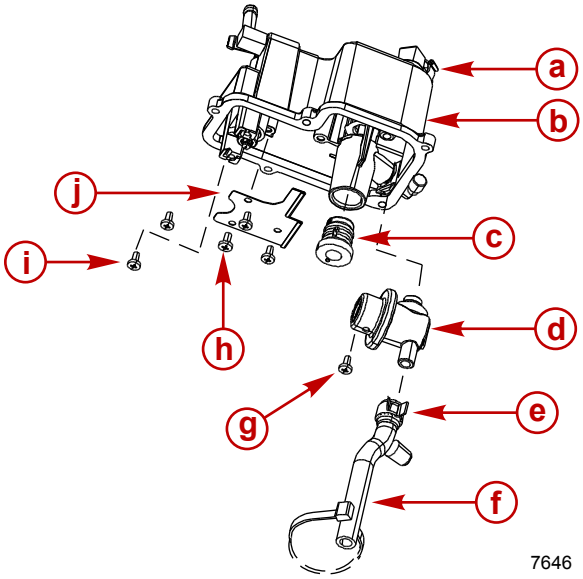


- **a -** Fuel inlet seat
- **b -** Electrical connector locking tab (3)
- **c -** Regulator screen
- **d -** Fuel pump grommet
- **e -** Threaded hole for baffle plate

Assembly

1. Install the electrical connector in the VST cover.
2. Apply Loctite 242 to the screw and install the pressure regulator.
3. Install the hose to the pressure regulator valve. Secure with a hose clamp.
4. Install the high-pressure pump insulator.
5. Apply Loctite 242 to the screws and install the baffle plate, if removed. Tighten the screws to the specified torque.

6. Install the float pin screws loosely.

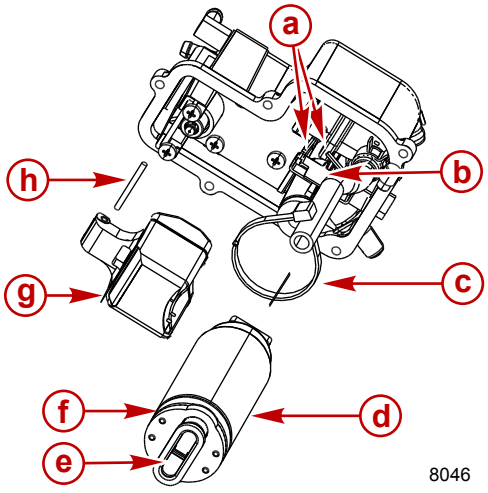


- **a -** Electrical connector
- **b -** Cover
- **c -** Insulator
- **d -** Pressure regulator
- **e -** Hose clamp
- **f -** Hose assembly
- **g -** Pressure regulator retaining screw
- **h -** Baffle plate screws (3)
- **i -** Float pin retaining screws (2)
- **j -** Baffle plate

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Pressure regulator retaining screw and baffle plate screws (3)	92-809821

Description	Nm	lb-in.	lb-ft
Pressure regulator retaining screw and baffle plate screws (3)	2.5	22	

7. Assemble the screen and grommet to the high-pressure fuel pump.
8. Insert the high-pressure fuel pump through the cable tie.
9. Connect the high-pressure fuel pump electrical wires.
10. Push the insulator over the wire connectors. Ensure the slot on the insulator fits on the fin on the cover.
11. Install the float pin through the hole in the float.
12. Assemble the float assembly under the float retainer screws as the float fuel shut off needle is installed in the seat.
13. Tighten the float pin retaining screws to the specified torque.

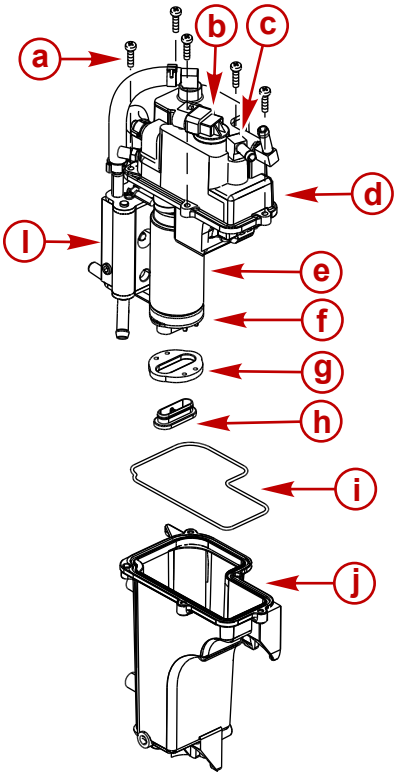


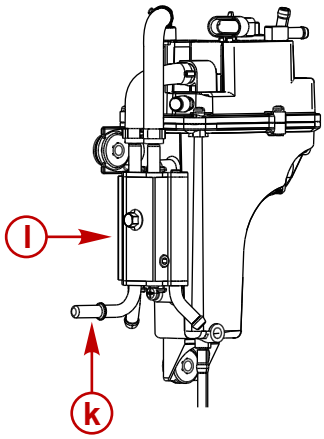
- **a -** Fuel pump electrical wires
- **b -** Insulator
- **c -** Cable tie
- **d -** High-pressure fuel pump
- **e -** Screen
- **f -** Isolator
- **g -** Float
- **h -** Float pin

Description	Nm	lb-in.	lb-ft
Float pin retaining screws (2)	2.5	22	

14. Install the grommet to the bottom of the high-pressure fuel pump.
15. Install the O-ring seal in the groove on the VST float chamber.
16. Assemble the float chamber to the upper VST cover assembly.

17. Assemble the fuel cooler to the VST fuel hoses.
18. Secure the VST cover assembly to the float chamber with five screws. Tighten the screws to the specified torque.
19. Install new hose clamps to the VST fuel hoses. Use the hose clamp tool and metal hose clamps.
20. Install the fuel cooler mounting bolt. Tighten to the specified torque.





7624

a - VST cover screws (5)
b - Electrical connector
c - Fuel inlet
d - VST cover assembly
e - High-pressure fuel pump
f - Isolator
g - Insulator
h - Screen
i - O-ring
j - VST float chamber
k - Fuel outlet
l - Fuel cooler

Hose Clamp Tool Kit	91-803146A04

Description	Nm	lb-in.	lb-ft
VST cover screws (5)	4.3	38	
Fuel cooler mounting bolt (M6 x 25) (3)	5.6	50	

High-Pressure Fuel Line

⚠ CAUTION

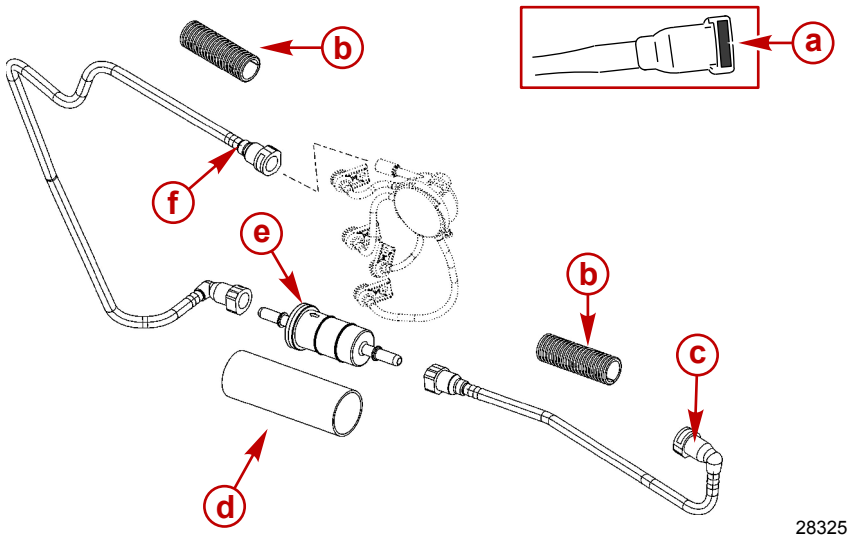
Failure to release pressure from the fuel system will result in fuel spraying out, which can cause a fire or explosion. Allow the engine to cool completely and release all fuel pressure before servicing any part of the fuel system. Always protect eyes and skin from pressurized fuel and vapors.

Removal

1. Disconnect the fuel line from the fuel distribution manifold by depressing the locking tab.
2. Disconnect the fuel line from the fuel cooler by depressing the locking tab.
3. Remove the high-pressure fuel line assembly.
4. Inspect the filter for cracks/debris; replace if necessary.

Installation

Connect the fuel lines as shown.



a - Locking tab
b - Conduit
c - Fuel line (to VST fuel cooler)
d - Protective sleeve
e - Fuel filter
f - Fuel line (to fuel distribution manifold)

Electronic Fuel Injection

Section 3D - Emissions

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Exhaust Emission Standards

Through the Environmental Protection Agency (EPA), the federal government has established exhaust emissions standards for all new marine engines sold in the U.S.

What Are Emissions?

Emissions are what comes out of the exhaust system in the exhaust gas when the engine is running. They are formed as a result of the process of combustion or incomplete combustion. To understand exhaust gas emissions, remember that both air and fuel are made of several elements. Air contains oxygen and nitrogen among other elements; gasoline contains mainly hydrogen and carbon. These four elements combine chemically during combustion. If combustion were complete, the mixture of air and gasoline would result in these emissions: water, carbon dioxide and nitrogen, which are not harmful to the environment. But combustion is not usually complete. Also, potentially harmful gases can be formed during and after combustion.

All marine engines must reduce the emission of certain pollutants, or potentially harmful gases, in the exhaust to conform with levels legislated by the EPA. Emissions standards become more stringent each year. Standards are set primarily with regard to three emissions: hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx).

Hydrocarbons – HC

Gasoline is a hydrocarbon fuel. The two elements of hydrogen and carbon are burned during combustion in combination with oxygen. But they are not totally consumed. Some pass through the combustion chamber and exit the exhaust system as unburned gases known as hydrocarbons.

Carbon Monoxide – CO

Carbon is one of the elements that make up the fuel burned in the engine along with oxygen during the combustion process. If the carbon in the gasoline could combine with enough oxygen (one carbon atom with two oxygen atoms), it would come out of the engine in the form of carbon dioxide (CO_2). CO_2 is a harmless gas. But carbon often combines with insufficient oxygen (one carbon atom with one oxygen atom). This forms carbon monoxide, CO. Carbon monoxide is the product of incomplete combustion and is a dangerous, potentially lethal gas.

Oxides of Nitrogen – NOx

NOx is a slightly different by-product of combustion. Nitrogen is one of the elements that makes up the air going into the engine. Under extremely high temperatures it combines with oxygen to form oxides of nitrogen (NOx). This happens in the engine's combustion chambers when temperatures are too high. NOx itself is not harmful, but when exposed to sunlight it combines with unburned hydrocarbons to create the visible air pollutant known as smog. Smog is a serious problem in California as well as many other heavily populated areas of the United States.

Controlling Emissions

The reduction of exhaust emissions is accomplished by controlling the air/fuel ratio that goes into the combustion chamber and with adjusting the timing curve of the spark ignition, based on engine sensor information. A microprocessor is used to manage the fuel injection duration and adjust the ignition timing. These adjustments are made in a microsecond during all engine operations. Adjustments are established by predetermined values programed into the microprocessor and are based on various sensor inputs to the microprocessor on the engine.

Stoichiometric (14.7:1) Air/Fuel Ratio

In the search to control pollutants and reduce exhaust emissions, engineers have discovered that they can be reduced effectively if a gasoline engine operates at an air/fuel ratio of 14.7:1. The technical term for this ideal ratio is stoichiometric. An air/fuel ratio of 14.7:1 provides the best control of all three elements in the exhaust under almost all conditions. The HC and CO content of the exhaust gas is influenced significantly by the air/fuel ratio. At an air/fuel ratio leaner than 14.7:1, HC and CO levels are low, but with a ratio richer than 14.7:1 they rise rapidly. It would seem that controlling HC and CO by themselves might not be such a difficult task; the air/fuel ratio only needs to be kept leaner than 14.7:1. However, there is also NOx to consider.

As the air/fuel ratio becomes leaner, combustion temperatures increase. Higher combustion temperatures raise the NOx content of the exhaust. But, enrichening the air/fuel ratio to decrease combustion temperatures and reduce NOx also increases HC and CO, as well as lowering fuel economy. So the solution to controlling NOx - as well as HC and CO - is to keep the air/fuel ratio as close to 14.7:1 as possible.

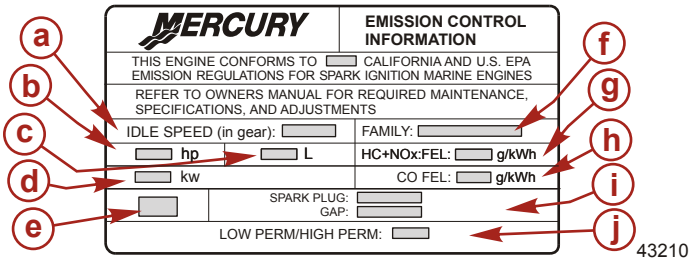
Emissions Information

EPA Emissions Regulations

All new outboards manufactured by Mercury Marine are certified to the United States Environmental Protection Agency, as conforming to the requirements of the regulations for the control of air pollution from new outboard motors. This certification is contingent on certain adjustments set to factory standards. For this reason, the factory procedure for servicing the product must be strictly followed and, wherever practicable, returned to the original intent of the design. **Maintenance, replacement, or repair of the emission control devices and systems may be performed by any marine spark ignition (SI) engine repair establishment or individual.**

Emission Certification Label

An emission certification label, showing emission levels and engine specifications directly related to emissions, is placed on the engine at the time of manufacture.



- **a -** Idle speed
- **b -** Engine horsepower
- **c -** Piston displacement
- **d -** Engine power - kilowatts
- **e -** Date of manufacture
- **f -** Family number
- **g -** Regulated emission limit for the engine family
- **h -** Regulated emission limit for the engine family
- **i -** Recommended spark plug and gap
- **j -** Percent of fuel line permeation

Owner Responsibility

The owner/operator is required to have routine engine maintenance performed to maintain emission levels within prescribed certification standards.

The owner/operator is not to modify the engine in any manner that would alter the horsepower or allow emission levels to exceed their predetermined factory specifications.

Dealer Responsibility

When performing service on all 1998 and newer outboards that carry a certification, attention must be given to any adjustments that are made that affect emission levels.

Adjustments must be kept within published factory specifications.

Replacement or repair of any emission related component must be executed in a manner that maintains emission levels within the prescribed certification standards.

Dealers are **not** to modify the engine in any manner that would alter the horsepower or allow emission levels to exceed their predetermined factory specifications.

Exceptions include manufacturer's prescribed changes, such as that for altitude adjustments.

Exceptions

- Carburetor jets may be changed for high altitude use in accordance with factory recommendations.
- Single engine exceptions may be allowed with permission from the EPA for racing and testing.

Service Replacement Certification Label

IMPORTANT: By federal law, it is required that all 1998 and newer Mercury Marine outboards have a visible and legible emission certification label. If this label is missing or damaged, contact Mercury Marine Service for a replacement.

Removal

Remove all remaining pieces of the damaged or illegible label. Do not install new label over the old label. Use a suitable solvent to remove any traces of the old label adhesive from the display location.

Replacement

If the label is missing or the date code illegible, contact Mercury Marine Technical Service for assistance. A replacement certification label will be issued through the Technical Service department.

Installation

Install the label on a clean surface in the original factory location.

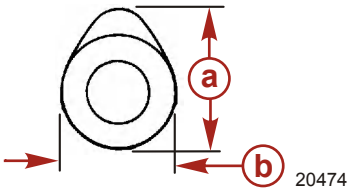
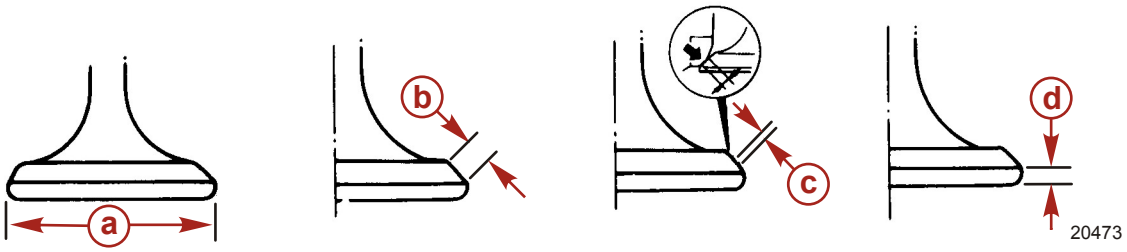
Model	Service Part Number	Location of Engine
Mercury/Mariner 40/50/60/40 Jet EFI FourStroke (995 cc)	If a replacement emission certification label is required, contact the Mercury Marine Service Department.	Inside of bottom cowl

Powerhead

Section 4A - Cylinder Head

Table of Contents

Cylinder Head Specification

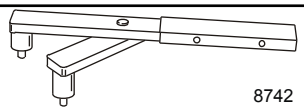
Cylinder Head Specifications		
Camshaft dimensions	Intake/exhaust "a"	30.83–31.03 mm (1.214–1.222 in.)
	Intake/exhaust "b"	25.90–26.10 mm (1.020–1.028 in.)
		
Intake/exhaust valve lift		4.73–5.13 mm (0.186–0.202 in.)
Runout limit		0.1 mm (0.0039 in.)
Camshaft bearing diameter		36.935–36.955 mm (1.4541–1.4549 in.)
Camshaft bearing oil clearance		0.045–0.090 mm (0.0018–0.0035 in.)
Valve spring free length		37.85–39.85 mm (1.491–1.569 in.)
Tilt limit		Less than 1.7 mm (0.060 in.)
Cylinder head flatness		0.1 mm (0.0039 in.)
Camshaft bore diameter		37.000–37.025 mm (1.4567–1.4577 in.)
Valve clearance (cold)	Intake	0.15–0.25 mm (0.006–0.010 in.)
	Exhaust	0.25–0.35 mm (0.010–0.014 in.)
Valve dimensions	Valve seat angles	30°, 45°, 60°
	Intake valve head diameter "a"	31.90–32.1 mm (1.256–1.264 in.)
	Exhaust valve head diameter "a"	25.90–26.1 mm (1.020–1.028 in.)
	Intake/exhaust face width "b"	2.00–3.14 mm (0.079–0.124 in.)
	Intake/exhaust seat width "c"	0.90–1.10 mm (0.035–0.043 in.)
	Intake/exhaust margin thickness "d"	0.50–0.90 mm (0.020–0.035 in.)
		
Intake stem outside diameter		5.475–5.490 mm (0.2156–0.2161 in.)
Exhaust stem outside diameter		5.460–5.475 mm (0.2150–0.2156 in.)
Valve guide inside diameter (intake/exhaust)		5.500–5.512 mm (0.2165–0.2170 in.)
Stem to guide clearance (intake)		0.010–0.037 mm (0.0004–0.0015 in.)
Stem to guide clearance (exhaust)		0.025–0.052 mm (0.0010–0.0020 in.)
Stem runout limit (maximum)		0.016 mm (0.0006 in.)
Rocker shaft outside diameter		15.971–15.991 mm (0.6288–0.6296 in.)

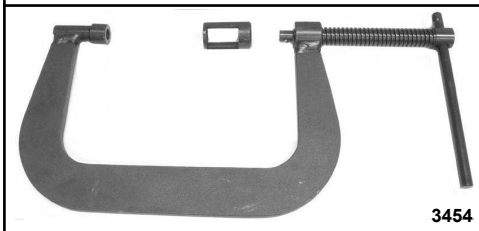
Cylinder Head Specifications	
Rocker arm inside diameter of bore	16.000–16.018 mm (0.6299–0.6306 in.)

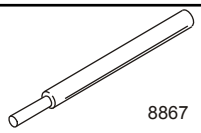
Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Coil plate mounting bolts	92-809821
		Cowl deflector mounting bolt threads	
95	2-4-C with PTFE	Camshaft oil seal lip	92-802859A 1
113	Loctite Moly Paste (Molybdenum Disulfide Grease)	Camshaft lobes	Obtain Locally
139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Valve stem	92-8M0078629
		Camshaft bearing journals	
		O-rings and oil pump prime	
		Rocker shaft and rocker arms	
		Cylinder head bolt threads and seat surface	

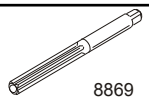
Special Tools

Flywheel Holder	91- 83163M
 8742	Holds and/or turns the flywheel while making engine repairs, also used to torque the flywheel or the engine coupler.

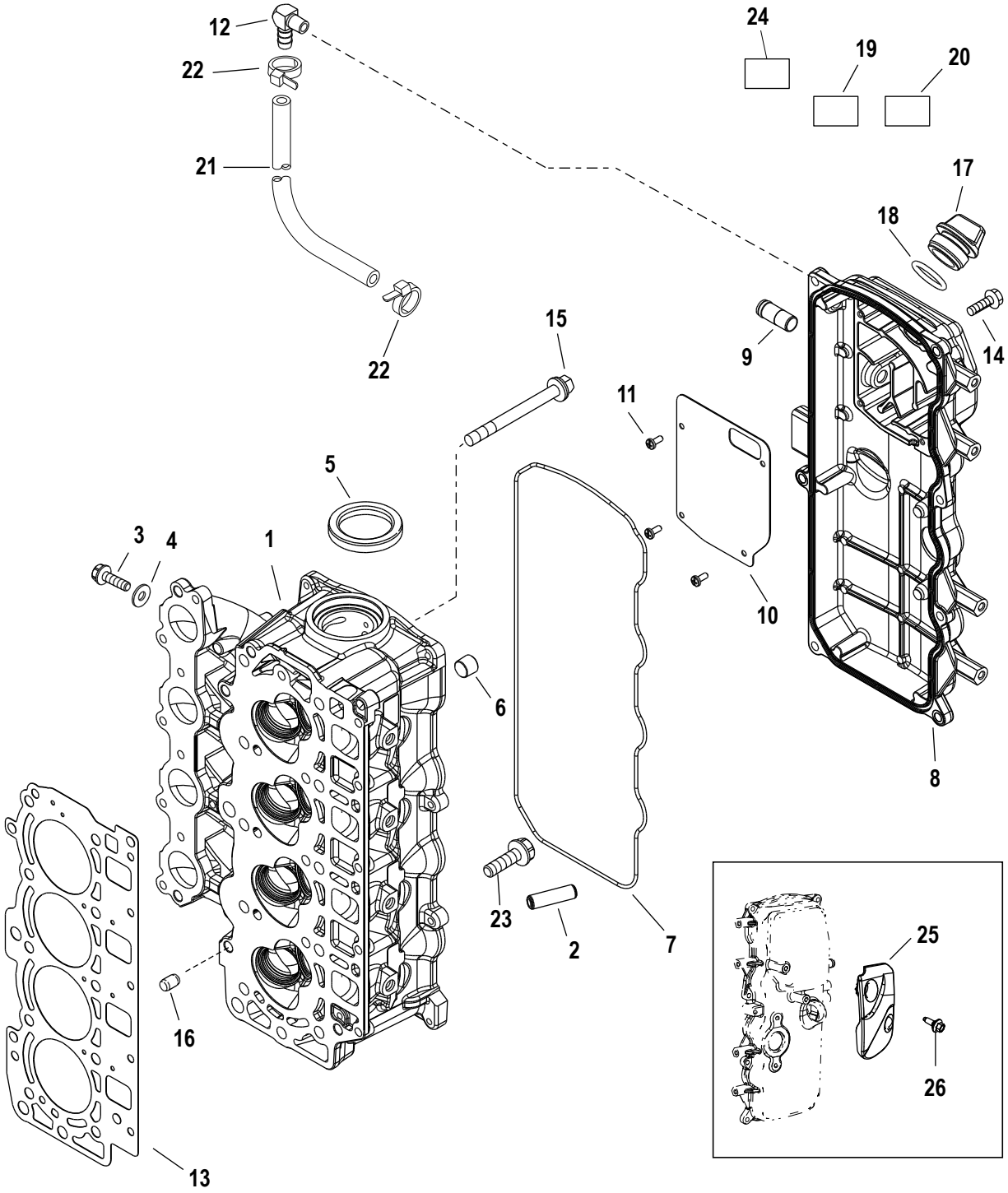
Valve Spring Compressor	91-809494A 1
 3454	Removes and installs valve springs.

Valve Guide Driver	94-809495001
 8867	Removes and installs valve guides.

Valve Guide Driver Bushing	91-809496A 1
 8868	Limits depth of valve guide installation.

Valve Guide Reamer	91-804775
 8869	Use to ream valve guides out to proper size.

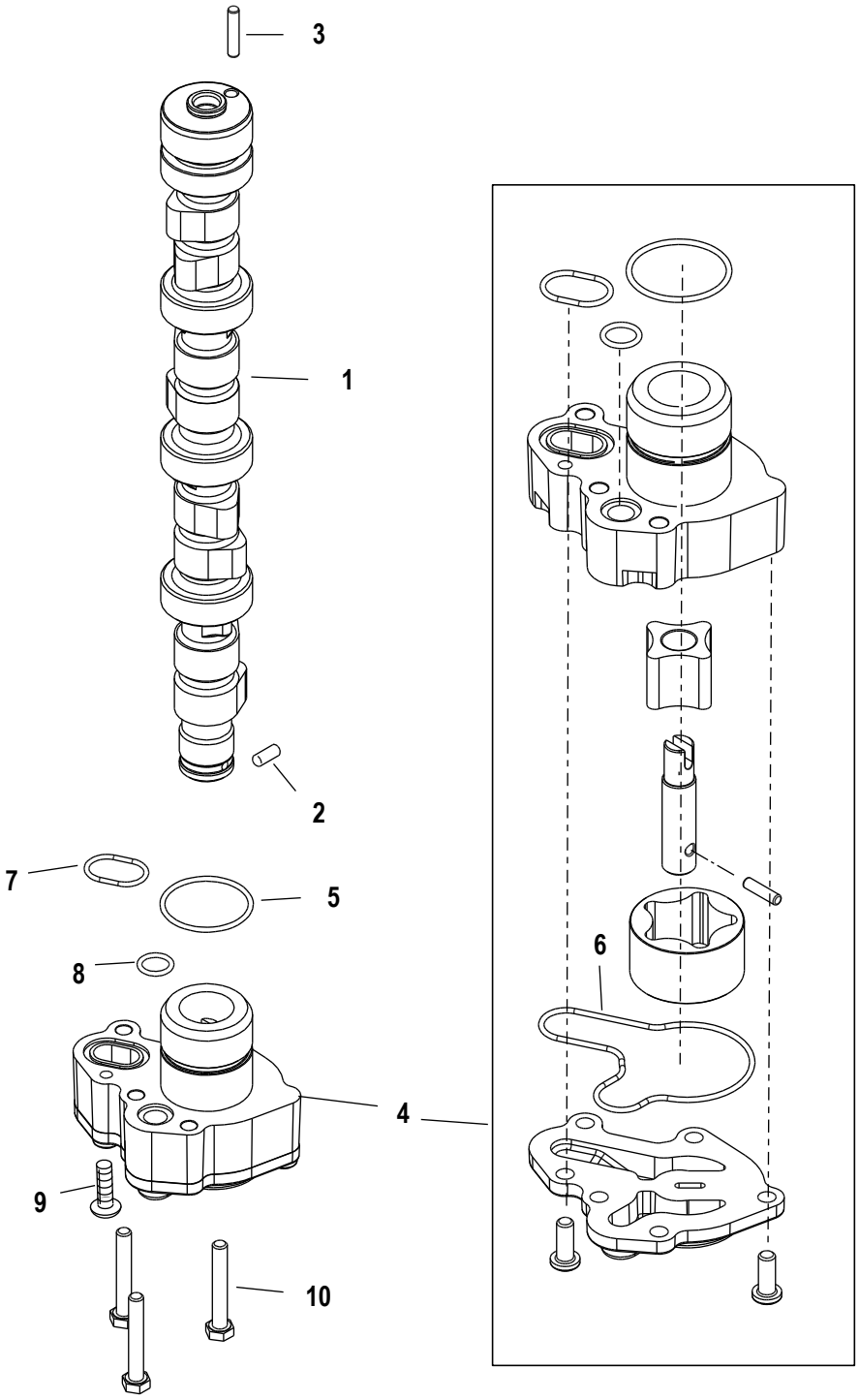
Cylinder Head Components



Cylinder Head Components

Ref. No.	Qty.	Description		Torque		
				Nm	lb-in.	lb-ft
1	1	Cylinder head				
2	8	Valve guide				
3	4	Bolt (M6 x 8)		8	70	
4	4	Washer				
5	1	Oil seal				
6	8	Pipe plug		20	177	
7	1	Seal				
8	1	Cover assembly				
9	1	Breather pipe				
10	1	Baffle plate				
11	4	Screw (M4 x 10)		Drive tight		
12	1	90° fitting (1/8-27)		Drive tight to 6 o'clock position		
13	1	Gasket				
14	7	Screw (M6 x 20)	First torque	4	35	
			Final torque	8	70	
15	10	Bolt (M9 x 95)	First torque	23		17
			Final torque	90° turn		
			Sequence per cast in characters on cylinder head			
16	2	Dowel pin				
17	1	Oil plug assembly		Drive tight		
18	1	O-ring				
19	1	Service referral decal				
20	1	Engine oil/valve clearance decal				
21	1	Hose (48.3 cm [19 in.])				
22	2	Cable tie				
23	5	Bolt (M6 x 25)	First torque	6	53	
			Final torque	12	106	
24	1	Power identification decal				
25	1	Cowl deflector				
26	2	Bolt (M6 special flange head)		10	89	

Camshaft Components

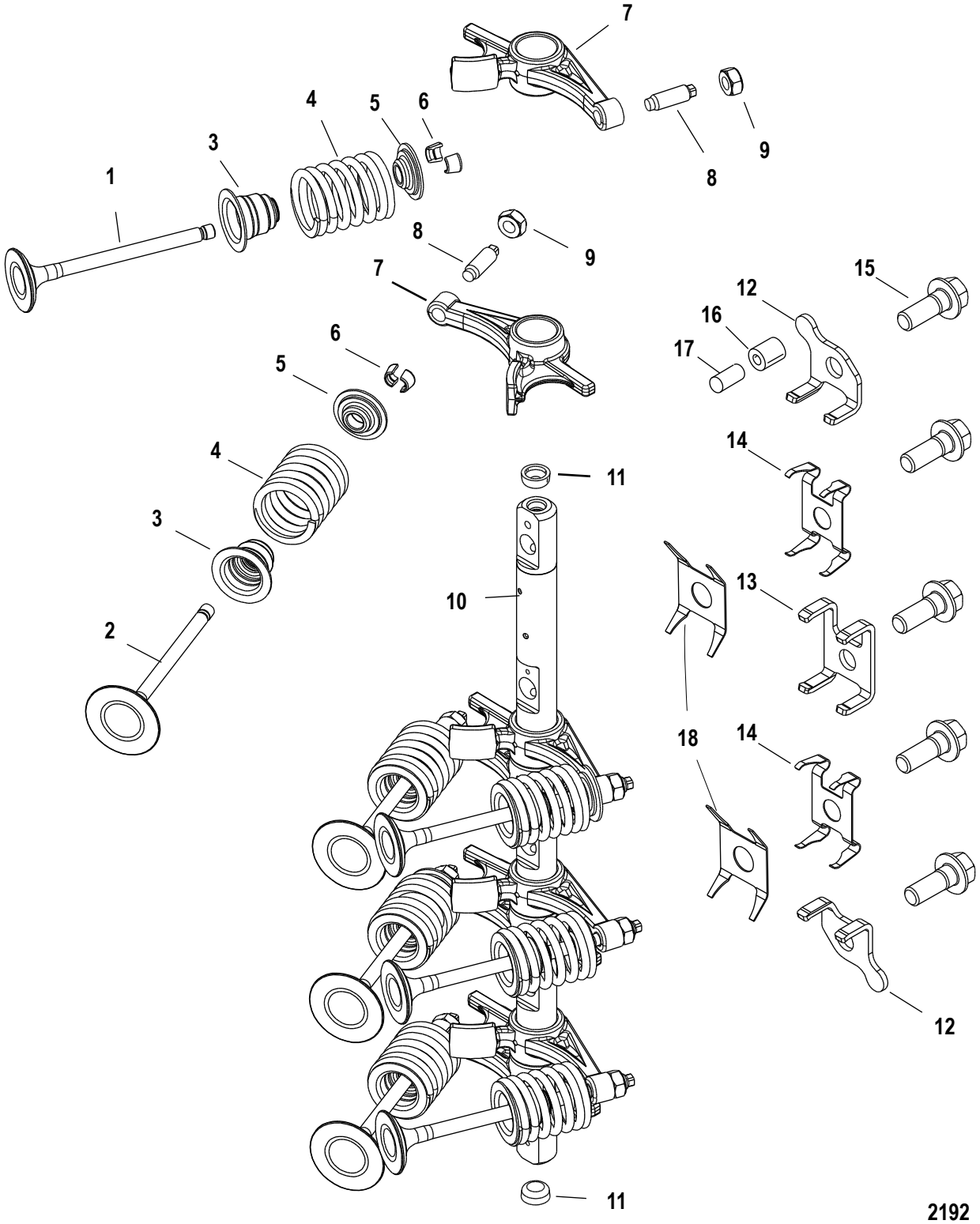


1773

Camshaft Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Camshaft			
2	1	Pin			
3	1	Dowel pin			
4	1	Oil pump assembly			
5	1	O-ring			
6	1	O-ring			
7	1	O-ring			
8	1	O-ring			
9	2	Bolt (M6 x 16)	8	70	
10	4	Bolt (M6 x 40)	8	70	

Intake/Exhaust Valve Components



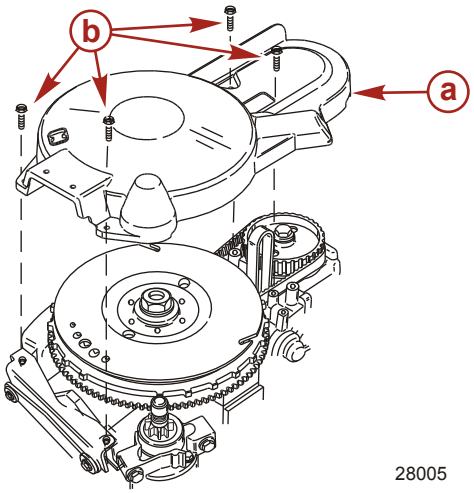
Intake/Exhaust Valve Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	4	Exhaust valve			
2	4	Intake valve			
3	8	Valve seal			
4	8	Valve spring			
5	8	Spring retainer			
6	16	Keeper			
7	8	Rocker arm			
8	8	Screw			
9	8	Nut	13.5	120	
10	1	Rocker shaft			
11	2	Plug			
12	2	Bracket			
13	1	Bracket			
14	2	Spring			
15	5	Bolt (M8 x 23)	18	160	
16	1	Seal cap			
17	1	Pin			
18	2	Overload spring			

Valve Cover

Removal

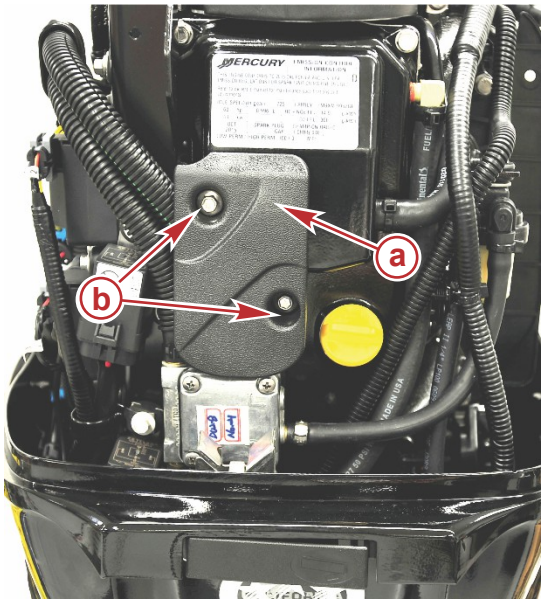
1. Disconnect the spark plug leads.
2. Remove the flywheel cover.



28005

a - Flywheel cover
b - Bolt (M6 x 25) (4)

3. Remove the two cowl deflector mounting bolts and the cowl deflector.

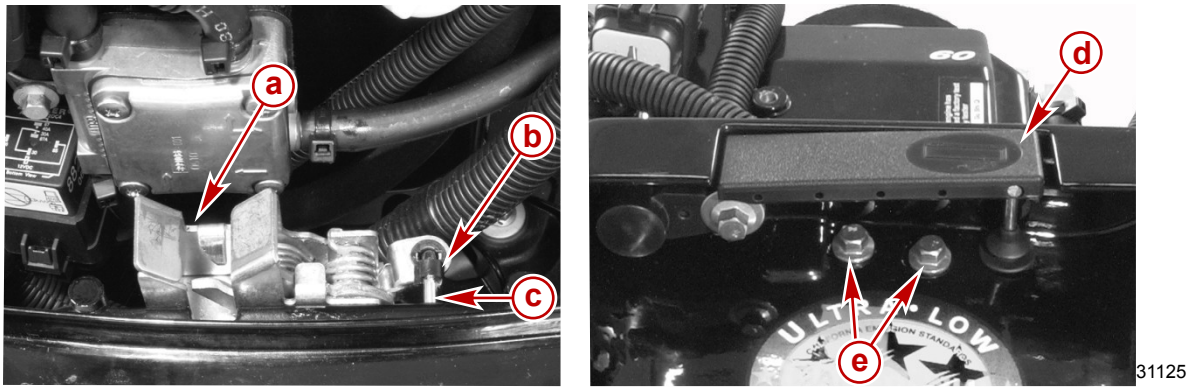


60775

a - Cowl deflector
b - Mounting bolts (M6 special flange head)

4. Remove the rear latch link retainer from the link.
5. Remove the two rear latch mounting bolts.

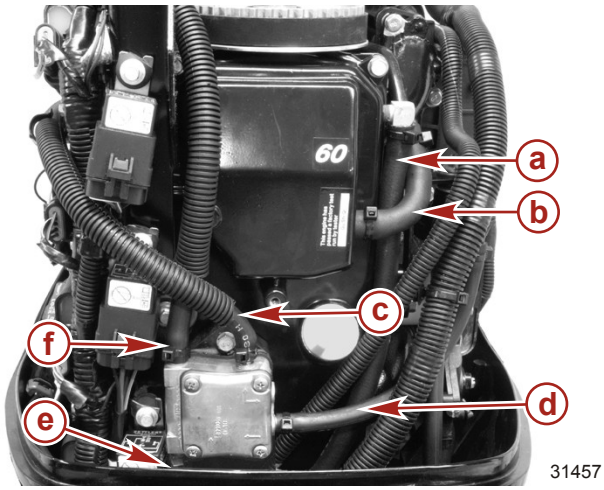
6. Remove the rear latch assembly and link.



a - Rear latch assembly
b - Rear latch link retainer
c - Link
d - Rear latch handle
e - Rear latch mounting bolts (M6 x 20)

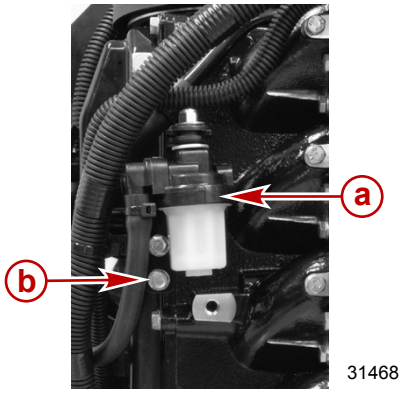
7. Cut the cable ties. Remove the fuel pump inlet/outlet hoses and fuel cooler water inlet/outlet hoses.

IMPORTANT: The hose fittings on the fuel pump can break if you try twisting or pulling the hoses off. Remove fuel pump hoses by slowly prying them off using a small screwdriver.



a - Crankcase vent hose
b - Crankcase breather hose
c - Fuel pump outlet hose (to VST)
d - Fuel pump inlet hose
e - Fuel cooler water outlet hose (to water pump indicator hole outlet)
f - Fuel cooler water inlet hose (from VST fuel cooler)

8. Remove the fuel filter bracket. Pull the assembly away from the valve cover.



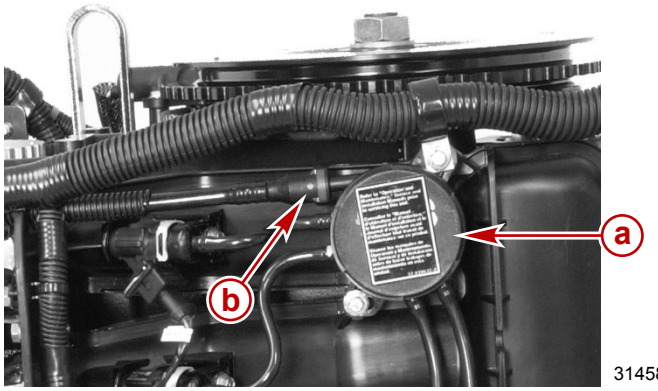
a - Fuel filter
b - Mounting bolts (M6 x 13) (2)

9. Release the pressure in the high-pressure fuel line. Refer to **Section 3C - Releasing Fuel Pressure in the High-Pressure Fuel Line**.

⚠ CAUTION

Failure to release pressure from the fuel system will result in fuel spraying out, which can cause a fire or explosion. Allow the engine to cool completely and release all fuel pressure before servicing any part of the fuel system. Always protect eyes and skin from pressurized fuel and vapors.

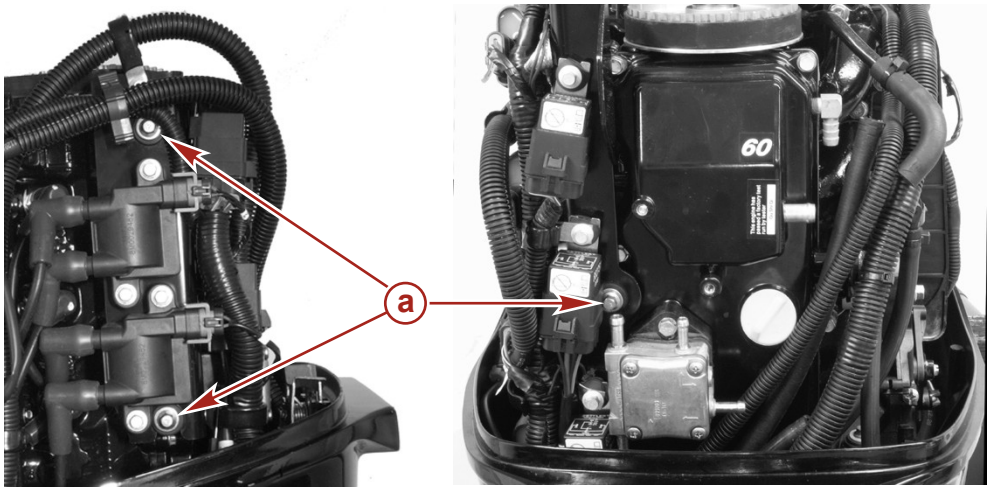
10. Depress the locking tab on the high-pressure fuel line. Disconnect the high-pressure fuel line from the fuel distribution manifold.



31458

a - Fuel distribution manifold
b - High-pressure fuel line

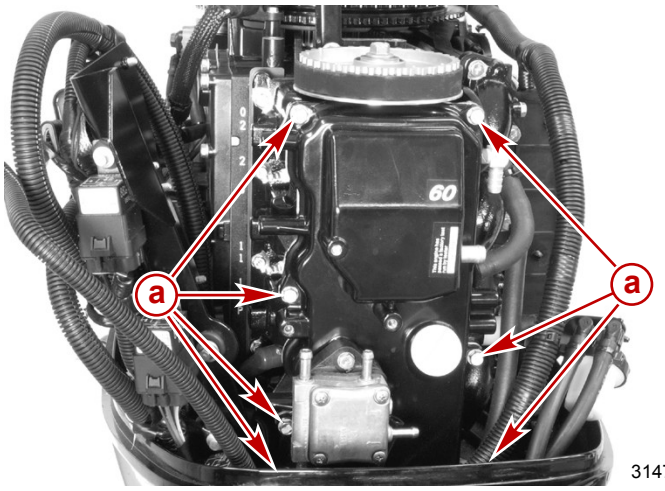
11. Remove the coil plate mounting bolts and move the coil plate assembly to the side.



42026

a - Coil plate mounting bolts (M6 x 30)

12. Remove the seven valve cover mounting bolts and the valve cover.



31470

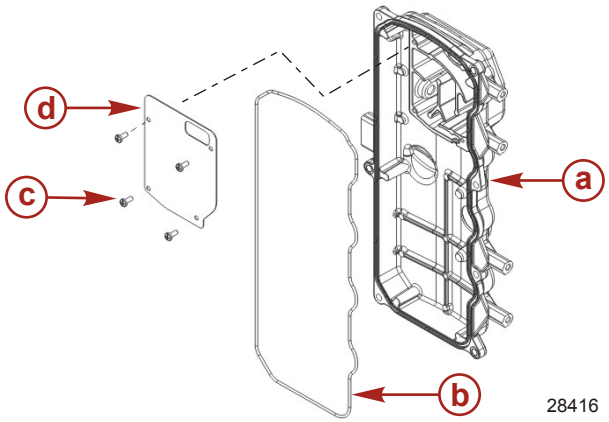
a - Valve cover mounting bolt (M6 x 20)

13. Remove the fuel pump mounting bolts and the fuel pump.

14. Remove the valve cover baffle plate and seal.

Installation

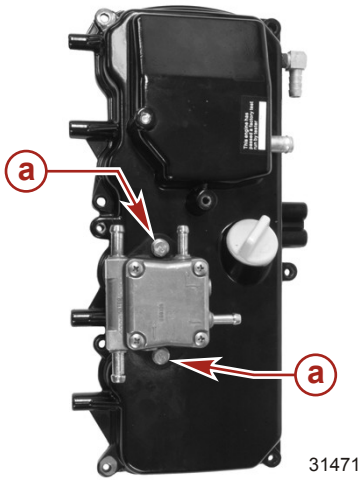
1. Install the valve cover seal.
2. Install the baffle plate. Tighten the screws to the specified torque.



a - Valve cover
b - Seal
c - Screw (M4 x 10) (4)
d - Baffle plate

Description	Nm	lb-in.	lb-ft
Baffle plate mounting screws	2	17.7	–

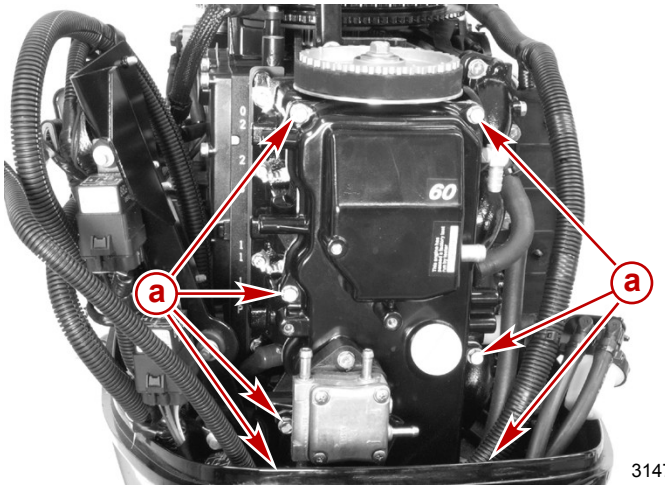
3. Install the fuel pump onto the valve cover. Tighten the bolts to the specified torque.



a - Fuel pump mounting bolts (M6 x 30)

Description	Nm	lb-in.	lb-ft
Fuel pump mounting bolts (M6 x 30) (2)	8.5	75.2	–

4. Install the valve cover onto the cylinder head. Tighten the seven mounting bolts to the specified torque.

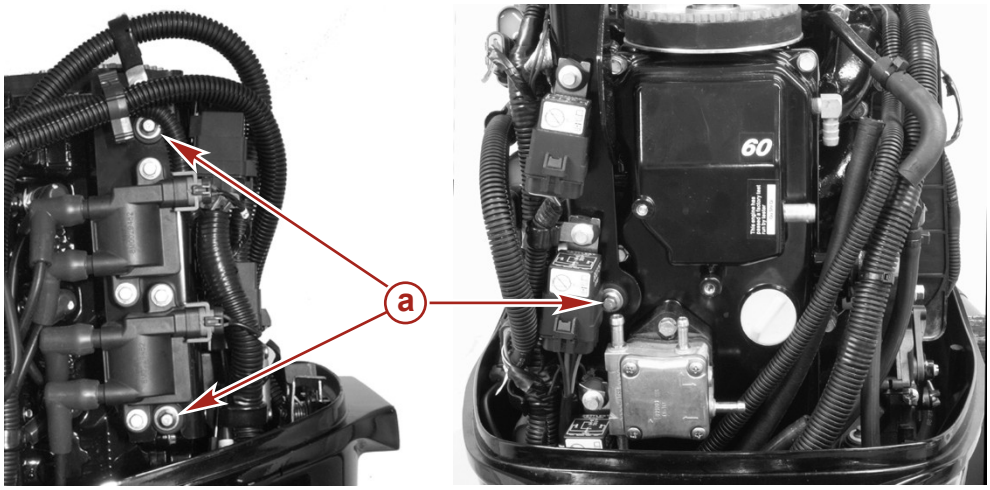


31470

a - Valve cover mounting bolt (M6 x 20)

Description	Nm	lb-in.	lb-ft
Valve cover mounting bolt (M6 x 20) (7)	8	70.8	–

5. Apply Loctite 242 Threadlocker to the three coil plate mounting bolts. Install the coil plate. Tighten the bolts to the specified torque.



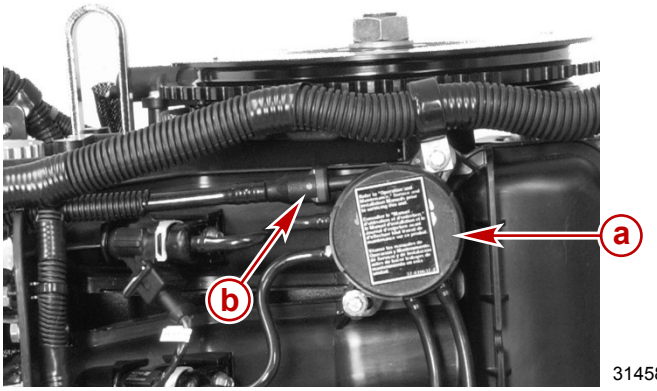
42026

a - Coil plate mounting bolts (M6 x 30)

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Coil plate mounting bolts	92-809821

Description	Nm	lb-in.	lb-ft
Coil plate mounting bolts (M6 x 30) (3)	8.5	75.2	–

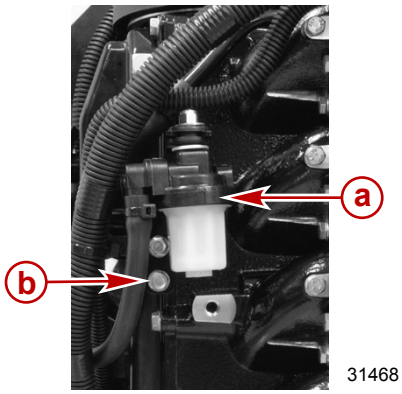
6. Install the high-pressure fuel line onto the fuel distribution manifold.



31458

a - Fuel distribution manifold
b - High-pressure fuel line

7. Install the fuel filter bracket onto the valve cover. Tighten the mounting bolts to the specified torque.

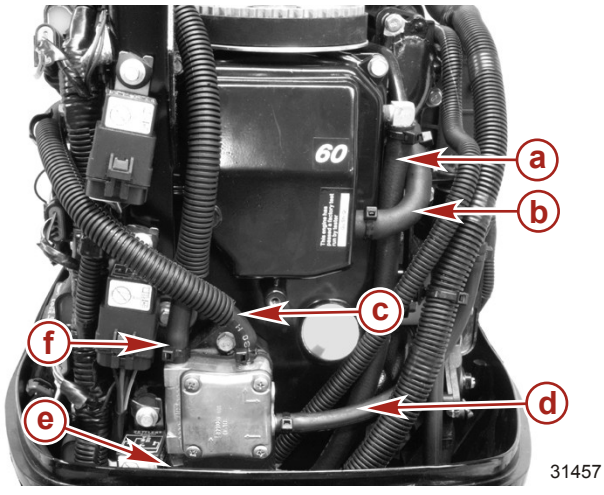


31468

a - Fuel filter
b - Mounting bolts (M6 x 13) (2)

Description	Nm	lb-in.	lb-ft
Mounting bolts (M6 x 13) (2)	8.5	75.2	–

8. Install the fuel pump inlet/outlet hoses and fuel cooler water inlet/outlet hoses. Secure with cable ties.
9. Install the crankcase breather hose and the vent hose. Secure with cable ties.

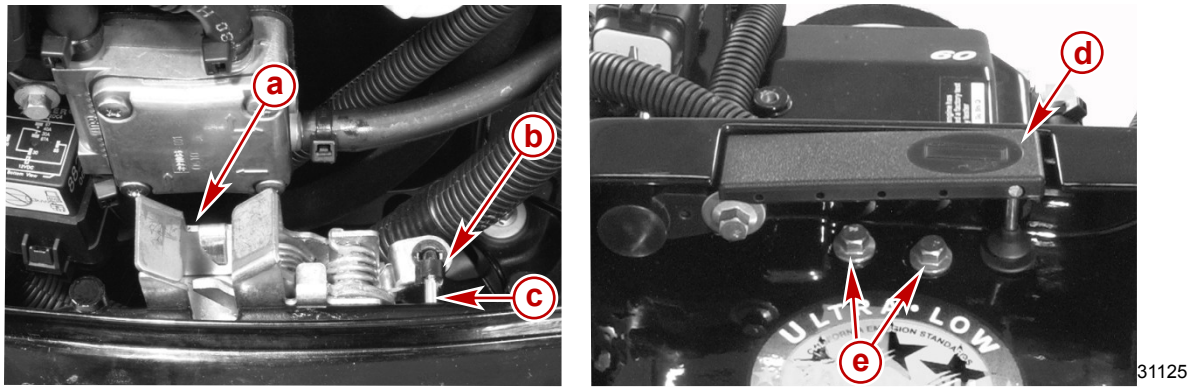


31457

a - Crankcase vent hose
b - Crankcase breather hose
c - Fuel pump outlet hose (to VST)
d - Fuel pump inlet hose
e - Fuel cooler water outlet hose (to water pump indicator hole outlet)
f - Fuel cooler water inlet hose (from VST fuel cooler)

10. Install the rear latch.
11. Install the two rear latch mounting bolts. Tighten the bolts to the specified torque.
12. Install the link into the rear latch assembly.

13. Fasten the rear latch link retainer over the link.

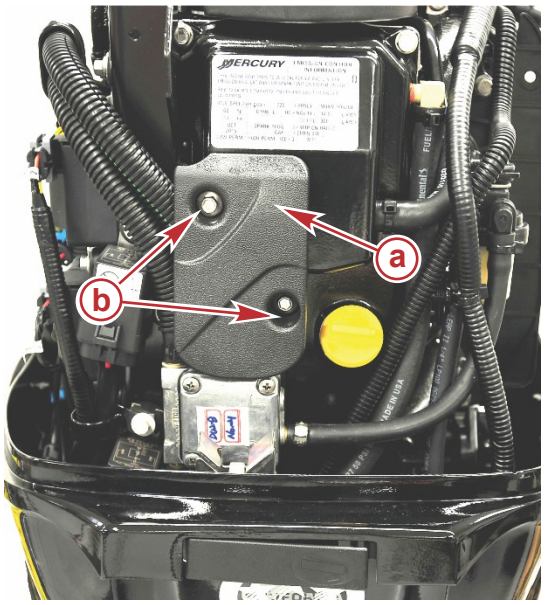


31125

a - Rear latch assembly
b - Rear latch link retainer
c - Link
d - Rear latch handle
e - Rear latch mounting bolts (M6 x 20)

Description	Nm	lb-in.	lb-ft
Rear latch mounting bolts (M6 x 20) (2)	10	88.5	–

14. Apply Loctite 242 Threadlocker to the cowl deflector special flange head bolt threads.
15. Install the cowl deflector. Tighten the bolts to the specified torque.



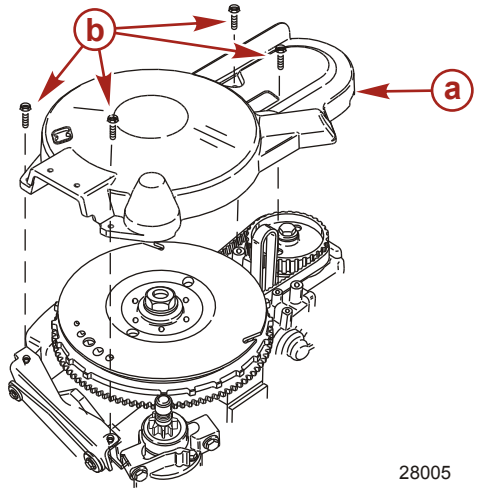
60775

a - Cowl deflector
b - Mounting bolts (M6 special flange head)

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Cowl deflector mounting bolt threads	92-809821

Description	Nm	lb-in.	lb-ft
Mounting bolts (M6 special flange head)	10	88.5	–

16. Install the flywheel cover. Tighten the bolts to the specified torque.



a - Flywheel cover
b - Bolt (M6 x 25) (4)

Description	Nm	lb-in.	lb-ft
Flywheel cover bolts	8.5	75.2	–

17. Install the spark plug leads.

Valve Clearance Adjustment

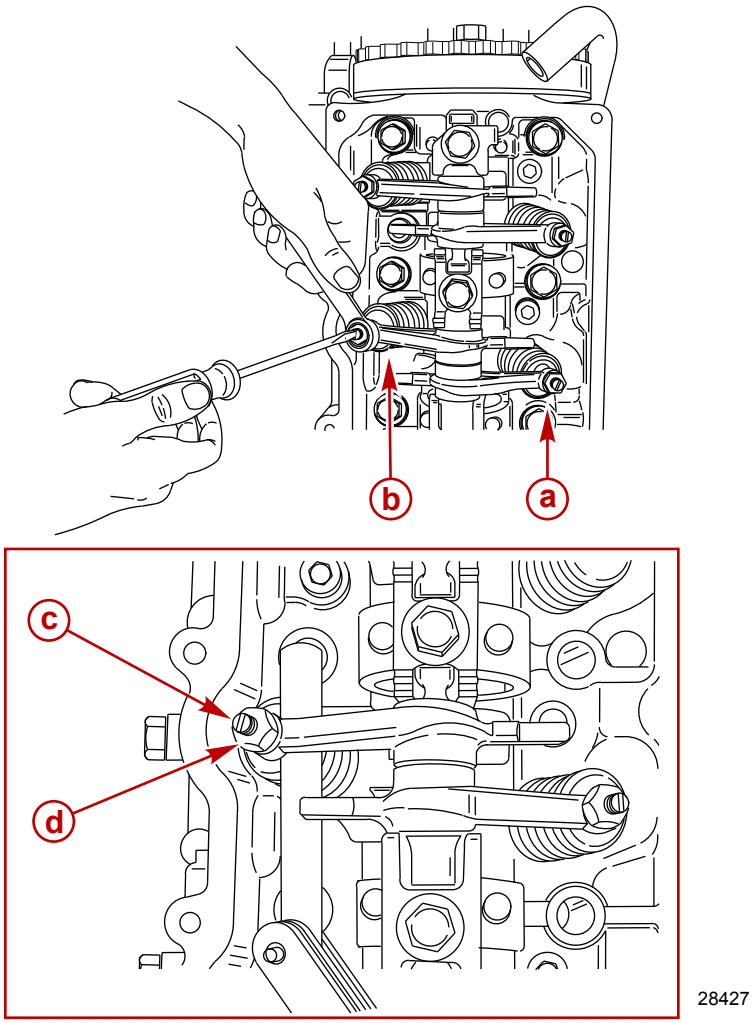
IMPORTANT: Valves should be adjusted when the engine is cold.

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

1. Remove the valve cover. Refer to **Valve Cover Removal**.
2. Measure the valve clearance with a feeler gauge.
3. Adjust the valve clearance if out of specification.

NOTE: *When loosening locknuts, hold the adjusting screw with a screwdriver to prevent it from moving.*



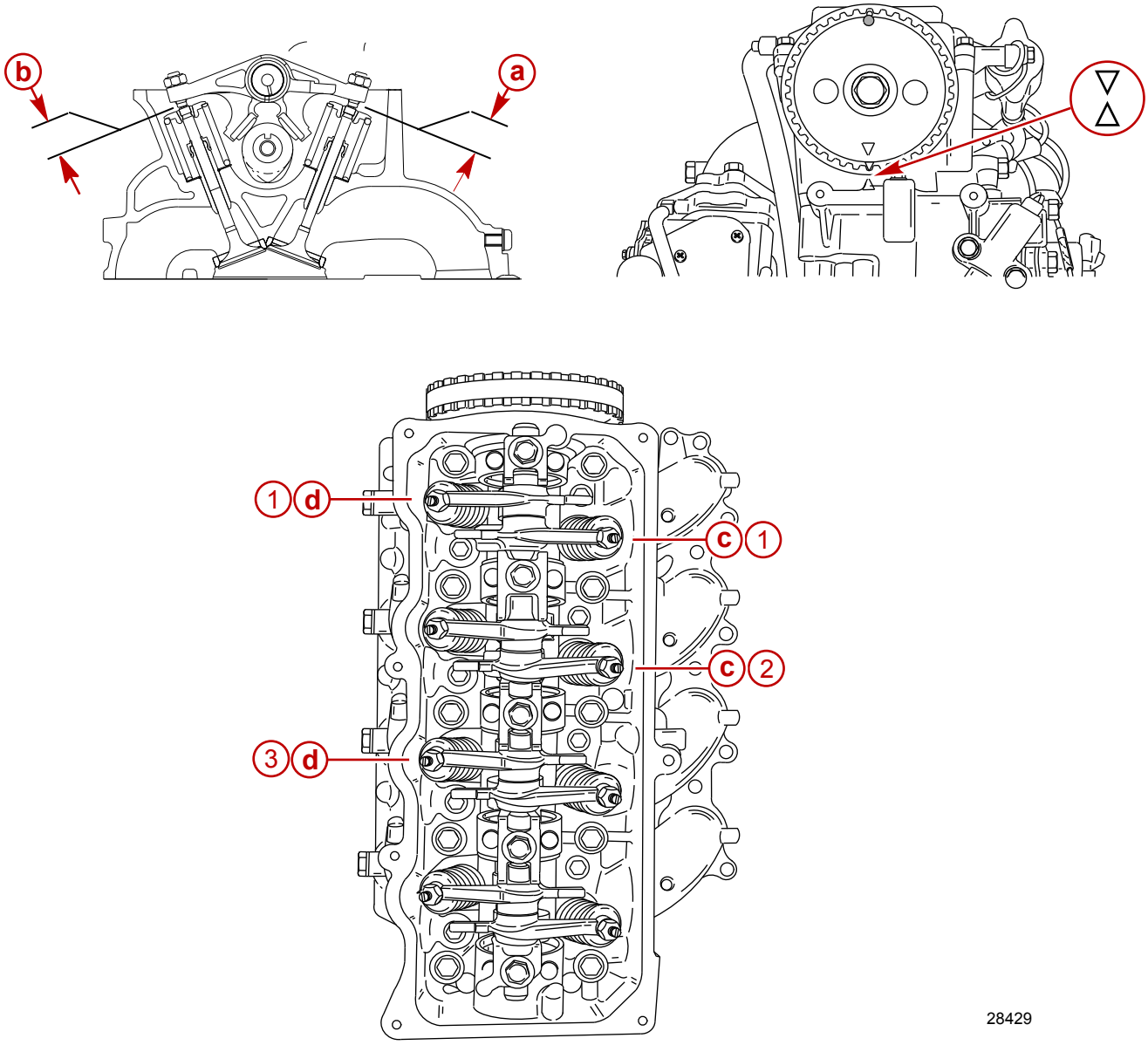
- **a -** Intake valves
- **b -** Exhaust valve
- **c -** Adjusting screw
- **d -** Locknut

Valve Clearance (Cold)	
Intake valves	0.15–0.25 mm (0.006–0.010 in.)
Exhaust valves	0.25–0.35 mm (0.010–0.014 in.)

No. 1 and No. 2 Intake Valves and No. 1 and No. 3 Exhaust Valves

1. Turn the flywheel and align the "Δ" mark on the driven gear with the cylinder head mark "Δ."

2. Adjust the valve clearance for No. 1 and No. 2 intake valves and No. 1 and No. 3 exhaust valves.



a - Intake valve clearance
b - Exhaust valve clearance
c - Intake valve
d - Exhaust valve

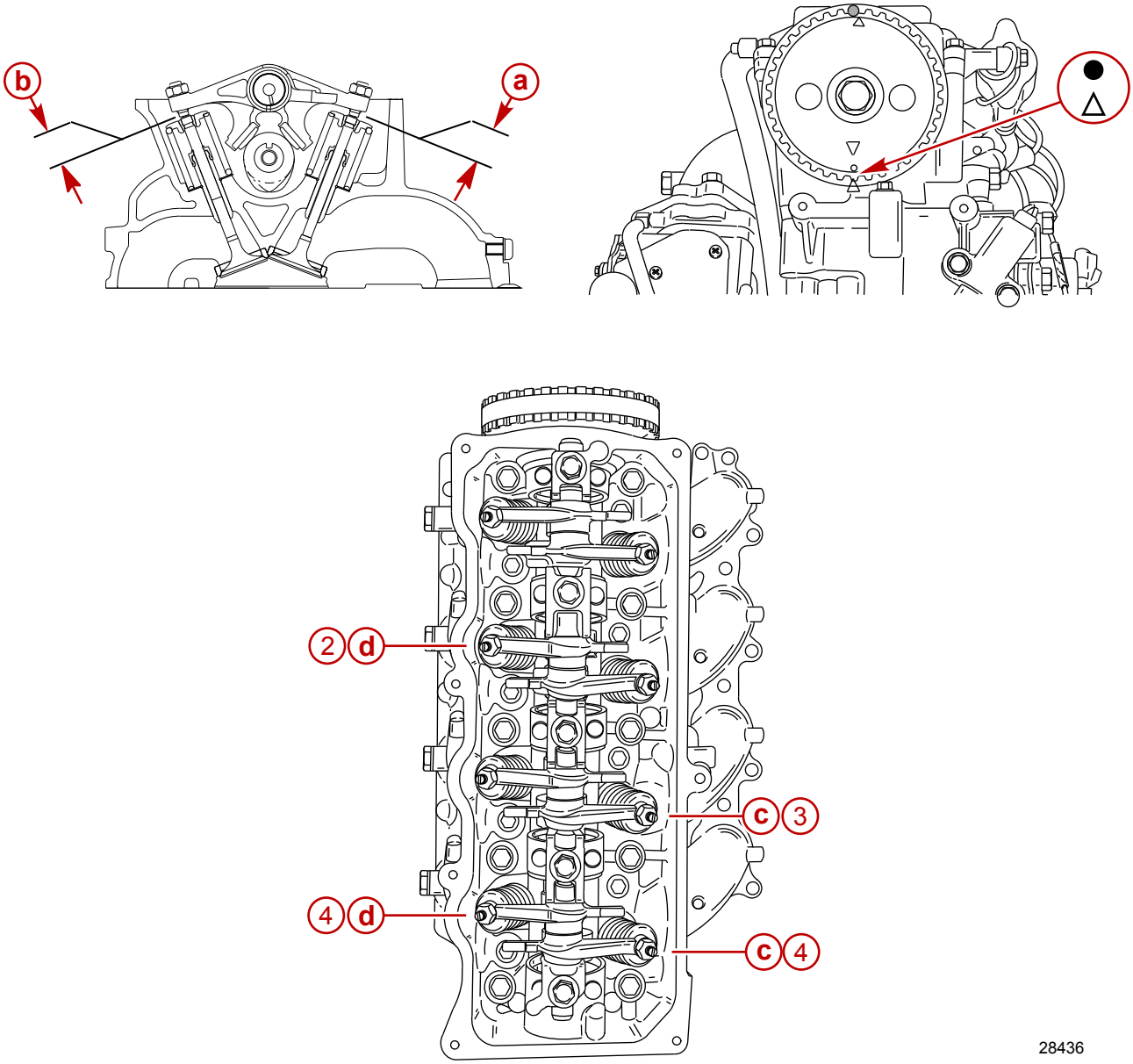
Valve Clearance (Cold)	
Intake valve	0.15–0.25 mm (0.006–0.010 in.)
Exhaust valve	0.25–0.35 mm (0.010–0.014 in.)

Description	Nm	lb-in.	lb-ft
Valve adjusting locknut	13.5	120	

No. 3 and No. 4 Intake Valves and No. 2 and No. 4 Exhaust Valves

1. Turn the driven gear and align the "O" mark on the gear with the cylinder head mark "Δ."

2. Adjust the valve clearance for No. 3 and No. 4 intake valves and No. 2 and No. 4 exhaust valves.



a - Intake valve clearance
b - Exhaust valve clearance
c - Intake valve
d - Exhaust valve

Valve Clearance (Cold)	
Intake valve	0.15–0.25 mm (0.006–0.010 in.)
Exhaust valve	0.25–0.35 mm (0.010–0.014 in.)

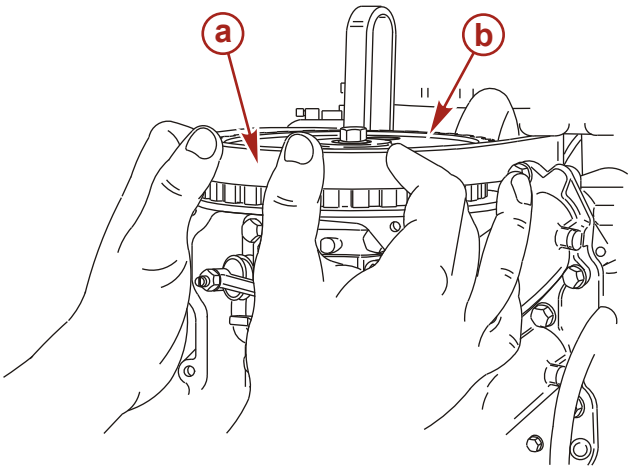
Description	Nm	lb-in.	lb-ft
Valve adjusting locknut	13.5	120	

Timing Belt

Removal

1. Remove the flywheel and stator. Refer to **Section 2B - Charging and Starting System**.

2. Align the marks on the drive and driven gear with the marks on the cylinder block. Refer to **Timing Belt - Installation**.
3. Remove the timing belt from the driven gear and drive gear.



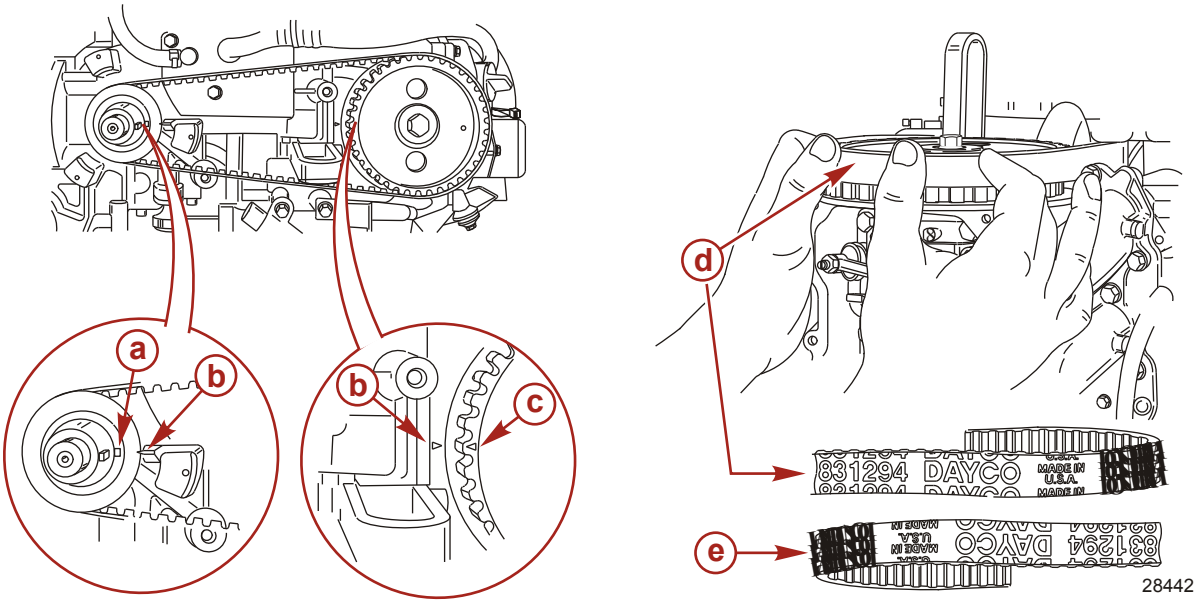
a - Timing belt
b - Driven gear

Installation

NOTE:

- *Protect the timing belt from water and oil.*
- *Use care not to scratch the belt.*
- *Do not use any metal device to help stretch the belt onto the driven gear.*

1. Align the marks on the drive and driven gear with the marks on the cylinder block, as shown.
2. Install the timing belt onto the drive gear and driven gear, as shown. The numbers/letters on the belt should be readable when the belt is installed.
3. Install the stator and flywheel. Refer to **Section 2B - Charging and Starting System**.

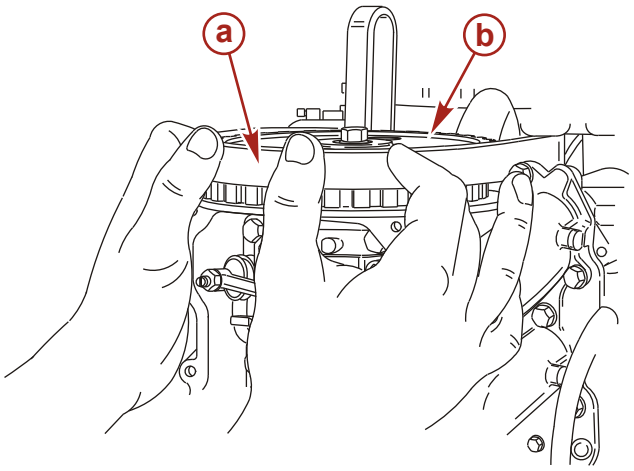


a - Drive gear mark
b - Cylinder block mark
c - Driven gear mark
d - Timing belt installed correctly
e - Timing belt installed incorrectly

Cylinder Head Removal

1. Remove valve cover. Refer to **Valve Cover Removal**.

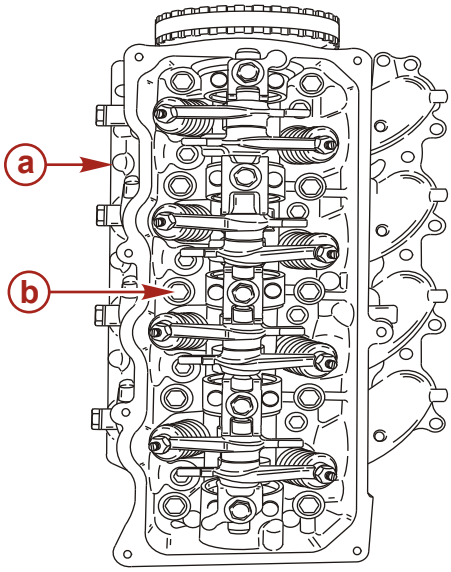
2. Remove timing belt from driven gear.

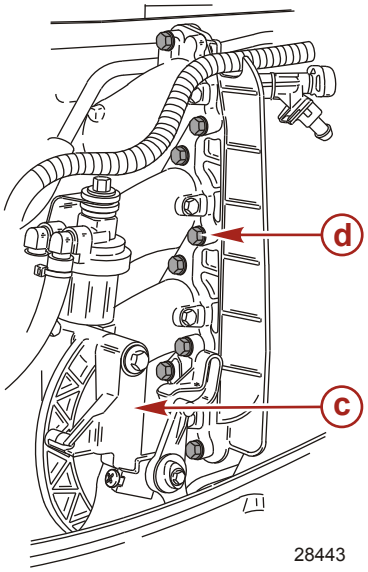


a - Timing belt
b - Driven gear

3. Remove the throttle and shift levers from the side of the cylinder head.
4. Remove the cylinder head and intake manifold assembly mounting bolts.
5. Separate the cylinder head from the block.

NOTE: *The cylinder head gasket is not reusable.*



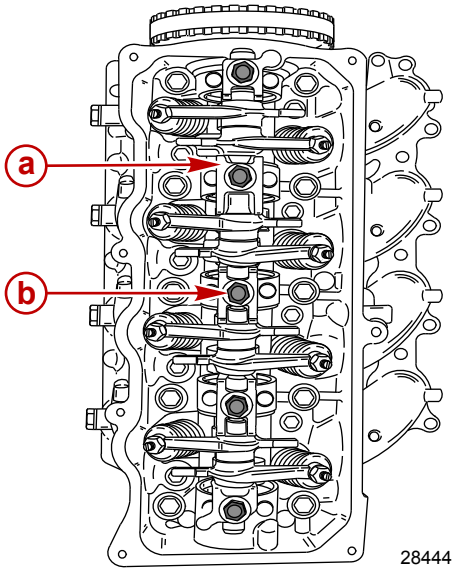


a - Flange bolt (M6 x 25) (5)
b - Center bolt (M9 x 95) (10)
c - Throttle and shift levers
d - Intake manifold bolt (M6 x 25) (8)

Cylinder Head Disassembly

Rocker Arm Assembly Removal

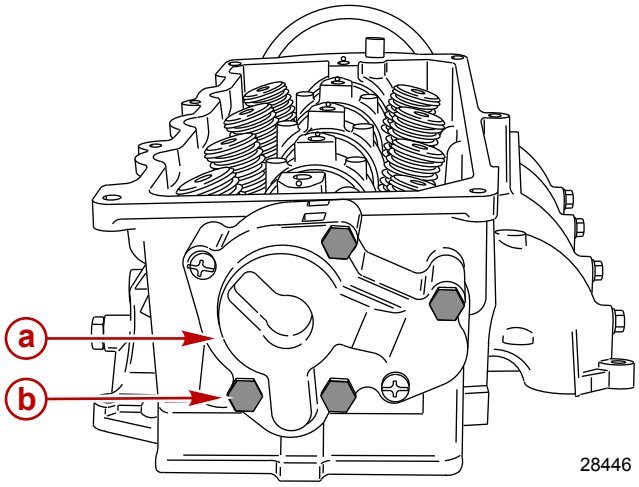
Remove five bolts and the rocker arm shaft.



a - Rocker arm shaft
b - Bolt (M8 x 23) (5)

Oil Pump Removal

1. Remove the four bolts securing the oil pump.
2. Remove the oil pump assembly using pry points on the oil pump body.

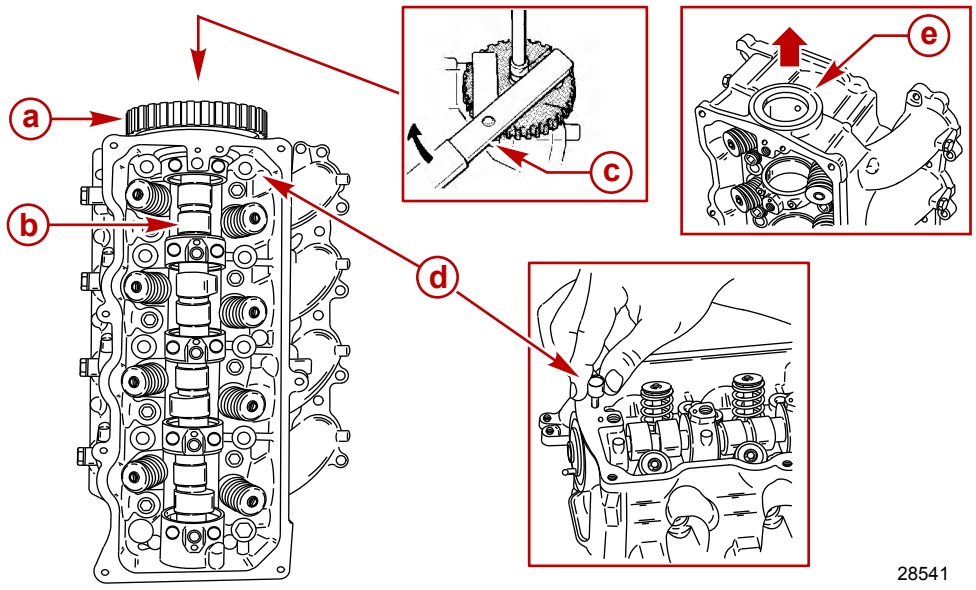


a - Oil pump assembly
b - Oil pump mounting bolt (M6 x 40) (4)

Camshaft Removal

1. Hold the driven gear using the flywheel holder. Remove the bolt and flat washer. Remove the driven gear.
2. Remove the camshaft retaining pin. Slide the camshaft out of the cylinder head.
   NOTE: *The cam can also be removed from the top without removing the cylinder head from the engine.*

3. Remove the camshaft oil seal from the cylinder head.



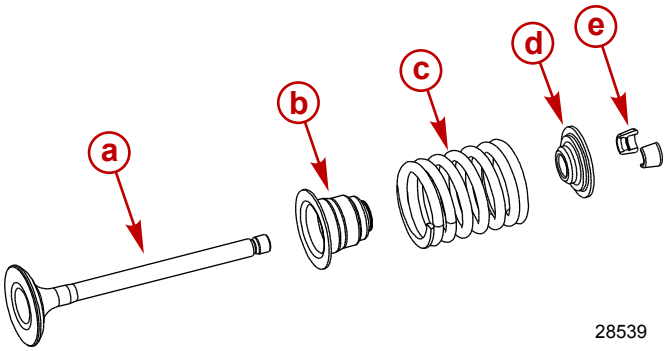
a - Driven gear
b - Camshaft
c - Flywheel holder
d - Camshaft retaining pin with seal
e - Camshaft oil seal

28541

Flywheel Holder	91- 83163M

Valve Removal

Valve Components



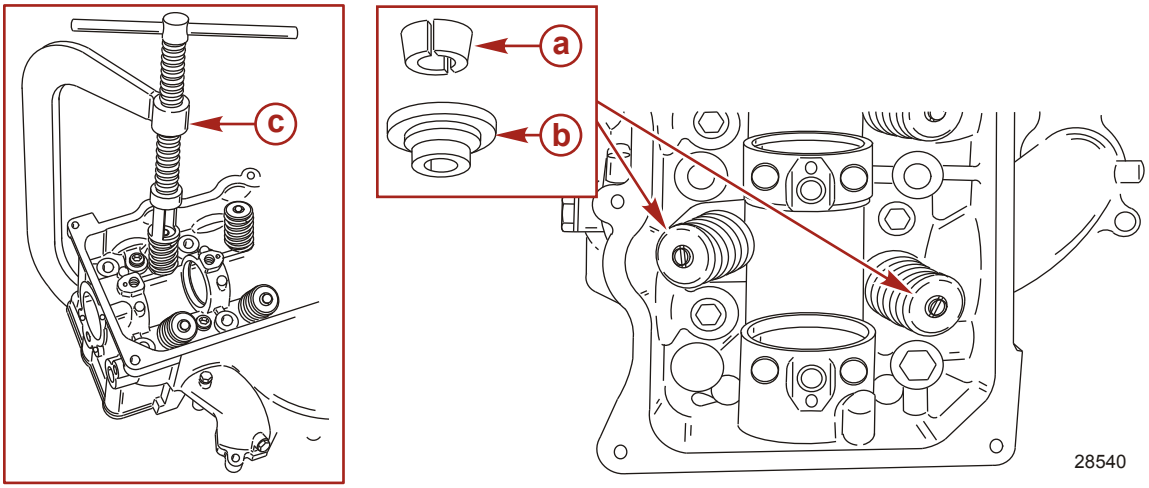
a - Valve
b - Valve seal
c - Spring
d - Spring retainer
e - Keepers

28539

Removal

1. Compress the valve spring with a valve spring compressor tool.
2. Remove the keepers, spring retainer, spring, and valve.

3. Remove and discard the valve seal.



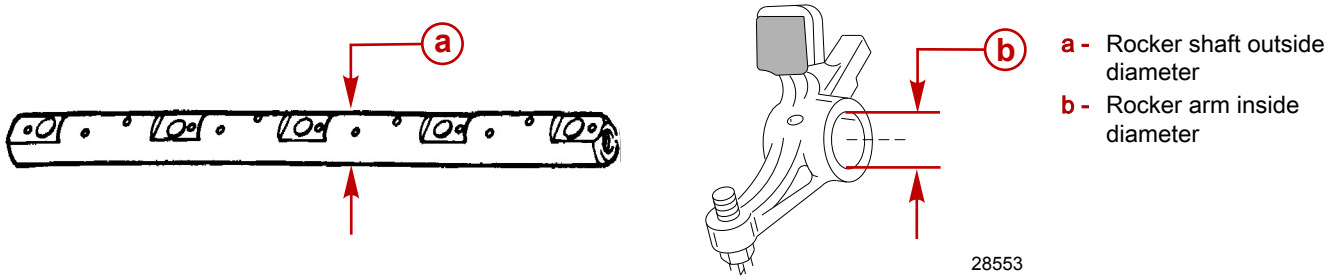
a - Keepers
b - Spring retainer
c - Valve spring compressor

Valve Spring Compressor	91-809494A 1

Cleaning/Inspection/Repair

Rocker Shaft and Rocker Arm Inspection

1. Measure the rocker shaft outside diameter. Replace the shaft if out of specification.
2. Measure the rocker arm inside diameter. Replace the rocker arms if out of specification.

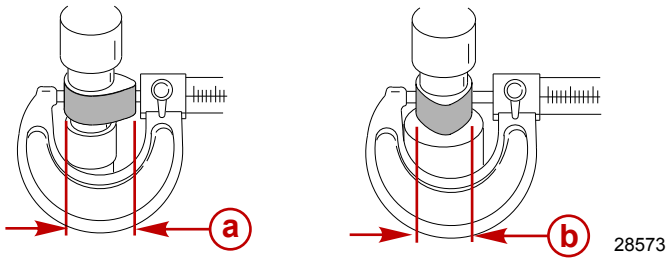


a - Rocker shaft outside diameter
b - Rocker arm inside diameter

Rocker Shaft and Arm	
Rocker shaft outside diameter	15.971–15.991 mm (0.6288–0.6296 in.)
Rocker arm inside diameter	16.000–16.018 mm (0.6299–0.6306 in.)

Camshaft Inspection

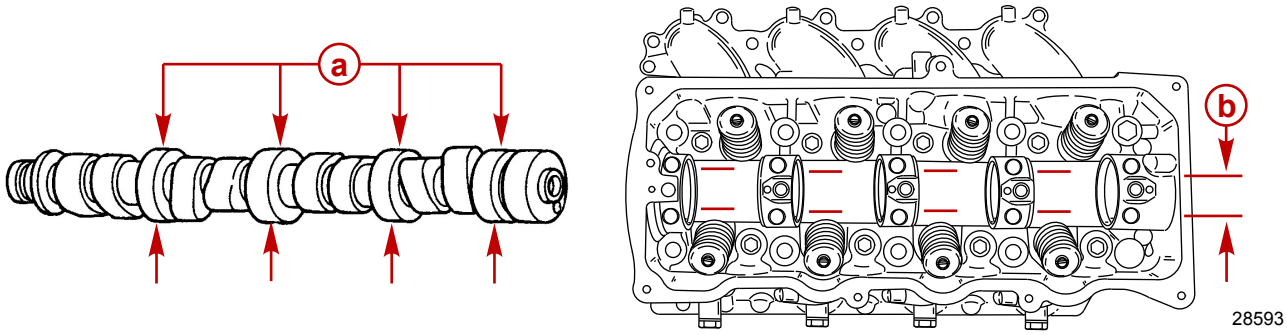
1. Inspect the camshaft for pitting, heat discoloration, scratches, and for the following measurements. Replace the camshaft if worn or not within specification.
2. Measure the camshaft lobe height and width.



a - Camshaft lobe height
b - Camshaft lobe width

Cylinder Head Specifications	
Camshaft Dimensions	
Intake/exhaust "a"	30.83–31.03 mm (1.214–1.222 in.)
Intake/exhaust "b"	25.90–26.10 mm (1.020–1.028 in.)

3. Measure the camshaft bore diameters (b) and the camshaft bearing diameters (a).

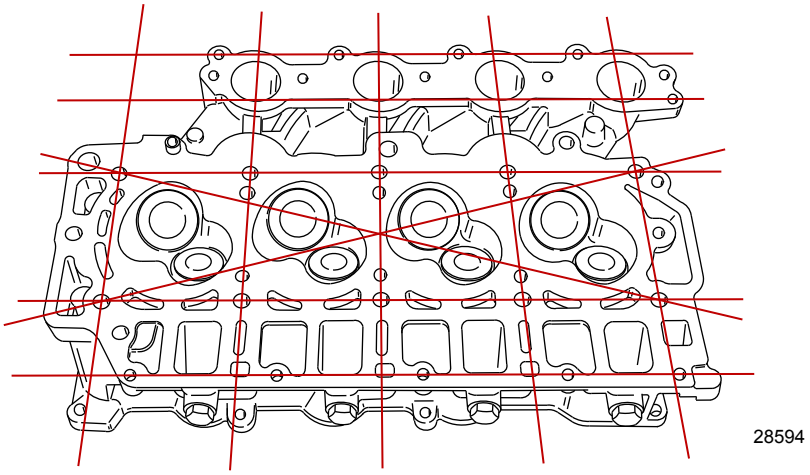


a - Camshaft bearing diameter
b - Camshaft bore diameter

Camshaft	
Bearing diameter	36.935–36.955 mm (1.4541–1.4549 in.)
Bore diameter	37.000–37.025 mm (1.4567–1.4577 in.)

Cylinder Head Inspection

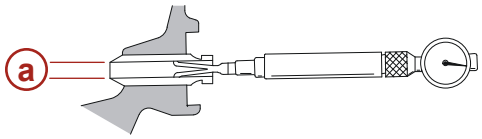
1. Inspect the cylinder head for mineral deposits or corrosion in the water passageways. Clean any deposits or corrosion observed.
2. Inspect the cylinder head for carbon deposits in the combustion chamber. Use a round scraper to clean away deposits. Be careful not to scratch or remove material.
3. Measure the cylinder head surface for flatness. Replace the cylinder head if out of specification.
4. Use a straight edge and a thickness gauge to inspect the cylinder head for flatness.



Cylinder Head Flatness	
Maximum limit	0.1 mm (0.0039 in.)

Valve Guides

Measure the valve guide inside diameter. Replace if out of specification.



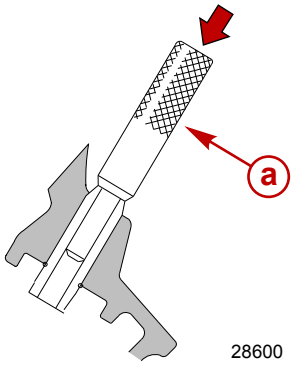
a - Valve guide inside diameter

Valve Guide Inside Diameter	
Intake/exhaust	5.500–5.512 mm (0.2165–0.2170 in.)

Valve Guide Replacement

NOTE: *Inexperienced personnel should not attempt to replace the valve guide. A reputable engine machine shop will have the tools to replace the valve guides and ream the guides to proper tolerance.*

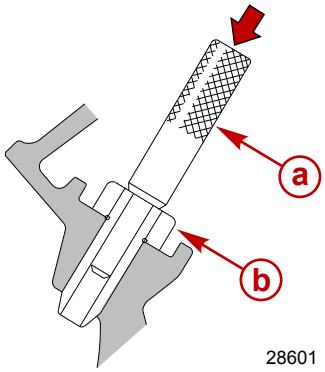
1. Remove the valve guide using a valve guide driver.



a - Valve guide driver

Valve Guide Driver	94-809495001

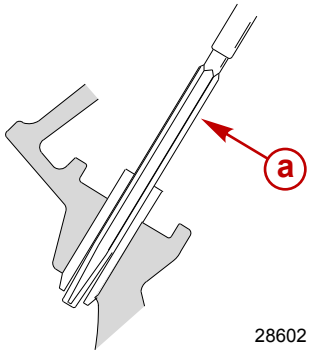
2. Install the valve guide and circlip using a valve guide driver bushing and the valve guide driver.



a - Valve guide driver
b - Valve guide driver bushing

Valve Guide Driver	94-809495001
Valve Guide Driver Bushing	91-809496A 1

3. Ream the valve guide to obtain the specified inside diameter.



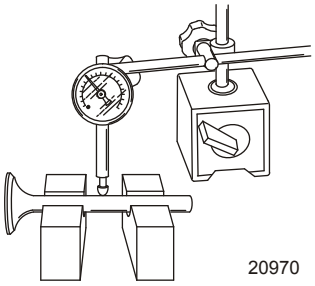
a - Valve guide reamer

Valve Guide Inside Diameter	
Intake/exhaust	5.500–5.512 mm (0.2165–0.2170 in.)

Valve Guide Reamer	91-804775

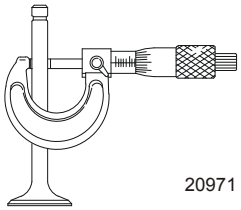
Valves

1. Inspect the valves for damage or warpage. Replace if necessary.
2. Measure the valve stem runout. Replace the valves if out of specification.



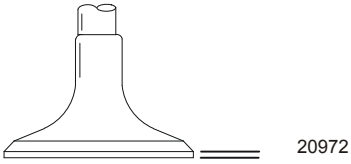
Valve Stem Runout (Maximum)	
Intake and exhaust valve	0.016 mm (0.0006 in.)

3. Measure the valve stem outside diameter. Replace the valves if out of specification.



Valve Stem Outside Diameter	
Intake	5.475–5.490 mm (0.2156–0.2161 in.)
Exhaust	5.460–5.475 mm (0.2150–0.2156 in.)

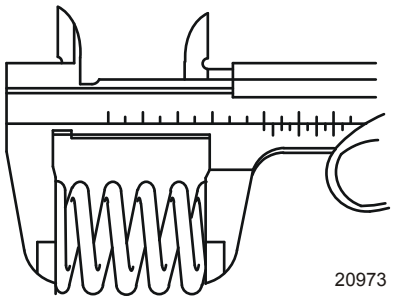
4. Measure the margin thickness of the valve. Replace the valve if out of specification.



Valve Margin Thickness	
Intake/exhaust	0.50–0.90 mm (0.020–0.035 in.)

Valve Springs

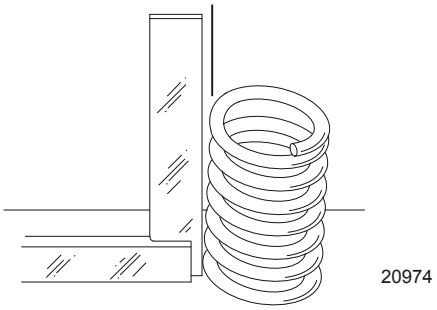
1. Check the free length of each valve spring. Replace if out of specification.



Valve Spring Free Length
37.85–39.85 mm (1.491–1.569 in.)

2. Measure the valve spring tilt. Replace if out of specification.

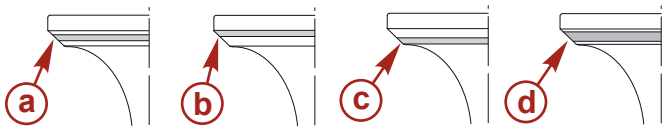
   NOTE: *Check each spring on a flat surface using a square. Rotate the spring and check the space between the top coil and the square.*



Valve Spring Tilt Limit
Less than 1.7 mm (0.060 in.) maximum

Valve Seat Reconditioning

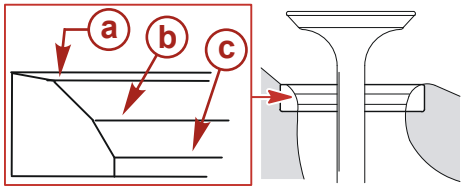
1. Clean the carbon deposits from the combustion chambers and valve seats. Check the valve seats for pitting.
2. Several different types of equipment are available for reseating valve seats. Follow the equipment manufacturer's instructions.
3. Apply a thin, even layer of mechanic's bluing dye (Dykem) onto the valve seat.
4. Insert the valve into the valve guide and lap the valve slowly on the valve seat.
5. Remove the valve and measure the valve seat contact pattern width. Resurface the valve seat if not in specification.



a - Correct valve seat contact width
b - Valve seat too high
c - Valve seat too low
d - Valve seat too wide

Valve Seat Contact Width	
Intake and exhaust valve	0.90–1.10 mm (0.035–0.043 in.)

6. To reface a valve seat, use a 30°, 45°, and 60° valve seat cutting tool.



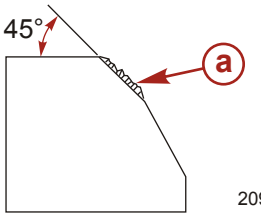
20964

a - 30° angle
b - 45° angle
c - 60° angle

NOTE: *When twisting the cutter, keep an even downward pressure to prevent chatter marks.*

NOTE: *After refacing the valve seat or replacing the valve and valve guide, the valve seat and valve face should be lapped.*

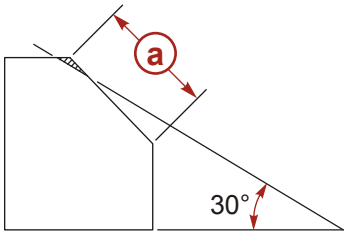
7. Start with the 45° cutting tool to clean up any pitting or rough surface of the valve seat.



20954

a - Rough surface of valve seat

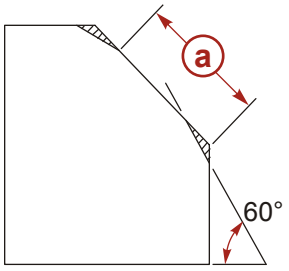
8. Use the 30° cutting tool to adjust the contact width of the top edge of the valve seat.



20976

a - Previous contact width

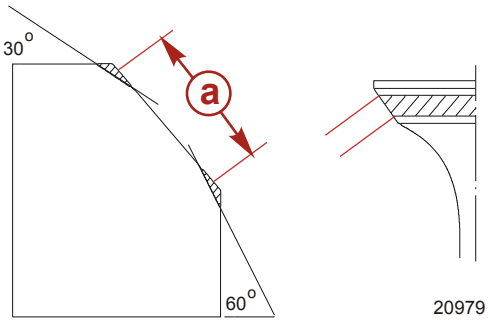
9. Use the 60° cutting tool to adjust the contact width of the bottom edge of the valve seat.



20977

a - Previous contact width

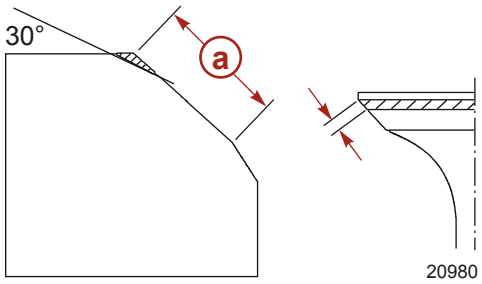
10. If the valve seat contact area is too wide and situated in the center of the valve face, use the 30° cutting tool to cut the top edge of the valve seat and the 60° cutting tool to cut the bottom edge of the valve seat, to adjust its contact width.



20979

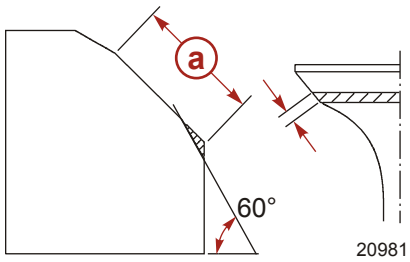
a - Previous contact width

11. If the valve seat contact area is too narrow and situated near the top of the valve face, use the 30° cutting tool to cut the top edge of the valve seat. If necessary, use the 45° cutting tool to center the area of contact and set its width.



a - Previous contact width

12. If the valve seat contact area is too narrow and situated near the bottom of the valve face, use the 60° cutting tool to cut the bottom edge of the valve seat. If necessary, use the 45° cutting tool to center the area of contact and set its width.

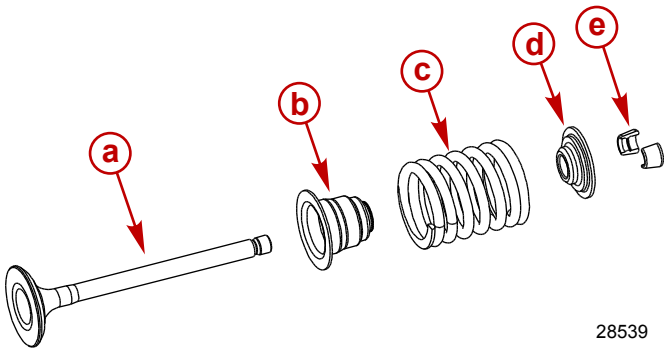


a - Previous contact width

Cylinder Head Assembly

Valve Installation

Valve Components

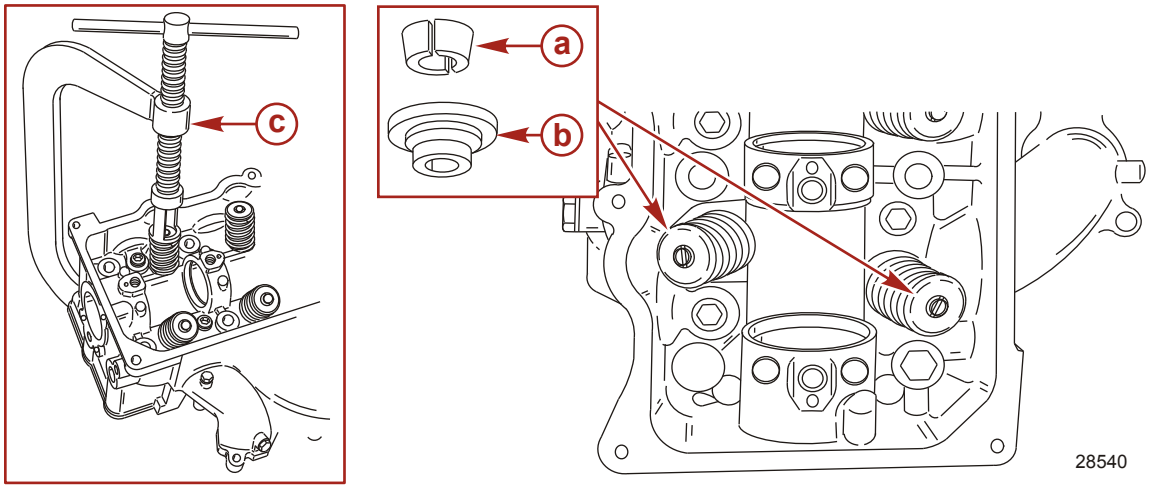


a - Valve
b - Valve seal
c - Spring
d - Spring retainer
e - Keepers

Installation

1. Install new valve seals into the valve guides. Refer to **Valve Guide Replacement**.
2. Lubricate the valve stem with Synthetic Blend 4-Stroke Outboard Oil 25W-40.
3. Install the valve, spring, and spring retainer.
4. Compress the valve spring using a valve spring compressor.

5. Install the keepers.



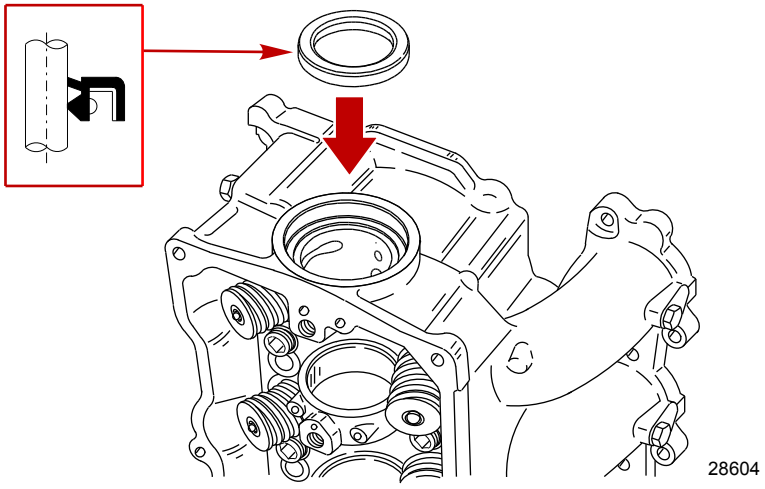
a - Keepers
b - Spring retainer
c - Valve spring compressor

Valve Spring Compressor	91-809494A 1

Tube Ref No.	Description	Where Used	Part No.
139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Valve stem	92-8M0078629

Camshaft Oil Seal Installation

1. Install a new oil seal.
2. Position the seal with the part number side facing outward. Press the seal in until it contacts the shoulder.
3. Lubricate the seal lip with 2-4-C with PTFE.



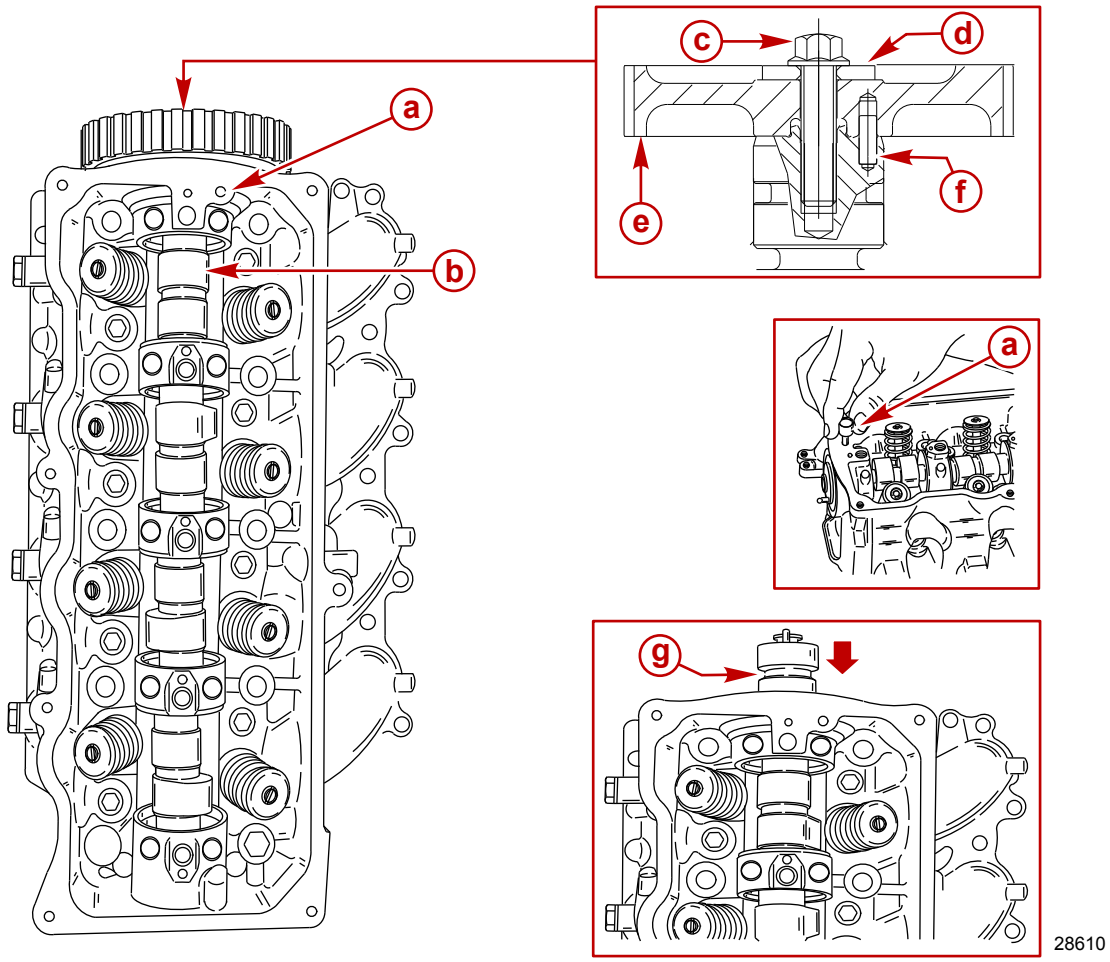
Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Camshaft oil seal lip	92-802859A 1

Camshaft Installation

1. Apply Synthetic Blend 4-Stroke Outboard Oil 25W-40 to the camshaft bearing journals.
2. Slide the camshaft into the cylinder head with the threaded end towards the driven gear.

NOTE: *The camshaft retaining pin groove must align with the retaining pin hole in the cylinder head.*

3. Install the camshaft retaining pin. Install the seal over the pin.
4. Install the alignment pin into the camshaft.
5. Install the driven gear onto the camshaft and alignment pin. Hold the gear with the flywheel holder tool and fasten with a washer and bolt. Tighten the bolt to the specified torque.
6. Remove any oil from the camshaft lobes.
7. Apply molybdenum disulfide grease to the lift portion of the lobes. Obtain from a local source.



a - Camshaft retaining pin with seal
b - Camshaft
c - Bolt (M10 x 40)
d - Washer
e - Driven gear
f - Alignment pin
g - Retaining pin groove

Flywheel Holder	91- 83163M

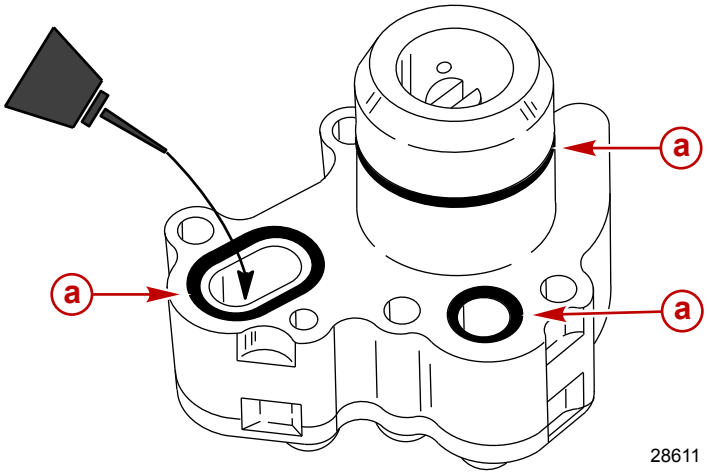
Tube Ref No.	Description	Where Used	Part No.
139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Camshaft bearing journals	92-8M0078629
113	Loctite Moly Paste (Molybdenum Disulfide Grease)	Camshaft lobes	Obtain Locally

Description	Nm	lb-in.	lb-ft
Driven gear retaining bolt (M10 x 40)	38		28

8. Ensure that the camshaft rotates smoothly.

Oil Pump Installation

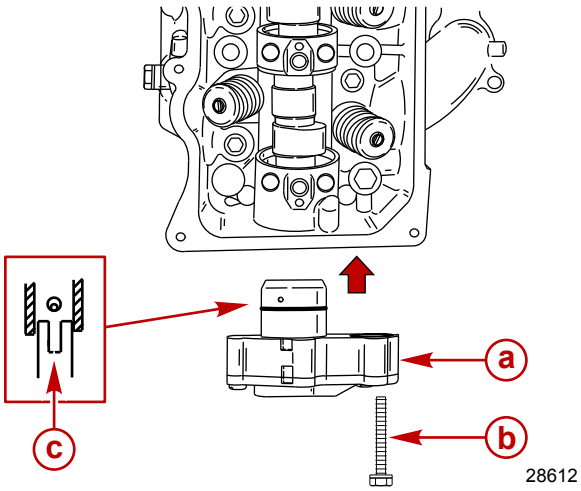
1. Install new O-ring seals. Lubricate the O-rings with Synthetic Blend 4-Stroke Outboard Oil 25W-40.
2. Prime the oil pump by pouring approximately 30 ml (1 fl oz) of Synthetic Blend 4-Stroke Outboard Oil 25W-40 into the oil pump body.



a - O-ring

Tube Ref No.	Description	Where Used	Part No.
139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	O-rings and oil pump prime	92-8M0078629

3. Align the oil pump shaft slot with the camshaft tang and install the oil pump.
4. Secure with four bolts. Tighten the bolts to the specified torque.



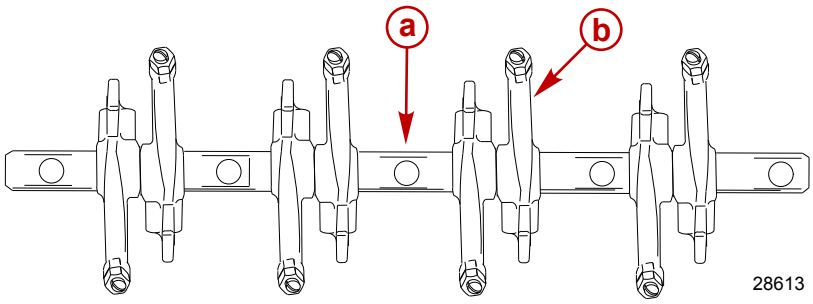
a - Oil pump
b - Bolt (M6 x 40)
c - Pump shaft slot aligned with camshaft tang

Description	Nm	lb-in.	lb-ft
Oil pump mounting bolts (M6 x 40)	8	70	

Rocker Arm Shaft Assembly

1. Apply Synthetic Blend 4-Stroke Outboard Oil 25W-40 to the rocker shaft and rocker arms.
2. Locate the end of the rocker shaft that gets installed towards the driven gear. The oil holes will line-up with the mating oil holes in the cylinder head.

3. Slide the rocker arms onto the rocker shaft, as shown.

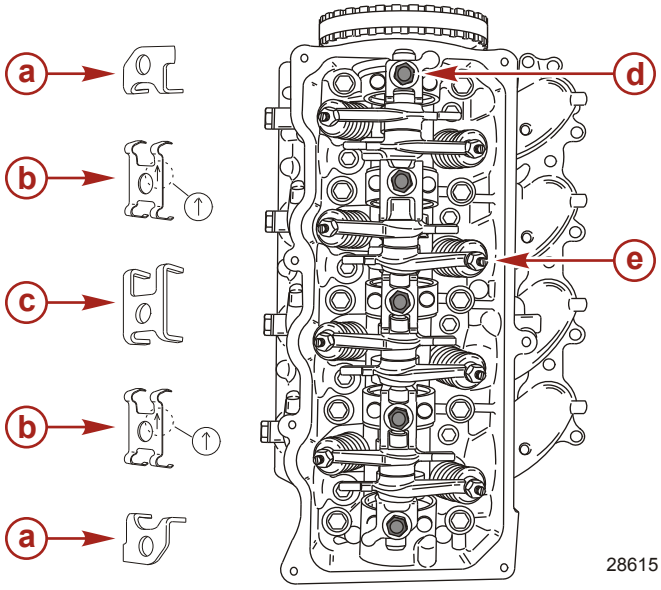


a - Rocker arm shaft
b - Rocker arm (8)

Tube Ref No.	Description	Where Used	Part No.
139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Rocker shaft and rocker arms	92-8M0078629

Rocker Arm Shaft Installation

1. Install the rocker arm shaft assembly, as shown.
2. Install the rocker arm hardware.
   NOTE: *The arrow on the rocker arm spring (b) must point towards the driven gear.*
3. Tighten the bolts to the specified torque.
   NOTE: *Leave all adjustment screws loose at this time.*



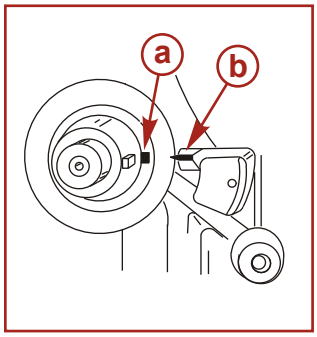
a - Rocker arm bracket (2)
b - Rocker arm spring (2)
c - Rocker arm bracket (1)
d - Bolt (M8 x 23) (5)
e - Adjustment screw

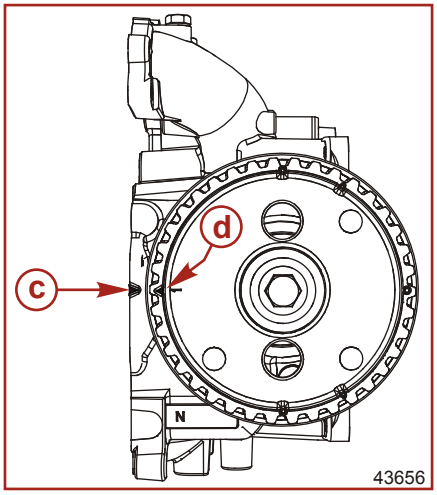
Description	Nm	lb-in.	lb-ft
Rocker arm mounting bolts (M8 x 23) (5)	18	160	

Cylinder Head Installation

1. Align the marks on the drive gear and cylinder block.

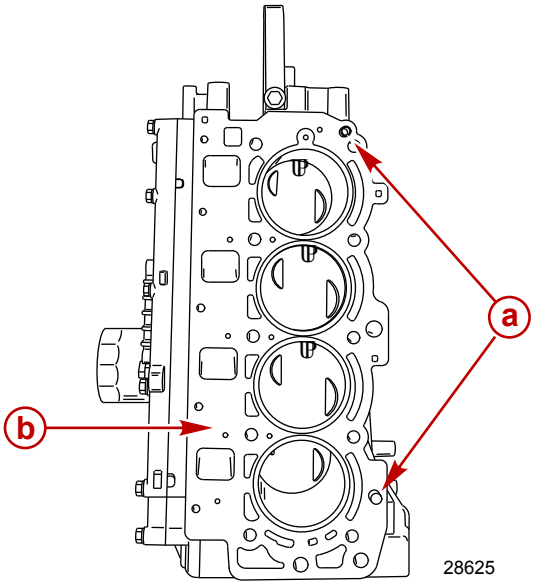
2. Align the marks on the driven gear and cylinder head.





a - Drive gear mark
b - Cylinder block mark
c - Cylinder head mark
d - Driven gear mark

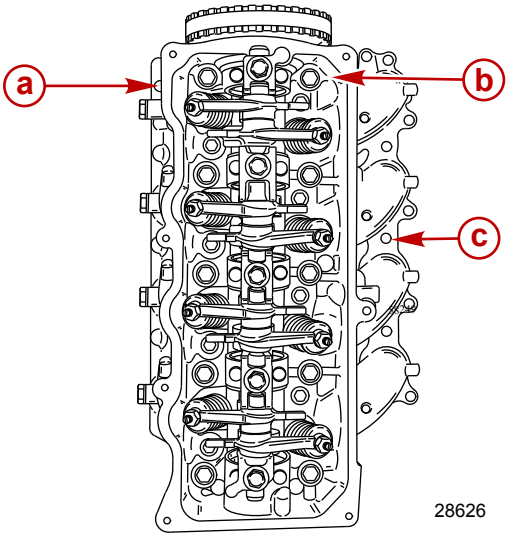
3. Install two dowel pins.
4. Install a new cylinder head gasket.



a - Dowel pins
b - Gasket

5. Apply Synthetic Blend 4-Stroke Outboard Oil 25W-40 to the threads of each bolt and seat surface.

6. Fasten the cylinder head to the cylinder block and intake manifold with bolts, as shown. Ensure the four O-ring seals are in place on the intake manifold.

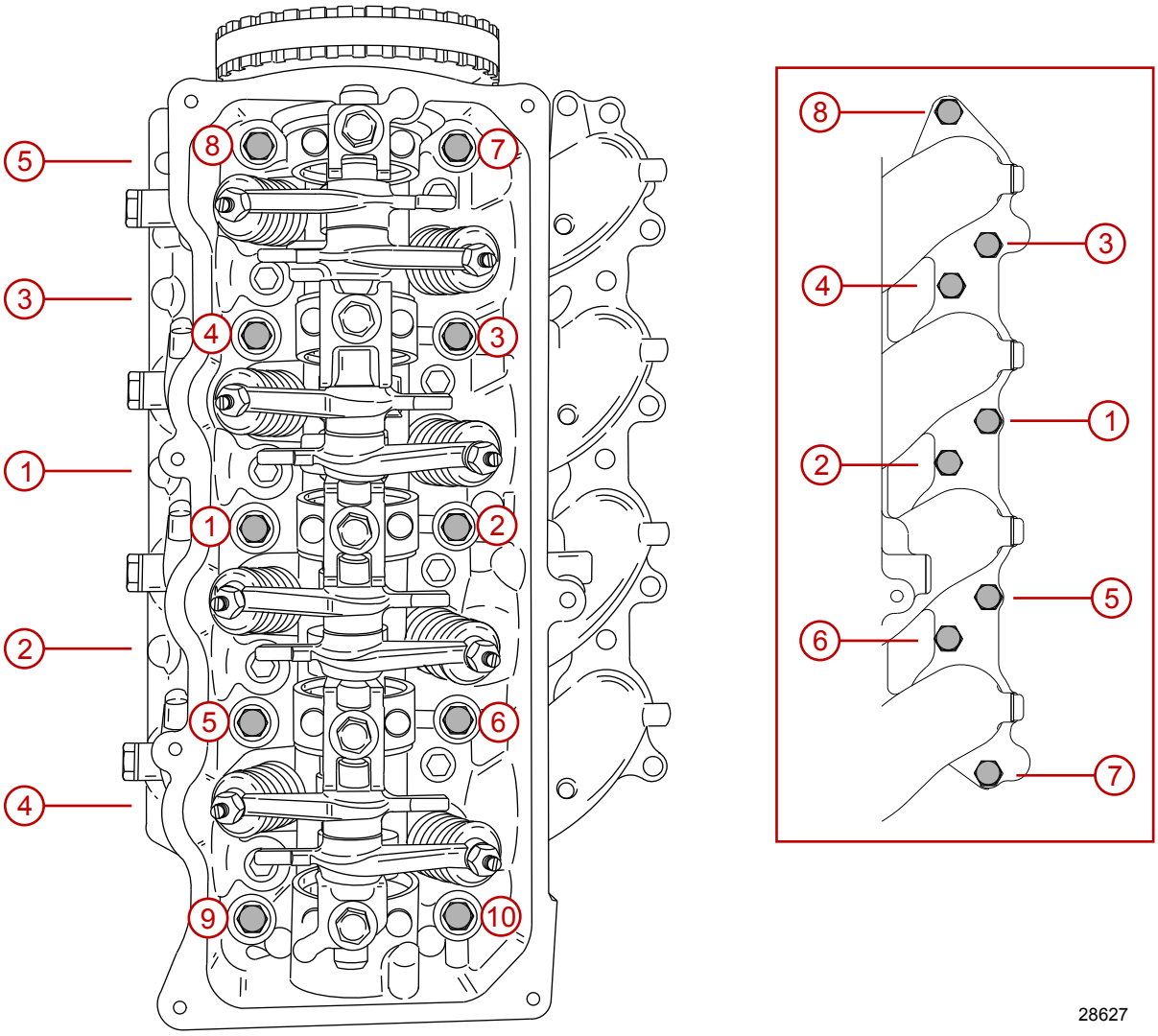


a - Flange bolts (M6 x 25) (5)
b - Center bolts (M9 x 95) (10)
c - Intake manifold bolts (M6 x 25) (8)

Tube Ref No.	Description	Where Used	Part No.
139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Cylinder head bolt threads and seat surface	92-8M0078629

7. Tighten the center bolts in sequence, in two steps, to the specified torque.
8. Tighten the cylinder head flange bolts in sequence, in two steps, to the specified torque.

9. Tighten the EFI intake manifold bolts in sequence to the specified torque.



Description		Nm	lb-in.	lb-ft
Center bolts (M9 x 95) (10)	**First**	23		17
	Final	90° turn		
Cylinder head flange bolts (M6 x 25) (5)	**First**	6	53	
	Final	12	106	
Intake manifold (M6 x 25) (8)		8	70	

10. Install the timing belt. Refer to **Timing Belt Installation**.
11. Adjust the valve clearance. Refer to **Valve Clearance Adjustment**.
12. Install the valve cover. Refer to **Valve Cover Installation**.
13. Install the throttle and shift components. Refer to **Section 7A - Throttle/Shift Linkage**.

Powerhead

Section 4B - Cylinder Block/Crankcase

Table of Contents

4 B

Cylinder Block/Crankshaft Specifications

Cylinder Block Specifications		
Cylinder block type		In-line, 4-Stroke - OHC, 8 valves
Displacement		995 cc (60.8 in³)
Stroke length		75 mm (2.953 in.)
Number of cylinders		4
Cylinder bore diameter	Standard	65 mm (2.5591 in.)
	Oversize - 0.25 mm (0.010 in.)	65.25 mm (2.5689 in.)
	Oversize - 0.50 mm (0.020 in.)	65.50 mm (2.5787 in.)
	Taper/out of round maximum	0.08 mm (0.003 in.)
Bore type		Cast iron
Crankshaft Specifications		
Crankshaft journal diameter		47.985–48.000 mm (1.8892–1.8898 in.)
Crankshaft pin diameter		43.982–44.000 mm (1.7316–1.7323 in.)
Crankshaft pin width		21.00–21.07 mm (0.8268–0.8295 in.)
Crankshaft runout		0.046 mm (0.0018 in.)
Crankshaft main bearing clearance		0.012–0.044 mm (0.0005–0.0017 in.)

Piston Specifications

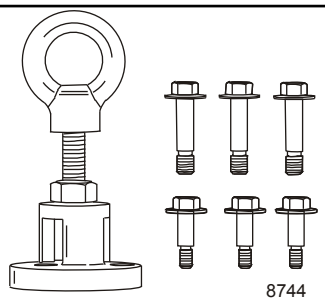
Piston Specifications		
Piston type		Aluminum
Skirt diameter	Measure point	13.0 mm (0.51 in.)
	Standard	64.950–64.965 mm (2.5570–2.5578 in.)
	Oversize - 0.25 mm (0.010 in.)	65.200–65.215 mm (2.5669–2.5675 in.)
	Oversize - 0.50 mm (0.020 in.)	65.450–65.465 mm (2.5768–2.5774 in.)
Piston to cylinder clearance		0.035–0.065 mm (0.0014–0.00261 in.)
Ring end gap (installed)	Top	0.15–0.30 mm (0.006–0.012 in.)
	Second	0.30–0.50 mm (0.012–0.020 in.)
	Bottom (oil ring)	0.20–0.70 mm (0.008–0.028 in.)
Ring side clearance	Top	0.02–0.06 mm (0.0008–0.0024 in.)
	Second	0.02–0.06 mm (0.0008–0.0024 in.)
Compression ratio		9.7:1
Cylinder compression (peak)		1240–1450 kPa (180–210 psi)
Piston pin diameter		15.965–15.970 mm (0.6285–0.6287 in.)

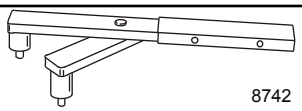
Piston Specifications		
Connecting rod	Small end inside diameter	15.985–15.998 mm (0.6293–0.6298 in.)
	Big end oil clearance	0.020–0.052 mm (0.0008–0.0020 in.)

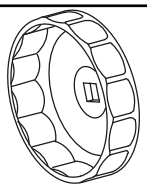
Lubricants, Sealants, Adhesives

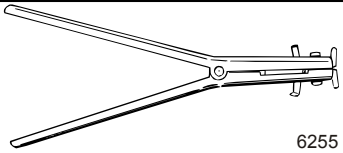
Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Oil pressure switch and engine coolant temperature (ECT) sensor threads	92-809822
12	Loctite Master Gasket Kit	Crankcase cover	92-12564 2
139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Piston pin	92-8M0078629
		Piston rings	
		Piston, piston rings, and cylinder bore	
		Crankshaft bearing surface	
		Connecting rod journals and oil seal lips	
		Engine oil sump	

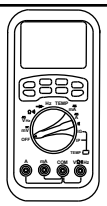
Special Tools

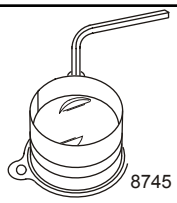
Flywheel Puller/Lifting Ring	91- 83164M
 8744	Removes flywheel from engine. Used for lifting powerhead/engine.

Flywheel Holder	91- 83163M
 8742	Holds and/or turns the flywheel while making engine repairs, also used to torque the flywheel or the engine coupler.

Oil Filter Wrench	91-889277002
 5221	Aids in the removal of the oil filter.

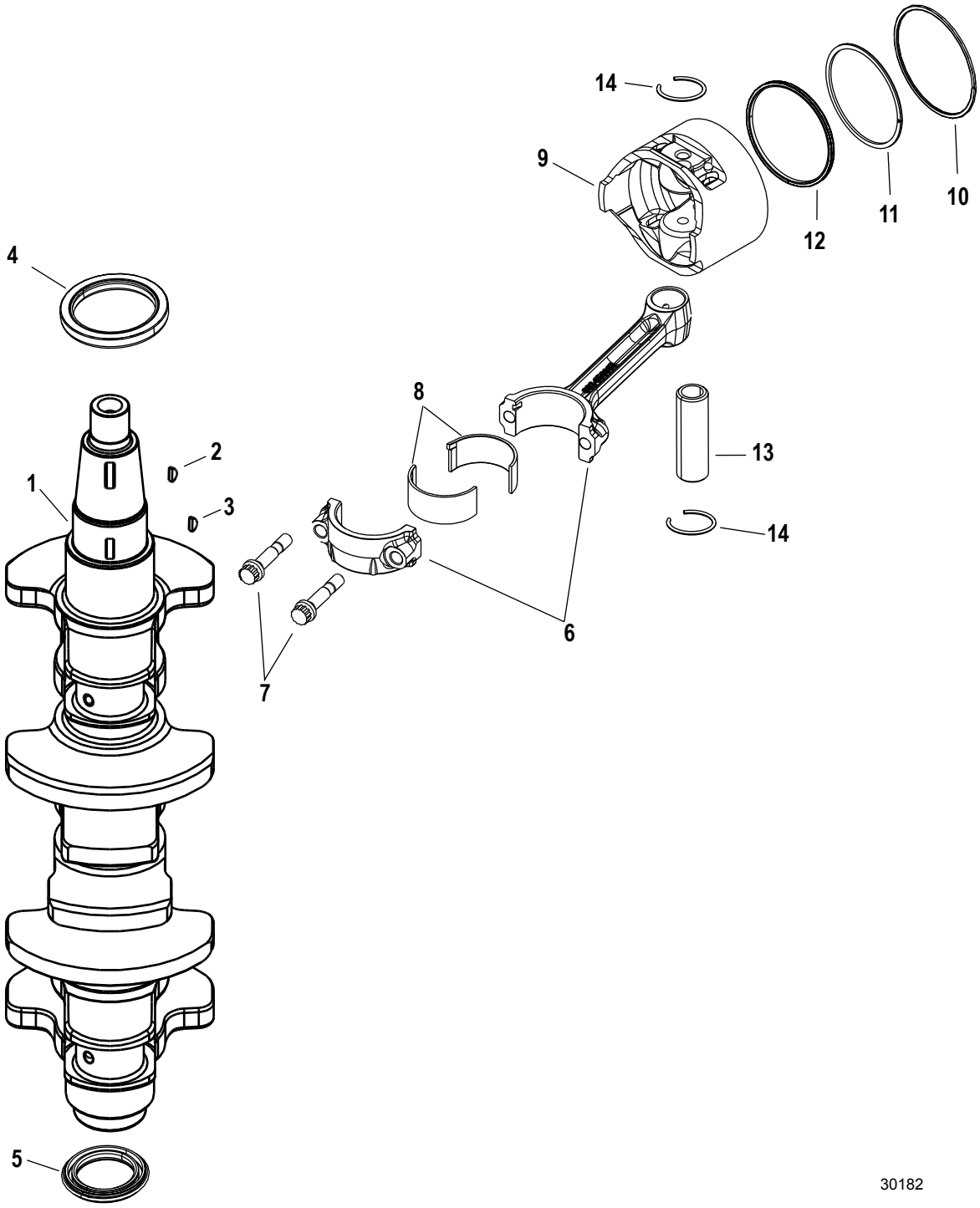
Piston Ring Expander	91- 24697
 6255	Expands piston rings for removal and installation.

DMT 2004 Digital Multimeter	91-892647A01
 4516	Measures RPM, ohms, amperes, AC and DC voltages; records maximums and minimums simultaneously, and accurately reads in high RFI environments.

Piston Ring Compressor	FT2997
 8745	Compresses the piston rings to ease piston installation

Notes:

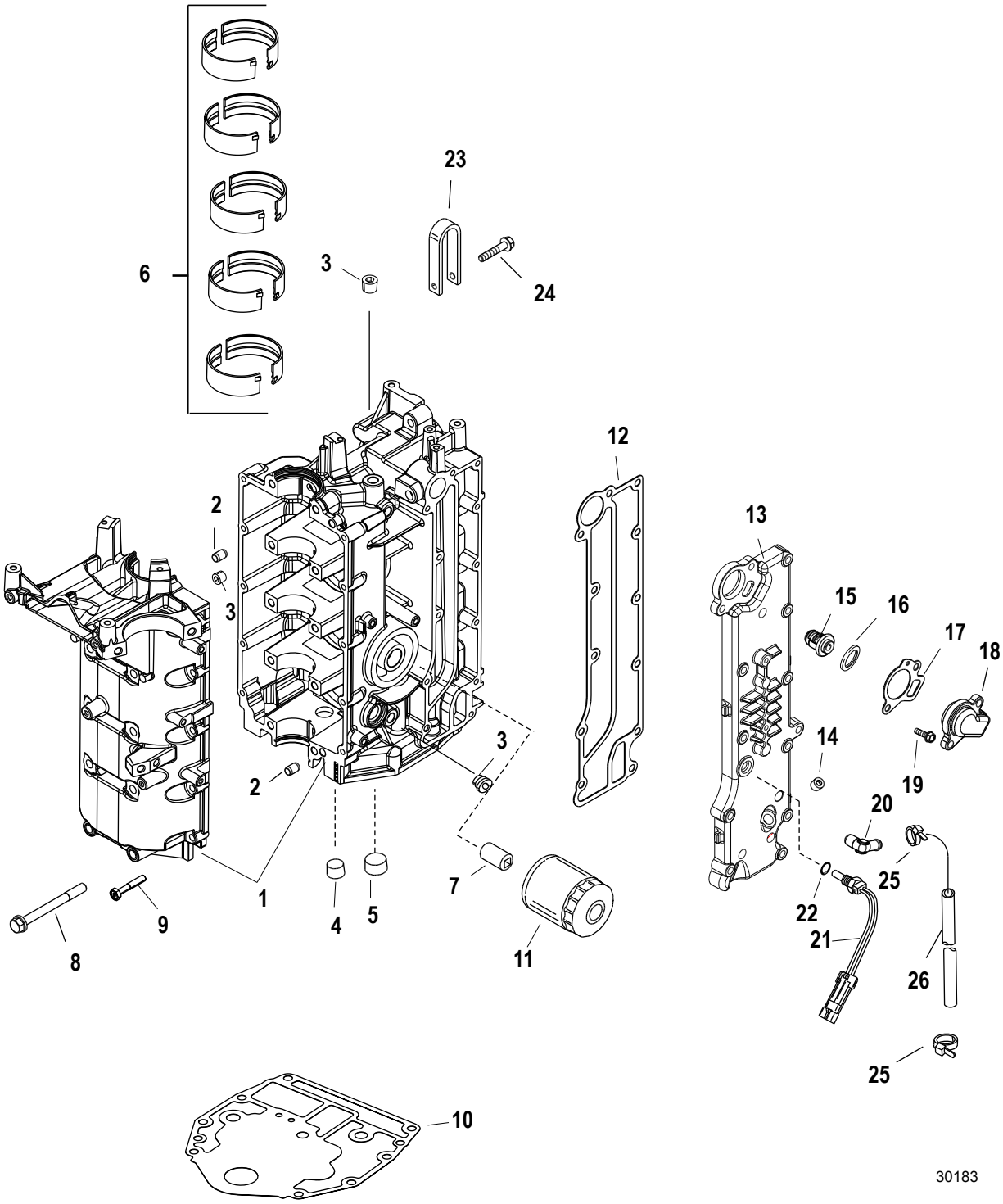
Crankshaft Components



Crankshaft Components

Ref. No.	Qty.	Description		Torque		
				Nm	lb-in.	lb-ft
1	1	Crankshaft				
2	1	Woodruff key				
3	1	Key				
4	1	Oil seal				
5	1	Oil seal				
6	4	Connecting rod				
7	8	Bolt	First torque	8	70	
			Final torque	40° turn		
8	8	Bearing (brown, black, blue)				
9	4	Piston assembly				
10	4	Top piston ring				
11	4	Second piston ring				
12	4	Oil ring				
13	4	Piston pin				
14	8	Piston pin retainer				

Cylinder Block and Crankcase Components



Cylinder Block and Crankcase Components

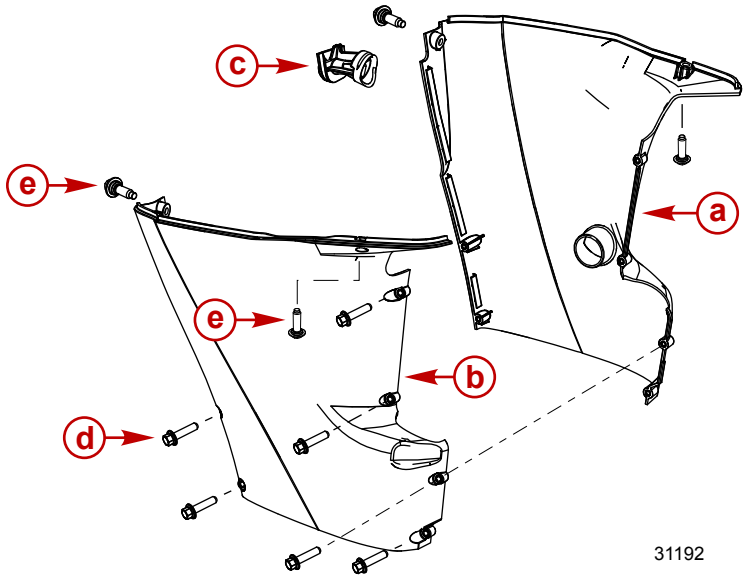
Ref. No.	Qty.	Description		Torque		
				Nm	lb-in.	lb-ft
1	1	Cylinder block assembly				
2	2	Dowel pin				
3	3	Plug		9	80	
4	1	Plug (½-14)		33		24.3
5	1	Plug (3/4-14)		33		24.3
6	10	Main bearing (brown, black, blue)				
7	1	Nipple		40		30
8	10	Bolt (M8 x 82)	First torque	15	133	
			Final torque	30		22
9	10	Bolt (M6 x 35)	First torque	6	53	
			Final torque	12	106	
10	1	Gasket				
11	1	Oil filter		8	70	
12	1	Gasket				
13	1	Exhaust cover assembly				
14	1	Plug		Drive tight		
15	1	Thermostat				
16	1	Gasket				
17	1	Gasket				
18	1	Cover				
19	12	Bolt (M6 x 35)	First torque	6	53	
			Final torque	12	106	
			Sequence per cast in characters on exhaust cover			
20	1	90° elbow fitting		Drive tight to 7 or 8 o'clock position		
21	1	Sensor		1.7	15	
22	1	O-ring				
23	1	Lifting eye				
24	1	Bolt (M8 x 35)		36		27
25	2	Cable tie				
26	1	Tubing (to VST cooler) (25.4 cm [10 in.])				

Powerhead Removal

⚠ WARNING

Performing service or maintenance without first disconnecting the battery can cause product damage, personal injury, or death due to fire, explosion, electrical shock, or unexpected engine starting. Always disconnect the battery cables from the battery before maintaining, servicing, installing, or removing engine or drive components.

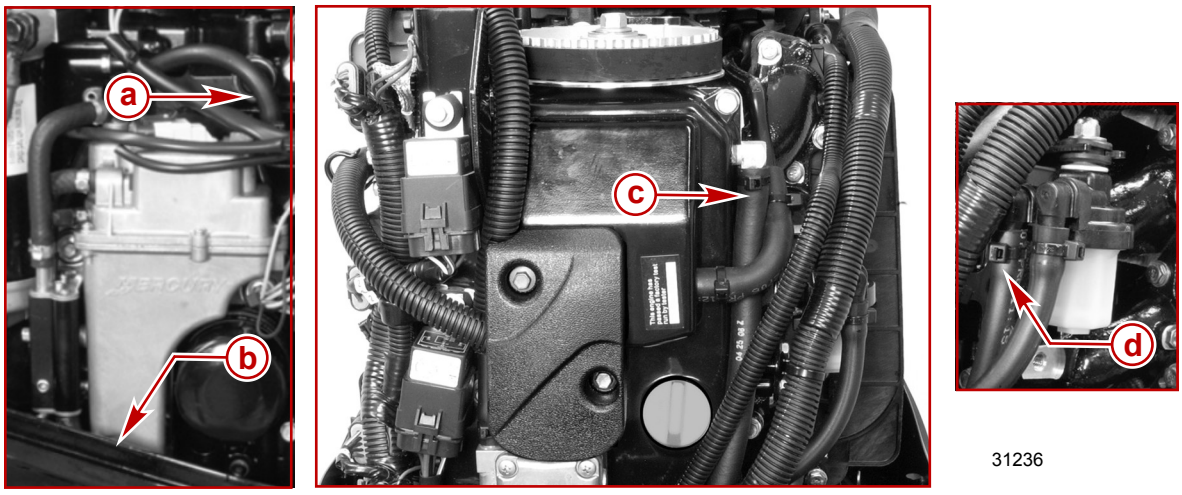
1. Disconnect the battery cables from the battery.
2. Remove the battery cables from the engine.
3. Disconnect the power trim wires and the cowl trim switch connector.
4. Remove the chaps.



a - Port chap
b - Starboard chap
c - Idle relief port boot
d - Black flange bolt (M6 x 30) (6)
e - Black flange bolt (M6 special shoulder) (4)

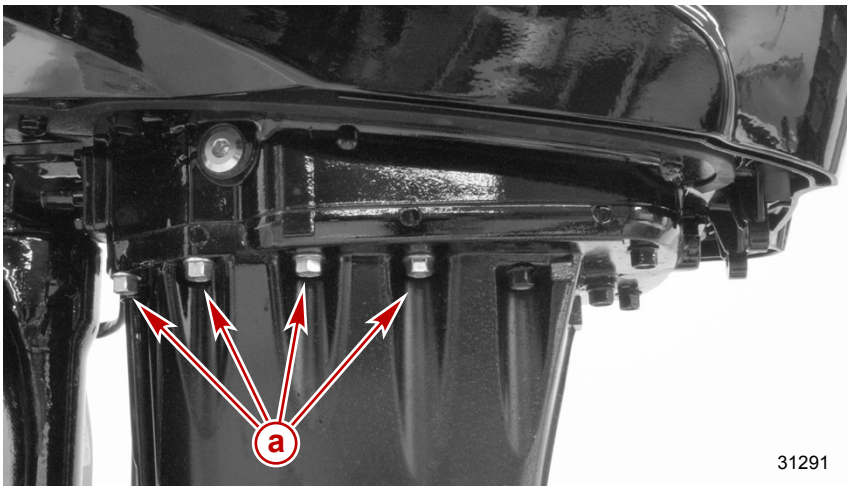
5. Drain the engine oil.
6. Remove the bolt securing the dipstick to the powerhead. Remove the dipstick.
7. Disconnect the vapor separator tank (VST) vent hose.
8. Disconnect the crankcase vent hose.
9. Disconnect the inlet hose from the fuel filter.

IMPORTANT: Do not twist or pull the fuel hoses. Remove the hoses by prying the hoses off with a small screwdriver.



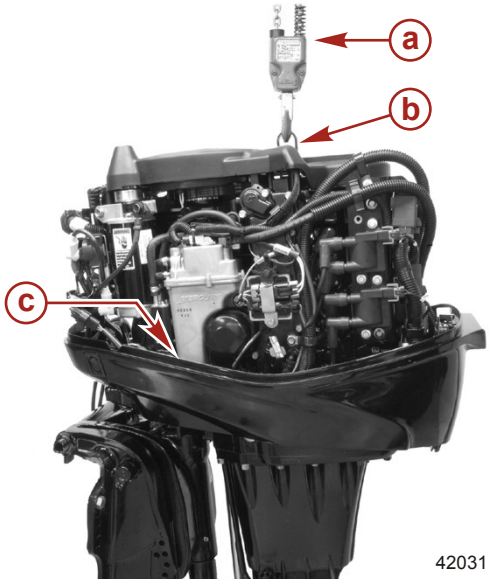
a - VST vent hose
b - VST drain hose
c - Crankcase vent hose
d - Fuel filter inlet hose

10. Remove the powerhead mounting bolts.



a - Bolt (M8 x 110) (4 each side)

11. Lift the powerhead from the driveshaft housing.
12. When the powerhead is raised slightly, remove the VST drain hose.



a - Hoist
b - Lifting eye
c - VST drain hose

Flywheel Puller/Lifting Ring	91- 83164M

Removing Powerhead Components

1. Remove the intake assembly. Refer to **Section 3C - Intake Manifold Assembly Removal**.
2. Remove the vapor separator assembly. Refer to **Section 3C - Vapor Separator Tank (VST) Removal**.
3. Remove the flywheel, stator, and starter. Refer to **Section 2B - Charging and Starting System**.

Flywheel Holder	91- 83163M
Flywheel Puller/Lifting Ring	91- 83164M

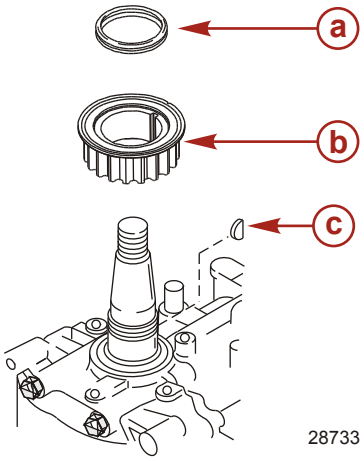
4. Disconnect and remove components in the following order:
   a. ECM bracket screws (3)
   b. Main harness ground wire screws (near bottom of starter)
   c. Starter solenoid mounting screws
   d. Oil pressure switch
   e. ECT sensor
   f. Regulator/rectifier mounting screws
   g. Crankshaft position sensor mounting screws

h. Ignition coil mounting screws

5. Remove the electrical components as an assembly. Disconnect the wiring and cut the cable ties, as necessary.
6. Remove the cylinder head. Refer to **Section 4A - Cylinder Head Removal**.

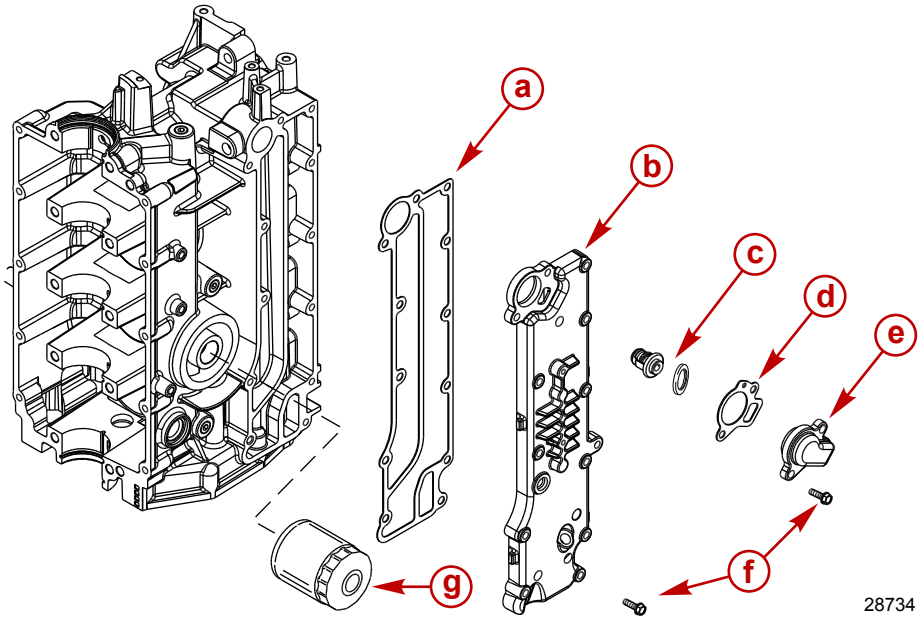
Cylinder Block Disassembly

1. Remove the drive gear components.



a - Load ring
b - Drive gear
c - Woodruff key

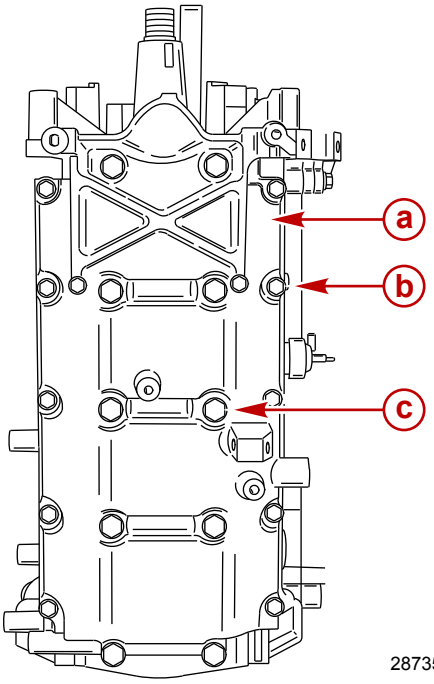
2. Remove the exhaust cover and gasket.
3. Remove the oil filter.



a - Gasket
b - Exhaust cover
c - Thermostat and gasket
d - Gasket
e - Thermostat cover
f - Exhaust cover mounting bolts (M6 x 35) (12)
g - Oil filter

Oil Filter Wrench	91-889277002

4. Remove the crankcase cover bolts.

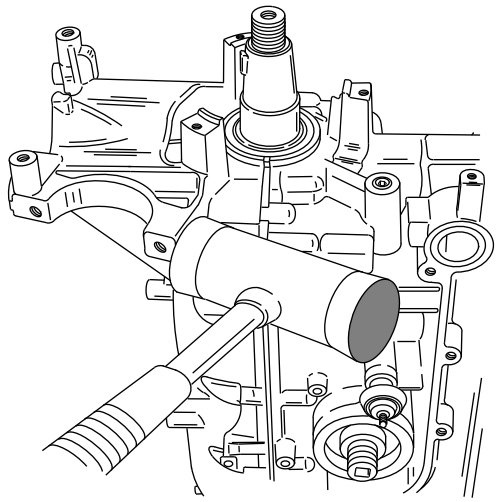


28735

a - Crankcase cover
b - Crankcase cover bolts (M6 x 35) (10)
c - Crankcase cover bolts (M8 x 82) (10)

5. Lightly strike the crankcase cover with a rubber or plastic hammer to separate it from the block.

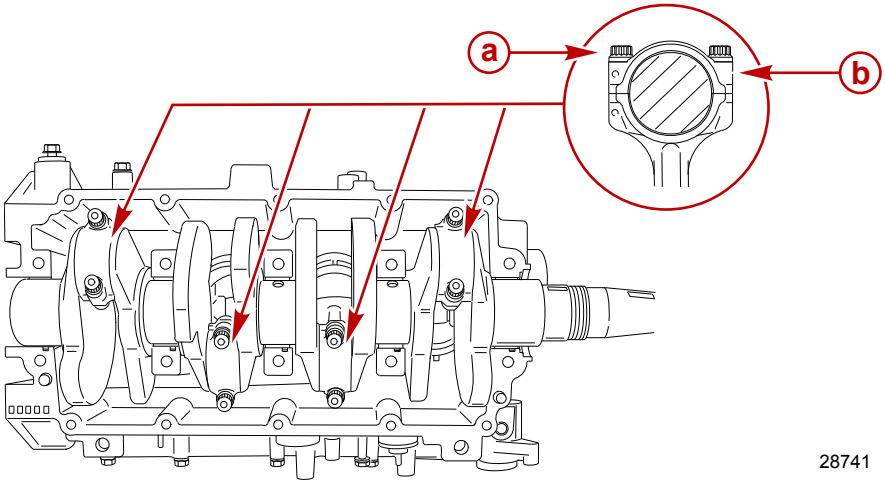
   NOTE: *If the cover will not separate, try prying it off with a screwdriver. Do not damage the split line sealing surface when prying the cover off.*



28736

6. Remove the connecting rod bolts with a 5/16 in. 12 point socket.

NOTE: *Each connecting rod and cap are a matched set. They must not be interchanged.*

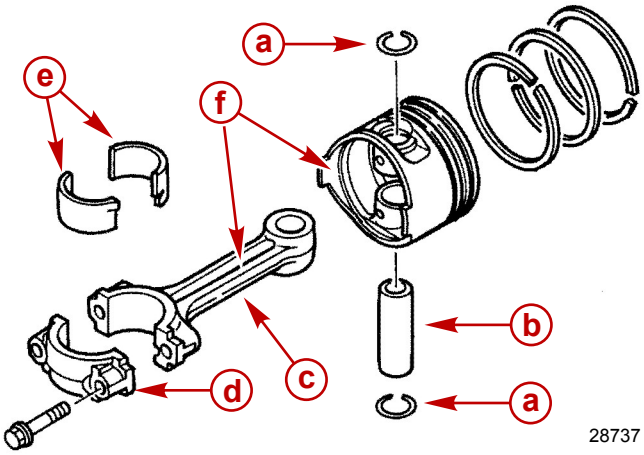


a - Connecting rod cap bolt
b - Connecting rod cap

7. Remove the carbon ridge from the cylinder bore.
8. Push the pistons out of the cylinder block. Keep each piston, connecting rod, and cap together as an assembly.
9. Remove the piston rings with a piston ring expander tool to prevent the rings from breaking.

Piston Ring Expander	91- 24697

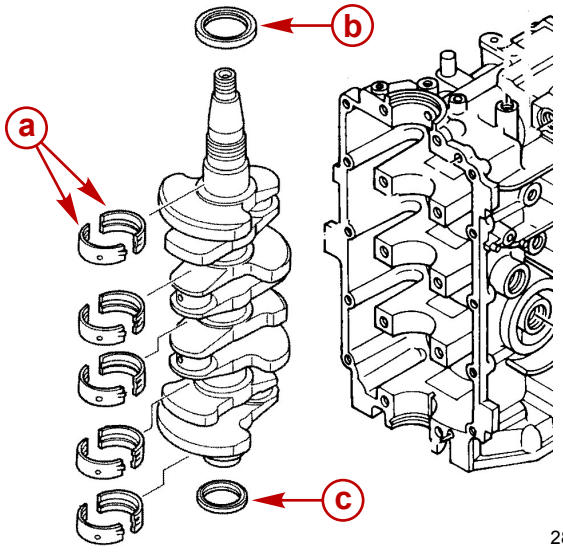
10. Remove the piston pin retainers with a needle nose pliers. Remove the piston pin.
11. Identify the cylinder number (1 through 4) on the inside of each connecting rod and piston with indelible ink or paint so they can be installed in their original location.



a - Piston pin retainers
b - Piston pin
c - Connecting rod
d - Connecting rod cap
e - Connecting rod bearings
f - Cylinder number scribe mark

12. Remove the crankshaft from the block.

13. Remove the main bearings and crankshaft seal from the crankshaft.

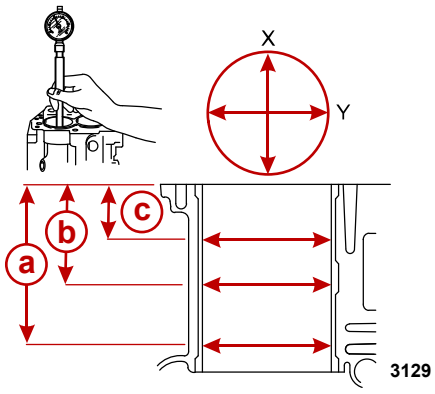


a - Main bearings
b - Upper crankshaft oil seal
c - Lower crankshaft oil seal

Cleaning/Inspection/Repair

Cylinder Bore

1. Inspect the water jacket areas for mineral deposit and blockage. Clean the water jacket area as needed.
2. Inspect the cylinder bore surfaces. Deep scoring will require oversize pistons.
3. Measure the cylinder bore in six places with a bore gauge. Determine the maximum taper/out of round of the cylinder bore.

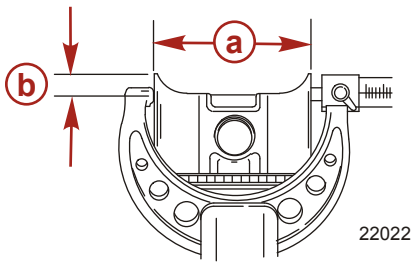


a - 60 mm (2.4 in.)
b - 40 mm (1.6 in.)
c - 20 mm (0.8 in.)

Cylinder Bore	Maximum taper/out of round
Standard - 65 mm (2.5591 in.)	0.08 mm (0.003 in.)
Oversize - 0.25 mm (0.010 in.): 65.25 mm (2.5689 in,)	0.08 mm (0.003 in.)
Oversize - 0.50 mm (0.020 in.): 65.50 mm (2.5787 in,)	0.08 mm (0.003 in.)

Piston

1. Inspect the piston. Replace if damaged or worn.
2. Measure the piston at a point 5.0 mm (0.200 in.) from the bottom of the piston skirt and 90° from the wrist pin.



a - Piston diameter (replace if out of limit)
b - 5.0 mm (0.200 in.) from bottom of piston skirt

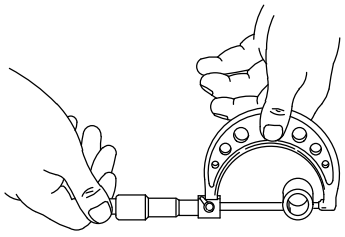
Piston Diameter	
Standard	64.950–64.965 mm (2.5570–2.5578 in.)
Oversize - 0.25 mm (0.010 in.)	65.200–65.215 mm (2.5669–2.5675 in.)
Oversize - 0.50 mm (0.020 in.)	65.450–65.465 mm (2.5768–2.5774 in.)

The minimum piston to cylinder wall clearance is defined by the formula: **Minimum cylinder bore measurement – Maximum piston diameter measurement = Piston to cylinder clearance.**

Piston to Cylinder Wall	
Clearance	0.035–0.065 mm (0.0014–0.00261 in.)

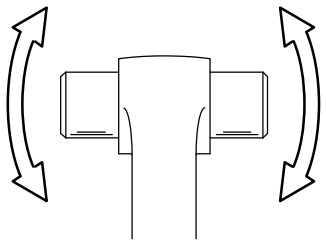
Piston Pin

1. Measure the piston pin.

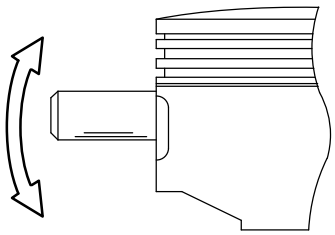


Piston Pin	
Diameter	15.965–15.970 mm (0.6285–0.6287 in.)

2. Install the piston pin into the connecting rod. There should be no noticeable free play. Replace the pin and/or the connecting rod, as necessary.



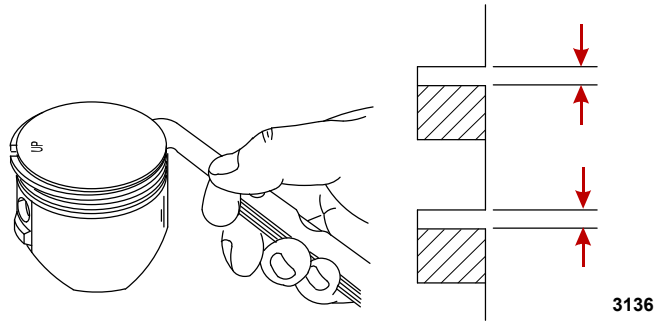
3. Install the piston pin into the piston. There should be no noticeable free play. Replace the pin and/or the piston, as necessary.



Piston Rings

Piston Ring Side Clearance

Measure the piston ring side clearance. Replace the piston and/or rings if out of specification.

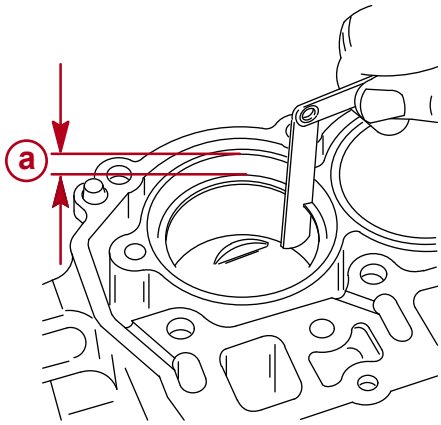


Piston Ring Side Clearance	
Top	0.02–0.06 mm (0.0008–0.0024 in.)
Second	0.02–0.06 mm (0.0008–0.0024 in.)

Piston Ring End Gap Clearance

Measure the piston ring end gap clearance. Replace the piston rings as a set if out of specification.

1. Push the piston ring into the bore of the cylinder with the crown of the piston to a depth of 20 mm (0.8 in.).
2. If the piston rings require replacement, replace the rings as a set.



a - 20 mm (0.8 in.)

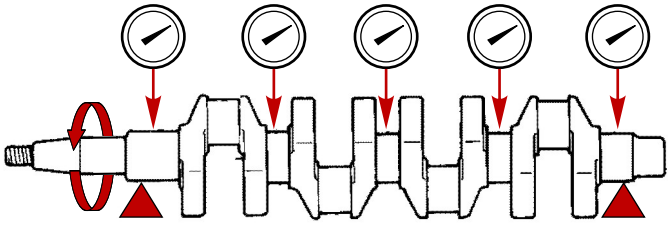
Piston Ring End Gap	
Top	0.15–0.30 mm (0.006–0.012 in.)
Second	0.30–0.50 mm (0.012–0.020 in.)
Bottom (oil ring)	0.20–0.70 mm (0.008–0.028 in.)

Crankshaft

Crankshaft Runout

1. Thoroughly clean the crankshaft and inspect the bearing surfaces. Replace the crankshaft if the bearing surfaces are pitted, scored, or discolored.

2. Measure the crankshaft for runout. Replace the crankshaft if out of specification.


28760

Crankshaft	
Runout	0.046 mm (0.0018 in.)

Crankcase Main Bearings

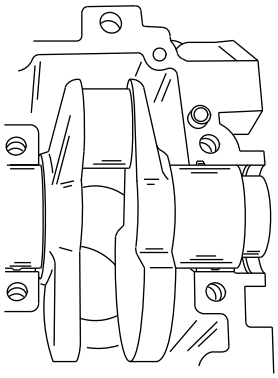
Measure the crankshaft main bearing clearance as outlined in the following procedure. Replace the bearings as a set if the clearance is out of specification.

Main Bearing	
Clearance	0.012–0.044 mm (0.0005–0.0017 in.)

Crankshaft Main Bearing Clearance Measurement

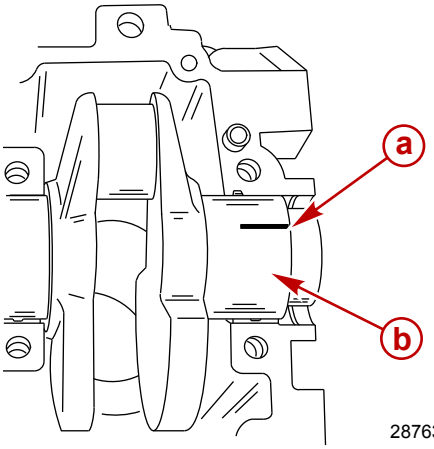
IMPORTANT: Do not interchange the main bearings. Install in their original position.

1. Clean the sealing material from the crankcase cover and cylinder block.
2. Clean the oil from the following areas:
   - Main bearing surfaces on the cylinder block and crankcase cover
   - Main bearings
   - Crankshaft bearing surfaces
3. Install the main bearings onto the cylinder block.
   NOTE: *Align each bearing projection with the notch in the cylinder block.*
4. Install the crankshaft into the cylinder block.


28762

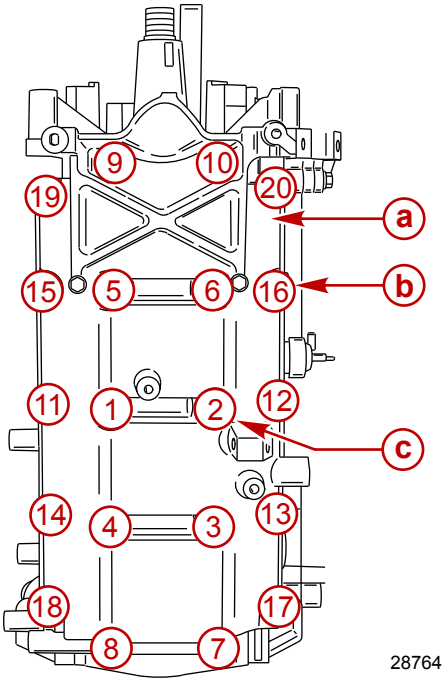
5. Place a piece of plastigauge onto each crankshaft bearing surface.

NOTE: *Do not put plastigauge over the oil hole on the bearing surface of the crankshaft.*



a - Plastigauge
b - Crankshaft bearing surface

6. Install the bearing halves into the crankcase.
   NOTE: *Align each bearing projection with the notch in the crankcase.*
7. Install the crankcase onto the cylinder block.
8. Apply oil to the crankcase cover bolts. Torque the bolts to specification in the sequence shown on the crankcase cover.
   IMPORTANT: Do not move the crankshaft until measurement has been completed.

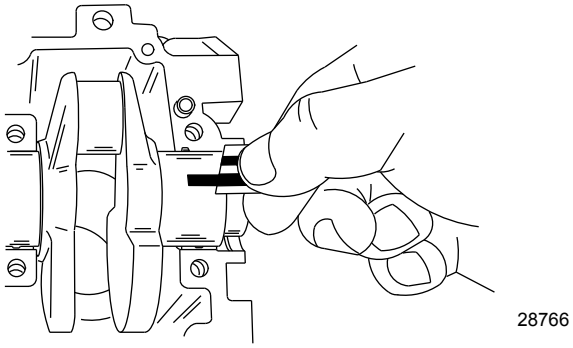


a - Crankcase cover
b - Outer bolt (M6 x 35) (10)
c - Center bolt (M8 x 82) (10)

Description		Nm	lb-in.	lb-ft
Center bolts (M8 x 82) (10)	**First**	15	132.7	–
	Final	30	–	22.1
Outer bolts (M6 x 35) (10)	**First**	6	53.1	–
	Final	12	106.2	–

9. Remove the crankcase cover bolts. Remove the crankcase cover.

10. Measure the plastigauge at its maximum compressed width.


28766

11. If the oil clearance is out of specification limit, replace the bearings as a set.

Main Bearing	
Oil clearance	0.012–0.044 mm (0.0005–0.0017 in.)

12. If replacement of the main bearings is required, refer to **Cylinder Block Assembly—Main Bearing Installation**.

Connecting Rod Oil Clearance

Measure the connecting rod oil clearance using the measurement steps outlined following.

Connection Rod	
Big end oil clearance	0.020–0.052 mm (0.0008–0.0020 in.)

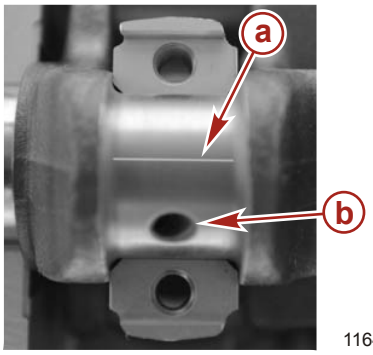
Connecting Rod Oil Clearance Measurement

IMPORTANT: Do not interchange connecting rod caps. Install the connecting rod caps in their original positions.

1. Clean all the oil from the connecting rod bearing surfaces and connecting rod journals on the crankshaft.
2. Install the connecting rod onto the crankshaft.

   IMPORTANT: Install the connecting rods in their original locations (#1, #2, #3, and #4). Make sure that the "O" (up) mark on the connecting rod cap faces towards the flywheel end of the crankshaft.
3. Place a piece of plastigauge on the crankpin journals.

   NOTE: *Do not put plastigauge over the oil hole on the bearing surface of the crankshaft.*

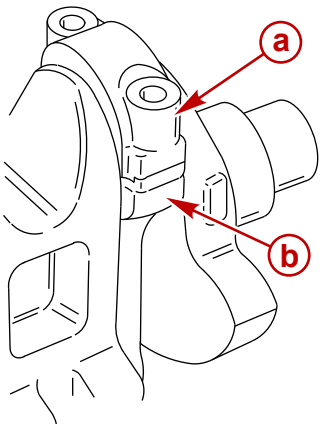


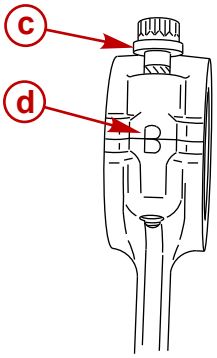
11644

a - Plastigauge
b - Crankshaft oil hole

4. Install the connecting rod cap and tighten the connecting rod cap bolts to specification.

IMPORTANT: Do not rotate the crankshaft while performing this measurement.



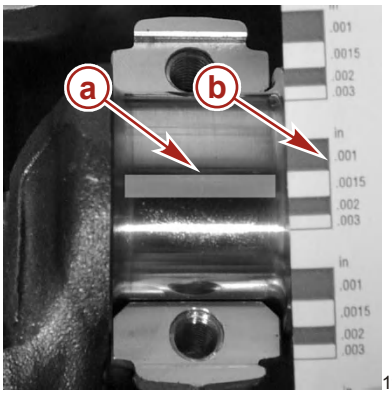


30230

a - Connecting rod cap
b - Connecting rod
c - Connecting rod cap bolt
d - Identification mark

Description		Nm	lb-in.	lb-ft
Connecting rod cap bolt	**First**	6	53	
	Final	17	150	

5. Remove the connecting rod cap.
6. Measure the plastigauge at its maximum compressed width.



11650

a - Compressed plastigauge
b - Plastigauge scale

7. If the oil clearance is out of specification limit, measure the diameter of the connecting rod and crankpin journal. Replace as needed.

Thermostat

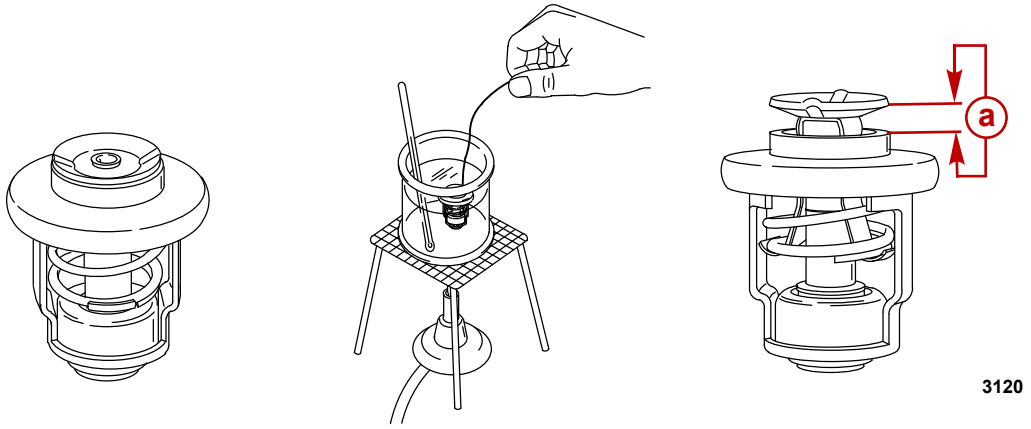
Inspect the thermostat. Replace if damaged, seized, or corroded.

Thermostat Measurement Test

1. Tie a piece of thread or other nonconductive material onto the thermostat.
2. Suspend the thermostat in cold water.
3. Suspend a thermometer in the water.

   IMPORTANT: Do not allow the thermometer to contact the heating surface of the container. An inaccurate temperature reading may result.
4. Slowly heat the water while observing the thermostat and thermometer.

5. Measure the thermostat opening when the specified water temperature is achieved.



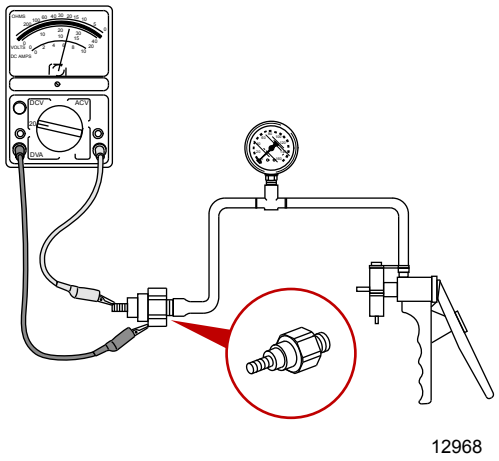
a - Minimum thermostat valve lift

Thermostat Specifications	
Starts to open	48–51 °C (118–123 °F)
Minimum thermostat valve lift above 63 °C (145 °F)	3 mm (0.12 in.)

Oil Pressure Switch Test

NOTE: *Use a vacuum/pressure tool with a gauge to test proper functioning of the oil pressure switch. Obtain tools locally.*

The oil pressure switch is normally closed. Check the oil pressure switch for continuity at the specified pressure. Replace the switch if out of specification.



DMT 2004 Digital Multimeter	91-892647A01

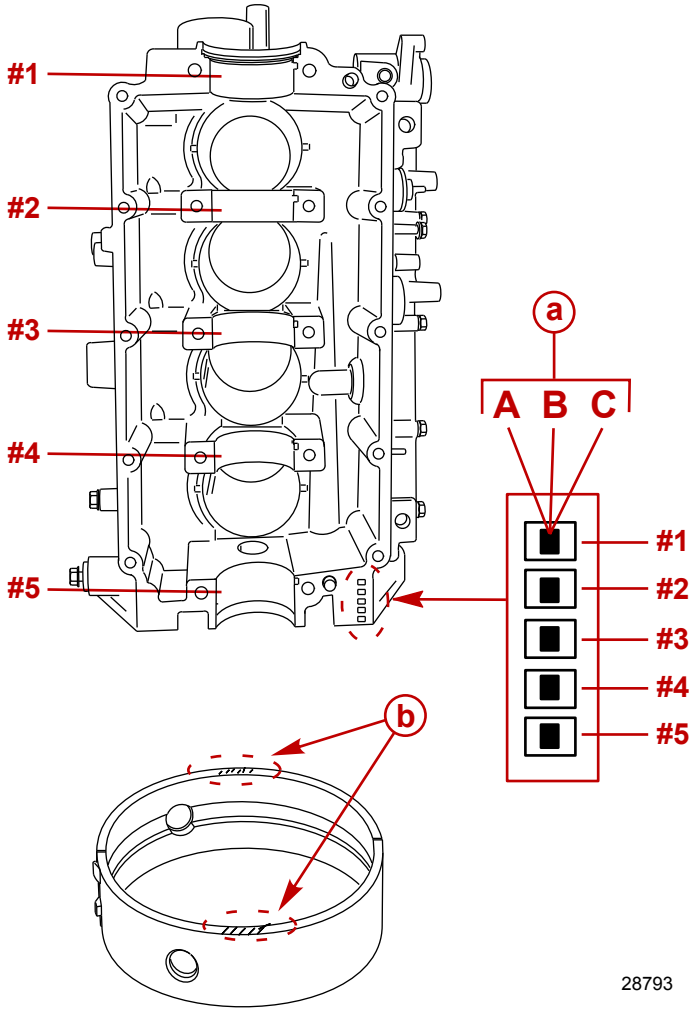
Oil Pressure Switch Continuity	
Below 20 kPa (2.9 psi)	Continuity
Above 20 kPa (2.9 psi)	No continuity

Cylinder Block Assembly

Selecting New Main Bearings

1. Locate the main bearing code letters on the cylinder block.
2. Refer to the following reference chart to select the correct main bearings.
3. Use the color coded main bearings that match the main bearing code letter.

Main Bearing Code Letter	Main Bearing Color Code
A	Blue
B	Black
C	Brown



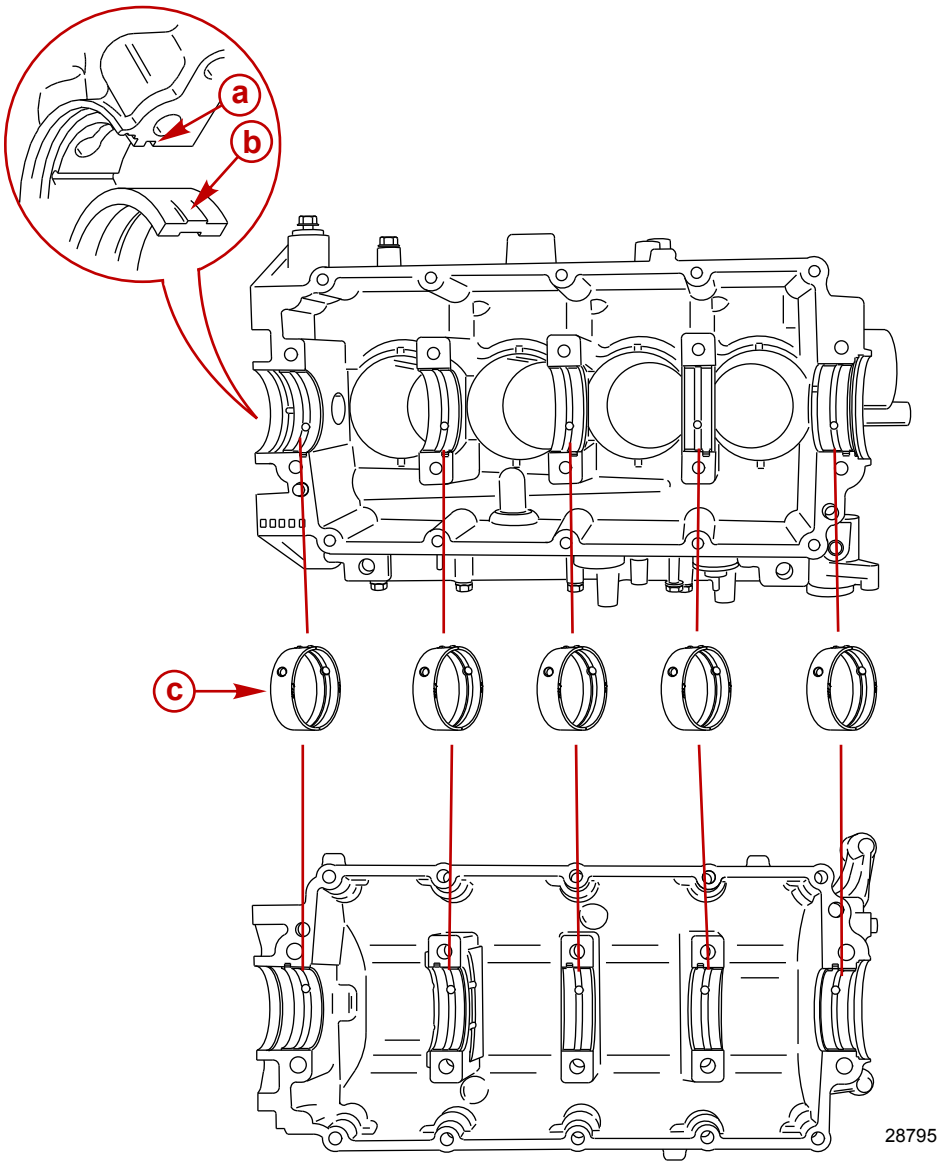
a - Main bearing code letters
b - Main bearing identification code location

Main Bearing Installation

IMPORTANT: Do not interchange used main bearings. Install in their original position.

1. Check the clearance of each bearing following the procedure in **Cleaning/Inspection/Repair**.
2. Clean the oil from the main bearing surfaces on the cylinder block and crankcase cover.

3. Install the main bearings. Ensure that the locking tab on each bearing fits into its notch in the cylinder block.

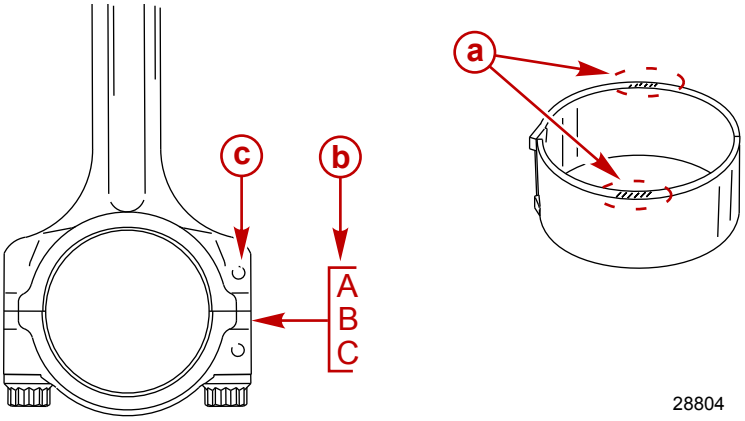


a - Notch in cylinder block
b - Locking tab
c - Main bearing (5)

Selecting New Connecting Rod Bearings

1. Locate the connecting rod bearing code letter that is scribed on the side of the connecting rod.
2. Refer to the following reference chart to select the correct connecting rod bearings.
3. Use the color coded connecting rod bearings that match the connecting rod bearing code letter.

Connecting Rod Bearing Code Letter	Connecting Rod Bearing Color Code
A	Blue
B	Black
C	Brown



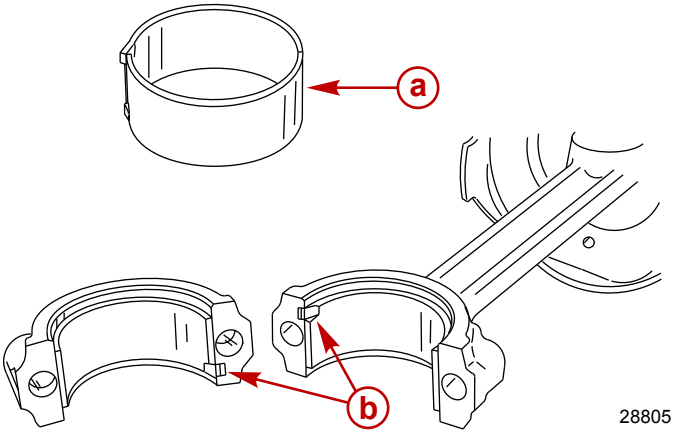
28804

- **a -** Connecting rod bearing identification color location
- **b -** Connecting rod bearing code letters
- **c -** Connecting rod mark

Connecting Rod Bearing Installation

IMPORTANT: Do not interchange used connecting rod bearings. Install the bearings in their original position.

1. Clean the oil from the bearing surfaces on each connecting rod.
2. Install the connecting rod bearings. Ensure the locking tab on each bearing fits into the notch.



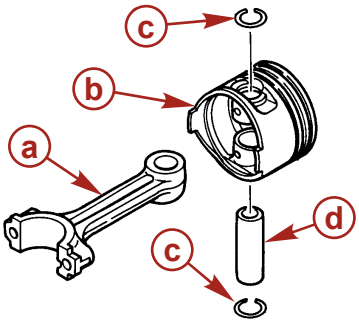
28805

- **a -** Connecting rod bearings
- **b -** Locking lug and notch

Piston Assembly

Assemble the connecting rod onto the piston. Lubricate the piston pin with Synthetic Blend 4-Stroke Outboard Oil 25W-40. Install the piston pin and secure with a new piston pin retainer.

IMPORTANT: Ensure the "UP" on the connecting rod and piston are facing the same direction.



6366

- **a -** Connecting rod
- **b -** Piston
- **c -** Piston pin retainer
- **d -** Piston pin

Tube Ref No.	Description	Where Used	Part No.
139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Piston pin	92-8M0078629

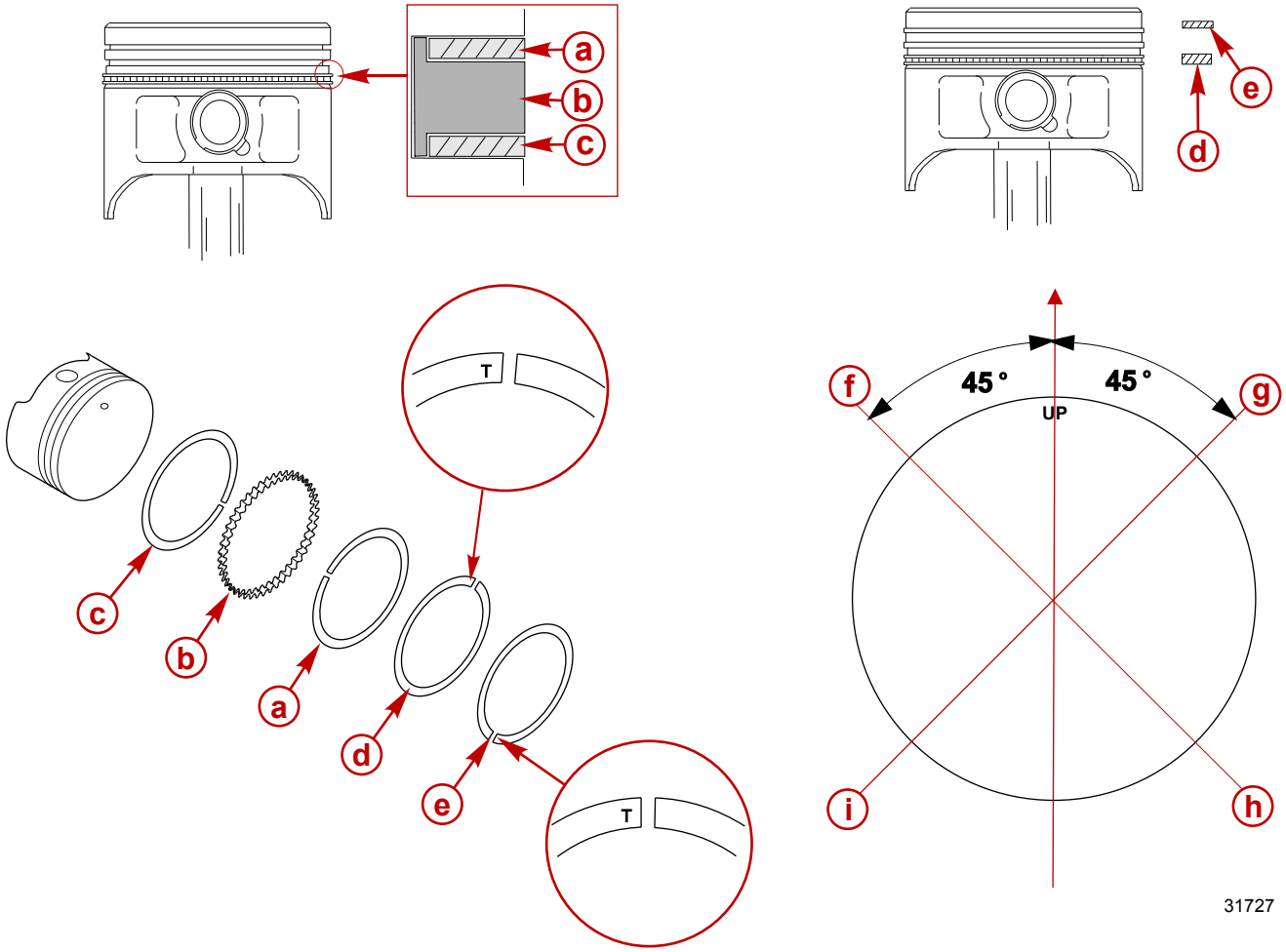
Piston Ring Installation

IMPORTANT: Use caution when installing piston rings to avoid scratching the piston.

1. Install the oil rings, second ring, and top ring.

   IMPORTANT: The "T" on the top and second ring must face the crown of the piston.

2. Lubricate the rings with Synthetic Blend 4-Stroke Outboard Oil 25W-40 after the rings are installed on the piston.



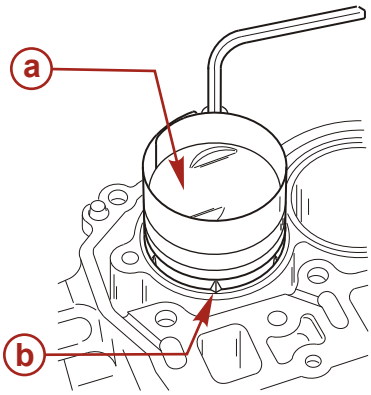
- **a -** Top oil control ring
- **b -** Expander
- **c -** Bottom oil control ring
- **d -** Second ring
- **e -** Top ring
- **f -** End gap - Top ring
- **g -** End gap - Bottom oil control ring
- **h -** End gap - Second ring
- **i -** End gap - Top oil control ring

Tube Ref No.	Description	Where Used	Part No.
139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Piston rings	92-8M0078629

Piston Installation

IMPORTANT: The cylinder bores must be clean before installing the pistons. Clean the bore with a light honing as necessary. After honing, clean the cylinder bores with water and mild detergent. After cleaning, swab out the cylinder bores with engine oil and a clean cloth. Wipe the cylinder bore with a clean dry cloth.

1. Lubricate the piston, rings, and cylinder bores with Synthetic Blend 4-Stroke Outboard Oil 25W-40.
2. Use a piston ring compressor tool to compress the piston rings.
3. Use a piston ring compressor tool to install the piston/connecting rod assembly into the cylinder block.
4. Push down on the piston compressor tool to ensure the tool is firmly seated against the block.
5. Ensure the "UP" mark on the top of the piston is towards the flywheel. Push the piston down into the cylinder bore until the rings have entered the cylinder.



21019

a - Piston
b - Ring compressor tool firmly seated against the cylinder block

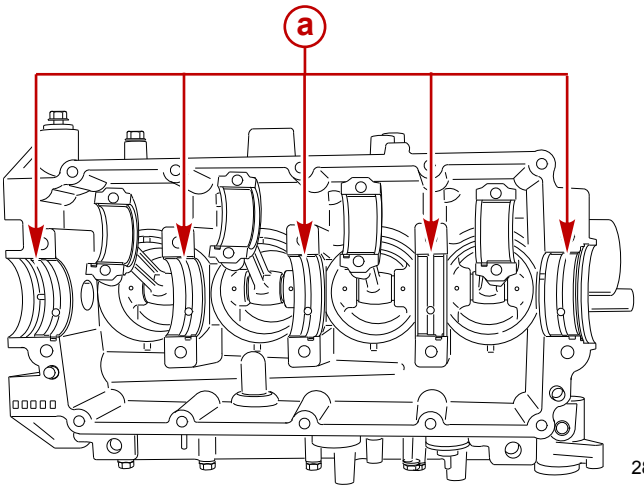
Tube Ref No.	Description	Where Used	Part No.
139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Piston, piston rings, and cylinder bore	92-8M0078629

Piston Ring Compressor	FT2997

6. Repeat the procedure for the remaining cylinders.

Crankshaft Installation

1. Lubricate the crankshaft bearing surfaces with Synthetic Blend 4-Stroke Outboard Oil 25W-40.



28806

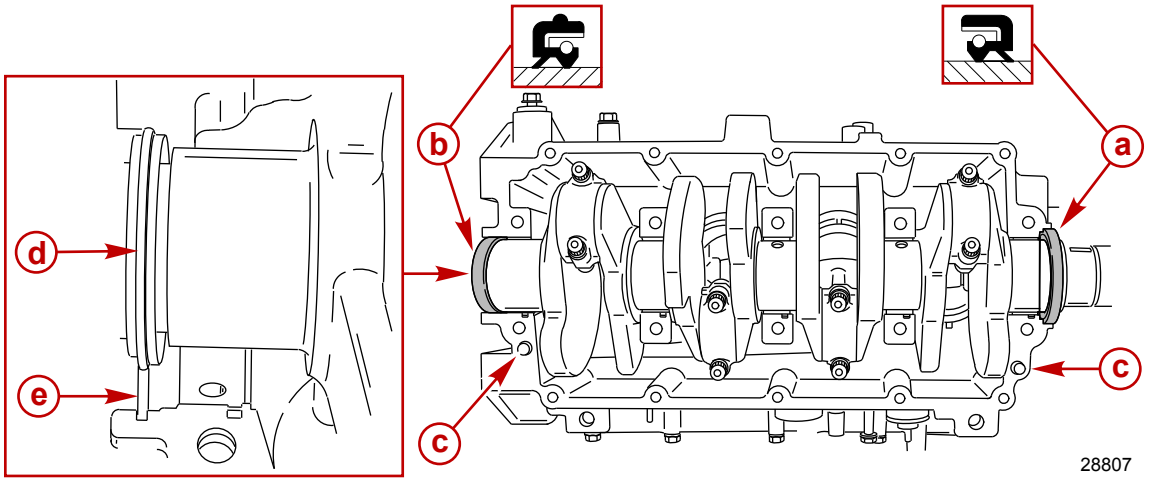
a - Crankshaft bearing surface

Tube Ref No.	Description	Where Used	Part No.
139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Crankshaft bearing surface	92-8M0078629

2. Lubricate the connecting rod journals with Synthetic Blend 4-Stroke Outboard Oil 25W-40.
3. Lubricate the oil seal lips with Synthetic Blend 4-Stroke Outboard Oil 25W-40.
4. Install the upper and lower oil seals on the crankshaft. Position the oil seal lips as shown.

5. If removed, install the dowel pins.
6. Carefully lower the crankshaft into place.

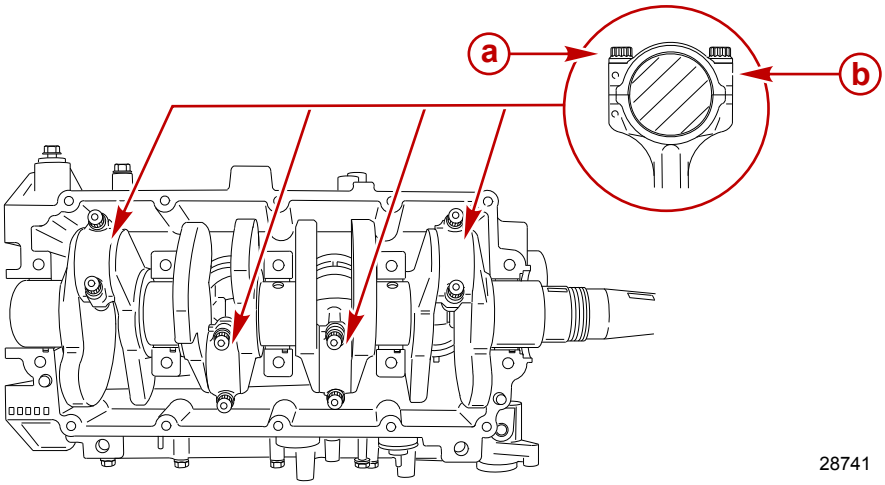
   IMPORTANT: Make sure the lower oil seal raised rib is positioned into the groove in the crankcase.



a - Upper oil seal
b - Lower oil seal
c - Dowel pin (2)
d - Lower oil seal (raised rib)
e - Oil seal groove

Tube Ref No.	Description	Where Used	Part No.
139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Connecting rod journals and oil seal lips	92-8M0078629

7. Assemble the connecting rods to the crankshaft. Install the connecting rod caps, aligning the code letter marked on the connecting rod and cap.
8. Apply oil to the connecting rod bolts. Tighten the bolts in sequence and in two steps to the specified torque.



a - Connecting rod cap bolt
b - Connecting rod cap

Description		Nm	lb-in.	lb-ft
Connecting rod cap bolt	**First**	6	53	
	Final	17	150	

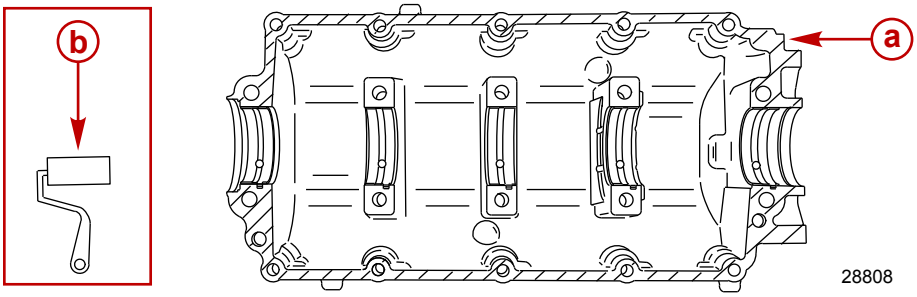
Crankcase Cover Installation

1. Clean the oil from the contacting surfaces of the crankcase cover and cylinder block.

   IMPORTANT: Make sure the contacting surface of the crankcase cover and cylinder block are clean before applying gasket sealant.

2. Apply a smooth even coat of Loctite Master Gasket Sealant to the contacting surfaces on the crankcase cover. Use a small (paint type) roller to spread out the sealant for a smooth even coverage. Instructions in the gasket sealant kit must be followed exactly.

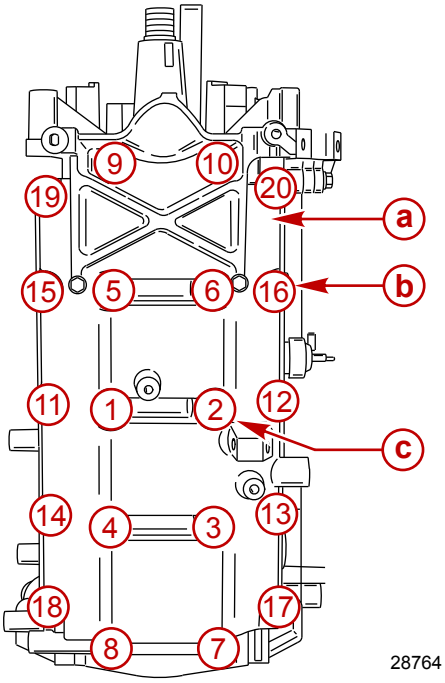
   NOTE: *Do not apply gasket sealant to the main bearings or the bolt holes.*



a - Contact surface of crankcase cover
b - Roller

Tube Ref No.	Description	Where Used	Part No.
12	Loctite Master Gasket Kit	Crankcase cover	92-12564 2

3. Install the dowel pins into the cylinder block.
4. Install the crankcase cover onto the cylinder block.
5. Apply oil to the bolt threads. Tighten bolts in sequence and in two steps to the specified torque.



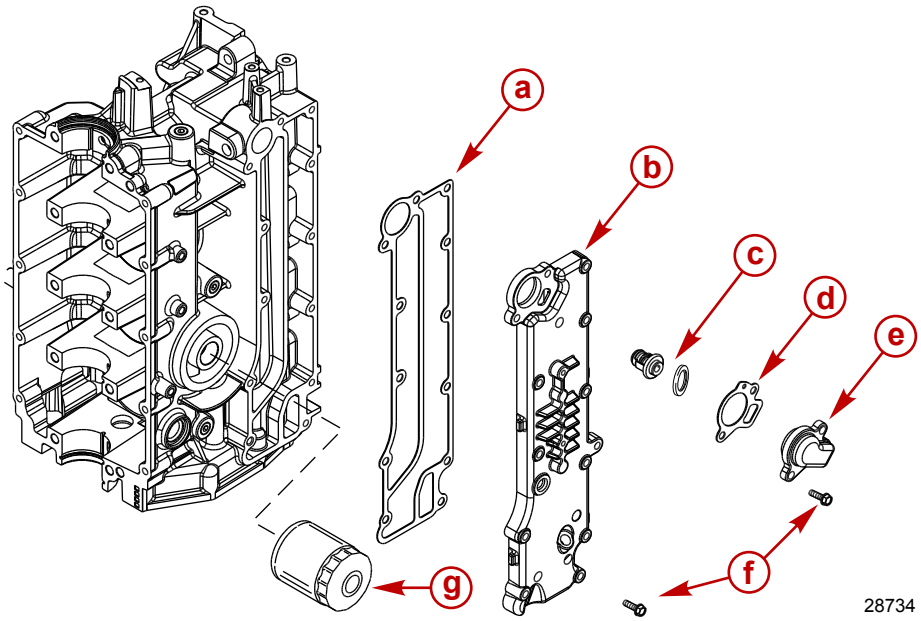
a - Crankcase cover
b - Outer bolt (M6 x 35) (10)
c - Center bolt (M8 x 82) (10)

Description		Nm	lb-in.	lb-ft
Center bolts (M8 x 82) (10)	**First**	15		11
	Final	30		22
Outer bolts (M6 x 35) (10)	**First**	6	53	
	Final	12	106	

Exhaust Cover Installation

1. Install the oil filter. Tighten to the specified torque using an oil filter wrench.

2. Install the exhaust cover along with the thermostat and thermostat cover. Use new gaskets.

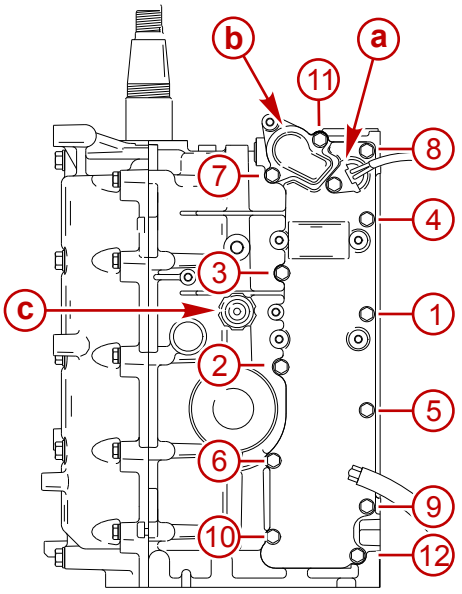


- **a -** Gasket
- **b -** Exhaust cover
- **c -** Thermostat and seal
- **d -** Gasket
- **e -** Thermostat cover
- **f -** Exhaust cover mounting bolts (M6 x 35) (12)
- **g -** Oil filter

Oil Filter Wrench	91-889277002

Description	Nm	lb-in.	lb-ft
Oil filter	8	70	

3. Tighten the bolts to the first torque value in the sequence shown below. Repeat this procedure for the second torque value.
4. Apply Loctite 567 PST Pipe Sealant to the oil pressure switch and engine coolant temperature (ECT) sensor threads.
5. Install the oil pressure switch and engine coolant temperature (ECT) sensor.



- **a -** Engine coolant temperature (ECT) sensor
- **b -** Thermostat cover
- **c -** Oil pressure switch

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Oil pressure switch and engine coolant temperature (ECT) sensor threads	92-809822

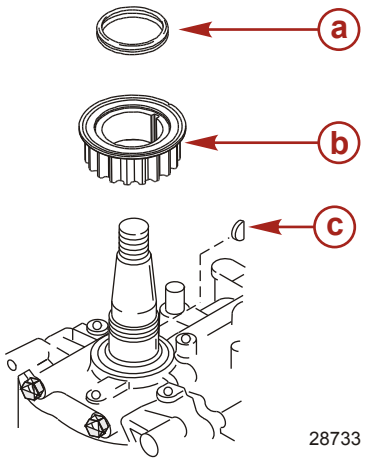
Description		Nm	lb-in.	lb-ft
Exhaust and thermostat cover bolts (M6 x 35) (12)	**First**	6	53	
	Final	12	106	

Description	Nm	lb-in.	lb-ft
Oil pressure switch	8.5	75	
Engine coolant temperature (ECT) sensor	1.7	15	

Drive Gear Installation

Install the drive gear components.

NOTE: *The load ring must be replaced if the flywheel is removed.*



a - Load ring
b - Drive gear
c - Woodruff key

Installing Powerhead Components

Cylinder Head

Install cylinder head. Refer to **Section 4A** for installation and torque values.

Engine Wiring Harness, Ignition, and Electrical Components

Install the wiring harness assembly to the powerhead in the same order removed.

Ignition Components

Refer to the appropriate section of the service manual for installation and torque values of the following ignition components:

- Timing belt (**Section 4A**)
- Ignition coils (**Section 2A**)
- ECM (**Section 3C**)
- Crankshaft position sensor (**Section 3C**)

Charging and Starting Components

Refer to **Section 2B** for installation and torque values of the following components:

- Starter motor
- Voltage regulator
- Stator
- Flywheel

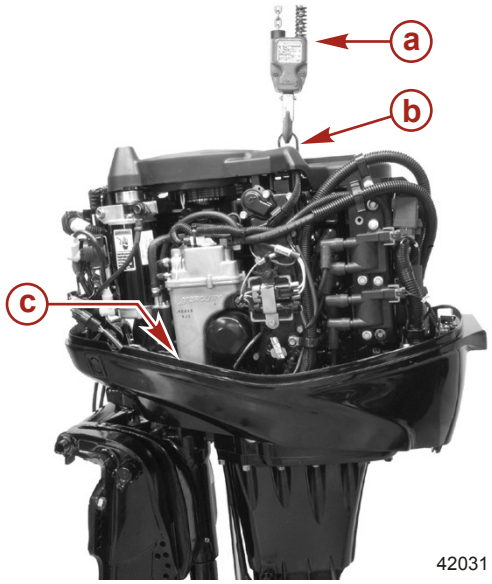
Fuel Components

Refer to **Section 3C** for the intake assembly/vapor separator installation.

Powerhead Installation

1. Install the powerhead and a new base gasket. While lowering the powerhead, install the vapor separator tank (VST) drain hose.

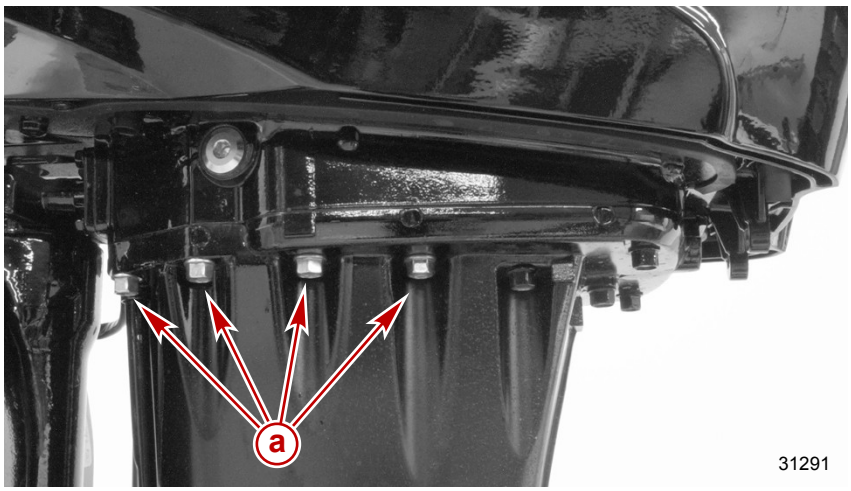
IMPORTANT: If the crankshaft splines do not line up with the driveshaft splines, shift the gearcase into forward, place a propeller on the propeller shaft and rotate it counterclockwise. This will allow the splines to line up.



a - Hoist
b - Lifting eye
c - VST drain hose

Flywheel Puller/Lifting Ring	91- 83164M

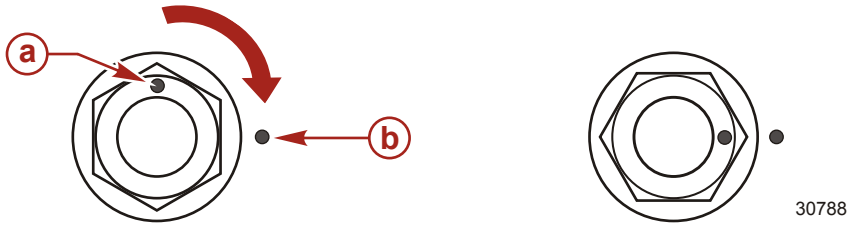
2. Install the powerhead mounting bolts.



a - Bolt (M8 x 110) (4 each side)

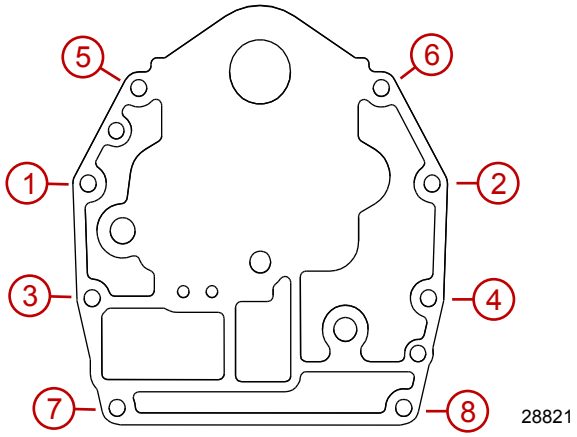
3. Tighten the mounting bolts in sequence in two steps to the specified torque.

NOTE: *To obtain 90° rotation of the powerhead mounting bolts, after the first torque has been set, put a paint mark on a corner point of the bolt head and a second paint mark 90° clockwise on the driveshaft housing, as shown. Rotate the bolt until the paint marks align.*



After the first torque
a - Mark on bolt head
b - Mark on driveshaft housing

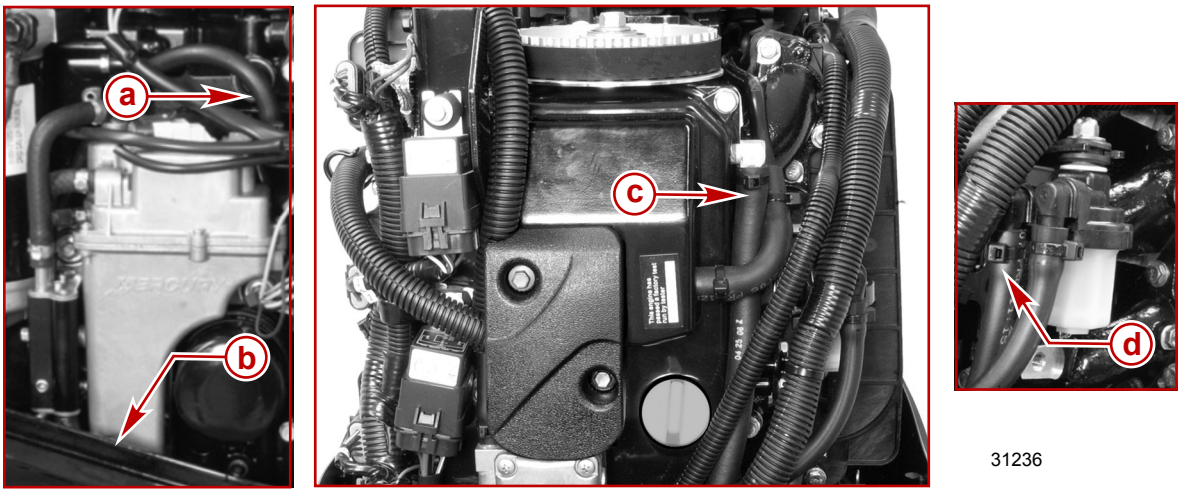
After the final torque



Powerhead mounting bolt torque sequence

Description		Nm	lb-in.	lb-ft
Powerhead mounting bolt (M8 x 110)	**First**	27		20
	Final	Plus 90° turn		

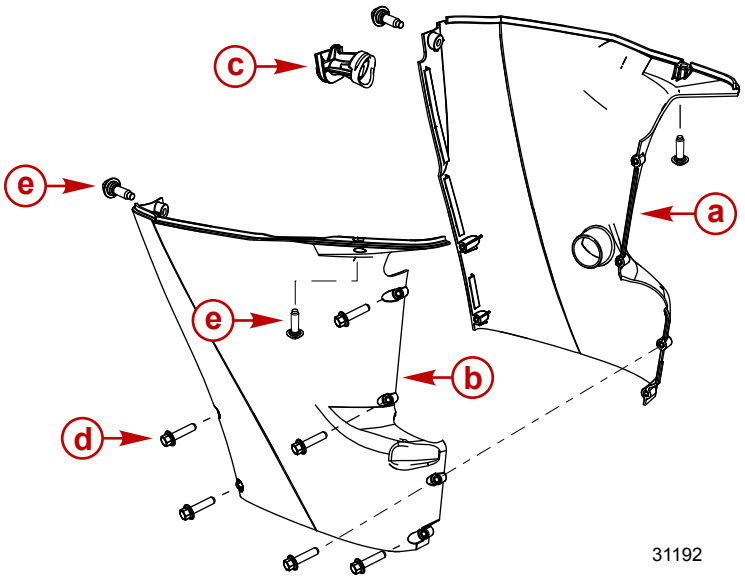
4. Reconnect the fuel hoses. Use cable ties to fasten all hose connections.



a - VST vent hose
b - VST drain hose
c - Crankcase vent hose
d - Fuel filter inlet hose

5. Reconnect the power trim harness wires.
6. Install the spark plugs. Tighten the spark plugs to the specified torque.

7. Install the bottom cowl. Tighten the bolts to the specified torque.



a - Port chap
b - Starboard chap
c - Idle relief port boot
d - Bolt (M6 x 30) (6)
e - Bolt (M6 special shoulder) (4)

Description	Nm	lb-in.	lb-ft
Spark plugs	17	150	
Bottom cowl bolts	6.8	60	

8. Connect the battery cables to the battery terminals.
9. Check the engine oil level.

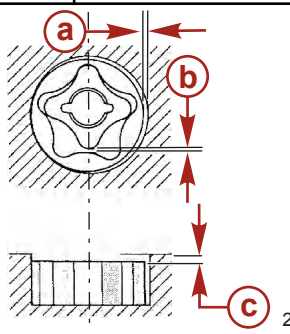
Tube Ref No.	Description	Where Used	Part No.
139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Engine oil sump	92-8M0078629

Powerhead

Section 4C - Lubrication

Table of Contents

Lubrication Specifications

Lubrication Specifications		
Pump type		Trochoid
3000 RPM with warm engine - 65 °C (149 °F)		207–276 kPa (30–40 psi) (reference only)
Oil pressure switch		20 kPa (2.9 psi)
Engine oil capacity		3 liters (3 US qts)
Oil pump dimensions	Outer rotor to housing "**a**"	0.11–0.23 mm (0.0045–0.0090 in.)
	Inner rotor to outer rotor "**b**"	0.12 mm (0.005 in.)
	Rotor to housing "**c**"	0.04–0.08 mm (0.0015–0.0031 in.)
 20467		

Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Oil pressure switch threads	92-809822
51	Loctite 222 Threadlocker	Oil pump cover screw threads	92-809818
139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Oil pump rotors, shaft, and cover seal	92-8M0078629
		O-rings and oil pump prime	

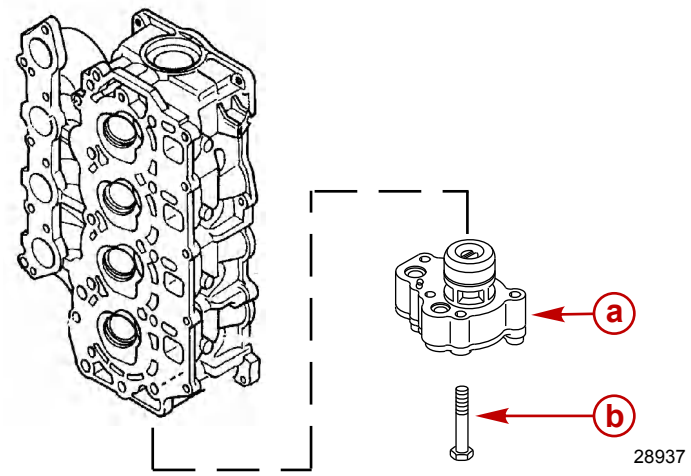
Special Tools

Torch Lamp	91- 63209
 8776	Heats surfaces to aid in the removal and installation of interference fit engine components.

Oil Pump Removal

1. Remove the powerhead. Refer to **Section 4B - Powerhead Removal**.
2. Remove the oil pump mounting bolts.

3. Remove the pump from the cylinder head by inserting a screwdriver in the pry points on the pump body.



a - Oil pump
b - Mounting bolts (M6 x 40) (4)

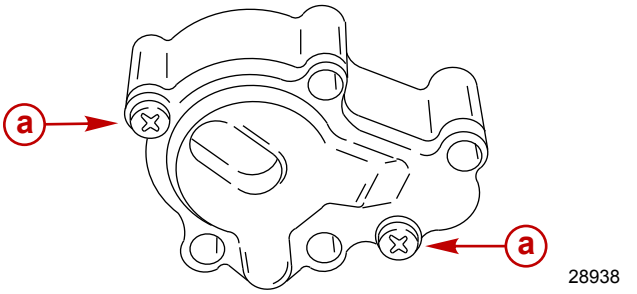
Oil Pump Disassembly

1. Remove the two screws securing the oil pump cover.

   NOTE: *Use a heat lamp to loosen the Loctite sealant on the screw threads.*

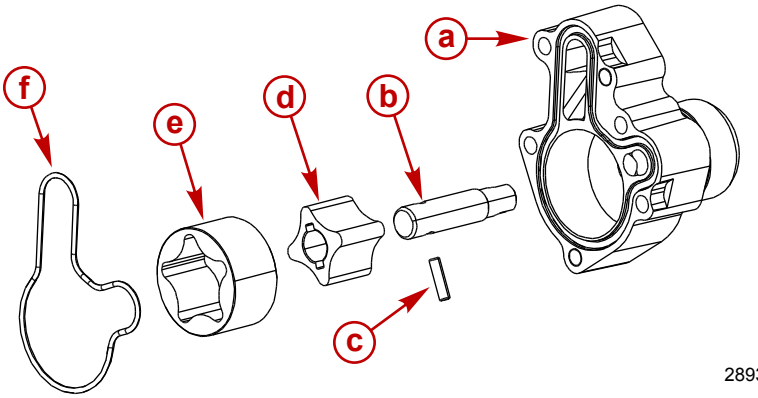
Torch Lamp	91- 63209

2. Remove the oil pump cover.



a - Cover screws

3. Disassemble the oil pump.

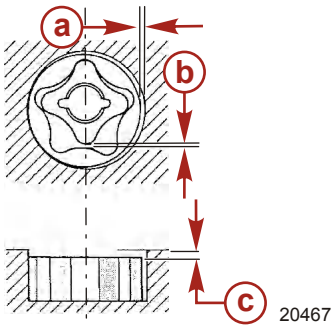


a - Oil pump housing
b - Oil pump shaft
c - Cross pin
d - Inner rotor
e - Outer rotor
f - Cover seal

Oil Pump Inspection

1. Check the oil pump components for pitting, scratches, and for the following measurements. Replace the oil pump if worn or out of specifications.
2. Using a feeler gauge, measure the following oil pump clearances:
   a. Between the outer rotor and pump housing "a."
   b. Between the inner rotor and outer rotor "b."

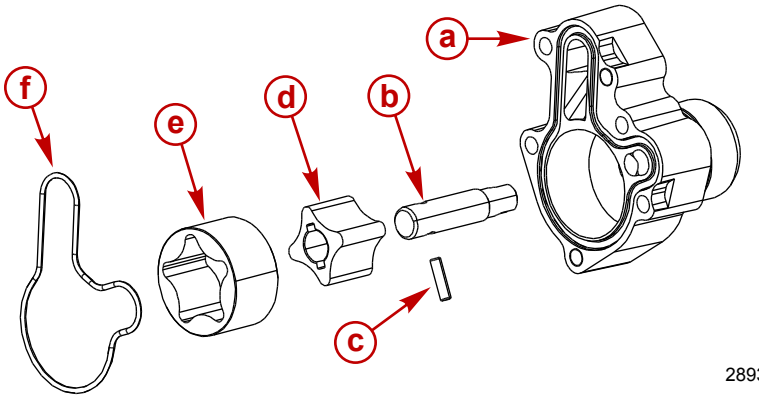
c. Between the outer rotor and pump housing "c."



Oil Pump Clearance Specifications	
Outer rotor to housing "**a**"	0.11–0.23 mm (0.0045–0.0090 in.)
Inner rotor to outer rotor "**b**"	0.12 mm (0.005 in.)
Rotor to housing "**c**"	0.04–0.08 mm (0.0015–0.0031 in.)

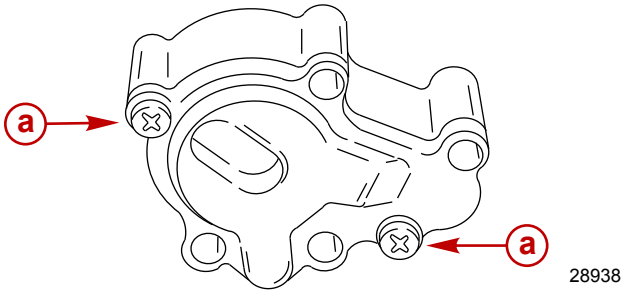
Oil Pump Assembly

1. Ensure the oil pump components are clean.
2. Thoroughly lubricate the oil pump components with Synthetic Blend 4-Stroke Outboard Oil 25W-40.
3. Install the outer rotor into the oil pump body.
4. Install the inner rotor into the oil pump body. Ensure the inner rotor drive pin keyway faces towards the cover.



a - Oil pump housing
b - Oil pump shaft
c - Drive pin
d - Inner rotor
e - Outer rotor
f - Cover seal

5. Install the oil pump shaft with the drive pin into the inner rotor. Ensure the drive pin engages with the inner rotor keyway.
6. Install the oil pump cover seal.
7. Apply Loctite 222 Threadlocker to the oil pump cover screw threads. Fasten the cover with two screws. Tighten the screws to the specified torque.



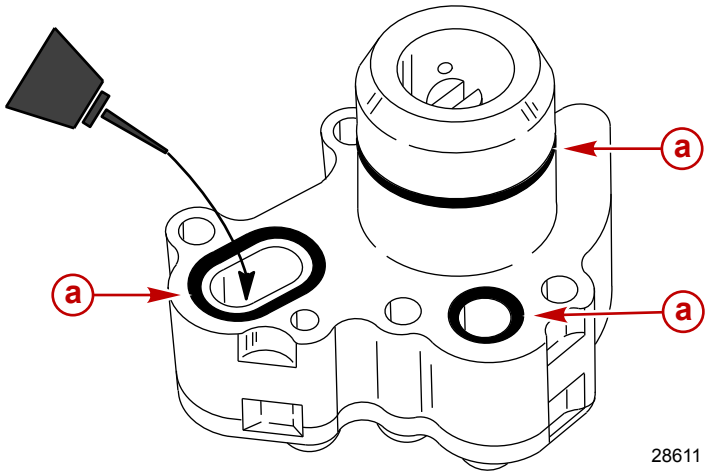
a - Cover screws

Tube Ref No.	Description	Where Used	Part No.
139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Oil pump rotors, shaft, and cover seal	92-8M0078629
51	Loctite 222 Threadlocker	Oil pump cover screw threads	92-809818

Description	Nm	lb-in.	lb-ft
Oil pump cover screws	8	70	

Oil Pump Installation

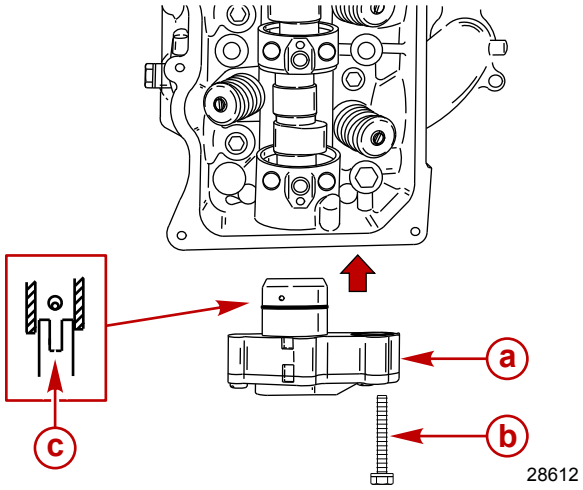
1. Install new O-ring seals. Lubricate the O-rings with Synthetic Blend 4-Stroke Outboard Oil 25W-40.
2. Prime the oil pump by pouring approximately 30 ml (1 fl oz) of Synthetic Blend 4-Stroke Outboard Oil 25W-40 into the oil pump body.



a - O-ring

Tube Ref No.	Description	Where Used	Part No.
139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	O-rings and oil pump prime	92-8M0078629

3. Align the oil pump shaft slot with the camshaft tang and install the oil pump.
4. Secure with four bolts. Tighten the bolts to the specified torque.



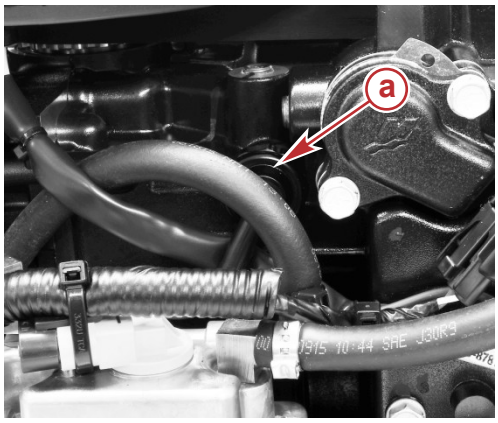
a - Oil pump
b - Bolt (M6 x 40)
c - Pump shaft slot aligned with camshaft tang

Description	Nm	lb-in.	lb-ft
Oil pump mounting bolts (M6 x 40)	8	70	

Oil Pressure Measurement

1. Warm the engine to operating temperature. Stop the engine.
2. Remove the oil pressure switch.
3. Install a pressure gauge with a range of 0–1000 kPa (0–150 psi).

NOTE: *The pressure gauge port thread size is 1/8 in. NPTF.*



a - Pressure switch

4. Start and run the engine.
5. Measure the oil pressure at 3000 RPM.
6. If out of specification:
   a. Inspect the oil pump. Refer to **Oil Pump Removal** and **Oil Pump Inspection**. Replace the oil pump if out of specification.
   b. If the oil pump is within specifications, inspect and clean the oil suction pipe and oil strainer. Refer to **Section 5A** for adapter plate removal and inspection procedures.
   c. Inspect the oil pressure relief valve. Replace if necessary.
   d. If the above components are clean and within specification, check the main engine block bearings and the connecting rod bearings. Refer to **Section 4B - Cleaning/Inspection/Repair**.
   e. Assemble components and install the powerhead. Refer to the appropriate sections in the service manual.
   f. Repeat steps one through four.

Engine Oil Pump Specification	
Oil pressure at 3000 RPM	207–276 kPa (30–40 psi)

7. Remove the pressure gauge.
8. Apply Loctite 567 PST Pipe Sealant to the oil pressure switch threads.
9. Install the oil pressure switch into the cylinder block. Tighten the switch to the specified torque.

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Oil pressure switch threads	92-809822

Description	Nm	lb-in.	lb-ft
Oil pressure switch	8.5	75	–

Mid-Section

Section 5A - Clamp/Swivel Brackets and Driveshaft Housing

Table of Contents

5A

Mid-Section Specifications

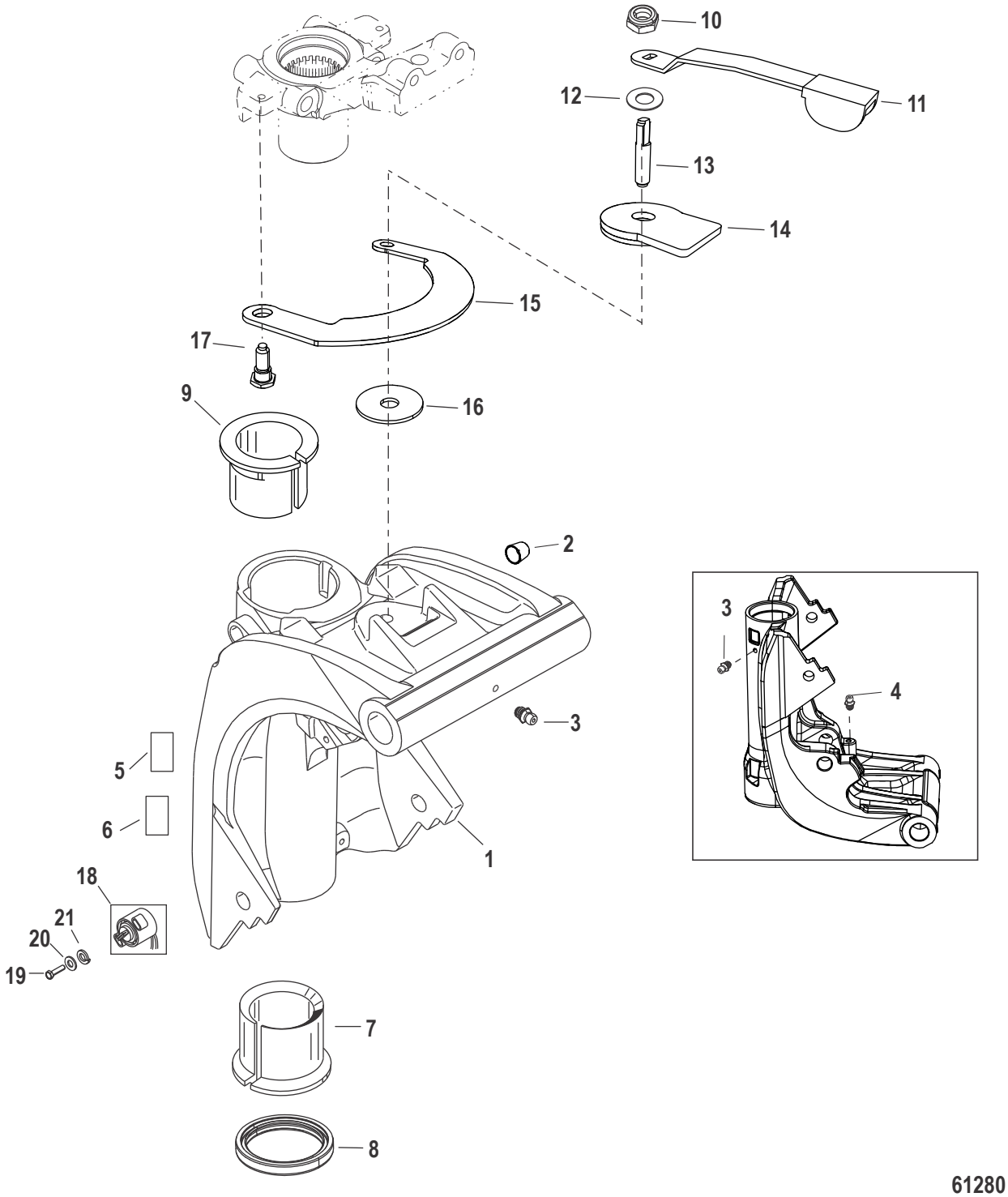
Mid-Section Specifications		
Recommended transom height		
Long shaft		508 mm (20 in.)
XL shaft		635 mm (25 in.)
Steering pivot range	Tiller	90°
	Remote	60°
Full tilt up angle		71°
Trim angle (on 12° boat transom)		Negative 4° to positive 16°
Allowable transom thickness (maximum)		70 mm (2.75 in.)

Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Shift bracket bolts (M6 x 20) (2)	92-809819
66	Loctite 242 Threadlocker	Cowl bolt threads	92-809821
		Bottom cowl pan flange bolt (M6 x 25) (6)	
95	2-4-C with PTFE	Grease fittings, tilt tube, and tilt lock lever	92-802859A 1
		Swivel bracket lower bushing and seal	
		Swivel bracket upper bushing and seal	
139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Oil pressure relief valve	92-8M0078629

Notes:

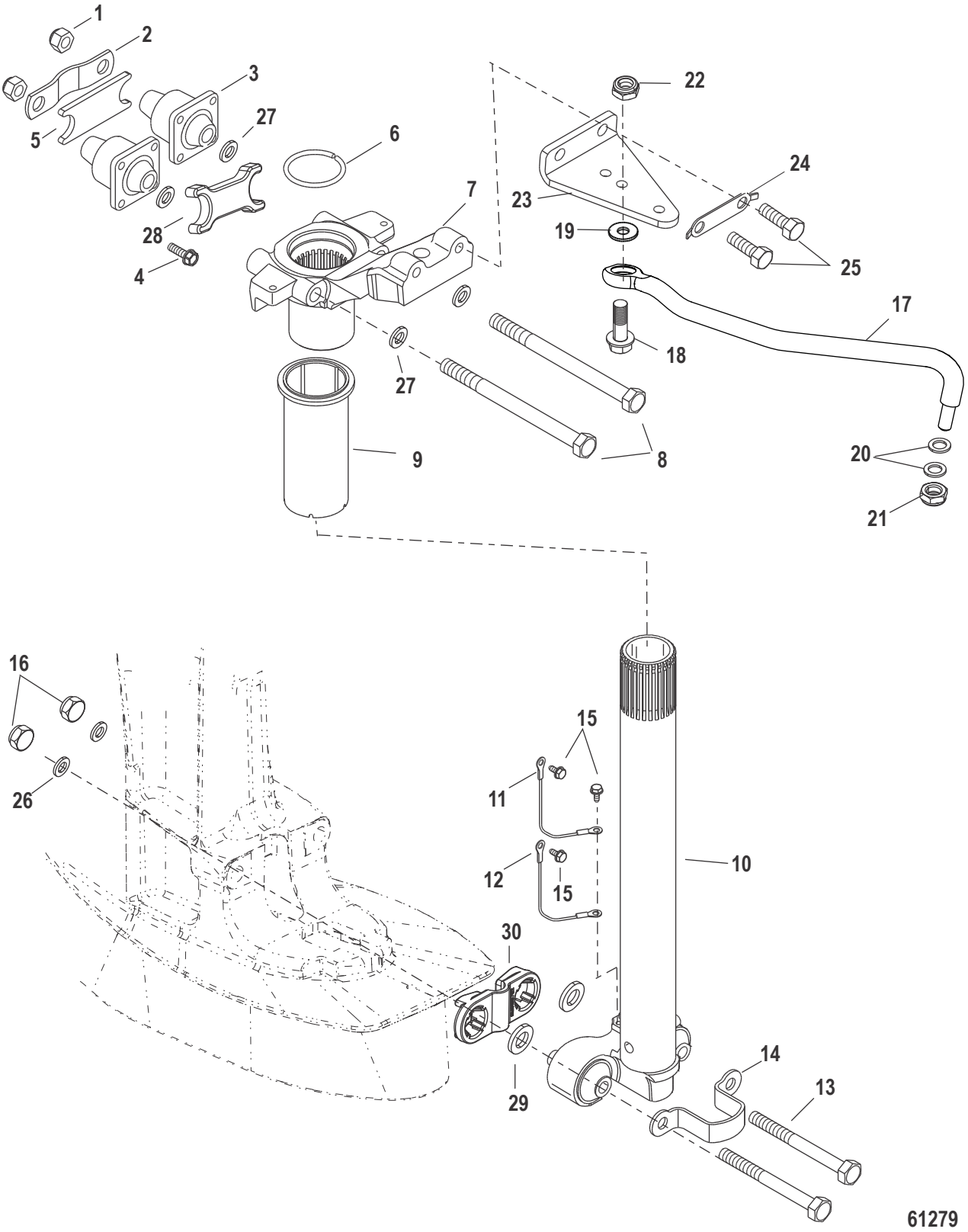
Swivel Bracket Components



Swivel Bracket Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Swivel bracket			
2	2	Trim pin bearing			
3	2	Grease fitting	Drive tight		
4	1	Grease fitting (handle)	Drive tight		
5	1	Copilot decal (handle)			
6	1	Serial number decal			
7	1	Lower bushing			
8	1	Seal			
9	1	Bushing			
10	1	Nut (3/8-24) (handle)	2.8	25	–
11	1	Copilot lever (handle)			
12	1	Washer (handle)			
13	1	Threaded rod (handle)			
14	1	Bracket plate (handle)			
15	1	Swivel head plate (handle)			
16	1	Friction disc (handle)			
17	2	Hex shoulder bolt (handle)	8	70.8	–
18	1	Power trim sender kit			
19	1	Screw (#10-24 x 3/4)			
20	2	Lockwasher			
21	1	Washer (0.203 x 0.406 x 0.040)			

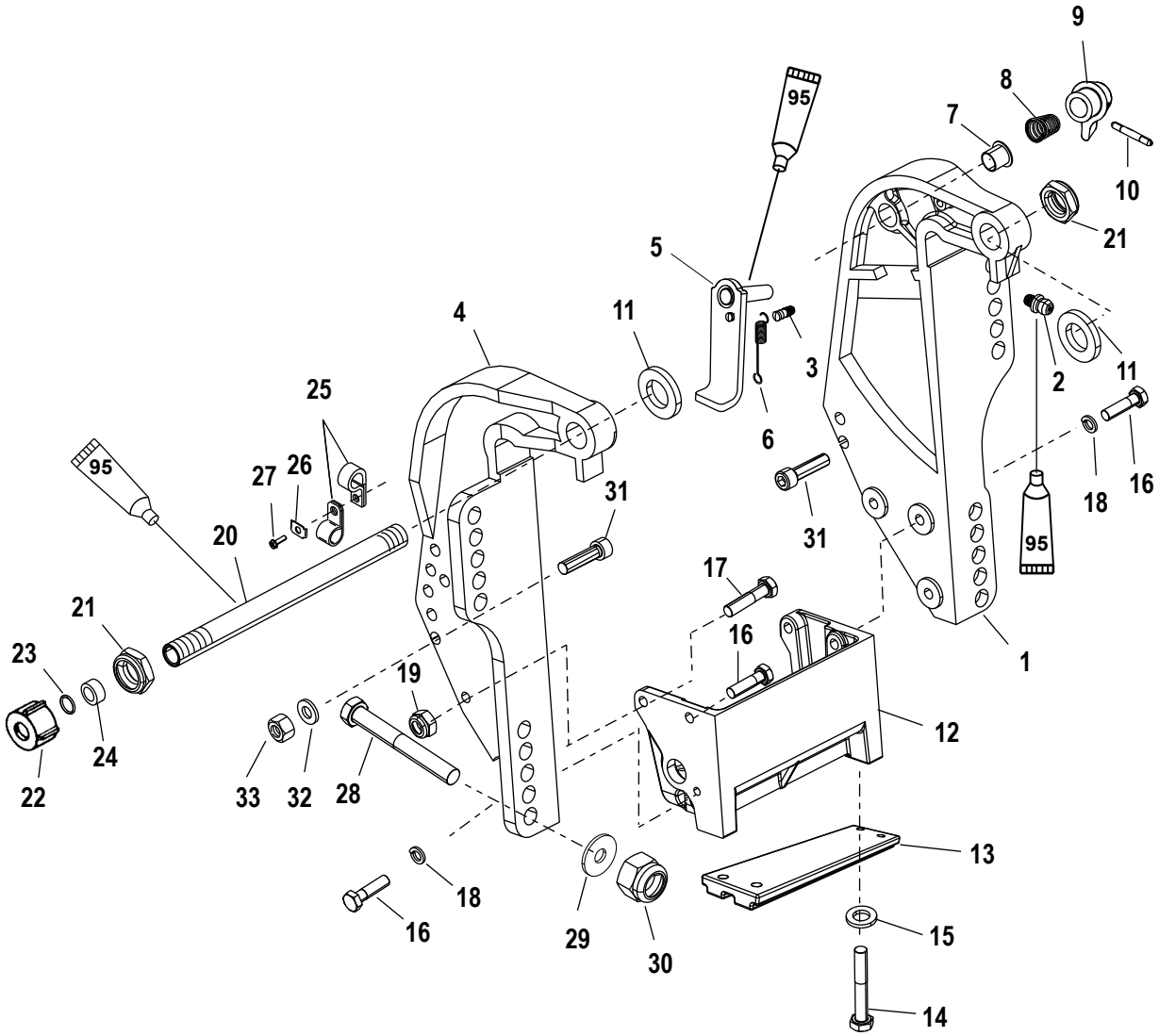
Steering Arm Components



Steering Arm Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	2	Nut (M12)	68	–	50.2
2	1	Upper mount strap			
3	2	Upper mount			
4	8	Bolt (M6 x 20)	14.7	130.1	–
5	1	Bumper			
6	1	Retaining ring			
7	1	Steering arm			
8	2	Bolt (M12 x 154)	54	–	39.8
9	1	Spacer			
10	1	Swivel tube			
11	1	Cable assembly			
12	1	Ground cable assembly			
13	2	Bolt (M10 x 120)	43	–	31.7
14	1	Lower mount strap			
15	3	Screw (#10-16 x 3/8)	Drive tight		
16	2	Nut (M10)			
17	1	Engine steering attaching kit (nonhandle)			
18	1	Screw (3/8-24 x 1.5) (nonhandle)	27	–	20
19	1	Washer (0.390 x 0.546 x 0.12) (nonhandle)			
20	2	Washer (0.390 x 0.625 x 0.062) (nonhandle)			
21	1	Nut (3/8-24) (nonhandle)	13.5	120	–
			Then back off 1/4 turn		
22	1	Nut (3/8-24) (nonhandle)	27	–	20
23	1	RideGuide steering bracket (nonhandle)			
24	1	Tab washer (nonhandle)			
25	2	Bolt (M10 x 30) (nonhandle)	43	–	31.7
26	2	Washer (0.453 x 0.812 x 0.105)			
27	4	Washer (0.500 x 0.810 x 0.90)			
28	1	Snubber SeaPro only			
29	2	Washer (22 x 11 x 3.4)			
30	1	Snubber SeaPro only			

Transom Bracket Components



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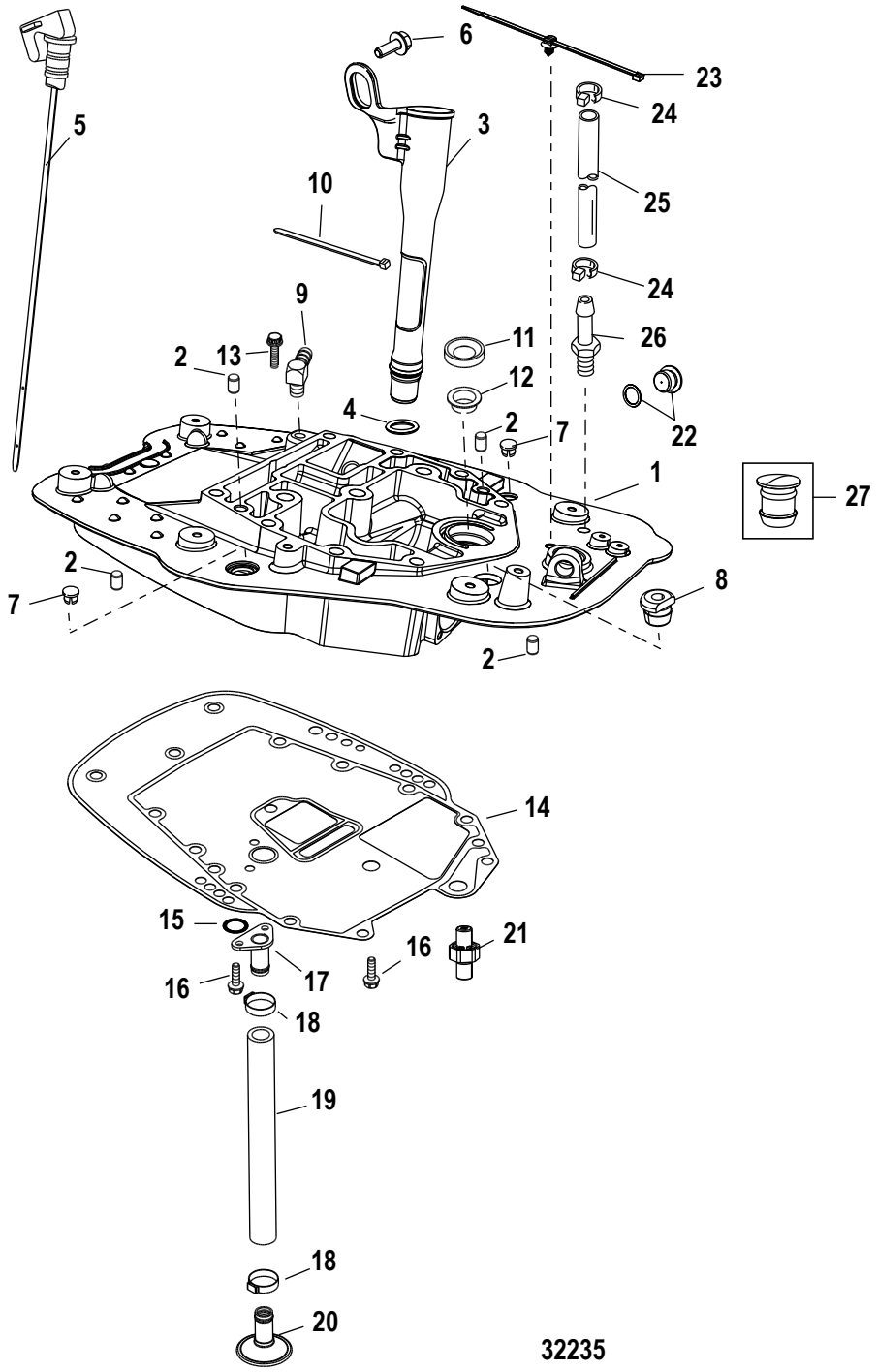
Transom Bracket Components

Ref. No.	Qty.	Description		Torque Nm	Torque lb-in.	Torque lb-ft
1	1	Port transom bracket				
2	1	Grease fitting				
3	1	Groove pin				
4	1	Starboard transom bracket				
5	1	Tilt lock lever				
6	1	Spring				
7	1	Nyliner				
8	1	Spring				
9	1	Knob				
10	1	Groove pin				
11	2	Washer				
12	1	Anchor bracket kit				
13	1	Anode kit				
14	2	Bolt (M6 x 25)		6.8	60	
15	2	Washer (0.281 x 0.500 x 0.060)				
16	5	Bolt (M8 x 30) (included in anchor bracket kit)		37		27.5
17	1	Bolt (M8 x 35) (included in anchor bracket kit)		37		27.5
18	4	Washer (0.330 x 0.560 x 0.060) (included in anchor bracket kit)				
19	2	Nut (M8)		37		27.5
20	1	Tilt tube				
21	2	Nut (0.875-14)	First	Port nut: Tighten nut to 43 Nm (32 lb-ft)		
			Final	Starboard nut: Tighten nut to 43 Nm (32 lb-ft), then back off 1/4 turn		
22	1	Seal kit (non-handle)				
23	1	O-ring (0.583 x 0.103) (non-handle)				
24	1	Spacer (non-handle)				
25	2	Clip				
26	1	C-washer				
27	1	Screw (#10-16 x 0.600)		Drive tight		
28	4	Bolt (0.500-20 x 4.00)		Drive tight		
29	4	Stainless steel washer (1.5 x 3.05 x 0.03)				
30	4	Nut (0.500-20)		75		55
31	2	Bolt (M10 x 40)		38		28
32	2	Washer				
33	2	Nut (M10)		38		28

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Grease fittings, tilt tube, and tilt lock lever	92-802859A 1

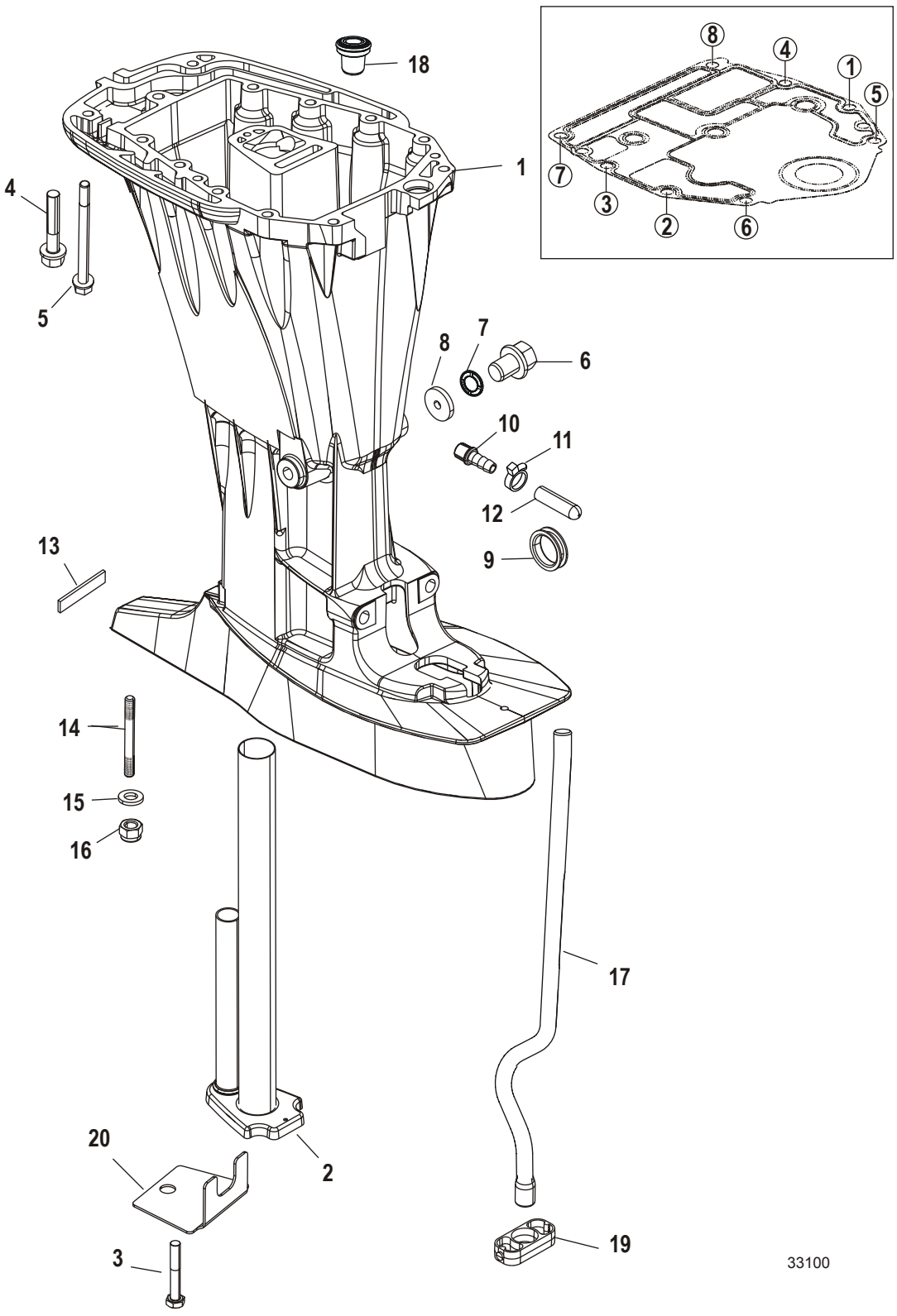
Adapter Plate Components



Adapter Plate Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Adapter plate			
2	4	Dowel pin			
3	1	Dipstick tube			
4	1	O-ring			
5	1	Dipstick			
6	1	Bolt (M6 x 16)	8.5	75	
7	2	Plug			
8	1	Grommet			
9	1	90° elbow fitting			
10	3	Cable tie			
11	1	Oil seal			
12	1	Bushing			
13	1	Bolt (M6 x 55)	17	150	
14	1	Gasket			
15	1	O-ring			
16	3	Bolt (M6 x 20)	8.5	75	
17	1	Top oil pickup plate			
18	2	Clamp			
19	1	Oil pickup hose			
20	1	Oil pickup baffle			
21	1	Oil pressure relief body	46		34
22	1	Plug (M18 x 1.5)	33		24.3
23	1	Cable tie clip			
24	AR	Cable tie			
25	1	Hose (145 cm [57 in.])			
26	1	Fitting			
27	1	Plug (jet)			

Driveshaft Housing Components

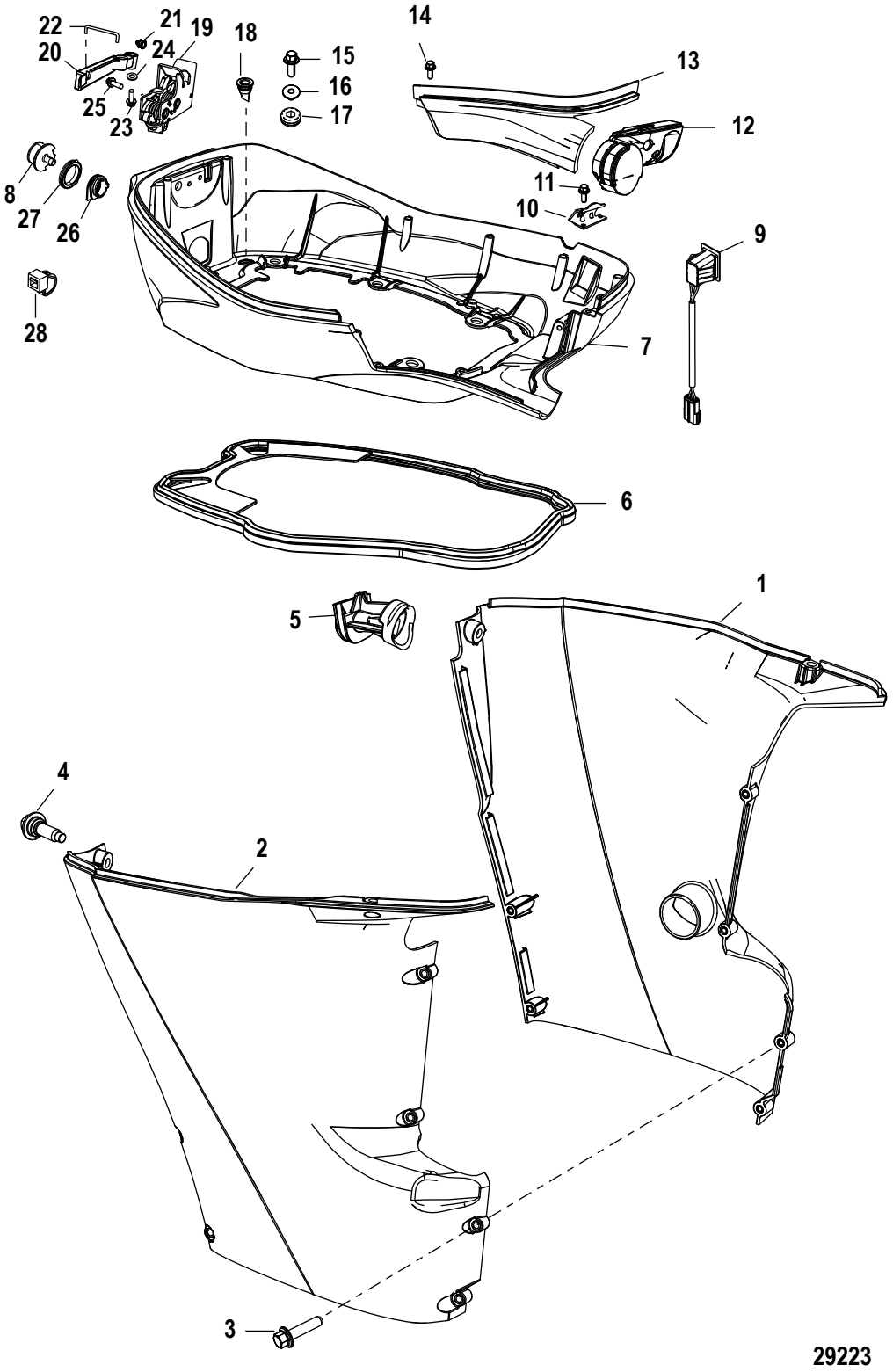


Driveshaft Housing Components

Ref. No.	Qty.	Description		Torque		
				Nm	lb-in.	lb-ft
1	1	Driveshaft housing				
2	1	Exhaust pipe				
3	1	Bolt (10 x 25)		30	–	22.1
4	5	Bolt (M8 x 45)		38	–	28
5	8	Bolt (M8 x 110)	First	27	–	20
			Final	Turn additional 90°		
6	1	Drain plug		24	–	17.7
7	1	Seal				
8	2	Bumper				
9	1	Grommet				
10	1	Fitting				
11	1	Cable tie (20 cm [8 in.])				
12	1	Cap				
13	1	Bumper				
14	1	Stud (M10 x 50) (non-Command Thrust)		16.3	144.2	–
		Stud (M10 x 100) (Command Thrust)				
15	1	Washer (0.406 x 0.750 x 0.105)				
16	1	Nut (M10)		54	–	39.8
17	1	Water tube				
18	1	Water tube seal				
19	1	Guide				
20	1	Plate				

NOTE: *40 hp and 60 hp SeaPro engines have the driveshaft housing and gearcase cover anodized. A sprayer is also added in the adapter plate exhaust cavity to add water to the exhaust system to cool the exhaust tube.*

Bottom Cowl Components

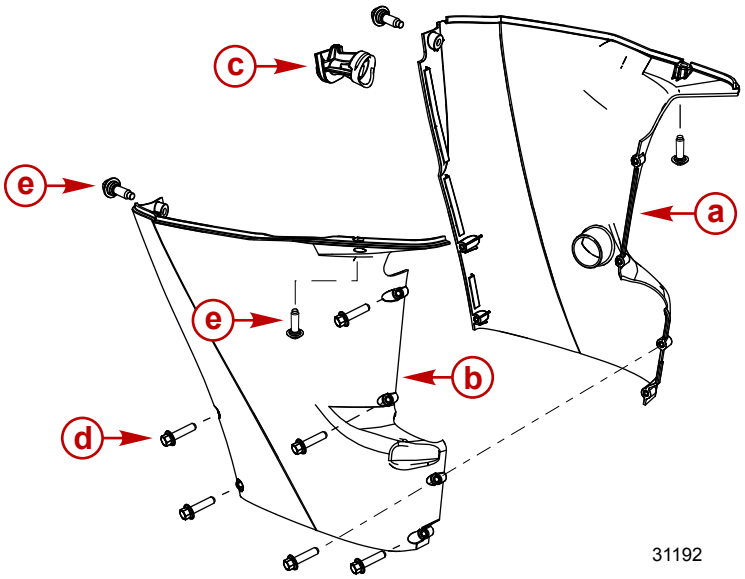


Bottom Cowl Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Port chap			
2	1	Starboard chap			
3	6	Bolt (M6 x 25)	8.5	75	
4	4	Bolt (M6 shoulder)	10	88.5	
5	1	Boot			
6	1	Seal			
7	1	Pan			
8	1	Fitting			
9	1	Trim switch			
10	1	Hook			
11	2	Bolt (M6 x 16)	6.8	60	
12	1	Grommet			
13	1	Cap			
14	1	Bolt (M6 x 16)	6.8	60	
15	6	Bolt (M6 x 25)	6.8	60	
16	6	Bushing			
17	6	Grommet			
18	2	Cowl drain			
19	1	Rear latch assembly			
20	1	Rear latch handle			
21	1	Seal			
22	1	Link			
23	1	Screw			
24	1	Washer			
25	2	Bolt (M6 x 20)	6.8	60	
26	1	Grommet			
27	1	Washer			
28	1	Cable tie			

Bottom Cowl Removal/Installation

1. Apply Loctite 242 Threadlocker to the bolt threads.
2. Tighten the bolts to the specified torque.



a - Port chap
b - Starboard chap
c - Idle relief port boot
d - Black flange bolt (M6 x 25) (6 or 4)
e - Black flange bolt (M6 special shoulder) (4)

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Cowl bolt threads	92-809821

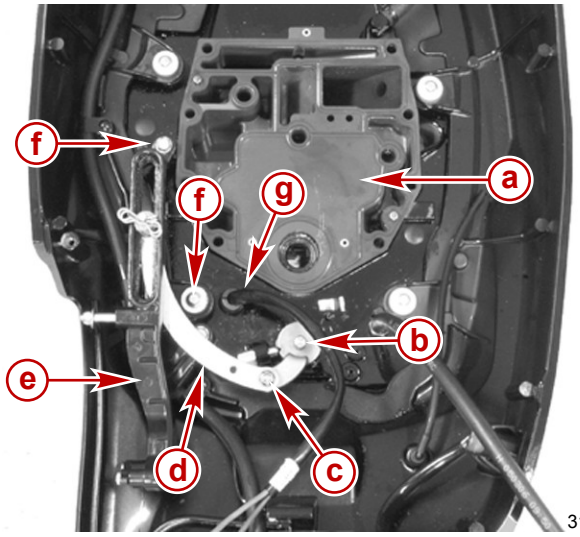
Description	Nm	lb-in.	lb-ft
Bolt (M6 x 25) (6)	8.5	75	
Bolt (M6 special shoulder) (4)	10	88.5	

Lower Mount/Steering Tube

Removal

1. Drain the engine oil.
2. Remove the powerhead. Refer to **Section 4B**.
3. Remove the powerhead gasket.
4. Pull the power trim wires down through the adapter plate.
5. Remove the locknut that secures the shift link to the shift shaft.

6. Pull the shift shaft straight up and out.

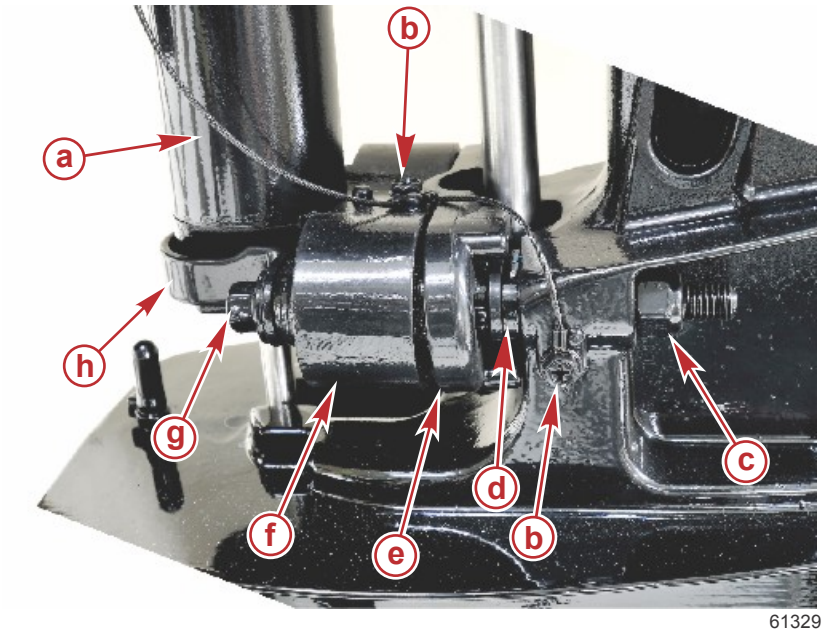


31221

Remote control model

- **a -** Powerhead gasket
- **b -** Shift shaft
- **c -** Locknut
- **d -** Shift link
- **e -** Shift bracket
- **f -** Bolt (M6 x 20) (2)
- **g -** Power trim wires

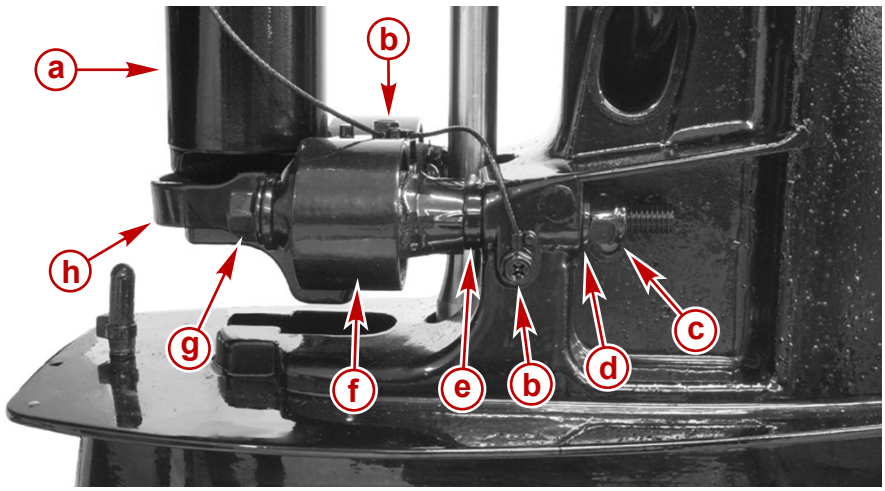
7. Support the driveshaft housing/adapter plate while removing the lower and upper mount bolts.
8. Remove the nuts and washers from the lower mount bolts.
9. Remove the ground cable.
10. Remove the lower mount bolts and strap.



61329

SeaPro

- **a -** Swivel tube
- **b -** Ground cable
- **c -** Nut (M10) (2)
- **d -** Spacer (2)
- **e -** Snubber
- **f -** Lower mount (2)
- **g -** Bolt (M10 x 120) (2)
- **h -** Strap

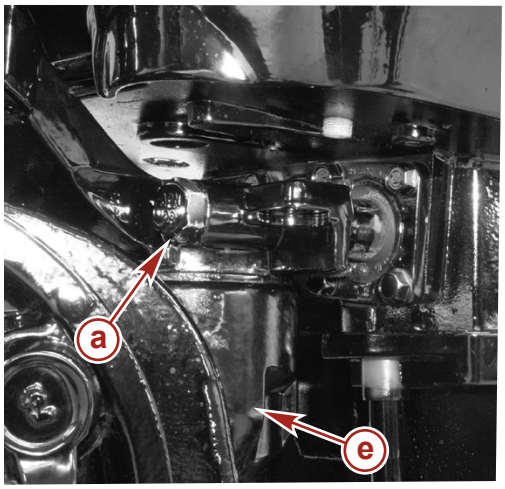


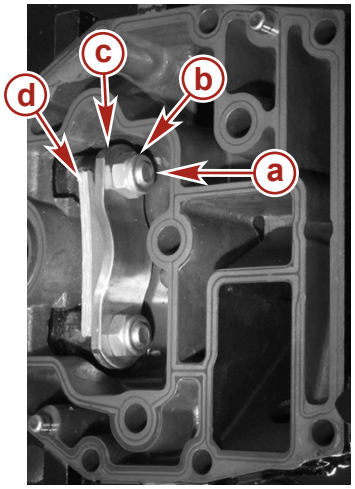
31266

Non-SeaPro

- **a -** Swivel tube
- **b -** Ground cable
- **c -** Nut (M10) (2)
- **d -** Washer (2)
- **e -** Washer (2)
- **f -** Lower mount (2)
- **g -** Bolt (M10 x 120) (2)
- **h -** Strap

11. Remove the nuts and washers from the upper mount bolts.

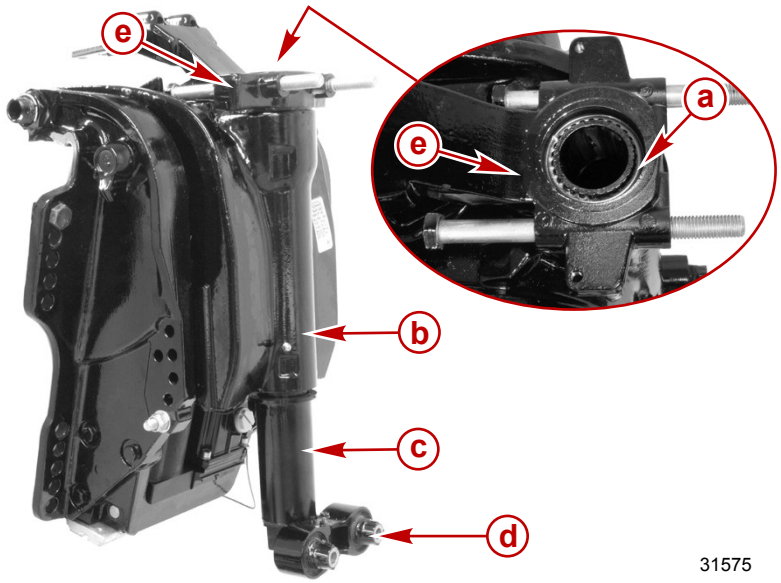




31604

- **a -** Bolt
- **b -** Nut
- **c -** Upper mount strap
- **d -** Bumper
- **e -** Swivel bracket

12. Remove the driveshaft housing/adapter plate from the swivel/clamp bracket assembly.
13. Push the steering tube up from the bottom and remove the retaining ring.



31575

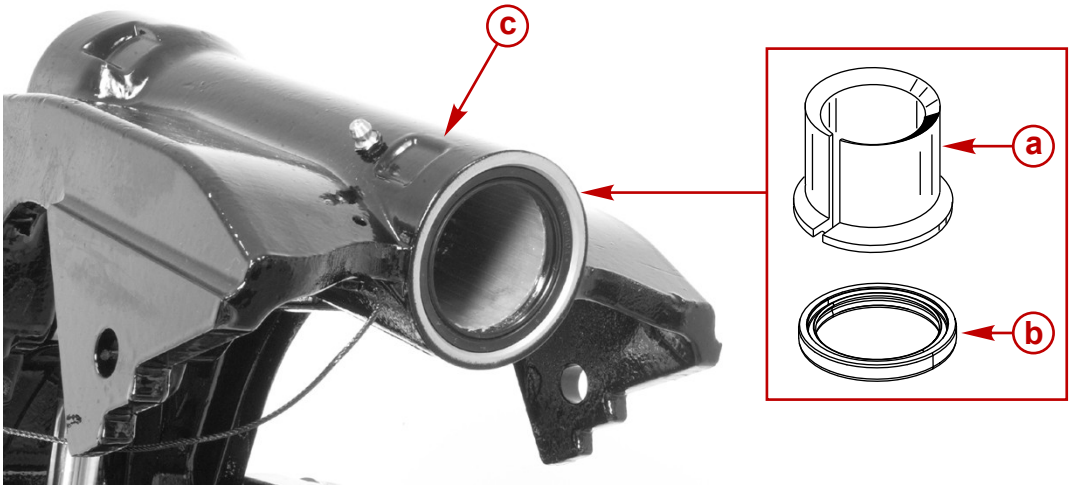
- **a -** Retaining ring
- **b -** Swivel bracket
- **c -** Spacer
- **d -** Steering tube
- **e -** Steering arm

14. Remove the steering tube from the swivel bracket.
15. Remove the lower seal and bushing.
16. Remove the upper bushing.

17. Remove the puck on remote steering models.

Installation

1. Remove the old grease from the swivel bracket.
2. Install the lower bushing and seal. Lubricate the bushing and seal with 2-4-C with PTFE.

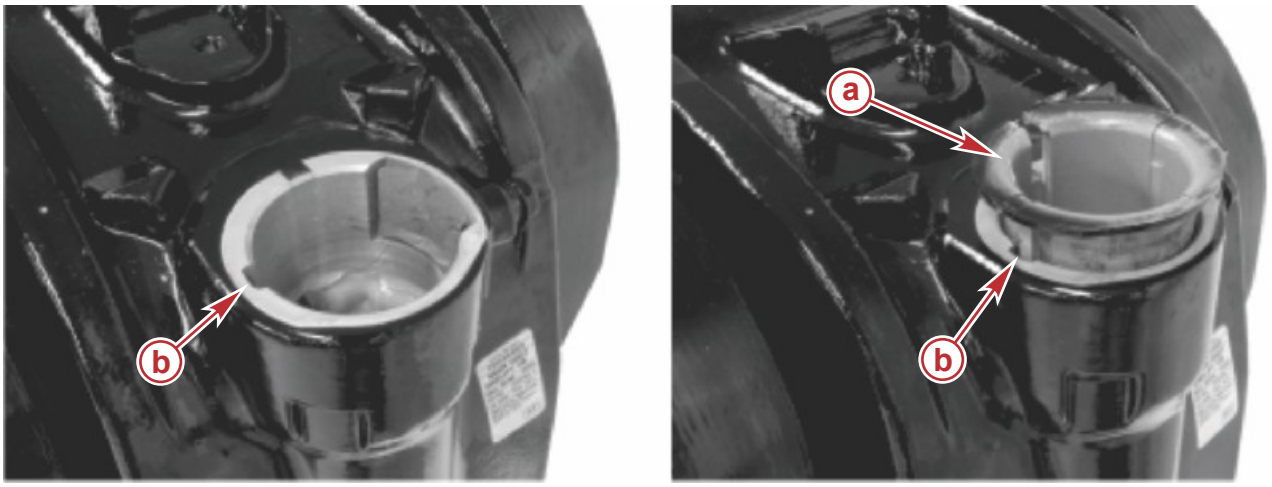


31578

a - Lower bushing
b - Seal
c - Swivel bracket

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Swivel bracket lower bushing and seal	92-802859A 1

3. Align the tab on the upper bushing with the notch in the swivel bracket and install the upper bushing. Lubricate the bushing and seal with 2-4-C with PTFE.



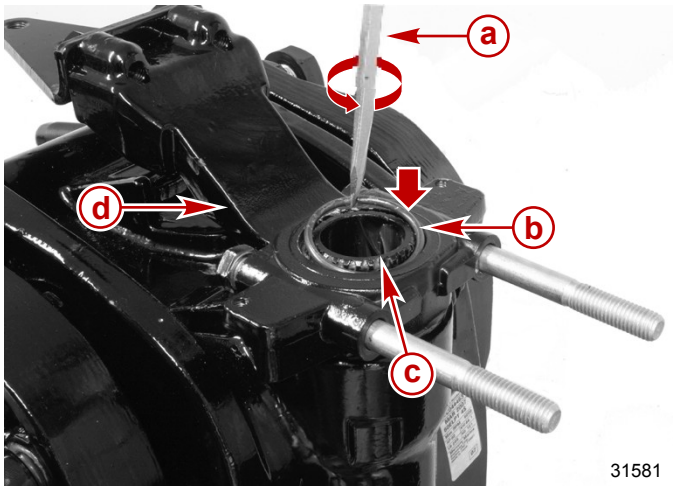
61436

a - Upper bushing
b - Notch

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Swivel bracket upper bushing and seal	92-802859A 1

4. Install the spacer onto the steering tube.
5. Insert the steering tube into the swivel bracket.

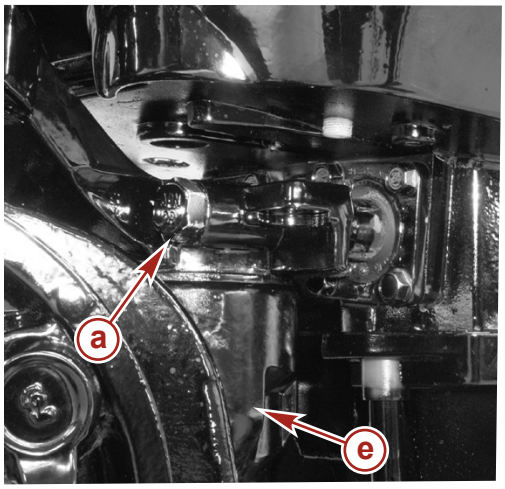
6. Align the splines on the steering tube and steering bracket. Install the steering arm onto the steering tube.
7. Push the steering tube up from the bottom while installing the retaining ring. Use a screwdriver to spread the retaining ring and push the retaining ring down onto the steering tube.

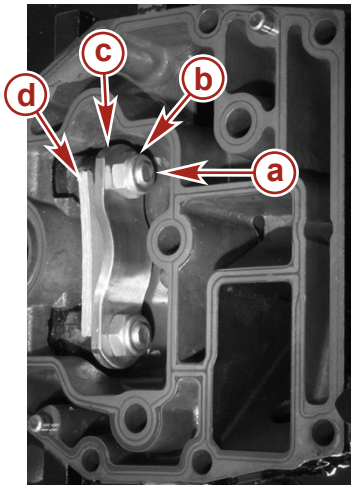


31581

a - Screwdriver
b - Retaining ring
c - Steering tube
d - Steering bracket

8. Install the driveshaft housing/adapter plate onto the swivel/clamp bracket assembly.
9. Install the bolts through the upper mounts. Install the bumper, upper mount strap, and nuts. Tighten the nuts to the specified torque.





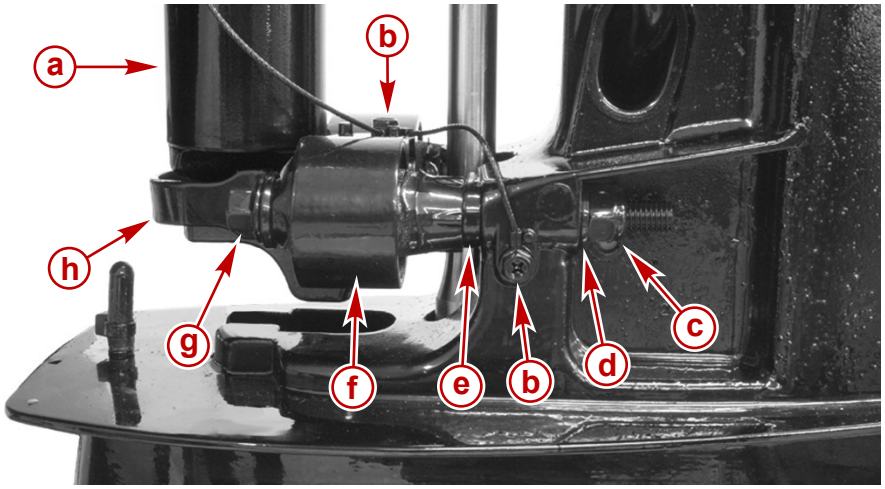
31604

a - Bolt
b - Nut
c - Upper mount strap
d - Bumper
e - Swivel bracket

Description	Nm	lb-in.	lb-ft
Upper mount bolt/nut	68	–	50.2

10. Install the lower mount bolts through the strap and lower mounts. Install the washers and nuts to the bolts. Tighten the nuts to the specified torque.

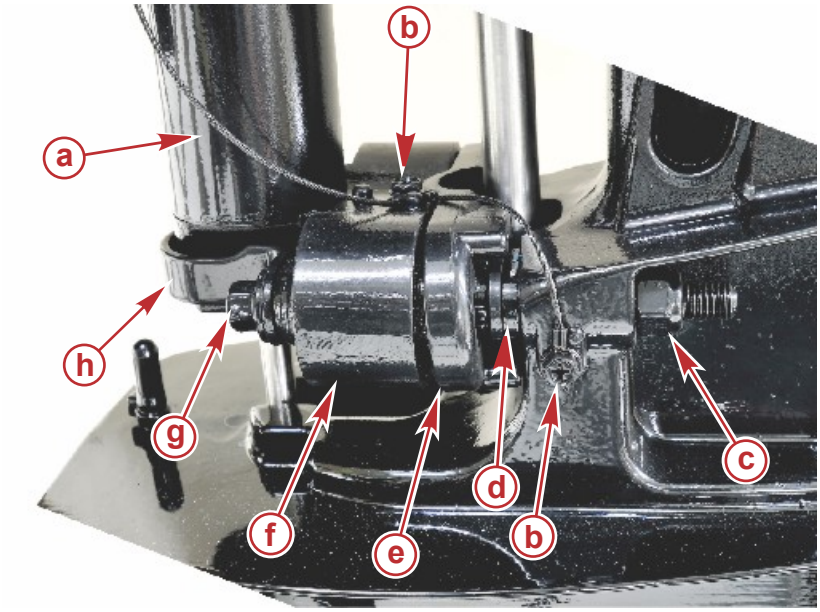
11. Install the ground cable.



31266

Non-SeaPro

- **a -** Swivel tube
- **b -** Ground cable
- **c -** Nut (M10) (2)
- **d -** Washer (2)
- **e -** Spacer (2)
- **f -** Lower mount (2)
- **g -** Bolt (M10 x 120) (2)
- **h -** Strap



61329

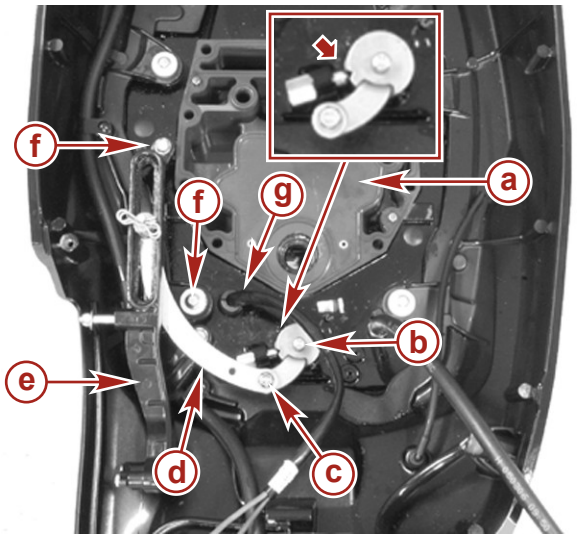
SeaPro

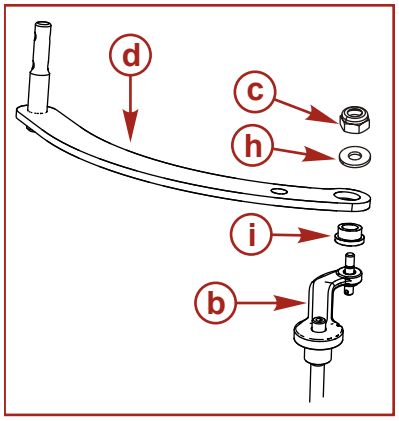
- **a -** Swivel tube
- **b -** Ground cable
- **c -** Nut (M10) (2)
- **d -** Washer (2)
- **e -** Snubber
- **f -** Lower mount (2)
- **g -** Bolt (M10 x 120) (2)
- **h -** Strap

Description	Nm	lb-in.	lb-ft
Lower mount bolt/nut	43	–	31.7

12. Install the powerhead gasket.
13. Pull the power trim wires up through the adapter plate.
14. Install the shift shaft.

15. Install the bushing into the shift link. Install the shift link onto the shift shaft. Secure with a washer and locknut. Tighten the locknut to the specified torque.





32959

Remote control model

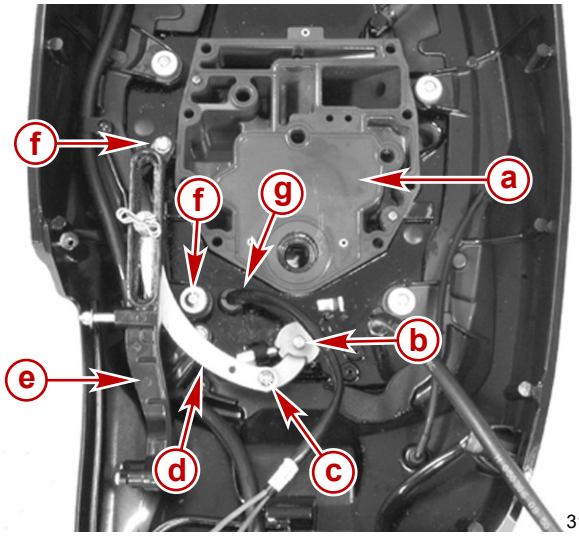
- **a -** Powerhead gasket
- **b -** Shift shaft
- **c -** Thin locknut (M6)
- **d -** Shift link
- **e -** Shift bracket
- **f -** Bolt (M6 x 20) (2)
- **g -** Power trim wires
- **h -** Washer
- **i -** Bushing

Description	Nm	lb-in.	lb-ft
Shift shaft thin locknut	6	53.1	–

16. Install the powerhead. Refer to **Section 4B**.

Adapter Plate and Driveshaft Housing Removal

1. Drain the engine oil.
2. Remove the powerhead. Refer to **Section 4B**.
3. Remove the lower unit. Refer to **Section 6**.
4. Remove the powerhead gasket.
5. Remove the locknut that secures the shift link to the shift shaft.
6. Remove the two shift bracket mounting bolts.
7. Remove the shift bracket assembly.

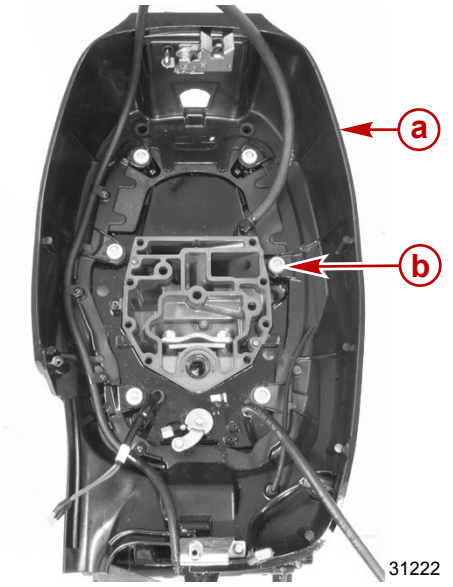


31221

Remote control model

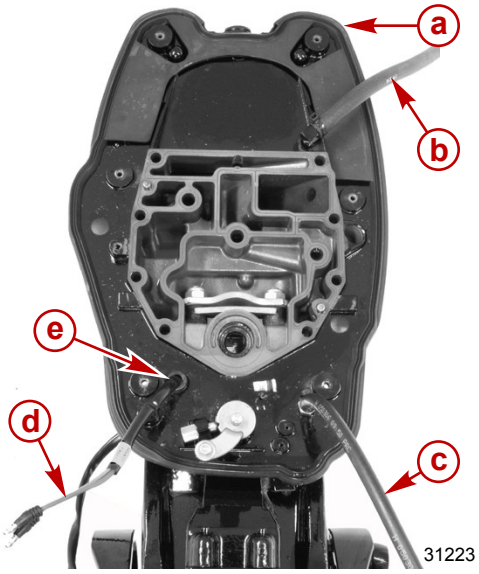
- **a -** Powerhead gasket
- **b -** Shift shaft
- **c -** Locknut
- **d -** Shift link
- **e -** Shift bracket
- **f -** Bolt (M6 x 20) (2)
- **g -** Power trim wires

8. Remove the six bolts securing the pan to the adapter plate. Remove the pan.



a - Bottom cowl pan
b - Flange bolt (M6 x 25) (6)

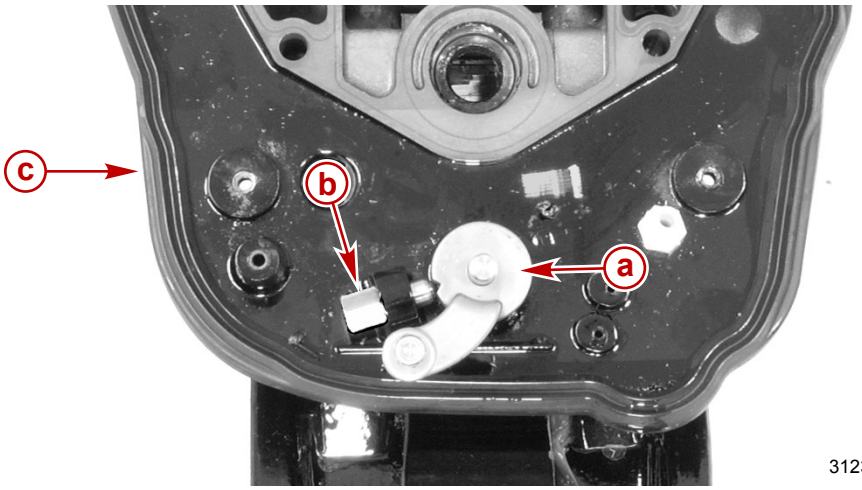
9. Remove the vent hoses.
10. Remove the grommet and the power trim wires.



a - Adapter plate
b - Vent hose
c - Vent hose
d - Power trim wires
e - Grommet

11. Remove the shift detent.
12. Pull the shift shaft straight up and out.

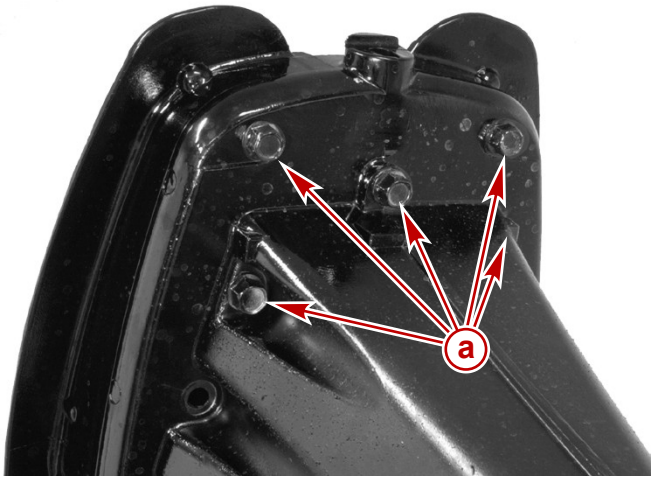
13. Remove the adapter plate gasket.



31231

a - Shift shaft
b - Shift detent
c - Adapter plate gasket

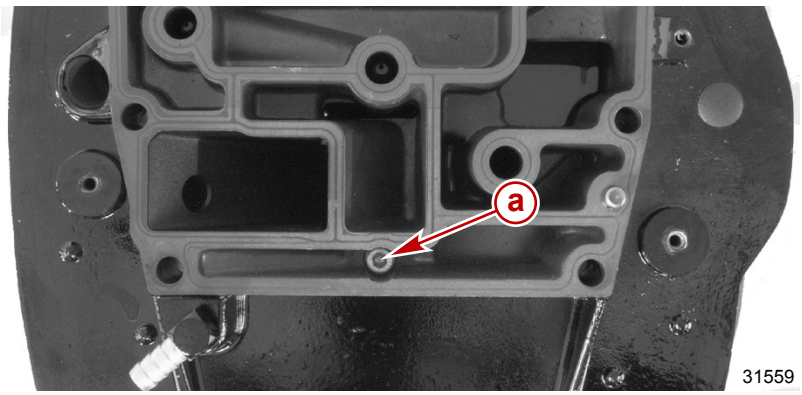
14. Remove the five adapter plate bolts from the aft/underside of the driveshaft housing.



31558

a - Bolt (M8 x 45) (5)

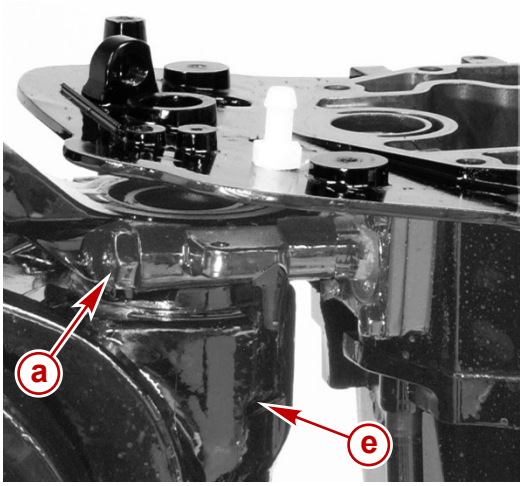
15. Remove the socket head bolt on top of the adapter plate.

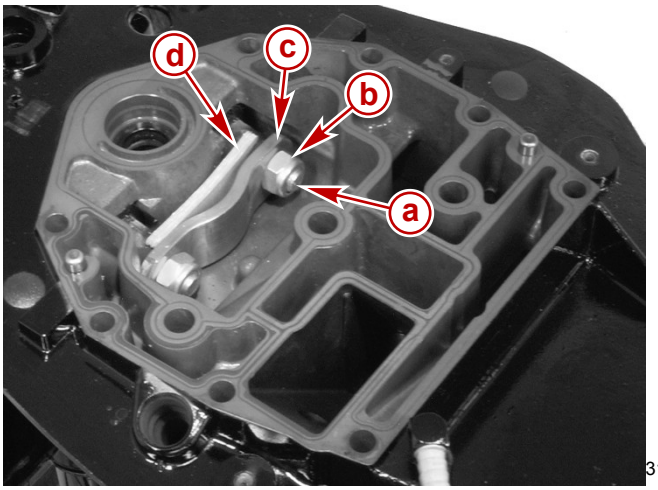


31559

a - Socket head bolt (M6 x 55)

16. Remove the nuts and washers from the upper mount bolts.

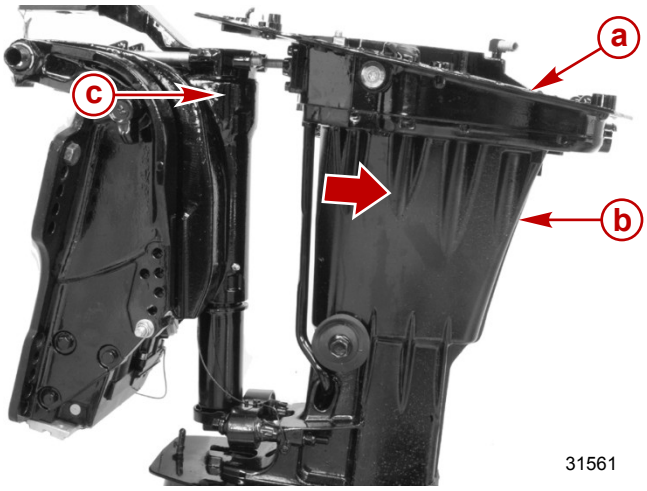




31556

a - Bolt
b - Nut
c - Upper mount strap
d - Bumper
e - Swivel bracket

17. Separate the driveshaft housing from the swivel bracket by pulling backward.
18. Remove the adapter plate.



31561

a - Adapter plate
b - Driveshaft housing
c - Swivel bracket

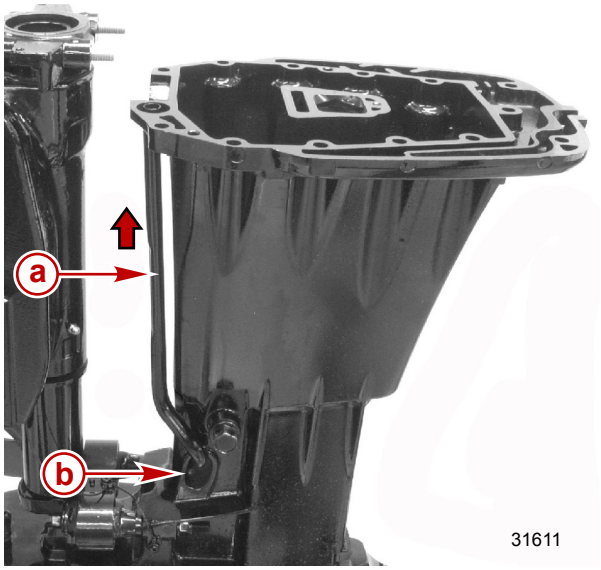
19. Remove the bolts securing the driveshaft housing and lower mount and remove the driveshaft housing from the swivel tube. Refer to **Lower Mount/Steering Tube**.
20. Inspect the powerhead gasket and adapter plate gasket before reassembly. Replace if necessary.

Water Tube

Removal

NOTE: *The driveshaft housing does not have to be removed from the swivel tube to remove the water tube.*

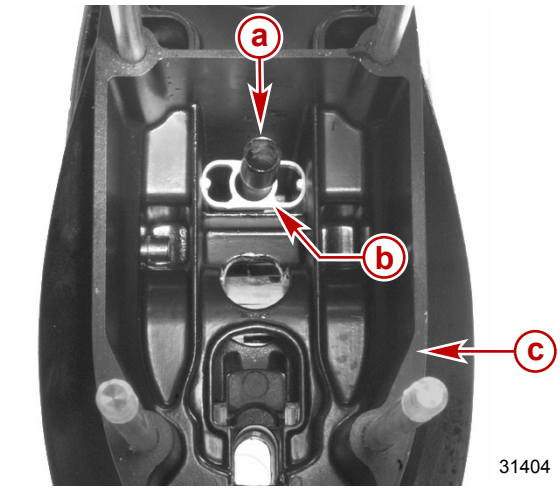
Remove the water tube from the driveshaft housing.



a - Water tube
b - Opening in driveshaft housing

Installation

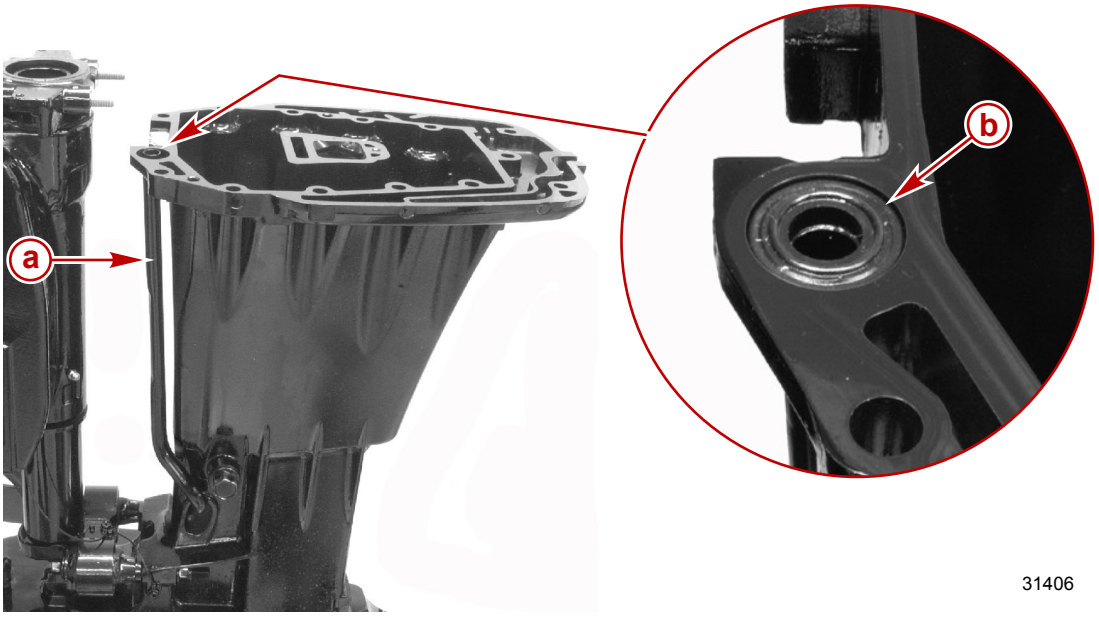
1. Install the water tube through the opening in the driveshaft housing and into the guide.



a - Water tube
b - Guide
c - Driveshaft housing

2. Install the water tube into the hole in the top of the driveshaft housing.

3. Push the upper seal onto the water tube until it is seated. Press the seal into the driveshaft housing.

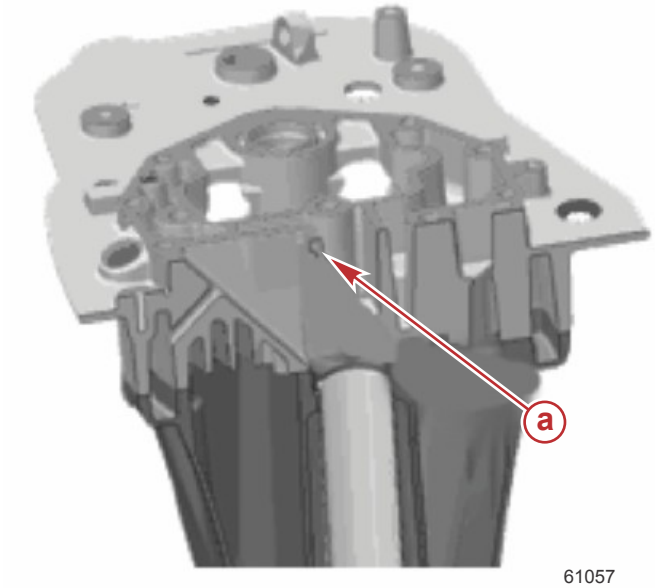


31406

a - Water tube
b - Upper seal

Exhaust Tube Removal/Installation

NOTE: *40 hp and 60 hp SeaPro engines have the driveshaft housing and gearcase cover anodized. A sprayer is also added in the adapter plate exhaust cavity to add water to the exhaust system to cool the exhaust tube.*



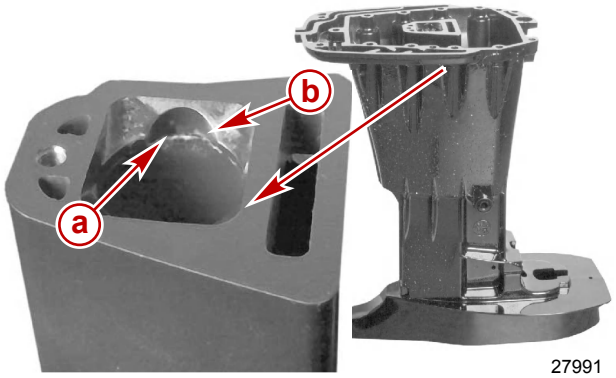
61057

a - Sprayer

Exhaust Tube Removal

1. Place the driveshaft housing on a smooth hard surface.

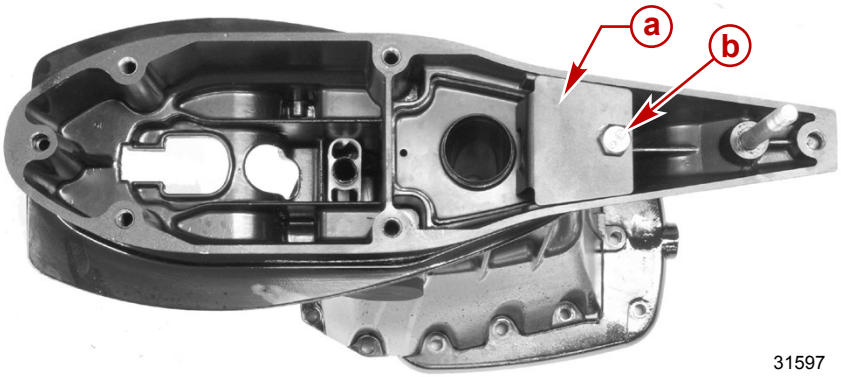
2. Carefully chisel the lip of the exhaust tube to remove the tube from the driveshaft housing exhaust tube flange.



27991

a - Exhaust tube lip
b - Driveshaft housing exhaust tube flange

3. Remove the bolt and plate from the bottom side of the driveshaft housing. Pull the exhaust tube out of the driveshaft housing.

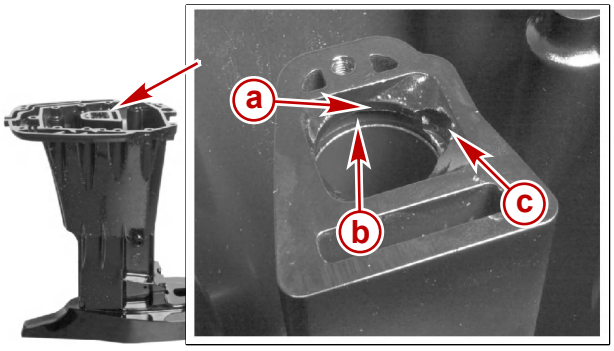


31597

a - Plate
b - Bolt (M10 x 25)

Exhaust Tube Installation

1. Insert the new tube into the driveshaft housing.
2. Push on the exhaust tube while aligning the tube to the opening of the driveshaft housing.

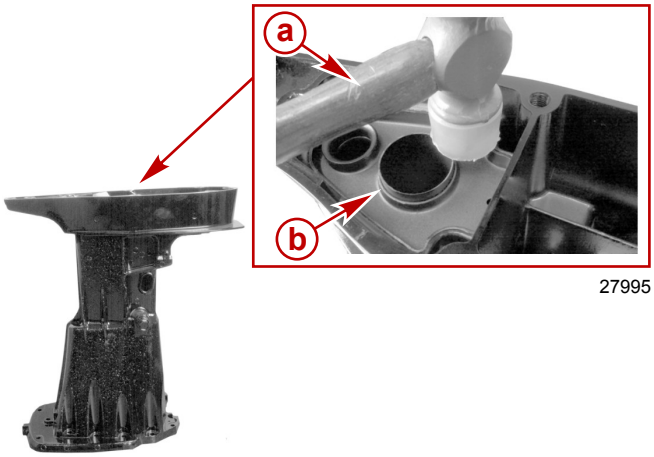


27994

a - Driveshaft housing exhaust tube seat
b - Exhaust tube
c - Driveshaft housing exhaust tube flange

3. Once the tube is partially inserted into the driveshaft housing exhaust tube opening, place the driveshaft housing on a smooth hard surface with the exhaust tube retainer facing up.

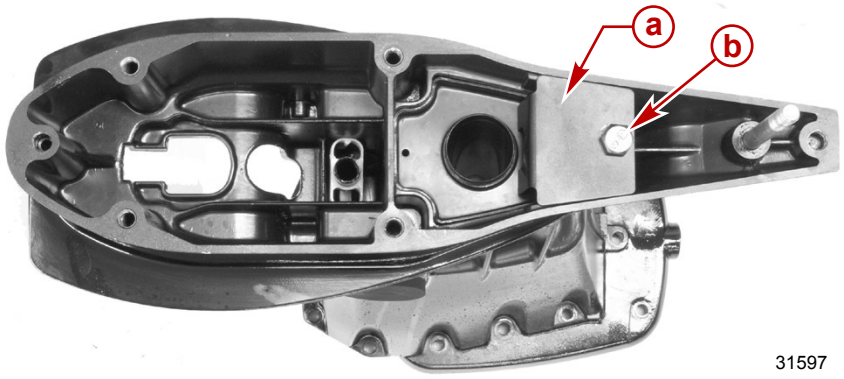
4. Use a soft face hammer to carefully seat the exhaust tube into the driveshaft housing exhaust tube opening.



27995

a - Soft face hammer
b - Exhaust tube retainer

5. Ensure the exhaust tube is seated in the driveshaft housing exhaust tube opening.
6. Install the plate. Tighten the bolt to the specified torque.

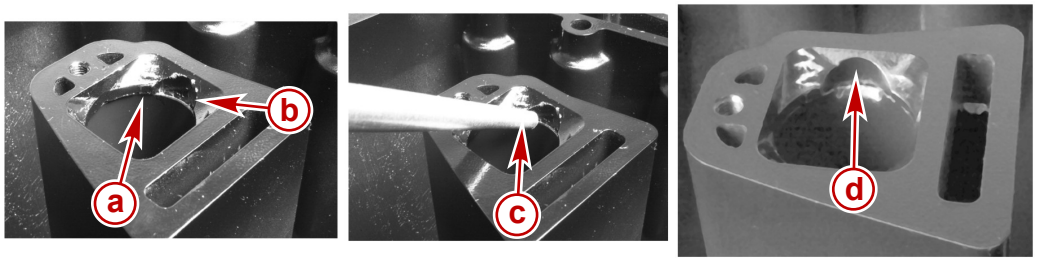


31597

a - Plate
b - Bolt (M10 x 25)

Description	Nm	lb-in.	lb-ft
Exhaust tube plate retaining bolt	30	–	22.1

7. Use an appropriate tool to peen the edge of the exhaust tube into the flange of the driveshaft housing.



27996

a - Exhaust tube seated in driveshaft housing
b - Driveshaft housing exhaust tube flange
c - Appropriate tool (punch shown)
d - Peened edge of exhaust tube

IMPORTANT: Failure to peen the edge of the exhaust tube into the flange of the driveshaft housing will allow the exhaust tube to become loose and rattle inside the driveshaft housing.

Adapter Plate Inspection/Cleaning/Assembly

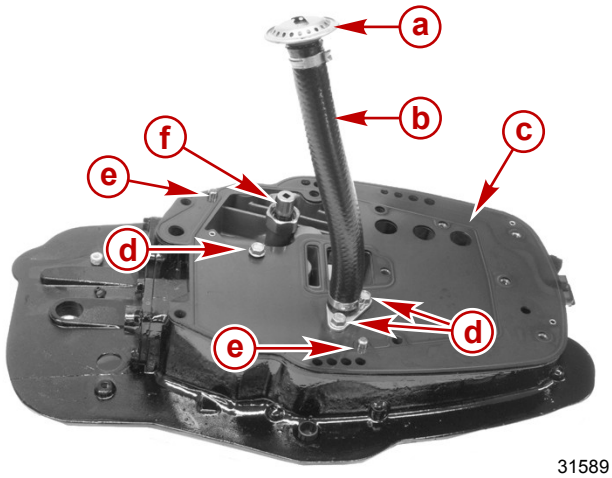
1. Disassemble, clean, and inspect the adapter plate components, as required.
2. The oil pressure relief valve must be clean and free to open and close without sticking.
3. The screen in the oil pickup baffle should be clean and free of damage.
4. The oil pickup hose must be in good condition and clamped securely at both ends.

5. Replace the O-ring on the oil pickup plate.

32957

- **a -** Oil pickup hose
- **b -** Oil pickup plate
- **c -** O-ring
- **d -** Oetiker clamp (25.6 mm) (2)

6. Install the adapter plate components. Lubricate the oil pressure relief valve with engine oil before installing. Tighten the components to the specified torque.



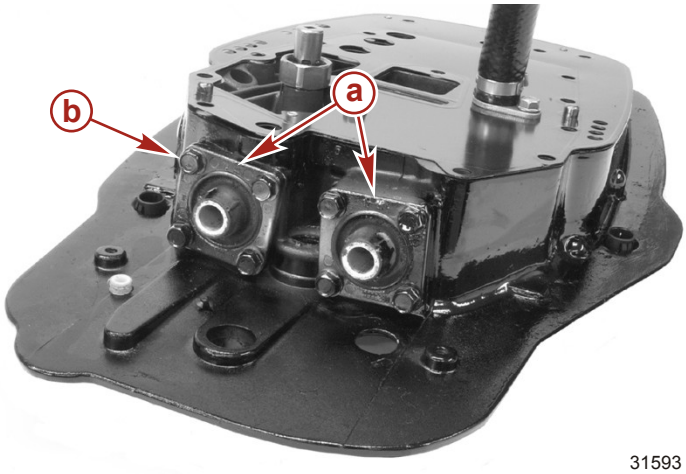
31589

- **a -** Oil pickup baffle
- **b -** Oil pickup hose
- **c -** Gasket
- **d -** Bolt (M6 x 20) (3)
- **e -** Dowel pin (2)
- **f -** Oil pressure relief valve

Tube Ref No.	Description	Where Used	Part No.
139	Synthetic Blend 4-Stroke Outboard Oil 25W-40	Oil pressure relief valve	92-8M0078629

Description	Nm	lb-in.	lb-ft
Oil pickup hose bolts (M6 x 20) (3)	8.5	75	
Oil pressure relief valve/deflector cup assembly	46		34

7. Inspect the upper mounts. Tighten the bolts to the specified torque.

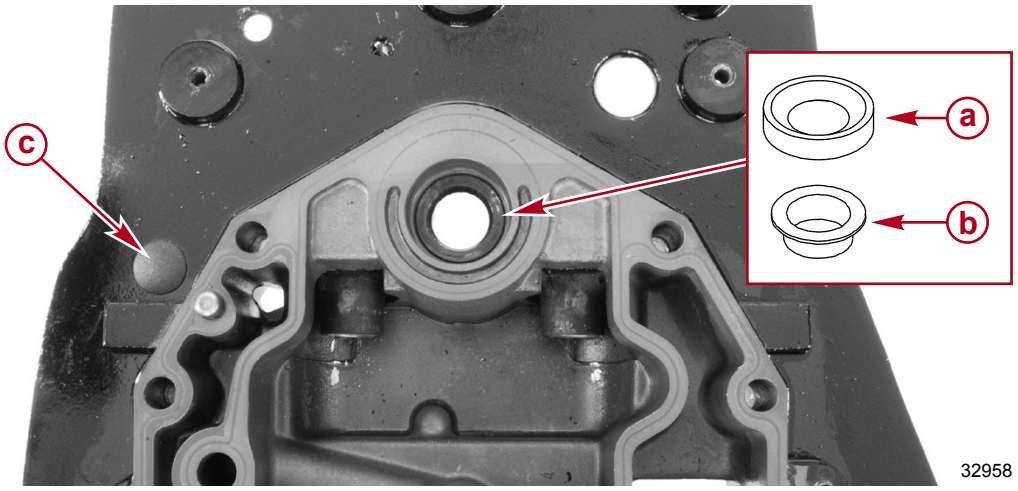


31593

- **a -** Upper mount (2)
- **b -** Bolt (M6 x 20) (4 per upper mount)

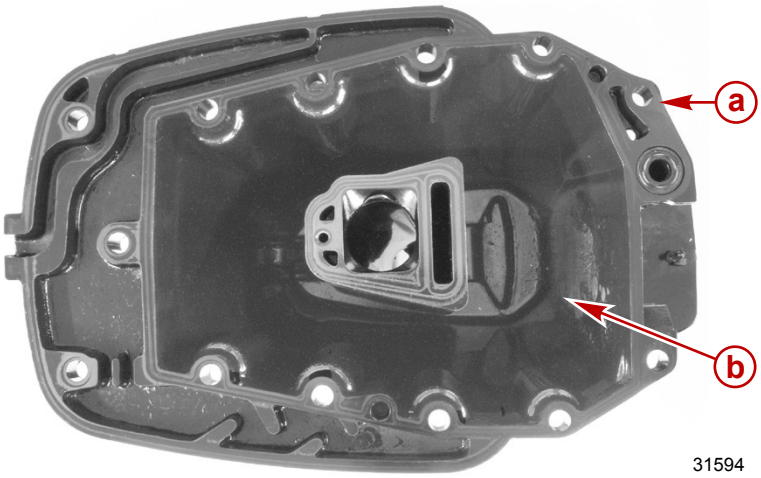
Description	Nm	lb-in.	lb-ft
Upper mount bolts (M6 x 20)	14.7	130	

8. Install a new driveshaft seal.



a - Driveshaft seal
b - Bushing
c - Plug

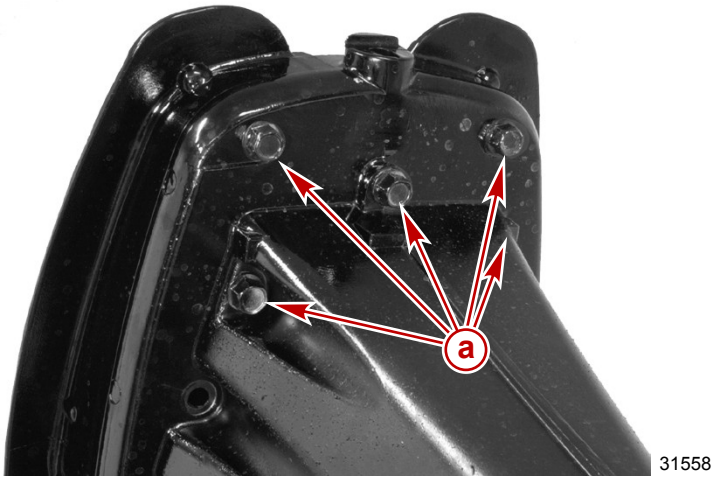
9. Inspect and clean the oil sump before assembly.



a - Driveshaft housing
b - Oil sump

Adapter Plate Installation

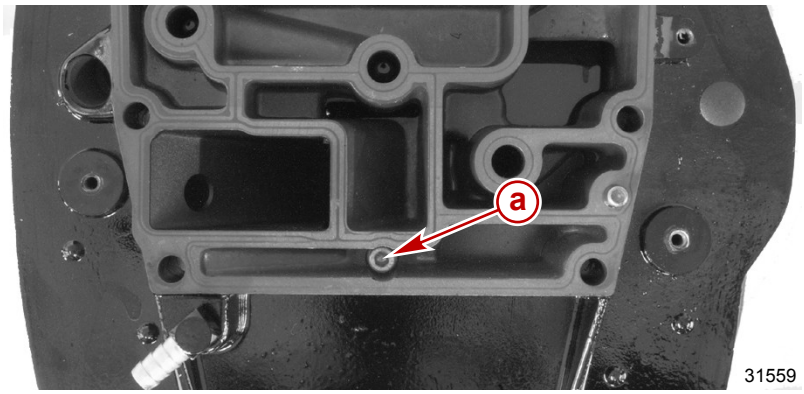
1. Place the adapter plate onto the driveshaft housing. Install five bolts into the adapter plate from the aft/underside of the driveshaft housing. Tighten the bolts to the specified torque.



a - Bolt (M8 x 45) (5)

Description	Nm	lb-in.	lb-ft
Adapter plate bolts (M8 x 45) (5)	38		28

2. Install the socket head bolt on the topside of the adapter plate. Tighten to the specified torque.

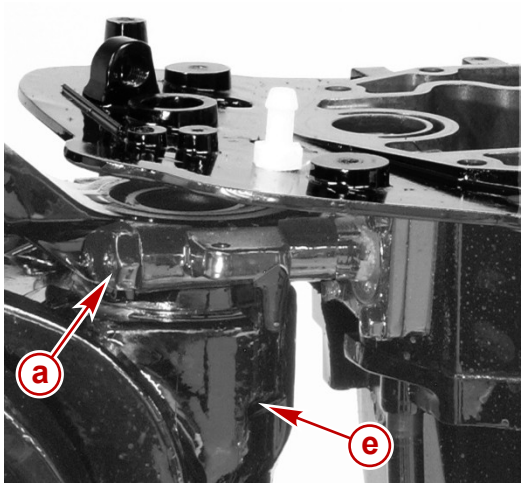


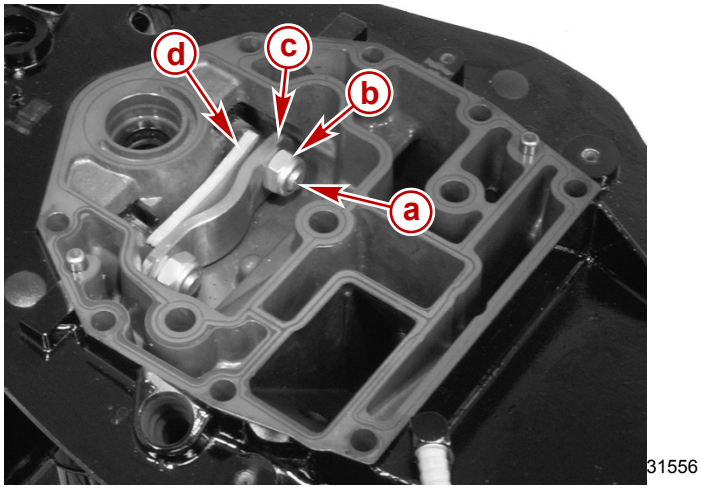
a - Socket head bolt (M6 x 55)

Description	Nm	lb-in.	lb-ft
Socket head bolt (M6 x 55)	17	150	

Driveshaft Housing Installation

1. Install the driveshaft housing assembly onto the transom bracket. Two people may be required for this, one to hold the driveshaft housing, the other to install the upper and lower bolts.
2. Install the driveshaft housing/adapter plate onto the swivel/clamp bracket assembly.
3. Install the bolts through the upper mounts. Install washers and nuts to the bolts. Tighten the nuts to the specified torque.



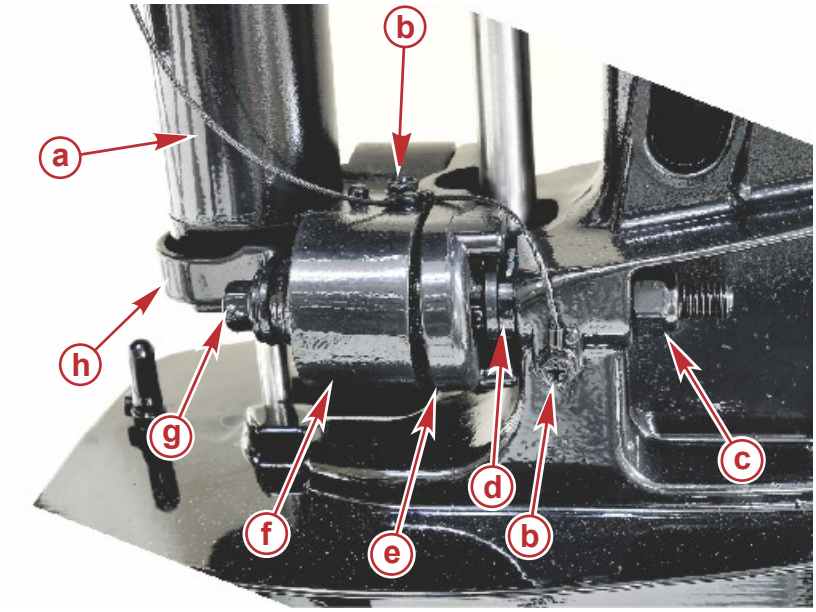


a - Bolt
b - Nut
c - Upper mount strap
d - Bumper
e - Swivel bracket

Description	Nm	lb-in.	lb-ft
Upper mount bolt/nut	68	–	50.2

4. Install the lower mount bolts through the strap and lower mounts. Install washers and nuts to the bolts. Tighten the nuts to the specified torque.

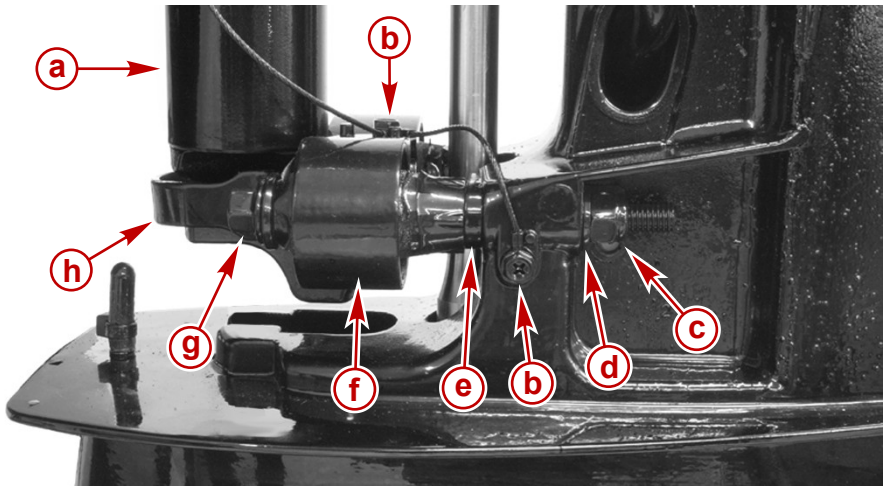
5. Install the ground cable. Tighten the bolts to the specified torque.



61329

SeaPro

- **a -** Swivel tube
- **b -** Ground cable
- **c -** Nut (M10) (2)
- **d -** Spacer (2)
- **e -** Snubber
- **f -** Lower mount (2)
- **g -** Bolt (M10 x 120) (2)
- **h -** Strap



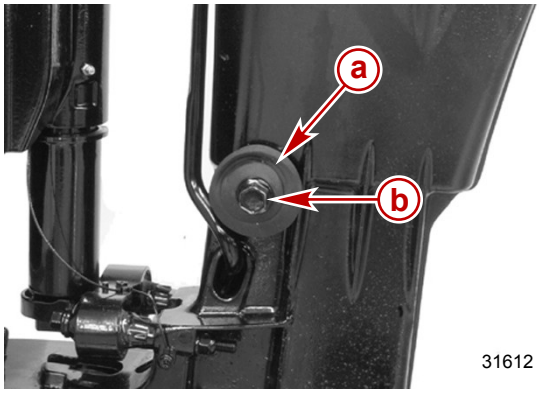
31266

Non-SeaPro

- **a -** Swivel tube
- **b -** Ground cable
- **c -** Nut (M10) (2)
- **d -** Washer (2)
- **e -** Spacer (2)
- **f -** Lower mount (2)
- **g -** Bolt (M10 x 120) (2)
- **h -** Strap

Description	Nm	lb-in.	lb-ft
Lower mount bolt/nut	43	–	31.7
Ground cable bolt	Drive tight		

6. Install the grommet and drain plug. Tighten to the specified torque.

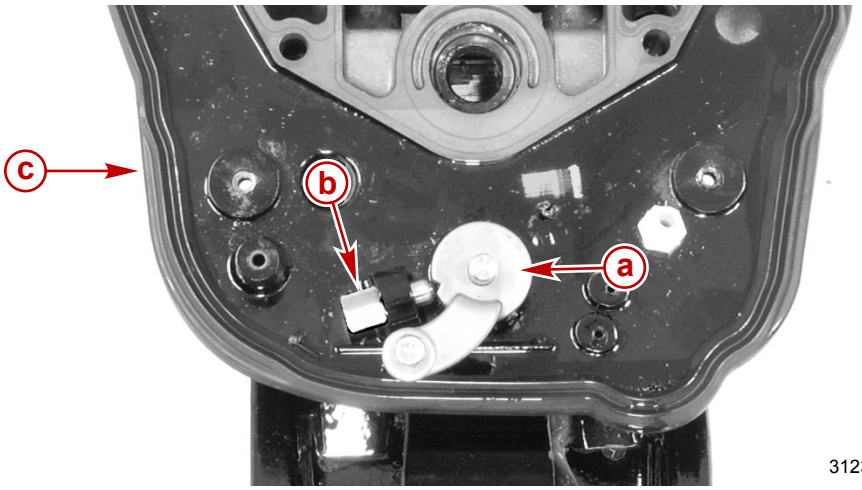


31612

- **a -** Grommet
- **b -** Drain plug

Description	Nm	lb-in.	lb-ft
Drain plug	24	–	17.7

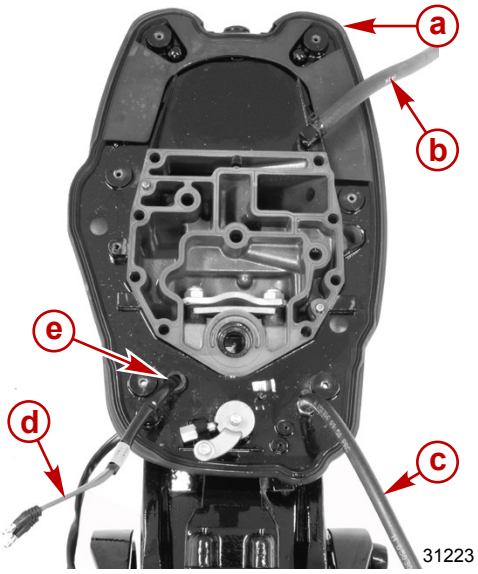
7. Install the shift shaft bushing into the adapter plate. Slide the shift shaft through the bushing, into the driveshaft housing.
8. Install the shift detent. Tighten to the specified torque.
9. Install the adapter plate gasket.



a - Shift shaft
b - Shift detent
c - Adapter plate gasket

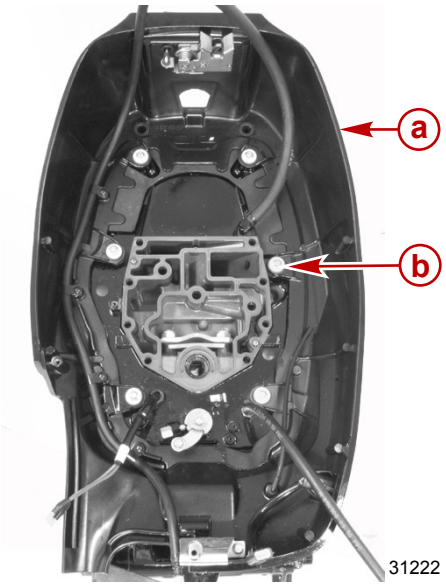
Description	Nm	lb-in.	lb-ft
Shift detent	20	177	–

10. Install the vent hoses. Secure with cable ties.
11. Install the grommet and the power trim wires.



a - Adapter plate
b - Vent hose
c - Vent hose
d - Power trim wires
e - Grommet

12. Apply Loctite 242 Threadlocker to the bottom cowl pan bolts. Attach the pan to the adapter plate. Tighten the bolts to the specified torque.

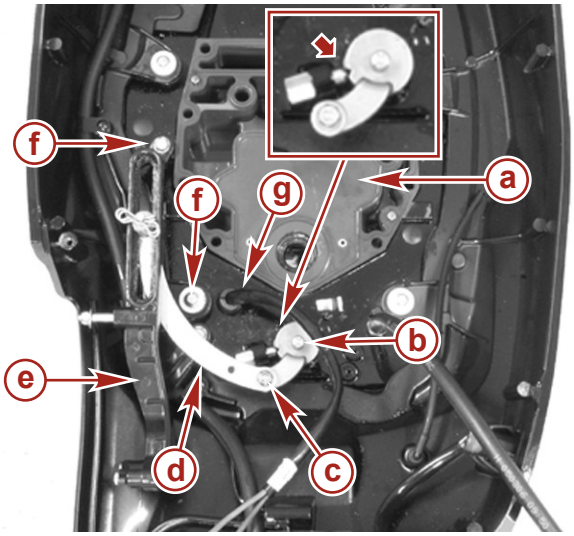


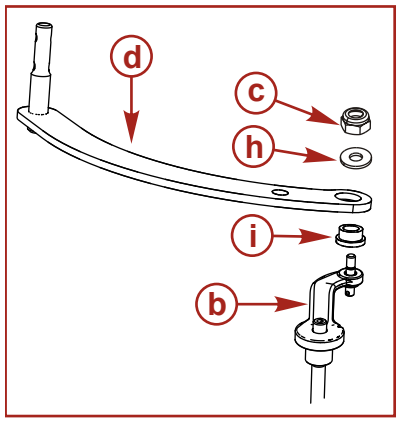
a - Bottom cowl pan
b - Flange bolt (M6 x 25) (6)

Tube Ref No.	Description	Where Used	Part No.
66	Loctite 242 Threadlocker	Bottom cowl pan flange bolt (M6 x 25) (6)	92-809821

Description	Nm	lb-in.	lb-ft
Bottom cowl pan flange bolts (M6 x 25) (6)	10	88.5	–

13. Apply Loctite 271 Threadlocker to the shift bracket bolts. Install the shift bracket. Tighten the bolts to the specified torque.
14. Install the bushing into the shift link. Install the shift link onto the shift shaft. Secure with a washer and locknut. Tighten the locknut to the specified torque.
15. Install the powerhead gasket.





32959

Remote control model

a - Powerhead gasket
b - Shift shaft
c - Thin locknut (M6)
d - Shift link
e - Shift bracket
f - Bolt (M6 x 20) (2)
g - Power trim wires
h - Washer
i - Bushing

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Shift bracket bolts (M6 x 20) (2)	92-809819

Description	Nm	lb-in.	lb-ft
Shift bracket mounting bolts (M6 x 20) (2)	6.8	60	–
Shift shaft thin locknut	6	53.1	–

16. Install the gear housing. Refer to **Section 6**.
17. Install the powerhead. Refer to **Section 4B**.

Mid-Section

Section 5B - Power Trim

Table of Contents

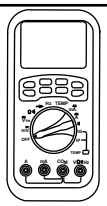
Power Trim Specifications

Power Trim Specifications	
Trim up circuit pressure, minimum	19300 kPa (2800 psi)
Trim down circuit pressure	3450–5515 kPa (500–800 psi)
System fluid	Power Trim and Steering Fluid or automotive automatic transmission fluid (ATF) (Type Dexron III)

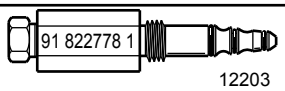
Lubricant, Sealant, Adhesives

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Shock rod threads	92-809819
9	Loctite 567 PST Pipe Sealant	Brass fitting threads	92-809822
95	2-4-C with PTFE	Pivot pin surface and lower pivot pin bore	92-802859A 1
		Upper pivot pin and bore, trim ram bore	
114	Power Trim and Steering Fluid	Power trim O-rings	92-858074K01
		Power trim O-rings	
		Power trim system	
		Power trim reservoir	

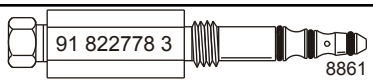
Special Tools

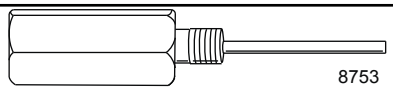
DMT 2004 Digital Multimeter	91-892647A01
 4516	Measures RPM, ohms, amperes, AC and DC voltages; records maximums and minimums simultaneously, and accurately reads in high RFI environments.

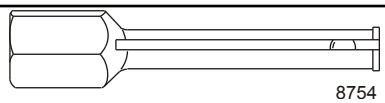
DVA/Multimeter Kit	91- 99750A 1
 3460	Tests the electrical and ignition systems; consists of a VOA meter with built-in direct voltage adapter.

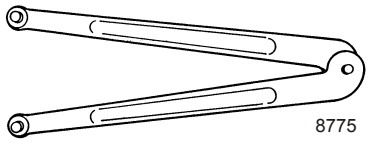
Adapter Fitting	91-822778A 1
 12203	Measures the internal pressure in the up mode for a single cylinder trim system.

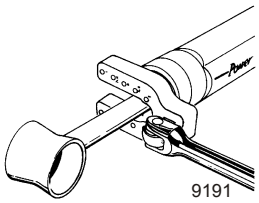
Power Trim Test Gauge Kit	91- 52915A 6
 3753	Tests circuit pressures for various trim pumps.

Adapter Fitting	91-822778A 3
	Install in place of the manual release valve to measure the internal pressure of the power trim pump in the down mode.

Expanding Rod	Snap On CG41-11
	Aids in the removal of the spool from the power trim pump.

Collet	Snap On CG41-14
	Aids in the removal of the spool from the power trim pump.

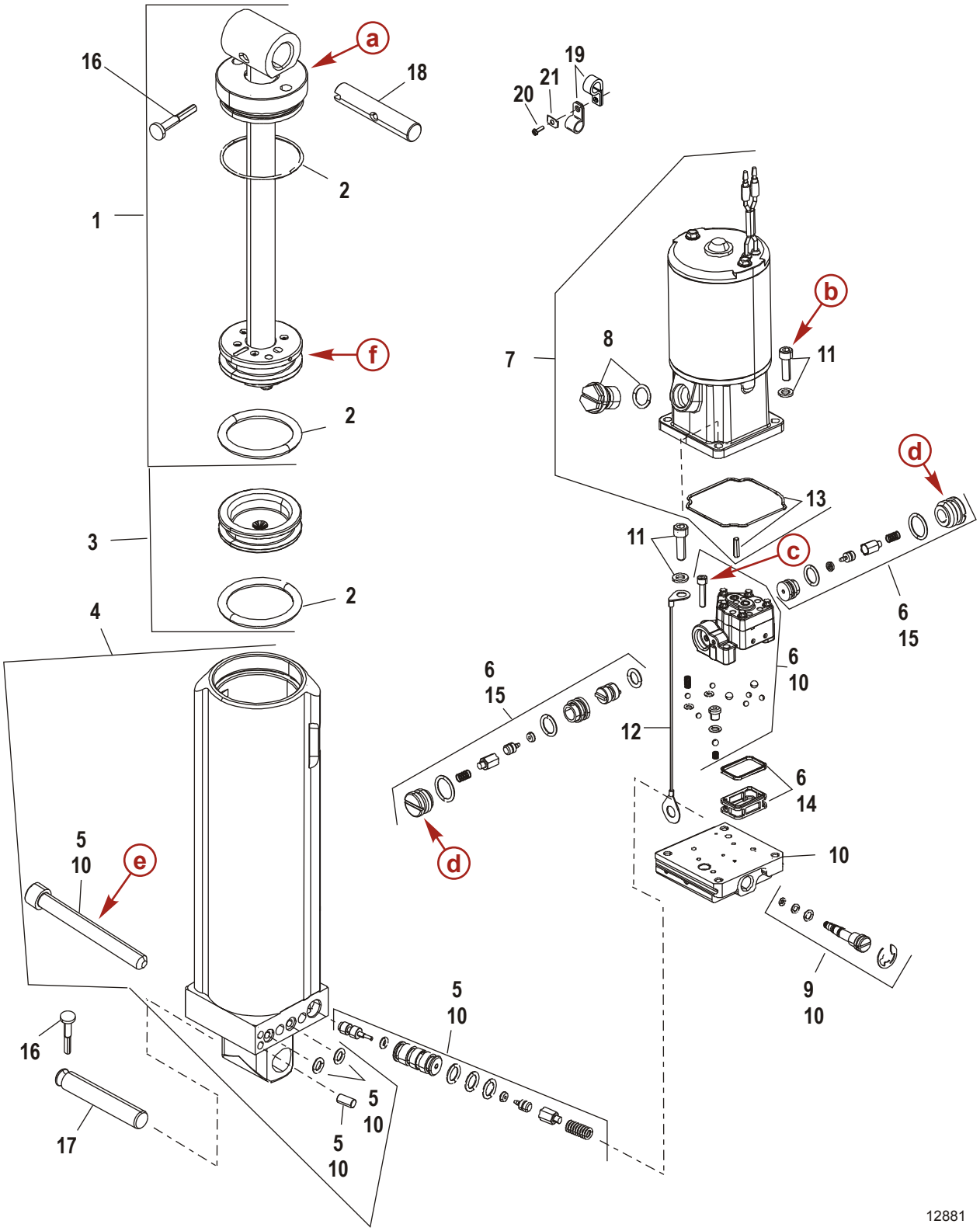
Spanner Wrench	91- 74951
	Removes and installs trim cylinder end caps.

Trim Cylinder End Cap Tool	91-821709T
	Allows easy removal of the trim cylinder end caps. Required if tilt limit spacers are to be installed or if the trim in limit spacer is to be removed (to allow additional trim in range).

Torch Lamp	91- 63209
	Heats surfaces to aid in the removal and installation of interference fit engine components.

Lockring Pliers	Snap-On SRP-4
	Aids in the removal of lockrings.

Power Trim Components



Power Trim Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Shock rod			
2	1	O-ring kit			
3	1	Memory piston assembly			
4	1	Cylinder assembly			
5	1	Trim limit valve kit			
6	1	Pump assembly			
7	1	Motor kit			
8	1	Reservoir plug			
9	1	Manual release assembly			
10	1	Manifold kit			
11	1	Screw kit (motor)			
12	1	Cable			
13	1	Driveshaft			
14	1	Filter kit			
15	1	Pressure operated check assembly kit			
16	2	Groove pin			
17	1	Anchor pin			
18	1	Shaft			
19	2	Clamp			
20	1	Screw			
21	1	C-washer			
a	1	Cylinder end cap	61		45
b	4	Motor/reservoir screw	9	80	
c	3	Oil pump screw	8	70	
d	2	Plug	13.5	120	
e	2	Cylinder screw	11.3	100	
f	1	Shock piston	122		90

Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	Power trim O-rings	92-858074K01

NOTE: *It is recommended that all O-rings be replaced when servicing the power trim system.*

Wire Color Code Abbreviations

Wire Color Abbreviations				
BLK	Black		BLU	Blue
BRN	Brown		GRY or GRA	Gray
GRN	Green		ORN or ORG	Orange
PNK	Pink		PPL or PUR	Purple
RED	Red		TAN	Tan
WHT	White		YEL	Yellow
LT or LIT	Light		DK or DRK	Dark

Power Trim General Information

General Information

The power trim system consists of an electric motor, pressurized fluid reservoir, pump, and trim cylinder.

Trim outboard through entire trim and tilt range several times to remove any air from the system.

The remote control or trim panel is equipped with a switch that is used for trimming the outboard up or down, for tilting the outboard for shallow water operation at slow speeds, or for trailering. The outboard can be trimmed up or down while engine is under power or when engine is not running.

Power Trim Operation

With most boats, operating around the middle of the trim range will give satisfactory results. However, to take full advantage of the trimming capability there may be times when you choose to trim your outboard all the way in or out. Along with an improvement in some performance aspects comes a greater responsibility for the operator, and this is being aware of some potential control hazards.

The most significant control hazard is a pull or torque that can be felt on the steering wheel or tiller handle. This steering torque results from the outboard being trimmed so the propeller shaft is not parallel to the water surface.

⚠ WARNING

Trimming the outboard beyond a neutral steering condition may result in a pull on the steering wheel or tiller handle and loss of boat control. Maintain control of the boat if trimming beyond a neutral steering condition.

Consider the following lists carefully.

1. Trimming in or down can:
   - Lower the bow.
   - Result in quicker planing off, especially with a heavy load or a stern heavy boat.
   - Generally improve the ride in choppy water.
   - Increase steering torque or pull to the right (with the normal right-hand rotation propeller.)
   - In excess, can lower the bow of some boats to a point where they begin to plow with their bow in the water while on plane. This can result in an unexpected turn in either direction (called bow steering or oversteering) if any turn is attempted, or if a significant wave is encountered.

⚠ WARNING

Operating the boat at high speeds with the outboard trimmed too far under can create excessive bow steer, resulting in the operator losing control of the boat. Install the trim limit pin in a position that prevents excessive trim under and operate the boat in a safe manner.

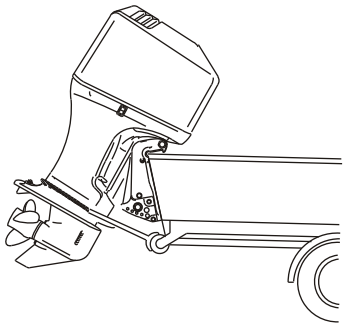
   - In rare circumstances, the owner may decide to limit the trim in. This can be accomplished by purchasing a stainless steel tilt pin from your dealer and inserting it in whatever adjustment hole in the transom brackets is desired. The nonstainless steel shipping bolt should not be used in this application other than on a temporary basis.
2. Trimming out or up can:
   - Lift the bow higher out of the water.
   - Generally increase top speed.
   - Increase clearance over submerged objects or a shallow bottom.
   - Increase steering torque or pull to the left at a normal installation height (with the normal right-hand rotation propeller.)
   - In excess, can cause boat porpoising (bouncing) or propeller ventilation.

- Cause engine overheating if any cooling water intake holes are above the waterline.

Trailering Boat/Outboard

Trailer your boat with the outboard tilted down in a vertical operating position.

If additional ground clearance is required, the outboard should be tilted up using an accessory outboard support device. Refer to your local dealer for recommendations. Additional clearance may be required for railroad crossings, driveways, and trailer bouncing.



21997

IMPORTANT: Do not rely on the power trim/tilt system or tilt support lever to maintain proper ground clearance for trailering. The outboard tilt support lever is not intended to support the outboard for trailering.

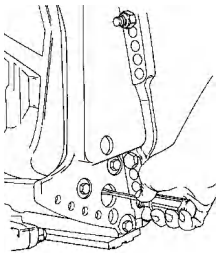
Shift the outboard to forward gear. This prevents the propeller from spinning freely.

Manual Tilting

If the outboard cannot be tilted using the power trim/tilt switch, the outboard can be manually tilted.

NOTE: *The manual tilt release valve must be tightened before operating the outboard to prevent the outboard from tilting up during reverse operation.*

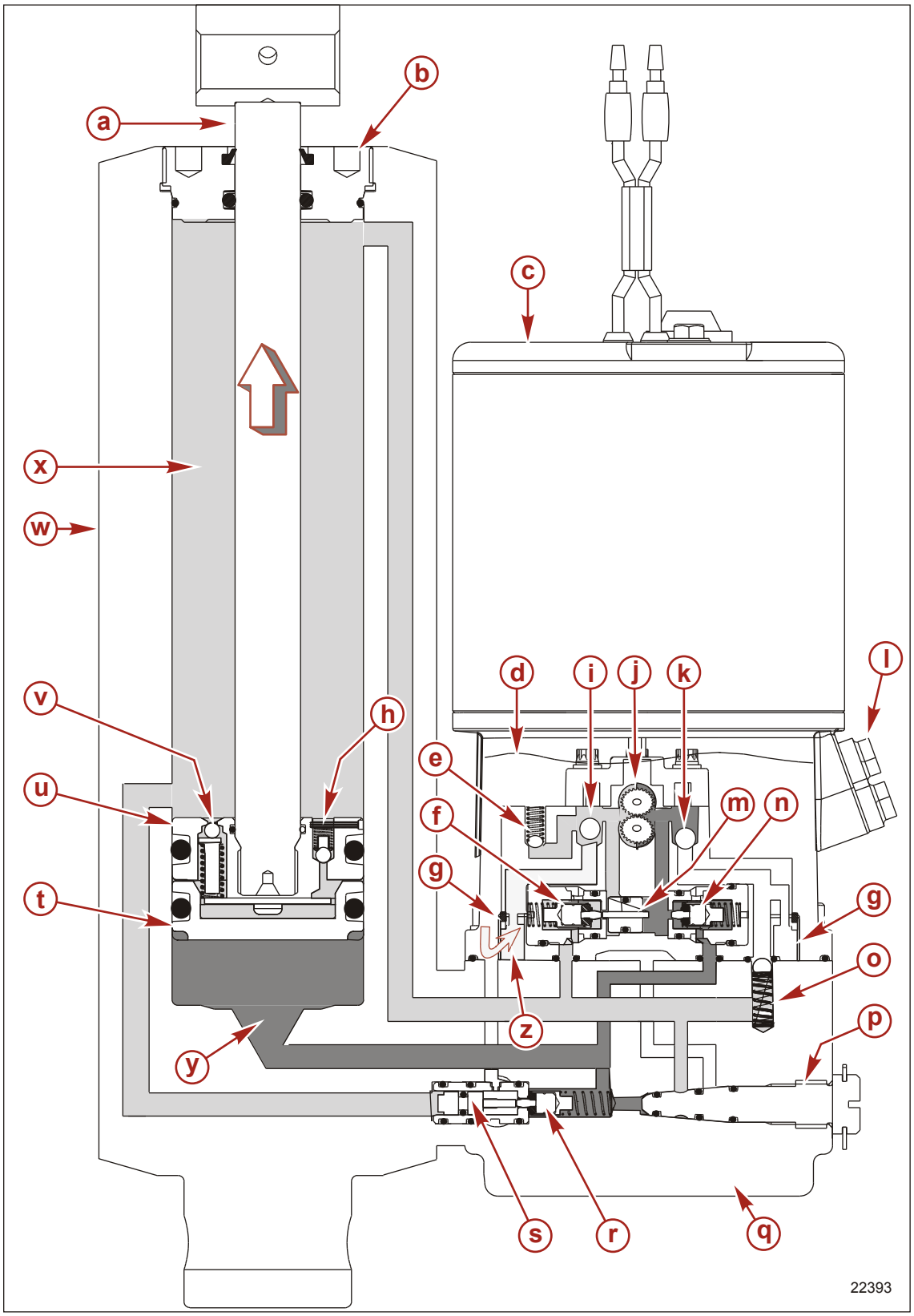
Turn out the manual tilt release valve three turns counterclockwise. This allows manual tilting of the outboard. Tilt the outboard to the desired position and tighten the manual tilt release valve.



22362

Power Trim Flow Diagrams

Trim Up Circuit



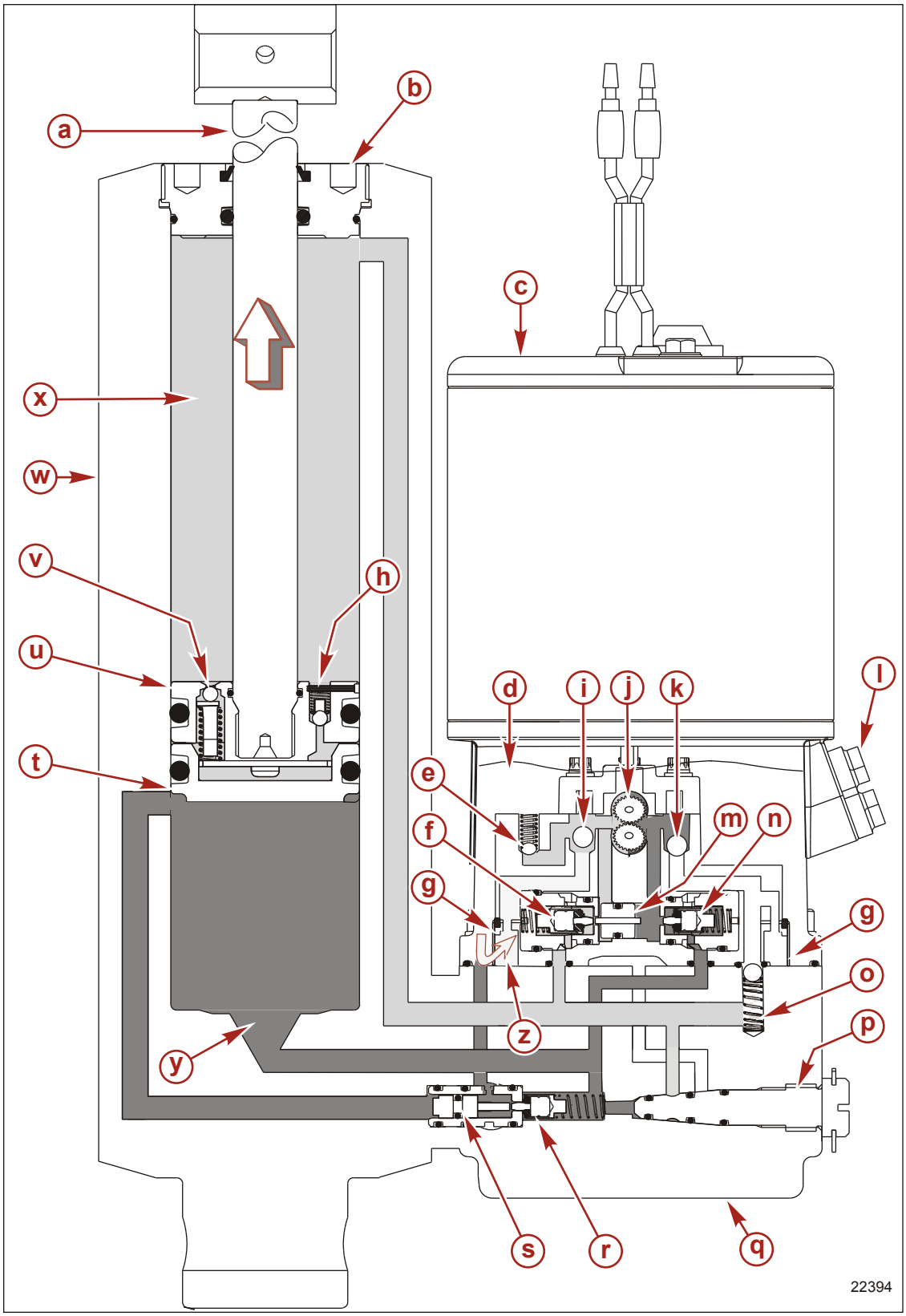
- **a -** Trim rod
- **b -** End cap
- **c -** Electric motor
- **d -** Reservoir oil
- **e -** Down circuit pressure relief valve
- **f -** Down circuit pressure operated valve
- **g -** Filter (two shown for clarity)
- **h -** Shock return valve
- **i -** Up circuit suction port
- **j -** Oil pump gears
- **k -** Down circuit suction port
- **l -** Oil fill cap
- **m -** Shuttle valve
- **n -** Up circuit pressure operated valve
- **o -** Manifold reverse suction valve
- **p -** Manual release valve
- **q -** Manifold
- **r -** Tilt relief valve
- **s -** Tilt relief piston
- **t -** Memory piston
- **u -** Shock piston
- **v -** Impact relief valve
- **w -** Cylinder
- **x -** Return oil
- **y -** Oil under pressure
- **z -** Filtered supply oil

When the trim switch is activated in the up position, the electric motor begins to rotate the pump gears, and the oil pump draws a small amount of oil through the filter and through the up circuit suction port. The oil pump gear rotation forces oil into the passages for the up circuit. Oil under pressure slides the shuttle valve against the down circuit pressure operated valve. The shuttle valve mechanically opens the down pressure operated valve, allowing oil from the down cavity of the trim cylinder to flow into the oil pump. This oil returning from the down cavity supplies most of the oil required for the up circuit. Oil in the up circuit is blocked from returning into the reservoir by the ball inside the down circuit suction port. The pressure of the oil forces the up circuit pressure operated valve to open, allowing the oil to enter the passages inside the manifold leading to the trim cylinder up cavity. Oil is blocked from all other passages by the closed manual release valve. Oil under pressure enters the trim cylinder below the memory piston. With an increasing amount of oil entering the cylinder, the memory and shock pistons force the trim rod up and out, raising the outboard engine. Oil on the top of the shock piston exits through a passage running down along the side of the cylinder and enters the manifold passages. The oil is drawn back into the pump through the open down pressure operated valve and enters the pump as supply for the up circuit.

The trim cylinder positions the outboard at the desired trim angle in the 20º maximum trim range. The system will not allow the outboard to be trimmed above the 20º trim range as long as the engine RPM is above approximately 2000 RPM.

The outboard can be trimmed above the 20º maximum trim angle for shallow water operation by keeping the engine RPM below 2000. If the RPM increases over 2000, and the propeller is deep enough, propeller thrust causes the trim system to return the outboard to the 20º maximum trim position. Refer to **Trim Limit**, following.

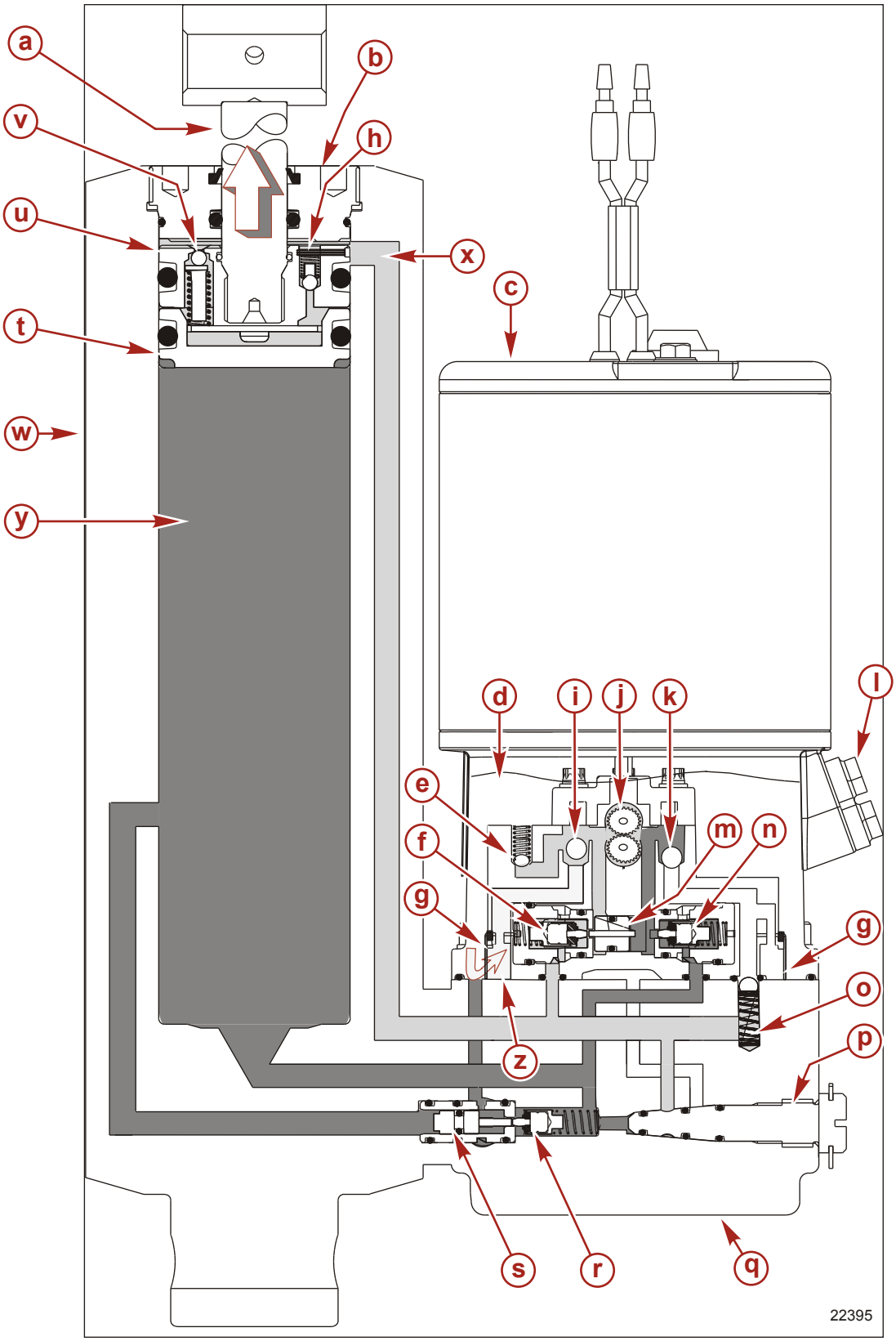
Tilt Circuit



- **a -** Trim rod
- **b -** End cap
- **c -** Electric motor
- **d -** Reservoir oil
- **e -** Down circuit pressure relief valve
- **f -** Down circuit pressure operated valve
- **g -** Filter (two shown for clarity)
- **h -** Shock return valve
- **i -** Up circuit suction port
- **j -** Oil pump gears
- **k -** Down circuit suction port
- **l -** Oil fill cap
- **m -** Shuttle valve
- **n -** Up circuit pressure operated valve
- **o -** Manifold reverse suction valve
- **p -** Manual release valve
- **q -** Manifold
- **r -** Tilt relief valve
- **s -** Tilt relief piston
- **t -** Memory piston
- **u -** Shock piston
- **v -** Impact relief valve
- **w -** Cylinder
- **x -** Return oil
- **y -** Oil under pressure
- **z -** Filtered supply oil

In the up mode, as the trim rod extends from the cylinder, the memory piston clears or uncovers the pressure relief passage. Oil from the up cavity enters this passage and, if required, causes the tilt relief piston to open the tilt pressure relief valve. This valve lowers the amount of pressure available to lift the outboard motor. With the engine in forward gear, and at high RPM, the oil pressure available cannot overcome the propeller thrust, limiting the trim range to below the pressure relief passage. Up pressure flows into the trim relief passage and returns back into the reservoir. When the engine RPM's fall, or if engine is not in forward gear, oil pressure is available to extend the trim rod up into the tilt range.

Maximum Tilt



- **a -** Trim rod
- **b -** End cap
- **c -** Electric motor
- **d -** Reservoir oil
- **e -** Down circuit pressure relief valve
- **f -** Down circuit pressure operated valve
- **g -** Filter (two shown for clarity)
- **h -** Shock return valve
- **i -** Up circuit suction port
- **j -** Oil pump gears
- **k -** Down circuit suction port
- **l -** Oil fill cap
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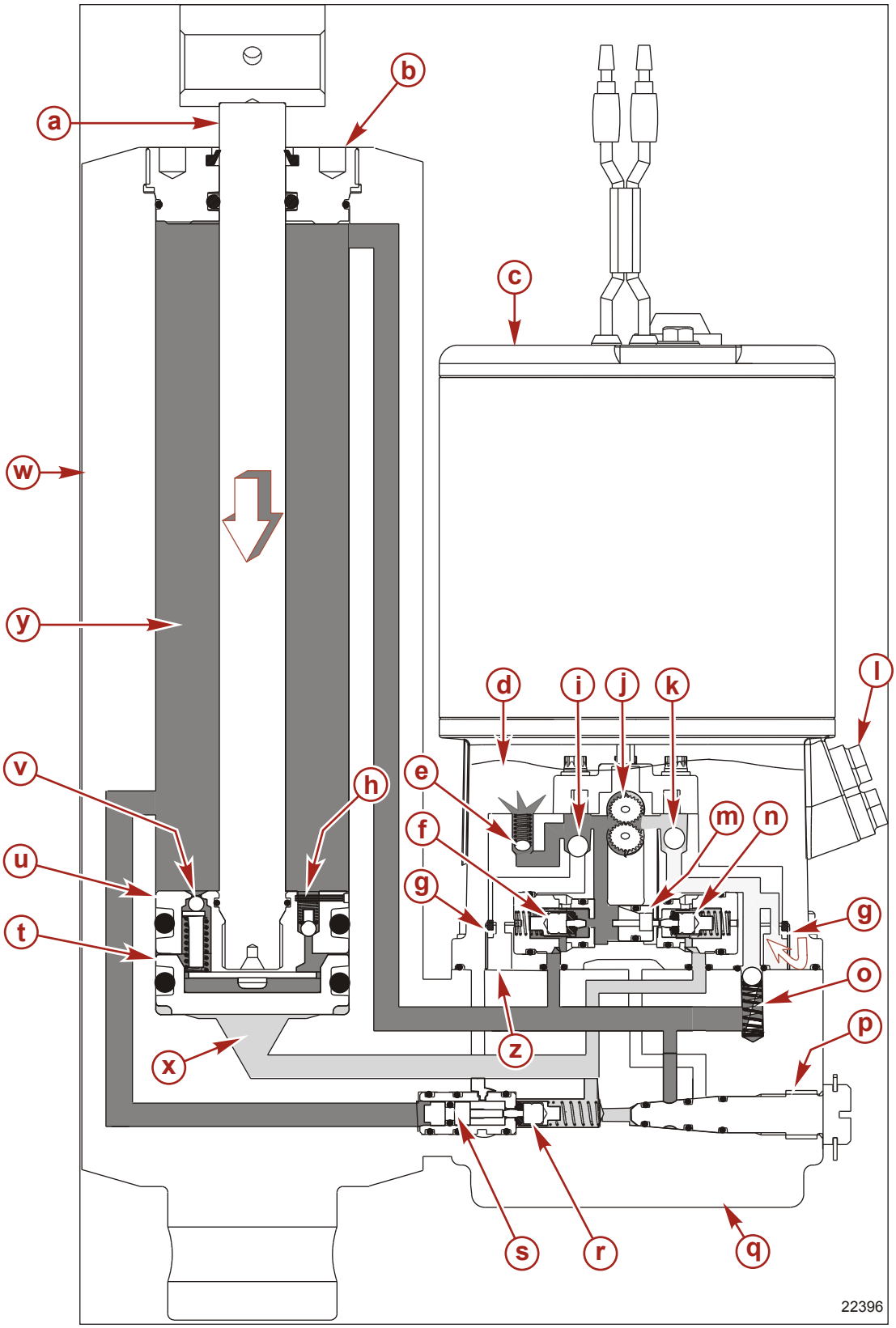
- **n -** Up circuit pressure operated valve
- **o -** Manifold reverse suction valve
- **p -** Manual release valve
- **q -** Manifold
- **r -** Tilt relief valve
- **s -** Tilt relief piston
- **t -** Memory piston
- **u -** Shock piston
- **v -** Impact relief valve
- **w -** Cylinder
- **x -** Return oil
- **y -** Oil under pressure
- **z -** Filtered supply oil

With the cylinder at maximum travel, due to no ram movement, the pressure inside of the trim cylinder increases to the pressure setting of the tilt relief valve. Pressure forces the tilt relief actuator to move and unseat the tilt relief valve allowing oil to return to the reservoir through passages in the manifold. Oil flow continues until the up button is released.

Trim Down



- **a -** Trim rod
- **b -** End cap
- **c -** Electric motor
- **d -** Reservoir oil
- **e -** Down circuit pressure relief valve
- **f -** Down circuit pressure operated valve
- **g -** Filter (two shown for clarity)
- **h -** Shock return valve
- **i -** Up circuit suction port
- **j -** Oil pump gears
- **k -** Down circuit suction port
- **l -** Oil fill cap
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- **r -** Tilt relief valve
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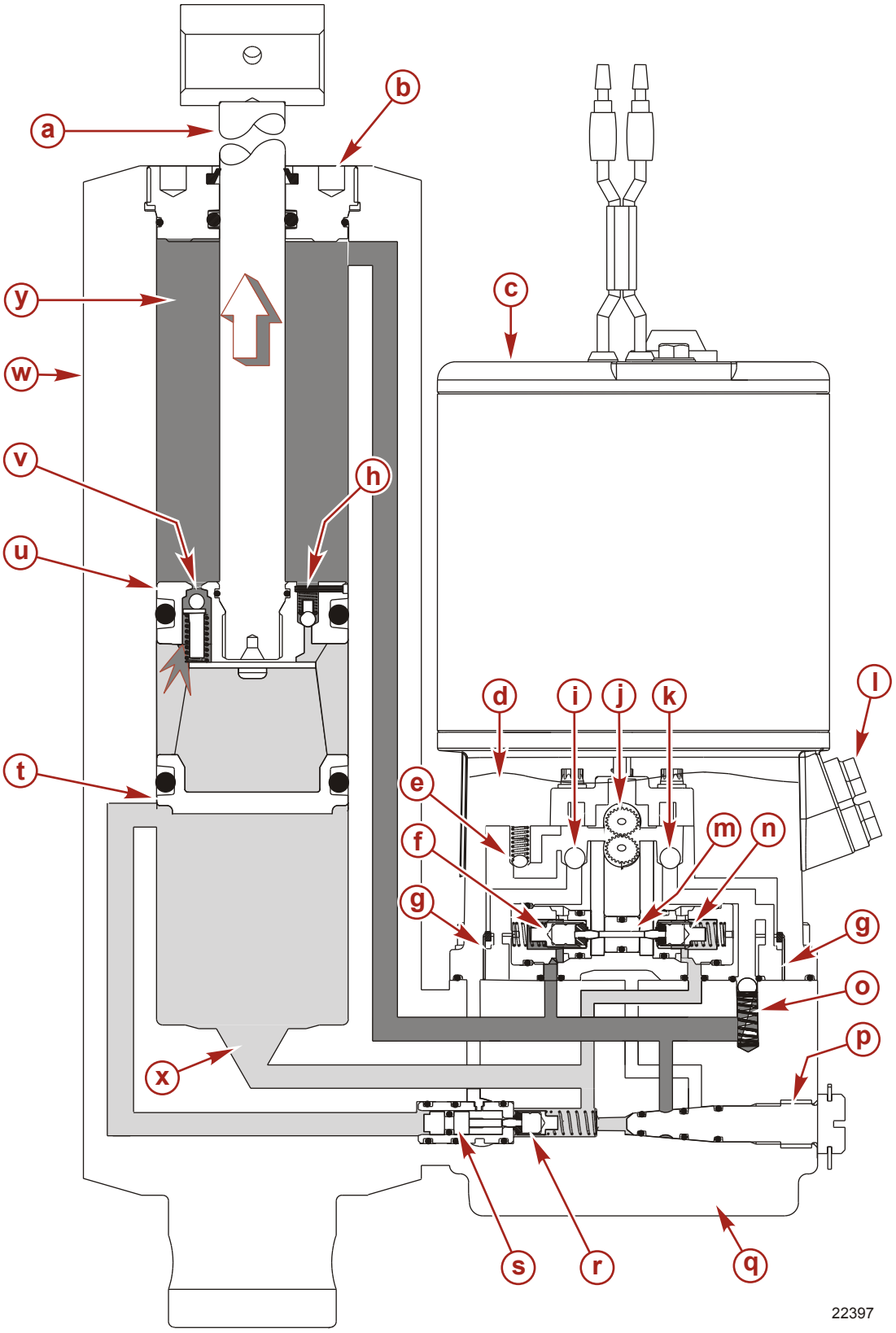
- **t -** Memory piston
- **u -** Shock piston
- **v -** Impact relief valve
- **w -** Cylinder
- **x -** Return oil
- **y -** Oil under pressure
- **z -** Filtered supply oil

When the trim switch is activated in the down position, the electric motor rotates the oil pump gears in the opposite direction. With the oil pump gears rotating backwards, the flow of oil is reversed. Oil is drawn through the filter, through the down circuit suction port, and into the oil pump gears. The pump forces pressurized oil into the down passages. Oil slides the shuttle valve into the up circuit pressure operated valve. The shuttle valve mechanically opens the up circuit pressure operated valve and allows oil from the up cavity of the trim cylinder to return into the oil pump. This oil, returning from the up cavity, supplies the oil required for the down circuit. The oil is blocked from returning into the reservoir by the ball inside the up circuit suction port. Oil, under pressure, opens the down circuit pressure operated valve and enters the down passages inside of the manifold. The manifold passage connects into the trim cylinder passage leading to the top of the cylinder. The cavity inside the cylinder above the shock piston is the down cavity. As the down cavity fills with oil, the trim rod retracts into the cylinder, lowering the outboard motor. Oil from the up cavity exits the cylinder and is drawn back into the pump through the open up circuit pressure operated valve. When the trim rod reaches full travel, the oil pressure inside the down circuit rises until the down circuit pressure relief valve opens, bypassing oil back into the reservoir. When the trim button is released, the pump stops supplying oil, both of the pressure operated valves close and, if open, the down circuit pressure relief valve closes. The closed valves locks the fluid on either side of the shock piston and memory piston, holding the outboard motor in position.

Shock Function Up



- **a -** Trim rod
- **b -** End cap
- **c -** Electric motor
- **d -** Reservoir oil
- **e -** Down circuit pressure relief valve
- **f -** Down circuit pressure operated valve
- **g -** Filter (two shown for clarity)
- **h -** Shock return valve
- **i -** Up circuit suction port
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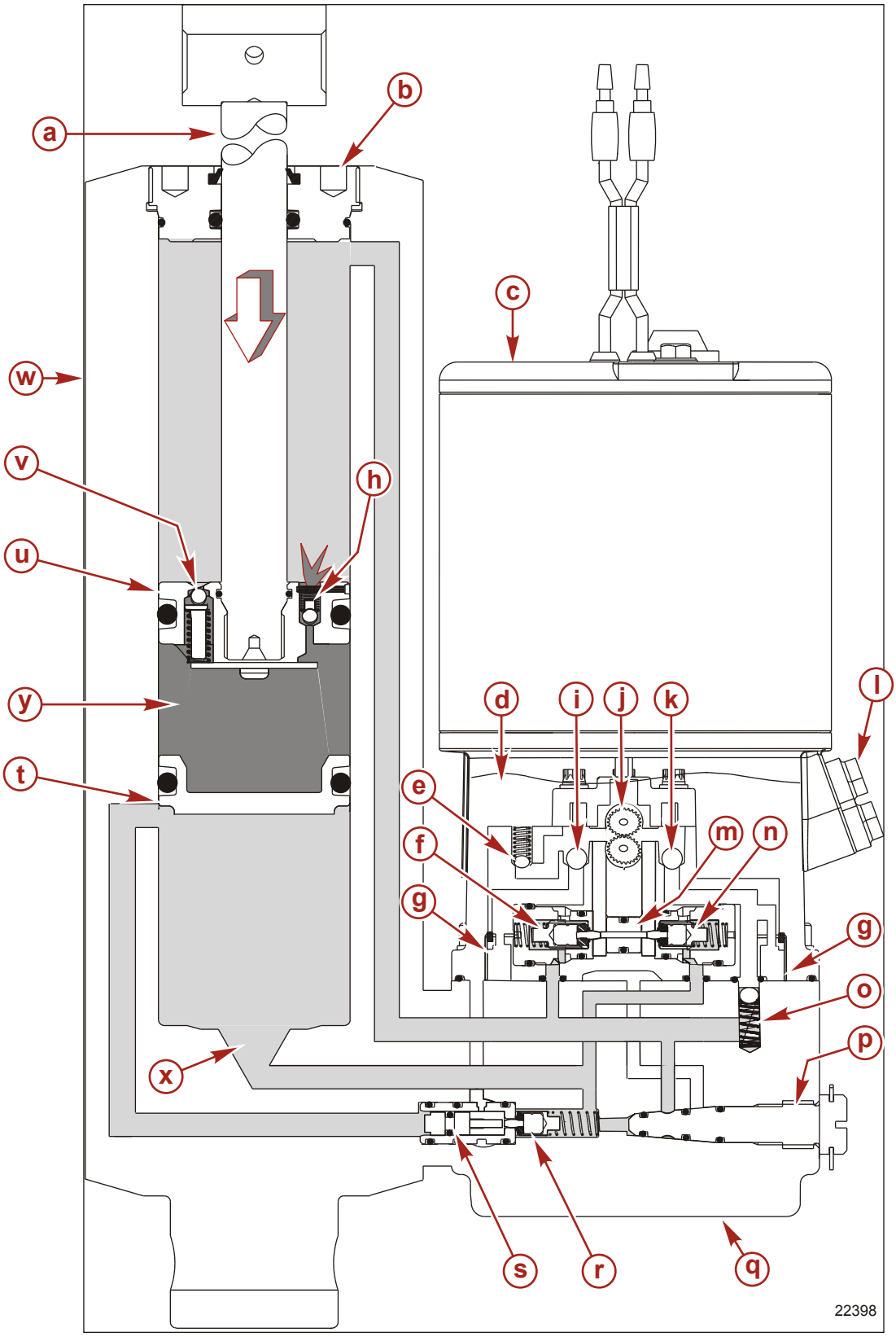
- **q -** Manifold
- **r -** Tilt relief valve
- **s -** Tilt relief piston
- **t -** Memory piston
- **u -** Shock piston
- **v -** Impact relief valve
- **w -** Cylinder
- **x -** Return oil
- **y -** Oil under pressure

Oil inside the down cavity is locked in a static position by the closed down circuit pressure operated valve, the manual release valve, and the manifold reverse suction valve. If the outboard strikes an underwater object while in forward gear, the trim rod tries to rapidly extend from the cylinder, increasing the pressure inside the trim cylinder down cavity and connecting passages. When the pressure increases to the relief valve setting, the impact relief valves located inside the shock piston open and allows the fluid to pass through the shock piston. As the fluid passes through the piston, the trim rod extends from the trim cylinder. The memory piston remains held in position by vacuum created by the oil in the up cavity being locked in a static position.

Shock Function Return



- **a -** Trim rod
- **b -** End cap
- **c -** Electric motor
- **d -** Reservoir oil
- **e -** Down circuit pressure relief valve
- **f -** Down circuit pressure operated valve
- **g -** Filter (two shown for clarity)
- **h -** Shock return valve
- **i -** Up circuit suction port
- **j -** Oil pump gears
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- **l -** Oil fill cap
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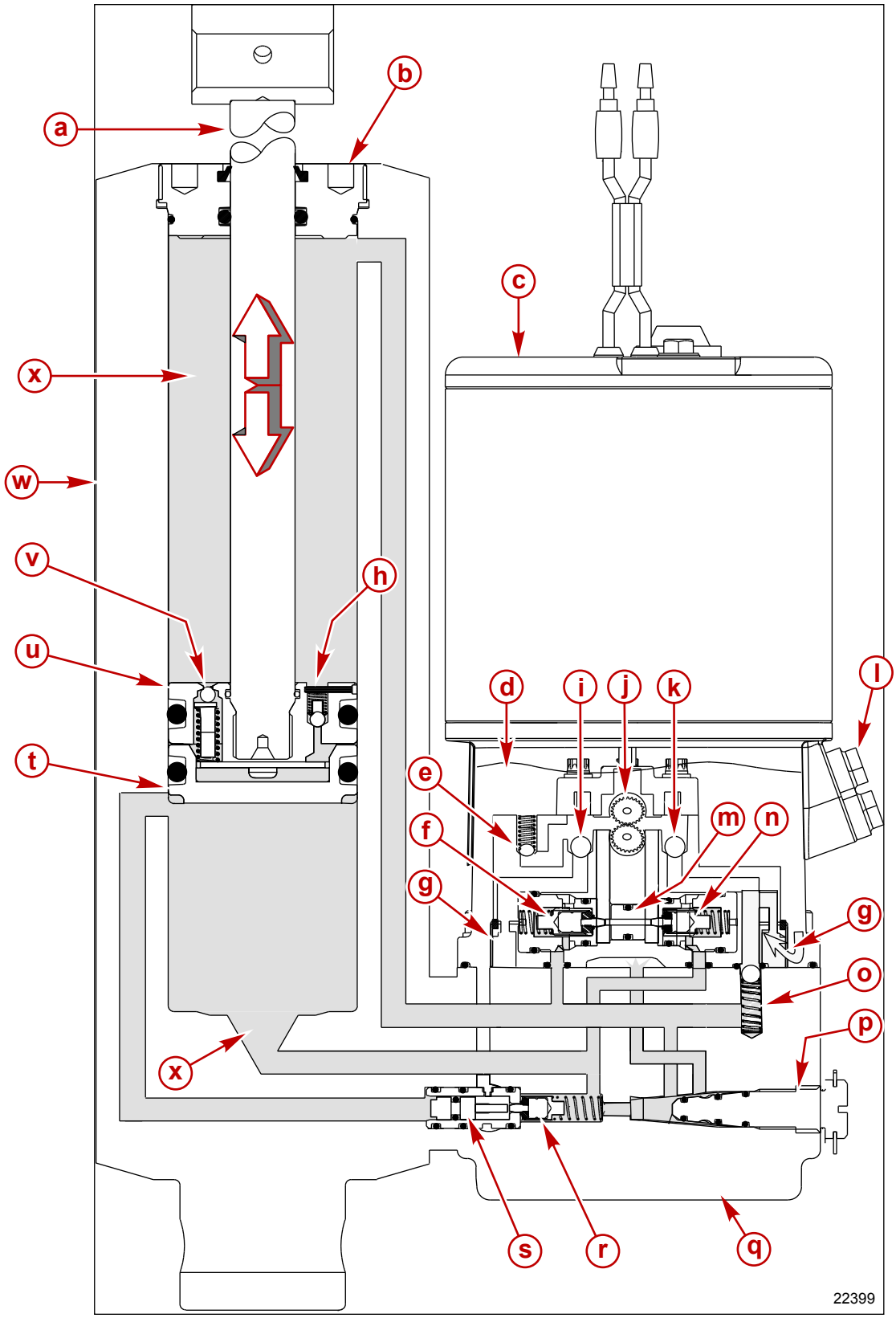
- **n -** Up circuit pressure operated valve
- **o -** Manifold reverse suction valve
- **p -** Manual release valve
- **q -** Manifold
- **r -** Tilt relief valve
- **s -** Tilt relief piston
- **t -** Memory piston
- **u -** Shock piston
- **v -** Impact relief valve
- **w -** Cylinder
- **x -** Return oil
- **y -** Oil under pressure

After the engine clears the underwater object, the weight of the engine increases the oil pressure between the memory piston and shock piston to the level required to open the shock return valve inside the shock piston. This allows the oil to bleed back through the shock piston into the down cavity. If required, additional oil enters the down cavity through the manifold reverse suction valve. This returns the engine back against the memory piston and into the original running position.

Manual Tilt



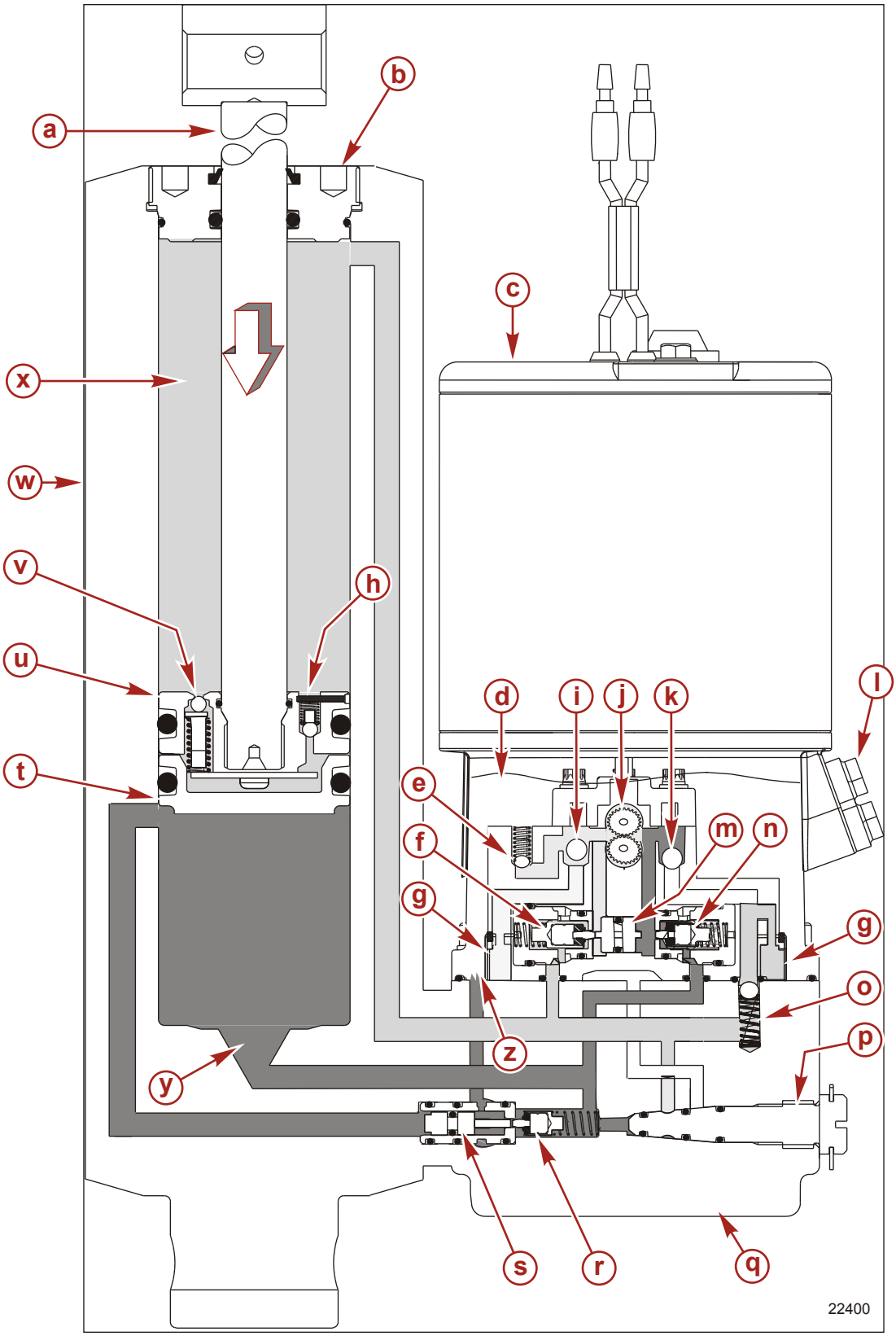
- a - Trim rod
- b - End cap
- c - Electric motor
- d - Reservoir oil
- e - Down circuit pressure relief valve
- f - Down circuit pressure operated valve
- g - Filter (two shown for clarity)
- h - Shock return valve
- i - Up circuit suction port
- j - Oil pump gears
- k - Down circuit suction port
- l - Oil fill cap
- m - Shuttle valve
- n - Up circuit pressure operated valve
- o - Manifold reverse suction valve
- p - Manual release valve
- q - Manifold
- r - Tilt relief valve
- s - Tilt relief piston
- t - Memory piston
- u - Shock piston
- v - Impact relief valve
- w - Cylinder
- x - Return oil

To manually tilt the outboard engine, back out the manual release valve 3-4 turns. With the valve backed out, the internal passages inside the manifold are connected. These passages connect both the cylinder down and up cavities, along with the reservoir, allowing the engine to be raised or lowered. Trim rod movement continues until the manual release valve is closed, locking the fluid inside of the cylinder and manifold. If the outboard motor is to be raised manually, turn the manual release valve counterclockwise to the full out position. When in the full out position, oil in the trim cylinder can flow freely from the up side to the down side, or from the down side to the up side. The oil return line into the reservoir is also open, allowing free oil flow to either side of the tilt cylinder to accommodate the differential oil capacities between the tilt cylinder up side and down side cavities.

When trimming the outboard in either the up or down position, with the manual tilt valve open or leaking, little or no movement occurs. Oil pressure from the pump moves to both the up cavity, and through the manual tilt valve into the down cavity. There is equal pressure in each cavity resulting in little or no movement.

IMPORTANT: Do not operate the outboard or trim the outboard in either the up or down direction with the manual tilt valve open. Damage to the O-rings may occur. Close the manual release valve before operating the trim or the outboard.

Trim Limit



- **a -** Trim rod
- **b -** End cap
- **c -** Electric motor
- **d -** Reservoir oil
- **e -** Down circuit pressure relief valve
- **f -** Down circuit pressure operated valve
- **g -** Filter (two shown for clarity)
- **h -** Shock return valve
- **i -** Up circuit suction port
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- **u -** Shock piston
- **v -** Impact relief valve
- **w -** Cylinder
- **x -** Return oil
- **y -** Oil under pressure
- **z -** Filtered supply oil

When the weight of the outboard and propeller thrust reach sufficient levels, the pressure inside the trim cylinder increases to the pressure required to move the tilt relief piston. The tilt relief piston pin opens the tilt relief valve. Up pressure flows into the trim relief passage, and returns back into the reservoir. If the outboard engine is positioned in the tilt range (beyond full trim position) when the tilt relief valve opens, it will move back down to the full trim position (trim limit).

Reverse Operation

To prevent the outboard from coming up or trailing out, when shifted into reverse and/or throttling back rapidly, oil in the trim system must be locked in a static position. This is accomplished with the up and down pressure operated valves. When the pump is not operating, the shuttle valve is in a centered position and the pressure operated valves are held closed by the springs behind the valve poppet. Oil is now locked in both ends of the cylinder preventing the trim rod from moving in or out.

Troubleshooting

Support the outboard with a tilt lock pin when servicing the power trim system.

IMPORTANT: After debris or failed components have been found, it is recommended that unit be disassembled completely and all O-rings be replaced. Check valve components and castings must be cleaned using engine cleaner and compressed air, or replaced prior to reassembly.

IMPORTANT: Power trim system is pressurized. Outboard must be in the full up position (trim rod fully extended) prior to fill/drain plug or manual release valve removal.

1. Refer to instructions following if disassembly is required when servicing.
2. Follow preliminary checks before proceeding to troubleshooting flow diagrams following.

Preliminary Checks

IMPORTANT: Operate power trim system after each check to see if problem has been corrected. If the problem has not been corrected, proceed to next check.

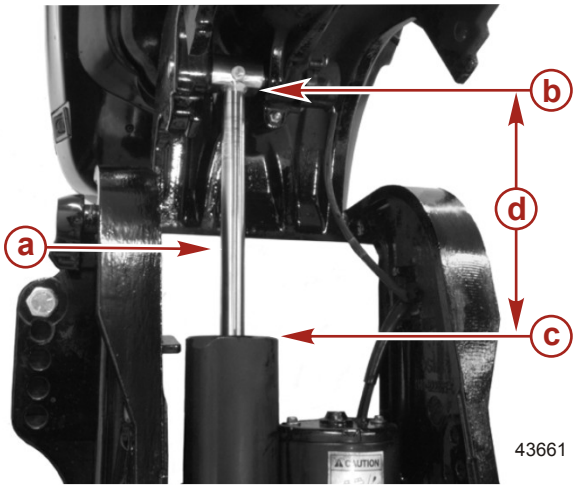
1. Ensure manual release valve is tightened to full clockwise position.
2. Check trim pump fluid level with outboard in full up position and fill if necessary. Refer to **Bleeding Power Trim Unit** in this section.
3. Check for external leaks in power trim system. Replace defective parts if leak is found.
4. Outboard not holding tilted position (falls down to trim position) indicates debris or defective components in trim assembly. Clean or replace components as required.

Trim/Tilt Cylinder Leakage Test

Method 1

1. Extend the trim/tilt cylinder to the full up position.
2. Measure the distance between the cylinder cap and the bottom of the cylinder rod eye.
3. Wait 24 hours and measure the distance again.
4. If the measured leak-down distance is greater than specified:
   - Rebuild the trim/tilt assembly using the O-ring rebuild kit and component repair kits. Refer to the component parts list.
   - or

- Replace the trim/tilt assembly.



a - Cylinder rod
b - Rod eye
c - Cylinder cap
d - Measured distance

Power Tilt System Leakage Specification	
Cylinder rod leak-down in 24 hour period	Less than 55 mm (2.2 in.)

Method 2

1. Extend the trim/tilt cylinder to the full up position.
2. Mark the cylinder rod 55 mm (2.2 in.) above the cylinder cap with an indelible marker.
3. Wait 24 hours.
4. If the marked line is not visible, the power tilt unit is not within specification for leakage:
   - Rebuild the trim/tilt assembly using the O-ring rebuild kit and component repair kits. Refer to the component parts list.
   - or
   - Replace the trim/tilt assembly.

Power Tilt System Leakage Specification	
Cylinder rod leak-down in 24 hour period	Less than 55 mm (2.2 in.)

Hydraulic System Troubleshooting

Condition/Problem

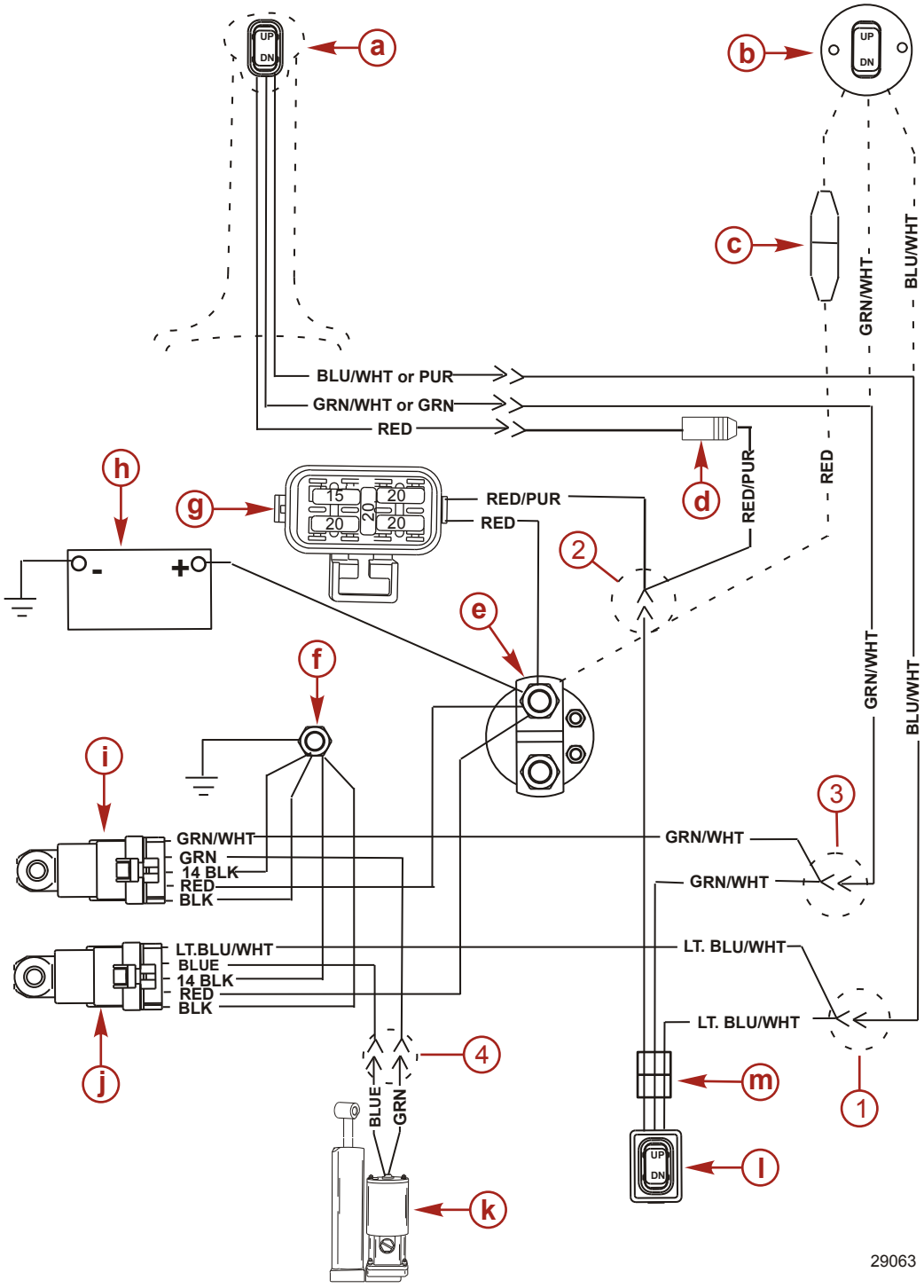
Condition of Trim System	Problem
Trim motor runs; trim system does not move up or down	1, 2, 5, 6, 9
Does not trim full down. Up trim OK.	2, 3, 4, 6
Does not trim full up. Down trim OK.	1, 2, 4, 6
Partial or jerky down/up	1, 3
Thump noise when shifting	2, 3, 5
Does not trim under load	2, 5, 7, 8, 9, 11
Does not hold trim position under load	4, 5, 6
Trail out when backing off from high speed	3, 4
Leaks down and does not hold trim	4, 5, 6
Trim motor working hard and trims slow up and down	7, 8
Trims up very slow	1, 2, 7, 8
Starts to trim up from full down position when the down trim button is depressed	3, 4
Trim position will not hold in reverse	2, 3, 4, 5, 12

Problem/Solution

No.	Problem	Solution
1.	Low fluid level	Add Power Trim and Steering Fluid or ATF (Type Dexron III).

No.	Problem	Solution
2.	Defective hydraulic pump	Pressure test pump. Refer to **Testing Power Trim System,** following.
3.	Trim cylinder shock piston ball not seated	Inspect ball seat for nicks or contamination.
4.	Trim cylinder piston or memory piston O-rings leaking or cut	Inspect O-rings for cuts or abrasion.
5.	Manual release valve leaking (check condition of O-rings) (valve not fully closed)	Ensure the valve is fully closed. Inspect O-rings.
6.	Debris in system	Inspect for debris. Refill system with clean fluid.
7.	Battery low	Check the battery.
8.	Electric motor defective	Replace the electric motor. Refer to **Power Trim Disassembly.**
9.	Broken motor/pump driveshaft	Inspect for damage.
10.	Air pocket under pump	Purge the system. Refer to **Bleeding Power Trim Unit**.
11.	Defective up relief valve	Replace the power trim pump assembly.
12.	Defective down relief valve	Replace the power trim pump assembly.

Troubleshooting the Power Trim Electrical System



- **a -** Trim switch (remote control mounted)
- **b -** Trim switch (panel mounted)
- **c -** Accessory fuse holder
- **d -** Remote control wiring plug connector
- **e -** Start solenoid
- **f -** Starter bolt
- **g -** Main fuse holder
- **h -** Battery
- **i -** Down relay

j - Up relay
k - Trim pump motor
l - Cowl switch
m - Three pin connector

DMT 2004 Digital Multimeter	91-892647A01
DVA/Multimeter Kit	91- 99750A 1

Troubleshooting the Up Circuit

NOTE: *Refer to previous wiring diagram for location of wire connections.*

Problem	Possible Cause	Remedy
Trim switch up is inoperative, but the cowl switch up does operate.	1. Open wire between connection (1) and trim switch. 2. Faulty trim switch.	1. Check for an open connection or cut wire. 2. Replace.
Cowl switch up is inoperative, but the trim switch up does operate.	1. Open wire between wire connection (2) and solenoid. 2. Faulty cowl switch.	1. Check for an open connection or cut wire. 2. Replace.
Trim switch up and cowl switch up are both inoperative.	1. Open wire between wire connection (1) and the down relay. 2. Open black wire between ground and up relay. 3. Open red wire between solenoid and up relay. 4. Faulty up relay.	1. Check for an open connection. 2. Check for an open connection. 3. Check for an open connection. 4. Replace relay.

Troubleshooting the Down Circuit

NOTE: *Refer to previous wiring diagram for location of wire connections.*

Problem	Possible Cause	Remedy
Trim switch down is inoperative, but the cowl switch down does operate.	1. Open wire between wire connection (3) and trim switch. 2. Faulty trim switch.	1. Check for an open connection or cut wire. 2. Replace.
Cowl switch down is inoperative, but the trim switch down does operate.	1. Open wire between connection (2) and solenoid. 2. Faulty cowl switch.	1. Check for an open connection or cut wire. 2. Replace.
Trim switch down and cowl switch down are both inoperative.	1. Open wire between wire connection (3) and the up relay. 2. Open black wire between ground and down relay. 3. Open red wire between solenoid and down relay. 4. Faulty down relay.	1. Check for an open connection. 2. Check for an open connection. 3. Check for an open connection. 4. Replace relay.

Troubleshooting the Up and Down Circuits (All Circuits Inoperative)

NOTE: *Refer to previous wiring diagram for location of wire connections.*

Problem	Possible Cause	Remedy
Trim switch up and down are both inoperative, but cowl switch does operate.	1. 20 amp fuse blown. 2. Faulty trim switch. 3. Wire is open between fuse holder and solenoid. 4. Wire is open between fuse holder and trim switch.	1. Replace fuse. Locate the cause of the blown fuse. Check electrical wiring for a shorted circuit. 2. Replace. 3. Check for an open connection or cut wire. 4. Check for a loose or corroded connection.
Trim switch and cowl switch are both inoperative.	1. One of the trim pump motor wires is open between the motor and the relays. 2. Faulty trim pump motor.	1. Check wire connections (4) for loose or corroded condition. 2. If voltage is present at connections (4) when the appropriate trim button is pressed, then motor is faulty. Replace motor.

Problem	Possible Cause	Remedy
Trim system operates (motor runs) without pressing the switches.	1. The trim or cowl switch is shorted.	1. Replace.

Testing Power Trim System with Test Gauge Kit

Up Pressure Check

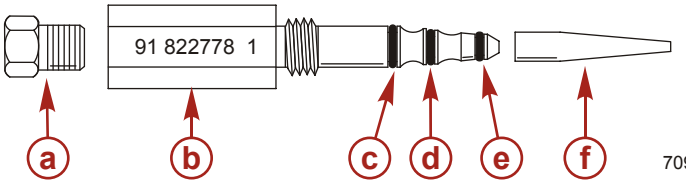
IMPORTANT: This test will not locate problems in the trim system. The test will measure system pressure. If minimum pressures are not obtainable, the trim system requires additional repair.

IMPORTANT: Check the battery for full charge before performing the tests.

1. Tilt the outboard to full up position and engage the tilt lock lever.
2. Slowly remove the fill plug to bleed pressure from the reservoir.
3. Remove the circlip securing the manual release valve and unscrew the release valve from the trim assembly.

   NOTE: *A small amount of trim fluid may drip from the manual release valve hole. Place a suitable container under the trim assembly to collect any leakage.*

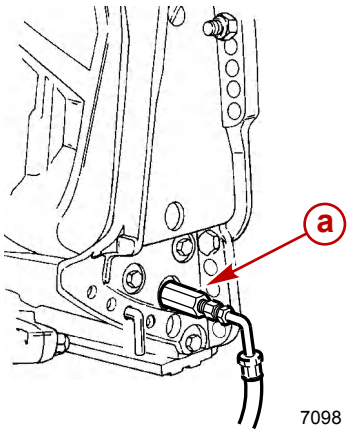
   NOTE: *Assemble the test adapter by using an O-ring installation tool to position the small O-ring onto the adapter, then install the medium O-ring, and lastly, the large O-ring. Thread the brass fitting into the test adapter securely using Loctite 567 PST Pipe Sealant on the threads.*



a - Brass fitting
b - Test adapter
c - Large O-ring
d - Medium O-ring
e - Small O-ring
f - O-ring installation tool

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Brass fitting threads	92-809822

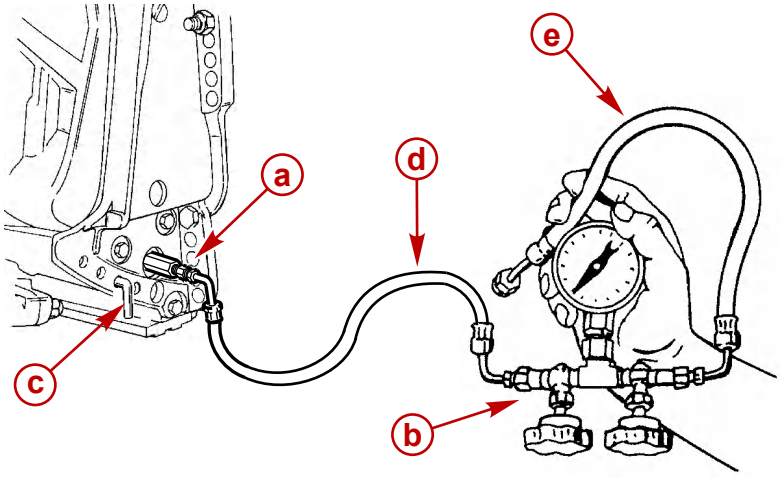
4. Install the test adapter into the manual release valve hole.



a - Test adapter

Adapter Fitting	91-822778A 1

5. Thread the hose from the test gauge kit into the brass fitting on the adapter.



7099

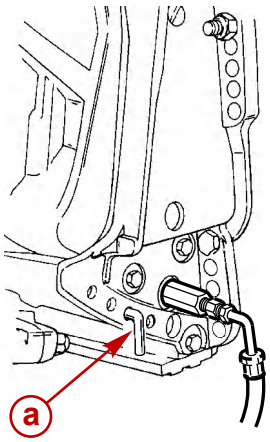
a - Brass fitting
b - Test gauge assembly
c - Tilt pin
d - Hose
e - Hose (not used)

Power Trim Test Gauge Kit	91- 52915A 6

6. Install the fill plug.
7. Run the trim up and disengage the tilt lock lever.

IMPORTANT: Install the tilt pin correctly to prevent transom failure and personal injury.

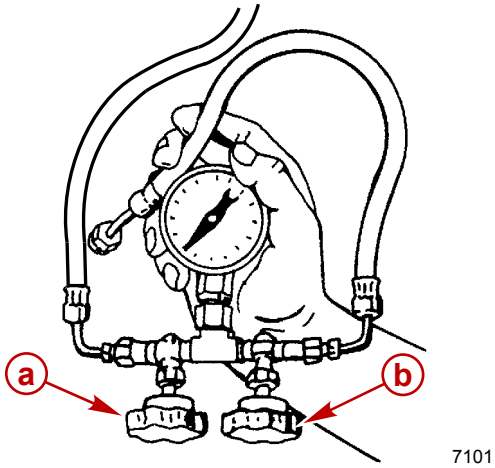
8. Move the outboard in until the hole in the swivel bracket ear aligns with the third tilt hole in the transom bracket. Lock the engine in the trim range by installing a 10 mm (3/8 in.) diameter tilt pin or two 10 mm (3/8 in.) hardened bolts and nuts through the transom brackets and swivel bracket in the hole shown.



7100

a - Tilt pin hole

9. Open valve "a" and close valve "b."



10. Run the trim up to the full up position. Record pressure reading on the gauge. Release the trim switch.

Power Trim	
Up pressure (minimum)	19,300 kPa (2800 psi)

11. Run the trim down to release pressure and remove the spare tilt pin or bolts and nuts.
12. Tilt the outboard full up and engage the tilt lock lever.
13. Slowly remove the fill plug to bleed pressure.
14. Remove the test gauge hose and adapter.
15. Install the manual release valve and secure the valve with circlip.
16. Tighten the fill plug.

NOTE: *If pressure is out of the specified pressure range, troubleshoot the system per instructions preceding in this section.*

Down Pressure Check

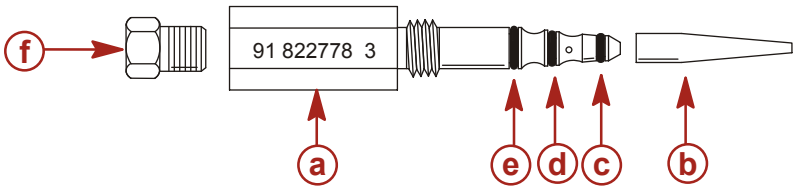
IMPORTANT: This test will not locate problems in the trim system. The test will measure system pressure. If minimum pressures are not obtainable, the trim system requires additional repair.

IMPORTANT: Check the battery for full charge before performing the tests.

1. Tilt the outboard to full up position and engage the tilt lock lever.
2. Slowly remove the fill plug to bleed pressure from the reservoir.
3. Remove the circlip securing the manual release valve and unscrew the release valve from the trim assembly.

NOTE: *A small amount of trim fluid may drip from the manual release valve hole. Place a suitable container under trim assembly to collect any leakage.*

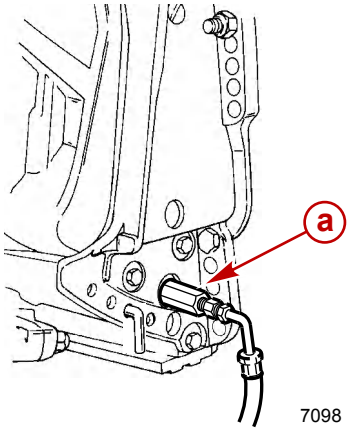
NOTE: *Assemble the test adapter by using an O-ring installation tool to position the small O-ring onto the adapter, then install the medium O-ring, and lastly, the large O-ring. Thread the brass fitting into the test adapter securely using Loctite 567 PST Pipe Sealant on the threads.*



- **a -** Test adapter
- **b -** O-ring installation tool
- **c -** Small O-ring (install first)
- **d -** Medium O-ring (install second)
- **e -** Large O-ring (install last)
- **f -** Brass fitting

Tube Ref No.	Description	Where Used	Part No.
9	Loctite 567 PST Pipe Sealant	Brass fitting threads	92-809822

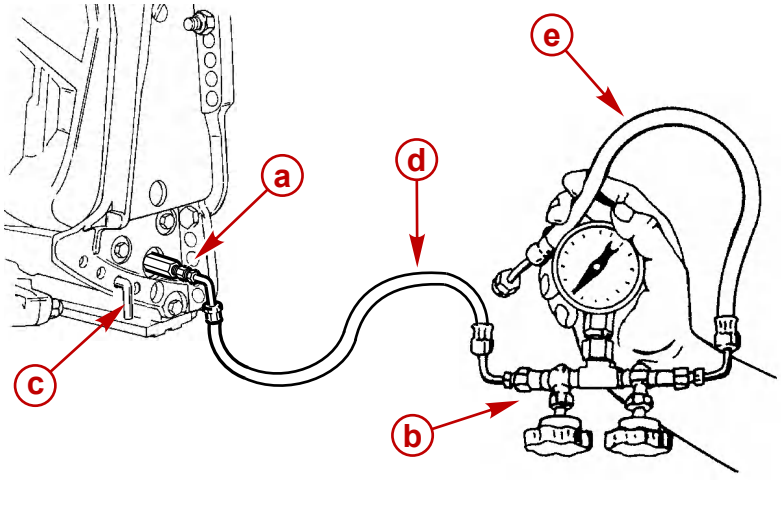
4. Install the test adapter into the manual release valve hole.



a - Test adapter

Adapter Fitting	91-822778A 3

5. Thread the hose from the test gauge kit into the brass fitting on the adapter.

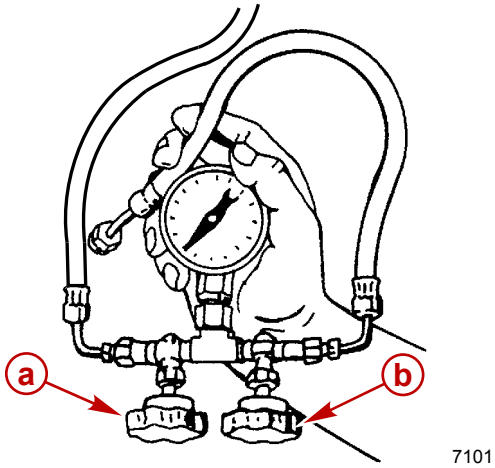


a - Brass fitting
b - Test gauge assembly
c - Tilt pin
d - Hose
e - Hose (not used)

Adapter Fitting	91-822778A 3
Power Trim Test Gauge Kit	91- 52915A 6

6. Install the fill plug.
7. Run the trim up and disengage the tilt lock lever.

8. Open valve "a" and close valve "b."



9. Run the trim up to the full down position. Record pressure reading on the gauge. Release the trim switch.

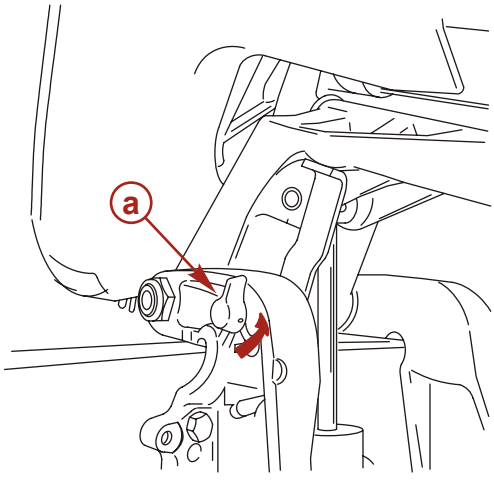
Power Trim	
Down pressure	3450–5515 kPa (500–800 psi)

10. Tilt the outboard full up and engage the tilt lock lever.
11. Slowly remove the fill plug to bleed pressure.
12. Remove the test gauge hose and adapter.
13. Install the manual release valve and secure the valve with the circlip.
14. Tighten the fill plug.

NOTE: *If the pressure is out of the specified pressure range, troubleshoot the system per instructions in this section.*

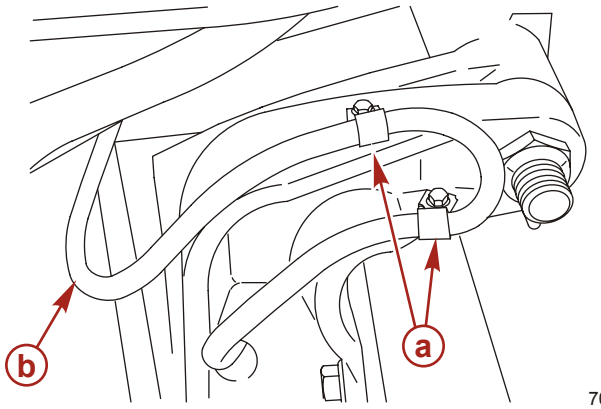
Power Trim System Removal

1. Tilt the outboard to the full up position and support with a tilt lock pin.



a - Tilt lock pin

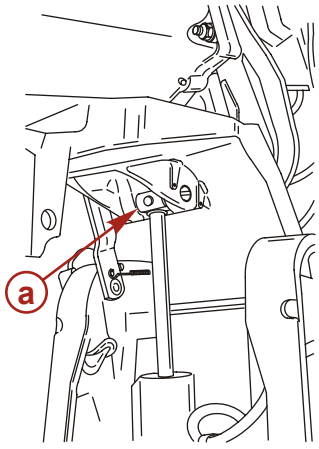
2. Disconnect the power trim wire harness and remove the J-clips.



7086

a - J-clips
b - Wire harness

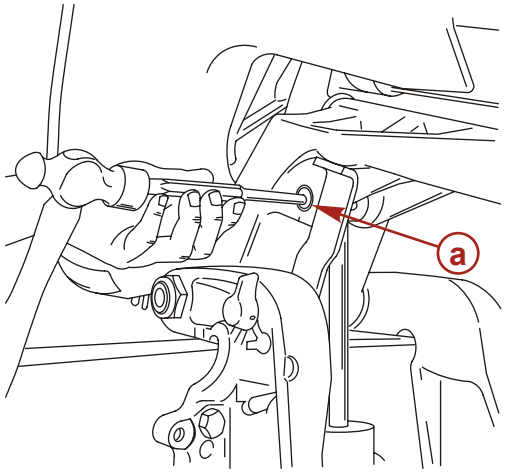
3. Remove the upper trilobe pin.



7088

a - Upper trilobe pin

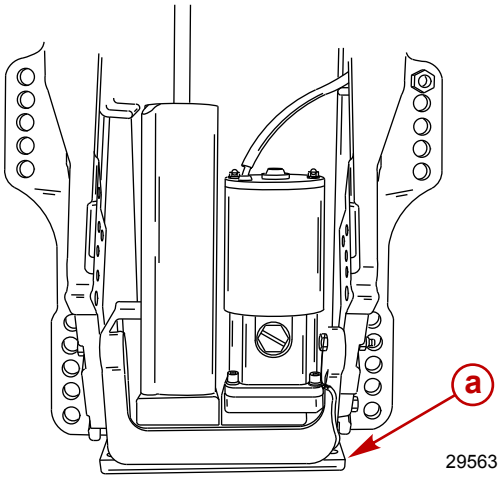
4. Drive out the upper pivot pin.



7089

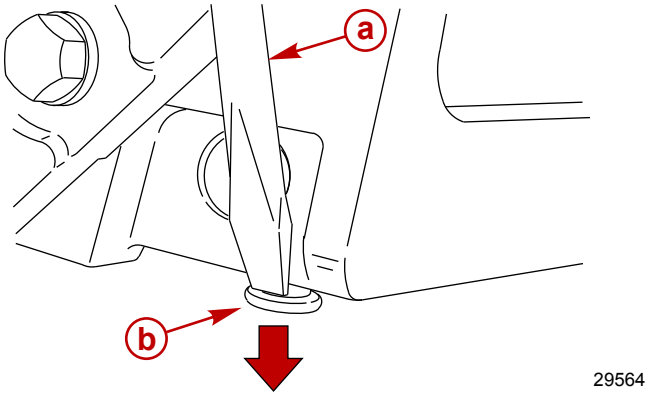
a - Upper pivot pin

5. Remove the sacrificial anode.



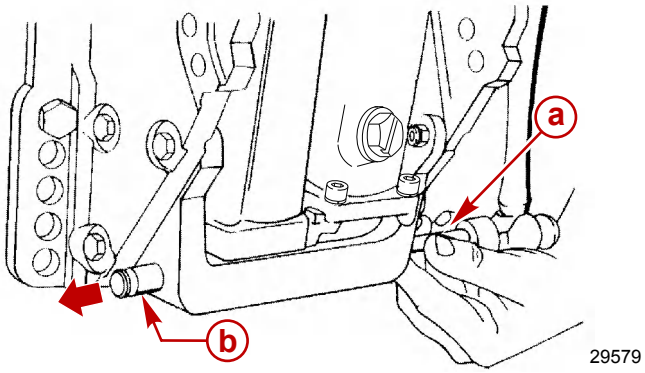
a - Sacrificial anode

6. Use a suitable punch to remove the lower trilobe pin.



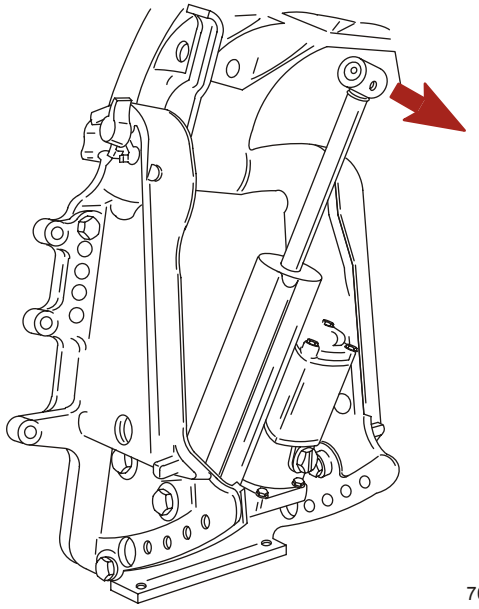
a - Punch
b - Lower trilobe pin

7. Use a suitable punch to drive out the lower pivot pin.



a - Punch
b - Lower pivot pin

8. Tilt the top part of the power trim assembly out first from the swivel bracket and remove the power trim assembly.



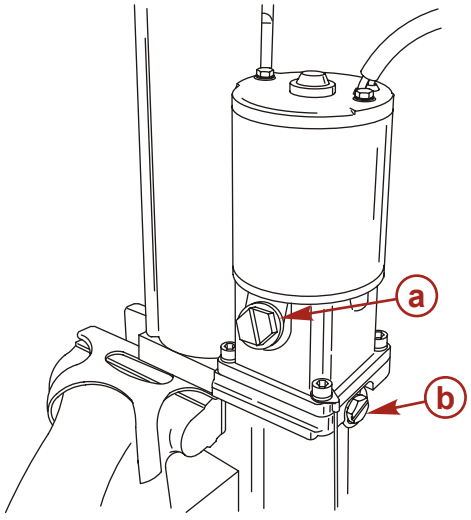
7093

Power Trim Disassembly

Draining Power Trim

IMPORTANT: Power trim system is pressurized. Trim rod must be fully extended in the up position, prior to fill/drain plug, or manual release valve removal.

1. Remove reservoir plug.
2. Remove manual release valve assembly to drain oil.



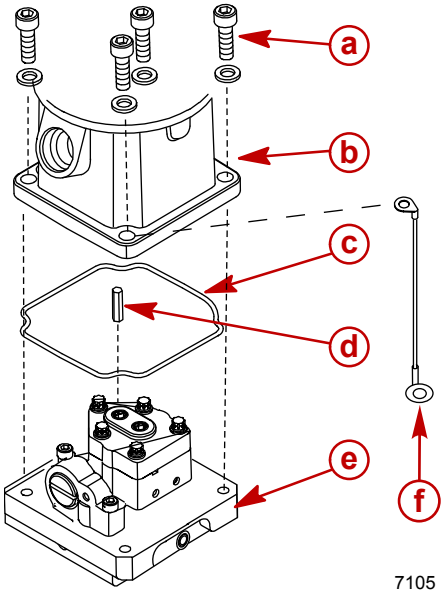
a - Reservoir plug
b - Manual release valve

7104

Trim Motor Removal

1. Secure power trim assembly in a soft jaw vise.

2. Remove four screws to detach motor/reservoir. Remove reservoir seal and coupler.

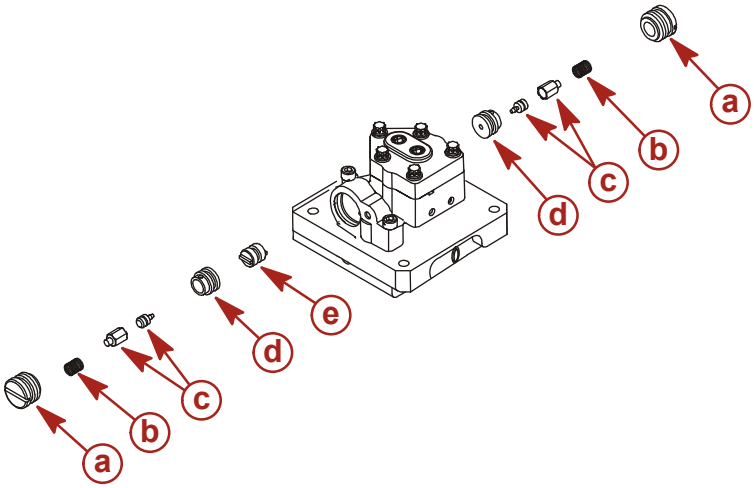


7105

a - Screw and washer (4)
b - Reservoir
c - Reservoir seal
d - Coupler
e - Manifold assembly
f - Ground strap

Power Trim Pump and Components Removal

1. Remove pressure operated plugs on pump. Remove spring and check valve/poppet from both sides. Use an expanding rod and collet to remove check valve/poppet.

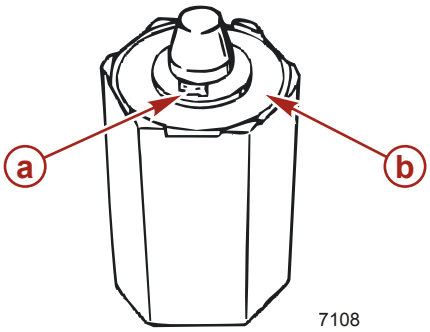


7106

a - Plug (2)
b - Spring (2)
c - Check valve/poppet (2)
d - Seat (2)
e - Spool

Expanding Rod	Snap On CG41-11
Collet	Snap On CG41-14

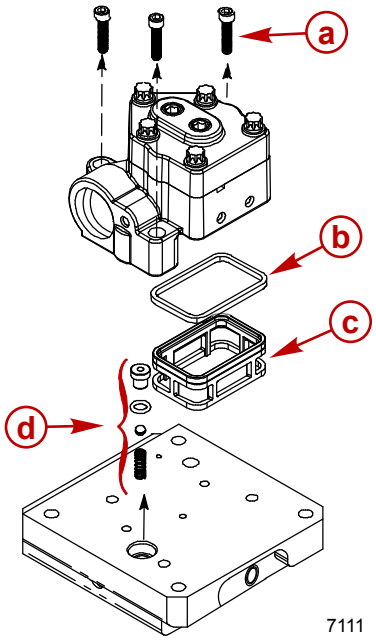
2. Inspect poppet assembly for debris in the area shown. If debris is found on poppet, replace poppet.



7108

a - Debris under valve
b - Rubber seat

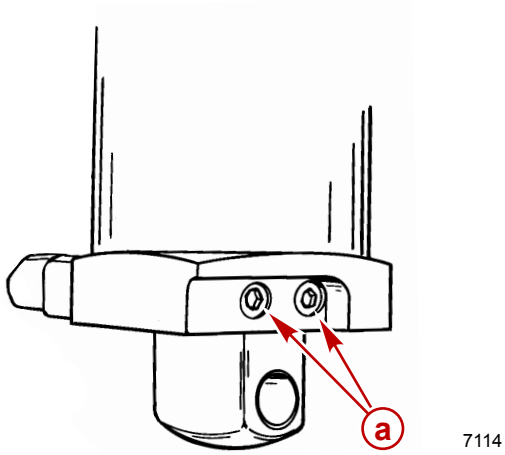
3. Remove three screws to remove pump. Remove filter and filter seal under pump. Remove suction seat assembly.



a - Screw (3)
b - Filter seal
c - Filter
d - Suction seat assembly

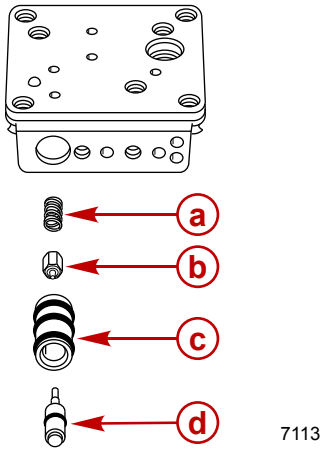
Manifold Removal

1. Remove two screws to remove manifold from cylinder.



a - Screw (2)

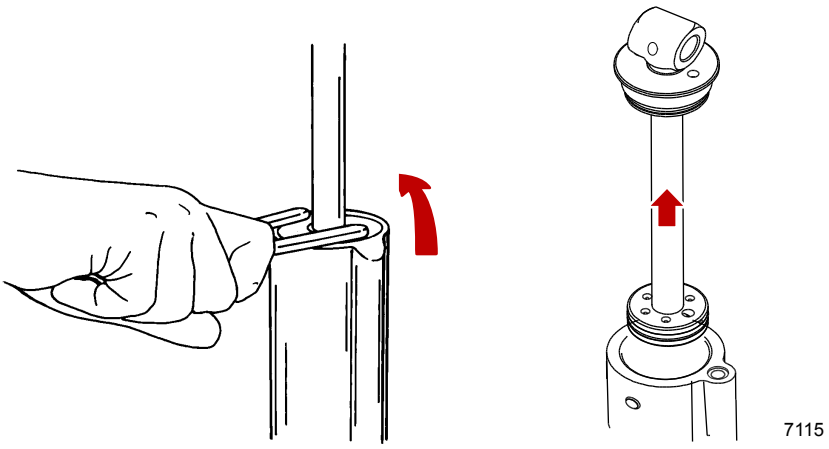
2. Remove tilt relief components.



a - Spring
b - Poppet
c - Spool housing
d - Trim limit spool

Shock Rod Removal

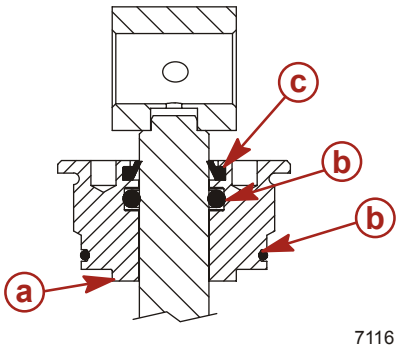
1. Unscrew end cap assembly from cylinder using spanner wrench 6.4 mm x 8 mm (1/4 in. x 5/16 in.) long pegs.
2. Remove shock rod assembly from cylinder.



Spanner Wrench	91- 74951
Trim Cylinder End Cap Tool	91-821709T

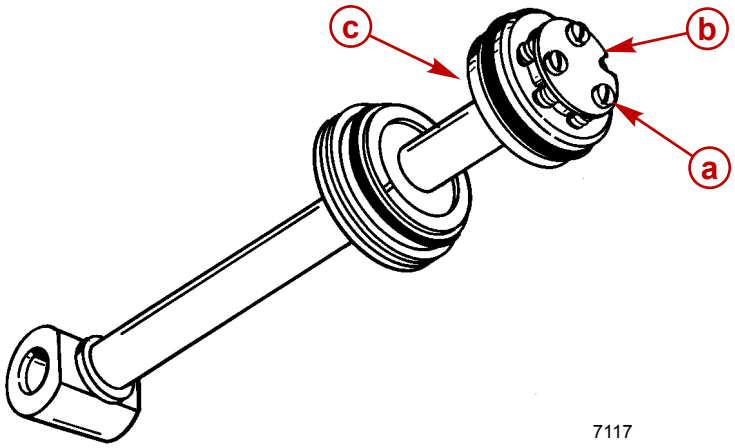
Shock Rod Disassembly

NOTE: *The only serviceable items on the shock rod assembly are the O-rings and wiper ring. If the shock rod requires any other repair, replace the shock rod assembly.*



a - End cap
b - O-ring (2)
c - Wiper ring

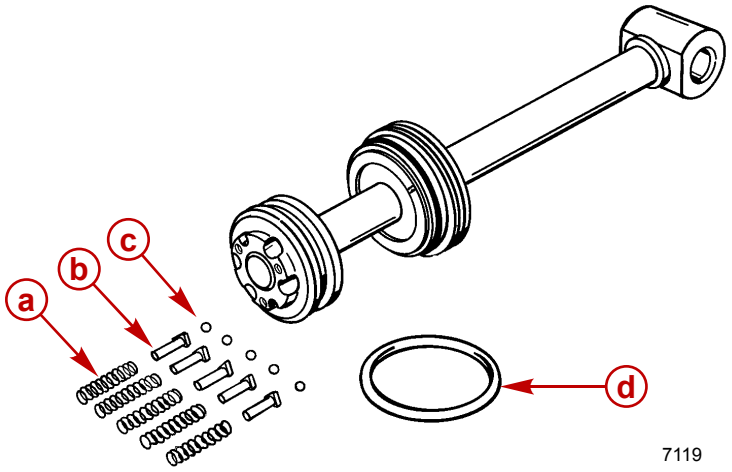
1. Place the shock rod assembly on a clean work surface.
2. Remove the three screws and remove the plate from the shock rod piston.



a - Screw (3)
b - Plate
c - Shock rod piston

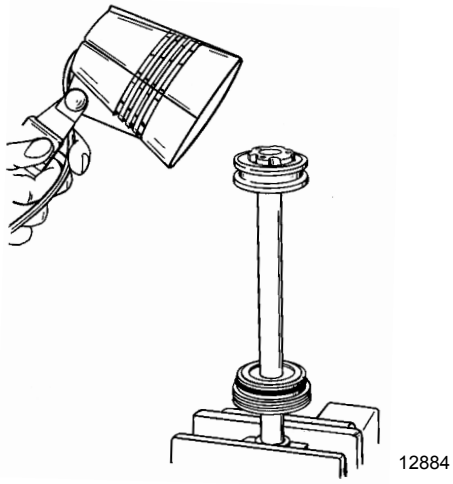
3. Remove the check ball components from the shock rod piston.

4. Remove the O-ring from the shock rod piston.



a - Spring (5)
b - Seat (5)
c - Ball (5)
d - O-ring

5. Place the shock rod into a soft jawed vise and apply heat to loosen the piston using a torch lamp.

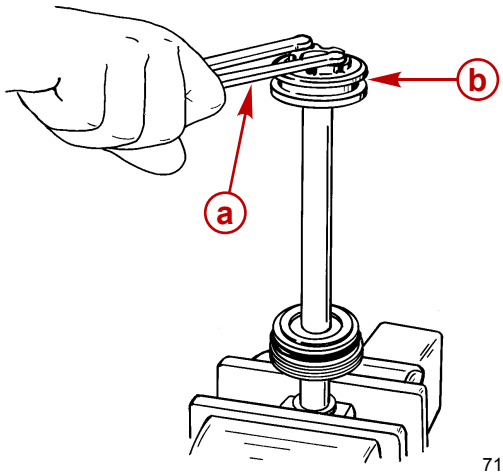


Torch Lamp	91- 63209

6. Loosen the shock rod piston using a spanner wrench (6.4 mm x 8 mm [1/4 in. x 5/16 in.] long pegs).

IMPORTANT: Use a spanner wrench with 6.4 mm x 8 mm (1/4 in. x 5/16 in.) long pegs to remove the shock rod piston.

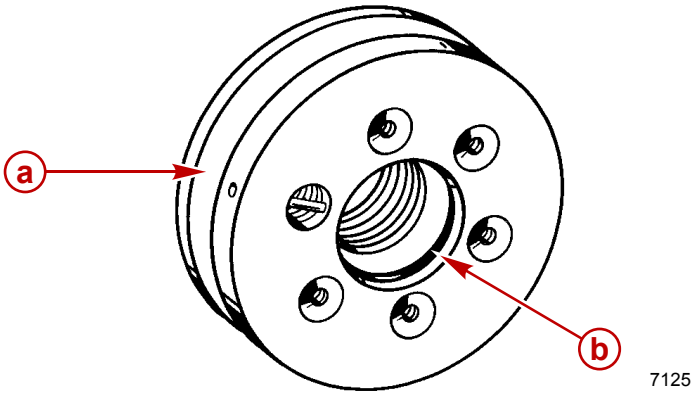
NOTE: *When using the trim cylinder end cap tool, use the large diameter pins, 5.97 mm (0.235 in.), in the 1 in. span position. Pins should be partially pulled out of the spanner wrench to extend approximately 9.5 mm (0.375 in.).*



a - Spanner wrench
b - Shock rod piston

Spanner Wrench	91- 74951
Trim Cylinder End Cap Tool	91-821709T

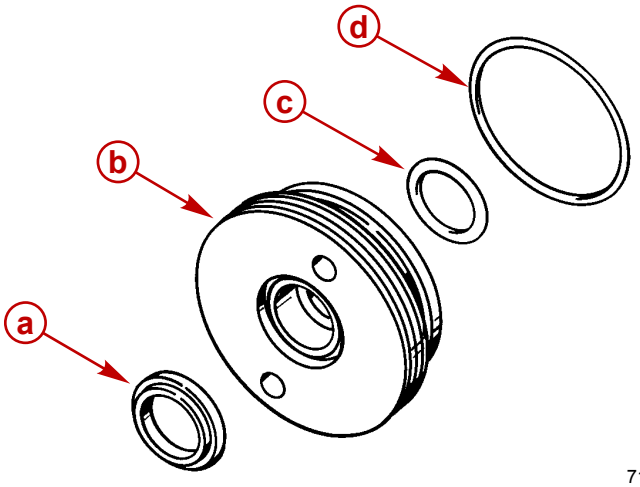
7. Allow the shock rod piston to cool. Remove from the shock rod.
8. Inspect the check valve for debris. Clean debris from the check valve if found. If debris cannot be cleaned from the check valve, replace the shock piston as an assembly.
9. Clean the shock and components with compressed air.
10. Remove the inner O-ring from the shock rod piston.



7125

a - Shock piston
b - O-ring

11. Remove the cylinder end cap assembly from the shock rod.
12. Inspect the shock rod components. If the wiper located in the cap has failed to keep the rod clean, replace the wiper.
13. Place the end cap on a clean work surface.
14. Remove the rod wiper, inner O-ring, and outer O-ring.



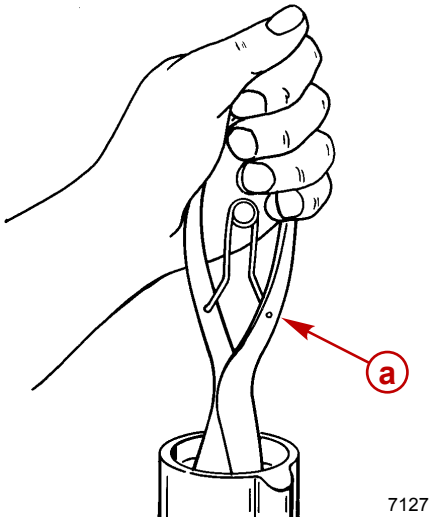
7126

a - Rod wiper
b - Cylinder end cap
c - Inner O-ring
d - Outer O-ring

Memory Piston Removal

1. Remove the memory piston from the cylinder using one of two methods:

a. Use lockring pliers or suitable tool.



a - Lockring pliers

Lockring Pliers	Snap-On SRP-4

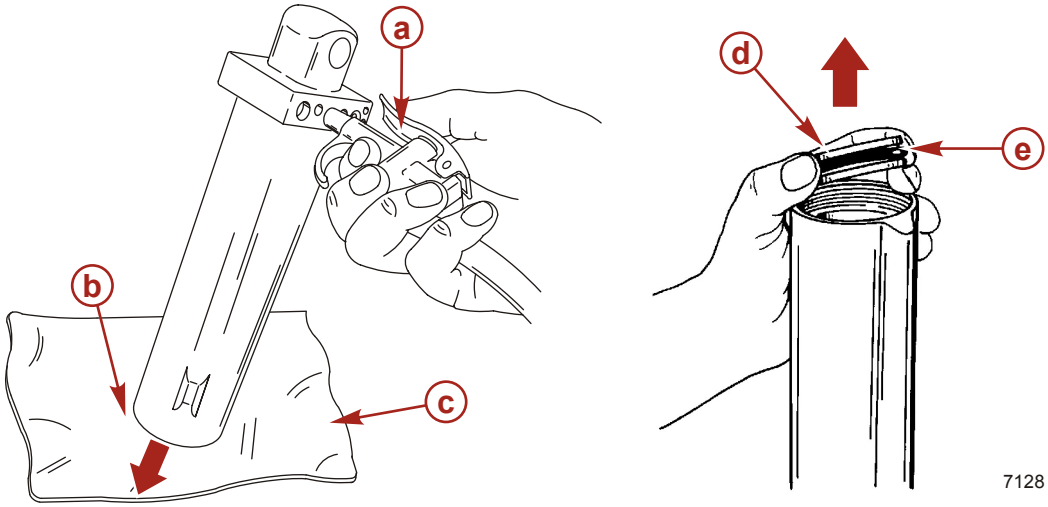
b. Blow compressed air into the manual release valve hole using an air nozzle.

⚠ WARNING

The memory piston cup may be expelled at a high velocity when air pressure is applied. Failure to position the cylinder opening down and away from your body could result in personal injury.

NOTE: *Point cylinder opening down and away. Use a shop rag or towel to catch the memory piston and avoid damage or personal injury.*

2. Remove the O-ring from the memory piston.



a - Adapter/air hose
b - Memory piston exit
c - Shop rag
d - Memory piston
e - O-ring

Power Trim Cleaning, Inspection, and Repair

IMPORTANT: Components must be dirt and lint free. Slightest amount of debris in the power trim system could cause system to malfunction.

1. Clean shock rod and components with parts cleaner and dry with compressed air.

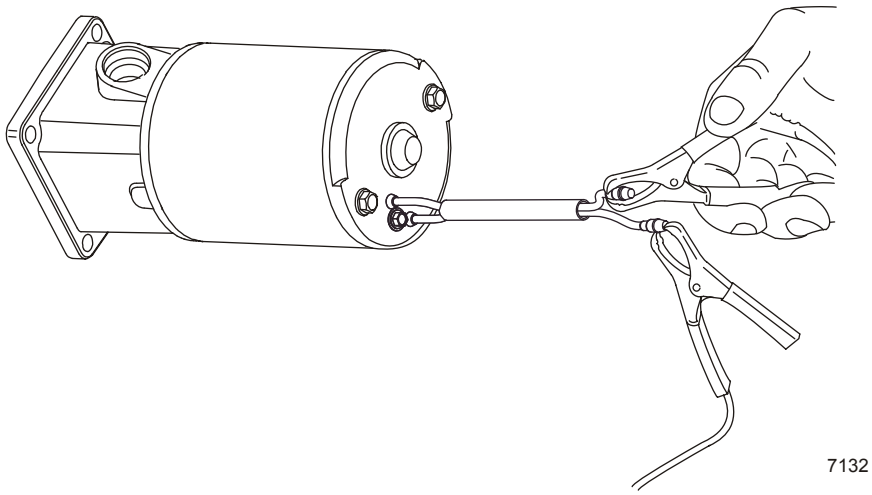
   NOTE: *It is recommended that all O-rings in trim system be replaced. Use O-ring kit 25-893914A02.*

2. Lubricate all O-rings with Power Trim and Steering Fluid. If not available, use automotive automatic transmission fluid (ATF).

Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	Power trim O-rings	92-858074K01

Trim Motor Electrical Tests

Connect a 12 volt supply to motor leads. If motor fails to run, replace pump motor.

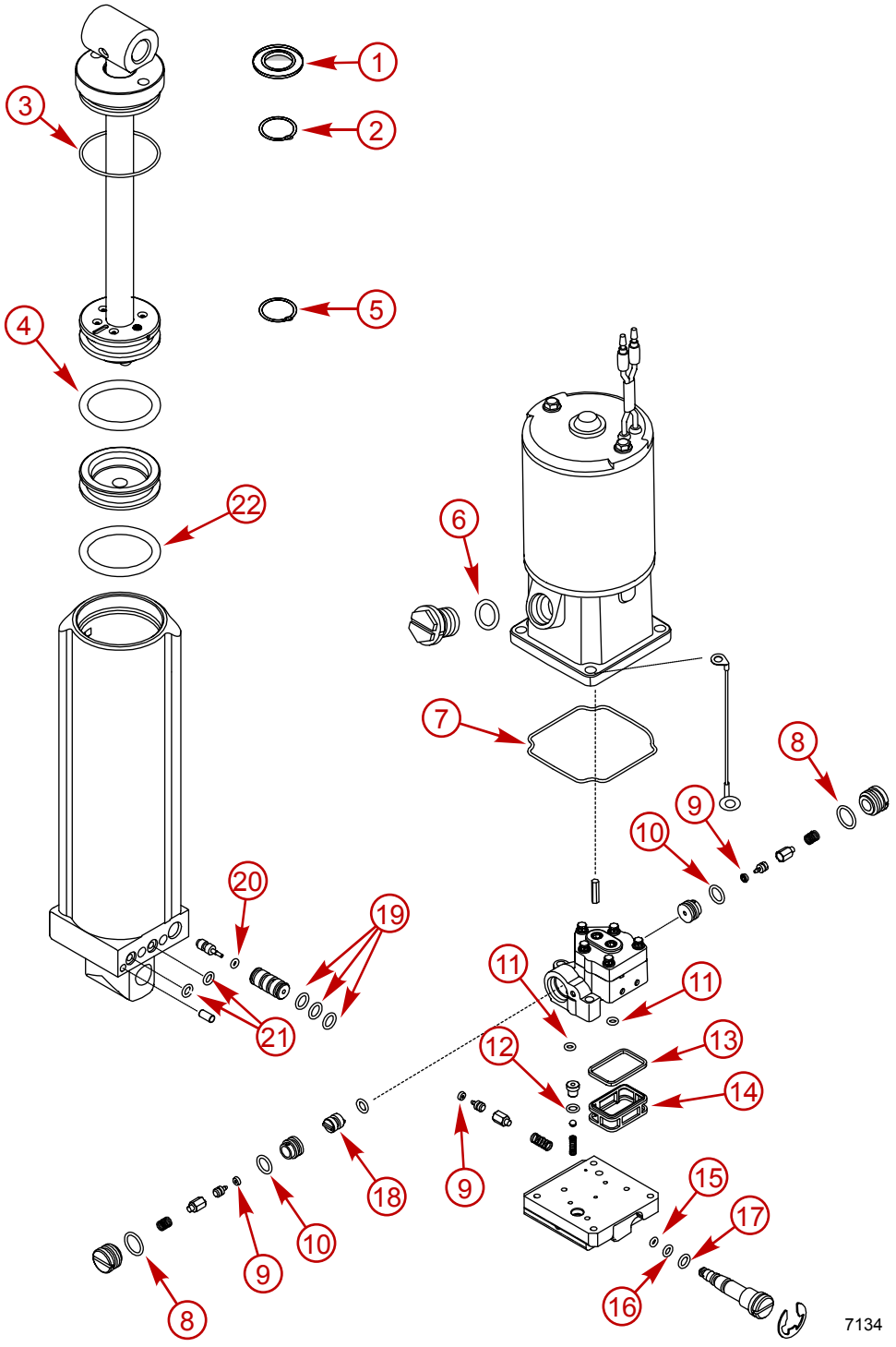


IMPORTANT: Trim motor is not serviceable. If motor fails to run, replace motor assembly.

Notes:

Power Trim Assembly

O-Ring and Seal Placement

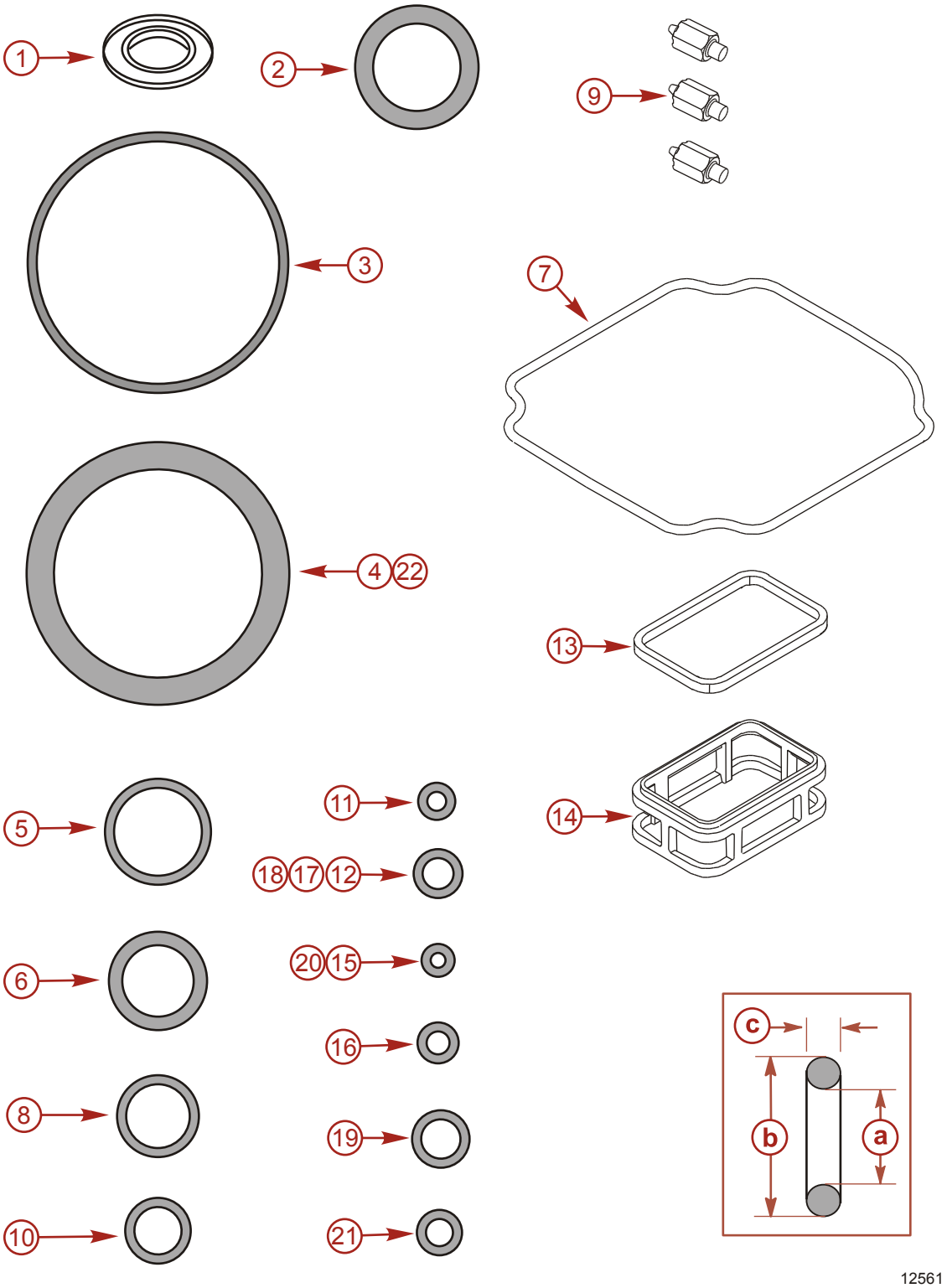


O-Ring and Seal Placement

O-Ring	Description	O-Ring I.D.	O-Ring O.D.	O-Ring Width
1	Wiper ring			
2	Inner cylinder cap	17.04 mm (0.671 in.)	24.10 mm (0.949 in.)	3.53 mm (0.139 in.)
3	Cylinder cap	47.34 mm (1.864 in.)	50.90 mm (2.004 in.)	1.78 mm (0.07 in.)
4	Shock piston	40.64 mm (1.6 in.)	53.086 mm (2.02 in.)	5.334 mm (0.21 in.)
5	Piston screw	17.17 mm (0.676 in.)	20.726 mm (0.816 in.)	1.78 mm (0.07 in.)
6	Reservoir plug	13.94 mm (0.549 in.)	19.17 mm (0.755 in.)	2.616 mm (0.103 in.)
7	Motor seal			
8	P.O. check plug	12.42 mm (0.489 in.)	15.97 mm (0.629 in.)	1.78 mm (0.07 in.)
9	Poppet assembly			
10	P.O. check seat	9.25 mm (0.364 in.)	12.80 mm (0.504 in.)	1.78 mm (0.07 in.)
11	Pump port	3.683 mm (0.145 in.)	7.239 mm (0.285 in.)	1.78 mm (0.07 in.)
12	Suction seat	6.07 mm (0.239 in.)	9.626 mm (0.379 in.)	1.78 mm (0.07 in.)
13	Filter seal			
14	Filter			
15	Manual release	2.90 mm (0.114 in.)	6.451 mm (0.254 in.)	1.78 mm (0.07 in.)
16	Manual release	4.47 mm (0.176 in.)	8.026 mm (0.316 in.)	1.78 mm (0.07 in.)
17	Manual release	6.07 mm (0.239 in.)	9.626 mm (0.379 in.)	1.78 mm (0.07 in.)
18	Spool	6.07 mm (0.239 in.)	9.626 mm (0.379 in.)	1.78 mm (0.07 in.)
19	Spool housing	7.645 mm (0.301 in.)	11.20 mm (0.441 in.)	1.78 mm (0.07 in.)
20	Trim limit spool	2.895 mm (0.114 in.)	6.451 mm (0.254 in.)	1.78 mm (0.07 in.)
21	Manifold	5.283 mm (0.208 in.)	8.839 mm (3.48 in.)	1.78 mm (0.07 in.)
22	Memory piston	40.64 mm (1.6 in.)	53.086 mm (2.02 in.)	5.334 mm (0.21 in.)

O-Ring Size

NOTE: *Refer to* ***O-Ring and Seal Placement*** *chart on previous page for description.*



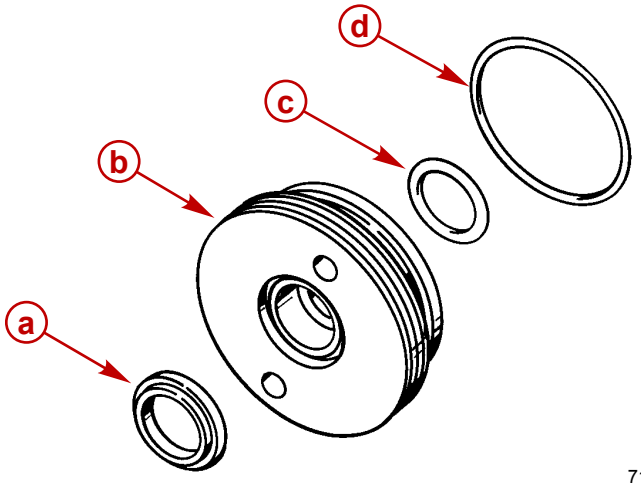
a - Inside diameter
b - Outside diameter
c - Width

Shock Rod Assembly

IMPORTANT: Lubricate all O-rings with Power Trim and Steering Fluid. If not available, use automotive automatic transmission fluid (ATF).

Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	Power trim O-rings	92-858074K01

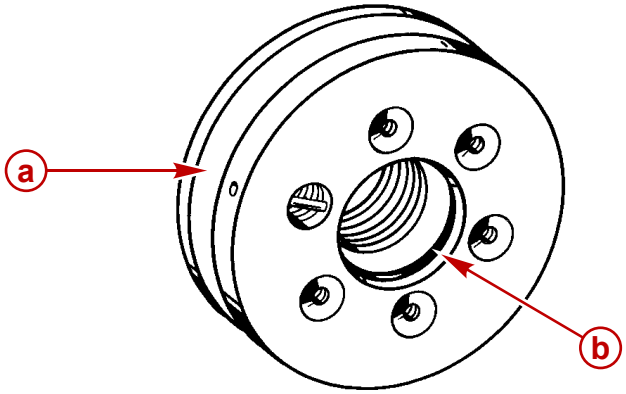
1. Install the lubricated O-rings to the end cap.



7126

- **a -** Rod wiper
- **b -** Cylinder end cap
- **c -** Inner O-ring
- **d -** Outer O-ring

2. Install the rod wiper.
3. Install the lubricated O-rings to the shock piston.

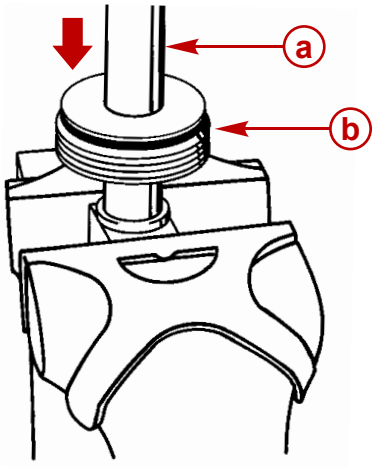


7125

- **a -** Shock piston
- **b -** O-ring

4. Clamp the shock rod in a soft jawed vise.

5. Position the trim cylinder end cap onto the rod, as shown.



a - Trim cylinder rod
b - Trim cylinder end cap

6. Apply Loctite 271 Threadlocker to the threads on the shock rod.

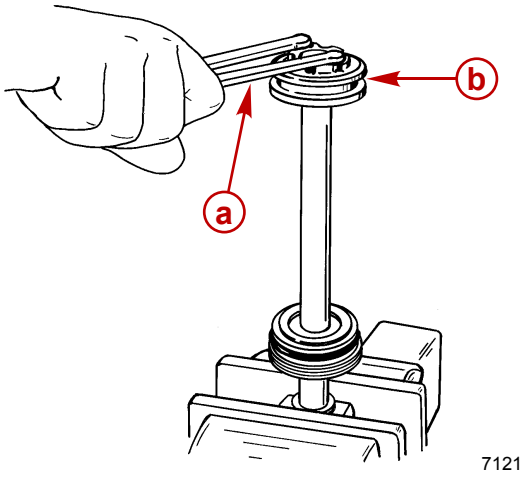
Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Shock rod threads	92-809819

7. Install the shock rod piston.

IMPORTANT: Use a spanner wrench with 6.4 mm x 8 mm (1/4 in. x 5/16 in.) long pegs to remove the shock rod piston.

8. Tighten the shock rod piston securely using a spanner wrench (6.4 mm x 8 mm [1/4 in. x 5/16 in.] long pegs). If a torquing type spanner tool is used to tighten the shock rod piston, then tighten to the specified torque.

NOTE: *When using the trim cylinder end cap tool, use the large diameter pins, 5.97 mm (0.235 in.), in the 1 in. span position. Pins should be partially pulled out of the spanner wrench to extend approximately 9.5 mm (0.375 in.).*



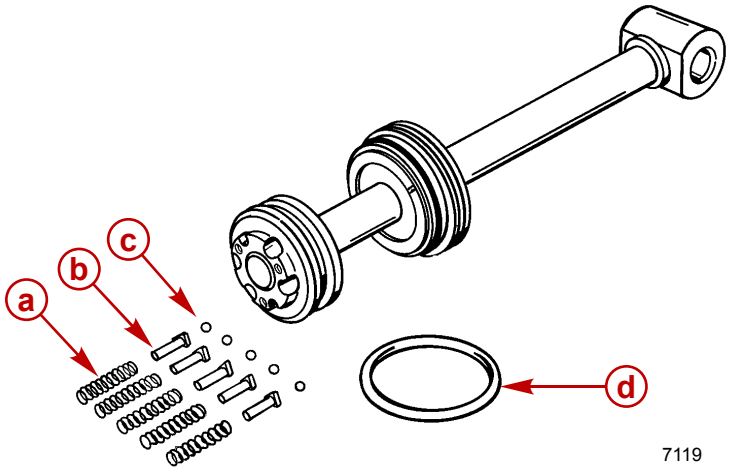
a - Spanner wrench
b - Shock rod piston

Spanner Wrench	91- 74951
Trim Cylinder End Cap Tool	91-821709T

Description	Nm	lb-in.	lb-ft
Shock rod piston	122		90

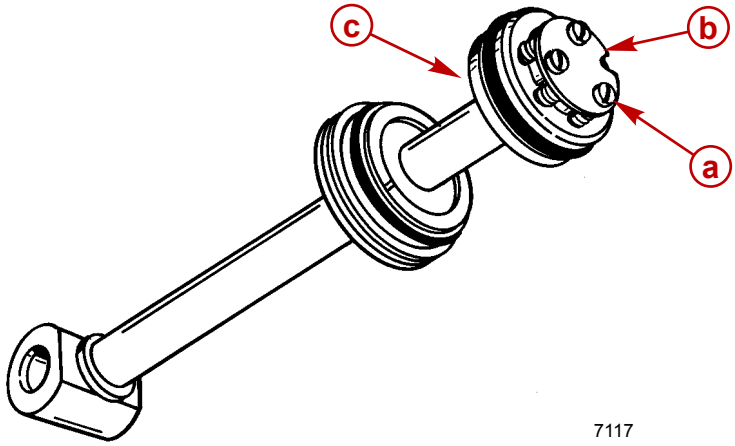
9. Remove the shock rod assembly from the vise.

10. Install the ball, seat, and spring (five sets) to the shock rod piston. Install O-ring onto the shock rod piston.



a - Spring (5)
b - Seat (5)
c - Ball (5)
d - O-ring

11. Secure the components with the plate. Tighten the screws to the specified torque.



a - Screw (3)
b - Plate
c - Shock rod piston

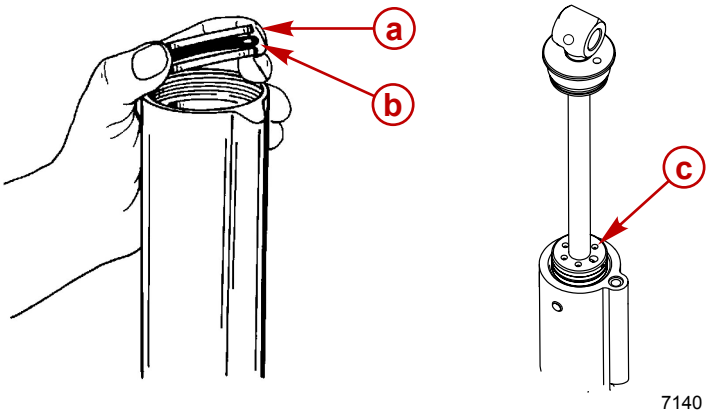
Description	Nm	lb-in.	lb-ft
Screw	4	35	

Shock Rod Installation

1. Place the trim cylinder in a soft jawed vice.
2. Install lubricated O-ring to the memory piston and place into the cylinder. Push memory piston all the way to bottom.
3. Fill cylinder 75 mm (3 in.) from top of cylinder using Power Trim and Steering Fluid. If not available, use automotive automatic transmission fluid (ATF).

Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	Power trim system	92-858074K01

4. Install the shock rod into the cylinder until power trim fluid flows through the oil blow off ball passage. Fill remaining cylinder to just below the cylinder threads.



a - Memory piston
b - O-ring
c - Oil blow off ball passage

IMPORTANT: End cap must not make contact with shock rod piston when tightening. Shock rod piston must be positioned in cylinder deep enough to avoid contact.

5. Tighten end cap securely using spanner wrench (6.4 mm x 8 mm [1/4 in. x 5/16 in.] long pegs). If a torquing type spanner tool is used to tighten the end cap, then tighten to the specified torque.

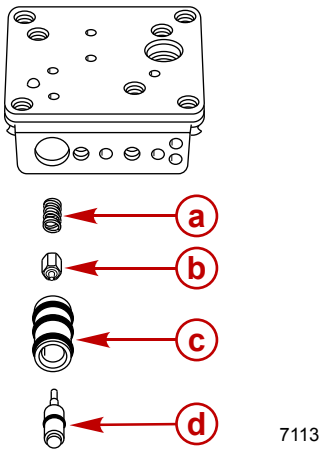
Spanner Wrench	91- 74951
Trim Cylinder End Cap Tool	91-821709T

Description	Nm	lb-in.	lb-ft
End cap	61		45

Trim Limit Installation

Lubricate all O-rings. Install spring, poppet, spool housing, and trim limit spool into manifold.

NOTE: *There are three different size springs used in this manifold. The heavy spring is used on 75–125 hp outboards. The medium spring is used on 40–60 hp Command Thrust outboards. The light spring is used on 30–60 hp outboards.*

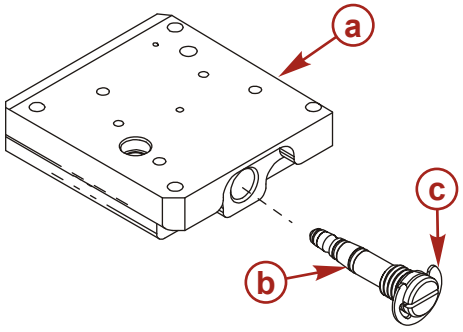


a - Spring
b - Poppet
c - Spool housing
d - Trim limit spool

Manual Release Valve Installation

1. Install E-clip (if removed) and lubricate O-rings on manual release valve.

2. Install manual release valve assembly into manifold.

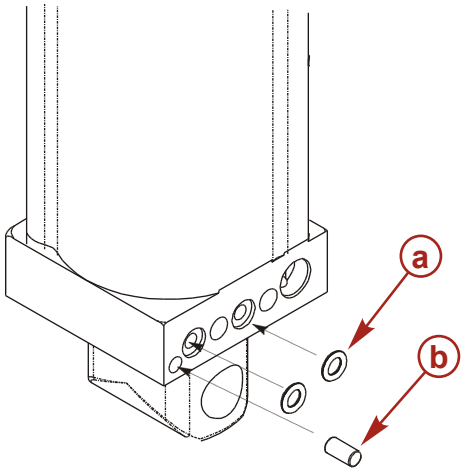


7141

a - Manifold
b - Manual release valve
c - E-clip

Manifold Installation

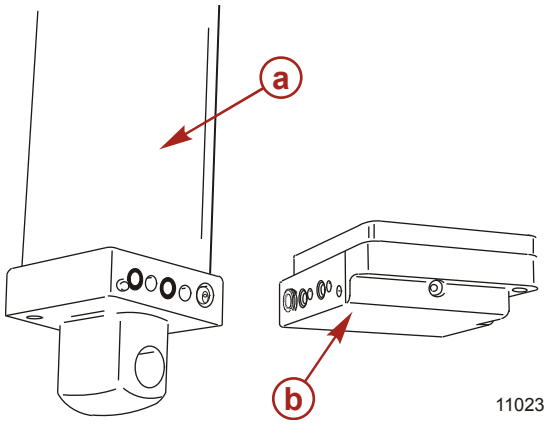
1. Install dowel pin and two lubricated O-rings into trim cylinder.



11022

a - O-ring (2)
b - Dowel pin

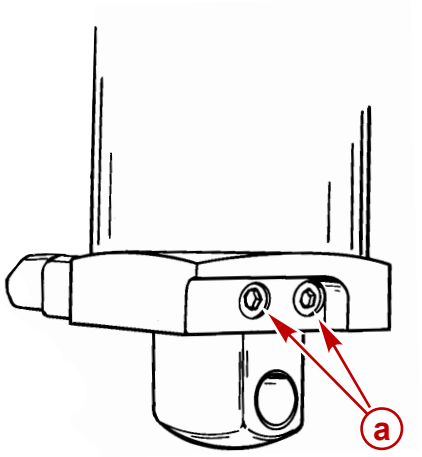
2. Align the trim cylinder and reservoir/manifold assembly together.



11023

a - Trim cylinder assembly
b - Reservoir/manifold assembly

3. Install the two long screws and tighten to the specified torque.



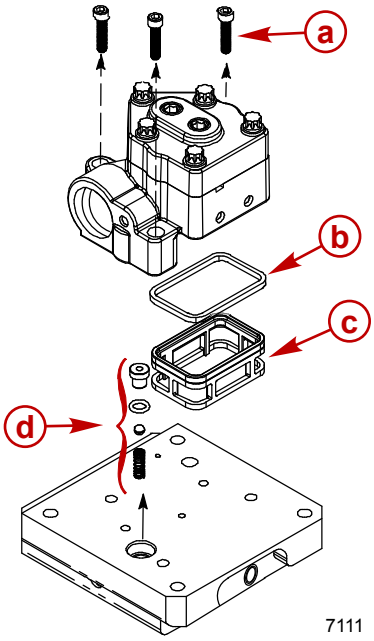
a - Screw (2)

Description	Nm	lb-in.	lb-ft
Trim cylinder screw	11.3	100	

Power Trim Pump and Components Installation

Pump Installation

1. Install spring, ball, lubricated O-ring, and plastic seat into manifold.
2. Check to see that O-rings are placed on bottom of pump.
3. Install filter and filter seal under the pump. Install pump onto manifold. Tighten screws to specified torque.



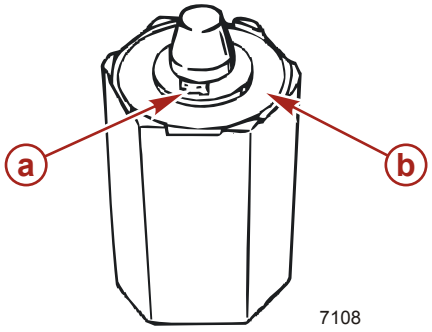
a - Screw (3)
b - Filter seal
c - Filter
d - Suction seat assembly

Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	Power trim O-rings	92-858074K01

Description	Nm	lb-in.	lb-ft
Screw	8	70	

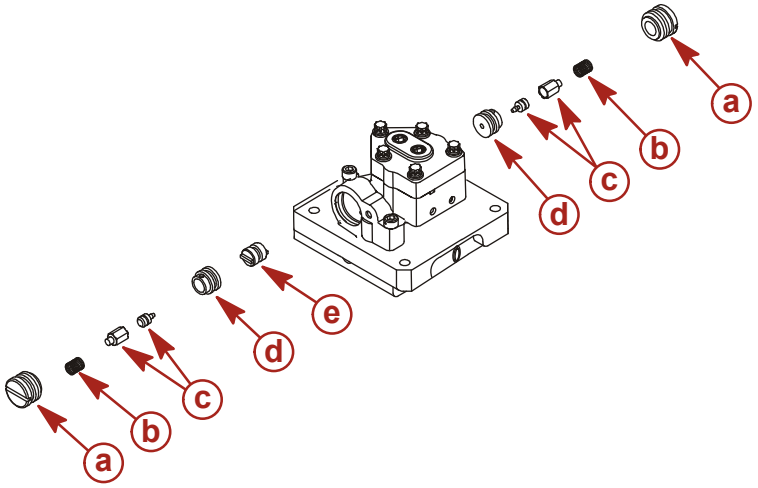
Pressure Operated Plugs

IMPORTANT: Inspect poppet assembly for debris in the area shown. If debris is found on poppet, replace poppet.



a - Debris under valve
b - Rubber seat

1. Lubricate O-rings.
2. Install spool, seat with O-ring, check valve/poppet, spring, and plug with O-ring into pump. Repeat for other side. Tighten plugs to specified torque.



a - Plug (2)
b - Spring (2)
c - Check valve/poppet (2)
d - Seat (2)
e - Spool

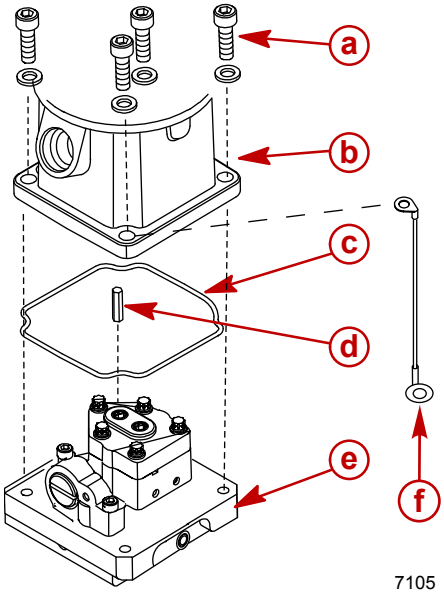
Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	Power trim O-rings	92-858074K01

Description	Nm	lb-in.	lb-ft
Plug	13.5	120	

Trim Motor Installation

1. Install coupler into top of pump. Make sure reservoir seal is in the reservoir groove and place reservoir onto manifold assembly.

2. Install the ground strap under the screw shown. Tighten screws to specified torque.



7105

a - Screw and washer (4)
b - Reservoir
c - Reservoir seal
d - Coupler
e - Manifold assembly
f - Ground strap

Description	Nm	lb-in.	lb-ft
Reservoir/manifold screw	9	80	

3. Fill reservoir to bottom of fill hole using Power Trim and Steering Fluid. If not available, use automotive automatic transmission fluid (ATF).

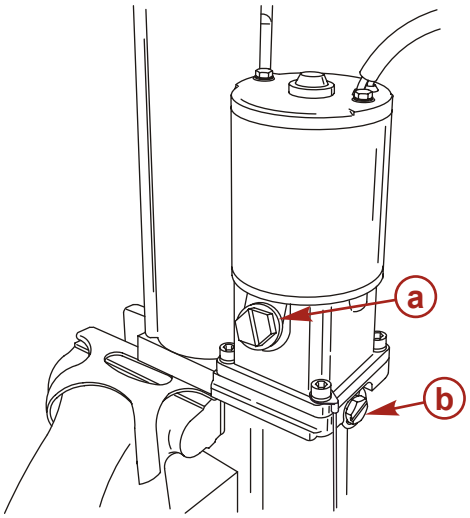
Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	Power trim reservoir	92-858074K01

Bleeding Power Trim Unit

1. Secure the power trim unit in a soft jawed vise.
2. Add Power Trim and Steering Fluid until it is even with the bottom of the fill hole. Install plug.

Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	Power trim reservoir	92-858074K01

3. Close the manual release valve. Turn full clockwise.



7104

a - Reservoir plug
b - Manual release valve

Direction	Color	Charge
Up	Blue	Positive (+)
	Green	Negative (–)
Down	Blue	Negative (–)
	Green	Positive (+)

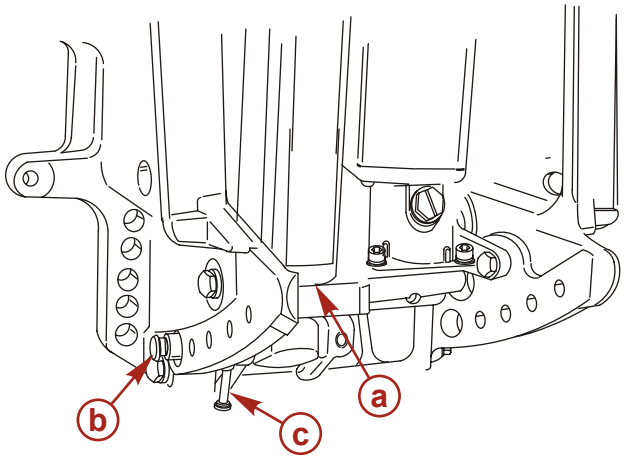
4. Connect power trim wire to 12 volt source.
5. Cycle system full up and down three times or until fluid level remains at proper level.
6. Recheck fluid level with rod fully extended, add fluid if required and repeat cycle until fluid level stays even with the bottom of the fill hole.

Power Trim System Installation

1. Apply 2-4-C with PTFE to lower pivot pin bore and pivot pin surface.

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Pivot pin surface and lower pivot pin bore	92-802859A 1

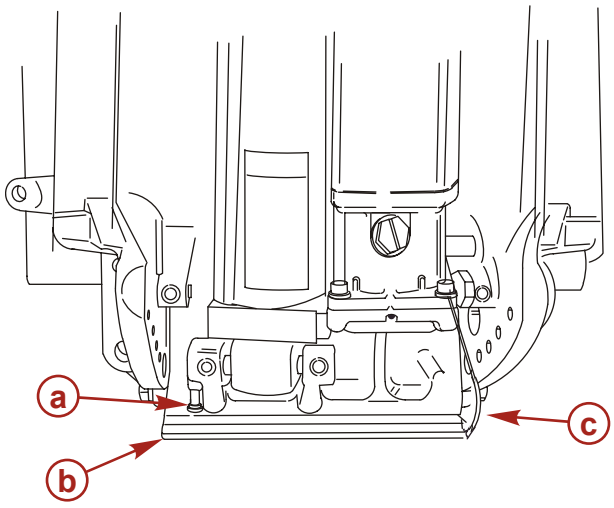
2. Position trim cylinder assembly, bottom first, between clamp brackets and route trim pump electrical harness through access hole in starboard clamp bracket.
3. Start lower pivot pin into pivot pin bore and position lower cross pin retained during disassembly in its respective hole.



7144

a - Trim cylinder assembly
b - Lower pivot pin
c - Lower cross pin

4. Using a suitable punch, drive lower pivot pin into clamp bracket and trim cylinder assembly until pivot pin is flush with outside surface.
5. Using a suitable punch, drive lower cross pin into its respective bore until seated.
6. Install sacrificial aluminum anode to reservoir bracket placing ground strap to anode, as shown.

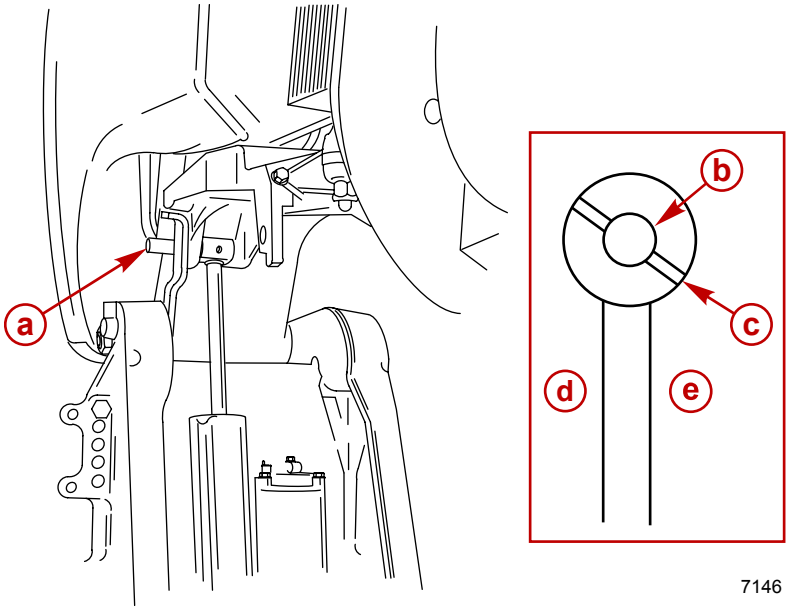


7145

a - Lower cross pin
b - Sacrificial anode
c - Ground strap

7. Apply 2-4-C with PTFE to surface of upper pivot pin, pivot pin bore, and trim ram bore.

NOTE: *Install trim ram with cross hole located as shown. If trim ram is installed reversed, the trim sender will not operate.*

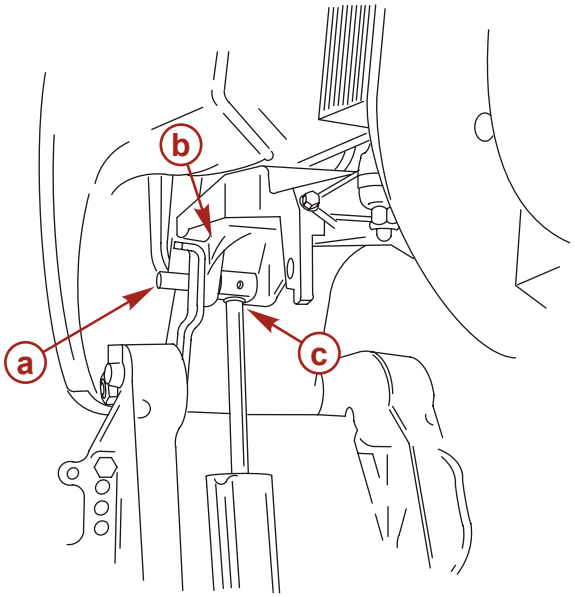


7146

- **a -** Pivot pin
- **b -** Trim ram bore
- **c -** Cross hole
- **d -** Transom side
- **e -** Engine side

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Upper pivot pin and bore, trim ram bore	92-802859A 1

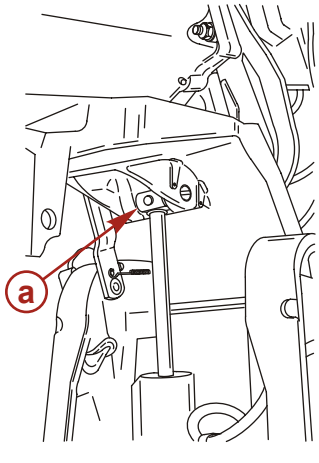
8. Using a suitable mallet, drive upper pivot pin into swivel bracket and through trim ram until pivot pin is flush with swivel bracket.



7152

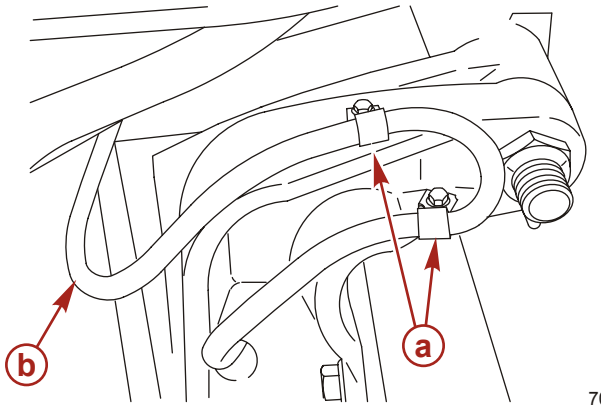
- **a -** Pivot pin
- **b -** Swivel bracket
- **c -** Trim ram

9. Drive upper trilobe pin in until seated.



a - Trilobe pin

10. Secure trim harness with clamps.



a - J-clips
b - Trim harness

11. Recheck fluid level.
12. Power trim may now be operated to lower outboard to desired position. Trim system is self-purging.
13. Reconnect power trim leads to relays under ignition cover.
14. Reinstall spark plug leads to spark plugs.
15. Reinstall cowls.
16. Connect battery leads to battery terminals.

Notes:

Mid-Section

Section 5C - Gas Assist Manual Trim/Tilt

Table of Contents

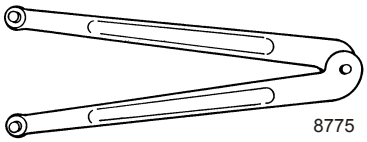
5C

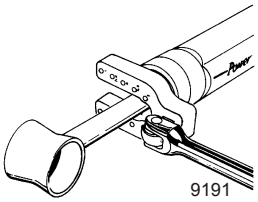
Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Shock rod threads	92-809819
95	2-4-C with PTFE	Threads on the accumulator and base	92-802859A 1
		Lower pivot pin hole and pivot pin surface	
		The surface of the upper pivot pin, pivot pin hole, and shock cylinder rod eye	
114	Power Trim and Steering Fluid	O-ring lubrication	92-858074K01
		O-ring lubrication	
		Power trim O-rings	
		Shock cylinder	
		Manual tilt system	

Special Tools

Torch Lamp	91- 63209
 8776	Heats surfaces to aid in the removal and installation of interference fit engine components.

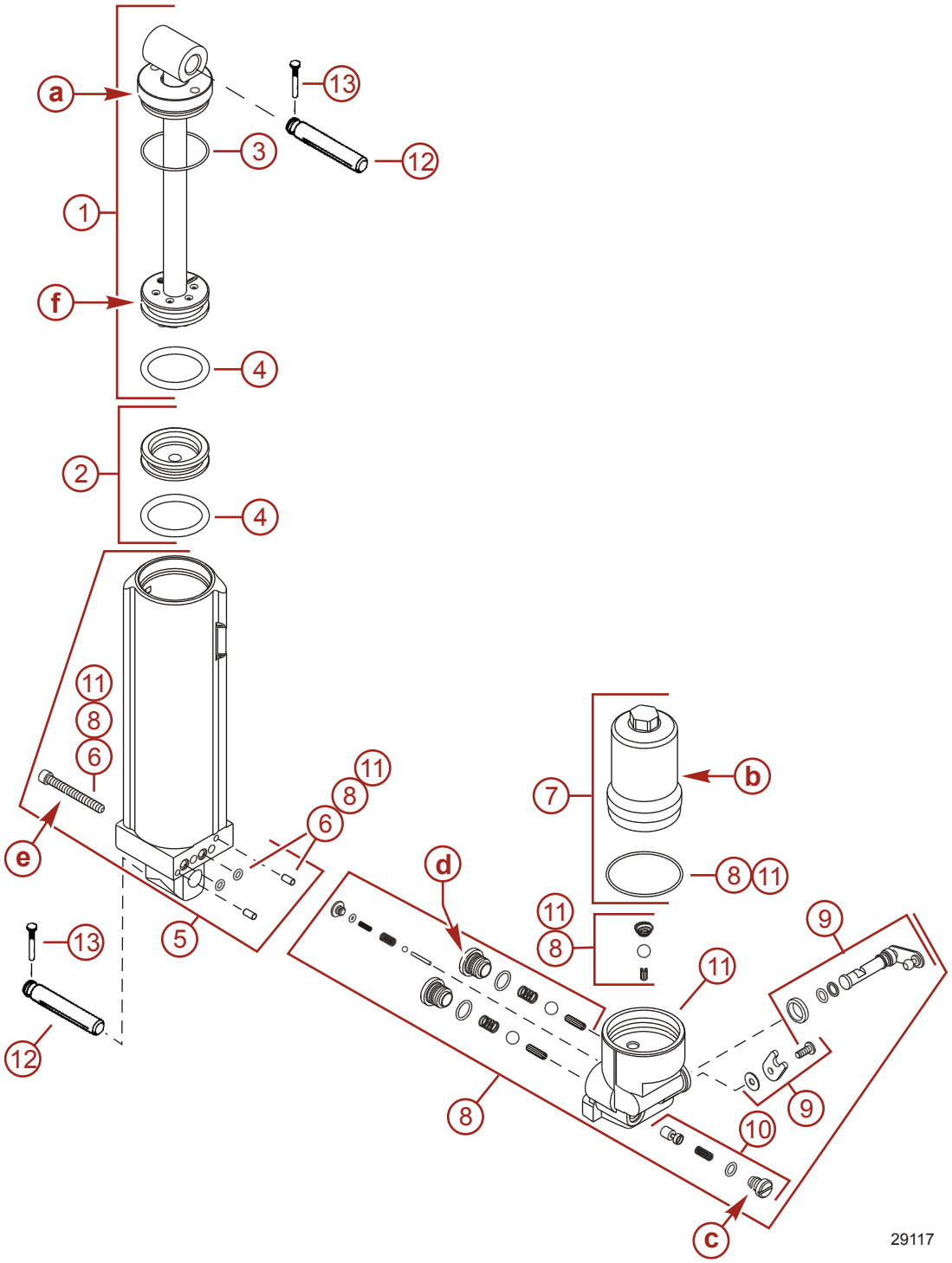
Spanner Wrench	91- 74951
 8775	Removes and installs trim cylinder end caps.

Trim Cylinder End Cap Tool	91-821709T
 9191	Allows easy removal of the trim cylinder end caps. Required if tilt limit spacers are to be installed or if the trim in limit spacer is to be removed (to allow additional trim in range).

Lockring Pliers	Snap-On SRP-4
 4799	Aids in the removal of lockrings.

Notes:

Gas Assist Manual Trim/Tilt Components

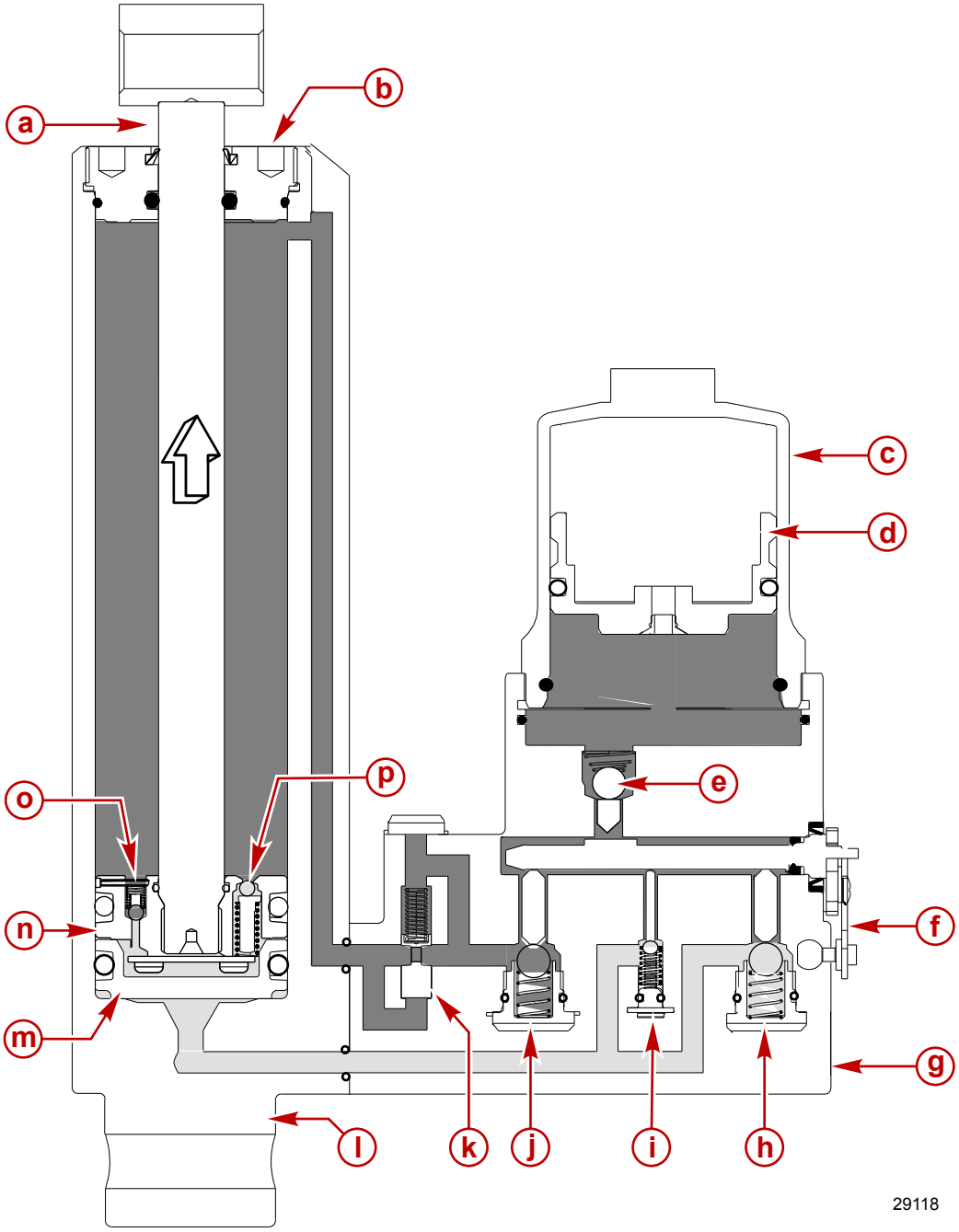


Gas Assist Manual Trim/Tilt Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Shock rod assembly	61		45
2	1	Memory piston assembly			
3	1	O-ring rebuild kit			
4	2	O-ring			
5	1	Cylinder assembly			
6	1	Bolt and seal kit			
7	1	Accumulator assembly	47.5		35
8	1	Valve body assembly			
9	1	Cam kit			
10	1	Velocity valve kit	8.5	75	
11	1	Check system repair kit	8.5	75	
12	2	Pin			
13	2	Groove pin			

	Description	Nm	lb-in.	lb-ft
a	Cylinder end cap	61		45
b	Accumulator	47.5		35
c	Velocity valve	8.5	75	
d	Transfer valve plug (2)	8.5	75	
e	Socket head bolt	11.3	100	
f	Shock piston	122		90

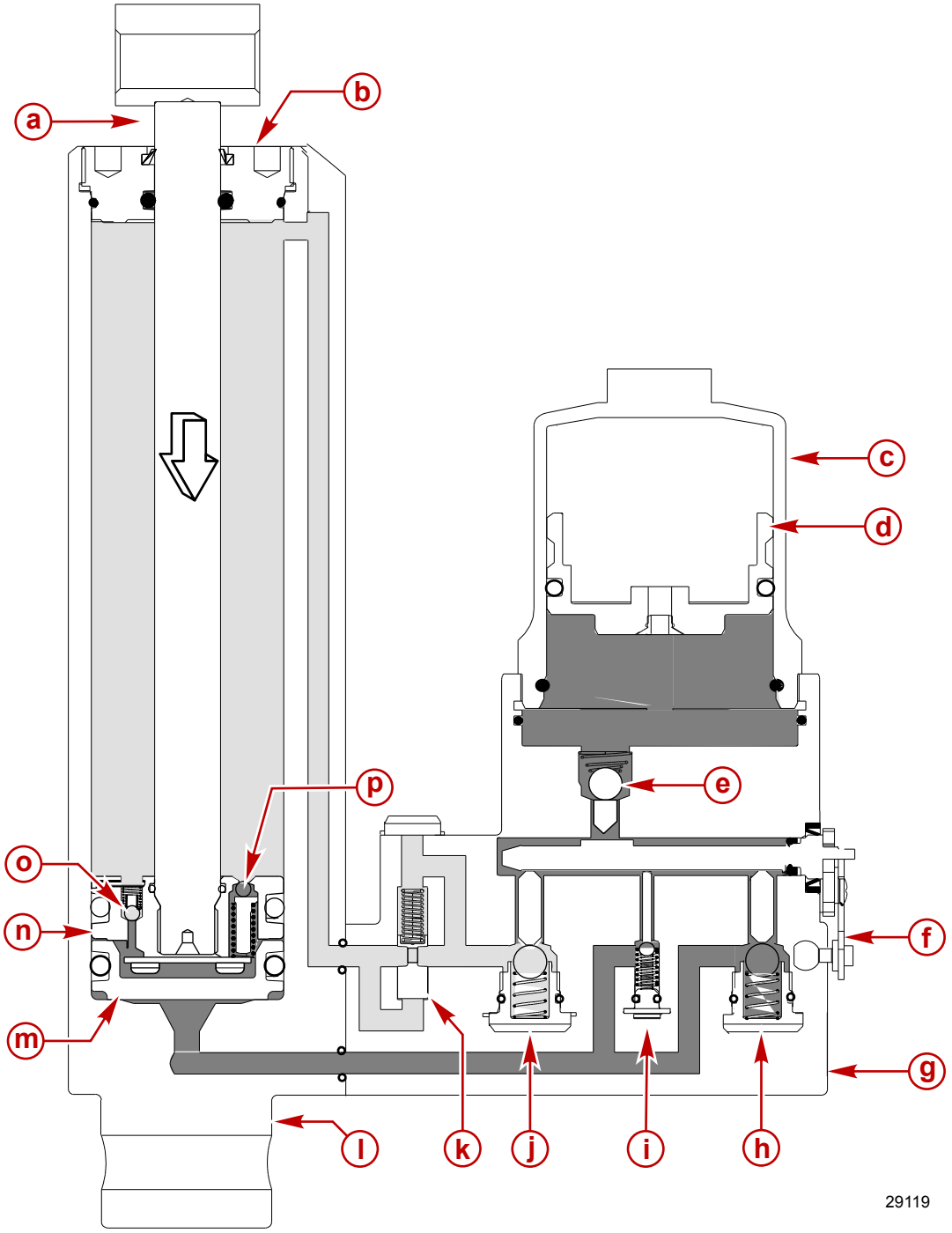
Gas Assist Manual Trim/Tilt - Up Circuit



- **a -** Shock rod
- **b -** End cap
- **c -** Accumulator
- **d -** Accumulator piston
- **e -** Accumulator check valve
- **f -** Camshaft lever
- **g -** Manifold
- **h -** Down circuit fast transfer valve
- **i -** Down circuit slow transfer valve
- **j -** Up circuit fast transfer valve
- **k -** Surge valve
- **l -** Cylinder
- **m -** Memory piston
- **n -** Shock piston
- **o -** Shock return valve
- **p -** Impact relief valve

With the engine in the down position, the accumulator piston is at the top of the accumulator with the gas at maximum pressure. To raise the engine, rotate the camshaft lever all the way down. The internal shaft connected to the camshaft lever moves the push rods, opening the accumulator check valve, both fast transfer valves, and the down circuit slow transfer valve. As the operator lifts the engine, oil, under pressure inside the accumulator, flows around the slow transfer valve and the down circuit fast transfer valve. Oil flows into the bottom of the tilt cylinder forcing the memory piston into the shock piston and then forcing the shock rod up and out. Oil above the shock piston exits the cylinder through an interconnecting passage alongside the cylinder and returns into the manifold. Inside the manifold, the oil flows past the groove in the surge valve, through the up circuit fast transfer valve, and mixes with the oil flowing from the accumulator into the cavity below the shock piston (up cavity). With the engine in the correct position, the camshaft lever is rotated up and the push rods allow the check valves to close. The closed check valves prevent the oil from traveling between cavities and locks the engine into position.

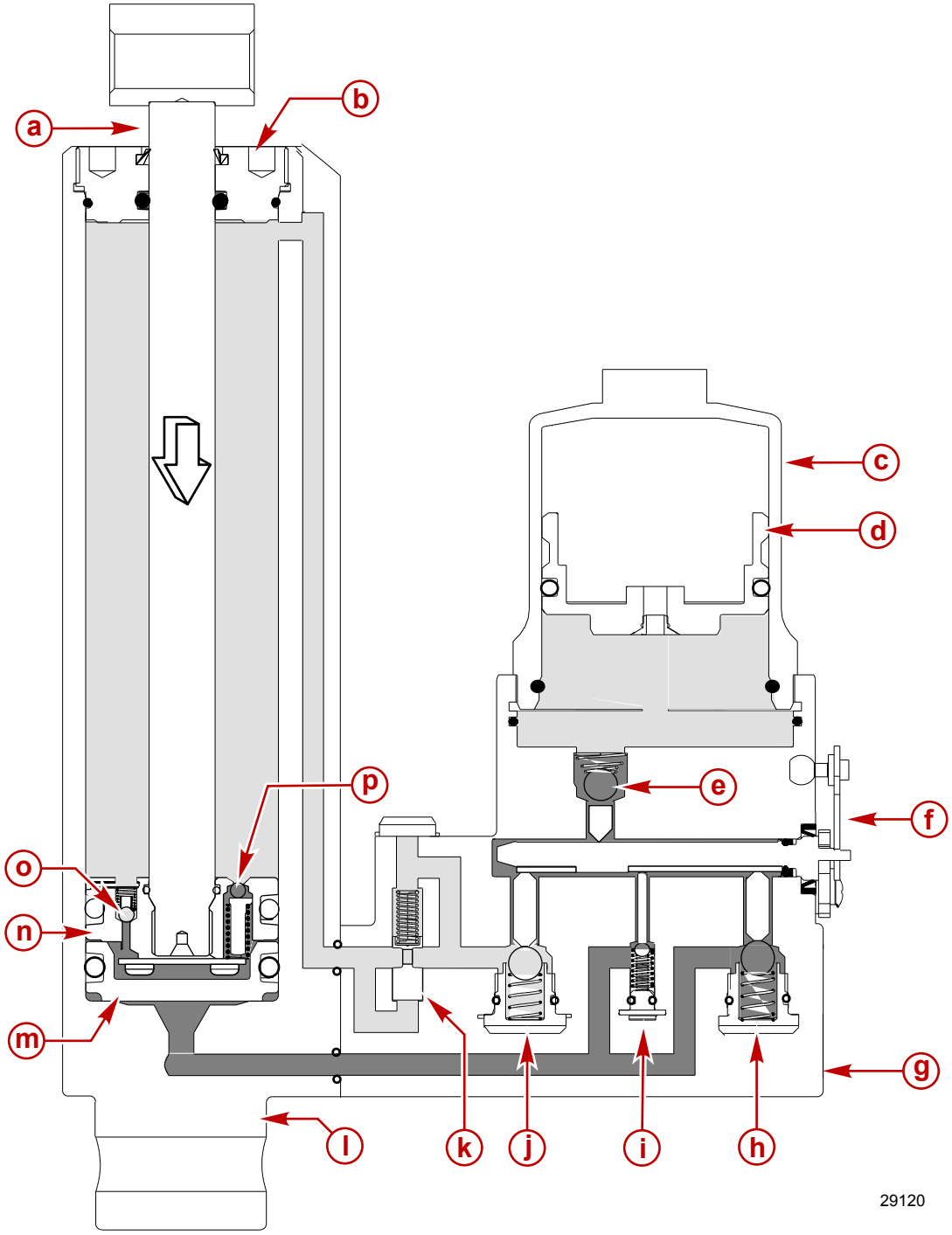
Gas Assist Manual Trim/Tilt - Down Circuit



- **a -** Shock rod
- **b -** End cap
- **c -** Accumulator
- **d -** Accumulator piston
- **e -** Accumulator check valve
- **f -** Camshaft lever
- **g -** Manifold
- **h -** Down circuit fast transfer valve
- **i -** Down circuit slow transfer valve
- **j -** Up circuit fast transfer valve
- **k -** Surge valve
- **l -** Cylinder
- **m -** Memory piston
- **n -** Shock piston
- **o -** Shock return valve
- **p -** Impact relief valve

With the engine tilted up, the accumulator piston is at the bottom of the accumulator with the gas pressure low. To lower the engine, the camshaft lever is rotated down; the internal cam will cause the push rods to open the accumulator check valve, both fast transfer valves, and the down circuit slow transfer valve. The operator pushes down on the engine cowl to overcome the pressure inside the cylinder. Fluid flows out the bottom of the cylinder, past the down circuit fast transfer valve and the down circuit slow transfer valve. Fluid then flows past the up circuit fast transfer valve, surge valve, and through the interconnecting passage into the top of the cylinder (down cavity). Since the volume of the tilt cylinder below the piston is greater than the volume above the piston, the excess fluid enters the accumulator and compresses the gas above the accumulator piston. With the engine in the correct trim position, the camshaft lever is rotated up; the push rods allow the check valves to close, locking the engine into position.

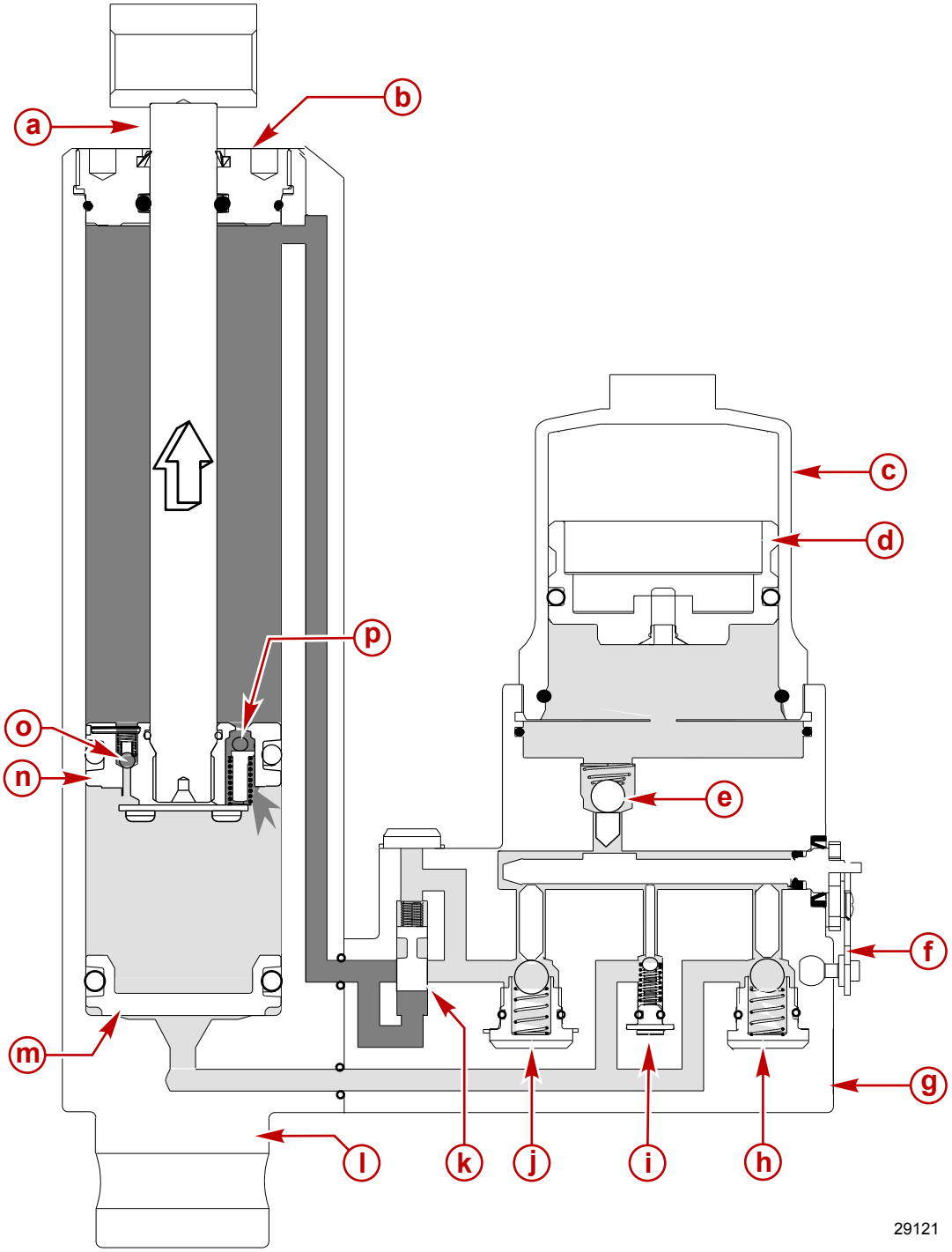
Gas Assist Manual Trim/Tilt - Slow Tilt Down Under Pressure



- **a -** Shock rod
- **b -** End cap
- **c -** Accumulator
- **d -** Accumulator piston
- **e -** Accumulator check valve
- **f -** Camshaft lever
- **g -** Manifold
- **h -** Down circuit fast transfer valve
- **i -** Down circuit slow transfer valve
- **j -** Up circuit fast transfer valve
- **k -** Surge valve
- **l -** Cylinder
- **m -** Memory piston
- **n -** Shock piston
- **o -** Shock return valve
- **p -** Impact relief valve

To tilt the engine down under high thrust conditions (where the propeller thrust forces the shock rod down, creating higher pressure below the memory piston), the camshaft lever is rotated slightly downward. The internal shaft connected to the lever opens the down circuit slow transfer valve allowing oil under pressure into the cavity around the shaft. The higher oil pressure opens the up circuit fast transfer valve allowing oil from the bottom of the cylinder to flow above the shock piston while lowering the engine. Additional oil flows into the accumulator as the internal pressure forces the accumulator check valve to open. Oil flowing into the accumulator moves the accumulator piston and compresses the gas.

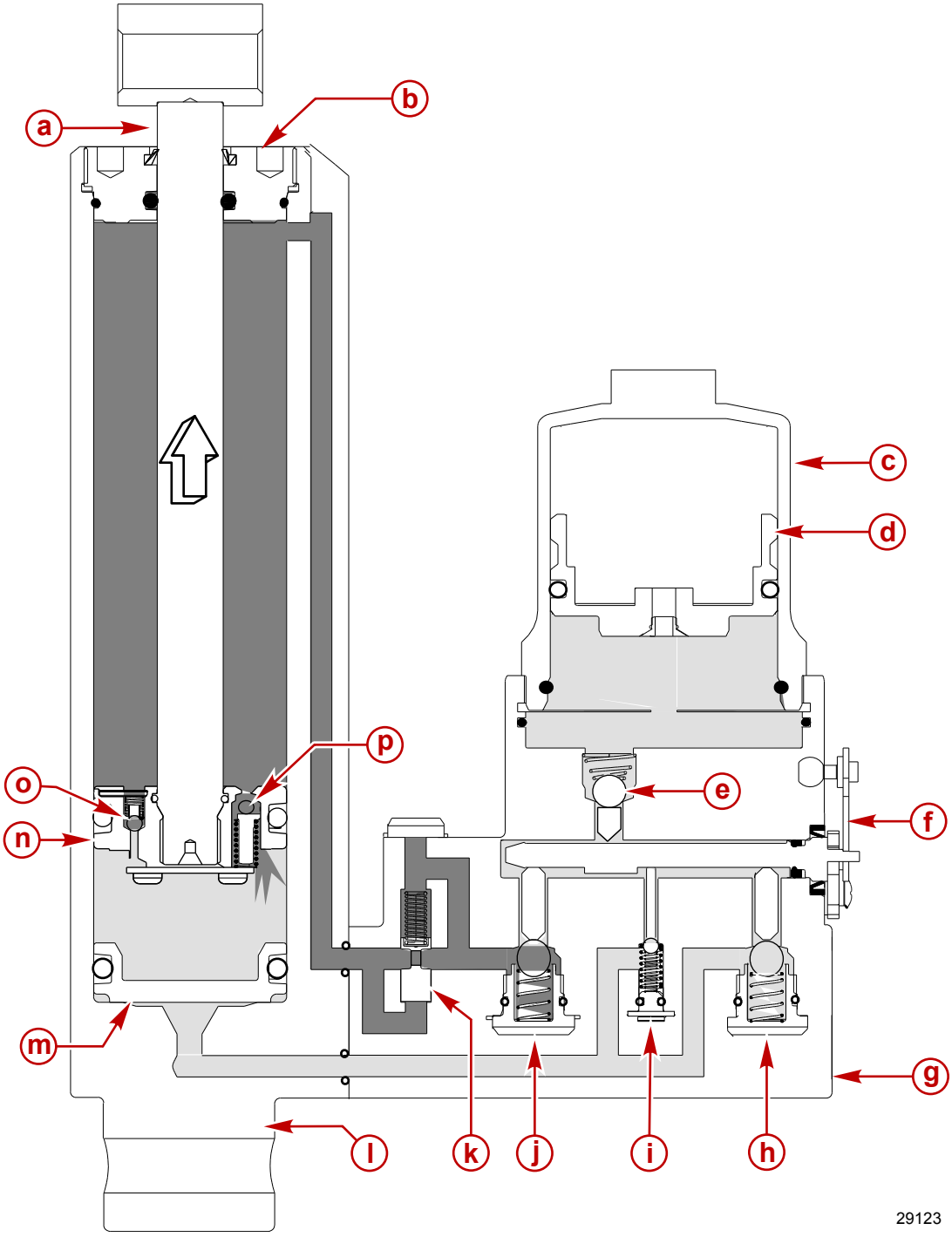
Gas Assist Manual Trim/Tilt - Underwater Strike (Valves Open)



- **a -** Shock rod
- **b -** End cap
- **c -** Accumulator
- **d -** Accumulator piston
- **e -** Accumulator check valve
- **f -** Camshaft lever
- **g -** Manifold
- **h -** Down circuit fast transfer valve
- **i -** Down circuit slow transfer valve
- **j -** Up circuit fast transfer valve
- **k -** Surge valve
- **l -** Cylinder
- **m -** Memory piston
- **n -** Shock piston
- **o -** Shock return valve
- **p -** Impact relief valve

When the drive unit strikes a submerged object while in forward motion, the shock rod extends from the tilt cylinder. Fluid attempts to exit the cylinder through the interconnecting passage. The rapid fluid flow increases the pressure below the surge valve, causing the valve to move, closing the oil return passage back to the accumulator. Oil inside the upper cavity is locked in a static position by the closed surge valve. As the shock rod extends outward, the oil pressure above the shock piston reaches sufficient pressure to open the impact relief valve. Oil flows into the cavity below the shock piston created as the shock rod and shock piston moves away from the memory piston.

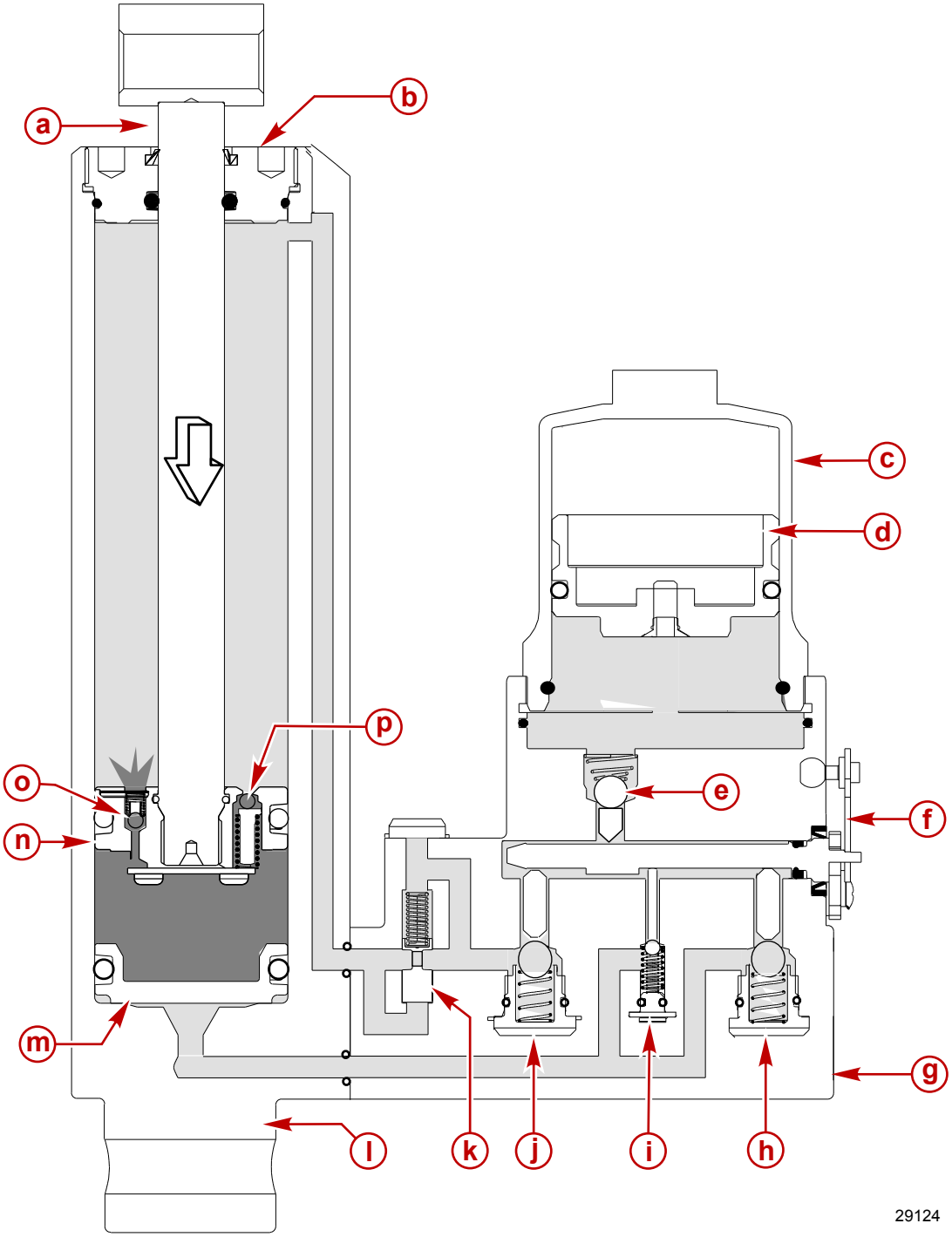
Gas Assist Manual Trim/Tilt - Underwater Strike (Valves Closed)



- **a -** Shock rod
- **b -** End cap
- **c -** Accumulator
- **d -** Accumulator piston
- **e -** Accumulator check valve
- **f -** Camshaft lever
- **g -** Manifold
- **h -** Down circuit fast transfer valve
- **i -** Down circuit slow transfer valve
- **j -** Up circuit fast transfer valve
- **k -** Surge valve
- **l -** Cylinder
- **m -** Memory piston
- **n -** Shock piston
- **o -** Shock return valve
- **p -** Impact relief valve

When the drive unit strikes a submerged object while in forward motion, the shock rod extends from the tilt cylinder. Oil in the cylinder is locked in a static position by the closed up circuit fast transfer valve, the closed down circuit slow transfer valve, and the closed down circuit fast transfer valve. Fluid attempts to exit the cylinder through the interconnecting passage back into the accumulator. The closed up circuit fast transfer valve prevents the fluid return. As the shock rod extends outward, the pressure above the shock piston reaches sufficient pressure to open the impact relief valve. Oil flows through the impact relief valve into the cavity below the shock piston created as the shock rod and shock piston moves away from the memory piston.

Gas Assist Manual Trim/Tilt - Shock Return Function



- a - Shock rod
- b - End cap
- c - Accumulator
- d - Accumulator piston
- e - Accumulator check valve
- f - Camshaft lever
- g - Manifold
- h - Down circuit fast transfer valve
- i - Down circuit slow transfer valve
- j - Up circuit fast transfer valve
- k - Surge valve
- l - Cylinder
- m - Memory piston
- n - Shock piston
- o - Shock return valve
- p - Impact relief valve

After the drive clears the object, the weight of the engine increases oil pressure between the memory piston and the shock piston and opens the shock return valve, allowing oil to flow into the cavity above the shock piston as the drive returns to its original running position.

Gas Assist Manual Trim/Tilt System Troubleshooting

IMPORTANT: Support the outboard with the tilt lock lever when servicing the manual tilt system.

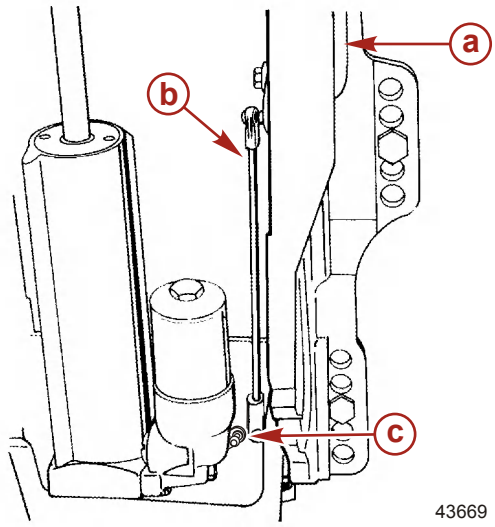
IMPORTANT: After debris or failed components have been found (during troubleshooting procedure), it is recommended the unit be disassembled completely and all O-rings be replaced. Check ball components and castings must be cleaned using engine cleaner and compressed air or replaced prior to reassembly.

Refer to **Gas Assist System Disassembly** instructions if disassembly is required when servicing.

Camshaft Link Rod Adjustment

IMPORTANT: The camshaft lever must open and close freely.

1. Tilt the outboard to the full up position and engage the tilt lock lever.
2. Disconnect the camshaft link rod end from the tilt lever.
3. Move the tilt lever to the forward position.
4. Rotate the camshaft lever to the full up position.
5. Adjust the length of the link rod so the end snaps onto the ball of the tilt lever without moving the tilt lever or the camshaft lever.



- a - Tilt lever
- b - Camshaft link rod
- c - Camshaft lever (on trim assembly)

External Leakage

Check for external leaks in the manual tilt system. Replace defective parts if a leak is found.

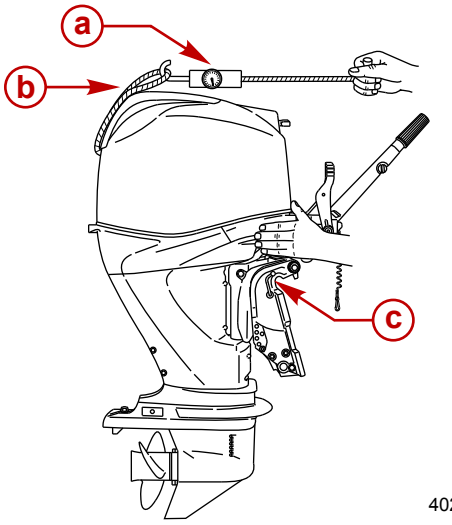
IMPORTANT: If cut or damaged O-rings are found, inspect machined surfaces for scoring, burrs, or debris.

Accumulator

1. Move the tilt lever rearward to rotate the camshaft lever down.
2. Push down on the engine cowl to lower the engine to the full down position.
3. Attach the weight scale to the cowl handle.
   IMPORTANT: Place padding between the weight scale and the cowl to protect the cowl.
4. Pull the weight scale in a manner to simulate the lifting of the outboard.

NOTE: The angle of pull must be 10°–15° to accurately measure the force required to tilt the outboard. It may be necessary to add an extension between the cowl handle and the weight scale to maintain the correct pull angle.

5. Measure the maximum force required to pull the outboard to the full up position.
6. Replace the accumulator if the force required to tilt the outboard is not within the specification.



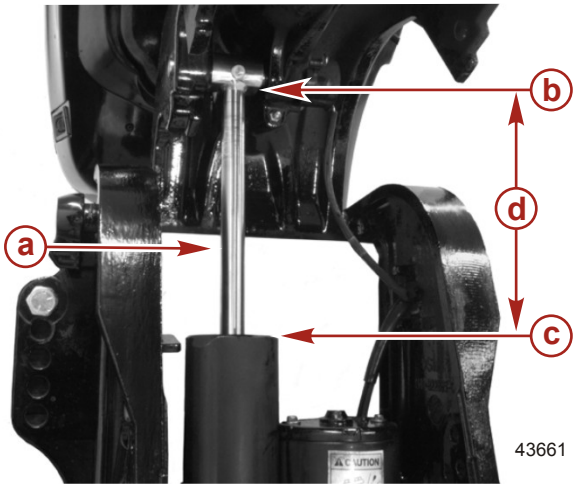
a - Weight scale
b - Extension rope
c - Manual release lever

Accumulator Test	
Force required to tilt the outboard	Less than 43 kg force (95 lbf)

Trim/Tilt Cylinder Leakage Test

Method 1

1. Extend the trim/tilt cylinder to the full up position.
2. Measure the distance between the cylinder cap and the bottom of the cylinder rod eye.
3. Wait 24 hours and measure the distance again.
4. If the measured leak-down distance is greater than specified:
   - Rebuild the trim/tilt assembly using the O-ring rebuild kit and component repair kits. Refer to the component parts list.
   - or
   - Replace the trim/tilt assembly.



a - Cylinder rod
b - Rod eye
c - Cylinder cap
d - Measured distance

Power Tilt System Leakage Specification	
Cylinder rod leak-down in 24 hour period	Less than 55 mm (2.2 in.)

Method 2

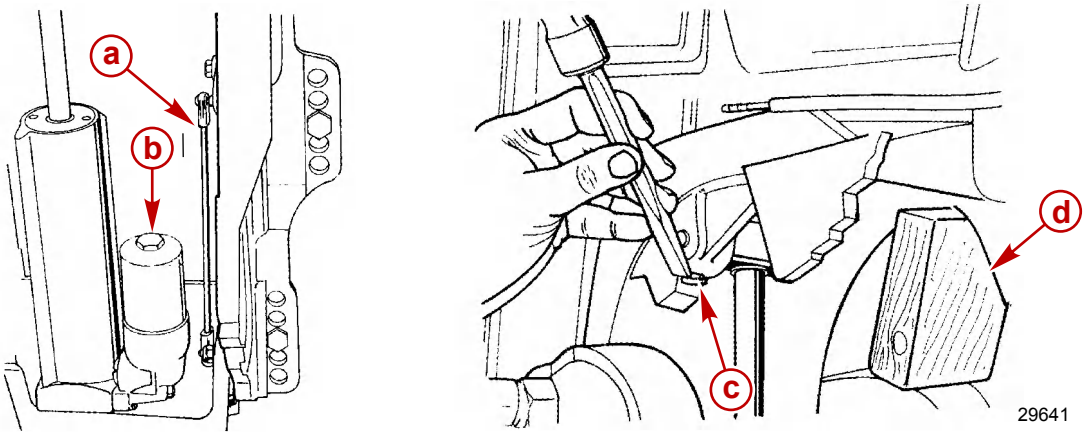
1. Extend the trim/tilt cylinder to the full up position.
2. Mark the cylinder rod 55 mm (2.2 in.) above the cylinder cap with an indelible marker.

3. Wait 24 hours.
4. If the marked line is not visible, the power tilt unit is not within specification for leakage:
   - Rebuild the trim/tilt assembly using the O-ring rebuild kit and component repair kits. Refer to the component parts list.
   - or
   - Replace the trim/tilt assembly.

Power Tilt System Leakage Specification	
Cylinder rod leak-down in 24 hour period	Less than 55 mm (2.2 in.)

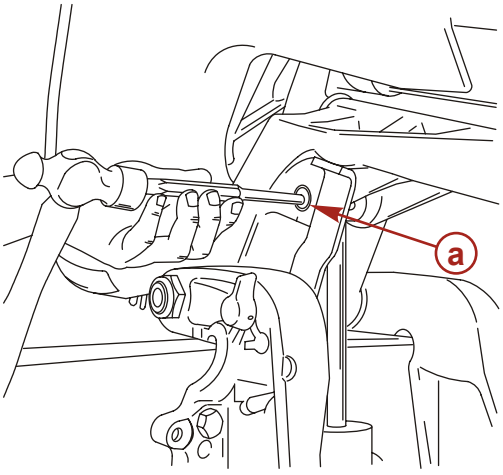
Gas Assist Manual Trim/Tilt System Removal

1. Support the outboard in the up position using the tilt lock lever.
2. Remove the link rod.
3. Position a wooden block under the transom bracket instead of the tilt lock for access of removing the pin. Use a suitable punch to remove (drive down) the upper trilobe pin. Retain the pin for assembly.



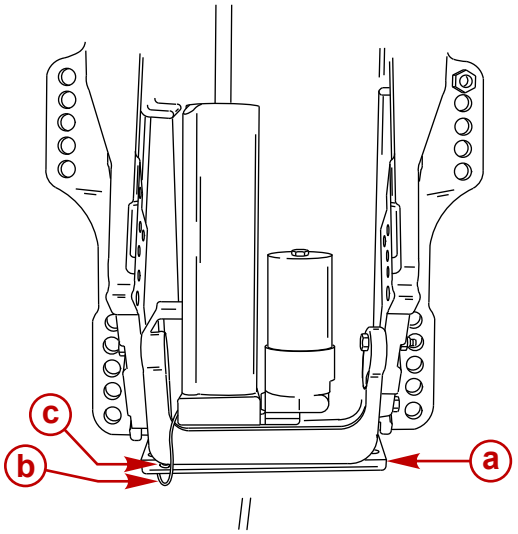
a - Link rod
b - Accumulator
c - Upper trilobe pin
d - Wooden block

4. Position the tilt lock and remove the piece of wood. Use a suitable punch to drive out the upper pivot pin.



a - Upper pivot pin

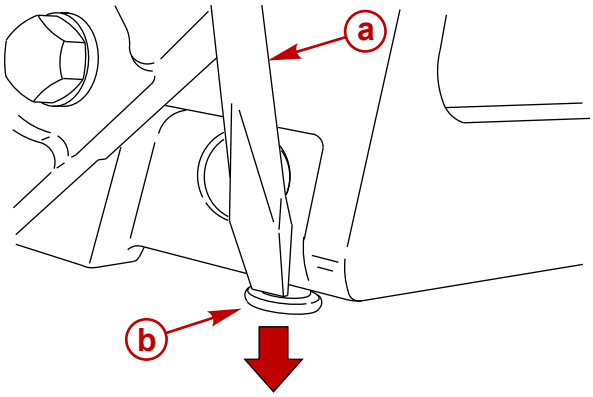
5. Remove the anode and ground wire.



29744

a - Anode
b - Ground wire
c - Trilobe pin

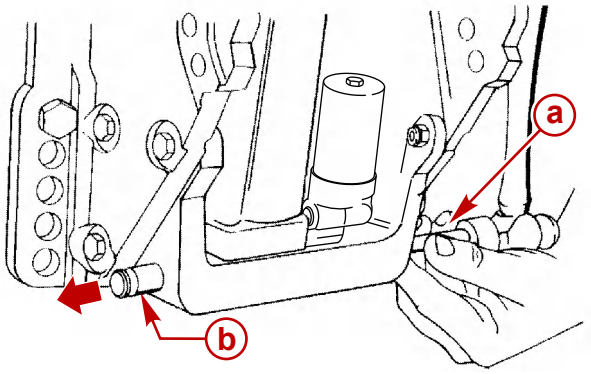
6. Use a punch to remove (drive down) the lower trilobe pin. Retain the pin for assembly.



29564

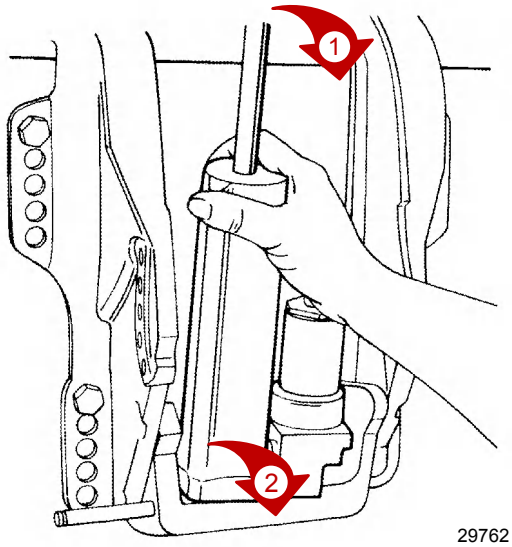
a - Punch
b - Lower trilobe pin

7. Use a suitable punch to drive out the lower pivot pin.
8. Tilt the shock absorber assembly out, top first, from the clamp bracket and remove the assembly.



29745

a - Punch
b - Lower pivot pin



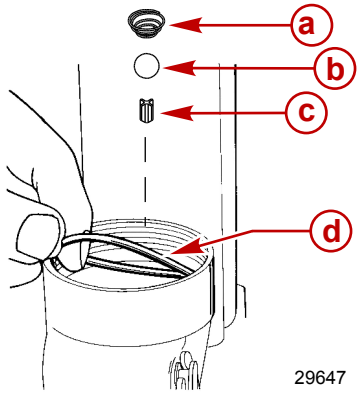
Gas Assist System Disassembly

NOTE: *The accumulator contains a high-pressure nitrogen charge and is not serviceable. Replace if necessary.*

1. Place the manual tilt system in a soft jawed vise.
2. Position the shock rod to the full up position.
3. Rotate the camshaft lever to the down position.
4. Loosen the surge valve plug enough to drip fluid, wait until the dripping stops.
5. When the fluid stops dripping, loosen and remove the accumulator.
6. If the piston can be pushed into the accumulator by hand, the accumulator is defective. Replace the accumulator.

a - Accumulator
b - Camshaft lever
c - Surge valve
d - Piston

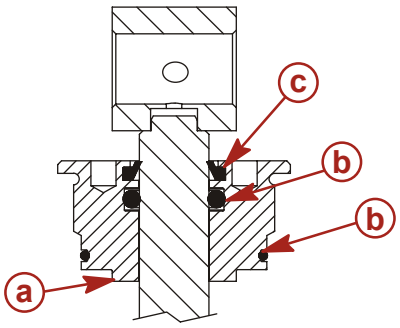
7. Remove the O-ring, conical spring, steel ball, and plunger.



a - Conical spring
b - Steel ball
c - Plunger
d - O-ring

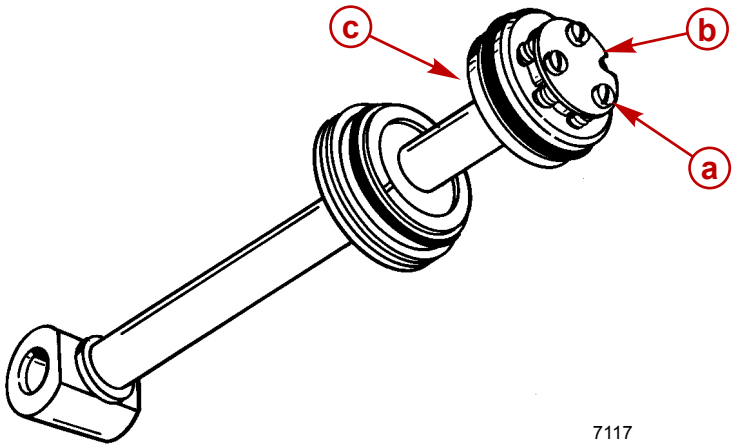
Shock Rod Disassembly

NOTE: *The only serviceable items on the shock rod assembly are the O-rings and wiper ring. If the shock rod requires any other repair, replace the shock rod assembly.*



a - End cap
b - O-ring (2)
c - Wiper ring

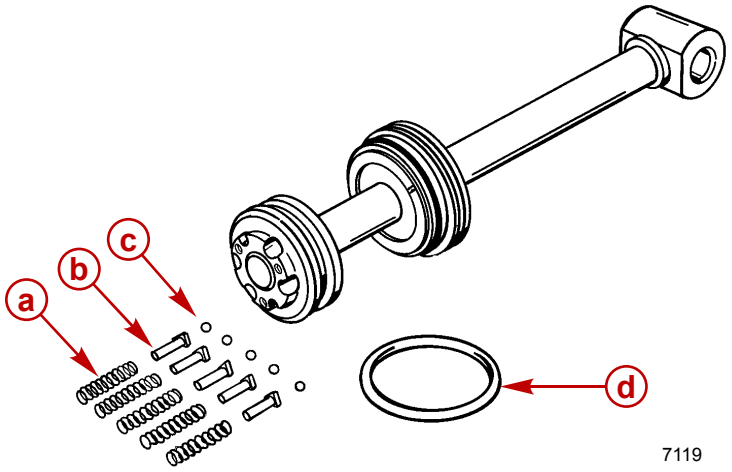
1. Place the shock rod assembly on a clean work surface.
2. Remove the three screws and remove the plate from the shock rod piston.



a - Screw (3)
b - Plate
c - Shock rod piston

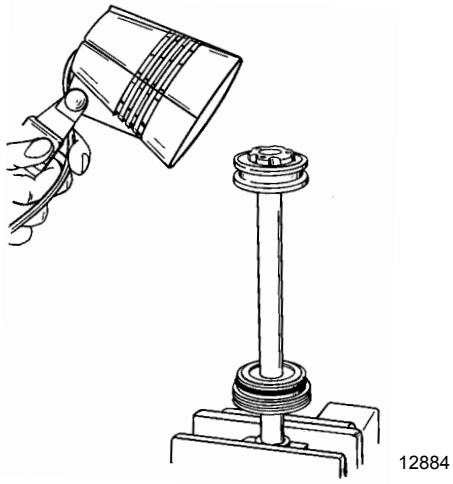
3. Remove the check ball components from the shock rod piston.

4. Remove the O-ring from the shock rod piston.



a - Spring (5)
b - Seat (5)
c - Ball (5)
d - O-ring

5. Place the shock rod into a soft jawed vise and apply heat to loosen the piston using a torch lamp.

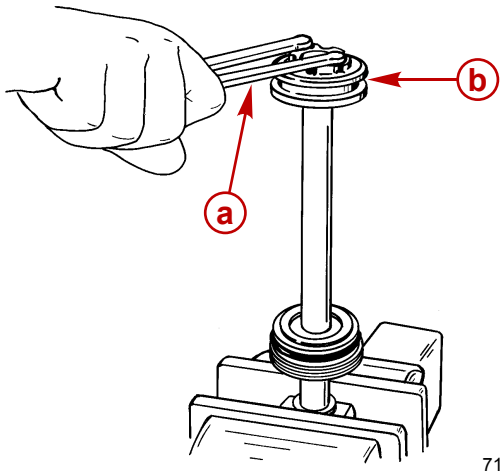


Torch Lamp	91- 63209

6. Loosen the shock rod piston using a spanner wrench (6.4 mm x 8 mm [1/4 in. x 5/16 in.] long pegs).

IMPORTANT: Use a spanner wrench with 6.4 mm x 8 mm (1/4 in. x 5/16 in.) long pegs to remove the shock rod piston.

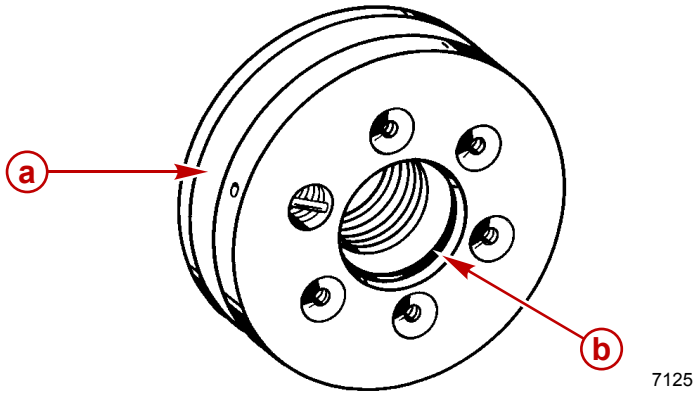
NOTE: *When using the trim cylinder end cap tool, use the large diameter pins, 5.97 mm (0.235 in.), in the 1 in. span position. Pins should be partially pulled out of the spanner wrench to extend approximately 9.5 mm (0.375 in.).*



a - Spanner wrench
b - Shock rod piston

Spanner Wrench	91- 74951
Trim Cylinder End Cap Tool	91-821709T

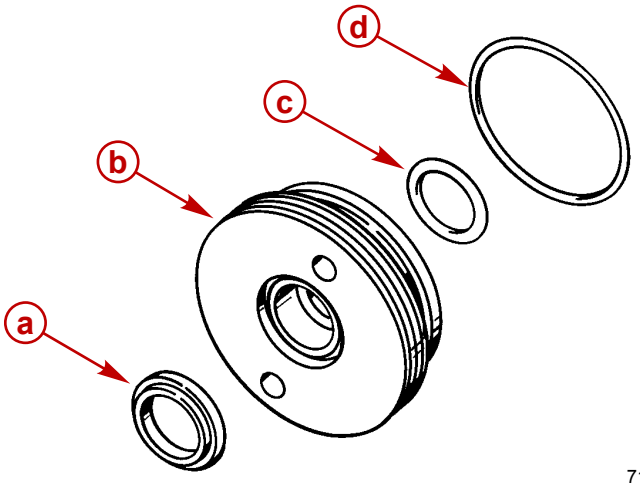
7. Allow the shock rod piston to cool. Remove from the shock rod.
8. Inspect the check valve for debris. Clean debris from the check valve if found. If debris cannot be cleaned from the check valve, replace the shock piston as an assembly.
9. Clean the shock and components with compressed air.
10. Remove the inner O-ring from the shock rod piston.



7125

a - Shock piston
b - O-ring

11. Remove the cylinder end cap assembly from the shock rod.
12. Inspect the shock rod components. If the wiper located in the cap has failed to keep the rod clean, replace the wiper.
13. Place the end cap on a clean work surface.
14. Remove the rod wiper, inner O-ring, and outer O-ring.



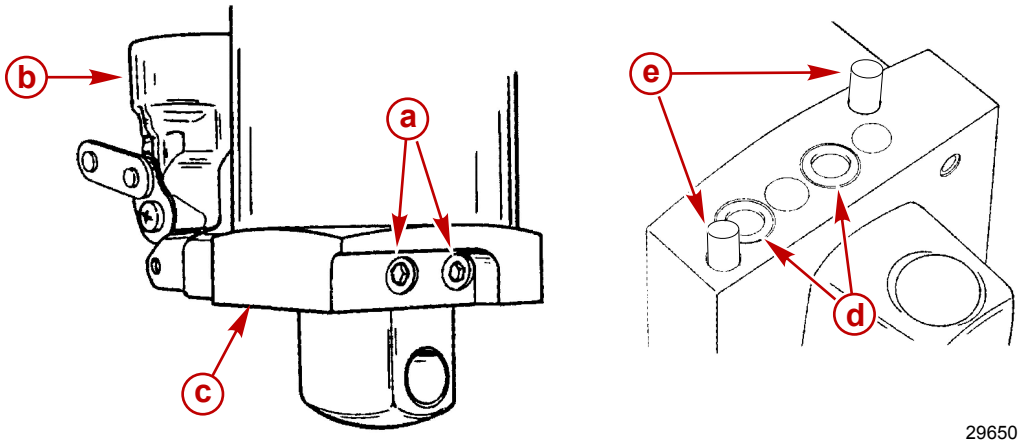
7126

a - Rod wiper
b - Cylinder end cap
c - Inner O-ring
d - Outer O-ring

Valve Block Removal

1. Remove the two socket head bolts from the shock cylinder.
2. Separate the valve block and the shock cylinder.

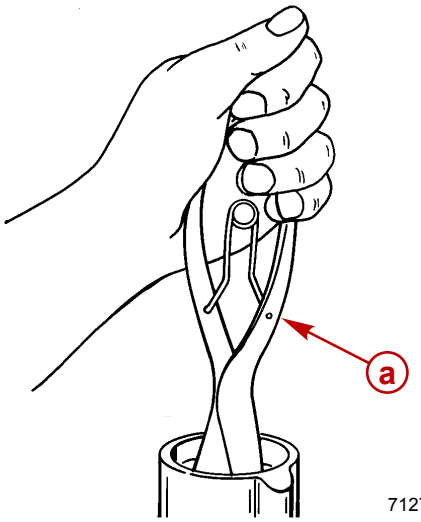
3. Remove the O-rings and dowel pins.



a - Socket head bolt (2)
b - Valve block
c - Shock cylinder
d - O-ring (2)
e - Dowel pin (2)

Memory Piston Removal

1. Remove the memory piston from the cylinder using one of two methods:
   a. Use lockring pliers or suitable tool.



a - Lockring pliers

Lockring Pliers	Snap-On SRP-4

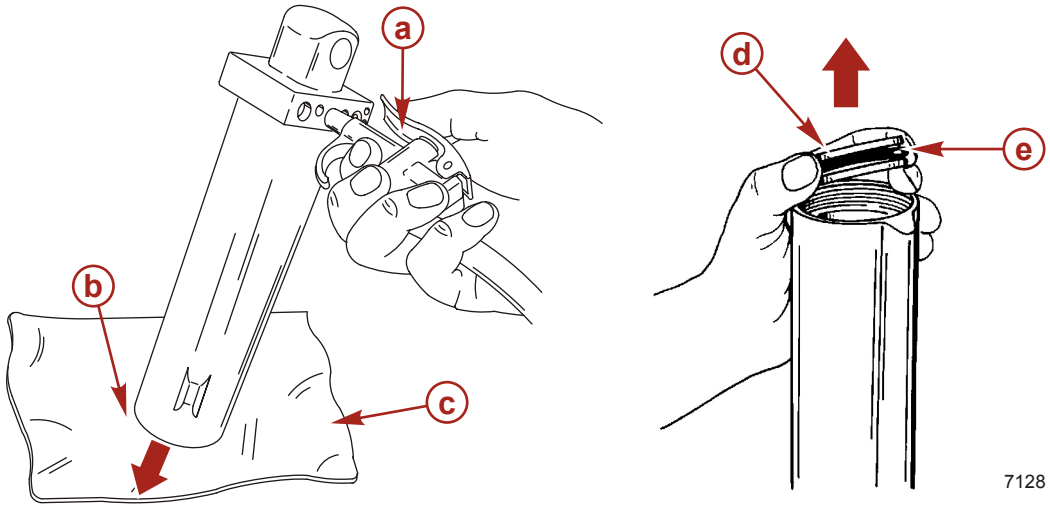
   b. Blow compressed air into the manual release valve hole using an air nozzle.

⚠ WARNING

The memory piston cup may be expelled at a high velocity when air pressure is applied. Failure to position the cylinder opening down and away from your body could result in personal injury.

NOTE: *Point cylinder opening down and away. Use a shop rag or towel to catch the memory piston and avoid damage or personal injury.*

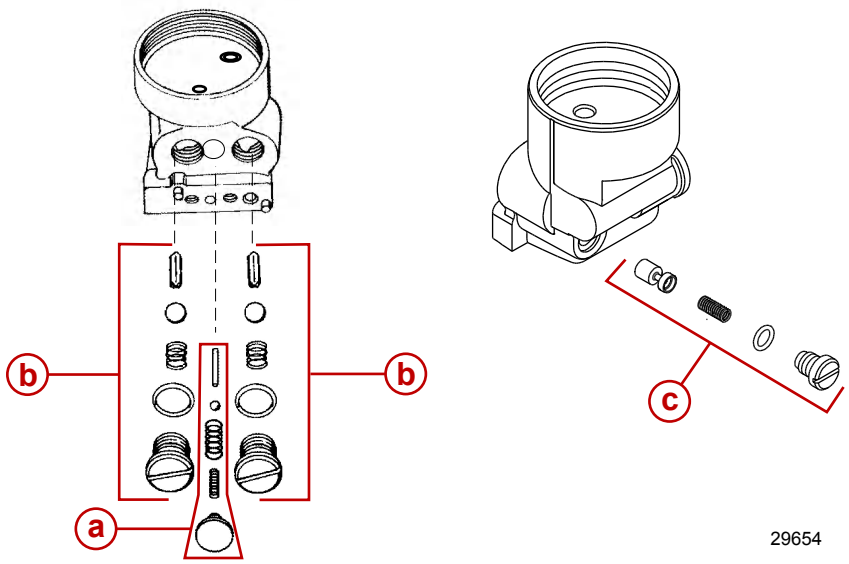
2. Remove the O-ring from the memory piston.



a - Adapter/air hose
b - Memory piston exit
c - Shop rag
d - Memory piston
e - O-ring

Valve Block Disassembly

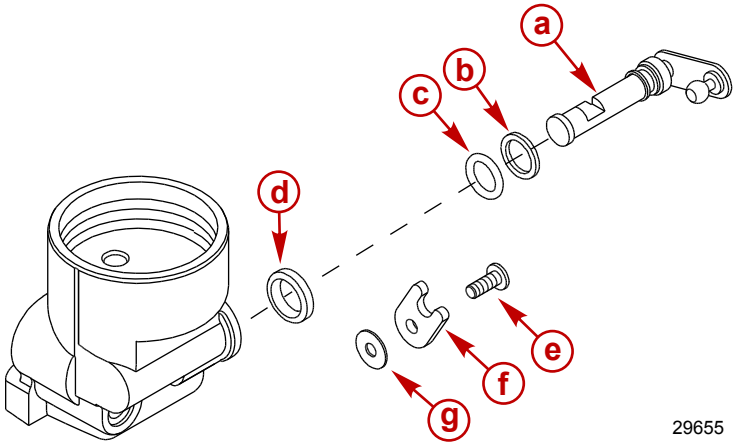
1. Remove the down circuit slow transfer valve plug and components.
2. Remove the up and down circuit fast transfer valve plugs and components.
3. Remove the surge valve plug and components.



a - Down circuit slow transfer valve components
b - Up and down circuit fast transfer valve components
c - Surge valve components

4. Remove the camshaft lever screw.

5. Remove the camshaft lever assembly.



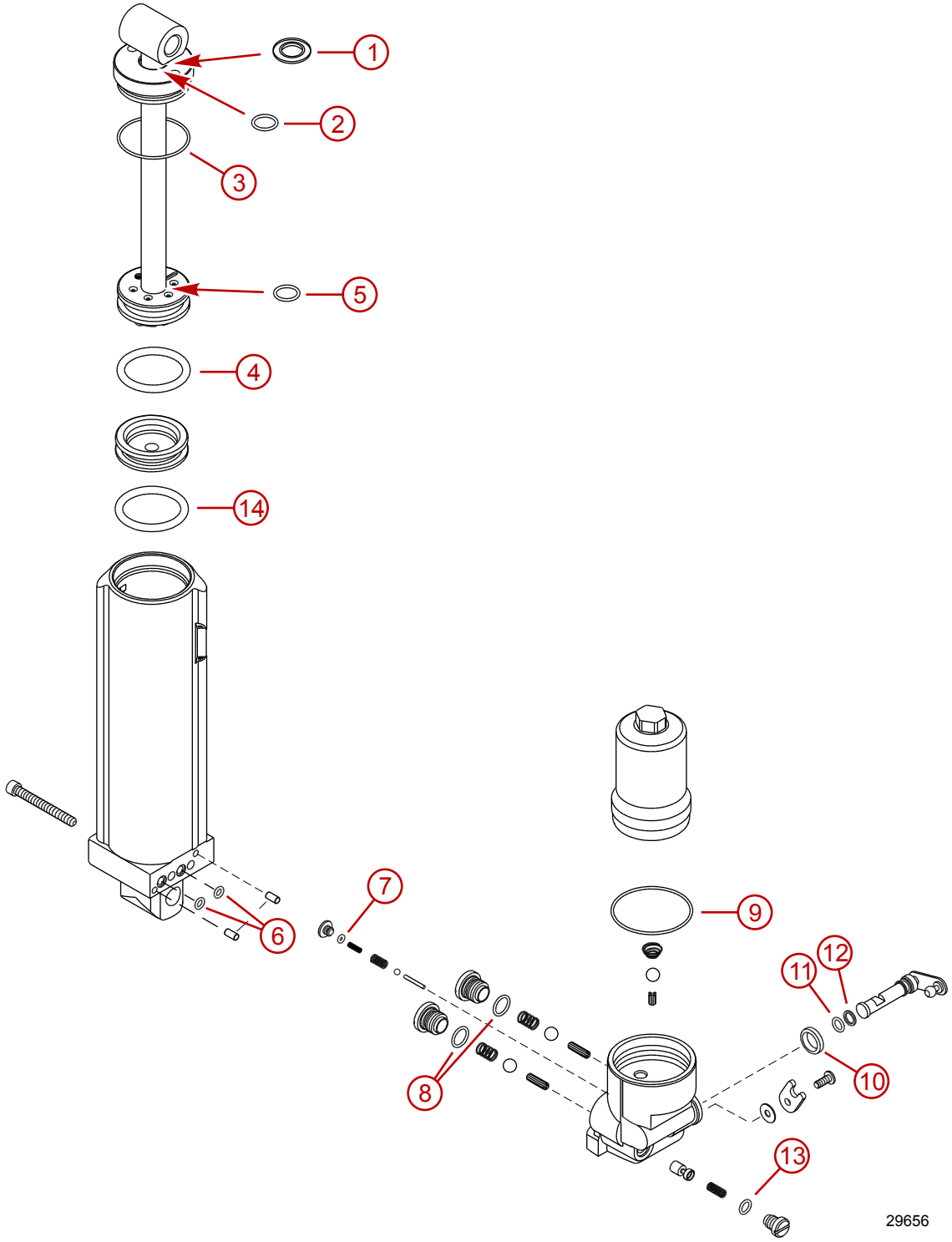
a - Camshaft lever
b - Backup ring
c - O-ring
d - Shaft seal
e - Screw
f - Retainer clip
g - Spacer

Gas Assist System Cleaning and Inspection

IMPORTANT: Dirt or contaminants in the hydraulic system can damage the system's internal components. Do not allow dirt or contamination to enter the system and perform all hydraulic inspections, service, or assembly procedures in a clean work area.

1. It is recommended that all O-rings exposed during disassembly be replaced.
2. Clean components, filter, and check valve seats using an engine cleaner and compressed air. Do not use cloth rags.
3. Inspect all machined surfaces for burrs or scoring to assure O-ring longevity.
4. Inspect the shock rod. If the scraper (located in the cap) has failed to keep the rod clean, replace the scraper.

O-Ring and Seal Placement



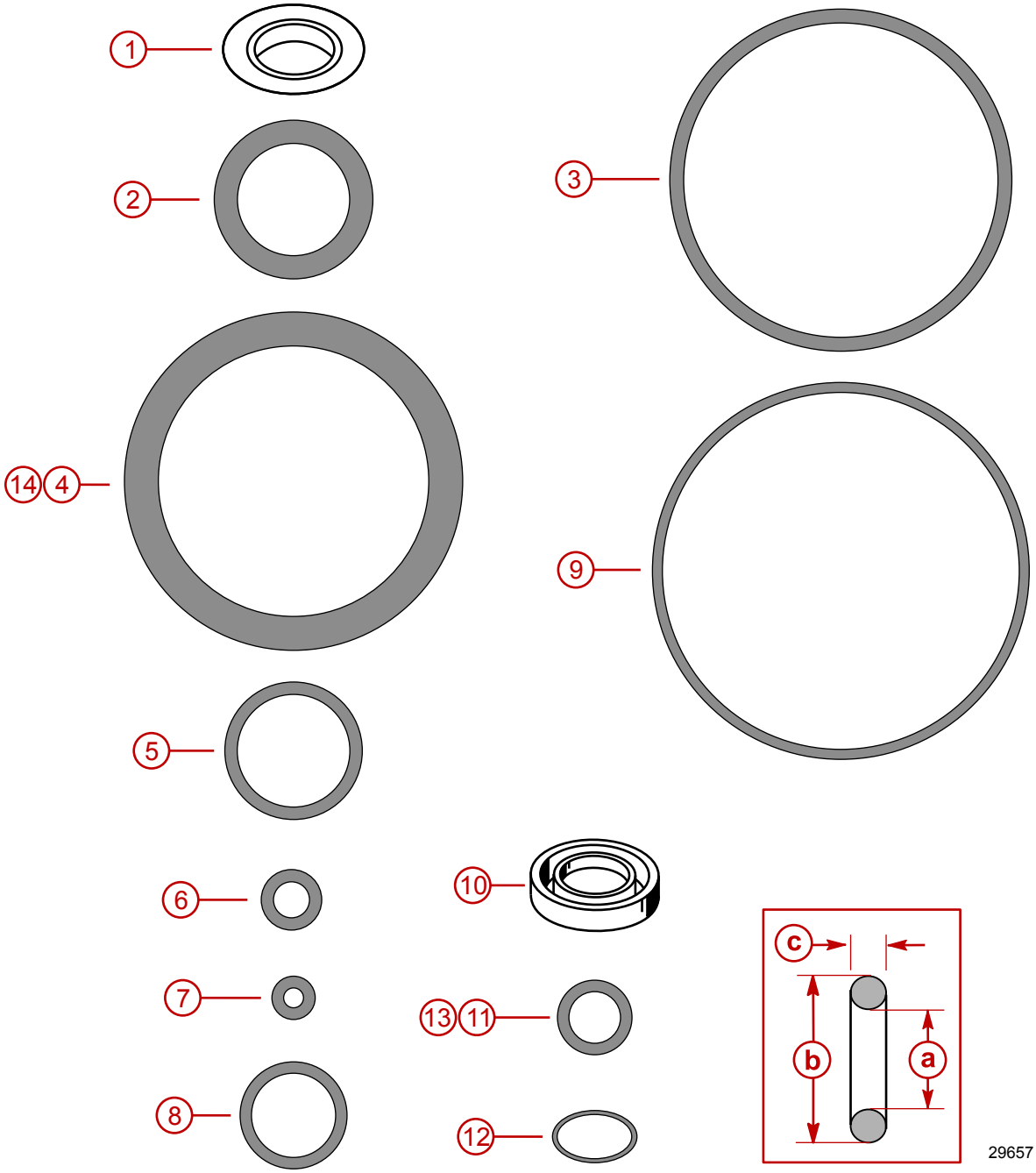
NOTE: *Lubricate all O-rings using Mercury/Quicksilver Power Trim and Steering Fluid. If not available, use automotive automatic transmission fluid (ATF).*

Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	O-ring lubrication	92-858074K01

IMPORTANT: It is recommended that all O-rings be replaced when servicing the tilt system.

Actual O-Ring Size

NOTE: *Refer to* ***O-Ring and Seal Placement*** *chart on the previous page for description.*



a - Inside diameter
b - Outside diameter
c - Width

Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	O-ring lubrication	92-858074K01

O-Ring Description and Size

O-Ring	Description	O-Ring Inside Diameter	O-Ring Outside Diameter	O-Ring Width
1	Wiper ring			
2	Inner cylinder cap	17.04 mm (0.671 in.)	24.10 mm (0.949 in.)	3.53 mm (0.139 in.)
3	Cylinder cap	47.34 mm (1.864 in.)	50.90 mm (2.004 in.)	1.78 mm (0.070 in.)
4	Shock piston	40.64 mm (1.6 in.)	53.09 mm (2.02 in.)	5.334 mm (0.21 in.)
5	Piston bolt	17.17 mm (0.676 in.)	20.73 mm (0.816 in.)	1.78 mm (0.070 in.)
6 (2)	Manifold split line	5.28 mm (0.208 in.)	8.84 mm (0.348 in.)	1.78 mm (0.070 in.)
7	Slow valve	2.90 mm (0.114 in.)	6.451 mm (0.254 in.)	1.78 mm (0.070 in.)
8 (2)	Plug	12.42 mm (0.489 in.)	15.97 mm (0.629 in.)	1.78 mm (0.070 in.)
9	Accumulator	53.69 mm (2.114 in.)	57.25 mm (2.254 in.)	1.78 mm (0.070 in.)
10	Lip seal			
11	Camshaft	7.65 mm (0.301 in.)	11.20 mm (0.441 in.)	1.78 mm (0.070 in.)
12	Backup ring			
13	Surge valve	7.65 mm (0.301 in.)	11.20 mm (0.441 in.)	1.78 mm (0.070 in.)
14	Memory piston	40.64 mm (1.6 in.)	53.086 mm (2.02 in.)	5.334 mm (0.21 in.)

Gas Assist System Assembly

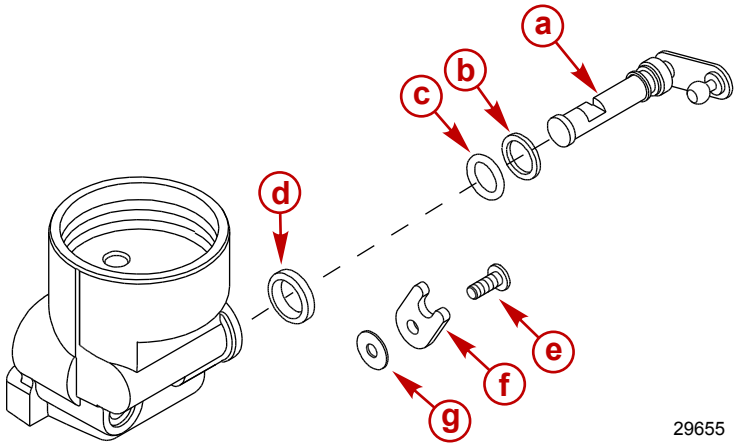
IMPORTANT: Components must be dirt and lint free. The slightest amount of debris in the tilt system could cause the system to malfunction.

Lubricate all O-rings with Mercury/Quicksilver Power Trim and Steering Fluid during assembly. If not available, use automotive automatic transmission fluid (ATF).

Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	O-ring lubrication	92-858074K01

Camshaft Lever Assembly

1. Install the O-ring and backup ring onto the camshaft.
2. Install the shaft seal into the valve block with the seal lips facing out.
3. Install the camshaft assembly into the valve block.
4. Secure the camshaft with the spacer, retainer plate, and screw. Tighten the screw securely.

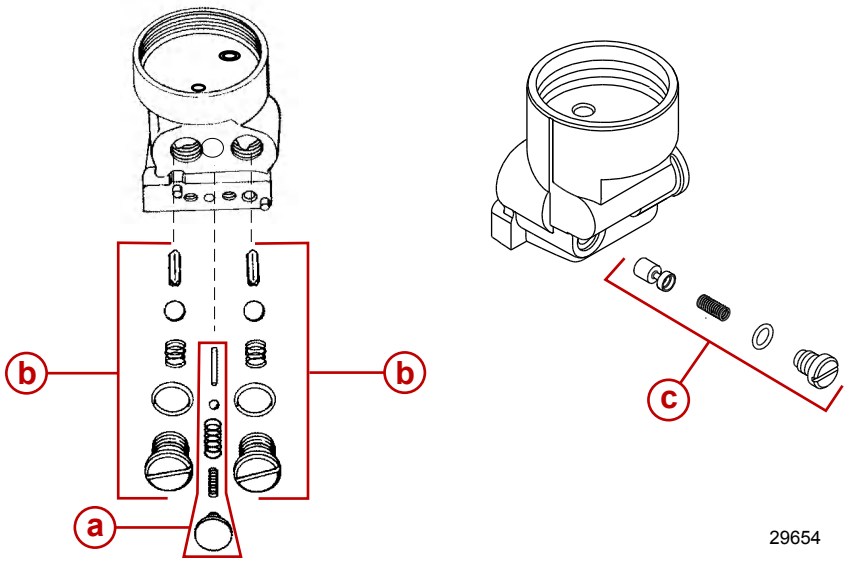


a - Camshaft lever
b - Backup ring
c - O-ring
d - Shaft seal
e - Screw
f - Retainer plate
g - Spacer

Valve Block Assembly

1. Install the down circuit slow transfer valve components into the valve block. Tighten the plug.
2. Install the up and down circuit fast transfer valve components. Tighten the plugs to the specified torque.

3. Install the surge valve components. Tighten the plug to the specified torque.

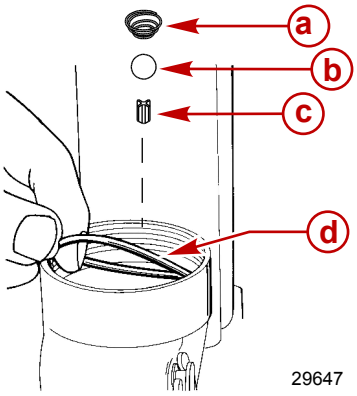


- **a -** Down circuit slow transfer valve components
- **b -** Up and down circuit fast transfer valve components
- **c -** Surge valve components

Description	Nm	lb-in.	lb-ft
Transfer valve plug (2)	8.5	75	
Surge valve plug	8.5	75	

Accumulator Check Valve Assembly

Install the lubricated O-ring, plunger, steel ball, and conical spring into the valve block.

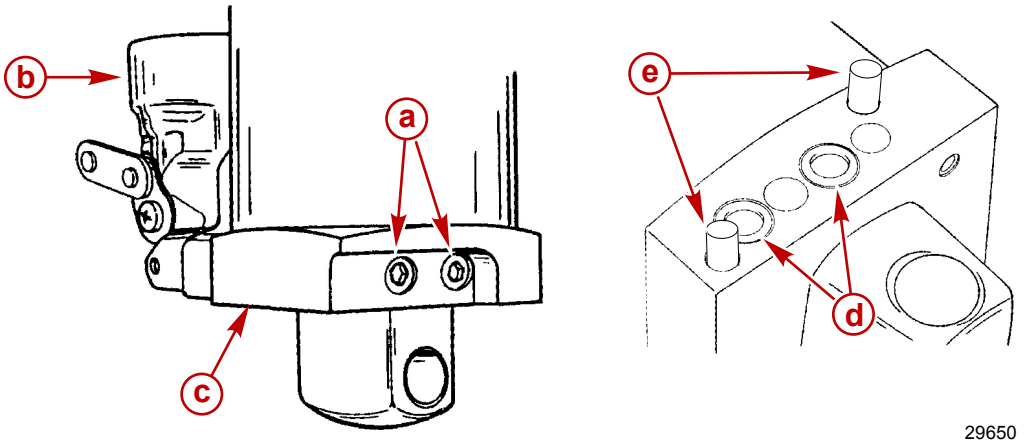


- **a -** Conical spring
- **b -** Steel ball
- **c -** Plunger
- **d -** O-ring

Valve Block Installation

1. Install the lubricated O-rings and dowel pins.

2. Install the valve block to the shock cylinder. Secure with two socket head bolts and tighten to the specified torque.



- **a -** Socket head bolt (2)
- **b -** Valve block
- **c -** Shock cylinder
- **d -** O-ring (2)
- **e -** Dowel pin (2)

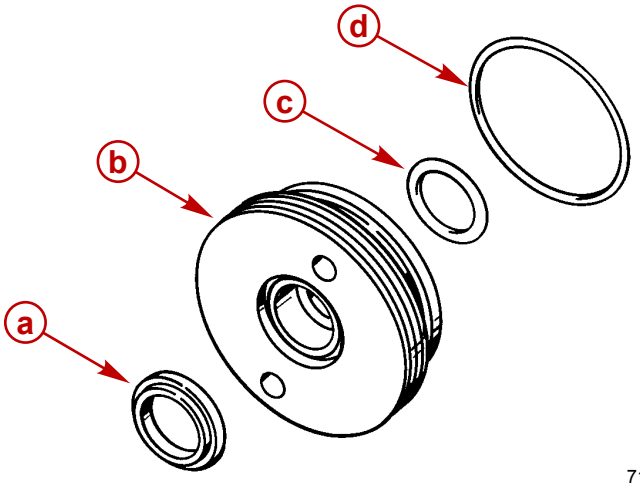
Description	Nm	lb-in.	lb-ft
Socket head bolt (2)	11.3	100	

Shock Rod Assembly

IMPORTANT: Lubricate all O-rings with Power Trim and Steering Fluid. If not available, use automotive automatic transmission fluid (ATF).

Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	Power trim O-rings	92-858074K01

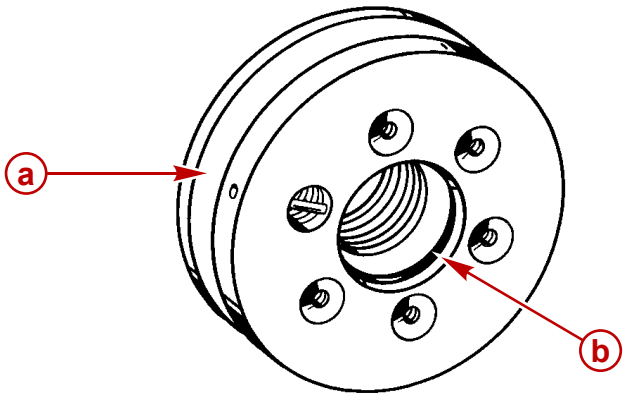
1. Install the lubricated O-rings to the end cap.



- **a -** Rod wiper
- **b -** Cylinder end cap
- **c -** Inner O-ring
- **d -** Outer O-ring

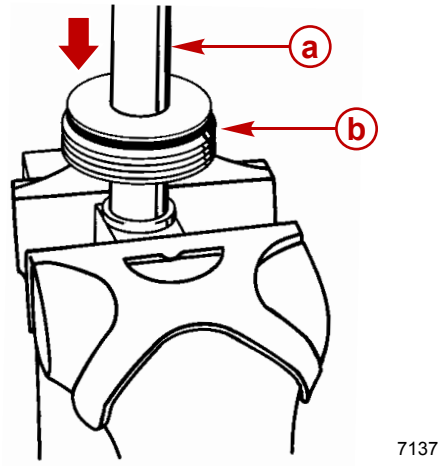
2. Install the rod wiper.

3. Install the lubricated O-rings to the shock piston.



a - Shock piston
b - O-ring

4. Clamp the shock rod in a soft jawed vise.
5. Position the trim cylinder end cap onto the rod, as shown.



a - Trim cylinder rod
b - Trim cylinder end cap

6. Apply Loctite 271 Threadlocker to the threads on the shock rod.

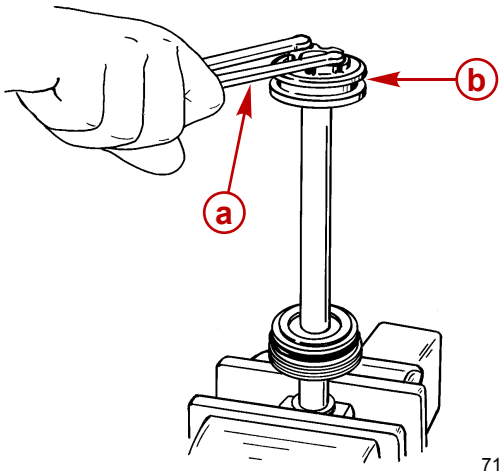
Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Shock rod threads	92-809819

7. Install the shock rod piston.

IMPORTANT: Use a spanner wrench with 6.4 mm x 8 mm (1/4 in. x 5/16 in.) long pegs to remove the shock rod piston.

8. Tighten the shock rod piston securely using a spanner wrench (6.4 mm x 8 mm [1/4 in. x 5/16 in.] long pegs). If a torquing type spanner tool is used to tighten the shock rod piston, then tighten to the specified torque.

NOTE: *When using the trim cylinder end cap tool, use the large diameter pins, 5.97 mm (0.235 in.), in the 1 in. span position. Pins should be partially pulled out of the spanner wrench to extend approximately 9.5 mm (0.375 in.).*



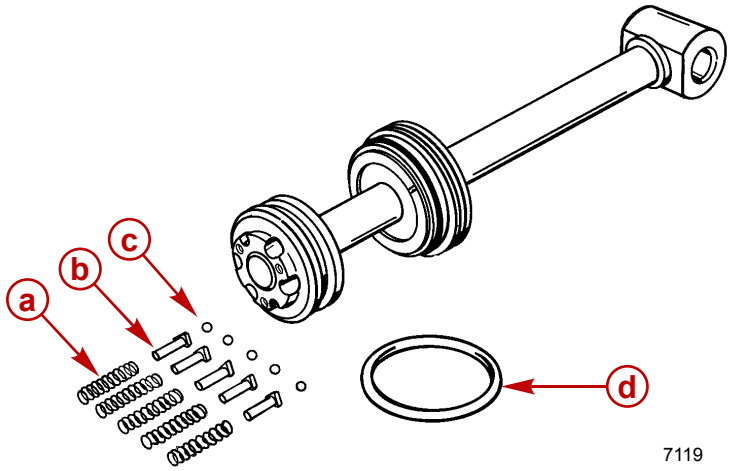
7121

a - Spanner wrench
b - Shock rod piston

Spanner Wrench	91- 74951
Trim Cylinder End Cap Tool	91-821709T

Description	Nm	lb-in.	lb-ft
Shock rod piston	122		90

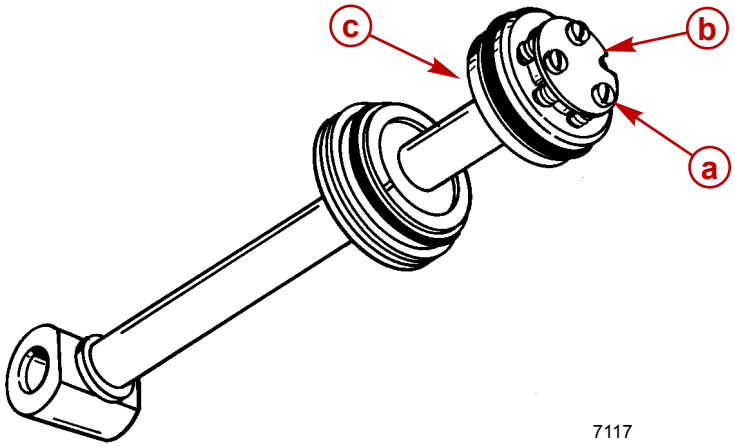
9. Remove the shock rod assembly from the vise.
10. Install the ball, seat, and spring (five sets) to the shock rod piston. Install O-ring onto the shock rod piston.



7119

a - Spring (5)
b - Seat (5)
c - Ball (5)
d - O-ring

11. Secure the components with the plate. Tighten the screws to the specified torque.



7117

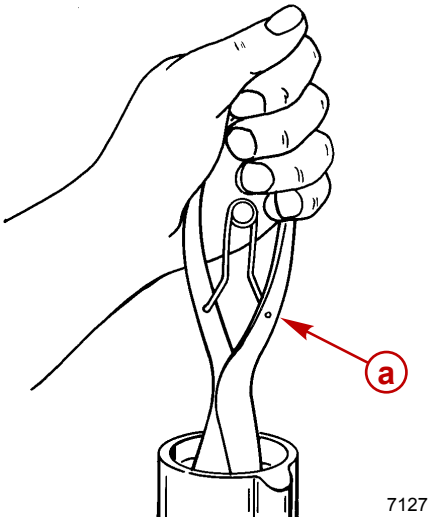
a - Screw (3)
b - Plate
c - Shock rod piston

Description	Nm	lb-in.	lb-ft
Screw	4	35	

Shock Rod Installation and Fluid Filling Procedure

Filling Procedure Option One

1. Place the cylinder in a soft jawed vice.
2. With the camshaft lever closed (up position), fill the cylinder and accumulator base to the top with Mercury/Quicksilver Power Trim and Steering Fluid, or automotive automatic transmission fluid (ATF). Let the bubbles disperse.
3. Install a lubricated O-ring onto the memory piston.
4. Using lockring pliers, set the memory piston into the top of the cylinder, then open the camshaft lever (down position) and push the memory piston down to just below the cylinder threads. Close the camshaft lever (up position).

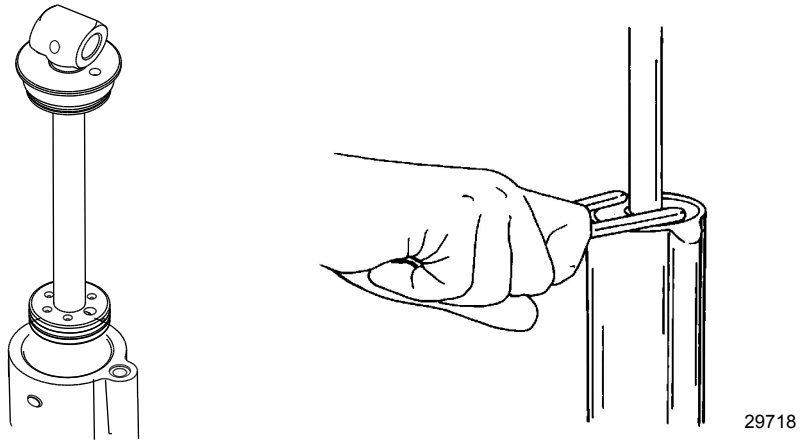


a - Lockring pliers

Lockring Pliers	Snap-On SRP-4

Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	Shock cylinder	92-858074K01

5. Add fluid to the top of the cylinder and install the shock rod assembly. Open the cam lever (down position) and push the shock rod assembly down to 3 mm (1/8 in.), below the cylinder threads. Close the camshaft lever (up position).
6. Add fluid to the top of the cylinder. Open the camshaft lever (down position) and thread the end cap into the cylinder.
7. Tighten the end cap securely using a spanner wrench (6.4 mm x 8 mm [1/4 in. x 5/16 in.] long pegs). If a torquing type spanner tool is used to tighten the end cap, tighten to the specified torque. Close the camshaft lever (up position).

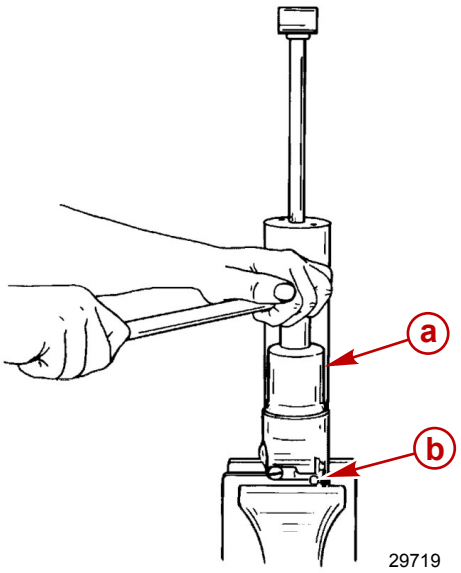


Spanner Wrench	91- 74951

Trim Cylinder End Cap Tool	91-821709T

Description	Nm	lb-in.	lb-ft
Shock cylinder end cap	61		45

8. Open and close the camshaft lever, watching for bubbles coming from the accumulator check ball hole. When the bubbles stop, fill the accumulator base to the top with fluid. Grease the threads on the accumulator and the base with 2-4-C with PTFE. Partially thread the accumulator into the base and open the camshaft lever (down position). Tighten the accumulator to the specified torque.



a - Accumulator
b - Camshaft lever

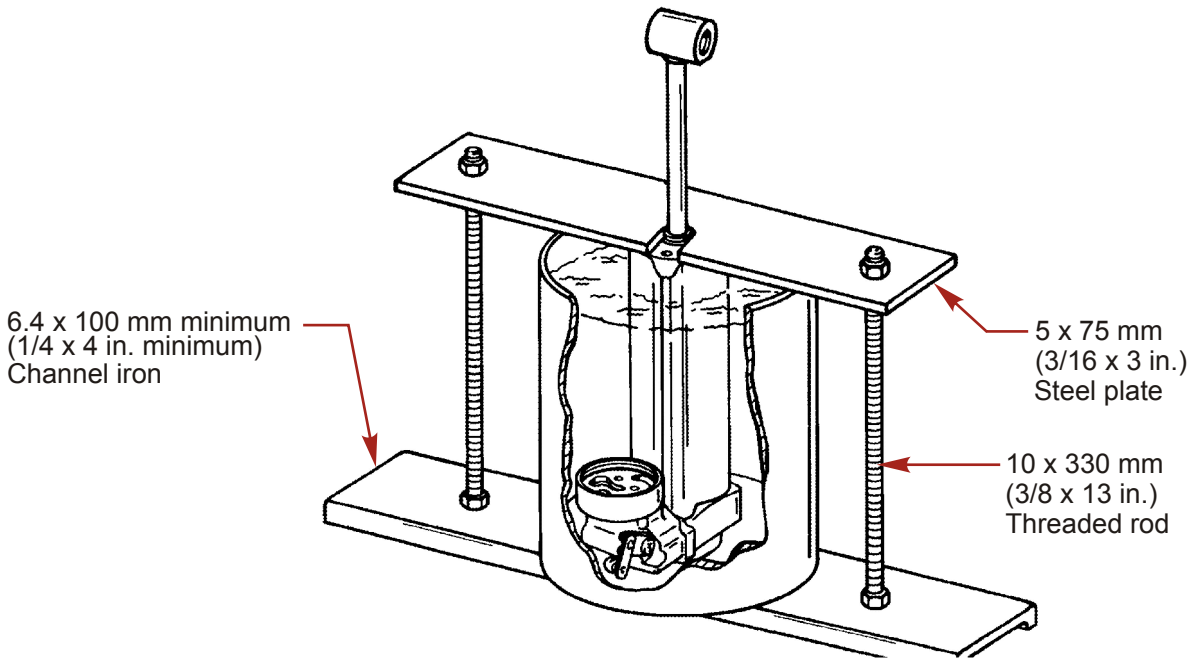
NOTE: *If the filling procedure is done correctly, it should be hard to turn the cylinder rod assembly by hand.*

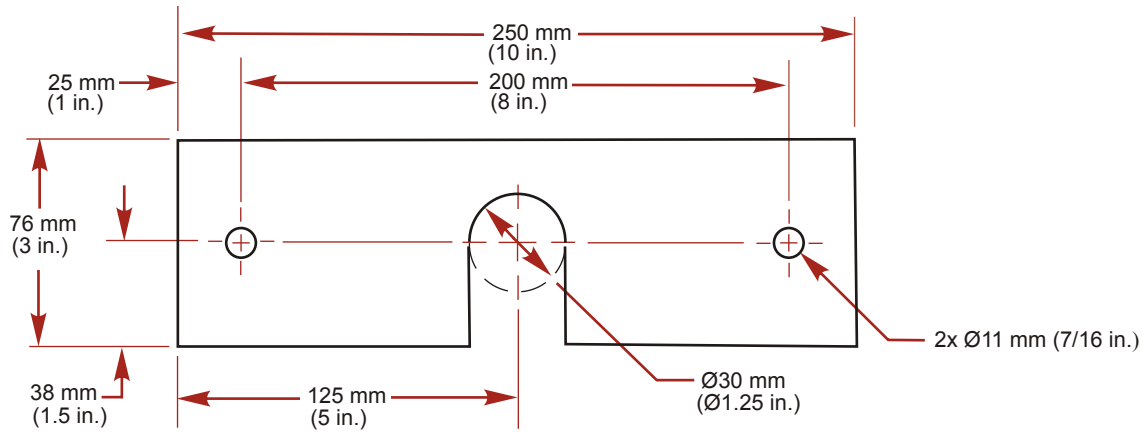
Description	Nm	lb-in.	lb-ft
Accumulator	47.5		35

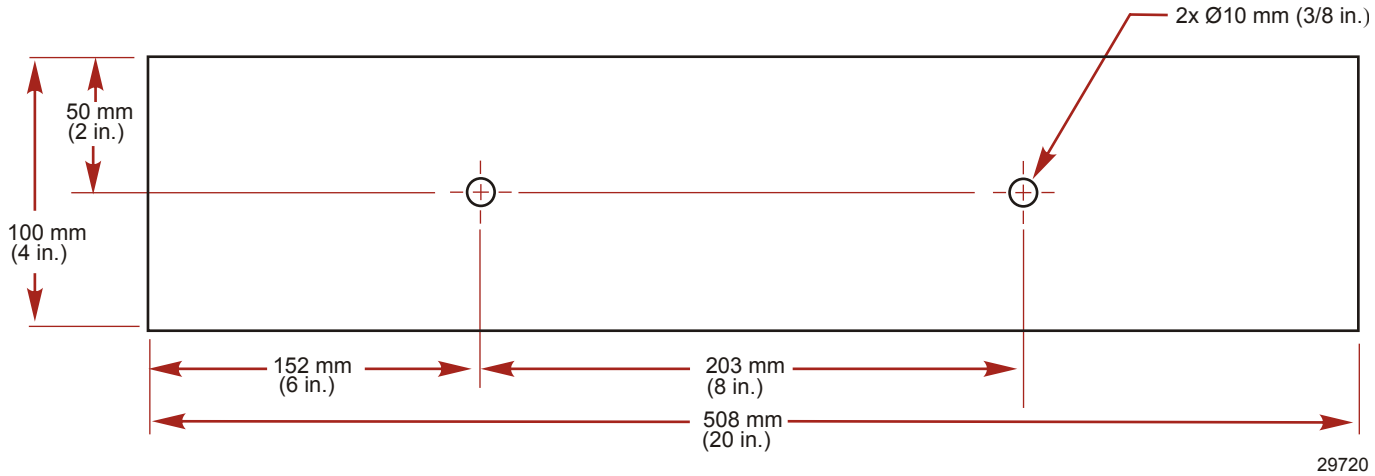
Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Threads on the accumulator and base	92-802859A 1

Filling Procedure Option Two

IMPORTANT: While bleeding the tilt system, time must be allowed between each stroke to allow the air bubbles to dissipate.



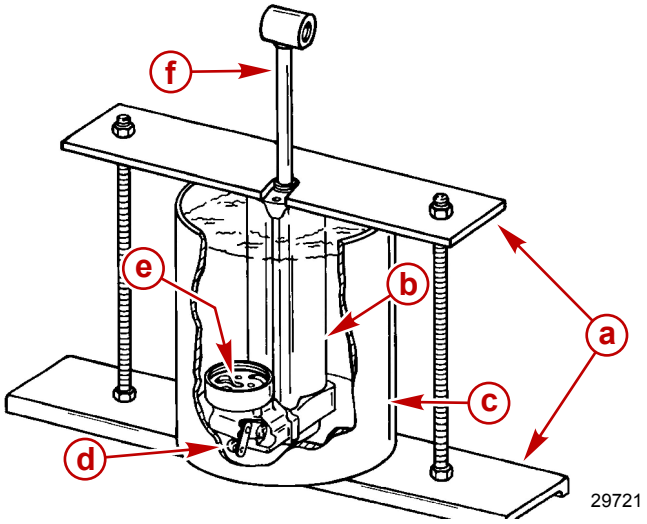




29720

1. With the shock rod in the full up position and the cam lever open (facing down), secure the tilt system to the retaining tool and container. (A #10 can or 3 lb. coffee can could be used.)
2. Fill the container to near full level using Mercury/Quicksilver Power Trim and Steering Fluid. If not available, use automotive automatic transmission fluid (ATF).

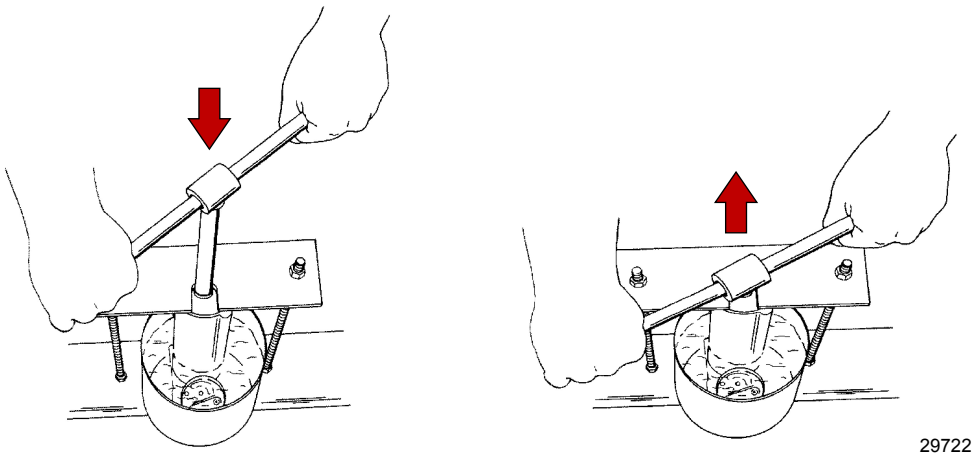
   IMPORTANT: Fluid level must remain above the accumulator base during the bleeding process.



- **a -** Retaining tool
- **b -** Tilt system unit
- **c -** Container
- **d -** Camshaft lever
- **e -** Accumulator base
- **f -** Shock rod

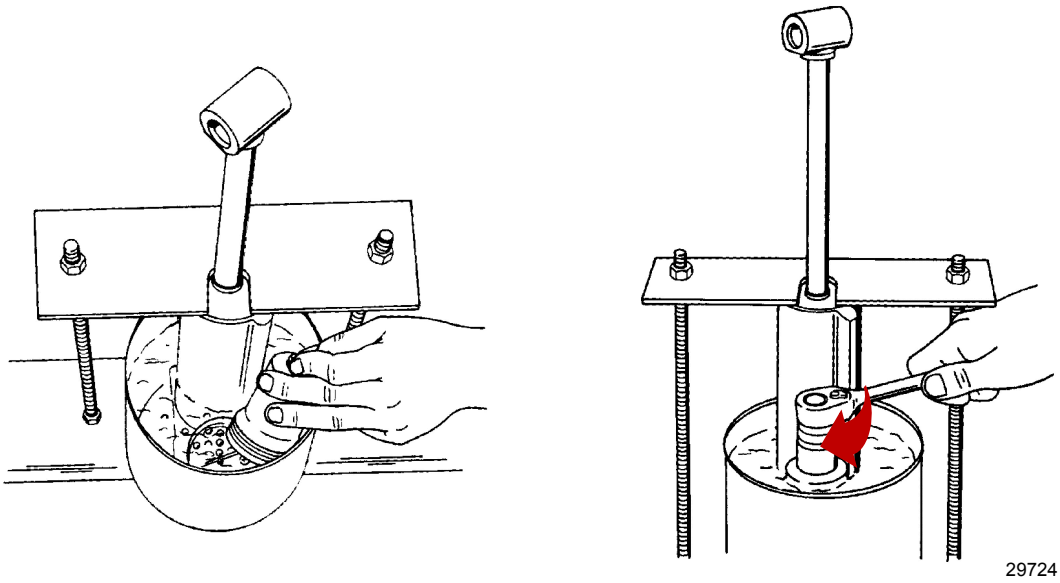
Tube Ref No.	Description	Where Used	Part No.
114	Power Trim and Steering Fluid	Manual tilt system	92-858074K01

3. Bleed the unit by slowly pushing the shock rod down (18–20 seconds per stroke) until it bottoms out. Wait until all air bubbles exit the accumulator base.
4. Pull the rod slowly up a distance of 76 mm (3 in.).
5. Wait until all the air bubbles exit the accumulator base.
6. Slowly cycle the rod down and up five to eight times using short strokes of 76 mm (3 in.). Allow the bubbles to dissipate during each stroke.

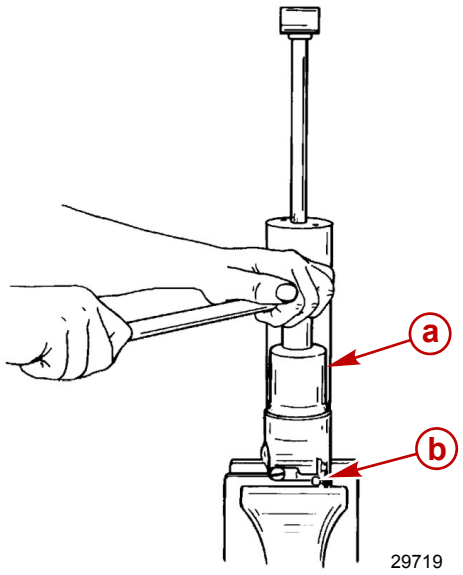


7. Allow the unit to stand five minutes, then proceed to cycle unit two or three more times using short strokes. No air bubbles should appear from accumulator port at this time.
8. With the oil level well above accumulator base, slowly pull the rod to the full up position.
9. Install the accumulator. Do not allow air to enter the system.

10. Tighten the accumulator snugly at this time.



11. With the camshaft lever open (facing down), remove the tilt assembly from the oil and secure it in a soft jawed vise. Tighten the accumulator to specification.



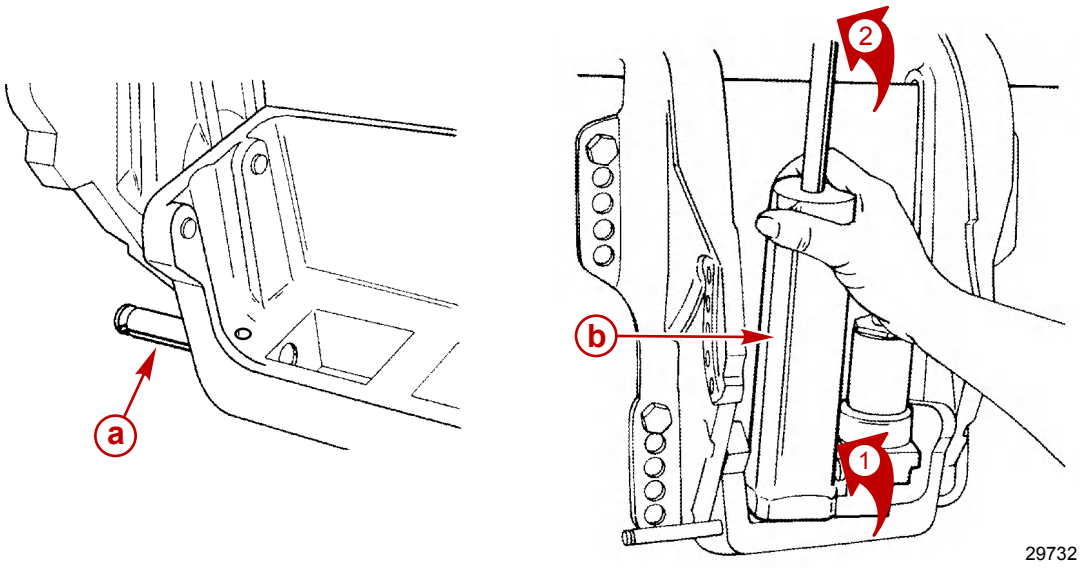
a - Accumulator
b - Camshaft lever

Description	Nm	lb-in.	lb-ft
Accumulator	47.5		35

Manual Tilt System Installation

1. Apply 2-4-C with PTFE to the lower pivot pin hole and pivot pin surface.
2. Start the lower pivot pin into the pivot pin hole.

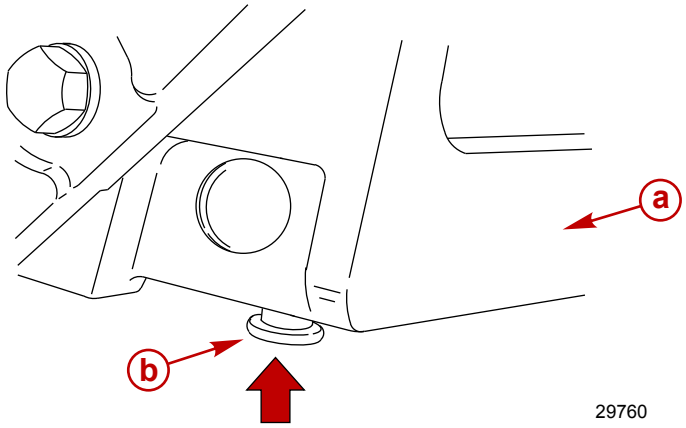
3. Install the manual tilt system, bottom first. Connect the release valve link rod.



a - Lower pivot pin
b - Manual tilt system

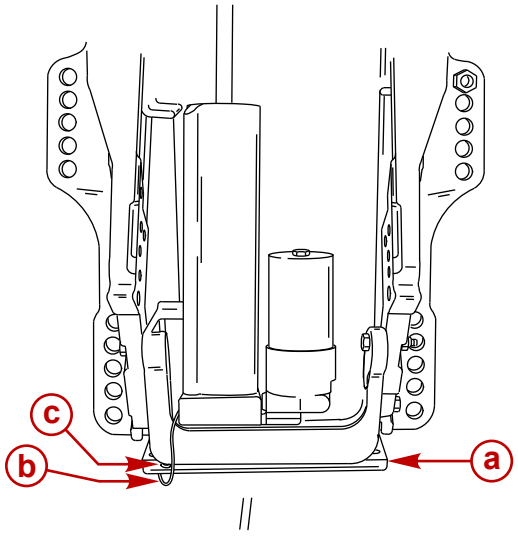
Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Lower pivot pin hole and pivot pin surface	92-802859A 1

4. Using a suitable punch, drive the lower pivot pin into the anchor bracket and the tilt cylinder assembly until the pivot pin is flush with the outside surface.
5. Install the trilobe pin into the anchor bracket and the lower pivot pin.
6. Using a punch, drive the lower trilobe pin in until seated.



a - Anchor bracket
b - Lower trilobe pin

7. Install the anode and ground wire. Secure with two bolts and washers. Tighten the bolts to the specified torque.

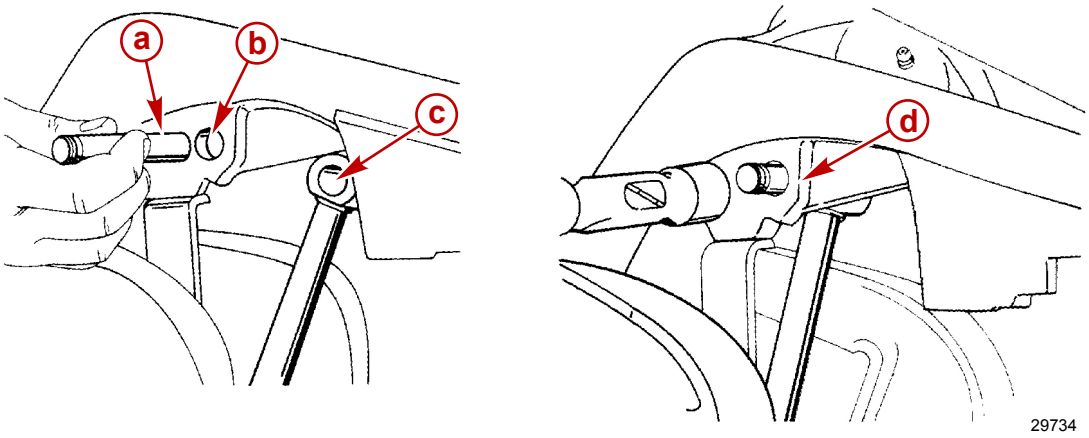


29744

a - Anode
b - Ground wire
c - Trilobe pin

Description	Nm	lb-in.	lb-ft
Anode mounting bolts (M6 x 25) (2)	6	53	

8. Apply 2-4-C with PTFE to the surface of the upper pivot pin, pivot pin hole, and shock cylinder rod eye.
9. Using a mallet, drive the upper pivot pin into the swivel bracket and through the shock cylinder rod eye until the pivot pin is flush with the swivel bracket.

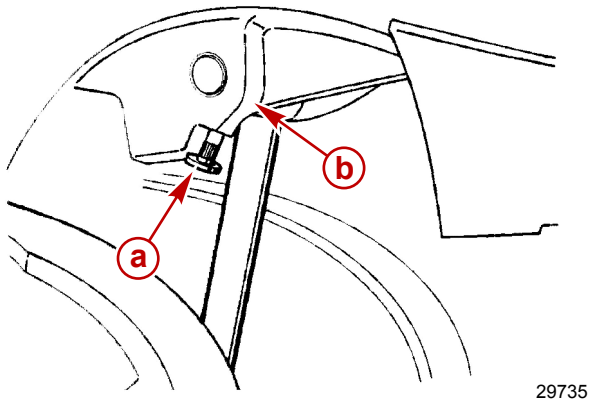


29734

a - Pivot pin
b - Pivot pin bore
c - Shock cylinder rod eye
d - Swivel bracket

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	The surface of the upper pivot pin, pivot pin hole, and shock cylinder rod eye	92-802859A 1

10. Drive the upper trilobe pin into its hole until seated.



a - Trilobe pin
b - Swivel bracket

11. Adjust and install the camshaft link rod. Refer to **Camshaft Link Rod Adjustment**.
12. Check the operation of the gas assist manual trim/tilt.

Lower Unit

Section 6A - Gear Housing - EZ Shift (1.83:1 Gear Ratio)

Table of Contents

6A

Gear Housing Specifications (1.83:1)

Gear Housing Specifications		
Gear ratio		1.83:1
Gear shift positions		F–N–R
Reduction gear type		Spiral bevel gear
Clutch type		Dog clutch
Propeller shaft type		Spline
Propeller direction (rear view)		Clockwise
Gear housing capacity		340 ml (11.5 fl oz)
Lubricant type		High Performance Gear Lubricant or Premium Gear Lubricant
Forward gear - number of teeth		22
Pinion gear - number of teeth		12
Pinion height		0.64 mm (0.025 in.)
Pinion gear locating tool	Part number	91-817008A 2
	Flat number	
	Disc number	
Forward gear backlash		0.28–0.43 mm (0.011–0.017 in.)
Backlash indicating tool	Part number	91-19660 1
	Mark number	4
Water pressure	At 800 RPM	7–21 kPa (1–3 psi)
	At 6000 RPM	83–172 kPa (12–25 psi)
Leak test		69–83 kPa (10–12 psi) for five minutes

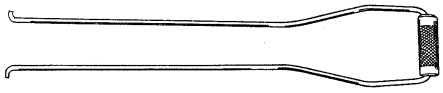
Lubricants, Sealants, Adhesives

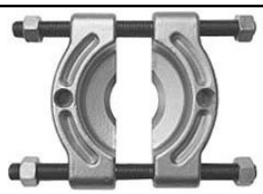
Tube Ref No.	Description	Where Used	Part No.
4	Assembly Grease	Forward bearing race	8M0071836
7	Loctite 271 Threadlocker	Bearing carrier seals	92-809819
		Outside diameter of small diameter bearing carrier oil seal	
		Outside diameter of large diameter bearing carrier oil seal	
		Pinion nut threads	
		Bolt	
		Outside diameter of shift shaft seal	
		Outside diameter of water pump seal	
		Water pump mounting bolt threads	
		Threads of gear housing retaining bolts	
87	High Performance Gear Lubricant	Driveshaft bearing rollers	92-858064K01
		Gear housing	

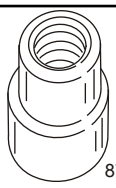
Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Cam follower, propeller shaft splines, and bearing carrier seals	92-802859A 1
		Actuator rod	
		Sliding clutch cross pin	
		Outside diameter of the bearing carrier needle bearing	
		Reverse gear bearing inside diameter	
		Reverse gear bearing outside diameter	
		Outside diameter of the forward gear roller bearing	
		Inside diameter of the forward gear roller bearing	
		Outside diameter of the lower driveshaft needle bearing	
		Inside diameter of the upper driveshaft bearing	
		Actuator rod cam pocket	
		O-ring, bearing carrier, and related gear housing bores	
		Inside diameter of shift shaft seal	
		Shift shaft bushing O-ring	
		Shift shaft bushing and O-ring	
		Water pump base O-ring, seal lips, and gear housing bore	
		Water pump gasket bead	
		Inside diameter of the water pump cover and water tube coupler	
		Water tube coupler inner diameter and shift shaft splines	
		Driveshaft splines and upper shift shaft splines	
117	Loctite 7649 Primer N	Driveshaft and pinion nut threads	92-809824

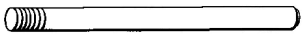
Special Tools

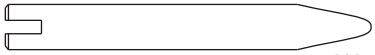
Puller Jaws Assembly	91-46086A1
 9514	Removes bearing carrier and bearing races; use with Puller Bolt (91-85716).

Puller	91- 27780
 8760	Removes gears, bearings, and races.

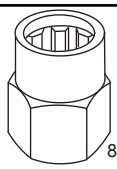
Universal Puller Plate	91-37241
 8505	Removes bearings from gears and the driveshaft.

Driveshaft Bearing Driver Head	91- 37312T
 8762	Removes bearings from gears and bearing carrier.

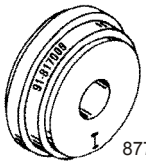
Driver Rod	91- 37323
 25431	Aids in the removal and installation of various bearings and bearing races

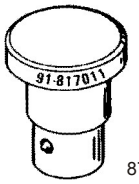
Slotted Cross Pin Tool	91- 86642 1
 9895	Assists in clutch assembly/disassembly.

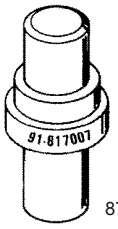
Driveshaft Bearing Retainer Wrench	91-43506T
 9520	Removes and installs the threaded bearing retainer.

Driveshaft Holding Tool	91-877840A 1
 8780	Holds driveshaft while removing pinion nut.

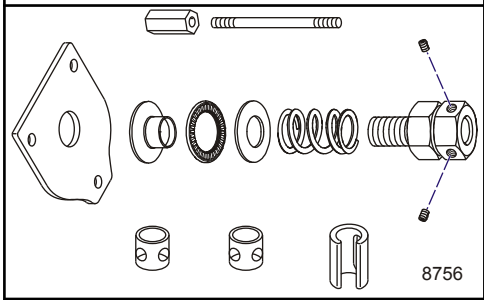
Lower Driveshaft Bearing Driver Assembly	91-817058A 1
 8778	Removes and installs lower driveshaft bearing.

Forward Gear Bearing Race Driver Cup	91-817009T
 8771	Aids in the installation of forward gear bearing race.

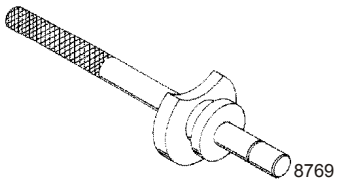
Needle Bearing Installer	91-817011T
 8772	Installs needle bearing in the bearing carrier.

Bearing Carrier Seal Installer	91-817007T
 8768	Installs upper and lower bearing carrier seals.

Forward Gear Bearing Installer	91-817005
 8763	Aids in the installation of the forward gear needle bearing.

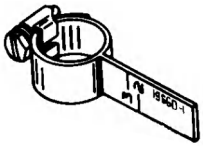
Bearing Preload Tool	91-14311A04
 8756	Simulates a load on the driveshaft for accurate pinion height and backlash measurements.

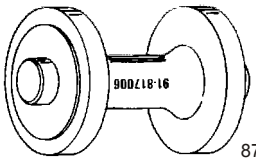
Pinion Gear Location Tool	91-8M0043678
 42308	Checks gearcase pinion gear height. Used with 91-817008A2

Pinion Gear Location Tool	91-817008A 2
 8769	Checks gearcase pinion gear height.

Dial Indicator	91- 58222A 1
 9479	Used to obtain a variety of measurements including gear backlash, pinion gear location, and TDC.

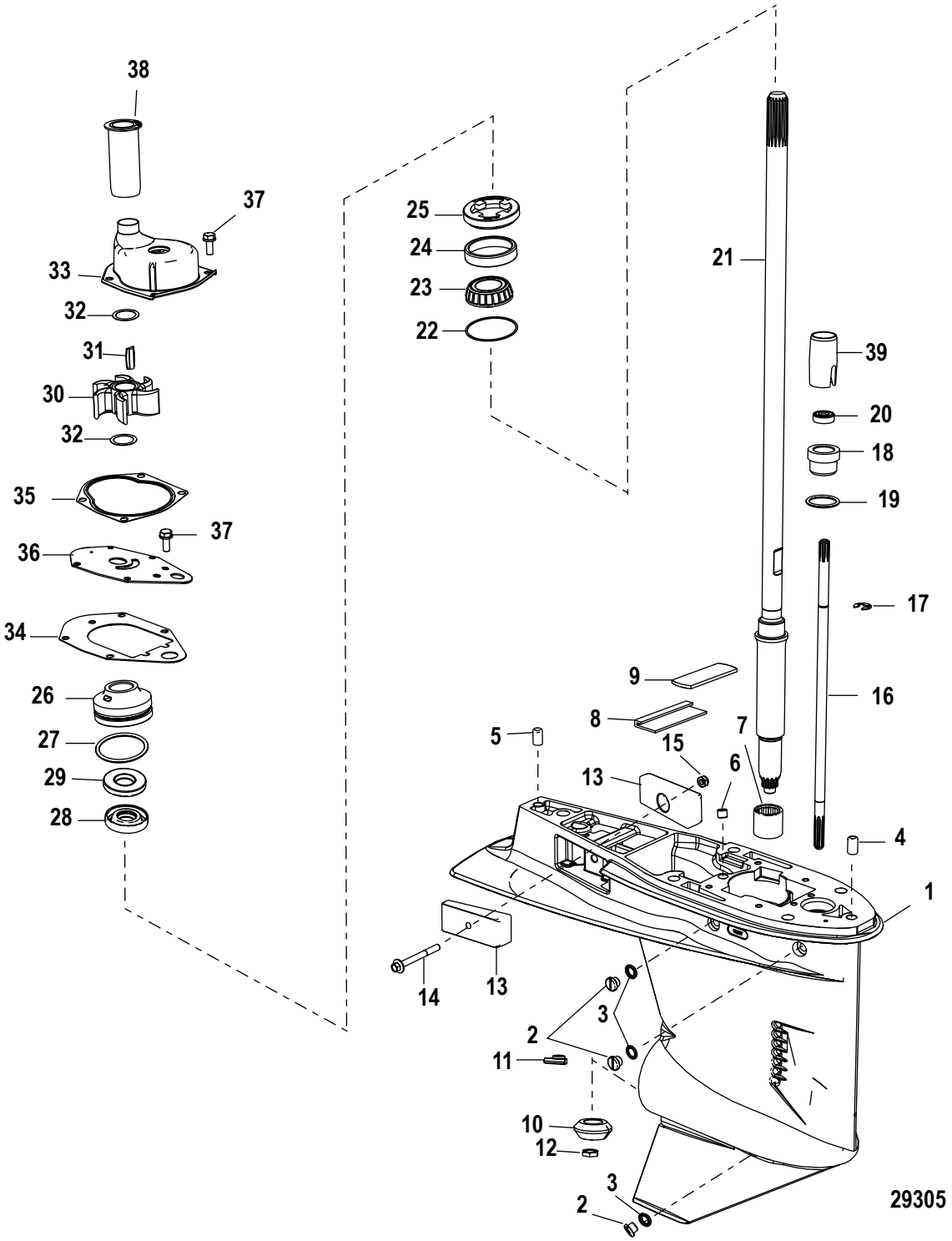
Dial Indicator Adapter	91-83155
 2999	Dial indicator holding fixture.

Backlash Indicator	91- 19660 1
 8757	Measures gear backlash.

Water Pump Base Seal Installer	91-817006
 8767	Installs upper and lower water pump base seals.

Notes:

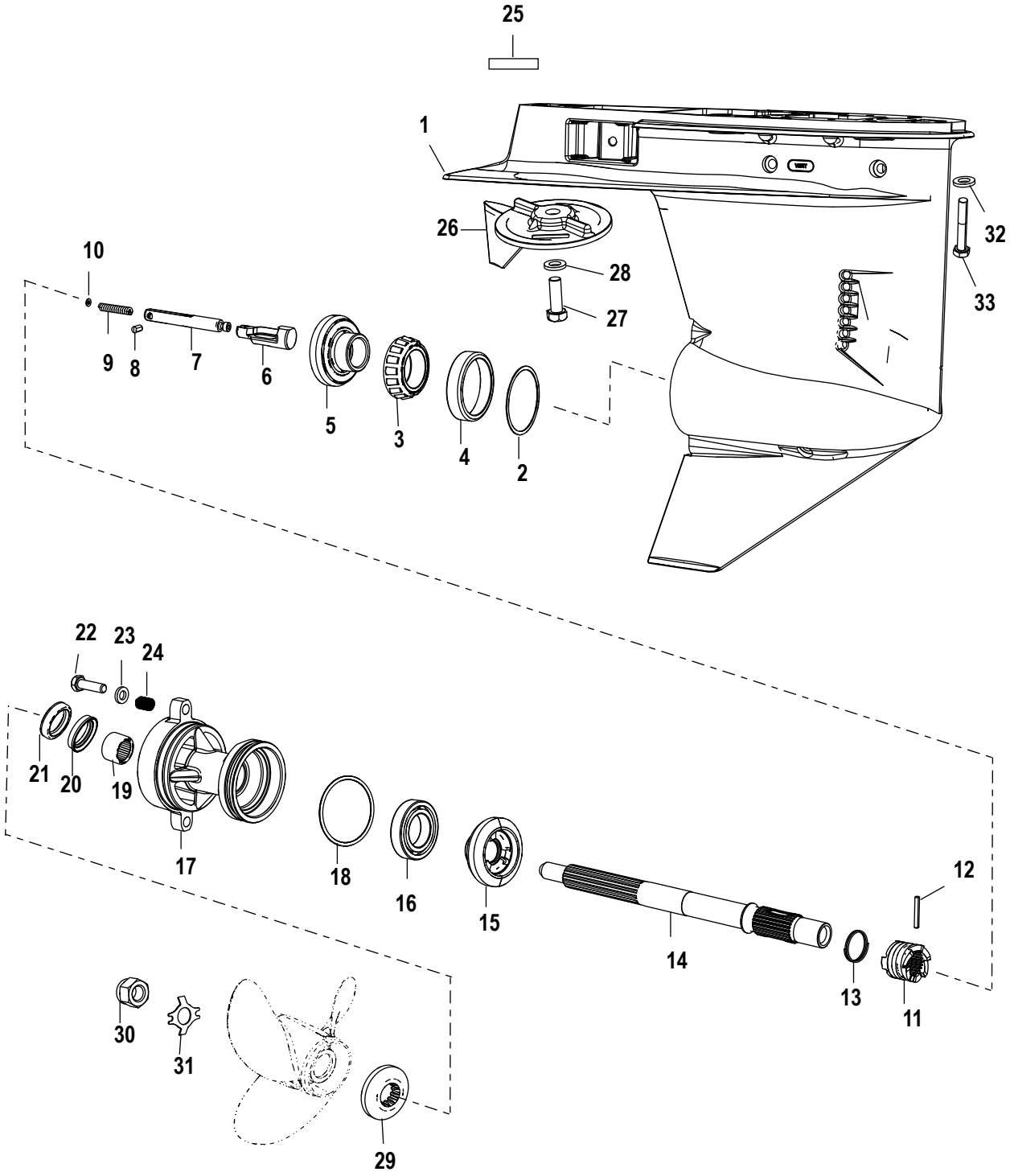
Gear Housing Driveshaft Components (1.83:1)



Gear Housing Driveshaft Components (1.83:1)

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Gear housing (87.4 mm [3.44 in.] torpedo diameter)			
2	1	Drain plug	6.5	58	
3	2	Seal			
4	1	Dowel pin (3/8 x 5/8 with hole)			
5	1	Dowel pin (3/8 x 5/8 without hole)			
6	1	Pipe plug (1/16-27)			
7	1	Roller bearing			
8	1	Seal/plate kit			
9	1	Filler plate			
10	1	Pinion gear (12 teeth)			
11	1	Shift cam			
12	1	Nut (7/16-20)	67		50
13	2	Anode			
14	1	Bolt (M6 x 55)	7	62	
15	1	Nut (M6)			
16	1	Shift shaft assembly			
17	1	E-ring			
18	1	Bushing assembly			
19	1	O-ring (0.987 x 0.103)			
20	1	Oil seal			
21	1	Driveshaft			
22	AR	Shim set			
23	1	Roller bearing assembly			
24	1	Cup			
25	1	Bearing retainer	102		75
26	1	Water pump base			
27	1	O-ring (1.859 x 0.139)			
28	1	Oil seal			
29	1	Oil seal			
30	1	Impeller			
31	1	Key			
32	2	Washer			
33	1	Water pump			
34	1	Lower gasket			
35	1	Upper gasket			
36	1	Face plate			
37	6	Bolt (M6 x 16)	6.8	60	
38	1	Coupler			
39	1	Bushing			

Gear Housing Propeller Shaft Components (1.83:1)



Gear Housing Propeller Shaft Components (1.83:1)

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Gear housing			
2	AR	Shim set			
3	1	Bearing assembly			
4	1	Cup			
5	1	Forward gear (22 teeth)			
6	1	Cam follower			
7	1	Rod actuator			
8	1	Actuator rod cross pin			
9	1	Spring			
10	1	Washer			
11	1	Clutch			
12	1	Cross pin			
13	1	Spring			
14	1	Propeller shaft			
15	1	Reverse gear (22 teeth)			
16	1	Bearing			
17	1	Bearing carrier			
18	1	O-ring			
19	1	Needle bearing			
20	1	Oil seal			
21	1	Oil seal			
22	2	Bolt (M8 x 30)	25.5		18.8
23	2	Washer (0.323 x 0.590 x 0.090)			
24	2	Threaded insert			
25	1	Gear ratio decal			
26	1	Trim tab			
27	1	Bolt (M10 x 30)	30		22
28	1	Washer (0.406 x 0.750 x 0.105)			
29	1	Thrust hub			
30	1	Prop nut kit	74.6		55
31	1	Tab washer			
32	4	Washer (0.406 x 0.750 x 0.105)			
33	4	Bolt (M10 x 45)	54		40

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Bearing carrier seals	92-809819
95	2-4-C with PTFE	Cam follower, propeller shaft splines, and bearing carrier seals	92-802859A 1

General Service Recommendations

There may be more than one way to disassemble or reassemble a particular part, therefore, it is recommended the entire procedure be read prior to repair.

IMPORTANT: Read the following before attempting any repairs.

In many cases, disassembly of a subassembly may not be necessary, until cleaning and inspection reveals that disassembly is required for replacement of one or more components.

Service procedure order in this section is a normal disassembly/reassembly sequence. It is suggested the sequence be followed without deviation to assure proper repairs. When performing partial repairs, follow the instructions to the point where the desired component can be replaced, then proceed to reassembly and installation of that component in the reassembly part of this section. Use the **Table of Contents** (on back of section divider) to find correct page number.

Threaded parts are right-hand (RH), unless otherwise indicated.

When holding, pressing, or driving is required, use soft metal vise jaw protectors or wood for protection of parts. Use a suitable mandrel (one that will contact only the bearing race) when pressing or driving bearings.

Whenever compressed air is used to dry a part, verify that no water is present in the air line.

Bearings

Upon disassembly of the gear housing, all bearings must be cleaned and inspected. Clean bearings with solvent and dry with compressed air. Air should be directed at the bearing so that it passes through the bearing. Do not spin bearing with compressed air, as this may cause bearing to score from lack of lubrication. After cleaning, lubricate bearings with High Performance Gear Lubricant. Do not lubricate tapered bearing cups until after inspection.

Inspect all bearings for roughness, catches, and bearing race side wear. Work inner bearing race in and out, while holding outer race, to check for side wear.

When inspecting tapered bearings, determine condition of rollers and inner bearing race by inspecting bearing cup for pitting, scoring, grooves, uneven wear, imbedded particles and/or discoloration from overheating. Always replace tapered bearing and race as a set.

Inspect gear housing for bearing races that have spun in their respective bores. If race has spun, gear housing must be replaced.

Roller bearing condition is determined by inspecting the bearing surface of the shaft that the roller bearing supports. Check shaft surface for pitting, scoring, grooves, imbedded particles, uneven wear, and/or discoloration from overheating. The shaft and bearing must be replaced, if the conditions described are found.

Shims

Keep a record of all shim amounts and location during disassembly to aid in reassembly. Be sure to follow shimming instructions during reassembly, as gears must be installed to correct depth and have the correct amount of backlash to avoid noisy operation and premature gear failure.

Seals

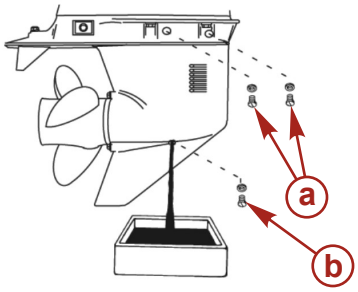
As a normal procedure, all O-rings and oil seals should be replaced without regard to appearance. To prevent leakage around oil seals, apply Loctite 271 to outer diameter of all metal case oil seals. When using Loctite on seals or threads, surfaces must be clean and dry. To ease installation, apply 2-4-C with PTFE on all O-rings. To prevent wear, apply 2-4-C with PTFE on inner diameter of oil seals.

Draining and Inspecting Gear Housing Lubricant

⚠ WARNING

Rotating propellers can cause serious injury or death. Never operate the boat out of the water with a propeller installed. Before installing or removing a propeller, place the drive unit in neutral and engage the lanyard stop switch to prevent the engine from starting. Place a block of wood between the propeller blade and the anti-ventilation plate.

1. Position a clean drain pan under the gear housing. Remove the vent screws and the fill/drain screw with gaskets from the gear housing.



26977

a - Vent screws
b - Fill/drain screw

2. Inspect the gear lubricant for metal particles. Presence of a small amount of fine metal particles resembling powder indicates normal wear. Presence of larger particles or a large quantity of fine particles, indicates need for gear housing disassembly and inspection.
3. Note the color of the gear lubricant. White or cream color indicates the presence of water in the lubricant. Check the drain pan for water separation from the lubricant. Presence of water in the gear lubricant indicates the need for disassembly, and inspection of oil seals, seal surfaces, O-rings, and gear housing components. Pressure check the gearcase prior to disassembly.

   NOTE: *When draining the gearcase for the first time, the lubricant may appear cream colored due to the mixing of assembly lubricant and gear lubricant. This is not an indication of water intrusion. If, during the subsequent draining of the gearcase, the lubricant appears cream colored or milky, water may be present. Gearcase should be disassembled and all gaskets, seals, and O-rings replaced. Inspect all components for water damage.*

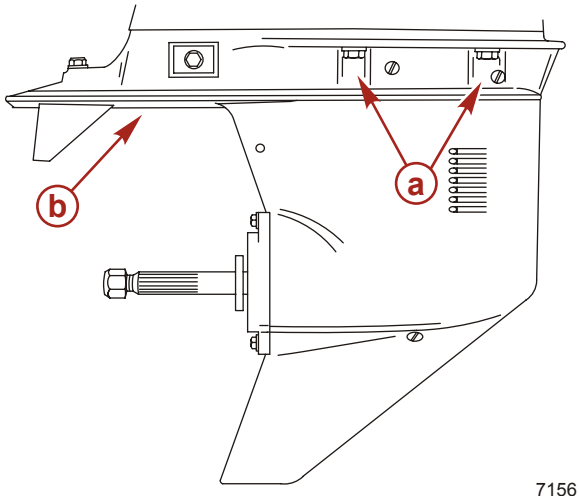
   NOTE: *Gear lubricant drained from a recently run gearcase will be a light chocolate brown in color due to agitation/ aeration. Oil which is stabilized will be a clear yellow brown in color.*

Gear Housing Removal

⚠ WARNING

Accidental starting can cause serious injury. Before removing or installing the gear housing, disconnect and isolate the spark plug leads. Disable the ignition system by removing the keys from the ignition (if equipped) and engaging the lanyard stop switch to prevent the engine from starting.

1. Remove and isolate the spark plug leads from the spark plugs.
2. Shift the engine into forward gear.
3. Tilt the engine to the full up position.
4. Remove the four fasteners.
5. Remove the locknut and washer.



7156

a - Fasteners (2 each side)
b - Locknut and washer (recessed)

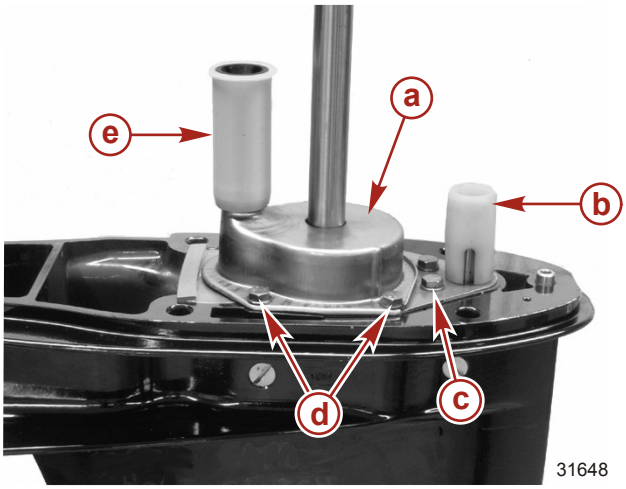
6. Remove the gear housing.

Gear Housing Disassembly

Water Pump Disassembly

NOTE: *If the water tube coupler stayed on the water tube (inside of the driveshaft housing) when the gear housing was removed, pull the coupler from the water tube.*

1. Replace the water tube coupler, if damaged.
2. Remove the six bolts and washers.
3. Remove the water pump cover.

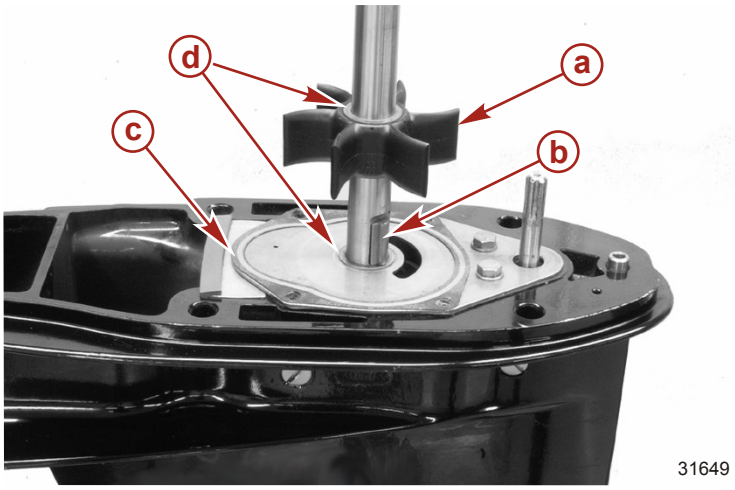


31648

- **a -** Water pump cover
- **b -** Bushing
- **c -** Bolt (M6 x 16) (2) (face plate)
- **d -** Bolt (M6 x 16) (4) (cover)
- **e -** Water tube coupler

IMPORTANT: The circular groove formed by the impeller sealing bead should be disregarded when inspecting the cover and plate, as the depth of the groove will not affect the water pump output.

4. Replace the cover if the thickness of the steel at the discharge slots is 1.50 mm (0.060 in.) or less, or if the grooves, other than the impeller sealing bead groove, in the cover roof are more than 0.75 mm (0.030 in.) deep.
5. Lift the impeller, drive key, plastic washers, and gasket from the driveshaft.

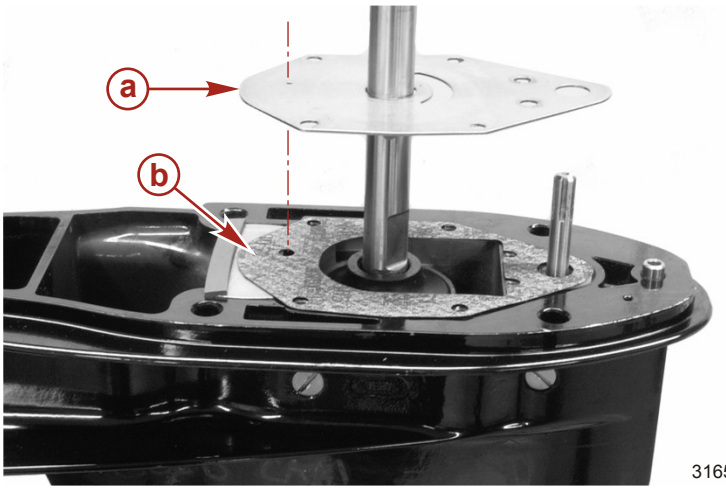


31649

- **a -** Impeller
- **b -** Drive key
- **c -** Gasket
- **d -** Plastic washer (2)

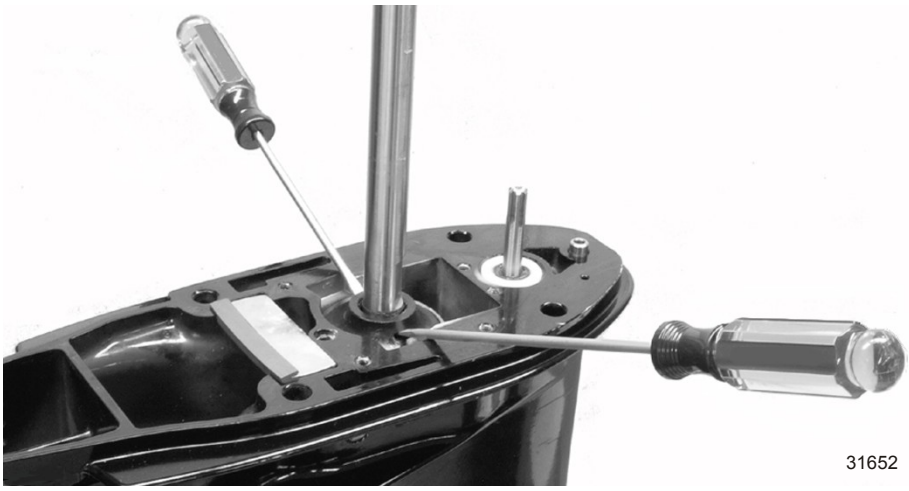
6. Inspect the impeller. Replace the impeller if any of the following conditions exist:
   - Impeller blades are cracked, torn, or worn.
   - Impeller is glazed or melted (caused by operation without sufficient water supply).
   - Rubber portion of the impeller is not bonded to the impeller hub.
7. Remove the face plate and gasket.

8. Replace the face plate if the grooves, other than the impeller sealing bead groove, in the face plate are more than 0.75 mm (0.030 in.) deep.



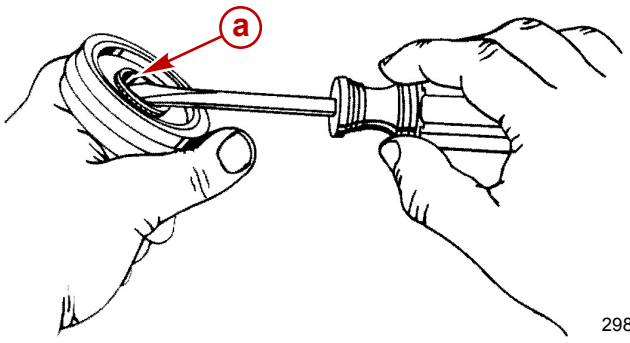
a - Face plate
b - Gasket

9. Remove the water pump base by lifting gently, as shown. Inspect carefully for cracks.



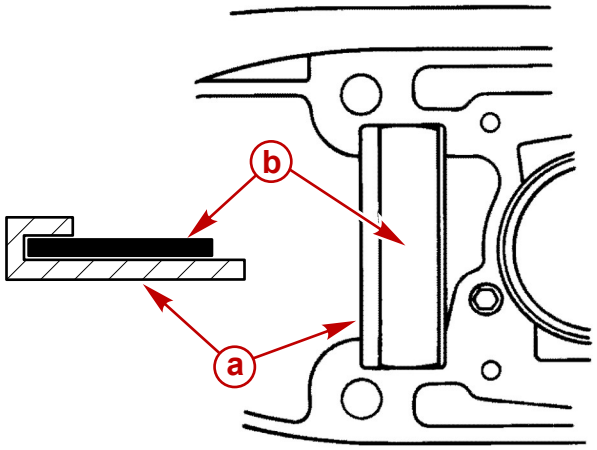
10. Remove and discard the seals if damaged. Secure the base to a bench top or lightly clamp the base in a vise when removing the seals.

IMPORTANT: Do not scratch the water pump base when removing the seals.



a - Seals

11. Replace the seal and filler plate if damaged or worn.



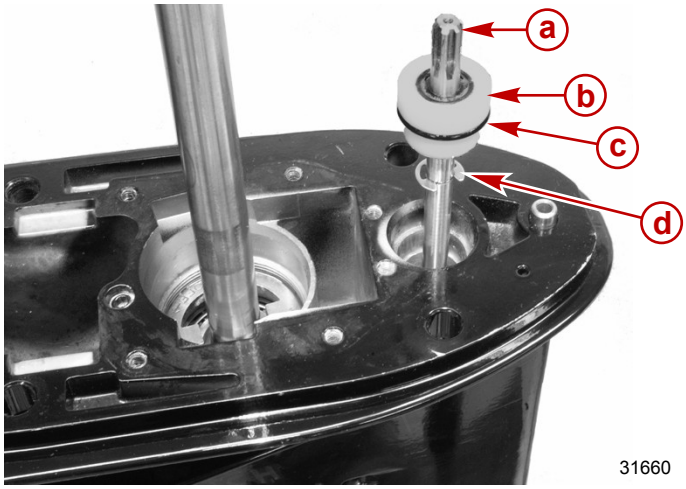
29809

a - Seal
b - Filler plate

Shift Shaft Removal

IMPORTANT: Check that the gear housing is in neutral.

With the gear housing in neutral, pull the shift shaft out of the gear housing. If pliers are used to pull the shift shaft out, wrap a strip of soft metal around the splines before clamping the pliers. Do not rotate the shaft while pulling it out.



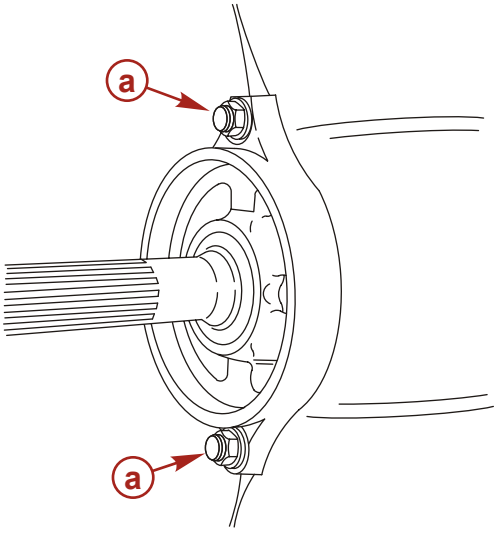
31660

a - Shift shaft
b - Bushing
c - O-ring
d - E-ring

Bearing Carrier and Propeller Shaft Disassembly

1. Shift the gear housing to neutral.

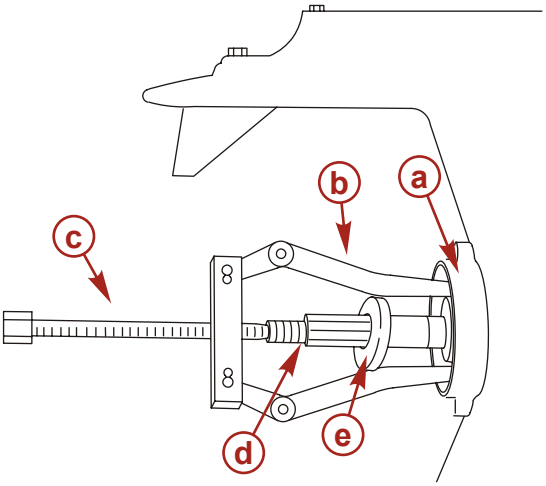
2. Remove the bolts and washers.



7175

a - Bolt and washer

3. With the propeller shaft horizontal, use a bearing puller to remove the carrier from the gear housing. Remove the propeller shaft components as an assembly. Do not lose the cam follower.



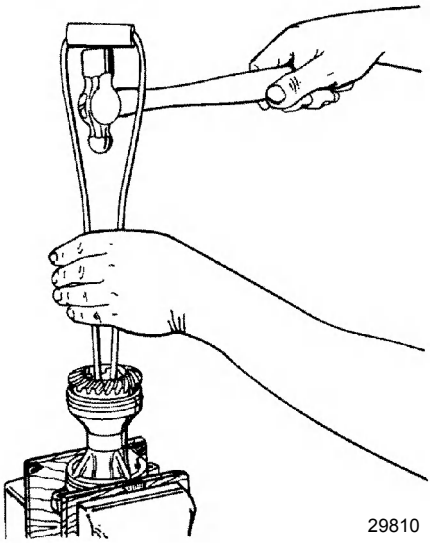
7177

a - Bearing carrier
b - Puller jaws
c - Puller bolt
d - Propeller shaft
e - Thrust hub

Puller Jaws Assembly	91-46086A1

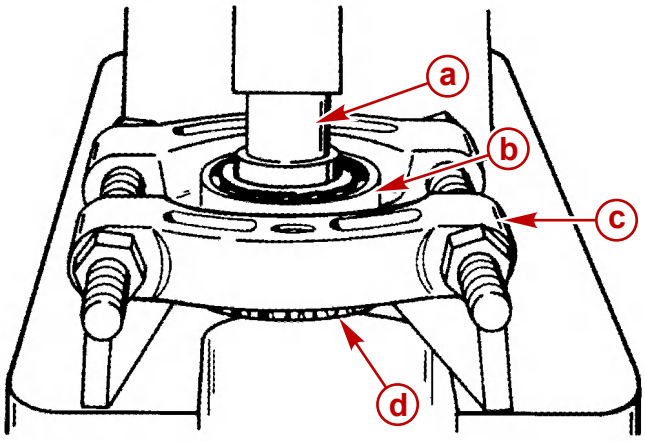
4. Replace the reverse gear if the gear teeth or clutch teeth on the reverse gear are chipped or worn. If the reverse gear must be replaced, the pinion and sliding clutch should be inspected for damage.

5. If the reverse gear bearing is rusted or does not roll freely, replace the bearing. Remove the bearing and reverse gear using a bearing puller.



Puller	91- 27780

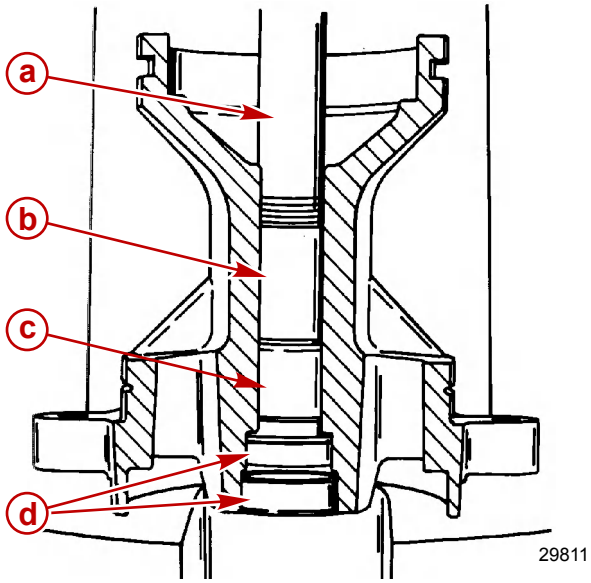
6. Remove the ball bearing from reverse gear.



a - Driver head
b - Bearing
c - Universal puller plate
d - Reverse gear

Universal Puller Plate	91-37241
Driveshaft Bearing Driver Head	91- 37312T

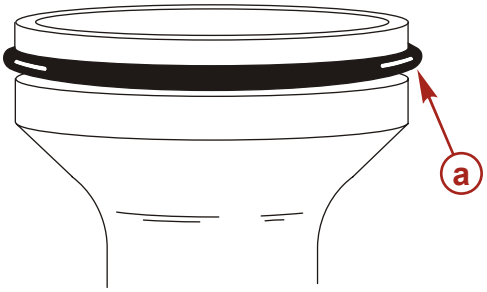
7. If the bearing is rusted or does not roll freely, replace the bearing. Remove the bearing and oil seals. Discard the oil seals.



a - Driver rod
b - Driver head
c - Propeller shaft bearing
d - Oil seal (2)

Driver Rod	91- 37323
Driveshaft Bearing Driver Head	91- 37312T

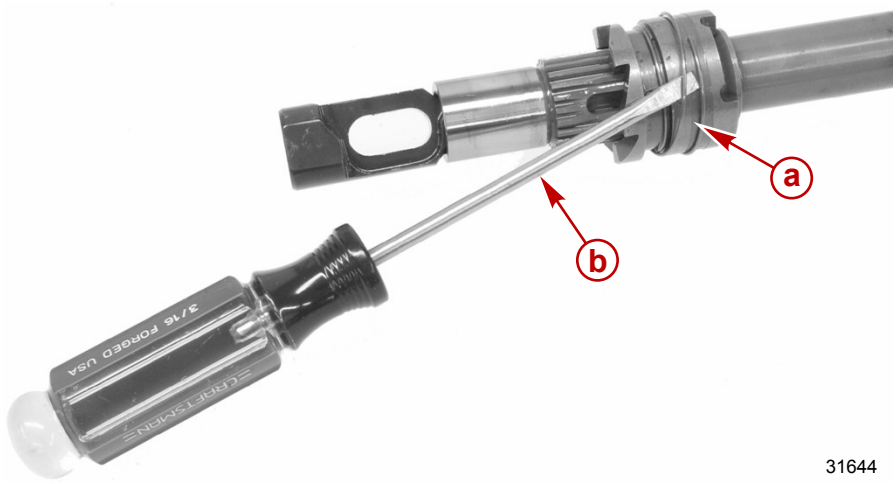
8. Remove the propeller shaft seals and bearing carrier O-ring.



a - O-ring

Propeller Shaft Disassembly

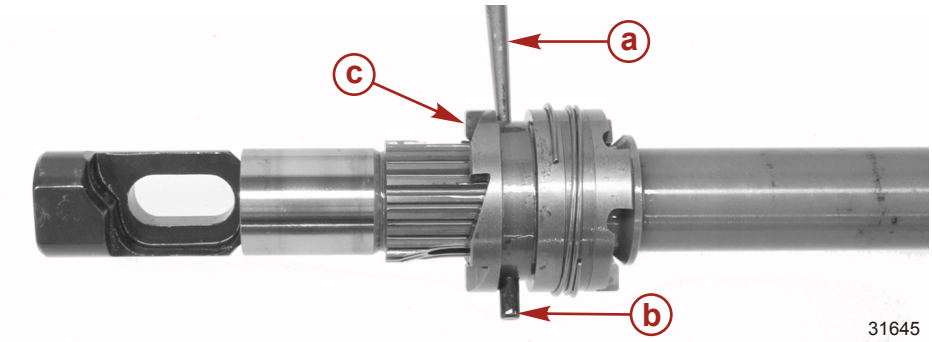
1. Remove the shift cam from the cam follower.
2. Insert a thin flat blade screwdriver or awl under the first coil of the cross pin retainer spring and rotate the propeller shaft to unwind the spring from the sliding clutch. Do not overstretch the spring.



a - Cross pin retainer spring
b - Flat blade screwdriver

3. Push the cross pin out of the sliding clutch with a slotted cross pin tool.

4. Pull the sliding clutch off of the propeller shaft.



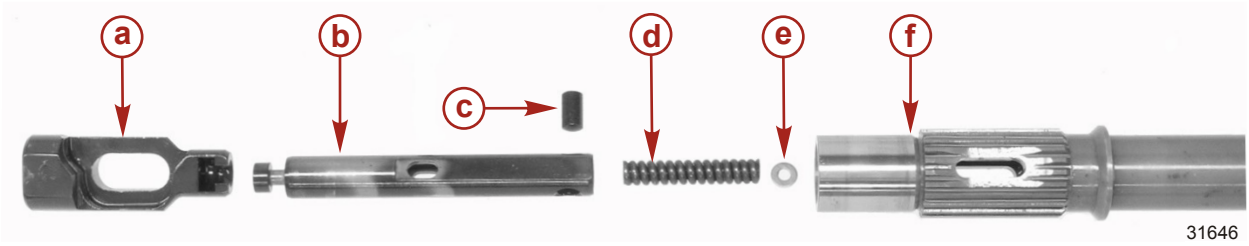
a - Slotted cross pin tool
b - Cross pin
c - Sliding clutch

Slotted Cross Pin Tool	91- 86642 1

5. Pull the cam follower and clutch actuator rod out of the propeller shaft. Do not force the cam follower up or down, or side to side, when removing it from the propeller shaft.

   IMPORTANT: The actuator rod cross pin is free and can fall out of the actuator rod. Care must be taken not to lose the pin.

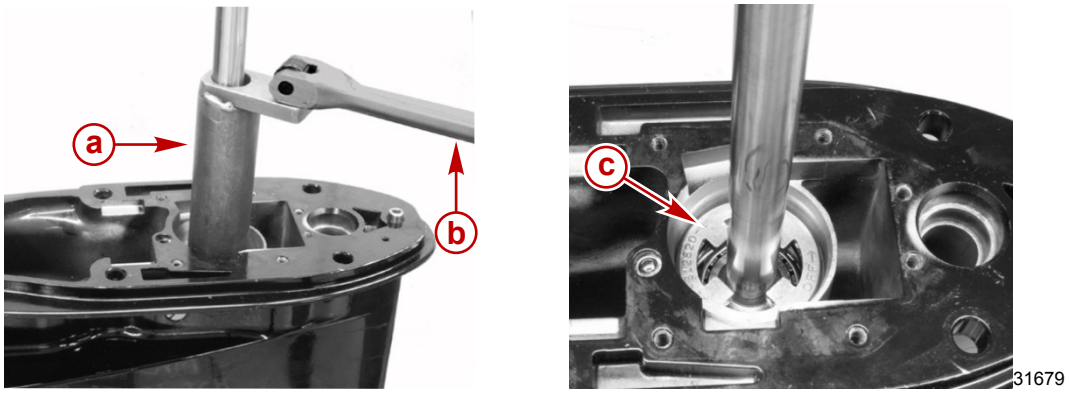
6. Remove the actuator rod cross pin from the actuator rod.
7. Remove the washer and spring from the actuator rod.



a - Cam follower
b - Clutch actuator rod
c - Actuator rod cross pin
d - Spring
e - Washer
f - Propeller shaft

Pinion Gear, Driveshaft, and Forward Gear

1. Remove the driveshaft bearing retainer using the bearing retainer wrench.

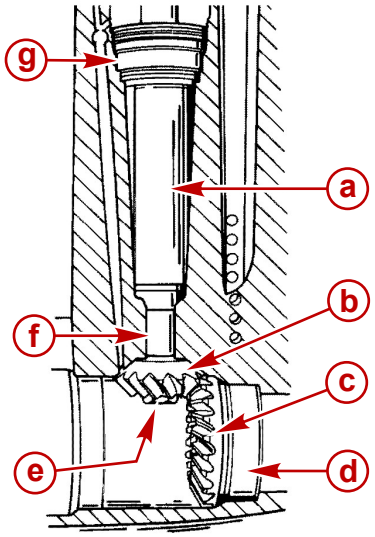


a - Bearing retainer wrench
b - Breaker bar
c - Bearing retainer

Driveshaft Bearing Retainer Wrench	91-43506T

2. Hold the driveshaft using the driveshaft holding tool. Remove and discard the pinion nut.

3. Remove the driveshaft, pinion gear, and forward gear.
4. Replace the pinion gear if it is chipped or worn.
5. Replace the lower driveshaft bearing if rusted or damaged; or does not roll freely. To remove, refer to **Driveshaft Bearing Removal**, following.
6. Replace the forward gear if gear teeth are chipped or worn.

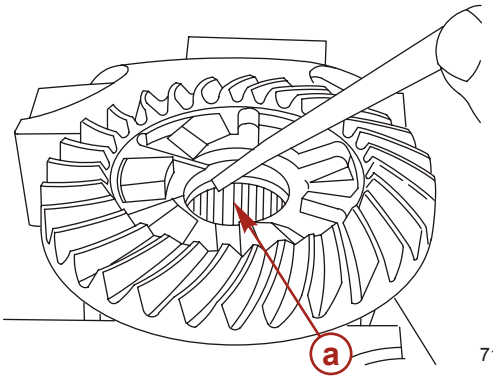


31680

- **a -** Driveshaft
- **b -** Pinion gear
- **c -** Forward gear
- **d -** Bearing
- **e -** Pinion nut
- **f -** Bearing
- **g -** Bearing/bearing race

Driveshaft Holding Tool	91-877840A 1

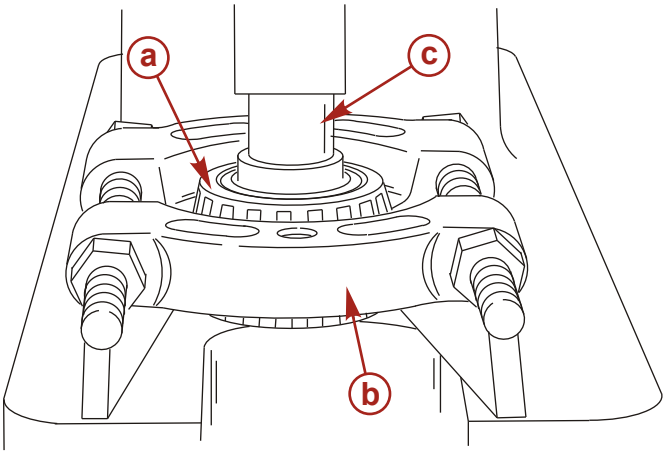
7. Replace the forward gear needle bearing if it is rusted or does not roll freely after cleaning in solvent. Remove with a hammer and punch, as shown.



7198

- **a -** Needle bearing

8. Replace the forward gear tapered roller bearing and race if either the bearing or race are rusted or damaged; or if the bearing does not roll freely after cleaning in solvent. Remove the bearing from the gear using the universal puller plate and mandrel. To remove the race, refer to **Forward Gear Bearing Race Removal**, following.



28155

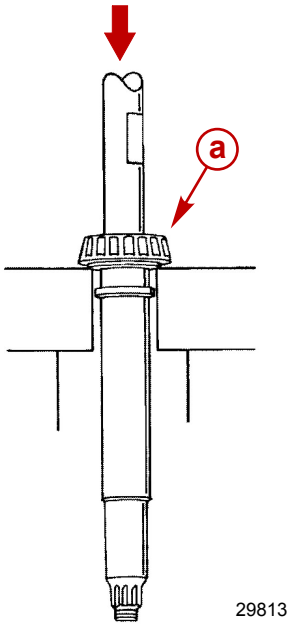
- **a -** Forward gear tapered roller bearing
- **b -** Universal puller plate
- **c -** Driveshaft bearing driver head

Driveshaft Bearing Driver Head	91- 37312T
Universal Puller Plate	91-37241

Driveshaft Bearing Removal

Upper Bearing

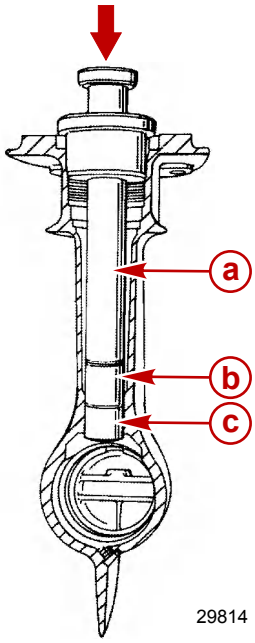
Replace the bearing and race if either the bearing or race are rusted or damaged; or if the bearing does not roll freely after cleaning in solvent.



a - Bearing

Lower Bearing

Remove the lower driveshaft bearing using the removal tool with the bushing installed.



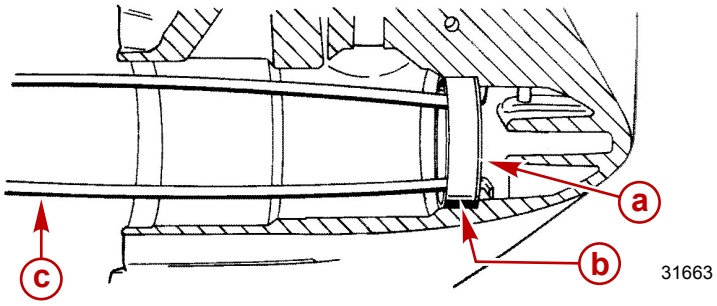
a - Bearing driver
b - Bushing
c - Bearing

Lower Driveshaft Bearing Driver Assembly	91-817058A 1

Forward Gear Bearing Race Removal

IMPORTANT: Retain shims for reassembly.

Remove the race and shims using a bearing puller.



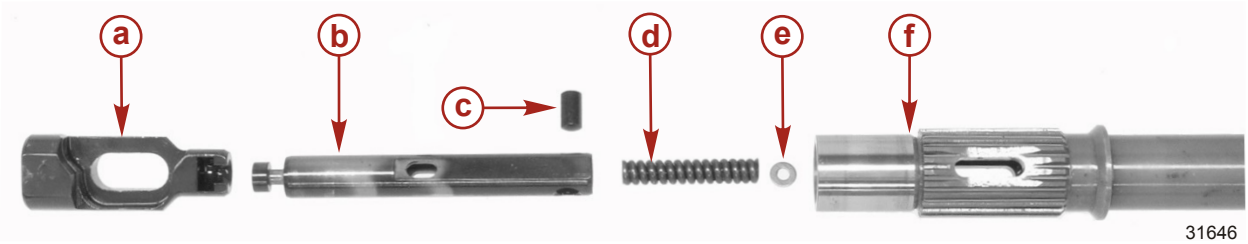
a - Shims
b - Race
c - Bearing puller

Puller	91- 27780

Gear Housing Assembly

Clutch Actuator Rod Assembly and Installation

1. Insert the spring, then the washer, into the clutch actuator rod.
2. Insert the actuator rod cross pin with flat towards the spring.
3. Place a small amount of 2-4-C with PTFE on the actuator rod and install the cam follower.



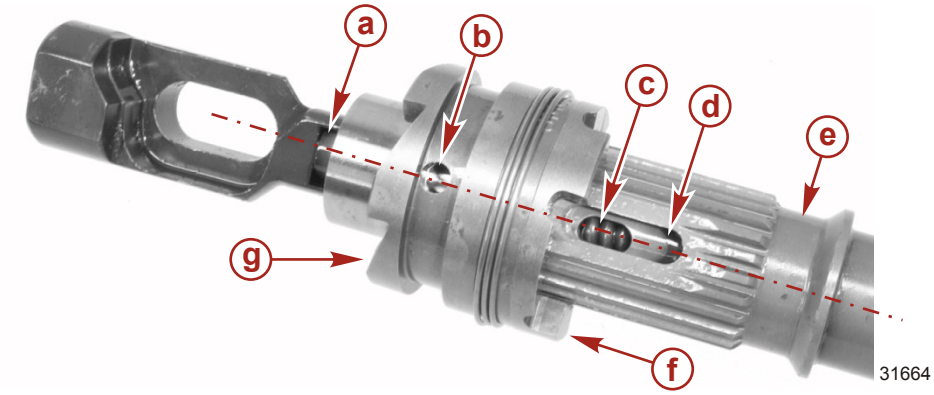
a - Cam follower
b - Clutch actuator rod
c - Actuator rod cross pin
d - Spring
e - Washer
f - Propeller shaft

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Actuator rod	92-802859A 1

Propeller Shaft Assembly

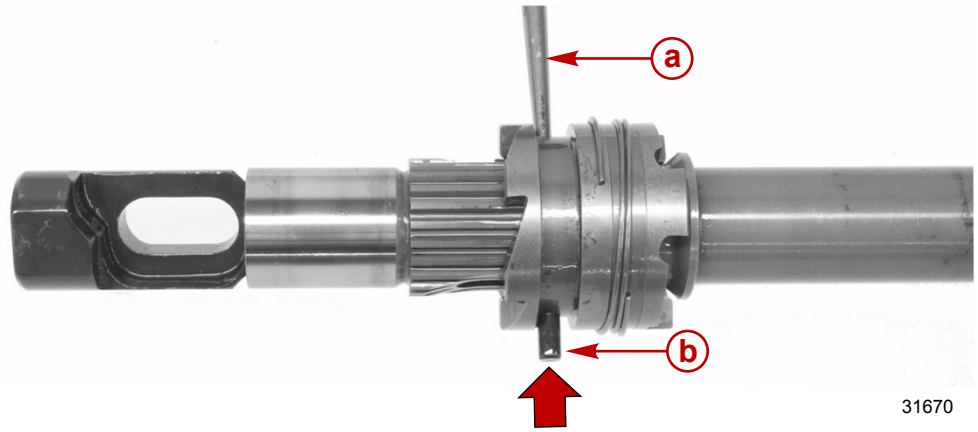
1. Insert the assembled clutch actuator rod/cam follower into the propeller shaft.
2. Position the sliding clutch onto the propeller shaft with the angled clutch teeth toward the cam follower. The cross pin hole in the sliding clutch must align with the cross pin slot on the propeller shaft.

NOTE: When installing the clutch, make sure the angled ratcheting clutch teeth are toward the forward gear, and the nonratcheting (square on both sides) are toward the reverse gear.



- **a -** Actuator rod
- **b -** Sliding clutch cross pin hole
- **c -** Clutch actuator spring
- **d -** Propeller shaft cross pin slot
- **e -** Propeller shaft
- **f -** Nonratcheting clutch teeth
- **g -** Ratcheting clutch teeth

3. Insert an awl or suitable tool into the cross pin hole in the sliding clutch and push the clutch actuator spring towards the propeller end of shaft.
4. Apply a small amount of 2-4-C with PTFE on the cross pin. Position the cross pin in the hole of the sliding clutch with the flat side of the pin toward the spring.
5. Push the cross pin through the sliding clutch, propeller shaft, and actuator rod, forcing the cross pin tool out.



- **a -** Awl
- **b -** Cross pin

Slotted Cross Pin Tool	91- 86642 1

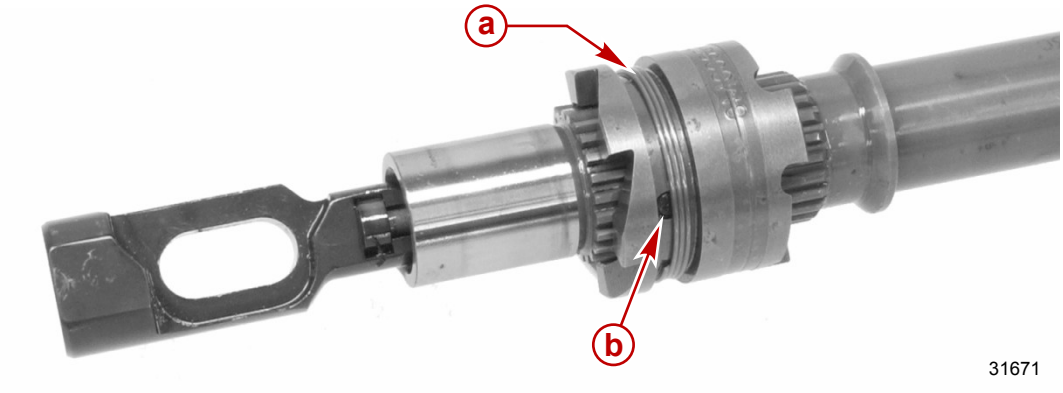
Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Sliding clutch cross pin	92-802859A 1

IMPORTANT: Applying side force to the propeller shaft before completely assembling the gear housing can damage the actuator rod. Install the bearing carrier before applying any side force to the propeller shaft.

6. Install the cross pin retaining spring onto the sliding clutch.

   IMPORTANT: Do not overstretch the retaining spring when installing onto the sliding clutch.
7. Spirally wrap the spring into the groove on the sliding clutch.

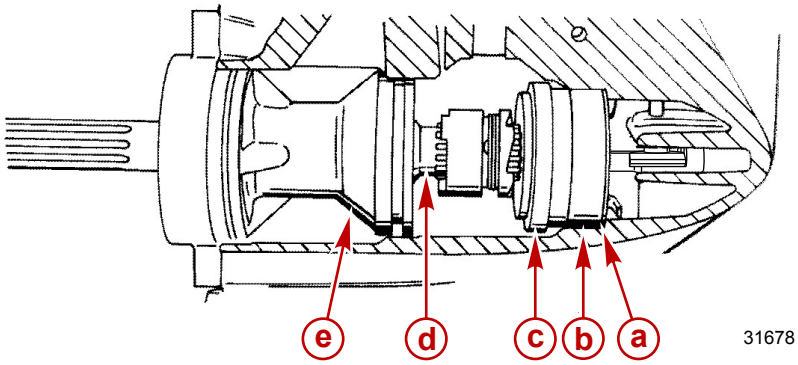
8. Verify that the spring coils do not overlap each other.



a - Retaining spring
b - Cross pin

Forward Gear Bearing Race Installation

1. Place the shims, retained from disassembly, into the housing. If the shims were lost or damaged, or a new gear housing is being assembled, start with a 0.25 mm (0.010 in.) shim.
2. Apply Assembly Grease to the bearing race. Drive the bearing race into the housing. Use a lead hammer to avoid damage to the propeller shaft.



a - Shims
b - Bearing race
c - Driver cup
d - Propeller shaft
e - Assembled bearing carrier

Forward Gear Bearing Race Driver Cup	91-817009T

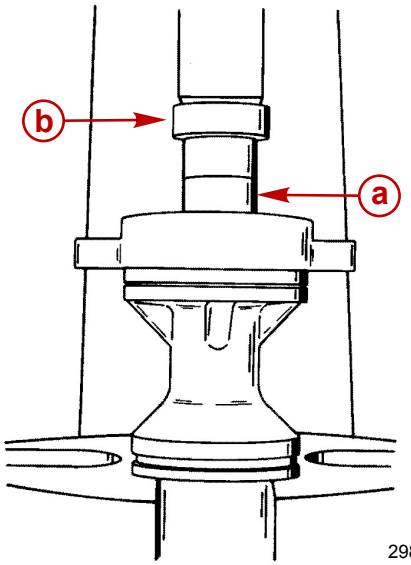
Tube Ref No.	Description	Where Used	Part No.
4	Assembly Grease	Forward bearing race	8M0071836

Bearing Carrier Assembly

Bearings and Seals

1. Lubricate the outside diameter of the needle bearing with 2-4-C with PTFE.
2. Install the needle bearing.

NOTE: *Push against the numbered end of the bearing.*

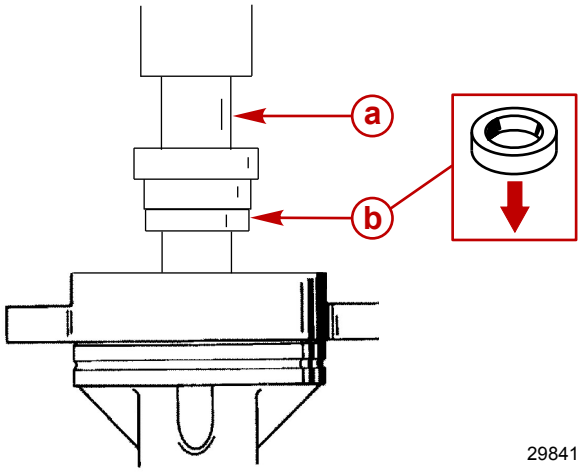


a - Needle bearing
b - Installer

Needle Bearing Installer	91-817011T

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Outside diameter of the bearing carrier needle bearing	92-802859A 1

3. Apply Loctite 271 Threadlocker on the outside diameter of the small diameter oil seal. The seal lip should face away from the shoulder on the installation tool. Press the seal in until the installer tool bottoms.

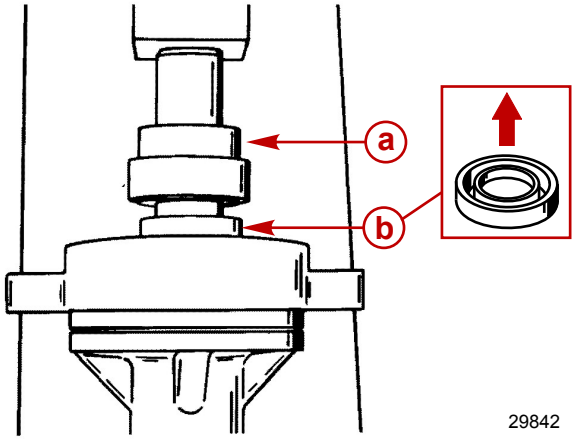


a - Installer tool
b - Small diameter seal

Bearing Carrier Seal Installer	91-817007T

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Outside diameter of small diameter bearing carrier oil seal	92-809819

4. Apply Loctite 271 Threadlocker on the outside diameter of the large diameter oil seal. The seal lip should face towards the shoulder on the installation tool. Press the seal in until the installer tool bottoms.

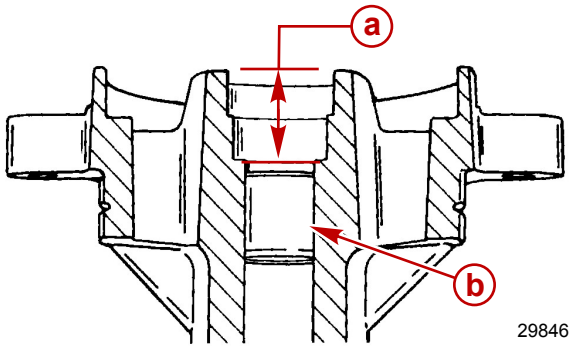


a - Installer tool
b - Large diameter seal

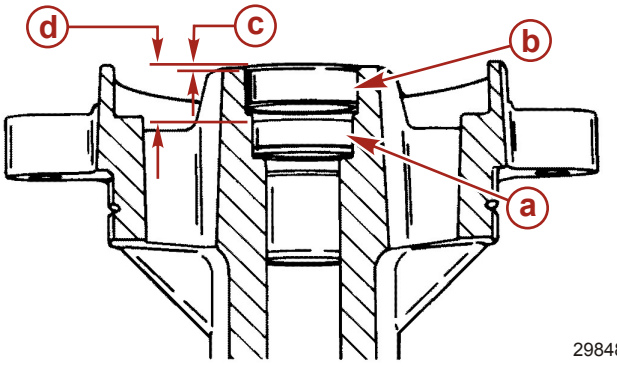
Bearing Carrier Seal Installer	91-817007T

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Outside diameter of large diameter bearing carrier oil seal	92-809819

NOTE: *If service tools are not available, the following reference dimensions apply for installing the bearing and seals to proper depths.*



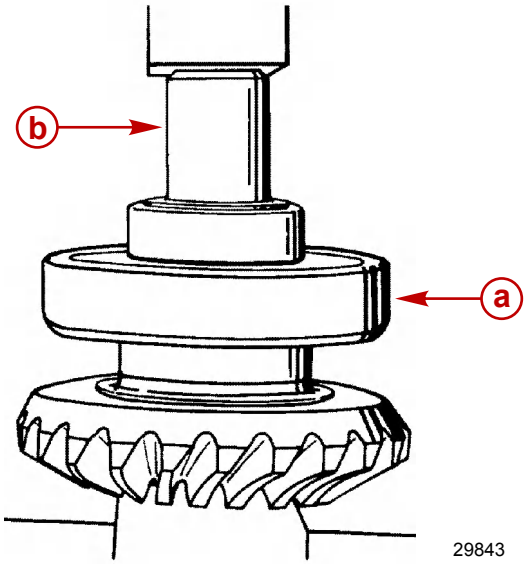
a - 20 mm (0.820 in.)
b - Bearing



a - Oil seal (lip down)
b - Oil seal (lip up)
c - 1 mm (0.040 in.)
d - 11 mm (0.440 in.)

Reverse Gear

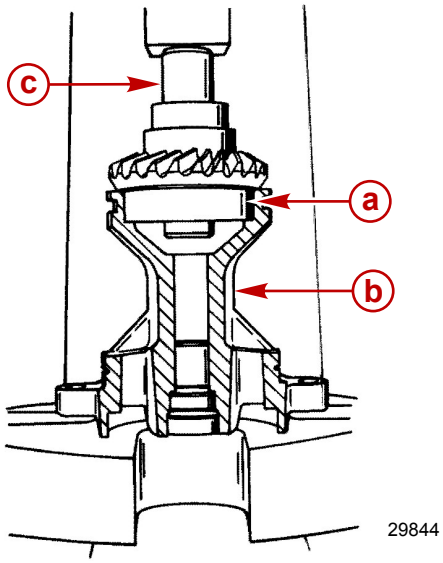
1. Lubricate the inside diameter of the bearing with 2-4-C with PTFE. Use a suitable mandrel and press on the gear until the bearing bottoms.



a - Bearing
b - Mandrel

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Reverse gear bearing inside diameter	92-802859A 1

2. Lubricate the outside diameter of the bearing with 2-4-C with PTFE. Use a suitable mandrel and press the reverse gear/bearing assembly into the bearing carrier until the bearing bottoms.



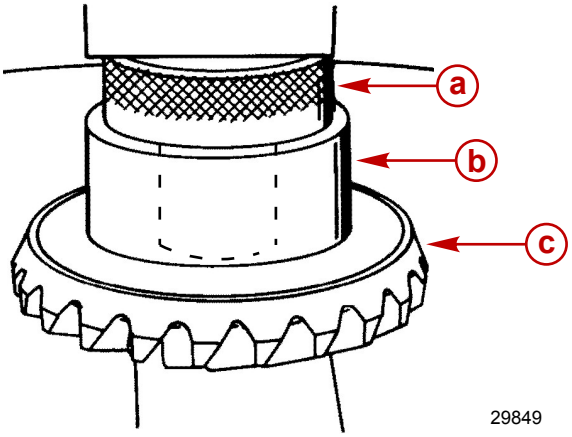
a - Reverse gear bearing
b - Bearing carrier
c - Mandrel

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Reverse gear bearing outside diameter	92-802859A 1

Forward Gear

1. Lubricate the outside diameter of the roller bearing with 2-4-C with PTFE. Press the new propeller shaft bearing into the gear until the installer tool bottoms.

NOTE: *Push against the numbered end of the bearing.*

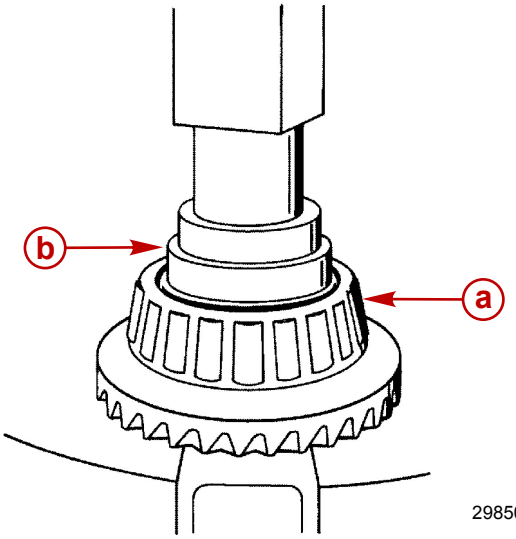


a - Installer tool
b - Roller bearing
c - Forward gear

Forward Gear Bearing Installer	91-817005

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Outside diameter of the forward gear roller bearing	92-802859A 1

2. Lubricate the inside diameter of the tapered roller bearing with 2-4-C with PTFE. Use a suitable mandrel and press the bearing onto the gear until the bearing bottoms on the gear.



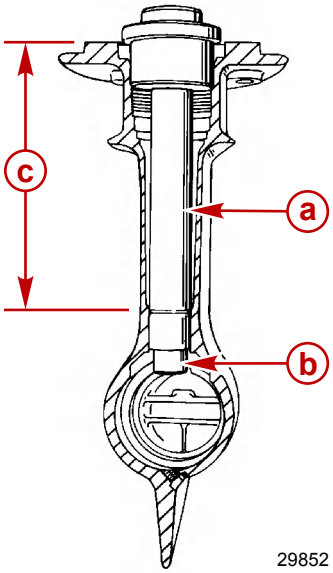
a - Tapered roller bearing
b - Mandrel

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Inside diameter of the forward gear roller bearing	92-802859A 1

Lower Driveshaft Bearing Installation

1. Lubricate the outside diameter of the needle bearing with 2-4-C with PTFE.
2. Install the bearing into the gear housing. Press until the installer tool bottoms.

NOTE: *Push against the numbered end of the bearing.*



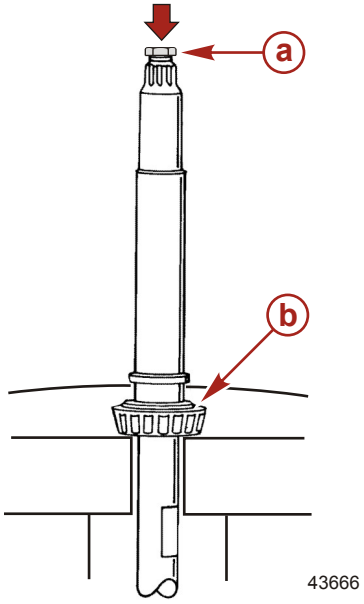
a - Installer tool
b - Needle bearing
c - Reference bearing depth - 179–179.5 mm (7.050–7.070 in.)

Lower Driveshaft Bearing Driver Assembly	91-817058A 1

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Outside diameter of the lower driveshaft needle bearing	92-802859A 1

Upper Driveshaft Bearing Installation

1. Lubricate the inside diameter of the bearing with 2-4-C with PTFE.
2. Thread a used pinion gear nut onto the end of the driveshaft. Leave approximately two threads of the nut exposed.
   IMPORTANT: The driveshaft threads must not extend beyond the nut to prevent damage to the threads while pressing.
3. Press the upper driveshaft bearing onto the driveshaft until the bearing contacts the driveshaft shoulder.
   IMPORTANT: Ensure the force is applied to the inner bearing race, not to the bearings.



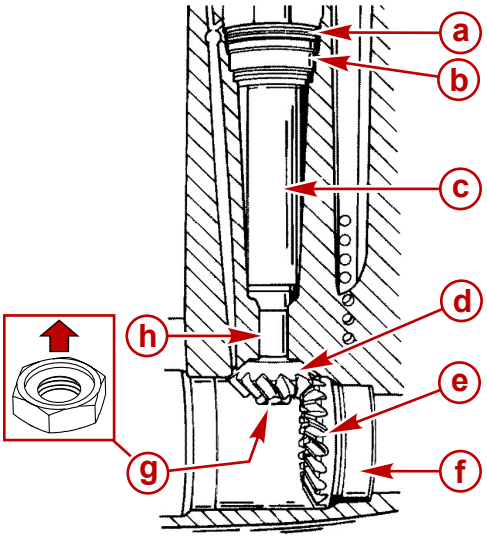
a - Used pinion gear nut
b - Upper driveshaft bearing

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Inside diameter of the upper driveshaft bearing	92-802859A 1

Forward Gear, Pinion Gear, Upper Driveshaft Race, Retainer, and Driveshaft Installation

NOTE: *If shims were lost or are not reusable (damaged), start with approximately 0.36 mm (0.015 in.).*

1. Install the forward gear assembly into the gear housing.
2. Apply High Performance Gear Lubricant to the bearing rollers before installation.
3. Install the driveshaft into the gear housing.
4. Install a new pinion nut with the recessed end toward the pinion gear. Refer to **Pinion Gear Depth,** following.
5. Install the upper driveshaft bearing retainer. Tighten the upper driveshaft bearing retainer to the specified torque using the bearing retainer wrench.



29893

- **a -** Upper driveshaft bearing retainer
- **b -** Bearing race and shims
- **c -** Driveshaft
- **d -** Pinion gear
- **e -** Forward gear
- **f -** Bearing
- **g -** Pinion nut
- **h -** Needle bearing

Driveshaft Bearing Retainer Wrench	91-43506T

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Driveshaft bearing rollers	92-858064K01

Description	Nm	lb-in.	lb-ft
Upper driveshaft bearing retainer	102		75

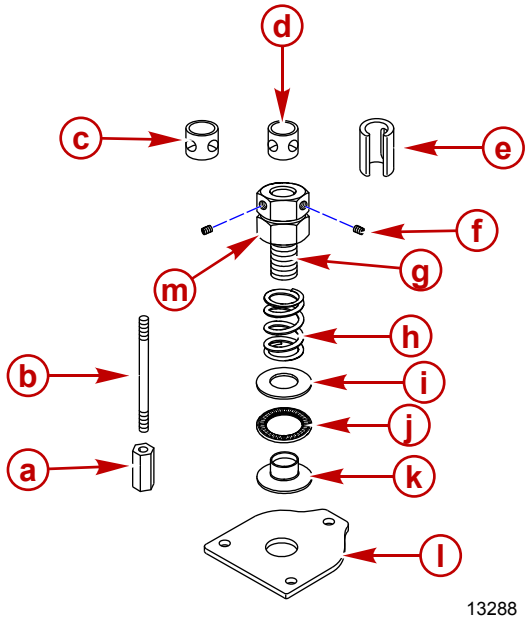
Pinion Gear Depth

NOTE: *Read the entire procedure before attempting any change in shim thickness.*

IMPORTANT: The forward gear assembly must be installed in the gear housing to pilot the end of the pinion gauge to obtain an accurate measurement.

1. Clean the gear housing bearing carrier shoulder and bore.
2. Position the gear housing upright (driveshaft vertical). Install the bearing preload tool in the sequence shown.
   a. Remove nicks and clean all bearing and thrust washer surfaces.
   b. Lubricate the thrust bearing. The thrust bearing must move freely.
   c. Thread the nut all the way onto the bolt. The bolt must be snug against the spring.
   d. The holes in the sleeve must align with the set screws.

e. Tighten the set screws against the driveshaft. The bolt should not slide on the driveshaft.



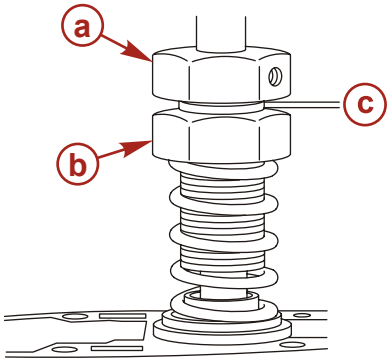
13288

Installation sequence: Bearing preload tool

- **a -** Coupler
- **b -** Threaded rod
- **c -** Sleeve - 22 mm (7/8 in.)
- **d -** Sleeve - 19 mm (3/4 in.)
- **e -** Sleeve - 16 mm (5/8 in.)
- **f -** Set screw (2)
- **g -** Bolt
- **h -** Spring
- **i -** Thrust washer
- **j -** Thrust bearing
- **k -** Adapter
- **l -** Plate
- **m -** Nut

Bearing Preload Tool	91-14311A04

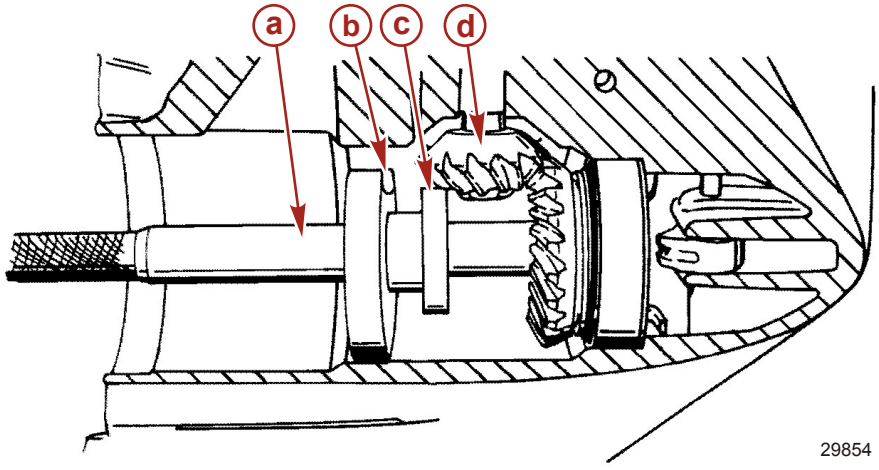
3. Measure the distance between the top of the nut and the bottom of the bolt head.
4. Increase this distance to 25.4 mm (1 in.) to preload the bearing.
5. Rotate the driveshaft 10 revolutions. This properly seats the upper driveshaft tapered roller bearing.



7275

- **a -** Bolt head
- **b -** Nut
- **c -** 25.4 mm (1 in.)

6. Install the pinion gear location tool. Position the access hole as shown. Insert a feeler gauge between the gauging surface and the pinion gear.



29854

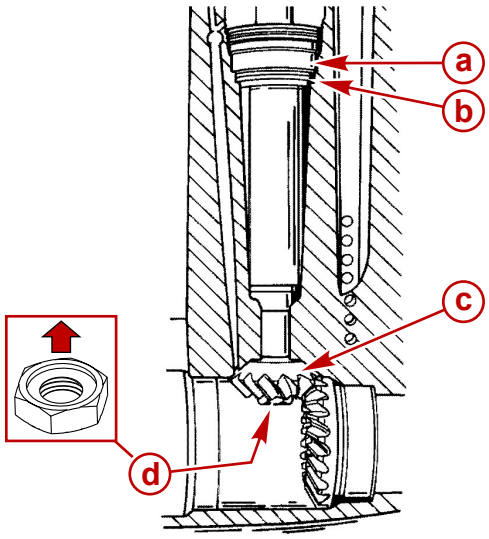
- **a -** Pinion gear location tool
- **b -** Access hole
- **c -** Gauging surface
- **d -** Pinion gear

Pinion Gear Location Tool	91-8M0043678

Pinion Gear Location Tool	91-817008A 2

7. The correct clearance between the gauging surface and the pinion gear is 0.64 mm (0.025 in.).
8. If the clearance is more than 0.64 mm (0.025 in.), remove shims from under the upper bearing cup. If the clearance is less than 0.64 mm (0.025 in.), add shims under the upper bearing race.
9. After the final adjustment to the pinion height and the forward gear backlash has been established, apply Loctite 271 Threadlocker to the threads and tighten the new pinion nut to the specified torque.

   NOTE: *Clean the driveshaft and pinion nut threads with Loctite Primer or a suitable degreaser before applying Loctite 271 Threadlocker.*



a - Bearing race
b - Shims
c - Pinion gear
d - Pinion nut

Tube Ref No.	Description	Where Used	Part No.
117	Loctite 7649 Primer N	Driveshaft and pinion nut threads	92-809824
7	Loctite 271 Threadlocker	Pinion nut threads	92-809819

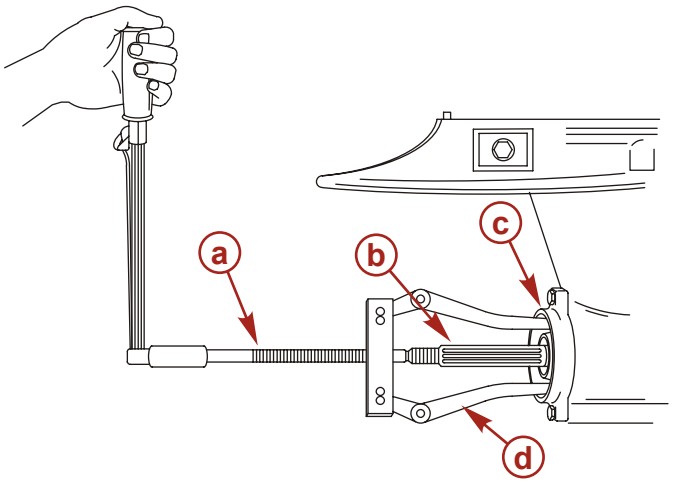
Description	Nm	lb-in.	lb-ft
Pinion nut	67		50

Forward Gear Backlash

NOTE: *Read the entire procedure before attempting any change in shim thickness.*

1. Obtain the correct pinion gear depth; refer to **Pinion Gear Depth**, preceding.
2. Install the bearing preload tool on the driveshaft; refer to **Pinion Gear Depth**, preceding.
3. Install the components, as shown.
4. While holding the driveshaft, tighten the puller bolt to specification.
5. Rotate the driveshaft 5–10 revolutions. This should properly seat the forward gear tapered roller bearing.

6. While holding the driveshaft, tighten the puller bolt to specification.

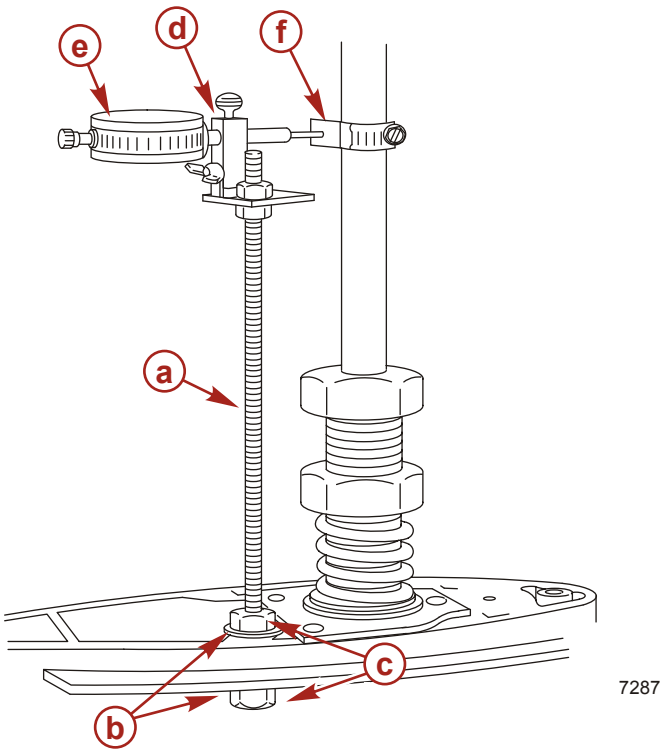


- **a -** Puller bolt
- **b -** Propeller shaft
- **c -** Bearing carrier
- **d -** Puller jaws

Puller Jaws Assembly	91-46086A1

Description	Nm	lb-in.	lb-ft
Puller bolt	5.1	45	

7. Install the components, as shown.



- **a -** Threaded rod (obtain locally)
- **b -** Washer (2)
- **c -** Nut (2)
- **d -** Dial indicator adapter kit
- **e -** Dial indicator
- **f -** Backlash indicator tool

Dial Indicator	91- 58222A 1
Dial Indicator Adapter	91-83155
Backlash Indicator	91- 19660 1

8. Position the dial indicator on the appropriate line (from chart) marked on the backlash indicator tool.

Backlash Indicator Tool Mark	
Align pointer of dial indicator with mark	4 or 9.3 mm (0.366 in.)

9. Lightly rotate the driveshaft back and forth. No movement should be noticed at the propeller shaft.
10. The dial indicator measures backlash which must be within specifications.

Forward gear (1.83:1 gear housing)	
Backlash specifications	0.31–0.41 mm (0.012–0.016 in.)
Forward gear (2.00:1 gear housing)	
Backlash specifications	0.36–0.48 mm (0.014–0.019 in.)

11. If the backlash is less than the minimum reading, remove shims in front of the forward gear bearing race. If the backlash is more than the maximum reading, add shims in front of the forward gear bearing race. When the final measurement has been made, apply Loctite 271 Threadlocker to the threads of the pinion nut.

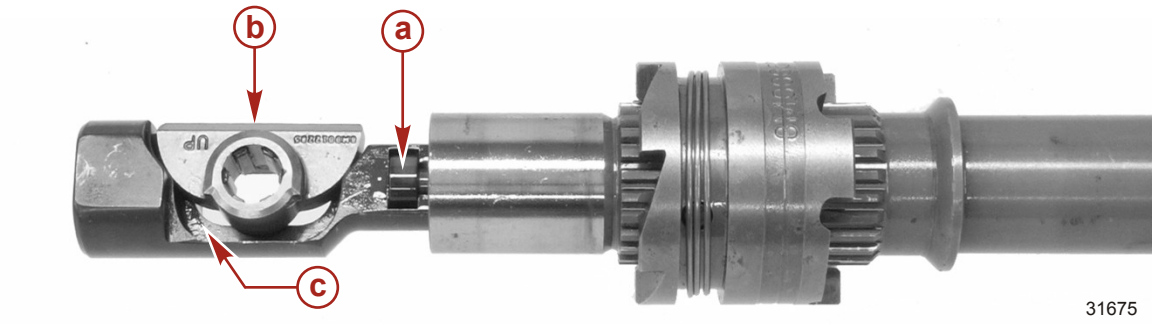
NOTE: *By adding or subtracting 0.05 mm (0.002 in.) shim, the backlash will change approximately 0.025 mm (0.001 in.).*

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Pinion nut threads	92-809819

Description	Nm	lb-in.	lb-ft
Pinion nut	68		50

Bearing Carrier and Propeller Shaft Installation

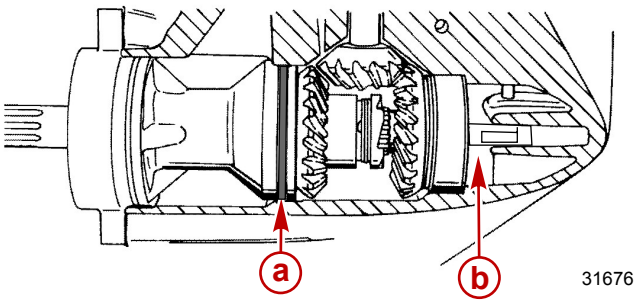
1. Place the gear housing in a soft jawed vice.
2. Coat the actuator rod cam pocket with 2-4-C with PTFE.
3. Place the shift cam into the cam pocket with the numbered "UP" side facing up.



a - Actuator rod
b - Shift cam
c - Cam pocket

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Actuator rod cam pocket	92-802859A 1

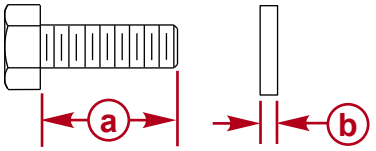
4. Install the propeller shaft assembly into the gear housing. Use care not to displace the shift cam.
5. Install the shift shaft into the cam.
6. Lubricate the O-ring, bearing carrier, and related gear housing bores with 2-4-C with PTFE.
7. Install the bearing carrier assembly into the gear housing.



a - O-ring
b - Cam follower

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	O-ring, bearing carrier, and related gear housing bores	92-802859A 1

8. Install 2.29 mm (0.090 in.) thick flat washers and bolts with Loctite 271 threadlocker.



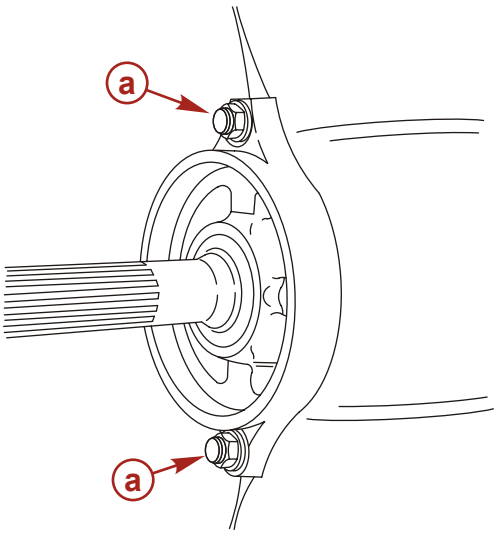
29856

a - Bolt length = 30 mm (1.18 in.)
b - Washer thickness = 2.29 mm (0.090 in.)

9.

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Bolt	92-809819

Tighten the bolts to the specified torque.



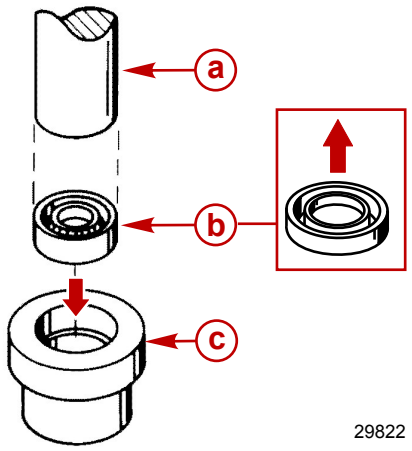
7175

a - Bolt and washer

Description	Nm	lb-in.	lb-ft
Bearing carrier bolts with 2.29 mm (0.090 in.) thick flat washers	30	–	22

Shift Shaft Assembly and Installation

1. Apply Loctite 271 Threadlocker on the outside diameter of the new seal. Install with the seal lip up.
2. Press the seal into the shift shaft bushing until the seal bottoms. Use a suitable tool.
3. Apply 2-4-C with PTFE on the inside diameter of the seal.

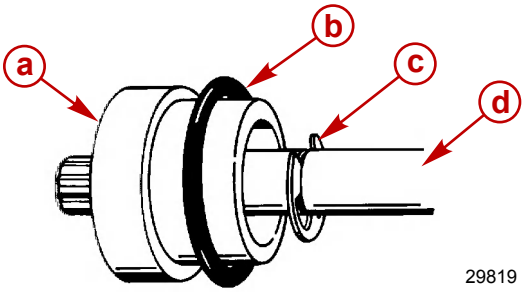


29822

a - Tool
b - Seal
c - Bushing

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Outside diameter of shift shaft seal	92-809819
95	2-4-C with PTFE	Inside diameter of shift shaft seal	92-802859A 1

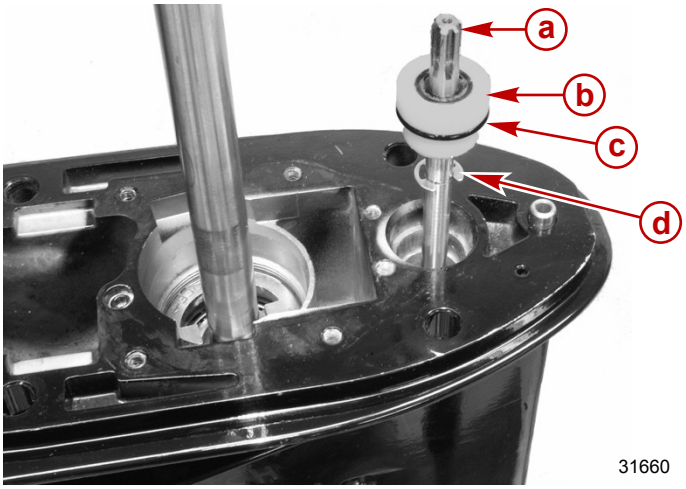
4. Apply 2-4-C with PTFE to the O-ring. Assemble the components.



a - Bushing with seal
b - O-ring
c - E-ring
d - Shift shaft

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Shift shaft bushing O-ring	92-802859A 1

5. Apply 2-4-C with PTFE to the O-ring and bushing. Install the shift shaft assembly through the gear housing into the splines on the shift cam.



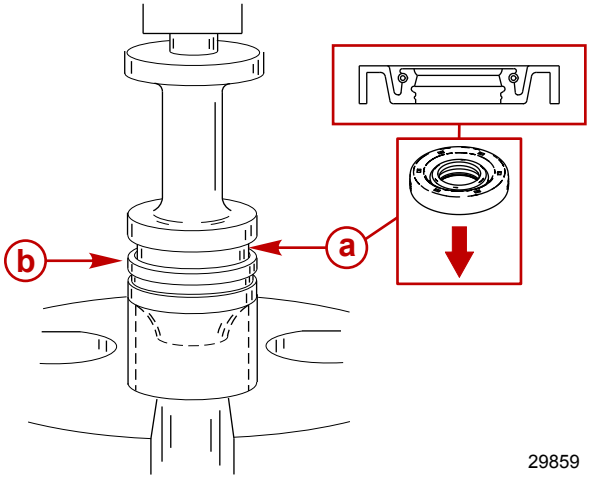
a - Shift shaft
b - Bushing
c - O-ring
d - E-ring

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Shift shaft bushing and O-ring	92-802859A 1

Water Pump Assembly and Installation

1. Place the seal shown onto the long shoulder side of the tool. Apply Loctite 271 Threadlocker to the outside diameter of the seal.

2. Press the seal into the water pump base until the tool bottoms.

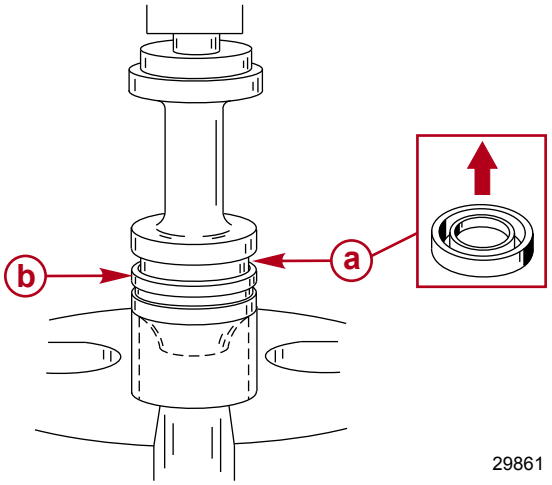


a - Seal
b - Long shoulder side of tool

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Outside diameter of water pump seal	92-809819

Water Pump Base Seal Installer	91-817006

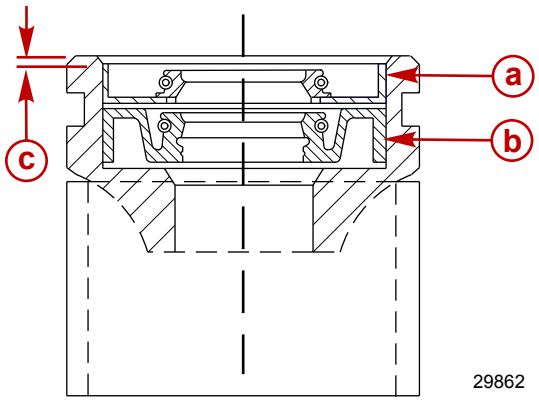
3. Place the seal onto the short shoulder side of the tool. The seal spring should face the shoulder of the tool during installation. Apply Loctite 271 Threadlocker to the outside diameter of the seal.
4. Press the seal into the water pump base until the tool bottoms.



a - Seal
b - Short shoulder side of tool

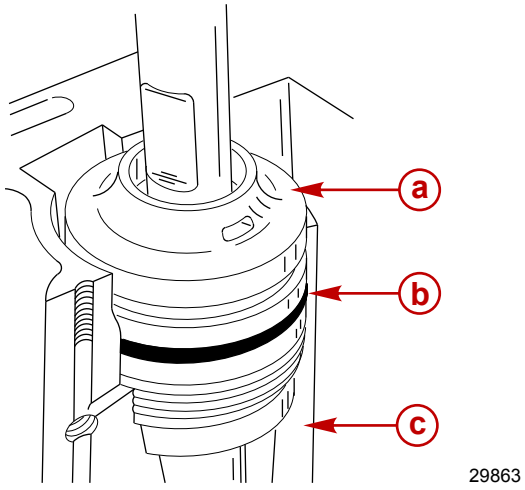
Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Outside diameter of water pump seal	92-809819

NOTE: *If the installation tool is not available, press the seals in, as shown, to the depths indicated.*



a - Upper oil seal
b - Lower oil seal
c - Upper seal depth - 1 mm (0.040 in.)

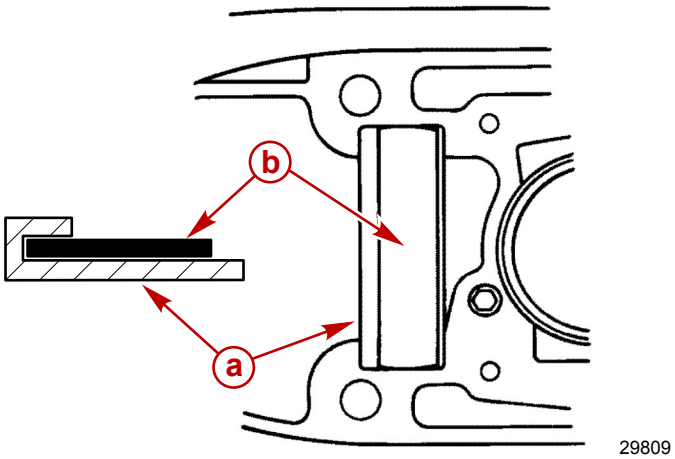
5. Install the O-ring. Apply 2-4-C with PTFE to the O-ring, seal lips, and gear housing bore.
6. Install the water pump base into the gear housing.



a - Water pump base
b - O-ring
c - Gear housing

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Water pump base O-ring, seal lips, and gear housing bore	92-802859A 1

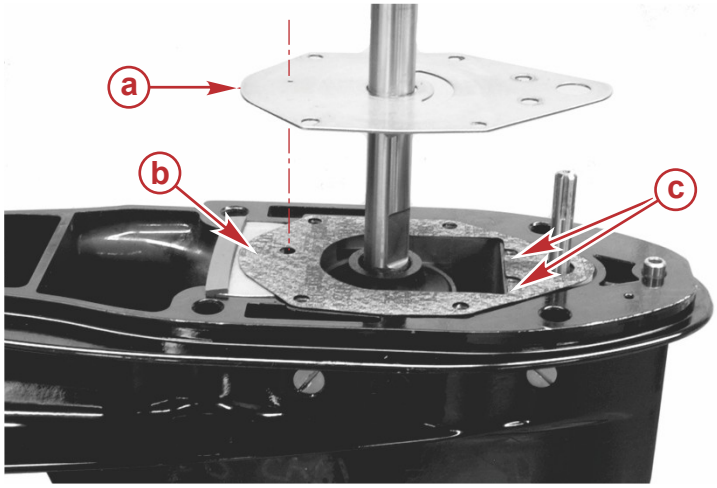
7. If removed previously, install the seal and filler plate.



a - Seal
b - Filler plate

8. Install the gasket onto the gear housing with the relief hole directly over the exhaust passage (offset to the port side).

9. Install the face plate with the small hole in the plate aligned with the relief hole in the gasket.

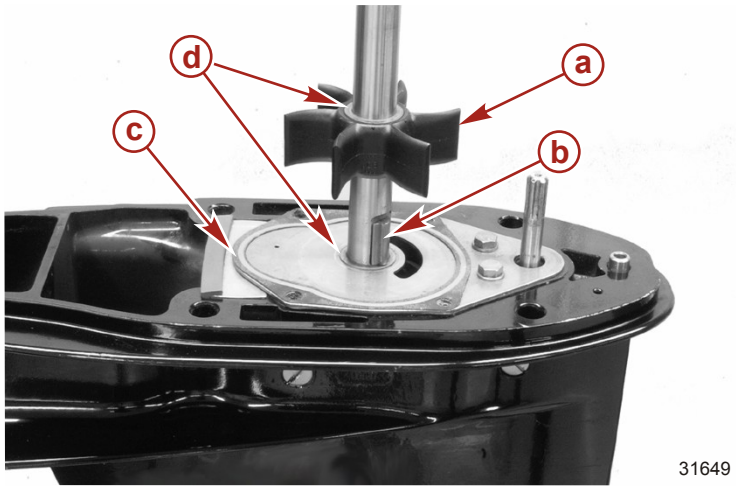


61895

- **a -** Face plate
- **b -** Gasket
- **c -** Front bolts

IMPORTANT: If the old impeller is reused, install in the original (clockwise) direction of rotation.

10. Secure the face plate with front two bolts.
11. Lubricate the gasket bead with 2-4-C with PTFE. Install the gasket with the bead facing toward the cover.
12. Install one plastic washer.
13. Install the drive key, impeller, and another plastic washer.



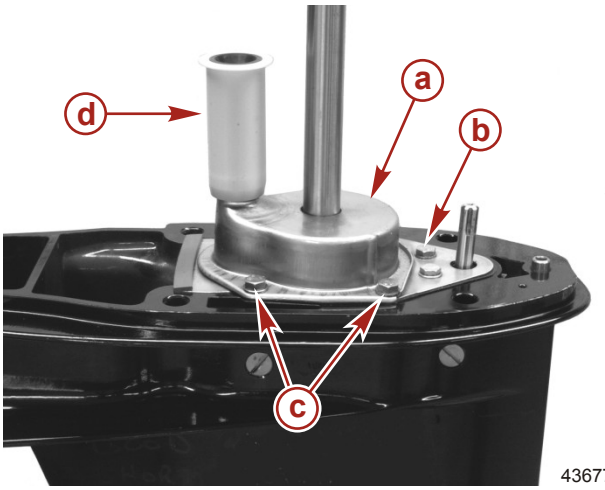
31649

- **a -** Impeller
- **b -** Drive key
- **c -** Gasket
- **d -** Plastic washer (2)

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Water pump gasket bead	92-802859A 1

14. Lubricate the inside diameter of the cover with 2-4-C with PTFE.
15. Rotate the driveshaft clockwise while pushing the water pump cover down.
16. Apply Loctite 271 Threadlocker on the bolt threads and tighten the bolts to the specified torque (in sequence shown).
    NOTE: *Install isolators and washers with the bolts, if equipped.*
17. If the water tube coupler stayed on the water tube in the driveshaft housing, remove the coupler from the water tube.

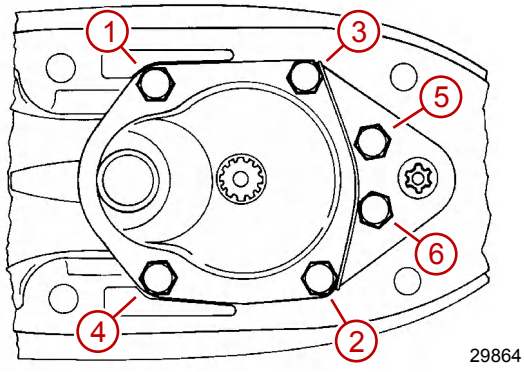
18. Lubricate the inside diameter of the water tube coupler with 2-4-C with PTFE. Install the water tube coupler onto the water pump assembly.



43677

a - Water pump cover
b - Bolt (M6 x 16) (2) (face plate)
c - Bolt (M6 x 16) (4) (cover)
d - Water tube coupler

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Inside diameter of the water pump cover and water tube coupler	92-802859A 1
7	Loctite 271 Threadlocker	Water pump mounting bolt threads	92-809819



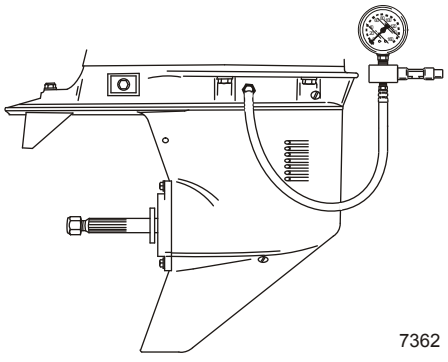
29864

Water pump bolt tightening sequence

Description	Nm	lb-in.	lb-ft
Water pump mounting bolts and face plate bolts (M6 x 16)	6.8	60	

Gear Housing Pressure Test

1. Remove the vent plug and install the pressure test gauge.


7362

2. Pressurize the housing and observe the gauge for fifteen minutes.

3. Rotate the driveshaft, propeller shaft, and shift shaft while the housing is pressurized to check for leaks.
4. If pressure drop is noted, immerse the housing in water.
5. Repressurize and check for air bubbles.
6. Replace the leaking seals, as necessary. Retest the housing after seal replacement.

Gear Housing Test Pressure	
Applied air pressure	69–83 kPa (10–12 psi)
Length of time	15 minutes

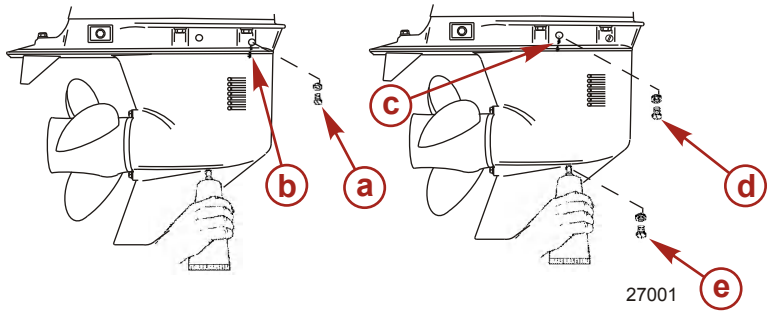
7. Remove the tester from the housing and install the vent plug and sealing washer.

Filling Gear Housing with Lubricant

IMPORTANT: Do not use automotive gear lubricant in the gear housing. Use only High Performance Gear Lubricant.

1. Remove any gasket material from the fill and vent screws and the housing.
2. Install a new sealing washer on the fill and vent screws.

   IMPORTANT: Never apply lubricant to the gear housing without first removing the vent screw, or the gear housing cannot be filled because of trapped air. Fill the gear housing only when the housing is in a vertical position.
3. Slowly fill the housing through the fill hole until the lubricant flows out of one vent hole.
4. Reinstall this vent screw and sealing washer only and continue filling until excess starts to flow out of the second vent hole.
5. Rotate the driveshaft clockwise approximately 10 revolutions. Let the gear housing sit for at least one minute to allow any trapped air to settle out, then top off the lubricant.
6. Replace the second vent screw and sealing washer.
7. Remove the gear lubricant tube from the fill hole and quickly install the fill/drain screw and sealing washer.



a - First vent screw
b - First vent hole
c - Second vent hole
d - Second vent screw
e - Fill/drain screw

IMPORTANT: Do not lose more than 30 cc (1 oz) of gear lubricant while reinstalling the fill/drain screw.

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Gear housing	92-858064K01

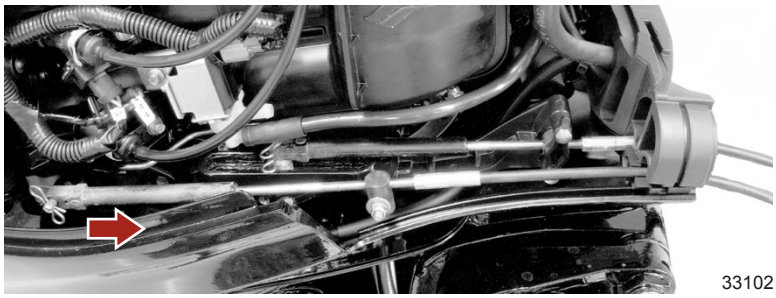
Description	Nm	lb-in.	lb-ft
Vent screw	6.8	60	

Gear Housing Installation

⚠ WARNING

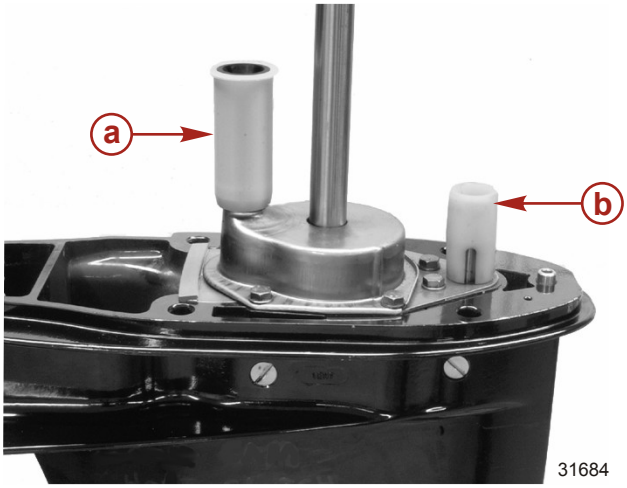
Accidental starting can cause serious injury. Before removing or installing the gear housing, disconnect and isolate the spark plug leads. Disable the ignition system by removing the keys from the ignition (if equipped) and engaging the lanyard stop switch to prevent the engine from starting.

1. Position the outboard shift linkage into the forward gear position.



Remote control model shown

2. Tilt the engine to the full up position and engage the tilt lock lever.
3. Shift the gear housing into the neutral position. The propeller shaft will rotate freely in either direction.
4. Apply 2-4-C with PTFE to the inside diameter of the water tube coupler.
5. Apply 2-4-C with PTFE to the shift shaft splines. Install the shift shaft bushing.



a - Water tube coupler
b - Shift shaft bushing

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Water tube coupler inner diameter and shift shaft splines	92-802859A 1

NOTICE
Installing the gear housing to the powerhead without adequately cleaning the top of the driveshaft can result in severe product damage. Any lubricant trapped in the space between the driveshaft and the crankshaft prevent the two from properly engaging. Always clean the top of the driveshaft before installing the gear housing.

6. Apply a light coat of 2-4-C with PTFE to the driveshaft splines.
7. Apply a light coat of 2-4-C with PTFE to the upper shift shaft splines. Do not apply lubricant to the ends of the shift shafts.

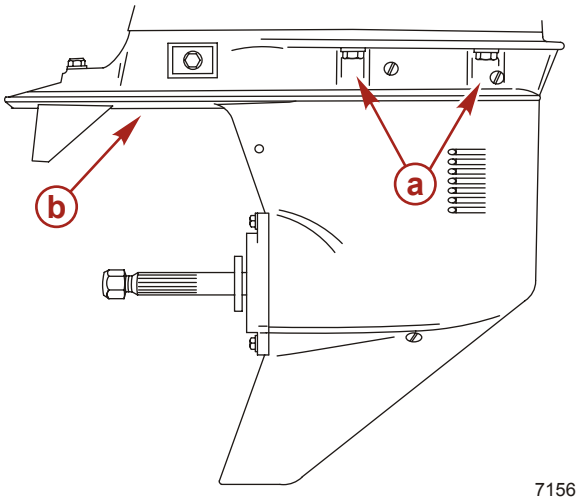
Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Driveshaft splines and upper shift shaft splines	92-802859A 1

8. Shift the gear housing into the forward gear position. In forward gear the gear housing will ratchet when the propeller shaft is turned clockwise. Resistance will be felt when the propeller shaft is rotated counterclockwise.

   NOTE: *During installation of the gear housing, it may be necessary to move the shift block located under the cowl slightly to align the upper shift shaft splines with the shift shaft coupler splines.*

   NOTE: *If the driveshaft splines will not align with the crankshaft splines, place a propeller onto the propeller shaft and turn it counterclockwise as the gear housing is pushed toward the driveshaft housing. Continue rotating the propeller shaft until the driveshaft splines align with the crankshaft splines.*
9. Apply Loctite 271 Threadlocker to the threads of the gear housing retaining bolts.
10. Position the gear housing so that the driveshaft is protruding into the driveshaft housing.

11. Move the gear housing up toward the driveshaft housing while aligning the upper shift shaft splines with the shift shaft coupler splines, the water tube with the water tube coupler, and the crankshaft splines with the driveshaft splines.
12. Install four fasteners and washers (two each side). Install the locknut and washer.
13. Torque the bolts and locknut to the specified torque.



7156

a - Bolt and washer (M10 x 45) (4)
b - Locknut and washer

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Threads of gear housing retaining bolts	92-809819

Description	Nm	lb-in.	lb-ft
Bolt and locknut	54		40

14. Check the shift operation as follows:
    - Place the shift lever in forward gear. The gear housing should ratchet when the propeller shaft is turned clockwise. Resistance should be felt when the propeller shaft is turned counterclockwise.
    - Place the shift lever into neutral. The propeller shaft should rotate freely in either direction.
    - While rotating the propeller shaft, place the shift lever into reverse gear. Resistance should be felt when the propeller shaft is rotated in either direction.

IMPORTANT: If the shift operation is not as described above, the gear housing must be removed and the cause of the problem corrected.

Trim Tab Adjustment and Replacement

IMPORTANT: The trim tab is now painted and does not aid in protecting the driveshaft housing and gear housing from galvanic corrosion and pitting of metal surfaces. Side anodes now provide protection. Do not paint or place protective coating on the side anodes, or corrosion protection function will be lost.

Replacement

Replace the trim tab if damaged. Mark the location of the old trim tab on the anti-ventilation plate before removal. Install the new trim tab in the same location.

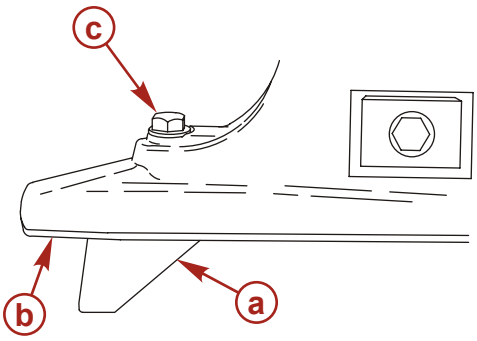
Adjustment

NOTE: *The trim tab provides a means to offset balance some of the steering load that is caused by propeller torque at higher operating speeds.*

NOTE: *Loosen the trim tab bolt sufficiently to allow the trim tab to disengage from the locking ridges in the gear housing before attempting to move the tab. Do not strike the trim tab with a hard object to make adjustments.*

1. Shift the engine control into neutral and turn the ignition key switch to the "OFF" position.
2. If at higher speeds the boat turns more easily to the left, loosen the screw and move the trim tab trailing edge to the left when viewed from behind. Tighten the retaining screw to the specified torque.

3. If the boat turns more easily to the right, loosen the screw and move the trim tab trailing edge to the right when viewed from behind. Tighten the trim tab retaining screw to the specified torque.



a - Trim tab
b - Anti-ventilation plate
c - Retaining screw and washer

Description	Nm	lb-in.	lb-ft
Trim tab retaining screw	30		22

Notes:

Lower Unit

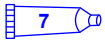
Section 6B - Gear Housing - Command Thrust EZ Shift (2.33:1 Gear Ratio)

Table of Contents

Gear Housing Specifications - Command Thrust (2.33:1) (S/N 1C033811 and Above)

Gear Housing Specifications		
Gear ratio		2.33:1
Gear shift positions		F–N–R
Reduction gear type		Spiral bevel gear
Clutch type		Dog clutch
Propeller shaft type		Spline
Propeller direction (rear view)		Clockwise
Gear housing capacity		710 ml (24 fl oz)
Lubricant type		High Performance Gear Lubricant or Premium Gear Lubricant
Forward gear - number of teeth		28 spiral/bevel
Pinion gear - number of teeth		12 spiral/bevel
Pinion height		0.64 mm (0.025 in.)
Pinion gear locating tool	Part number	91-12349A05
	Flat number	8
	Disc number	3
Forward gear backlash		0.30–0.48 mm (0.012–0.019 in.)
Backlash indicating tool	Part number	91-78473
	Mark number	4
Water pressure	At 800 RPM	14–41 kPa (2–6 psi)
	At 6000 RPM	83–172 kPa (12–25 psi)
Leak test		69–83 kPa (10–12 psi) for five minutes

Lubricant, Sealant, Adhesives

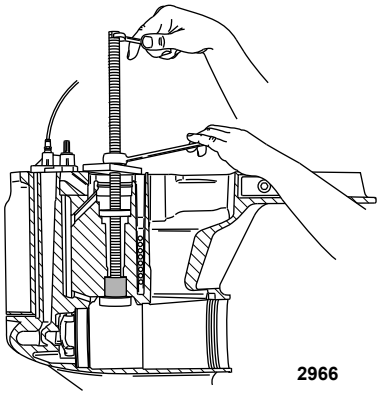
Tube Ref No.	Description	Where Used	Part No.
	Loctite 271 Threadlocker	Pinion nut, shift shaft seal outside diameter, water pump base screws, water pump cover screws, driveshaft ring seal	92-809819
		Stud - bearing carrier, outside diameter of propeller shaft seals	
		Outside diameter of bearing carrier seal	
		Outside diameter of seal	
		Outside diameter of driveshaft rubber ring	
		Pinion nut threads	
		Fastener threads	
		Outside diameter of shift shaft bushing seal	
		Bottom half of shift shaft bushing screw threads	
		Outside diameter of water pump upper seal	
		Outside diameter of lower water pump seal	
		Bottom half of water pump base screw threads	
		Bottom of water pump cover bolt threads	
		Threads of gear housing retaining bolts	
	High Performance Gear Lubricant	Gear housing	92-858064K01
		Thrust washers	
		Thrust bearing	
		Reverse gear bearing surface	
		Inside diameter of forward gear and outside diameter of needle bearing	
		Forward gear roller bearing and lower driveshaft tapered roller bearing	

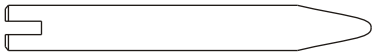
Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Shift shaft O-ring, inside diameter of all seals	92-802859A 1
		Bearing carrier O-ring, inner diameter of propeller shaft seals, cam follower	
		Outside diameter of forward gear bearing race	
		Outside diameter of needle bearing and bearing carrier bore	
		O-ring and seal lips; outside diameter of reverse gear bearing and bearing carrier bore	
		Inside diameter of bearing	
		Actuator rod	
		Surface of cross pin	
		Outside diameter of bearing race	
		Inside diameter of bearing sleeve and outside diameter of upper driveshaft bearing	
		Cam pocket of cam follower	
		O-ring, bearing carrier, and gear housing mating surfaces	
		Inside diameter of shift shaft bushing seal; shift shaft O-ring	
		Lip of each seal	
		Inside diameter of water pump cover	
		Water tube seal inner diameter	
		Driveshaft splines and shift shaft splines	
116	RTV 587 Ultra Blue Silicone Sealer	Water pump exhaust dam	92-809825
117	Loctite 7649 Primer N	Pinion nut threads and driveshaft threads	92-809824
		Clean pinion nut threads and driveshaft threads	
		Driveshaft and pinion nut threads	

Special Tools

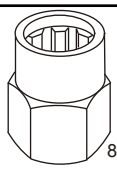
Puller Jaws Assembly	91-46086A1
 9514	Removes bearing carrier and bearing races; use with Puller Bolt (91-85716).

Slide Hammer	91-34569A 1
 6761	Aids in the removal of various engine components. Use with puller jaws.

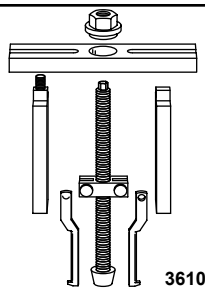
Bearing Removal and Installation Kit	91- 31229A 7
	Installs and removes the bearings in all gearcases. 91- 31229A 7 tool assembly includes the following components: 11- 24156 Hex Nut 12- 34961 Washer 91- 15755T Bearing Carrier 91- 29310 Plate 91- 30366T 1 Mandrel 91- 31229 Puller Shaft 91- 32325T Driver Head 91-32336 Driver Needle Bearing 91-36379 Puller/Head Gear 91- 36569T Driver Head 91- 36571T Pilot Washer 91-37292 Roller Bearing 91- 37311 Driver Head 91- 37312T -Driver Head 91- 37323 Driver Head Rod 91- 37324T Pilot Washer 91- 37350T Pilot Mandrel 91- 38628T Puller/Driver Head 91-52393T Driver Needle Bearing 91-52394 Head Pull Rod

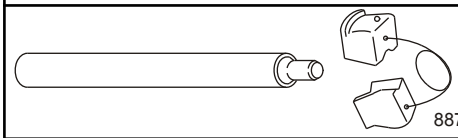
Slotted Cross Pin Tool	91- 86642 1
	Assists in clutch assembly/disassembly.

Dial Indicator	91- 58222A 1
	Used to obtain a variety of measurements including gear backlash, pinion gear location, and TDC.

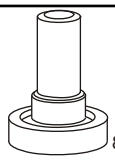
Driveshaft Holding Tool	91-877840A 1
	Holds driveshaft while removing pinion nut.

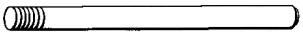
Universal Puller Plate	91-37241
	Removes bearings from gears and the driveshaft.

Bearing Puller Assembly	91- 83165T
 3610	Removes bearings, races and bearing carriers.

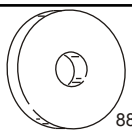
Bearing Race Driver	91- 14308T02
 8879	Removes pinion bearing race.

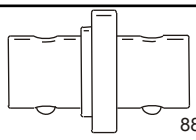
Bearing Cup Driver	91- 31106T
 8882	Installs the driven gear bearing cup.

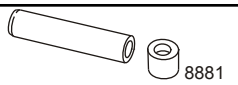
Bearing Installation Driver	91- 13945
 8877	Installs reverse gear needle bearing into prop shaft carrier.

Driver Rod	91- 37323
 25431	Aids in the removal and installation of various bearings and bearing races

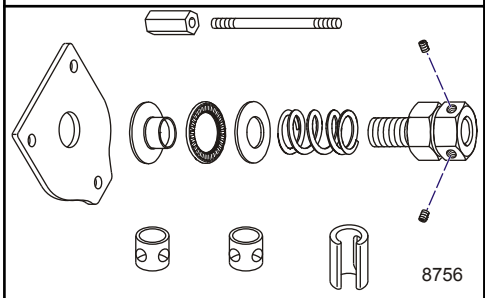
Oil Seal Driver	91- 31108T
 8883	Installs bearing carrier oil seals.

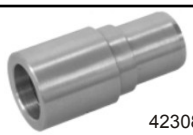
Pilot Mandrel	91- 37350T
 8884	Presses on inner race of forward gear roller bearing.

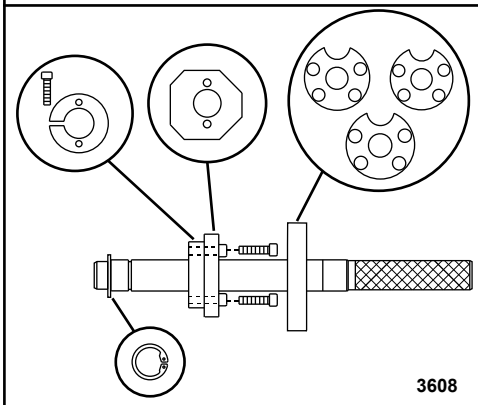
Bearing Driver	91-856875A 1
 8885	Installs prop shaft needle bearing into 3 jaw or 6 jaw forward gear.

Wear Sleeve Driver	91- 14310T 1
 8881	Installs wear sleeve onto driveshaft.

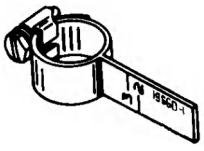
Bearing Installation Puller	91- 14309T02
 8880	Installs pinion bearing into gearcase.

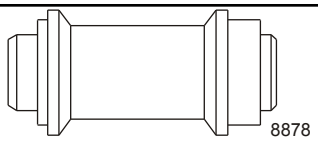
Bearing Preload Tool	91-14311A04
 8756	Simulates a load on the driveshaft for accurate pinion height and backlash measurements.

Pinion Gear Location Tool	91-8M0043678
 42308	Checks gearcase pinion gear height. Used with 91-817008A2

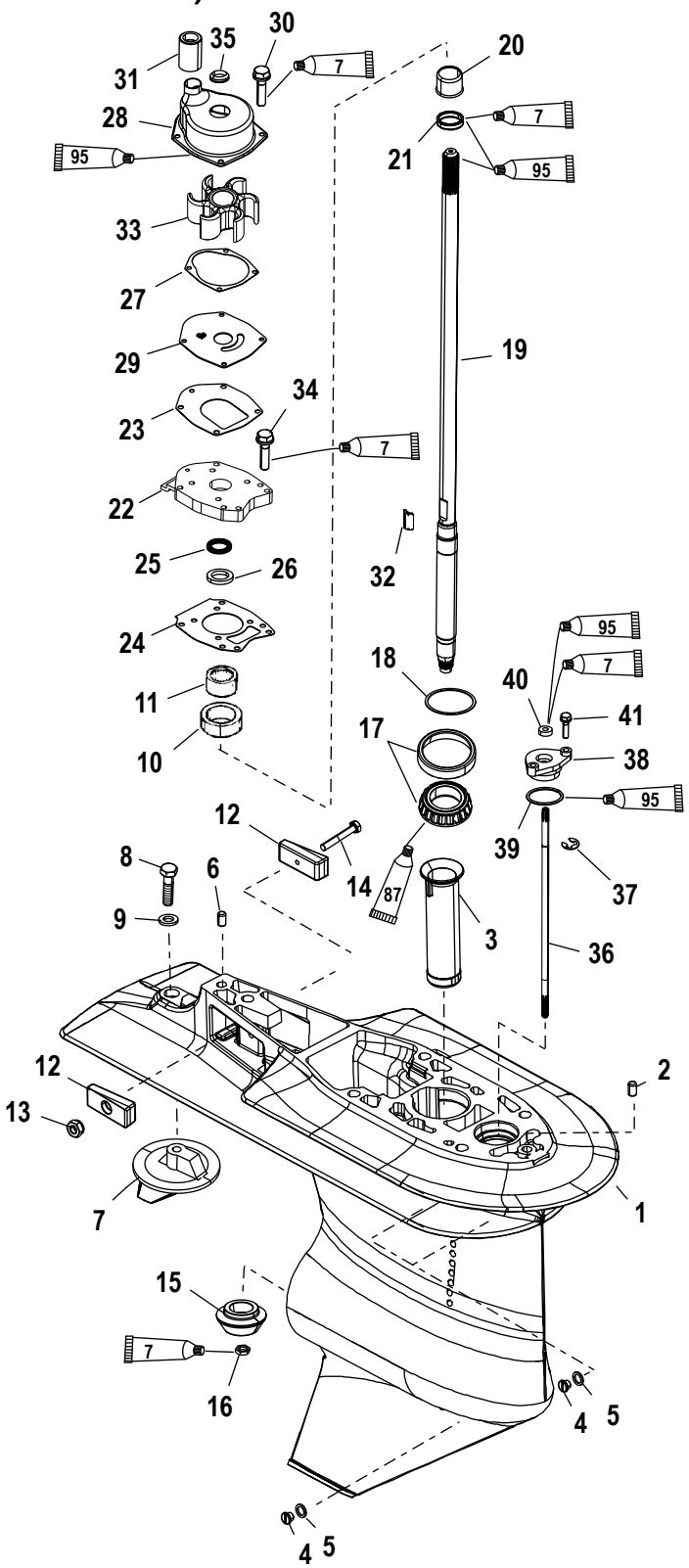
Pinion Gear Locating Tool	91- 12349A05
 3608	Measures pinion gear height.

Dial Indicator Adapter	91-83155
 2999	Dial indicator holding fixture.

Backlash Indicator	91- 19660 1
 8757	Measures gear backlash.

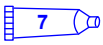
Oil Seal Driver	91- 13949
 8878	Installs oil seals into water pump base.

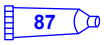
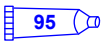
Gear Housing Driveshaft Components - Command Thrust EZ Shift (S/N 1C033811 and Above)



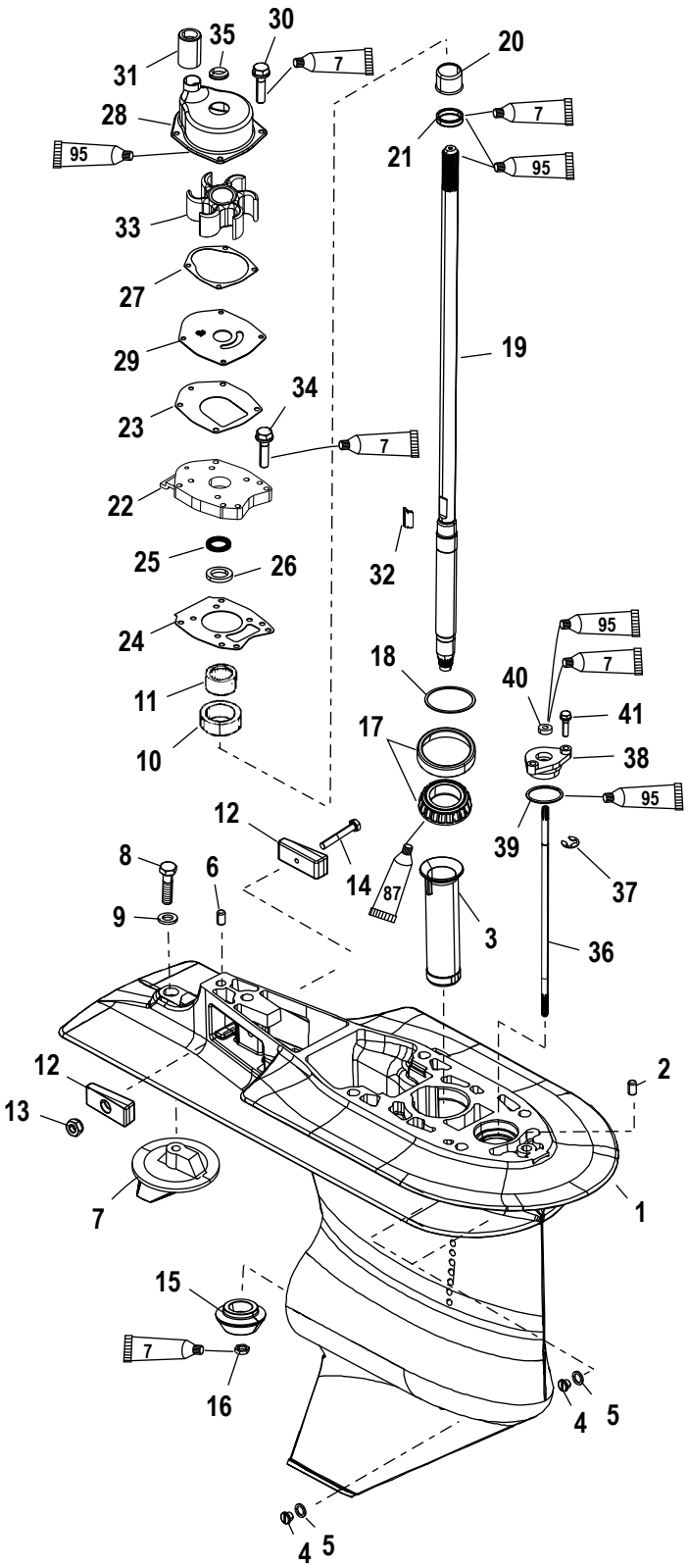
Gear Housing Driveshaft Components - Command Thrust EZ Shift (S/N 1C033811 and Above)

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Gear housing			
2	1	Dowel pin (front)			
3	1	Oiler tube			
4	3	Drain screw	7	62	–
5	3	Sealing washer			
6	1	Dowel pin (rear)			
7	1	Trim tab			
8	1	Screw	30	–	22.1
9	1	Washer			
10	1	Carrier			
11	1	Needle bearing			
12	2	Anode			
13	1	Nut			
14	1	Screw (M6 x 40)	7	62	–
15	1	Pinion gear (12 teeth)			
16	1	Nut	95	–	70.1
17	1	Tapered roller bearing			
18	AR	Shim assembly (sizes 0.006–0.048)			
19	1	Driveshaft assembly			
20	1	Wear sleeve assembly			
21	1	Seal			
22	1	Water pump base assembly			
23	1	Gasket			
24	1	Gasket			
25	1	Oil seal (upper)			
26	1	Oil seal (lower)			
27	1	Gasket			
28	1	Upper water pump housing			
29	1	Face plate			
30	4	Screw (M6 x 30)	7	62	–
31	1	Seal			
32	1	Key			
33	1	Impeller			
34	6	Screw (M6 x 25)	7	62	–
35	1	Face seal			
36	1	Shift shaft assembly			
37	1	E-ring			
38	1	Bushing assembly			
39	1	O-ring			
40	1	Oil seal			
41	2	Screw (M6 x 25)	7	62	–

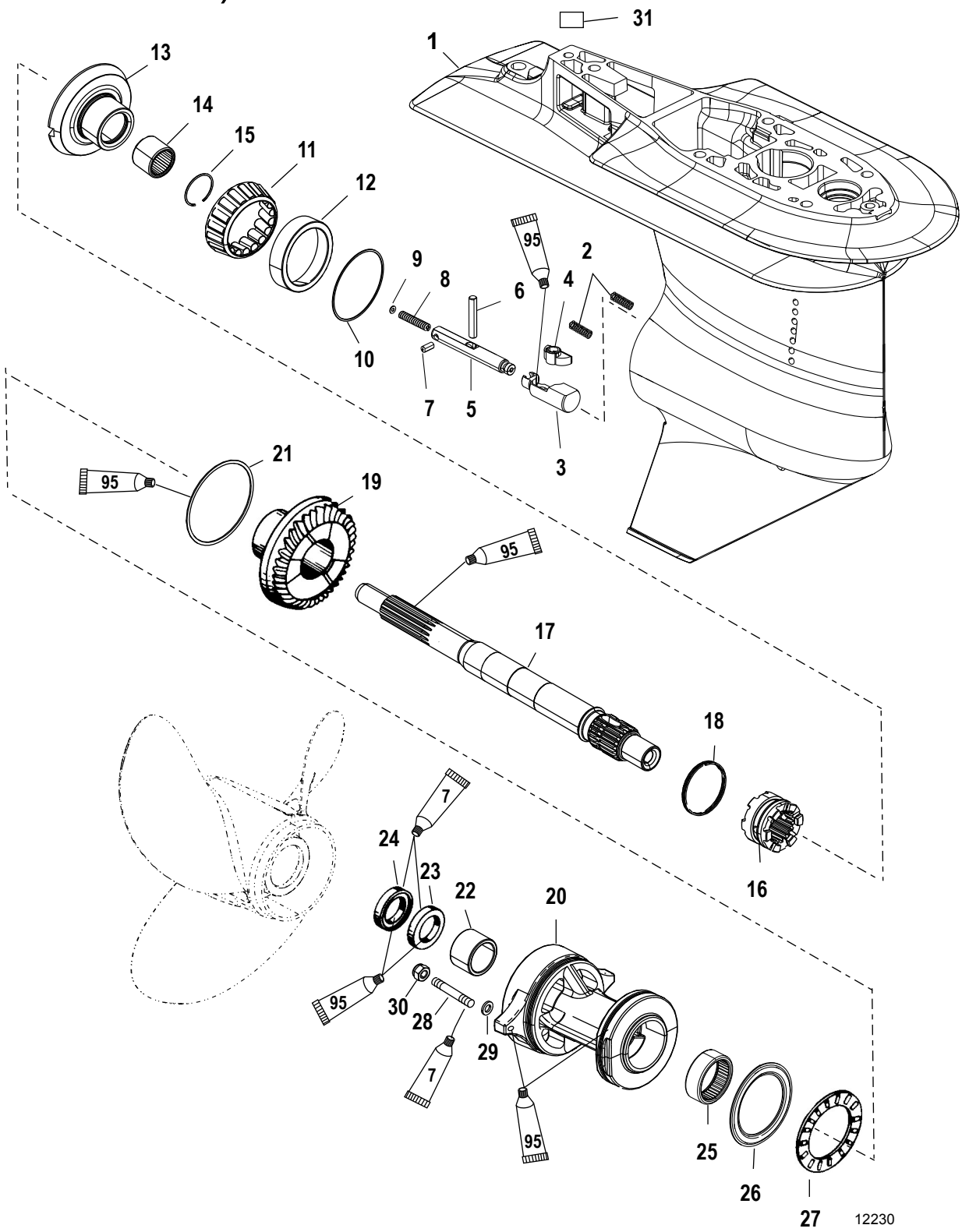
Tube Ref No.	Description	Where Used	Part No.
	Loctite 271 Threadlocker	Pinion nut, shift shaft seal outside diameter, water pump base screws, water pump cover screws, driveshaft ring seal	92-809819

Tube Ref No.	Description	Where Used	Part No.
	High Performance Gear Lubricant	Gear housing	92-858064K01
	2-4-C with PTFE	Shift shaft O-ring, inside diameter of all seals	92-802859A 1

Gear Housing Driveshaft Components - Command Thrust EZ Shift (S/N 1C033811 and Above)

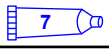
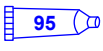


Gear Housing Propeller Shaft Components - Command Thrust EZ Shift (S/N 1C033811 and Above)



Gear Housing Propeller Shaft Components - Command Thrust EZ Shift (S/N 1C033811 and Above)

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Gear housing			
2	2	Insert			
3	1	Cam follower			
4	1	Shift cam			
5	1	Clutch actuator rod			
6	1	Cross pin			
7	1	Spring locator pin			
8	1	Spring			
9	1	Washer			
10	A/R	Shim assembly (size 0.006–0.038)			
11	1	Tapered roller bearing			
12	1	Cup			
13	1	Forward gear (28 teeth)			
14	1	Roller bearing			
15	1	Retaining ring			
16	1	Clutch			
17	1	Propeller shaft			
18	1	Spring			
19	1	Reverse gear (28 teeth)			
20	1	Bearing carrier assembly			
21	1	O-ring			
22	1	Roller bearing			
23	1	Oil seal (inner)			
24	1	Oil seal (outer)			
25	1	Roller bearing			
26	1	Thrust washer			
27	1	Thrust bearing			
28	2	Stud (M8 x 48)	Drive tight		
29	2	Washer			
30	2	Nut	30	–	22.1
31	1	Gear housing pinion identification decal			

Tube Ref No.	Description	Where Used	Part No.
	Loctite 271 Threadlocker	Stud - bearing carrier, outside diameter of propeller shaft seals	92-809819
	2-4-C with PTFE	Bearing carrier O-ring, inner diameter of propeller shaft seals, cam follower	92-802859A 1

General Service Recommendations

There may be more than one way to disassemble or reassemble a particular part, therefore, it is recommended the entire procedure be read prior to repair.

IMPORTANT: Read the following before attempting any repairs.

In many cases, disassembly of a subassembly may not be necessary, until cleaning and inspection reveals that disassembly is required for replacement of one or more components.

Service procedure order in this section is a normal disassembly/reassembly sequence. It is suggested the sequence be followed without deviation to assure proper repairs. When performing partial repairs, follow the instructions to the point where the desired component can be replaced, then proceed to reassembly and installation of that component in the reassembly part of this section. Use the **Table of Contents** (on back of section divider) to find correct page number.

Threaded parts are right-hand (RH), unless otherwise indicated.

When holding, pressing, or driving is required, use soft metal vise jaw protectors or wood for protection of parts. Use a suitable mandrel (one that will contact only the bearing race) when pressing or driving bearings.

Whenever compressed air is used to dry a part, verify that no water is present in the air line.

Bearings

Upon disassembly of the gear housing, all bearings must be cleaned and inspected. Clean bearings with solvent and dry with compressed air. Air should be directed at the bearing so that it passes through the bearing. Do not spin bearing with compressed air, as this may cause bearing to score from lack of lubrication. After cleaning, lubricate bearings with High Performance Gear Lubricant. Do not lubricate tapered bearing cups until after inspection.

Inspect all bearings for roughness, catches, and bearing race side wear. Work inner bearing race in and out, while holding outer race, to check for side wear.

When inspecting tapered bearings, determine condition of rollers and inner bearing race by inspecting bearing cup for pitting, scoring, grooves, uneven wear, imbedded particles and/or discoloration from overheating. Always replace tapered bearing and race as a set.

Inspect gear housing for bearing races that have spun in their respective bores. If race has spun, gear housing must be replaced.

Roller bearing condition is determined by inspecting the bearing surface of the shaft that the roller bearing supports. Check shaft surface for pitting, scoring, grooves, imbedded particles, uneven wear, and/or discoloration from overheating. The shaft and bearing must be replaced, if the conditions described are found.

Shims

Keep a record of all shim amounts and location during disassembly to aid in reassembly. Be sure to follow shimming instructions during reassembly, as gears must be installed to correct depth and have the correct amount of backlash to avoid noisy operation and premature gear failure.

Seals

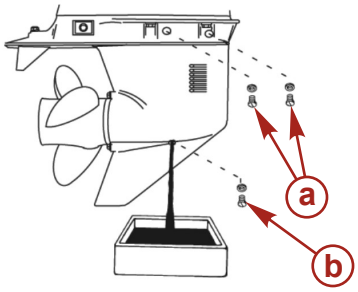
As a normal procedure, all O-rings and oil seals should be replaced without regard to appearance. To prevent leakage around oil seals, apply Loctite 271 to outer diameter of all metal case oil seals. When using Loctite on seals or threads, surfaces must be clean and dry. To ease installation, apply 2-4-C with PTFE on all O-rings. To prevent wear, apply 2-4-C with PTFE on inner diameter of oil seals.

Draining and Inspecting Gear Housing Lubricant

⚠ WARNING

Rotating propellers can cause serious injury or death. Never operate the boat out of the water with a propeller installed. Before installing or removing a propeller, place the drive unit in neutral and engage the lanyard stop switch to prevent the engine from starting. Place a block of wood between the propeller blade and the anti-ventilation plate.

1. Position a clean drain pan under the gear housing. Remove the vent screws and the fill/drain screw with gaskets from the gear housing.



26977

a - Vent screws
b - Fill/drain screw

2. Inspect the gear lubricant for metal particles. Presence of a small amount of fine metal particles resembling powder indicates normal wear. Presence of larger particles or a large quantity of fine particles, indicates need for gear housing disassembly and inspection.
3. Note the color of the gear lubricant. White or cream color indicates the presence of water in the lubricant. Check the drain pan for water separation from the lubricant. Presence of water in the gear lubricant indicates the need for disassembly, and inspection of oil seals, seal surfaces, O-rings, and gear housing components. Pressure check the gearcase prior to disassembly.

   NOTE: *When draining the gearcase for the first time, the lubricant may appear cream colored due to the mixing of assembly lubricant and gear lubricant. This is not an indication of water intrusion. If, during the subsequent draining of the gearcase, the lubricant appears cream colored or milky, water may be present. Gearcase should be disassembled and all gaskets, seals, and O-rings replaced. Inspect all components for water damage.*

   NOTE: *Gear lubricant drained from a recently run gearcase will be a light chocolate brown in color due to agitation/aeration. Oil which is stabilized will be a clear yellow brown in color.*

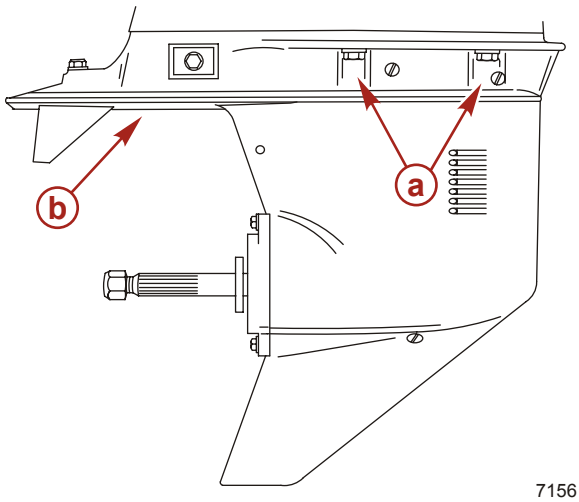
Gear Housing Removal

⚠ WARNING

Accidental starting can cause serious injury. Before removing or installing the gear housing, disconnect and isolate the spark plug leads. Disable the ignition system by removing the keys from the ignition (if equipped) and engaging the lanyard stop switch to prevent the engine from starting.

IMPORTANT: When removing or installing the gear housing, carefully guide the driveshaft through the driveshaft bushing to avoid scoring the bushing surface.

1. Remove and isolate the spark plug leads from the spark plugs.
2. Shift the engine into forward gear.
3. Tilt the engine to the full up position.
4. Remove the four fasteners.
5. Remove the locknut and washer.



7156

a - Fasteners (2 each side)
b - Locknut and washer (recessed)

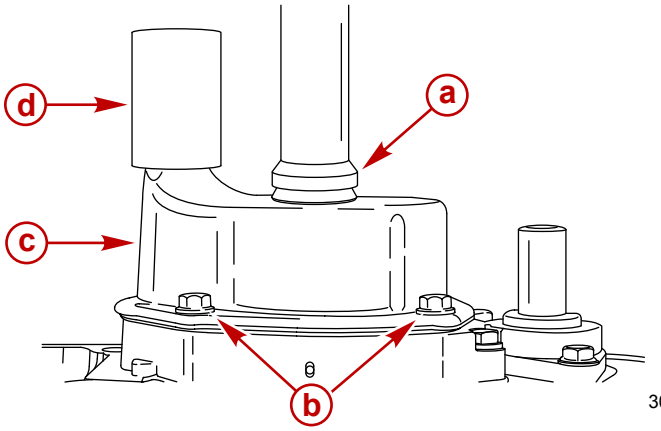
6. Remove the gear housing.

Gear Housing Disassembly

Water Pump Disassembly

NOTE: *If the water tube seal stayed on the water tube inside of the driveshaft housing when the gear housing was removed, remove the water tube seal from the water tube.*

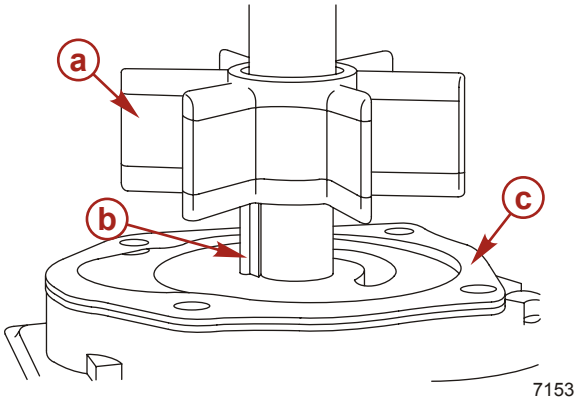
1. Replace the water tube seal, if damaged.
2. Remove the pump seal.
3. Remove two bolts on each side of the water pump housing.
4. Remove the cover.



- **a -** Pump seal
- **b -** Bolt (M6 x 30) (4)
- **c -** Cover
- **d -** Water tube seal

IMPORTANT: The circular groove formed by the impeller sealing bead should be disregarded when inspecting the cover and plate, as the depth of the groove will not affect water pump output.

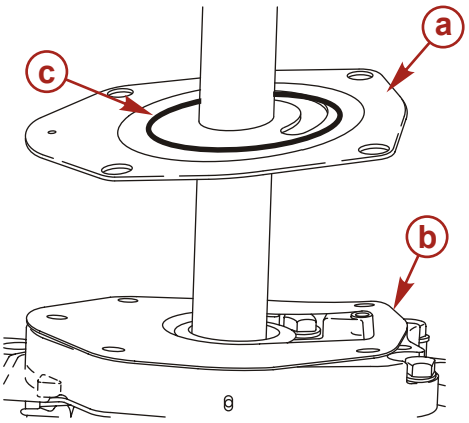
5. Replace the cover if the thickness of the steel at the discharge slots is 1.50 mm (0.060 in.) or less, or if the grooves, other than the impeller sealing bead groove, in the cover roof are more than 0.75 mm (0.030 in.) deep.
6. Lift the impeller, drive key, and gasket from the driveshaft.



- **a -** Impeller
- **b -** Drive key
- **c -** Gasket

7. Inspect the impeller. Replace the impeller if any of the following conditions exist:
   - Impeller blades are cracked, torn, or worn.
   - Impeller is glazed or melted.
   - Rubber portion of the impeller is not bonded to the impeller hub.
8. Remove the plate and gasket.

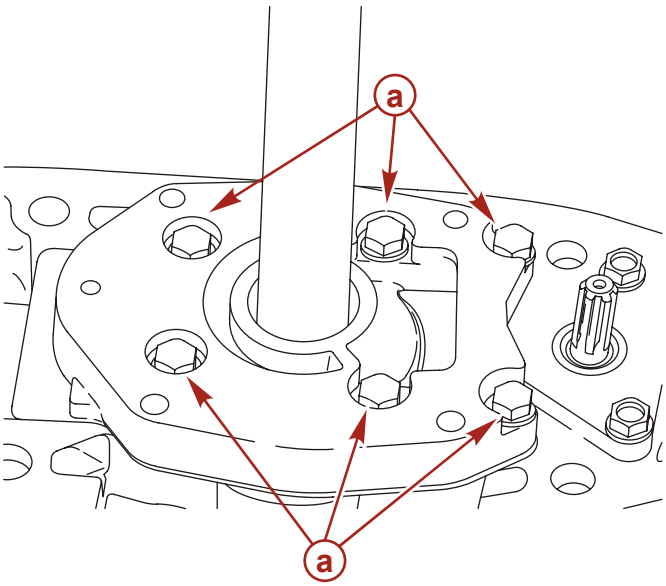
9. Replace the face plate if the grooves, other than the impeller sealing bead groove, in the face plate are more than 0.75 mm (0.030 in.) deep.



7165

a - Face plate
b - Gasket
c - Impeller sealing bead groove

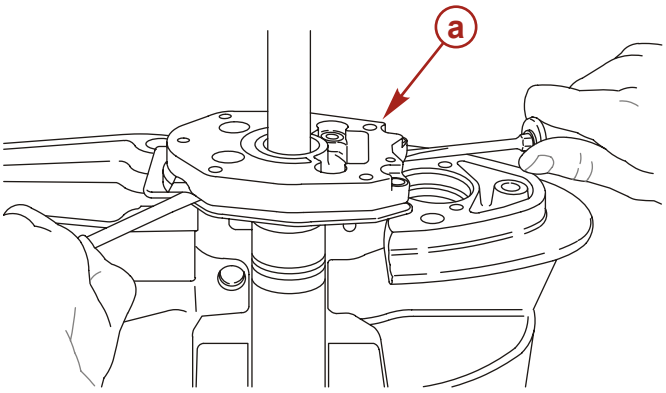
10. Remove the bolts and washers.



7168

a - Bolts and washers (6)

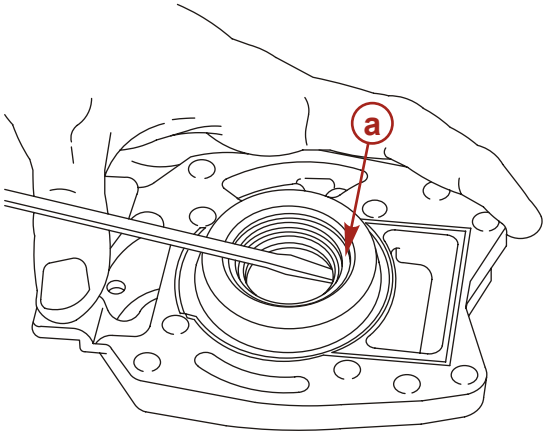
11. Remove the water pump base using flat screwdrivers to lightly pry up on the base.



7171

a - Water pump base

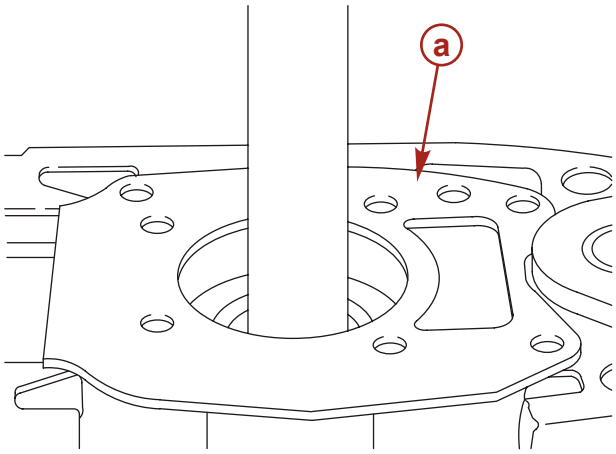
12. Remove and discard the seals. Clamp the water pump base in a vise while removing the seals.



7173

a - Seals

13. Remove the gasket.

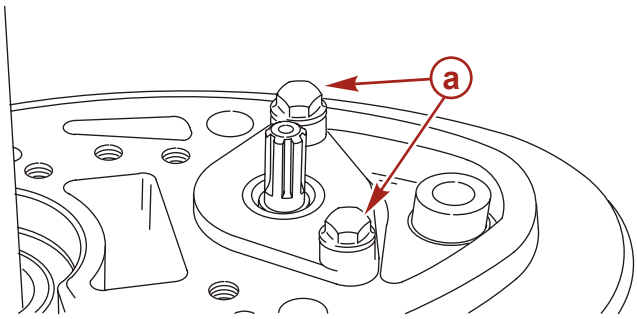


7174

a - Gasket

Shift Shaft Disassembly

1. Remove screws.

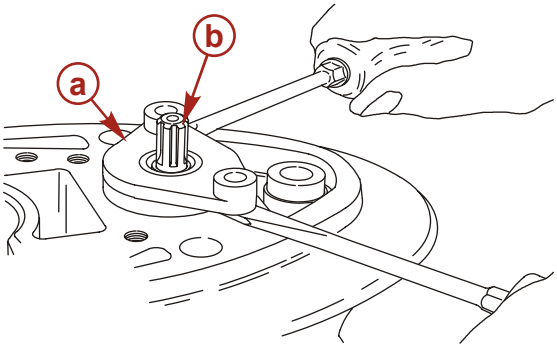


7206

a - Screw (M6 x 25) (2)

NOTE: *Remove rough edges from shift shaft splines before removing shift shaft bushing.*

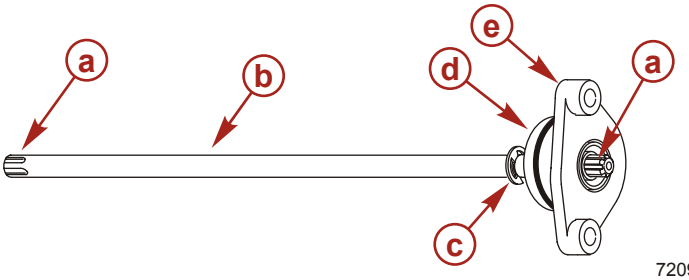
2. Remove shift shaft bushing and shift shaft.



7207

a - Bushing
b - Shift shaft

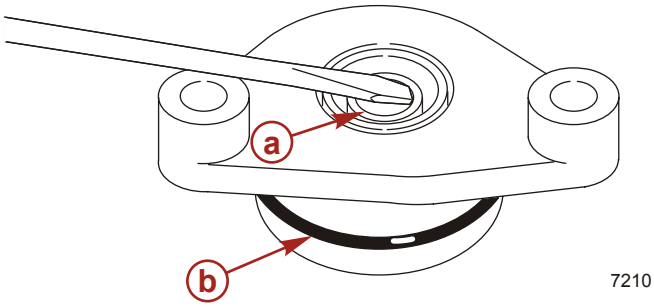
3. Remove shift shaft bushing and clip from shift shaft.
4. Replace shift shaft if splines are worn or shaft is twisted.
5. Remove and discard O-ring.



7209

a - Splines
b - Shift shaft
c - E-clip
d - O-ring
e - Bushing

6. Remove and discard seal. Lightly clamp the bushing in a vise when removing seal.



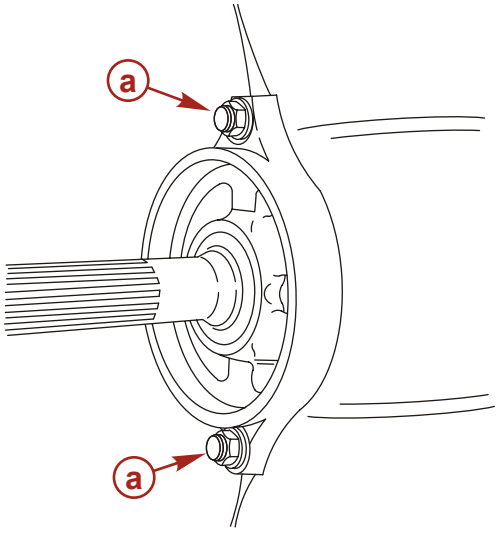
7210

a - Seal
b - O-ring

Bearing Carrier and Propeller Shaft Removal

1. Ensure the gear housing is in neutral.

2. Remove the fasteners.

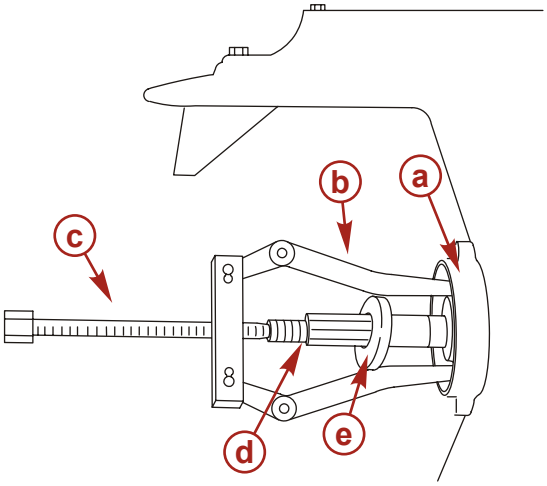


7175

a - Fasteners

NOTE: *The shift cam must be in the neutral position before the propeller shaft can be removed from the gear housing.*

3. With the propeller shaft horizontal, use the puller jaws and bolt to break the bearing carrier to gear housing seal.
4. Remove the bearing carrier/propeller shaft components as an assembly by pulling back on the propeller shaft.
5. Remove the propeller shaft from the bearing carrier.



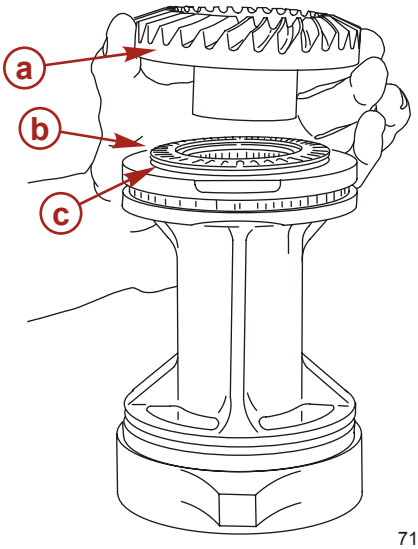
7177

a - Bearing carrier
b - Puller jaws
c - Puller bolt
d - Propeller shaft
e - Thrust hub

Puller Jaws Assembly	91-46086A1

6. Lift the reverse gear, thrust bearing, and thrust washer from the bearing carrier. Replace the thrust bearing and thrust washer if rusted or damaged.

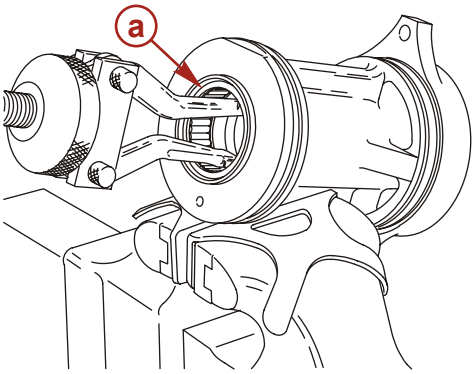
7. Replace the reverse gear if gear teeth or clutch teeth on the reverse gear are rounded or chipped. If the reverse gear must be replaced, the pinion gear and sliding clutch should be inspected for damage.



7178

a - Reverse gear
b - Thrust bearing
c - Thrust washer

8. If the reverse gear radial bearing is rusted or does not roll freely, remove the bearing with a slide hammer and appropriate jaws.

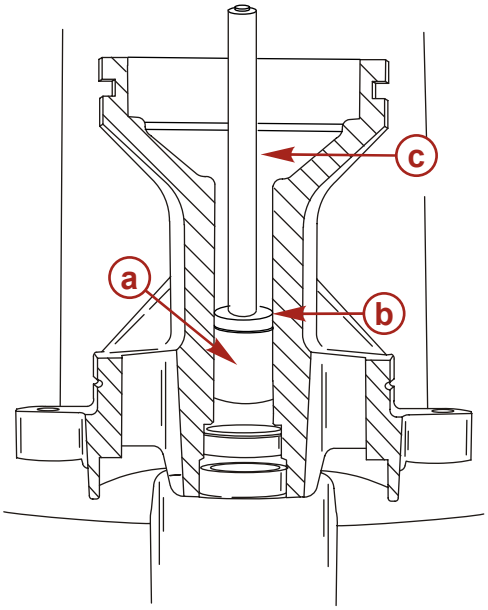


7180

a - Radial bearing

Slide Hammer	91-34569A 1

9. If bearing replacement is necessary, remove the oil seals and bearing using a mandrel and driver rod. Discard the oil seals.

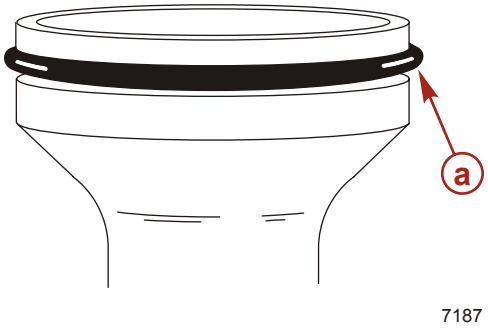


7185

a - Bearing
b - Mandrel
c - Driver rod

Bearing Removal and Installation Kit	91- 31229A 7

10. Remove the propeller shaft seals (if not removed previously) and bearing carrier O-ring.

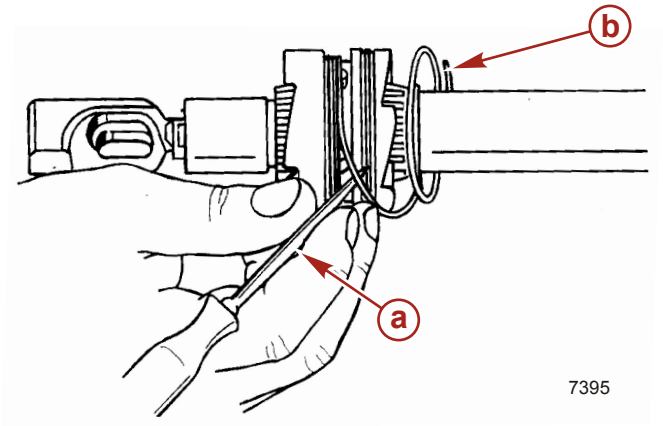


7187

a - O-ring

Propeller Shaft Disassembly

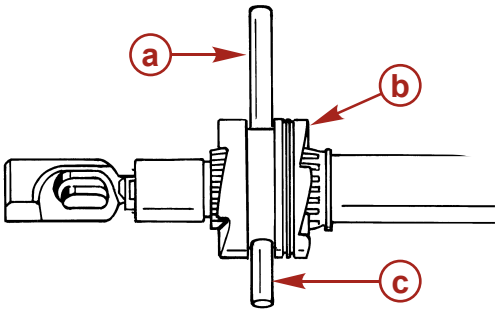
1. Remove the shift cam from the cam follower.
2. Insert a thin blade screwdriver or awl under the first coil of the cross pin retainer spring and rotate the propeller shaft to unwind the spring from the sliding clutch. Do not overstretch the spring.



7395

a - Awl
b - Cross pin retainer spring

3. Push the cross pin out of the sliding clutch with a slotted cross pin tool.
4. Pull the sliding clutch off of the propeller shaft.



7397

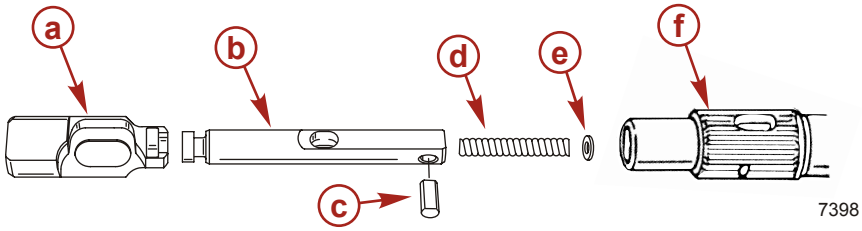
a - Slotted cross pin tool
b - Sliding clutch
c - Cross pin

Slotted Cross Pin Tool	91- 86642 1

5. Pull the cam follower and clutch actuator rod out of the propeller shaft. Do not force the cam follower up or down, or side to side, when removing it from the propeller shaft.

   IMPORTANT: The spring locator pin is free and can fall out of the actuator rod. Care must be taken not to lose the pin.
6. Remove the spring locator pin from the actuator rod.

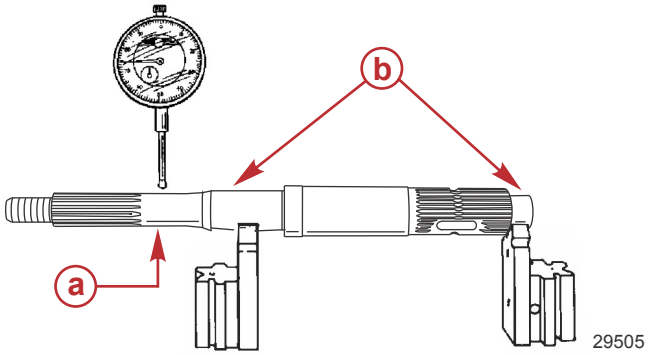
7. Remove the washer and spring from the actuator rod.



a - Cam follower
b - Clutch actuator rod
c - Spring locator pin
d - Spring
e - Washer
f - Propeller shaft

Propeller Shaft Inspection

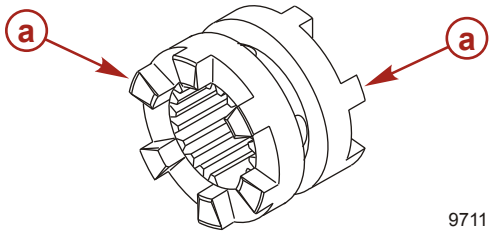
1. Clean propeller shaft with solvent and dry with compressed air.
2. Inspect bearing carrier oil seal surfaces for grooves. Replace shaft if groove is found.
3. Visually check bearing surfaces of propeller shaft for pitting, grooves, scoring, uneven wear, or bluish discoloration from overheating. Replace shaft and corresponding needle bearing if any of these conditions are found. The bearing carrier needle bearing contacts propeller shaft just in front of oil seal surface. The forward gear needle bearing contacts propeller shaft in front of sliding clutch splines.
4. Inspect propeller shaft splines for wear and/or corrosion damage.
5. Check propeller shaft for straightness.
   - Position propeller shaft roller bearing surfaces on V-blocks. Mount a dial indicator at front edge of propeller splines. Rotate propeller shaft. Dial indicator movement of more than 0.228 mm (0.009 in.), or a noticeable wobble, is reason for replacement.



a - Measuring point
b - Bearing surface

Dial Indicator	91- 58222A 1

6. Replace propeller shaft if any of the following exist:
   - Splines are twisted or worn.
   - Bearing surfaces of propeller shaft are pitted or worn.
   - Oil seal surface is grooved.
   - Shaft has a noticeable wobble or is bent more than 0.228 mm (0.009 in.). Propeller shaft trueness should be measured with a dial indicator with the propeller shaft on V-blocks.
7. Inspect sliding clutch jaws for damage. Jaws must not be chipped or rounded off. Replace the clutch if damaged. Rounded jaws indicate one or more of the following:
   - Improper shift cable adjustment.
   - Improper shift habits of operators. Shifting from neutral to reverse gear too slowly.
   - Engine idle speed too high while shifting.

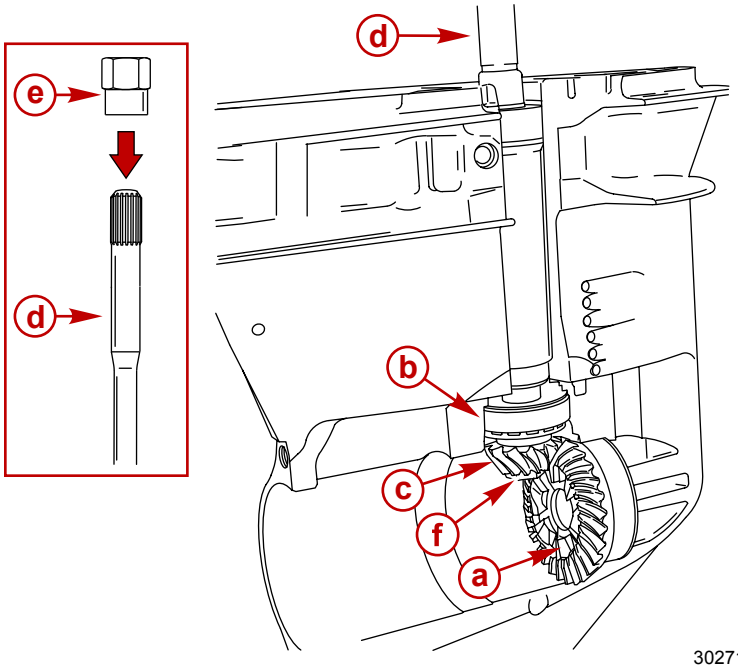


a - Clutch jaws

8. Check the cam follower for wear, pitting, scoring, or rough surface. If replacement is needed, replace cam follower and shift cam together.

Pinion Gear, Driveshaft, and Forward Gear Removal

1. Hold the driveshaft using the driveshaft holding tool. Remove and discard the pinion nut.
2. Remove the driveshaft, pinion gear, pinion bearing, and forward gear.
3. Replace the pinion gear if it is chipped or worn.
4. Replace the pinion bearing and race if either are rusted, pitted, or damaged; or if the bearing does not roll freely. To remove the race, refer to **Lower Driveshaft Bearing Race Removal.**
5. Replace the forward gear if the gear teeth or clutch teeth are chipped or worn.

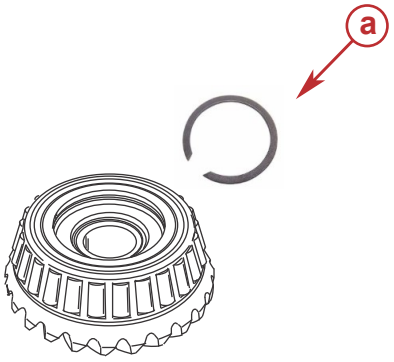


30271

- **a -** Forward gear/bearing
- **b -** Pinion bearing
- **c -** Pinion gear
- **d -** Driveshaft
- **e -** Driveshaft holding tool
- **f -** Pinion nut

Driveshaft Holding Tool	91-877840A 1

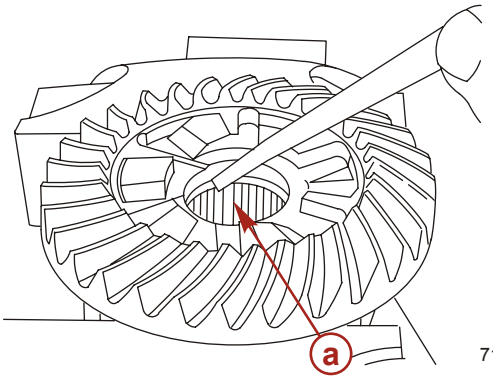
6. Replace the forward gear needle bearing if it is rusted or does not roll freely.
7. Use suitable tools to remove the retaining ring.



- **a -** Retaining ring

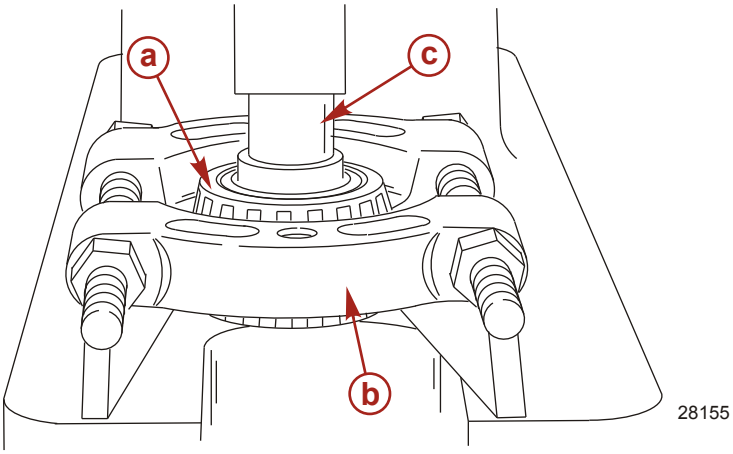
61938

8. Use a punch and hammer to remove the bearing.



a - Forward gear needle bearing

9. Replace the forward gear bearing and race if rusted, pitted, or damaged; or if the bearing does not roll freely. Remove the bearing from the gear using the universal puller plate and mandrel. To remove the race, refer to **Forward Gear Bearing Race Removal.**



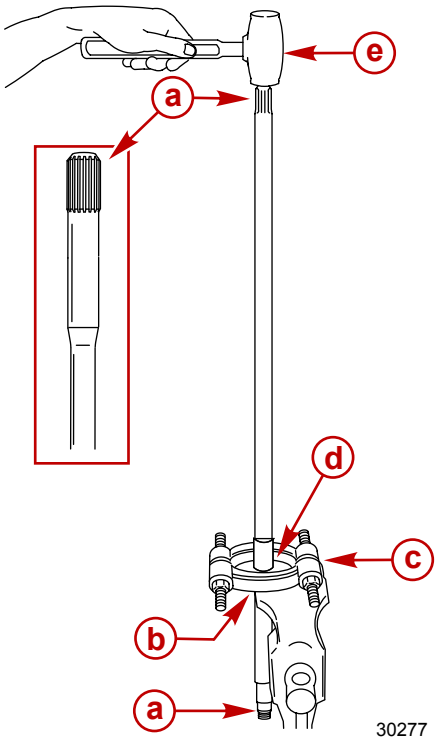
a - Forward gear bearing
b - Universal puller plate
c - Mandrel

Universal Puller Plate	91-37241
Bearing Removal and Installation Kit	91- 31229A 7

10. Replace the driveshaft if splines are worn or twisted.
11. If the bearing surface is damaged, replace the driveshaft and corresponding bearing.

IMPORTANT: Do not tighten the vise against the driveshaft.

12. If the wear sleeve is deeply grooved, allowing water to enter gearcase, remove and discard the sleeve using the universal puller plate and a mallet.



30277

a - Crankshaft/driveshaft splines
b - Bearing surface
c - Universal puller plate
d - Wear sleeve
e - Mallet

Universal Puller Plate	91-37241

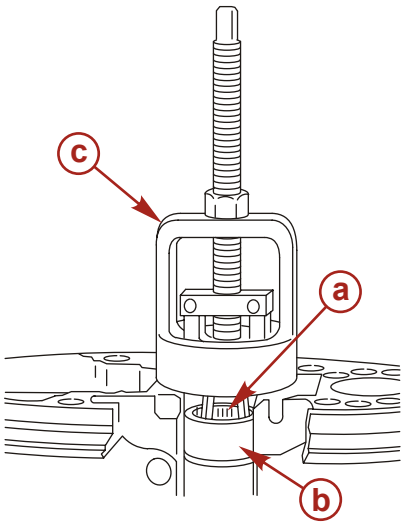
13. Remove and discard the rubber ring.

7200

a - Rubber ring

Upper Driveshaft Bearing Removal

1. Replace upper driveshaft bearing and sleeve if either are rust stained, or if bearing will not roll freely.
2. Remove bearing and then sleeve using puller assembly with suitable jaws.



7201

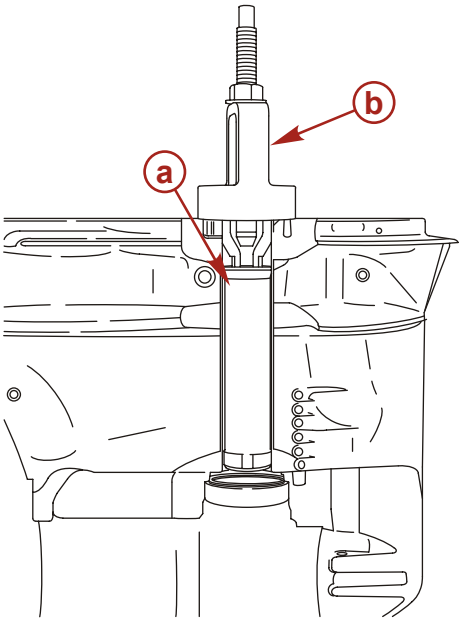
a - Upper driveshaft bearing
b - Sleeve
c - Puller assembly

Bearing Puller Assembly	91- 83165T

Oil Sleeve Removal

IMPORTANT: The upper driveshaft bearing and sleeve must be removed prior to oil sleeve removal. Refer to Upper Driveshaft Bearing Removal.

Remove oil sleeve, if necessary, using puller assembly with suitable jaws.



7202

- **a -** Oil sleeve
- **b -** Puller assembly

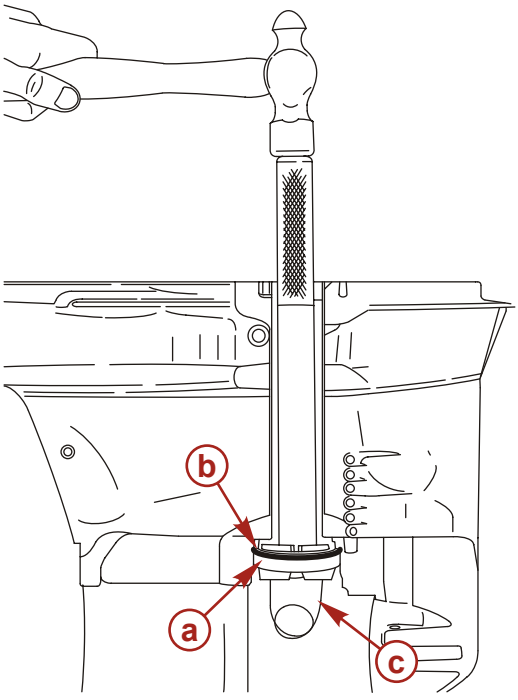
Bearing Puller Assembly	91- 83165T

Lower Driveshaft Bearing Race Removal

IMPORTANT: Upper driveshaft bearing/sleeve and oil sleeve do not have to be removed for lower driveshaft bearing race removal.

IMPORTANT: Retain shims for reassembly.

Remove race and shims using bearing race tool.



7203

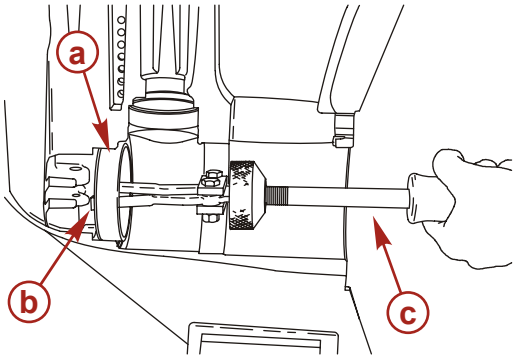
- **a -** Bearing race
- **b -** Shim
- **c -** Bearing race tool

Bearing Race Driver	91- 14308T02

Forward Gear Bearing Race Removal

IMPORTANT: Retain shims for reassembly. If shims are damaged, replace with new shims of equal thickness.

Remove race and shims using slide hammer.



7211

a - Race
b - Shims
c - Slide hammer

Slide Hammer	91-34569A 1

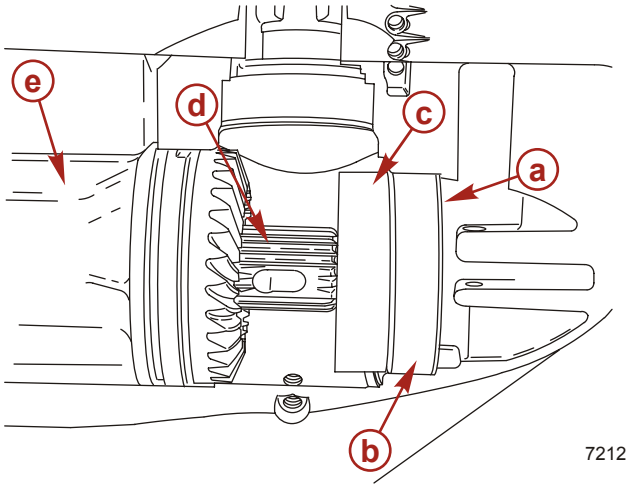
Gear Housing Assembly

Forward Gear Bearing Race Assembly

NOTE: *Propeller shaft should be vertical when installing bearing race.*

1. Place shims retained from disassembly into housing. If shims were lost, or a new gear housing is used for reassembly, start with 0.254 mm (0.010 in.) shim.
2. Assemble components, as shown, using bearing cup driver. Apply 2-4-C with PTFE to outside diameter of race. Drive race into housing by striking propeller shaft end with a dead blow hammer.

   NOTE: *Install a nut on the end of the propeller shaft to prevent damage to the threads while performing step 2.*



7212

a - Shims
b - Race
c - Bearing cup driver
d - Disassembled propeller shaft
e - Assembled bearing carrier

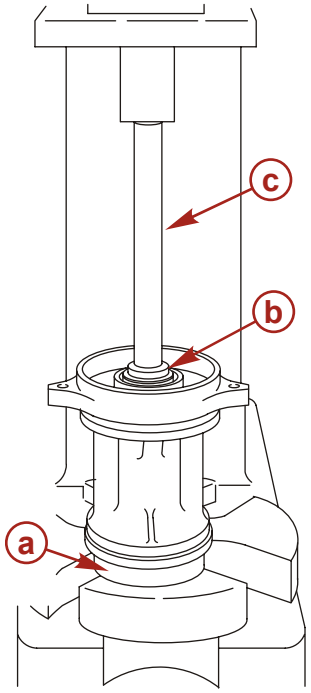
Bearing Cup Driver	91- 31106T

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Outside diameter of forward gear bearing race	92-802859A 1

Bearing Carrier Assembly

1. Lubricate outside diameter of bearing and bearing carrier bore with 2-4-C with PTFE.
2. Protect lip on forward side of bearing carrier, using bearing installation tool.

3. Press propeller shaft needle bearing, numbered side toward mandrel, into carrier until bearing bottoms out.



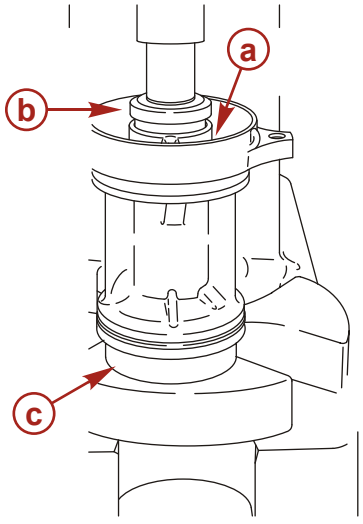
7224

a - Bearing installation tool
b - Mandrel
c - Driver rod

Bearing Installation Driver	91- 13945
Driver Rod	91- 37323

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Outside diameter of needle bearing and bearing carrier bore	92-802859A 1

4. Place smaller diameter seal on longer shoulder of oil seal driver with seal lip away from shoulder.
5. Protect lip on front side of bearing carrier using bearing installation driver. Apply Loctite 271 Threadlocker on the outside diameter of seal. Press seal into carrier until tool bottoms.



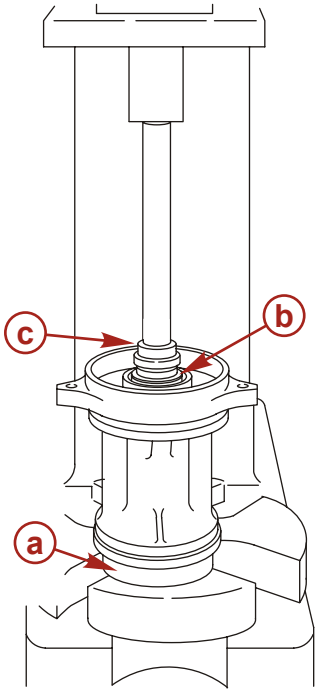
7225

a - Seal
b - Oil seal driver
c - Bearing installation driver

Oil Seal Driver	91- 31108T
Bearing Installation Driver	91- 13945

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Outside diameter of bearing carrier seal	92-809819

6. Place larger diameter seal on shorter shoulder of oil seal driver with seal lip toward shoulder.
7. Protect lip on front side of bearing carrier using bearing installation tool. Apply Loctite 271 Threadlocker on outside diameter of new seal. Press seal into carrier until tool bottoms.



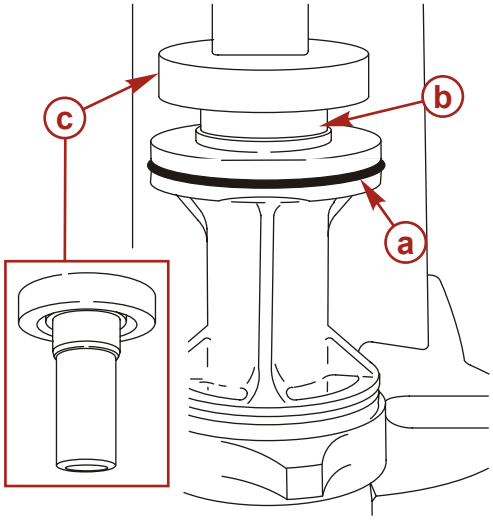
7228

a - Bearing installation tool
b - Seal
c - Oil seal driver

Oil Seal Driver	91- 31108T
Bearing Installation Driver	91- 13945

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Outside diameter of seal	92-809819

8. Install O-ring. Lubricate O-ring with 2-4-C with PTFE. Lubricate seal lips with 2-4-C with PTFE.
9. Lubricate outside diameter of reverse gear bearing and bearing carrier bore with a light coating of 2-4-C with PTFE.
10. Press bearing into carrier until tool bottoms.



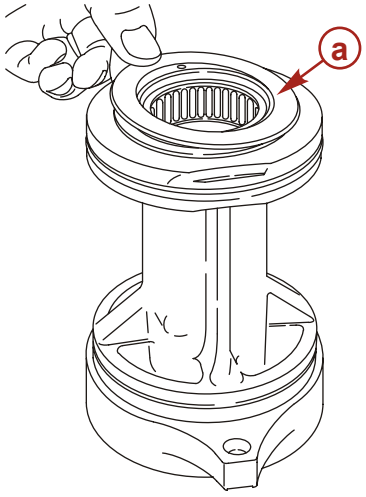
7230

a - O-ring
b - Bearing
c - Bearing installation tool

Bearing Installation Driver	91- 13945

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	O-ring and seal lips; outside diameter of reverse gear bearing and bearing carrier bore	92-802859A 1

11. Install thrust washer. Coat thrust washer with High Performance Gear Lubricant.

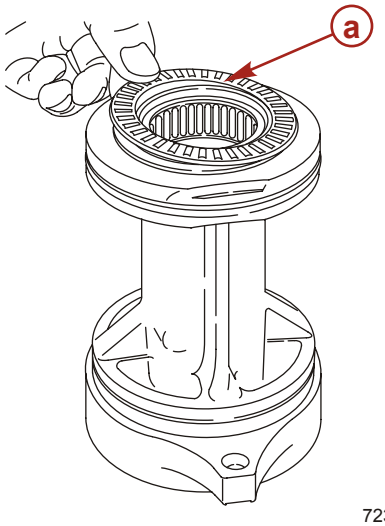


7232

a - Thrust washer

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Thrust washers	92-858064K01

12. Install thrust bearing. Coat thrust bearing with High Performance Gear Lubricant.

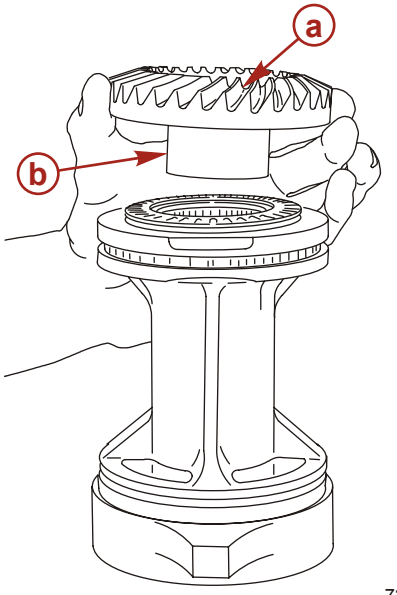


7233

a - Thrust bearing

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Thrust bearing	92-858064K01

13. Apply High Performance Gear Lubricant to bearing surface of reverse gear and install reverse gear.



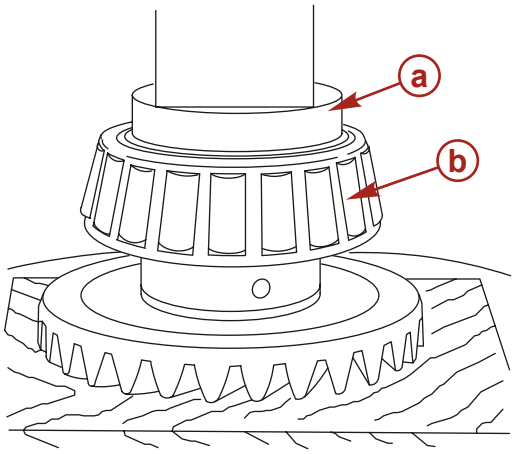
7234

a - Reverse gear
b - Bearing surface

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Reverse gear bearing surface	92-858064K01

Forward Gear Assembly

1. Apply 2-4-C with PTFE to the inside diameter of the bearing. Press bearing onto gear using suitable mandrel. Press only on inner race of bearing. The gear hub is longer than the bearing and you must use a tube type mandrel to install the bearing. This will allow the bearing to bottom out on the gear.



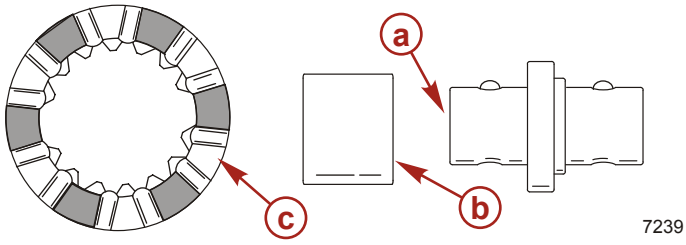
7235

a - Mandrel
b - Bearing

Pilot Mandrel	91- 37350T

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Inside diameter of bearing	92-802859A 1

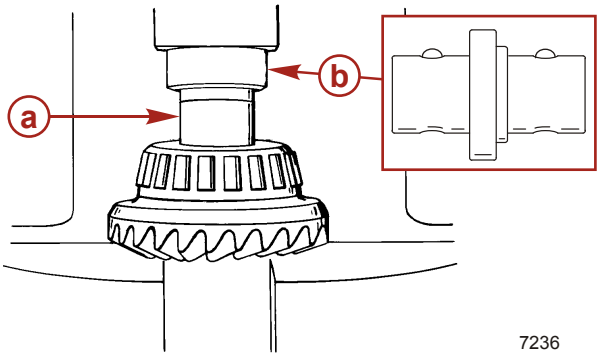
2. Replace the forward gear needle bearing with the forward gear bearing installer tool. The 6 jaw clutch requires the forward gear needle bearing be installed with the nonstepped side of the forward gear bearing installer tool.



a - Nonstepped side of tool
b - Numbered end of needle bearing
c - 6 jaw reverse clutch

Bearing Driver	91-856875A 1

3. Apply High Performance Gear Lubricant to inside diameter of forward gear and outside diameter of needle bearing. Press the needle bearing into the forward gear until the tool bottoms out on the gear.

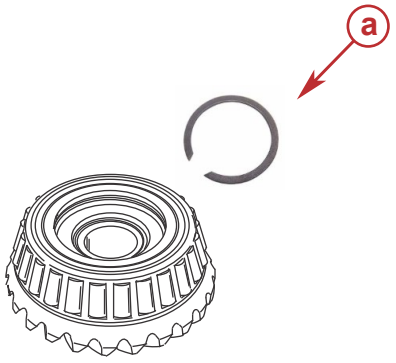


a - Needle bearing
b - Forward gear bearing installer

Bearing Driver	91-856875A 1

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Inside diameter of forward gear and outside diameter of needle bearing	92-858064K01

4. Install retaining ring into groove of forward gear by starting at one end of retaining ring and working it around until seated in groove.

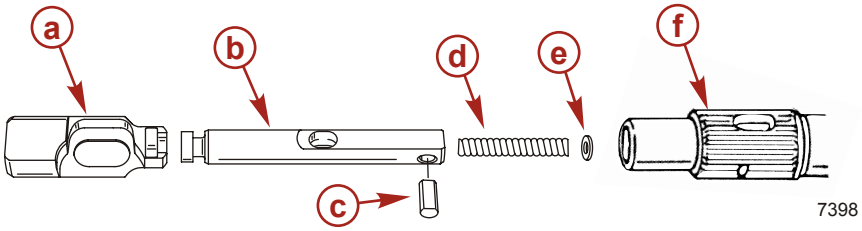


a - Retaining ring

Clutch Actuator Rod Assembly and Installation

1. Insert the spring, then the washer, into the clutch actuator rod.
2. Insert the spring locator pin with flat towards the spring.

3. Place a small amount of 2-4-C with PTFE on the actuator rod and install the cam follower.



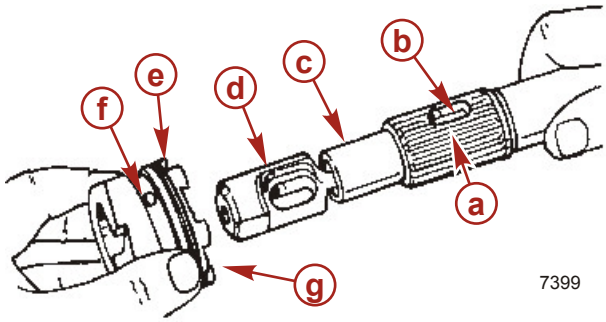
a - Cam follower
b - Clutch actuator rod
c - Spring locator pin
d - Spring
e - Washer
f - Propeller shaft

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Actuator rod	92-802859A 1

Propeller Shaft Assembly

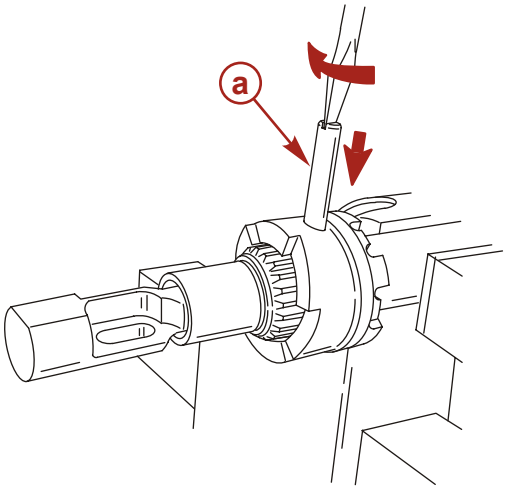
1. Insert the assembled clutch actuator rod/cam follower into the propeller shaft.
2. Position the sliding clutch onto the propeller shaft with the grooved ring (on sliding clutch) toward the propeller end of the propeller shaft. The cross pin hole in the sliding clutch must line up with the cross pin slot on the propeller shaft.

   NOTE: *When installing the clutch, make sure the angled ratcheting clutch teeth are toward the forward gear, and the non-ratcheting (square on both sides) are toward the reverse gear.*



a - Cross pin hole
b - Clutch actuator spring (not shown)
c - Propeller shaft
d - Cam follower
e - Grooved ring
f - Cross pin hole
g - Sliding clutch

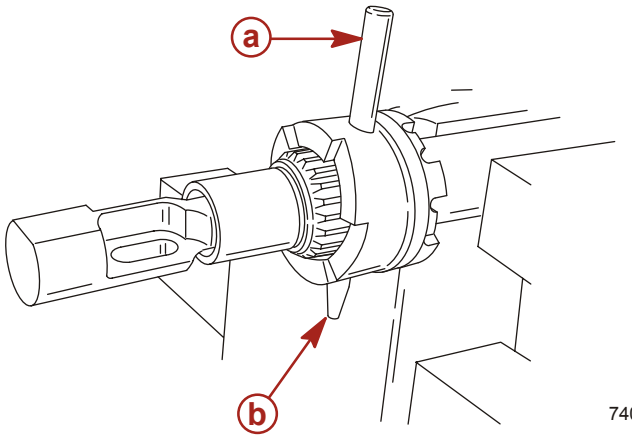
3. Lubricate the tapered end of the cross pin tool. Insert tapered end of tool into the clutch cross hole while pushing the clutch actuator spring towards the propeller end of the shaft. Using a screwdriver, rotate and push tool through the cross hole of the clutch.



a - Cross pin tool

Slotted Cross Pin Tool	91- 86642 1

4. Apply a small amount of 2-4-C with PTFE on the cross pin. Position the cross pin in the hole of the sliding clutch with the flat side of the pin toward the spring.



a - Cross pin
b - Cross pin tool

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Surface of cross pin	92-802859A 1

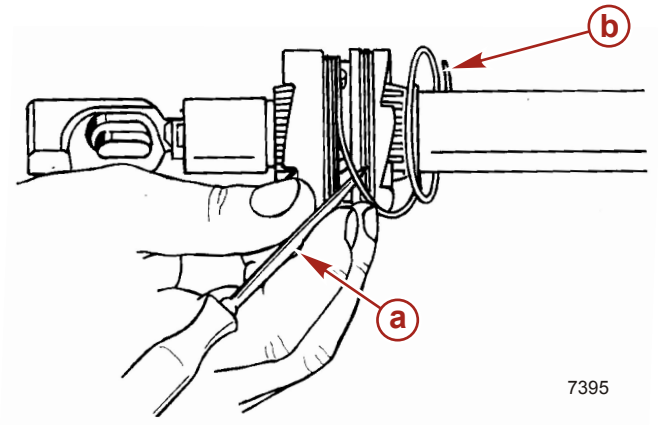
5. Push the cross pin through the sliding clutch, propeller shaft, and actuator rod, forcing the cross pin tool out.

   IMPORTANT: Applying side force to the propeller shaft before completely assembling the gear housing can damage the actuator rod. Install the bearing carrier before applying any side force to the propeller shaft.

6. Install the cross pin retaining spring onto the sliding clutch.

   IMPORTANT: Do not overstretch the retaining spring when installing onto the sliding clutch.

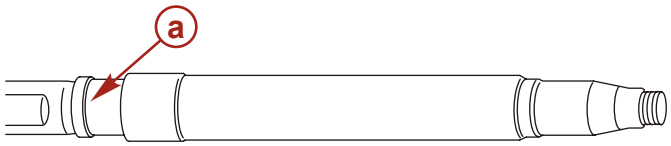
7. Spirally wrap the spring into the groove on the sliding clutch.
8. Verify that the spring coils do not overlap each other.



a - Awl
b - Cross pin spring

Driveshaft Wear Sleeve Installation

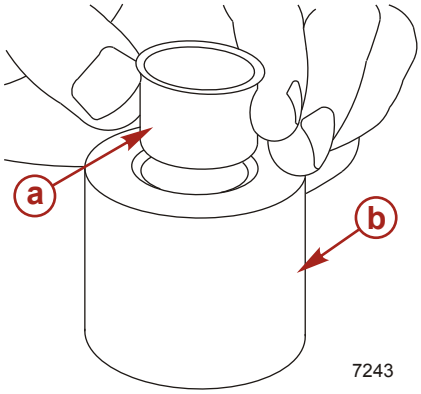
1. Install new rubber ring and apply a light coat of Loctite 271 Threadlocker on outside diameter.



a - Rubber ring

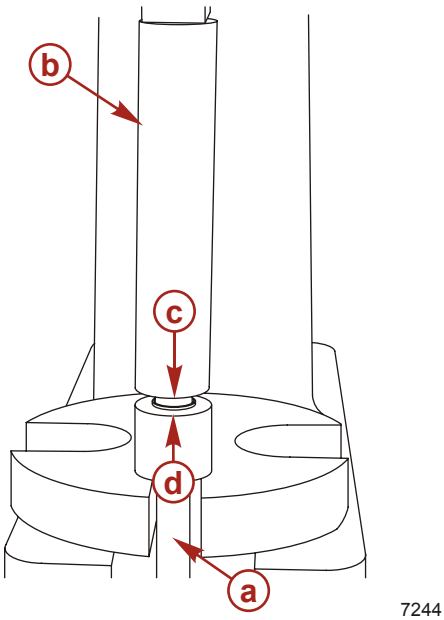
Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Outside diameter of driveshaft rubber ring	92-809819

2. Insert sleeve into holder.



a - Sleeve
b - Holder

3. Press sleeve onto driveshaft using wear sleeve installation tool. Continue pressing until the upper and lower part of the tool make surface to surface contact.



a - Driveshaft
b - Wear sleeve installation tool
c - Upper part of tool
d - Lower part of tool

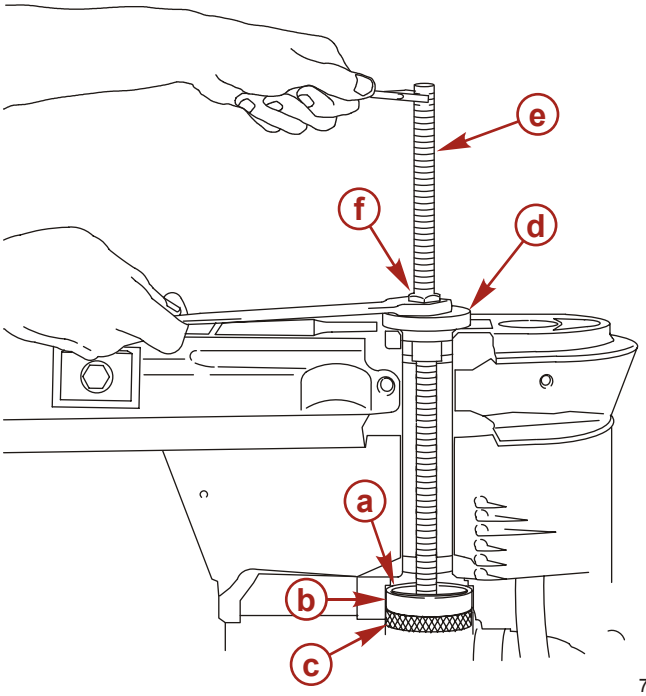
Wear Sleeve Driver	91- 14310T 1

4. Remove excess Loctite from assembled shaft.

Lower Driveshaft Bearing Race Installation

1. Lubricate outside diameter of bearing race with 2-4-C with PTFE.
2. Install shims and bearing race into housing. If shims were lost or a new gear housing is used during reassembly, start with 0.635 mm (0.025 in.) shims.

NOTE: *Verify shims are not displaced when drawing up race. Once shims and bearing cup are in place, position gear housing assembly so the driveshaft is vertical. This will aid in preventing the bearing cup from becoming misaligned in the bore.*



7246

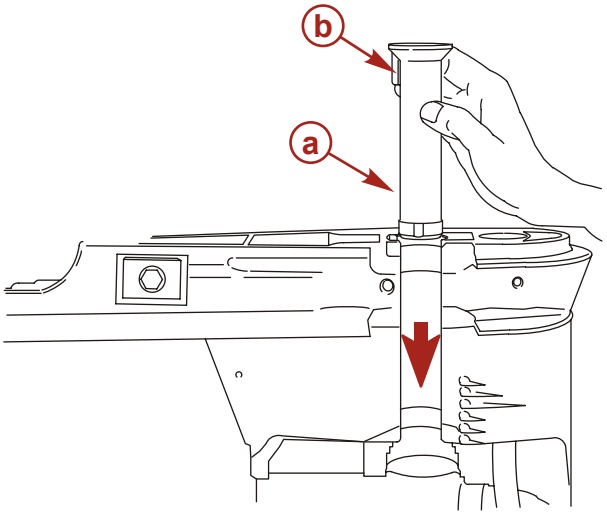
- **a -** Shims
- **b -** Bearing race
- **c -** Mandrel
- **d -** Mandrel
- **e -** Threaded rod
- **f -** Nut

Bearing Removal and Installation Kit	91- 31229A 7

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Outside diameter of bearing race	92-802859A 1

Oil Sleeve Installation

Install oil sleeve with tab positioned as shown.



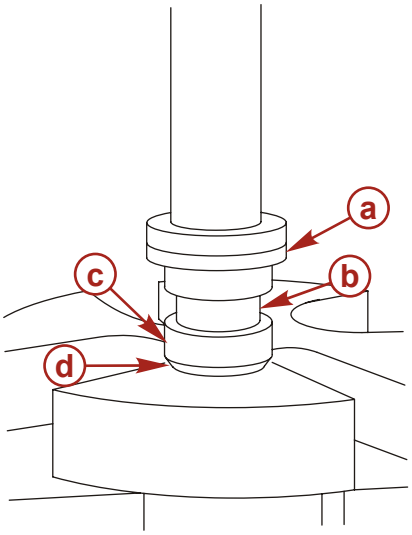
7263

- **a -** Oil sleeve
- **b -** Tab

Driveshaft Upper Bearing Installation

1. Lubricate inside diameter of bearing sleeve and outside diameter of bearing with 2-4-C with PTFE.

2. Press bearing into sleeve with a mandrel.



7264

- **a -** Mandrel
- **b -** Bearing
- **c -** Bearing sleeve
- **d -** Tapered end

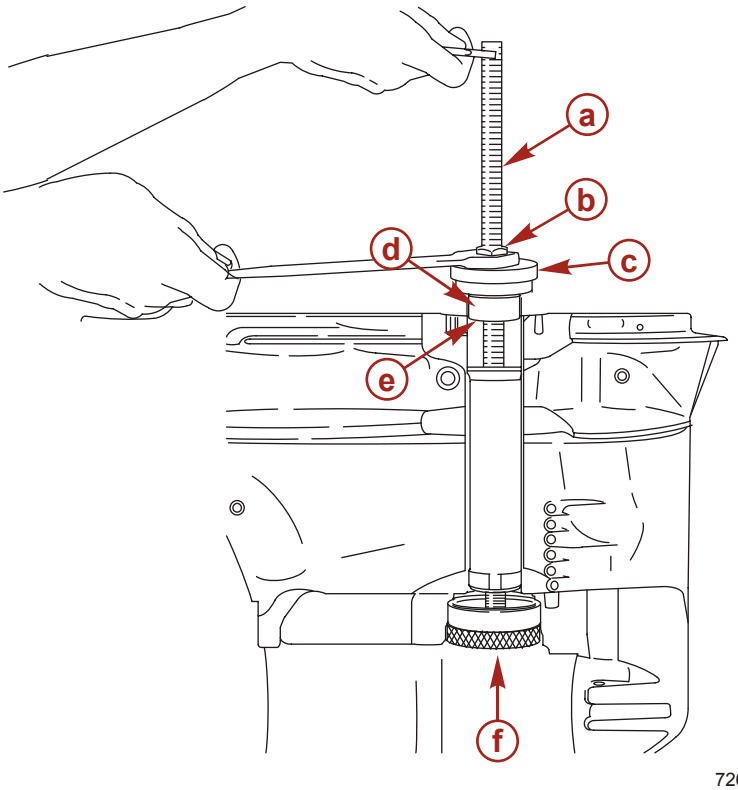
Bearing Installation Puller	91- 14309T02

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Inside diameter of bearing sleeve and outside diameter of upper driveshaft bearing	92-802859A 1

3. Install bearing/sleeve into housing.

IMPORTANT: Oil sleeve must be installed prior to upper driveshaft bearing installation.

IMPORTANT: Lower driveshaft bearing cup pilots the mandrel during installation of the upper driveshaft bearing/sleeve. Lower bearing cup must be installed prior to installing upper bearing/sleeve.



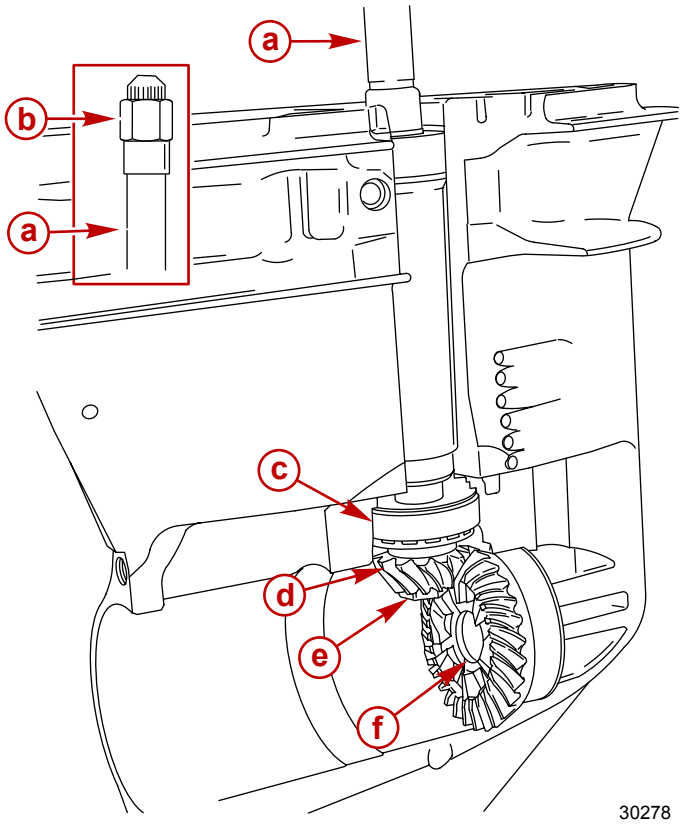
7268

- **a -** Threaded rod
- **b -** Nut
- **c -** Mandrel
- **d -** Bearing/sleeve
- **e -** Tapered end of sleeve
- **f -** Mandrel

Bearing Removal and Installation Kit	91- 31229A 7

Forward Gear, Driveshaft Lower Bearing, Pinion Gear, and Driveshaft Installation

1. Allow High Performance Gear Lubricant to penetrate into the bearing rollers. Install the forward gear bearing and lower driveshaft tapered roller bearing.
2. Clean the pinion nut and driveshaft threads with Loctite Primer or other suitable degreaser.
3. Install the pinion gear, driveshaft, and pinion nut.
4. Install the original pinion nut for checking the gear lash. After ensuring the pinion gear depth and forward gear backlash are within specification, remove the original pinion nut and apply Loctite 271 Threadlocker to the threads on the new pinion nut. Tighten the nut to the specified torque.



a - Driveshaft
b - Driveshaft holding tool
c - Lower driveshaft tapered roller bearing
d - Pinion gear
e - Pinion nut
f - Forward gear/bearing

Driveshaft Holding Tool	91-877840A 1

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Pinion nut threads	92-809819
87	High Performance Gear Lubricant	Forward gear roller bearing and lower driveshaft tapered roller bearing	92-858064K01
117	Loctite 7649 Primer N	Pinion nut threads and driveshaft threads	92-809824

Description	Nm	lb-in.	lb-ft
Pinion nut	95		70

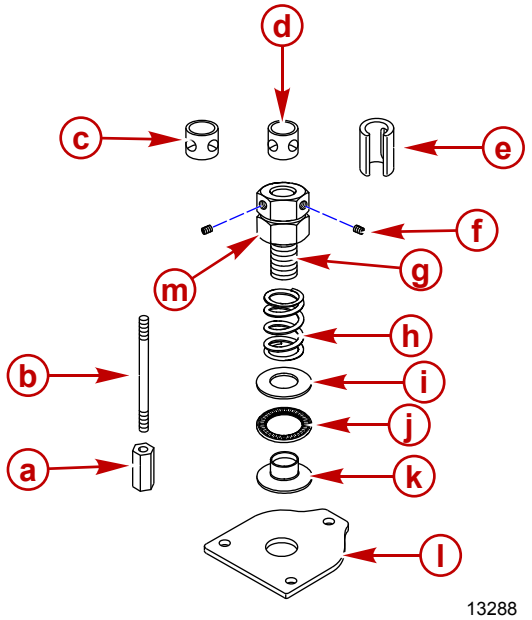
Pinion Gear Depth

IMPORTANT: The forward gear assembly pilots the end of the pinion gauge and must be installed in the gear housing when checking the pinion gear depth. Without it, an inaccurate measurement will be obtained.

NOTE: *Read the entire procedure before attempting any change in shim thickness.*

1. Clean the gear housing bearing carrier shoulder and diameter.

2. With the gear housing positioned with the driveshaft vertical, install the bearing preload tool with the 19 mm (3/4 in.) sleeve over driveshaft in the sequence shown. Align the holes in the sleeve with the set screws.

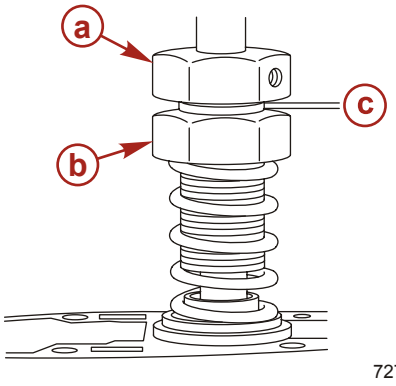


13288

- **a -** Coupler
- **b -** Threaded rod
- **c -** Sleeve - 22 mm (7/8 in.)
- **d -** Sleeve - 19 mm (3/4 in.)
- **e -** Split sleeve - 16 mm (5/8 in.)
- **f -** Set screw (2)
- **g -** Bolt
- **h -** Spring
- **i -** Thrust washer
- **j -** Thrust bearing
- **k -** Adapter
- **l -** Plate
- **m -** Nut

Bearing Preload Tool	91-14311A04

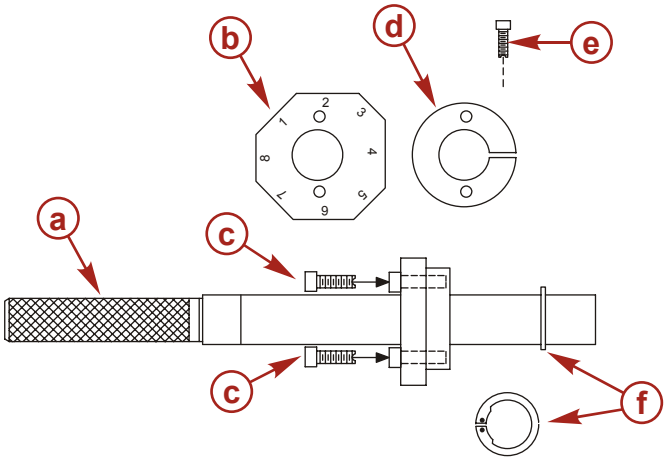
3. Measure the distance between the top of the nut and the bottom of the bolt head.
4. Increase this distance by 25.4 mm (1 in.).
5. Rotate the driveshaft 5–10 revolutions. This should properly seat the driveshaft tapered roller bearing.



7275

- **a -** Bolt head
- **b -** Nut
- **c -** 25.4 mm (1 in.)

6. Assemble the pinion gear locating tool as shown. Do not tighten the collar retaining screw at this time. Install the gauging block with the numbers away from the split collar.

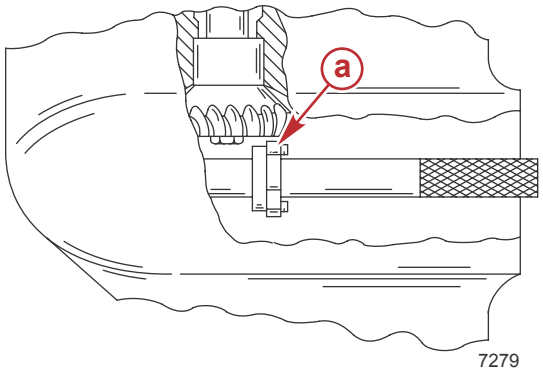


7277

- **a -** Arbor
- **b -** Gauging block
- **c -** Screw (2)
- **d -** Split collar
- **e -** Collar retaining screw
- **f -** Snap ring

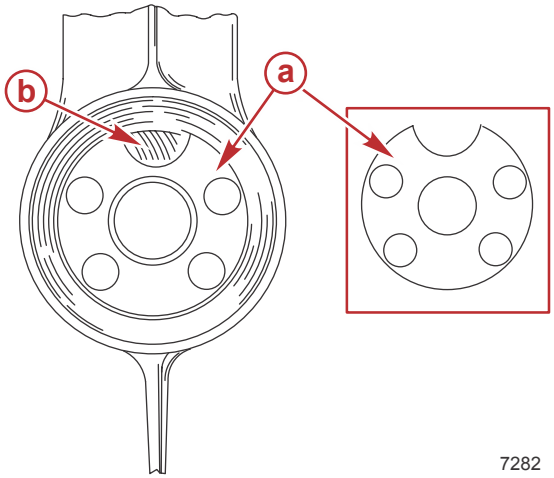
Pinion Gear Location Tool	91-8M0043678
Pinion Gear Locating Tool	91- 12349A05

7. Insert the tool into the forward gear assembly. Position the gauging block under the pinion gear, as shown.



a - Gauging block

8. Remove the tool, taking care not to change the gauging block position, and tighten the collar retaining screw.
9. Insert the tool into the forward gear assembly. Position flat #8 of the gauging block under the pinion gear.
10. Install locating disc #3 against the bearing carrier shoulder in the gear housing.
11. Position the access hole as shown.



a - Locating disc
b - Access hole

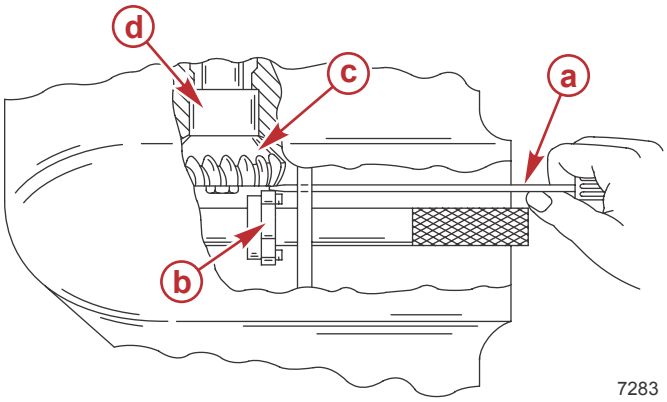
Gear Ratio (Pinion Gear Teeth/Reverse Gear Teeth)	Disc Number	Flat Number
2.33:1 (12/28)	3	8
2.31:1 (13/30)	3	8

12. Determine the pinion gear height by inserting a feeler gauge through the access hole in the locating disc.
13. The pinion gear height must be within the specification.

Pinion Gear Height Specification	
Gauging block clearance	0.64 mm (0.025 in.)

14. If the clearance is correct, leave the bearing preload tool on the driveshaft and proceed to **Forward Gear Backlash**, following.
15. If the clearance is more than 0.64 mm (0.025 in.), add shims behind the pinion bearing race. If the clearance is less than 0.64 mm (0.025 in.), remove shims from behind the pinion bearing race.

NOTE: *After the final adjustment to the pinion height and the forward gear backlash is established, clean the threads of the driveshaft and new pinion nut with Loctite 7649 Primer N and apply Loctite 271 Threadlocker. Tighten the pinion nut to the specified torque.*



7283

a - Feeler gauge
b - Gauging block
c - Pinion gear
d - Bearing race

Tube Ref No.	Description	Where Used	Part No.
117	Loctite 7649 Primer N	Clean pinion nut threads and driveshaft threads	92-809824
7	Loctite 271 Threadlocker	Pinion nut threads	92-809819

Description	Nm	lb-in.	lb-ft
Pinion nut	68		50

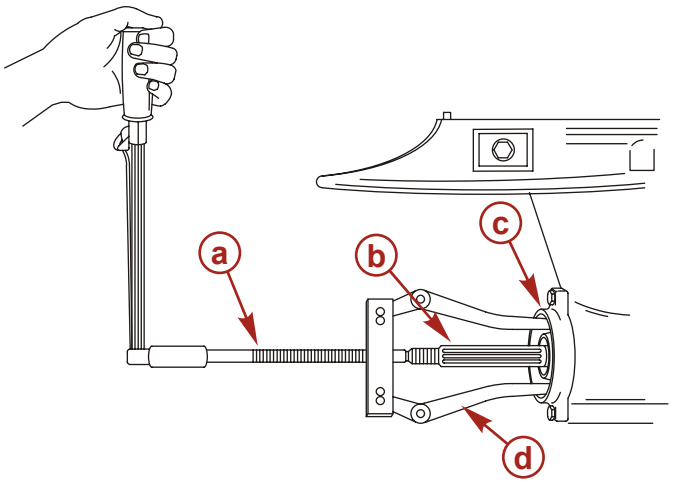
Forward Gear Backlash

NOTE: *Read the entire procedure before attempting any change in the shim thickness.*

1. Ensure you have correct pinion gear depth. Refer to **Pinion Gear Depth**, preceding.
2. Install the propeller shaft and propeller shaft bearing carrier. Tighten the propeller shaft bearing carrier bolts to the specified torque.

Description	Nm	lb-in.	lb-ft
Bearing carrier bolt	30		22

3. Install the puller jaws and puller bolt.
4. While holding the driveshaft to prevent it from turning, tighten the puller bolt to the specified torque.
5. With the gear shift in neutral, rotate the driveshaft 5–10 revolutions. This should properly seat the forward gear tapered roller bearing. Tighten the puller bolt to the specified torque.



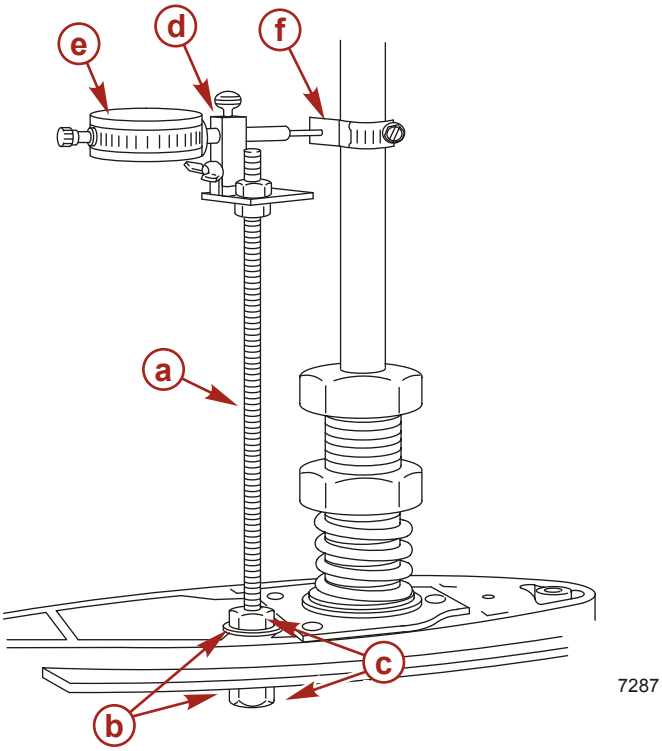
7286

a - Puller bolt
b - Propeller shaft
c - Bearing carrier
d - Puller jaws

Puller Jaws Assembly	91-46086A1

Description	Nm	lb-in.	lb-ft
Puller bolt	5.1	45	

6. Install the preload tool on the driveshaft.
7. Install the components, as shown.



- **a -** Threaded rod (obtain locally)
- **b -** Washer (2)
- **c -** Nut (2)
- **d -** Dial indicator adapter kit
- **e -** Dial indicator
- **f -** Backlash indicator tool

Dial Indicator	91- 58222A 1
Dial Indicator Adapter	91-83155
Backlash Indicator	91- 19660 1

8. Align the dial indicator to the #4 marked on the backlash indicator tool.

   NOTE: *The dial indicator must be perpendicular to the backlash indicator tool to obtain an accurate reading.*
9. Lightly rotate the driveshaft back and forth. No movement should be noticed at the propeller shaft.
10. The dial indicator measures backlash.

Forward Gear Backlash	
Forward gear backlash	0.30–0.48 mm (0.012–0.019 in.)

11. If backlash is less than the minimum specification, remove shims from in front of forward gear bearing race. If backlash is more than the maximum specification, add shims in front of forward gear bearing race.

    NOTE: *By adding or subtracting 0.050 mm (0.002 in.) shim, the backlash will change approximately 0.025 mm (0.001 in.).*
12. After the final adjustment to the pinion height and the forward gear backlash is established, clean the threads of the driveshaft and new pinion nut with Loctite 7649 Primer N and apply Loctite 271 Threadlocker. Tighten the pinion nut to the specified torque.

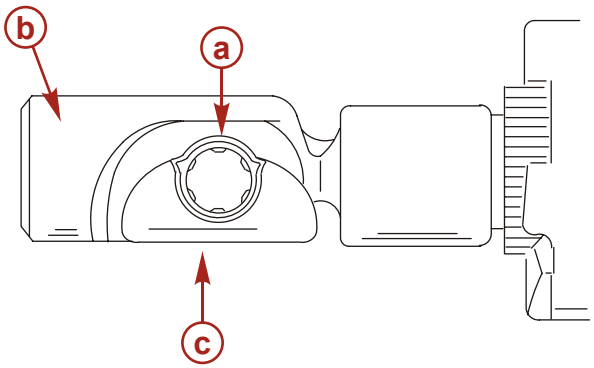
Tube Ref No.	Description	Where Used	Part No.
117	Loctite 7649 Primer N	Driveshaft and pinion nut threads	92-809824
7	Loctite 271 Threadlocker	Pinion nut threads	92-809819

Description	Nm	lb-in.	lb-ft
Pinion nut	68		50

Bearing Carrier and Propeller Shaft Installation

1. Place gear housing in a soft jaw vise with the driveshaft in a vertical position.
2. Coat cam pocket of cam follower with 2-4-C with PTFE.

3. Place shift cam into cam pocket of cam follower.

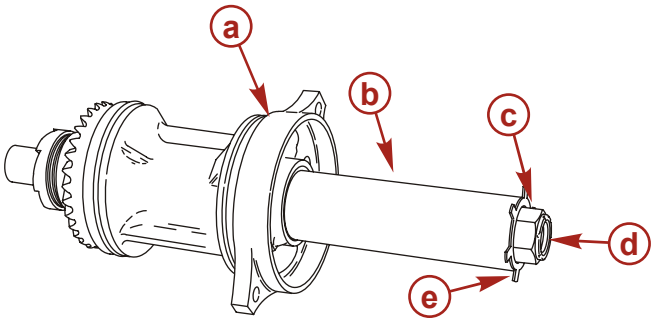


7402

a - Cam pocket
b - Cam follower
c - Shift cam

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Cam pocket of cam follower	92-802859A 1

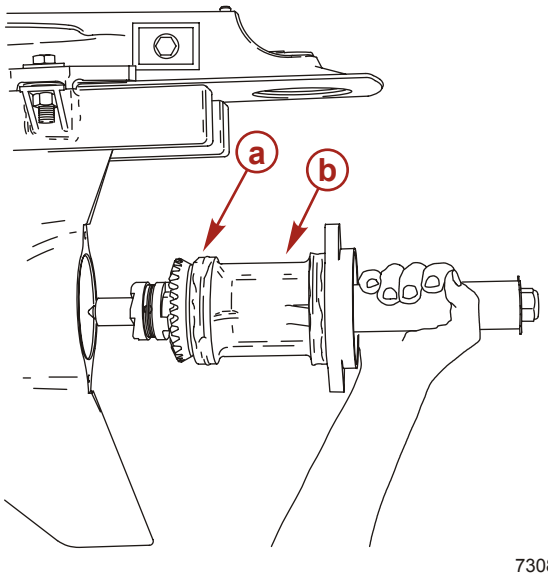
4. Insert propeller shaft assembly into bearing carrier.
5. Before installing bearing carrier assembly into gear housing, obtain a 152 mm (6 in.) long by 32–38 mm (1-1/4–1-1/2 in.) diameter piece of PVC pipe. Install the PVC pipe over the propeller shaft and secure the pipe against the bearing carrier assembly with the propeller nut and tab washer. This holds the reverse gear and thrust bearing tight against the bearing carrier preventing possible bearing damage during installation.



7289

a - Bearing carrier assembly
b - PVC pipe
c - Propeller nut
d - Propeller shaft
e - Tab washer

6. Lubricate O-ring, bearing carrier, and gear housing mating surfaces with 2-4-C with PTFE.
7. Install bearing carrier and propeller shaft into housing with the word "TOP" (located on flange) toward top of housing.

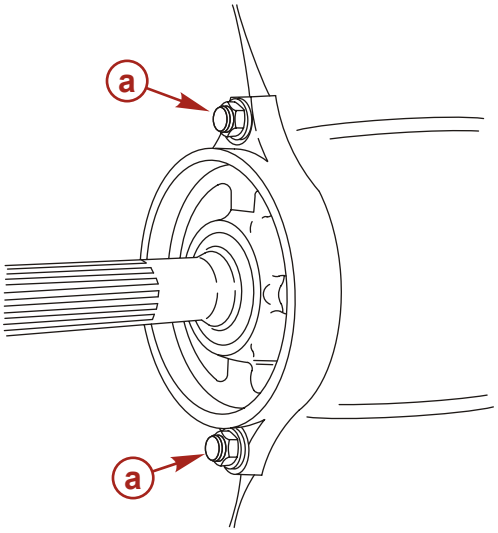


7308

a - O-ring
b - "TOP"

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	O-ring, bearing carrier, and gear housing mating surfaces	92-802859A 1

8. Secure bearing carrier with fasteners. Apply Loctite 271 Threadlocker on threads and torque to specification.
   NOTE: *Use thick 2.29 mm (0.090 in.) washers (12-855941) under fasteners if not previously installed.*



7175

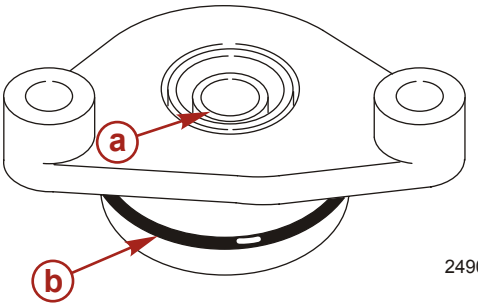
a - Fasteners

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Fastener threads	92-809819

Description	Nm	lb-in.	lb-ft
Fastener - washer thickness 2.29 mm (0.09 in.)	30		22
Fastener - washer thickness 1.52 mm (0.06 in.)	34		25

Shift Shaft Assembly

1. Apply Loctite 271 Threadlocker on the outside diameter of the shift shaft seal.
2. Using a suitable mandrel, press the seal into the shift shaft bushing until the seal is seated against the shoulder.
3. Install an O-ring onto the shift shaft bushing.
4. Apply 2-4-C with PTFE on the O-ring and the inside diameter of the shift shaft seal.

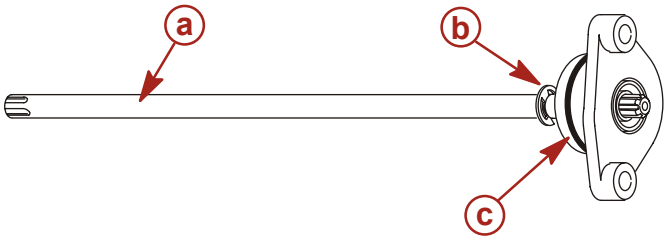


24900

a - Seal
b - O-ring

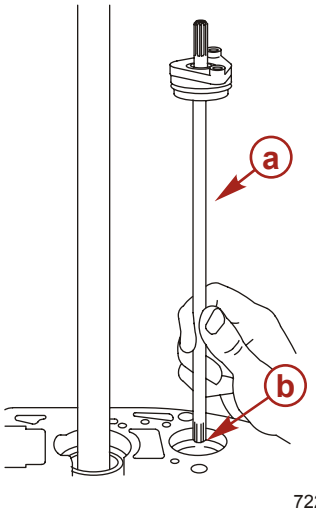
Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Outside diameter of shift shaft bushing seal	92-809819
95	2-4-C with PTFE	Inside diameter of shift shaft bushing seal; shift shaft O-ring	92-802859A 1

5. Assemble the components, as shown.



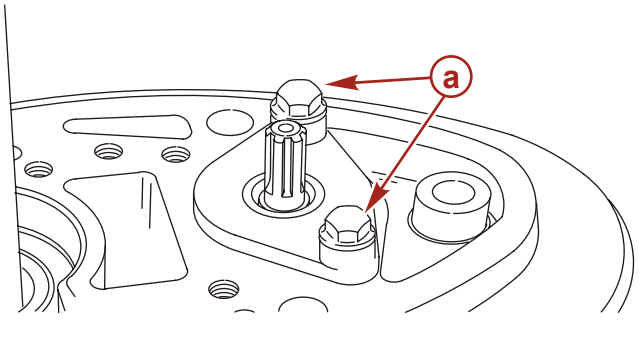
a - Shift shaft
b - E-clip
c - Shift shaft bushing

6. Install the shift shaft assembly. Insert the splines into the shift cam.



a - Shift shaft assembly
b - Splines

7. Apply Loctite 271 Threadlocker to the bottom half of the threads on each screw. Install the retaining screws and tighten to the specified torque.



a - Screw (M6 x 25) (2)

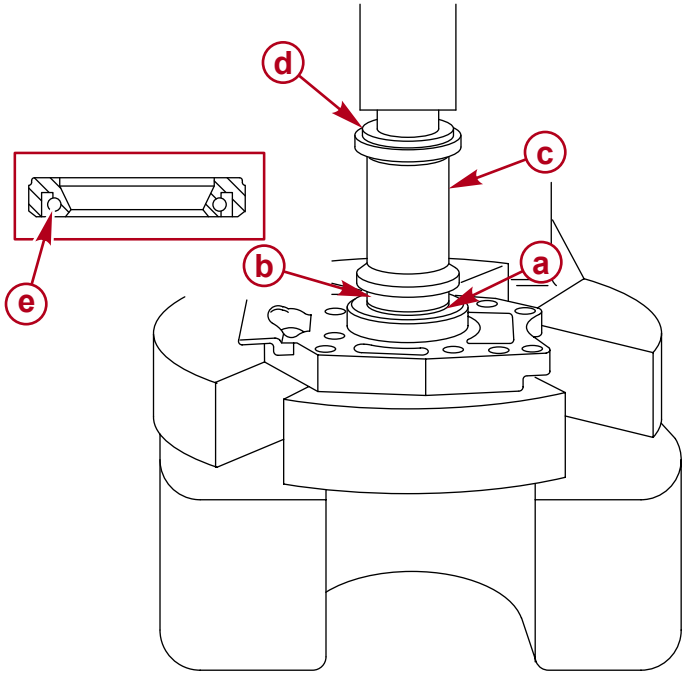
Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Bottom half of shift shaft bushing screw threads	92-809819

Description	Nm	lb-in.	lb-ft
Screw (M6 x 25) (2)	7	62	

Water Pump Assembly and Installation

1. Place the water pump base upper seal on the long shoulder side of the oil seal driver with the seal lip away from the shoulder.

2. Apply Loctite 271 Threadlocker on the outside diameter of the seal. Press the seal into the water pump base until the tool bottoms.



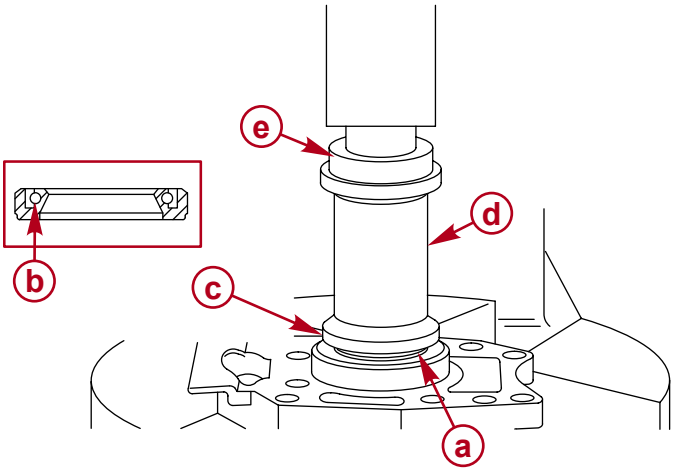
7313

- **a -** Upper seal
- **b -** Long shoulder side of driver
- **c -** Oil seal driver
- **d -** Short shoulder side of driver
- **e -** Spring

Oil Seal Driver	91- 13949

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Outside diameter of water pump upper seal	92-809819

3. Place the water pump base lower seal on the short shoulder side of the oil seal driver with the seal lip toward the shoulder.
4. Apply Loctite 271 Threadlocker on the outside diameter of the seal. Press the seal into the water pump base until the tool bottoms.
5. Lubricate the lip of each seal with 2-4-C with PTFE.



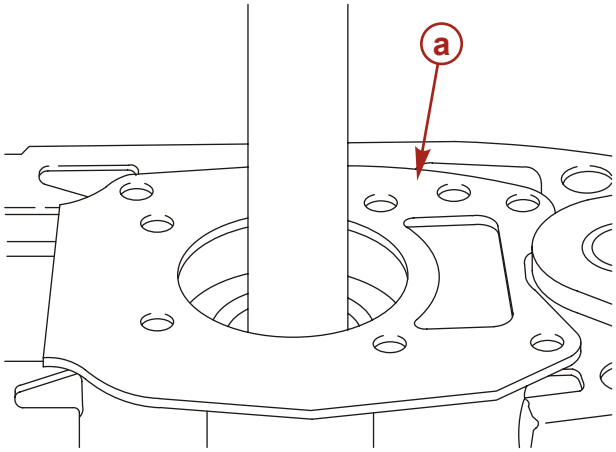
7315

- **a -** Lower seal
- **b -** Spring
- **c -** Short shoulder side of driver
- **d -** Oil seal driver
- **e -** Long shoulder side of driver

Oil Seal Driver	91- 13949

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Outside diameter of lower water pump seal	92-809819
95	2-4-C with PTFE	Lip of each seal	92-802859A 1

6. Install the gasket.

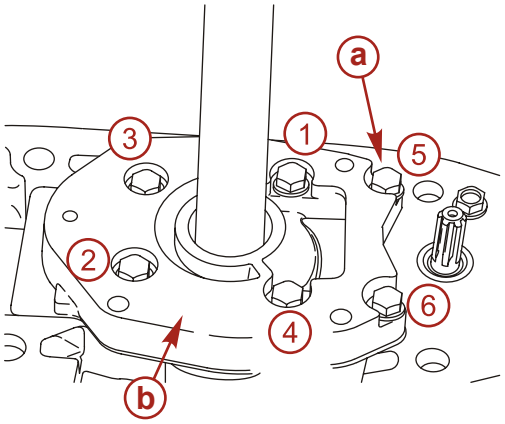


7174

a - Gasket

IMPORTANT: To prevent seal lip damage, remove any burrs or sharp edges from the driveshaft splines before installing the water pump base assembly.

7. Install the water pump base and secure with six screws. Apply Loctite 271 Threadlocker on the bottom half of the threads. Tighten, in sequence shown, to the specified torque.



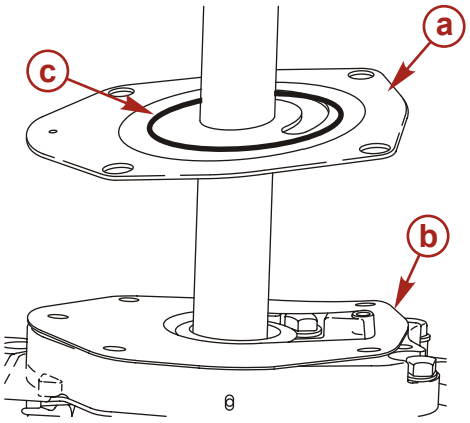
7320

a - Screw (M6 x 25) (6)
b - Water pump base

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Bottom half of water pump base screw threads	92-809819

Description	Nm	lb-in.	lb-ft
Screw (M6 x 25) (6)	7	62	

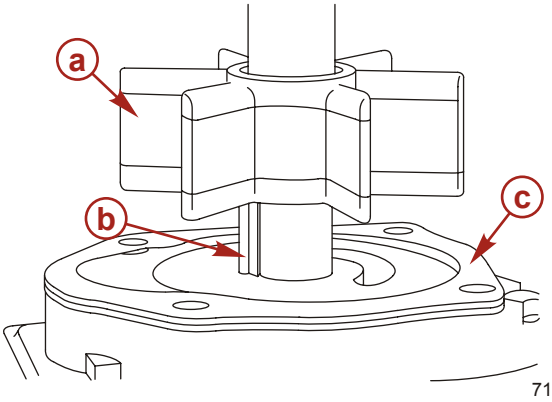
8. Install the gasket and plate.



7165

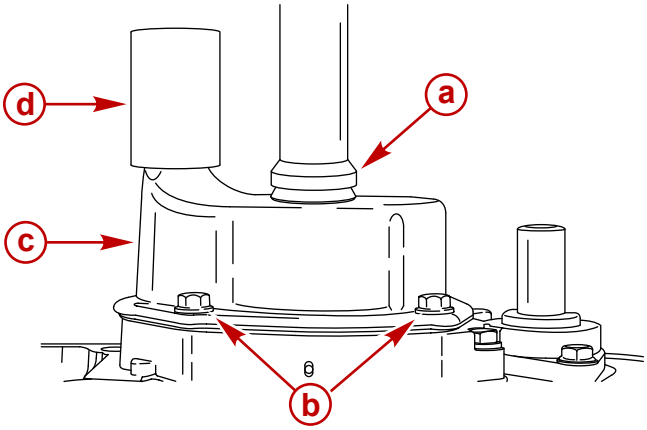
a - Plate
b - Gasket
c - Impeller sealing bead groove

9. Install the gasket, drive key, and impeller.



a - Impeller
b - Drive key
c - Gasket

10. Lubricate the inside diameter of the cover with 2-4-C with PTFE.
11. Rotate the driveshaft clockwise and push the impeller housing down and over the impeller until it contacts the water pump base.
12. Apply Loctite 271 Threadlocker to the bottom threads of the cover screws. Install the cover screws and tighten to the specified torque.
13. Install the face seal onto the water pump cover at a height of 8.00–8.13 mm (0.315–0.320 in.).



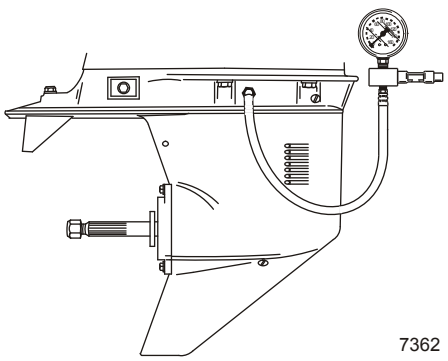
a - Face seal
b - Screw (M6 x 30) (4)
c - Cover
d - Water tube seal

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Inside diameter of water pump cover	92-802859A 1
7	Loctite 271 Threadlocker	Bottom of water pump cover bolt threads	92-809819

Description	Nm	lb-in.	lb-ft
Screw (M6 x 30)	7	62	

Gear Housing Pressure Test

1. Remove the vent plug and install the pressure test gauge.



2. Pressurize the housing and observe the gauge for fifteen minutes.
3. Rotate the driveshaft, propeller shaft, and shift shaft while the housing is pressurized to check for leaks.
4. If pressure drop is noted, immerse the housing in water.
5. Repressurize and check for air bubbles.
6. Replace the leaking seals, as necessary. Retest the housing after seal replacement.

Gear Housing Test Pressure	
Applied air pressure	69–83 kPa (10–12 psi)
Length of time	15 minutes

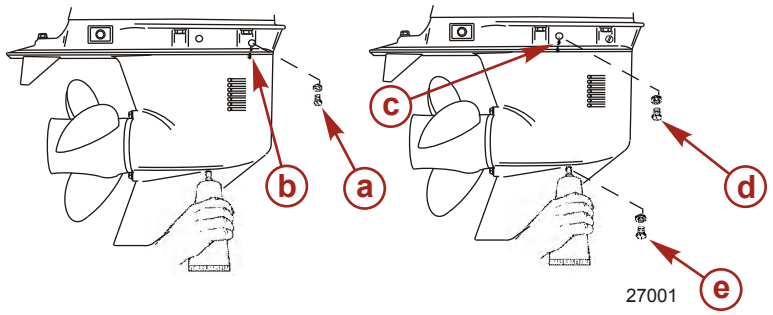
7. Remove the tester from the housing and install the vent plug and sealing washer.

Filling Gear Housing with Lubricant

IMPORTANT: Do not use automotive gear lubricant in the gear housing. Use only High Performance Gear Lubricant.

1. Remove any gasket material from the fill and vent screws and the housing.
2. Install a new sealing washer on the fill and vent screws.

   IMPORTANT: Never apply lubricant to the gear housing without first removing the vent screw, or the gear housing cannot be filled because of trapped air. Fill the gear housing only when the housing is in a vertical position.
3. Slowly fill the housing through the fill hole until the lubricant flows out of one vent hole.
4. Reinstall this vent screw and sealing washer only and continue filling until excess starts to flow out of the second vent hole.
5. Rotate the driveshaft clockwise approximately 10 revolutions. Let the gear housing sit for at least one minute to allow any trapped air to settle out, then top off the lubricant.
6. Replace the second vent screw and sealing washer.
7. Remove the gear lubricant tube from the fill hole and quickly install the fill/drain screw and sealing washer.



a - First vent screw
b - First vent hole
c - Second vent hole
d - Second vent screw
e - Fill/drain screw

IMPORTANT: Do not lose more than 30 cc (1 oz) of gear lubricant while reinstalling the fill/drain screw.

Tube Ref No.	Description	Where Used	Part No.
87	High Performance Gear Lubricant	Gear housing	92-858064K01

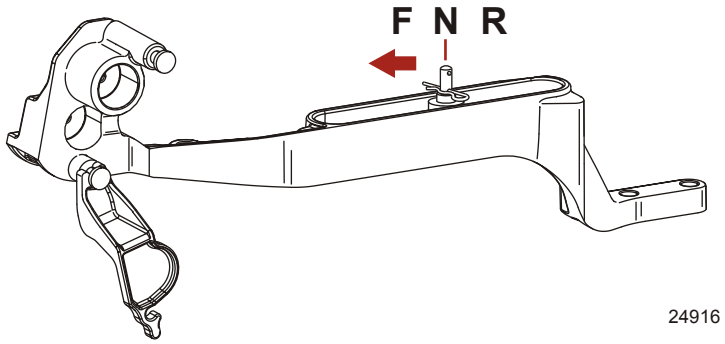
Description	Nm	lb-in.	lb-ft
Vent screw	6.8	60	

Gear Housing Installation

⚠ WARNING

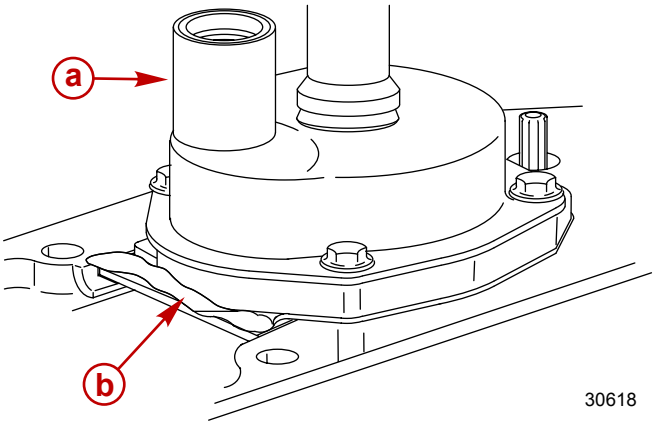
Accidental starting can cause serious injury. Before removing or installing the gear housing, disconnect and isolate the spark plug leads. Disable the ignition system by removing the keys from the ignition (if equipped) and engaging the lanyard stop switch to prevent the engine from starting.

1. Position the outboard shift linkage into the forward gear position.



2. Tilt the engine to the full up position and engage the tilt lock lever.
3. Install the water tube seal. Apply 2-4-C with PTFE to the inside diameter of the seal.
4. Apply a bead of RTV 587 Silicone Sealer to the water pump exhaust dam, as shown.

   NOTE: *For ease of gear housing installation, install the water tube seal labyrinth end onto the water tube in the driveshaft housing. The tapered end of the water tube seal goes onto the water pump.*



a - Water tube seal
b - RTV 587 Silicone Sealer

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Water tube seal inner diameter	92-802859A 1
116	RTV 587 Ultra Blue Silicone Sealer	Water pump exhaust dam	92-809825

NOTICE

Installing the gear housing to the powerhead without adequately cleaning the top of the driveshaft can result in severe product damage. Any lubricant trapped in the space between the driveshaft and the crankshaft prevent the two from properly engaging. Always clean the top of the driveshaft before installing the gear housing.

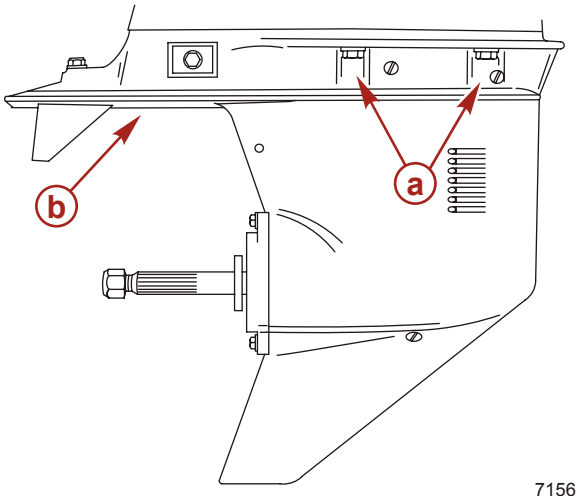
5. Apply a light coat of 2-4-C with PTFE to the driveshaft splines.
6. Apply a light coat of 2-4-C with PTFE to the gear housing shift shaft splines and the upper shift shaft splines. Do not apply lubricant to the ends of the shift shafts.

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Driveshaft splines and shift shaft splines	92-802859A 1

7. Shift the gear housing into the forward gear position. In forward gear the gear housing will ratchet when the propeller shaft is turned clockwise. Resistance will be felt when the propeller shaft is rotated counterclockwise.

   NOTE: *During installation of the gear housing, it may be necessary to move the shift block located under the cowl slightly to align the upper shift shaft splines with the shift shaft coupler splines.*
8. Apply Loctite 271 Threadlocker to the threads of the gear housing retaining bolts.
9. Position the gear housing so that the driveshaft is protruding into the driveshaft housing.
10. Move the gear housing up toward the driveshaft housing while aligning the upper shift shaft splines with the shift shaft coupler splines, the water tube with the water tube seal, and the crankshaft splines with the driveshaft splines.

11. Install four fasteners and washers (two each side). Install the locknut and washer.
12. Tighten the bolts and locknut (or nuts only if applicable) to the specified torque.



7156

a - Fasteners
b - Locknut and washer (recessed)

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Threads of gear housing retaining bolts	92-809819

Description	Nm	lb-in.	lb-ft
Bolt or nut	54		40

13. Check the shift operation as follows:
    - Place the shift lever in forward gear. The gear housing should ratchet when the propeller shaft is turned clockwise. Resistance should be felt when the propeller shaft is turned counterclockwise.
    - Place the shift lever into neutral. The propeller shaft should rotate freely in either direction.
    - While rotating the propeller shaft, place the shift lever into reverse gear. Resistance should be felt when the propeller shaft is rotated in either direction.

IMPORTANT: If the shift operation is not as described above, the gear housing must be removed and the cause of the problem corrected.

Trim Tab Adjustment and Replacement

IMPORTANT: The trim tab is now painted and does not aid in protecting the driveshaft housing and gear housing from galvanic corrosion and pitting of metal surfaces. Side anodes now provide protection. Do not paint or place protective coating on the side anodes, or corrosion protection function will be lost.

Replacement

Replace the trim tab if damaged. Mark the location of the old trim tab on the anti-ventilation plate before removal. Install the new trim tab in the same location.

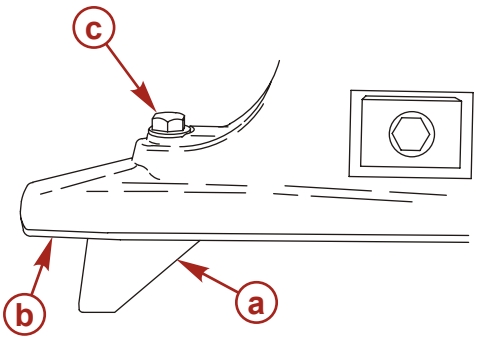
Adjustment

NOTE: *The trim tab provides a means to offset balance some of the steering load that is caused by propeller torque at higher operating speeds.*

NOTE: *Loosen the trim tab bolt sufficiently to allow the trim tab to disengage from the locking ridges in the gear housing before attempting to move the tab. Do not strike the trim tab with a hard object to make adjustments.*

1. Shift the engine control into neutral and turn the ignition key switch to the "OFF" position.
2. If at higher speeds the boat turns more easily to the left, loosen the screw and move the trim tab trailing edge to the left when viewed from behind. Tighten the retaining screw to the specified torque.

3. If the boat turns more easily to the right, loosen the screw and move the trim tab trailing edge to the right when viewed from behind. Tighten the trim tab retaining screw to the specified torque.



7383

a - Trim tab
b - Anti-ventilation plate
c - Retaining screw and washer

Description	Nm	lb-in.	lb-ft
Trim tab retaining screw	30		22

Notes:

Attachments/Control Linkage

Section 7A - Throttle/Shift Linkage

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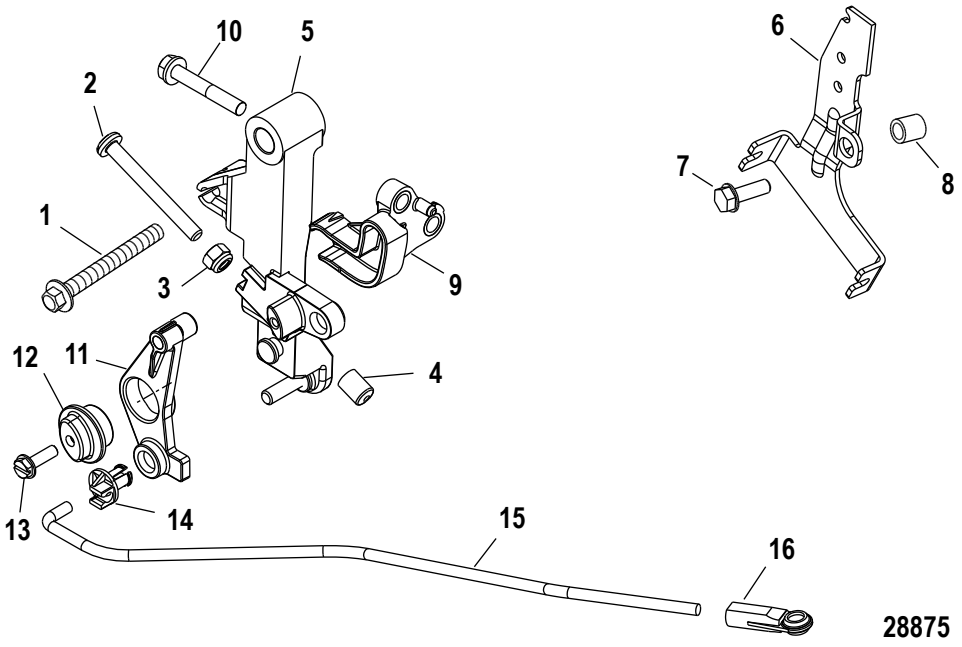
7
A

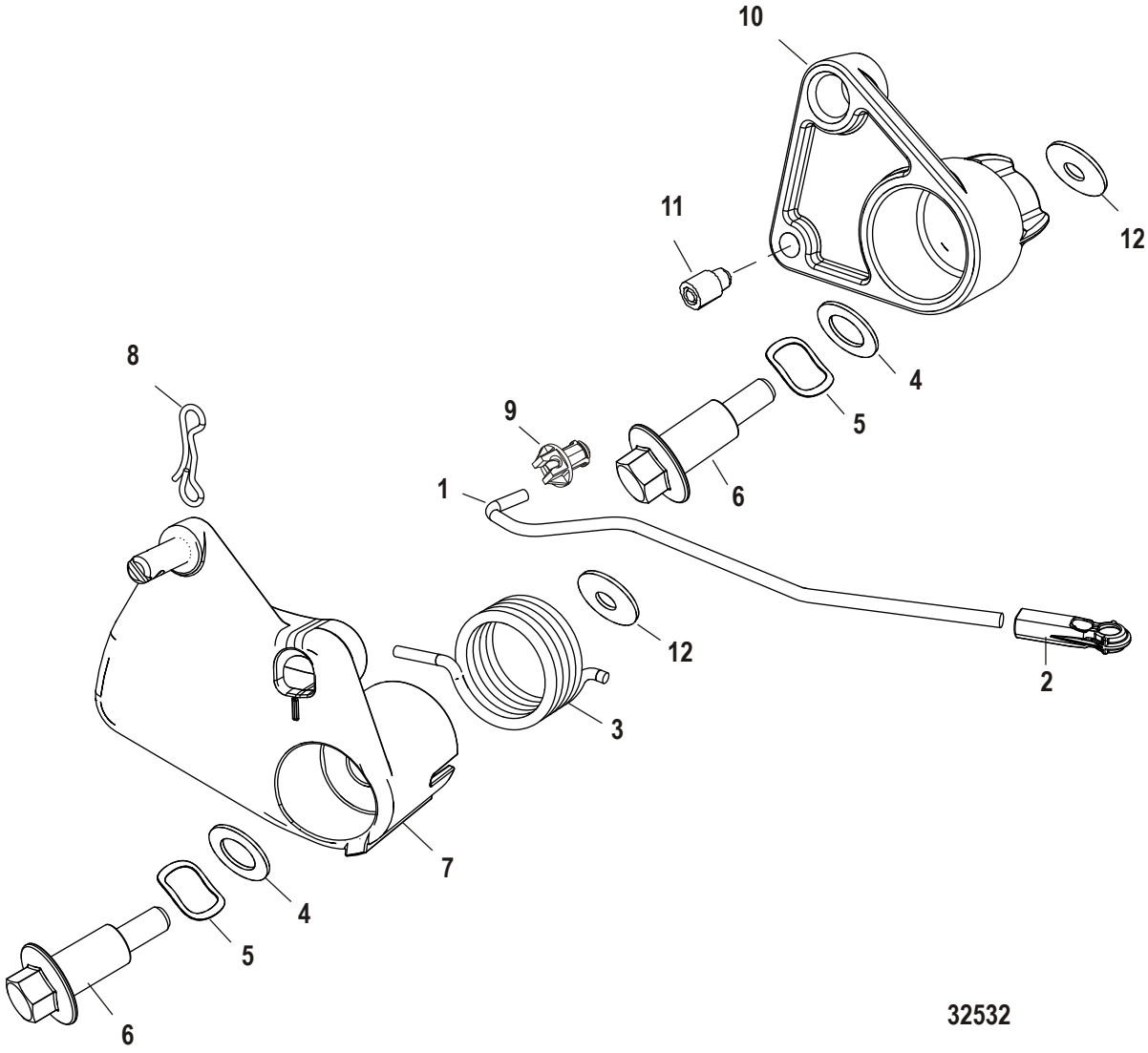
Tiller Handle Throttle Linkage Components



Tiller Handle Throttle Linkage Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Bolt (M8 x 70)	11.3	100	
2	1	Bolt (M6 x 60)			
3	1	Nut (M6)			
4	1	Cap			
5	1	Throttle lever			
6	1	Bracket			
7	2	Bolt (M6 x 20)	8.5	75	
8	1	Bushing			
9	1	Throttle cam			
10	2	Bolt (M6 x 40)	8.5	75	
11	1	Throttle arm			
12	1	Bushing			
13	1	Screw (#10-16 x 5/8)	Drive tight		
14	1	Bushing			
15	1	Throttle link assembly			
16	1	Socket			

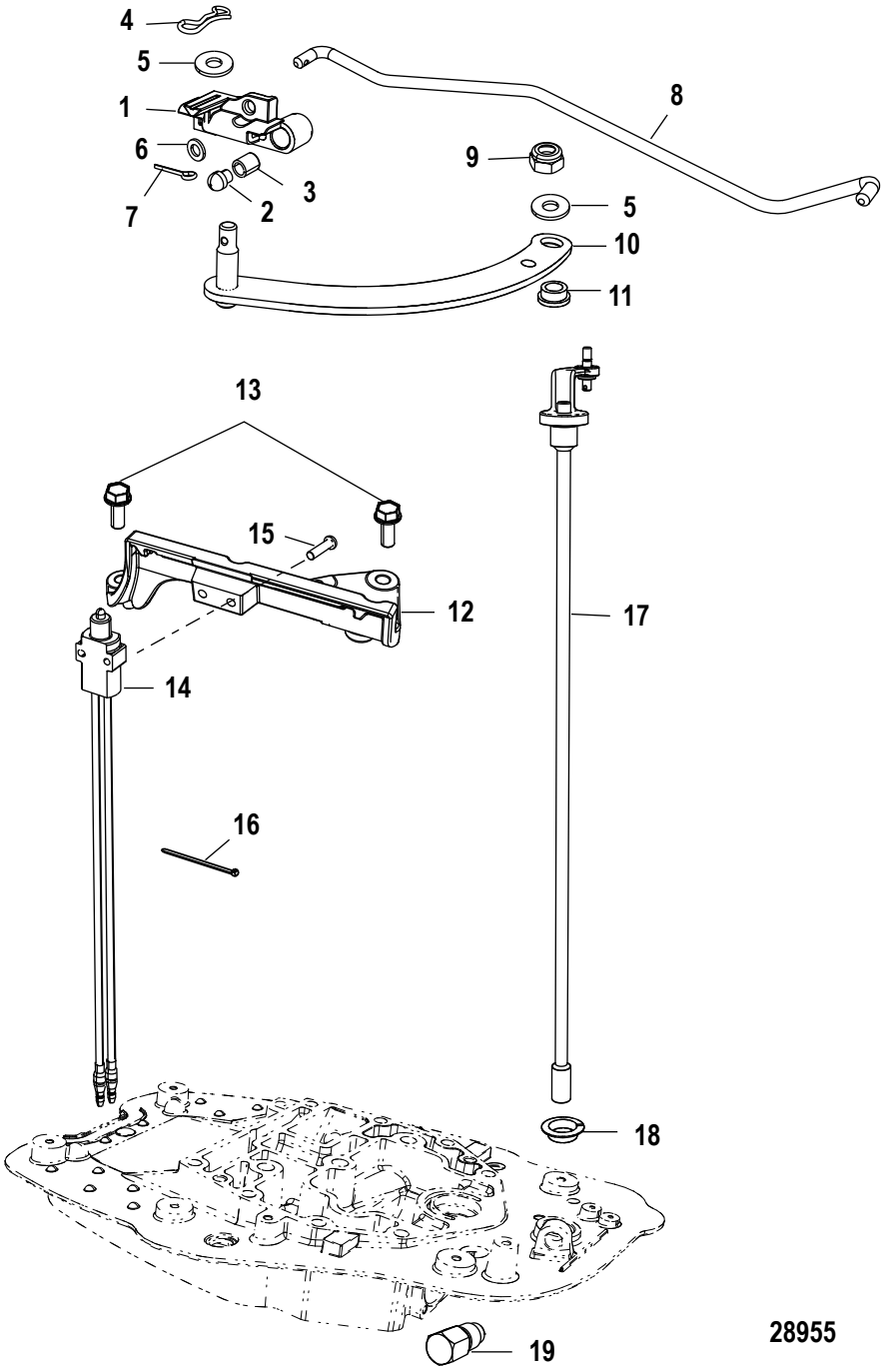
Remote Control Throttle Linkage Components



Remote Control Throttle Linkage Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Throttle link assembly			
2	1	Socket			
3	2	Throttle cam return spring			
4	2	Washer			
5	2	Wave washer			
6	2	Shoulder bolt	11.3	100	
7	1	Throttle cam			
8	1	Bow tie clip pin			
9	1	Bushing			
10	1	Cam follower			
11	1	Throttle roller			
12	2	Washer			

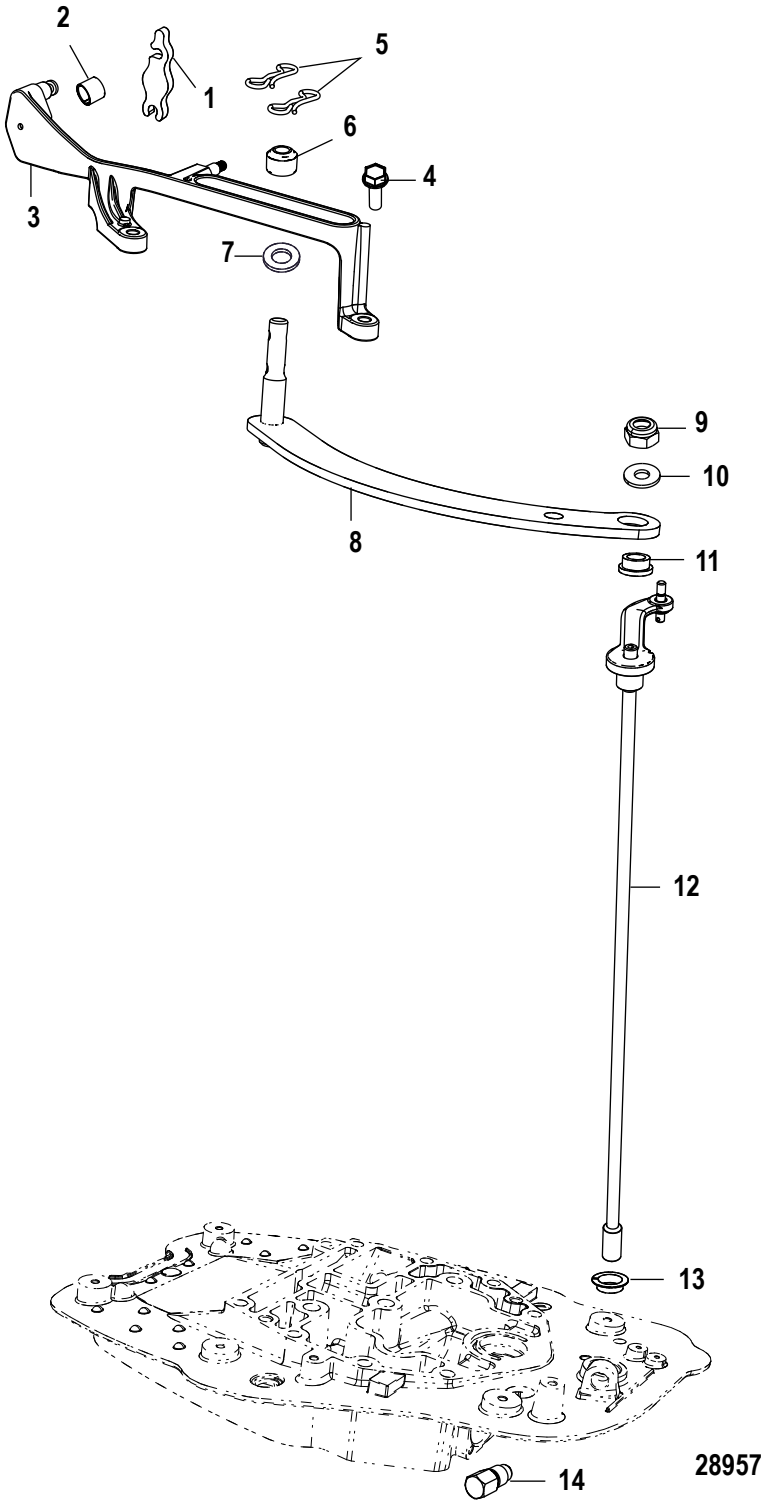
Tiller Handle Shift Linkage Components



Tiller Handle Shift Linkage Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Shift slide			
2	1	Detent			
3	1	Detent spring			
4	1	Bow tie clip pin			
5	2	Washer (0.2656 x 0.500 x 0.0625)			
6	1	Washer (0.281 x 0.500 x 0.060)			
7	1	Cotter pin			
8	1	Shift rod			
9	1	Nut (M6)	6	53	
10	1	Shift link			
11	1	Bushing			
12	1	Shift link bracket			
13	2	Bolt (M6 x 20)	8.5	75	
14	1	Switch assembly			
15	2	Screw (#10-16)	5	44	
16	1	Cable tie			
17	1	Upper shift shaft			
18	1	Nyliner			
19	1	Shift detent assembly	20	177	

Remote Control Shift Linkage Components



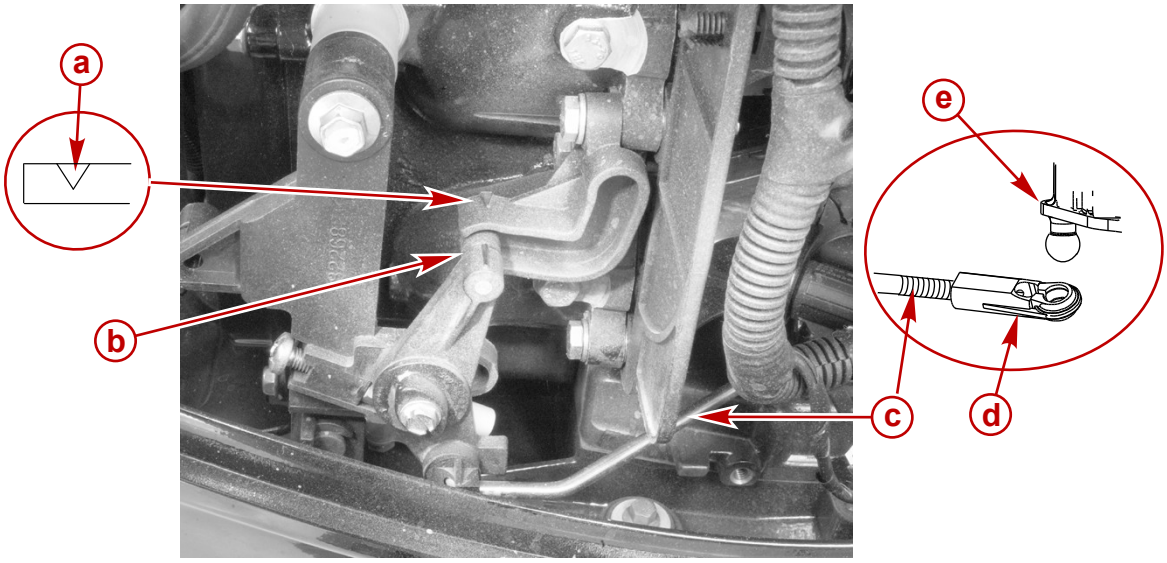
Remote Control Shift Linkage Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Latch			
2	1	Barrel retainer cup			
3	1	Bracket			
4	2	Bolt (M6 x 20)	8.5	75	
5	2	Bow tie clip pin			
6	1	Roller			
7	1	Washer			
8	1	Shift link			
9	2	Nut (M8)	6	53	
10	2	Washer			
11	1	Bushing			
12	1	Upper shift shaft			
13	1	Nyliner			
14	1	Shift detent assembly	20	177	

Throttle Link Setting - Tiller Handle Models and 40 HP Jet Models

Idle

1. For 40 hp Jet models, remove the remote control cable from the throttle arm. For tiller handle models, use the throttle twist grip to advance the throttle arm.
2. Position the throttle body so that the idle speed screw is resting against the stop.
3. Remove the link rod ball socket from the throttle body. Adjust the length of the link rod so that the center of the throttle arm roller lines up with the alignment mark. Attach the link rod ball socket.

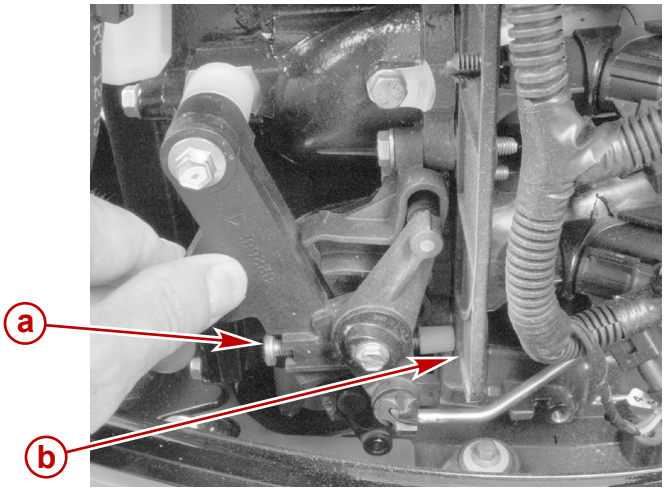


31472

a - Alignment mark
b - Throttle arm roller
c - Link rod
d - Link rod ball socket
e - Throttle body

Full Throttle Setting

Advance the throttle body to full throttle position. Adjust the full throttle stop screw so when the screw contacts the throttle stop there will be a small amount of free play in the throttle linkage at full throttle. Do not allow the throttle body to act as a throttle stop.



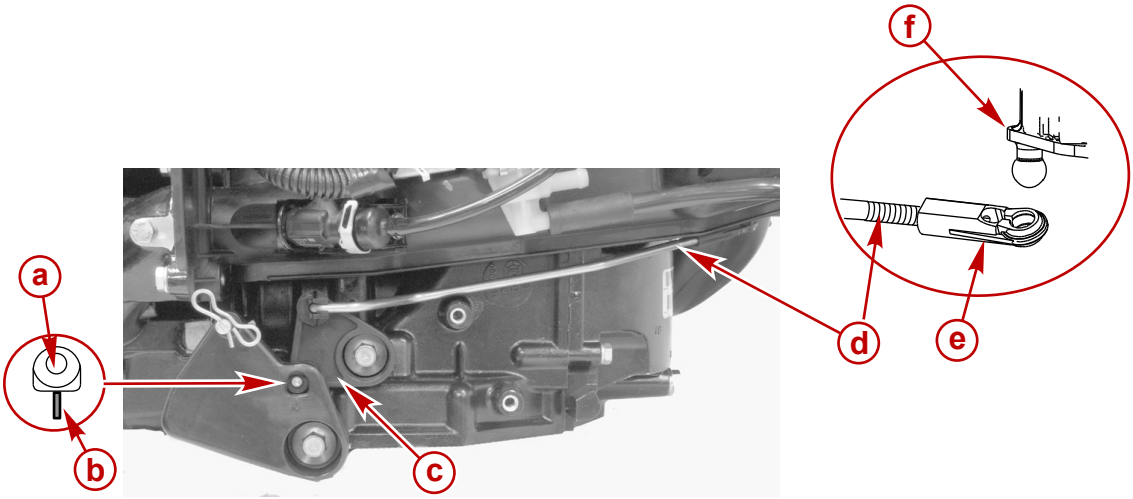
31477

a - Full throttle stop screw
b - Throttle stop

Throttle Link Setting - Remote Control Models

1. Remove the remote control throttle cable from the throttle cam.

2. Position the throttle body so that the idle speed screw is resting against the stop.
3. Remove the link rod ball socket from the throttle body. Adjust the length of the link rod so that the center of the cam follower roller lines up with the alignment mark. Attach the link rod ball socket.

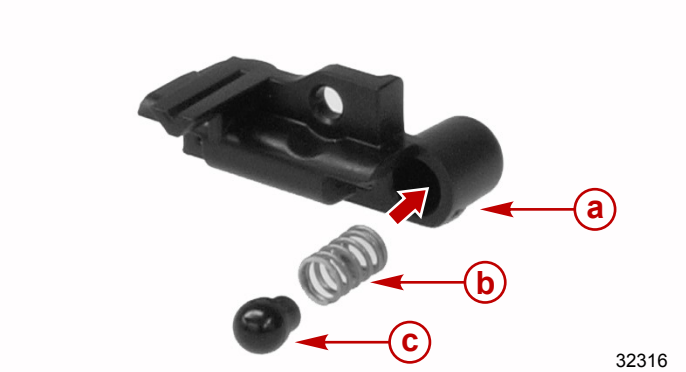


31478

- **a -** Cam follower roller
- **b -** Alignment mark
- **c -** Cam follower
- **d -** Link rod
- **e -** Link rod ball socket
- **f -** Throttle body

Tiller Handle Shift Linkage Assembly

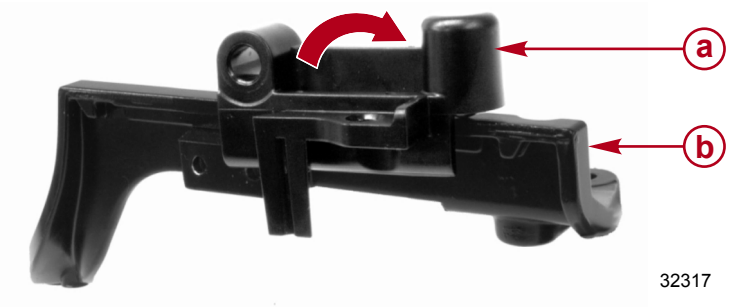
1. Install the spring and detent into the shift slide.



32316

- **a -** Shift slide
- **b -** Spring
- **c -** Detent

2. Place the shift slide, along with the detent and spring, onto the shift bracket as shown. Rotate the shift slide over the top edge of the shift bracket until it snaps in place.

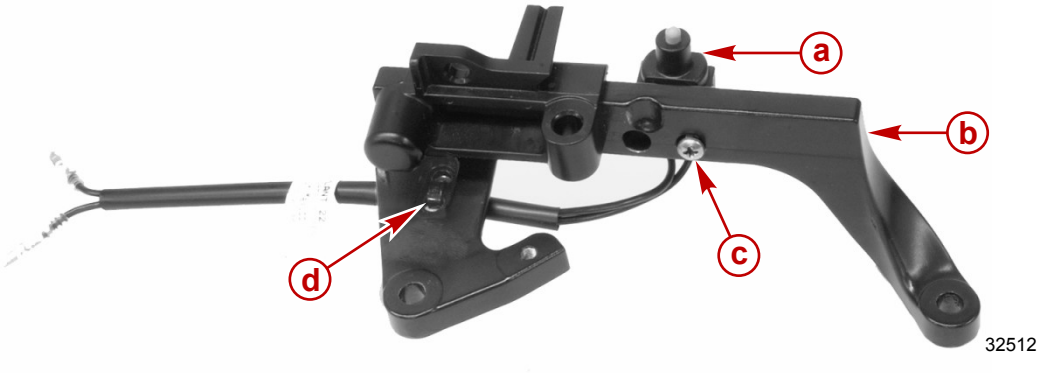


32317

- **a -** Shift slide
- **b -** Shift bracket

3. Install the neutral safety switch onto the shift slide with two screws. Tighten the screws to the specified torque.

4. Secure the neutral switch wires to the shift bracket with a cable tie.



a - Neutral safety switch
b - Shift bracket
c - Screw (#10-16) (2)
d - Cable tie

Description	Nm	lb-in.	lb-ft
Neutral safety switch mounting screws	5	44	

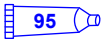
Attachments/Control Linkage

Section 7B - Tiller Handle

Table of Contents

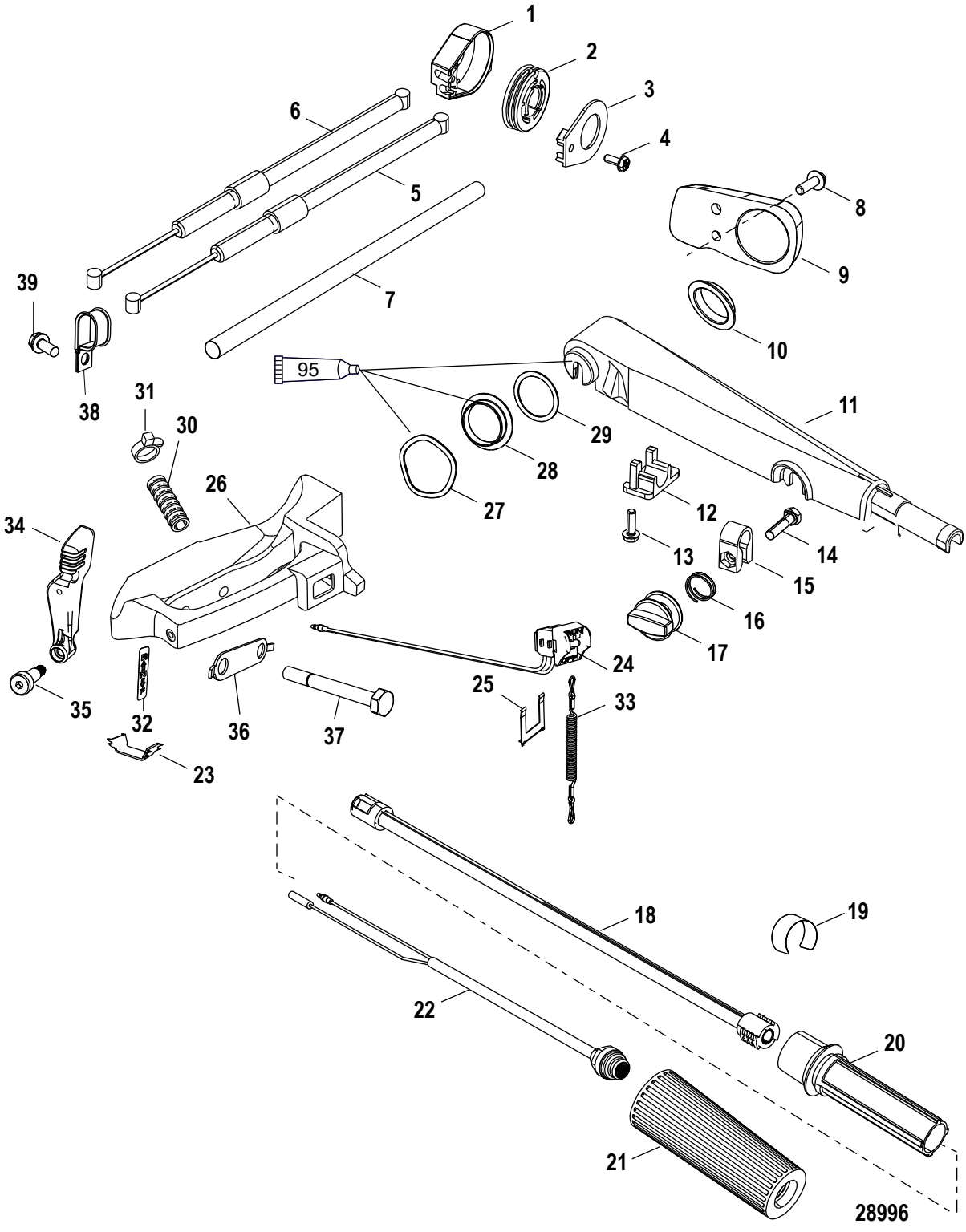
7
B

Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
	2-4-C with PTFE	Tiller tube, wave washers, and bushings Tiller handle bushings	92-802859A 1

Notes:

Tiller Handle Components



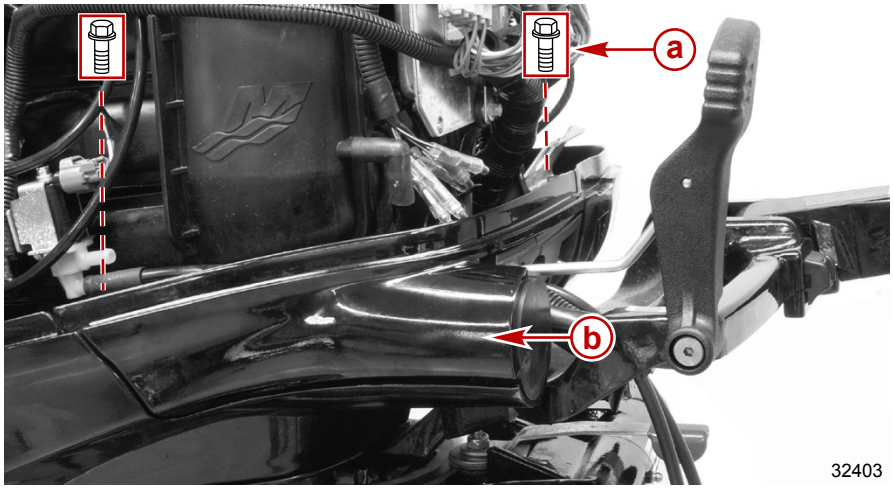
Tiller Handle Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Pulley case cover			
2	1	Pulley			
3	1	Case			
4	1	Screw (#10-16 x 1/2 in.)	2.3	20	
5	1	Throttle cable, 77.5 cm (30.5 in.)			
6	1	Throttle cable, 105.4 cm (41.5 in.)			
7	1	Sleeve			
8	2	Bolt (M8 x 25)	15.3	135	
9	1	Cover			
10	1	Bushing			
11	1	Steering handle arm			
12	1	Retainer			
13	1	Bolt (M5 x 16)	4	35	
14	1	Bolt (M6 x 25)	6	53	
15	1	Throttle lock			
16	1	Spring			
17	1	Throttle knob			
18	1	Tiller tube			
19	1	Decal			
20	1	Throttle handle			
21	1	Grip			
22	1	Stop switch			
23	2	Clip			
24	1	Stop switch			
25	1	Retainer			
26	1	Tiller bracket			
27	1	Wave washer			
28	1	Bushing			
29	1	Washer			
30	1	Conduit			
31	1	Cable tie			
32	1	F-N-R shift decal			
33	1	Lanyard assembly			
34	1	Shift handle kit			
35	1	Bolt (M8)	11.3	100	
36	1	Tab washer			
37	2	Bolt (M10 x 90)	47.5		35
38	1	Clamp			
39	1	Bolt (M6 x 16)	8.5	75	

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Tiller tube, wave washers, and bushings	92-802859A 1

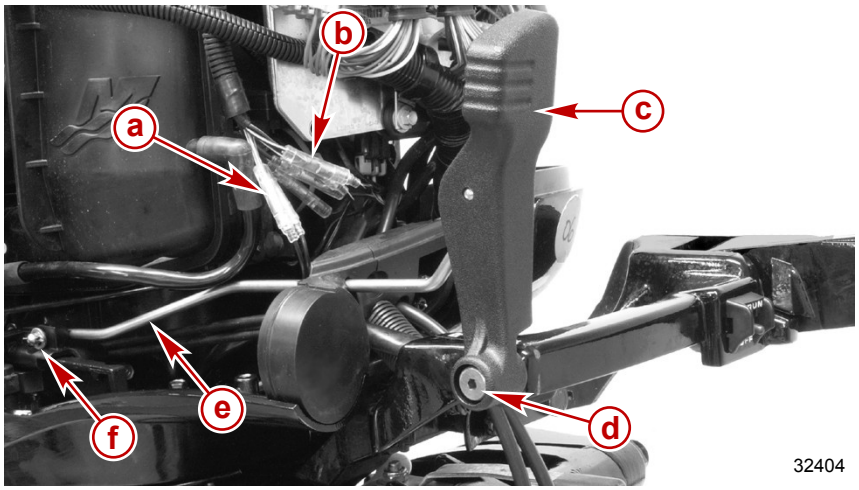
Tiller Handle Removal

1. Remove the access cover.



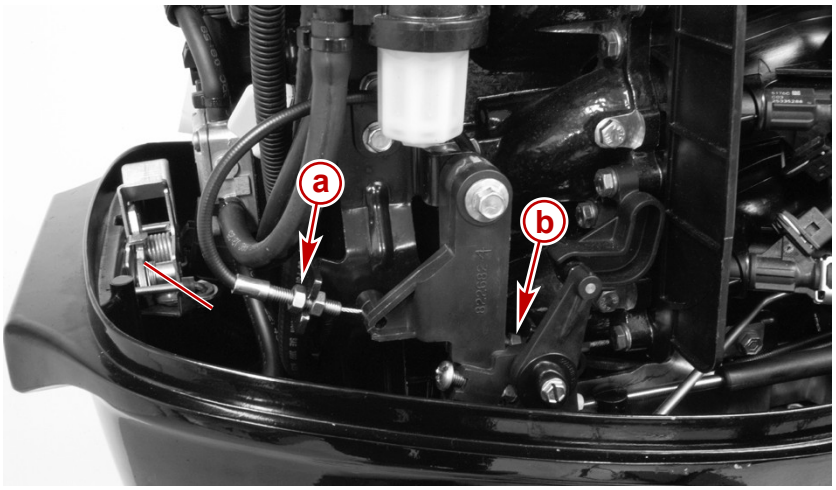
a - Bolt (M6 x 16) (2)
b - Access cover

2. Disconnect the tiller handle wires from the engine harness and neutral switch.
3. Remove the cotter pin and washer from the shift rod.
4. Remove the shift rod from the shift slide.
5. Remove the shoulder bolt securing the shift handle.
6. Remove the shift rod and handle.



a - Neutral switch wires
b - Engine harness wires
c - Shift handle
d - Shoulder bolt
e - Shift rod
f - Cotter pin and washer

7. Loosen the jam nuts and disconnect the throttle cables from the throttle lever.

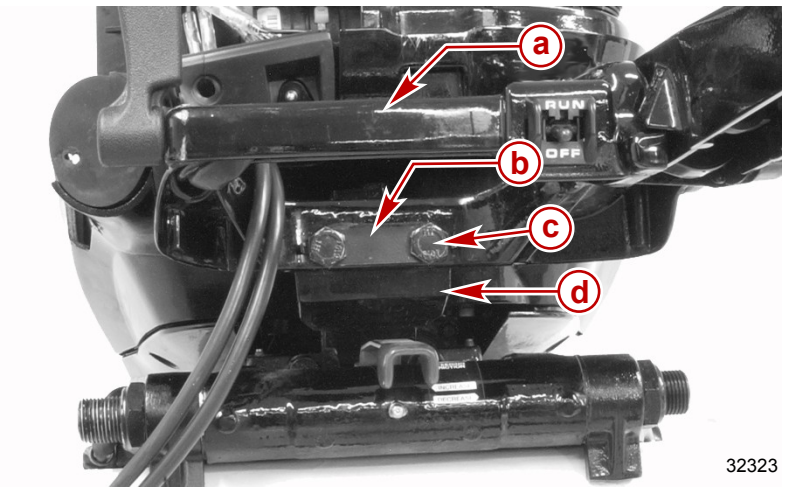


32399

Jet model shown

a - Long throttle cable
b - Short throttle cable

8. Remove the two bolts securing the tiller handle. Remove the tiller handle assembly from the outboard.



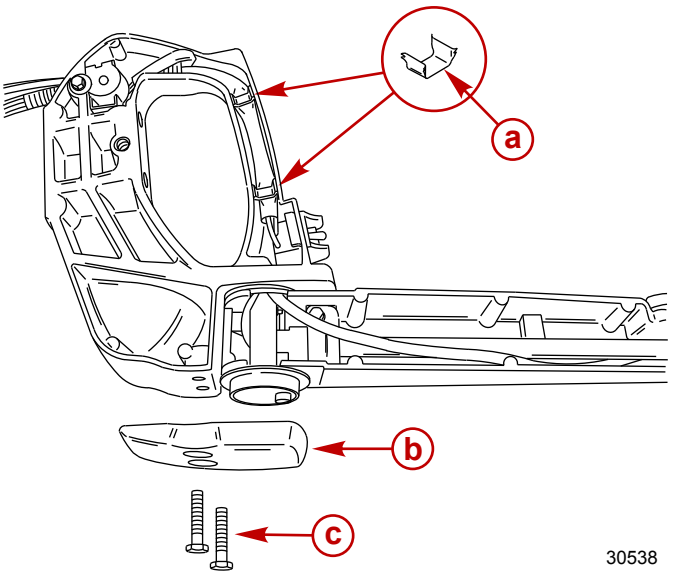
32323

a - Tiller handle
b - Tab washer
c - Bolt (M10 x 90) (2)
d - Swivel bracket

Disassembly/Assembly

Tiller Handle Disassembly

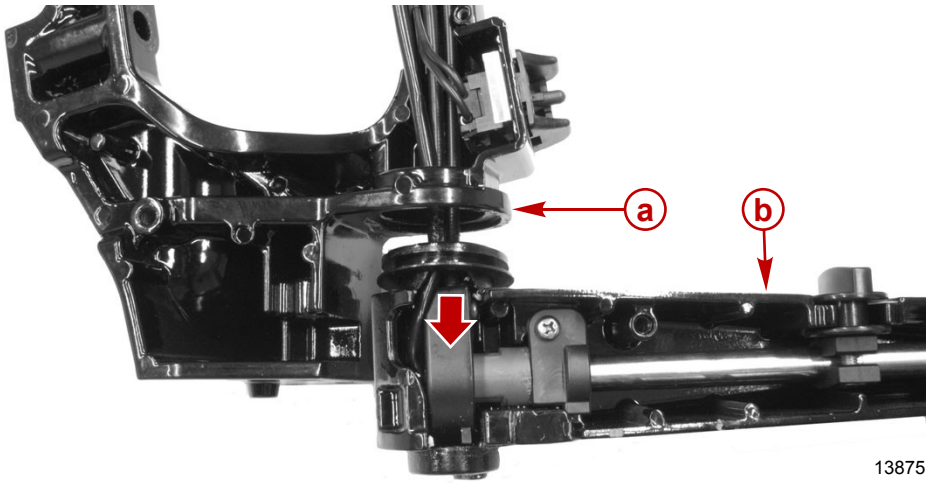
1. Pry the two clips out of the bracket.
2. Remove the bolts and the side cover.



30538

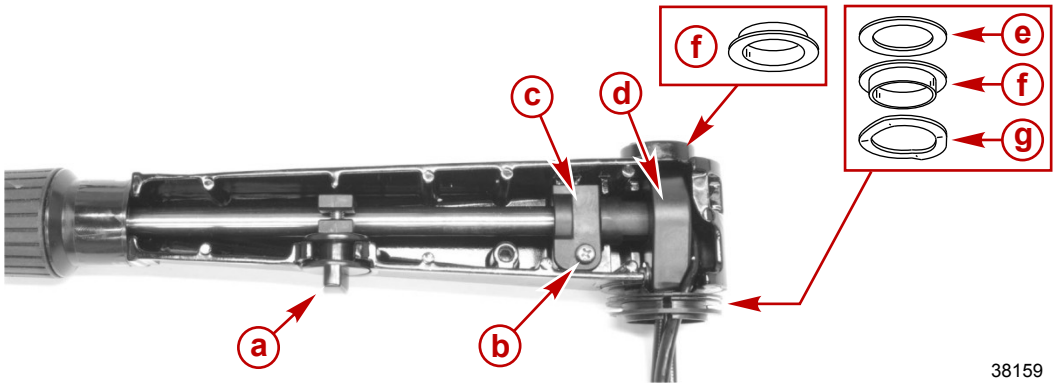
a - Clips
b - Side cover
c - Bolts (M8 x 25) (2)

3. Separate the tiller handle and carrying handle while pulling the throttle cable ends and tiller handle stop switch wires through the carrying handle.



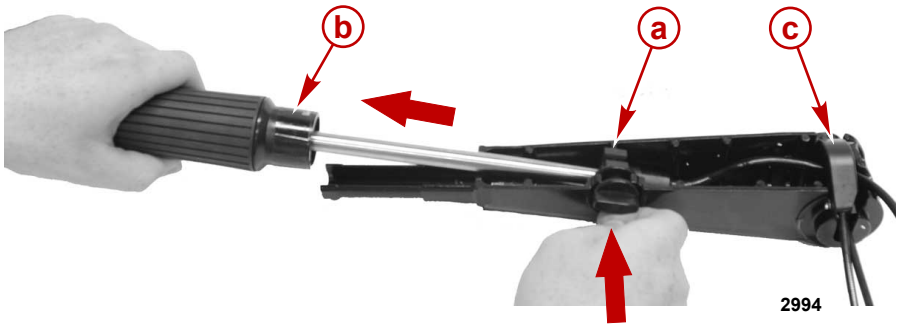
a - Carrying handle
b - Tiller handle

4. Remove the screw from the throttle shaft bracket.
5. Remove the throttle shaft bracket.
6. Loosen the throttle shaft friction control knob.
7. Remove the washer, wave washer, and bushings.



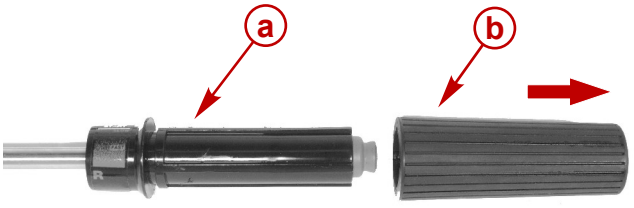
a - Throttle shaft friction control knob and clamp assembly
b - Retainer screw
c - Throttle shaft bracket
d - Throttle cable pulley housing
e - Washer
f - Bushing (2)
g - Wave washer

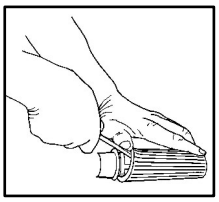
8. Remove the throttle handle while pulling the throttle shaft/grip and pushing on the throttle shaft friction control knob.
9. Remove the throttle cable pulley housing.



a - Throttle shaft friction control knob
b - Throttle shaft/grip
c - Throttle cable pulley housing

10. Remove the rubber grip from the throttle handle. Use a flat tip screwdriver to pry/push the rubber grip off the throttle handle.

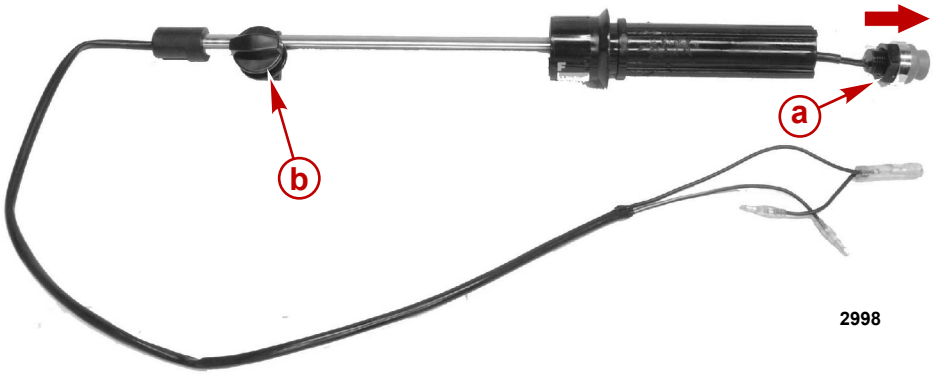




2997

a - Throttle handle
b - Rubber grip

11. Remove the stop button and wires.
12. Remove the throttle shaft friction control knob assembly.



2998

a - Stop button/wire assembly
b - Throttle shaft friction control knob and clamp assembly

13. Remove the throttle shaft from the throttle handle.

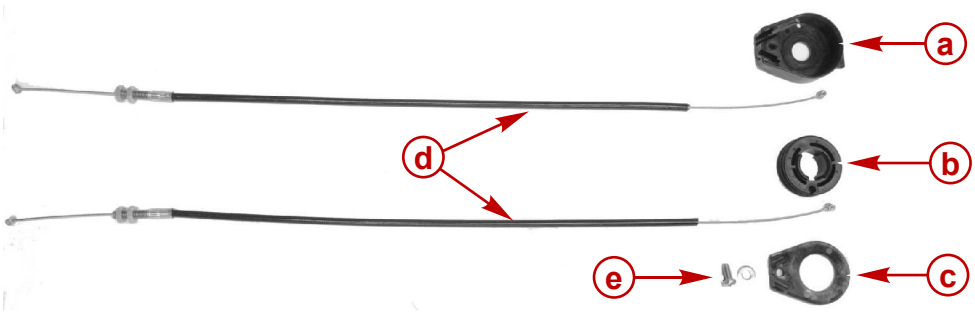
2996

a - Throttle shaft
b - Throttle handle

Throttle Cable Case

Disassembly/Inspection

1. Remove the screw and remove the cover from the cable holder.
2. Remove the cables and pulley from the case.
3. Inspect the pulley for cracks. Inspect the cables for kinks, frayed, or broken cables. Ensure the cables slide freely in the outer jacket.
4. If any defects are found, replace the component.



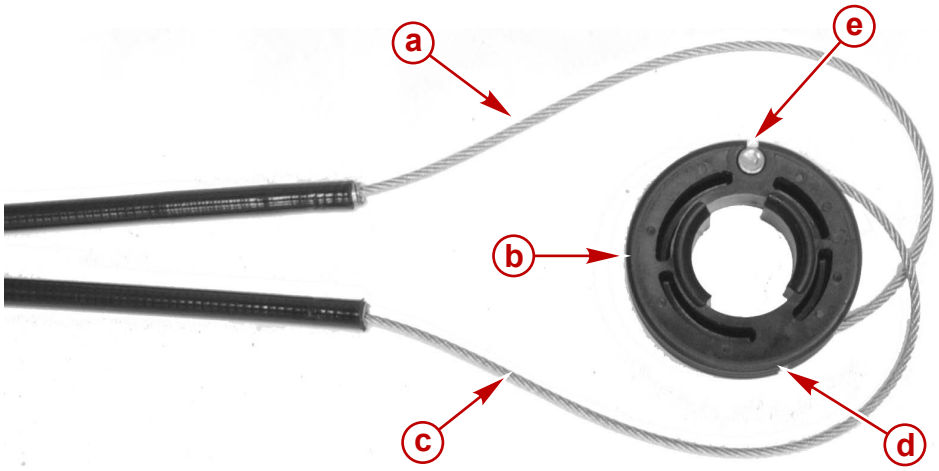
3008

a - Cable case
b - Pulley
c - Cover
d - Cables
e - Screw and washer

Assembly

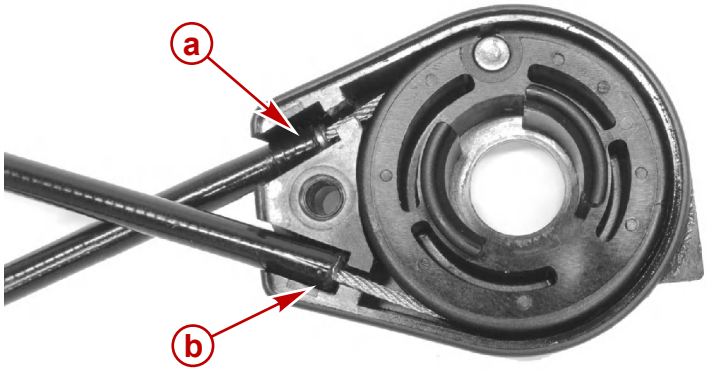
1. Install the short and long throttle cable ends into the pulley as shown.
   - Place the short cable into the top groove.

- Place the long cable into the bottom groove.



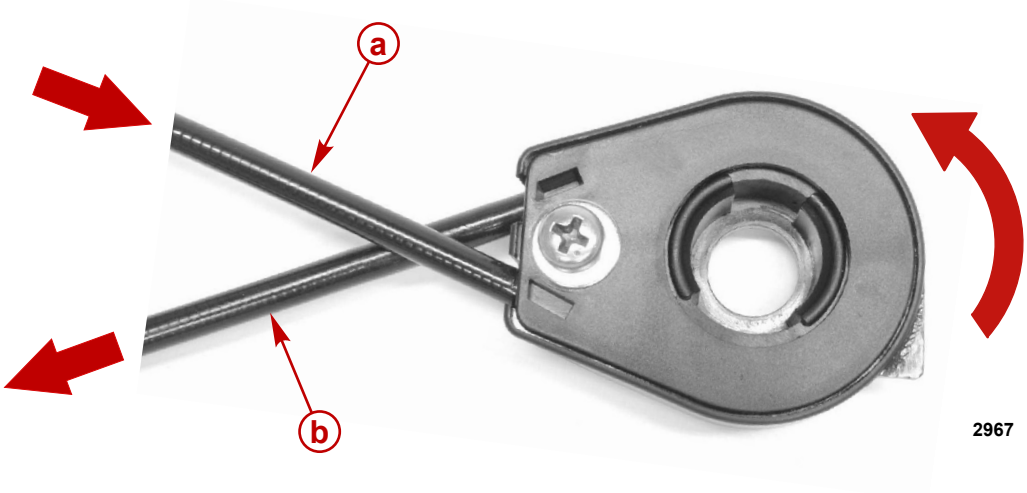
a - Long throttle cable
b - Pulley
c - Short throttle cable
d - Long cable end barrel in slot
e - Short cable end barrel in slot

2. Install the pulley with cables into the case.
3. Ensure the cable ends are fully positioned in the case.



a - Long throttle cable end positioned in case
b - Short throttle cable end positioned in case

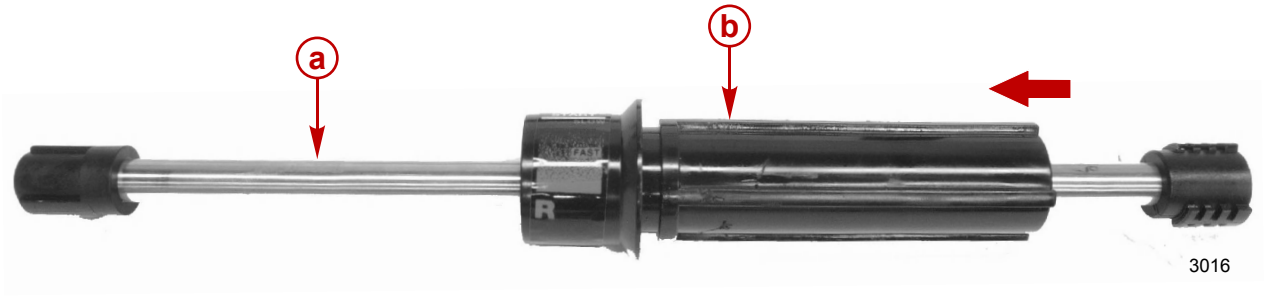
4. Hold the throttle cables in place and install the cover with a screw and washer.
5. Rotate the pulley and ensure the throttle cables move freely in the correct direction.



a - Short throttle cable
b - Long throttle cable

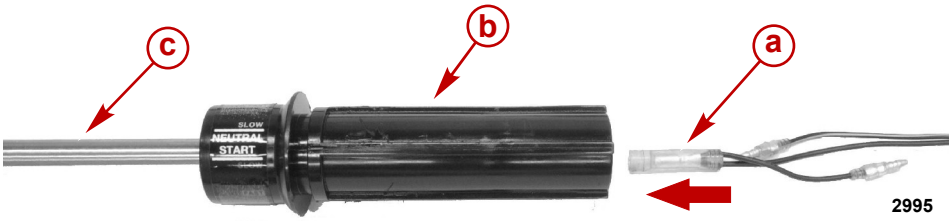
Tiller Handle Assembly

1. Install the throttle handle onto the throttle shaft.



a - Throttle shaft
b - Throttle handle

2. Route the stop button wires through the throttle shaft.

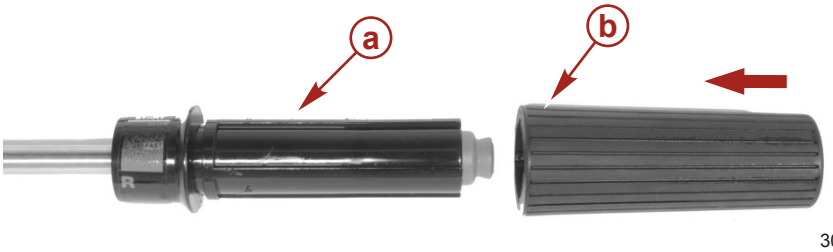


a - Stop button wires
b - Throttle handle
c - Throttle shaft

3. Seat the stop button in the end of the throttle handle.
4. Install the throttle shaft friction control knob assembly.

a - Stop button
b - Throttle shaft friction control knob and clamp assembly

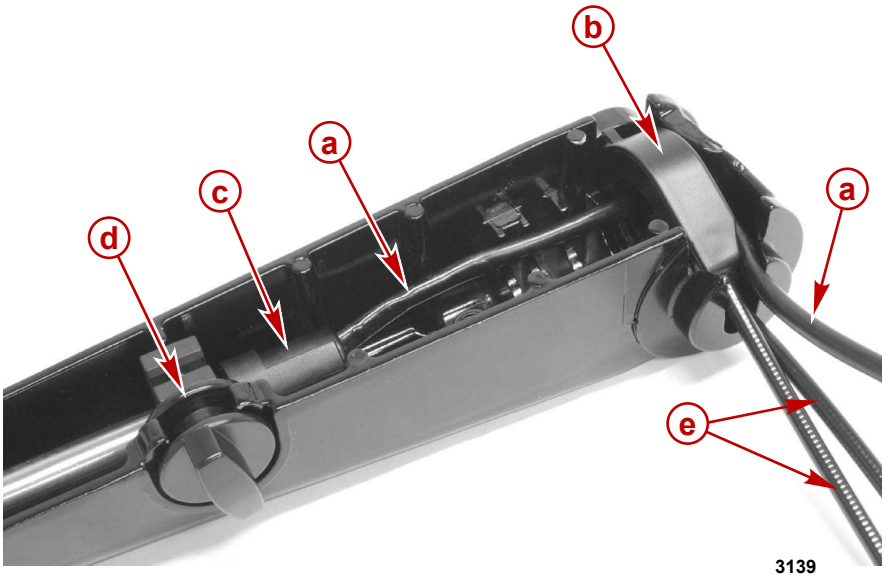
5. Install the rubber grip onto the throttle handle.



a - Throttle handle
b - Rubber grip

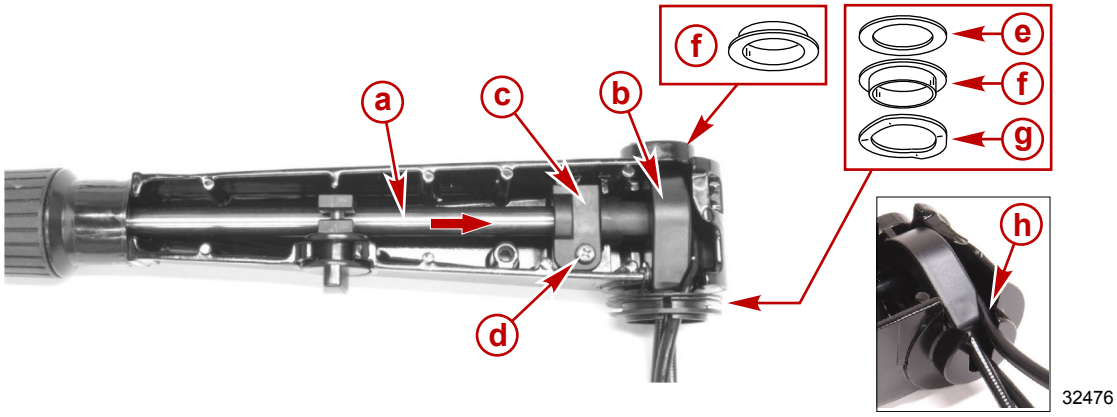
6. Feed the stop button wires through the throttle cable pulley housing.
7. Install the throttle cable pulley housing into the tiller handle.

8. Place the throttle handle assembly onto the tiller handle.
9. Align the throttle shaft friction control knob assembly with slot in the tiller handle. Install the throttle shaft friction control knob in the tiller handle.



- a - Stop button wires
- b - Throttle cable pulley housing
- c - Throttle shaft
- d - Throttle shaft friction control knob assembly
- e - Throttle cables

10. Insert the throttle shaft into the throttle cable pulley housing.
11. Route the stop button wires around the notch in the throttle cable pulley housing.
12. Install the bushings, washer, and wave washer onto the tiller handle pivot points as shown.
13. Install the throttle shaft bracket. Tighten the screw to the specified torque.

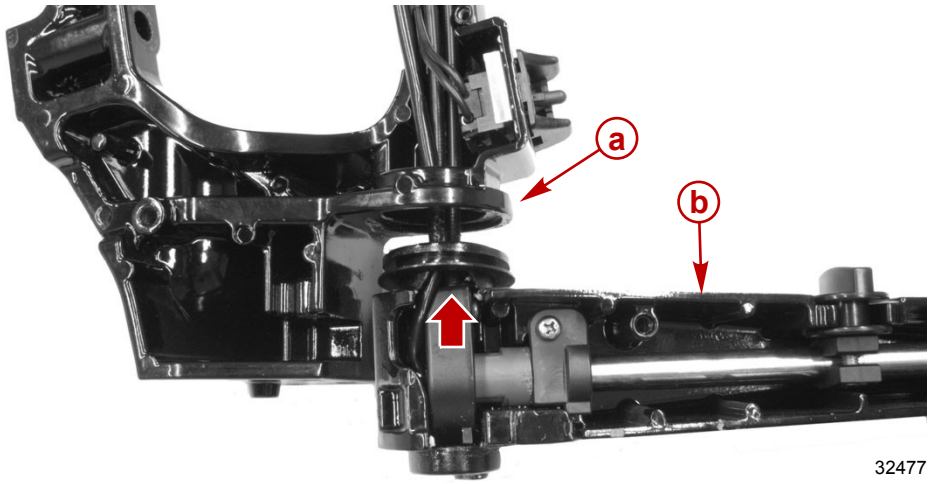


- a - Throttle shaft
- b - Throttle cable pulley housing
- c - Throttle shaft bracket
- d - Throttle shaft bracket retainer screw
- e - Washer
- f - Bushing
- g - Wave washer
- h - Notch for stop button wires

Description	Nm	lb-in.	lb-ft
Throttle shaft bracket retainer screw	4	35	

14. Install the throttle cables into the sleeve.
15. Install the stop button wires into the sleeve.
16. Guide the cables and the stop button wire through the hole in the carrying handle.
17. Apply 2-4-C with PTFE to the bushings.

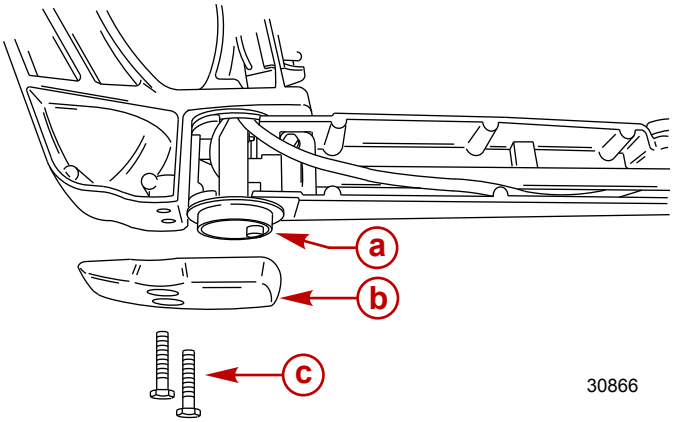
18. Install the tiller handle into the carrying handle.



a - Carrying handle
b - Tiller handle

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Tiller handle bushings	92-802859A 1

19. Attach the side cover with two bolts. Tighten the bolts to the specified torque.

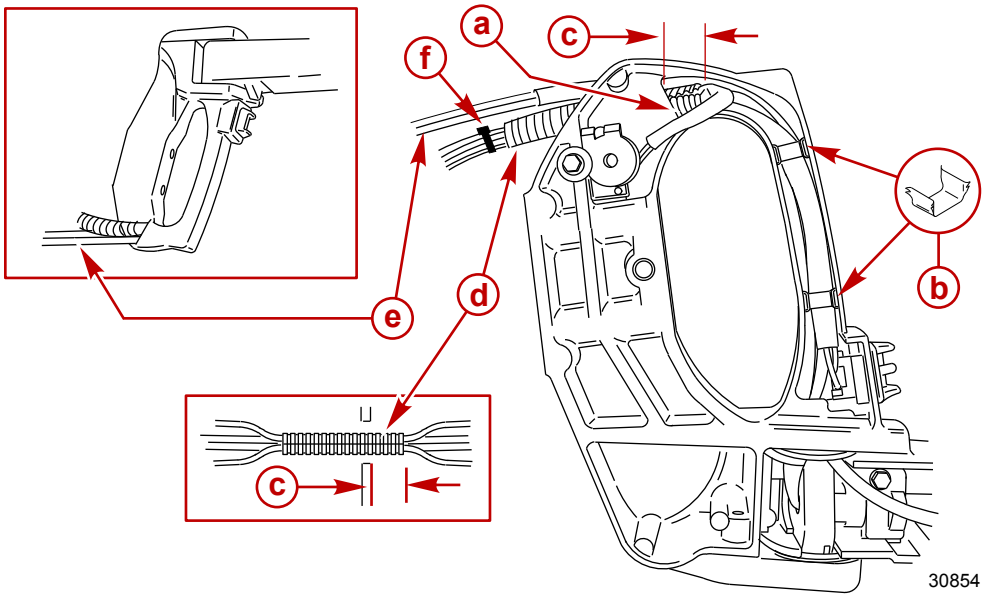


a - Bushing
b - Side cover
c - Bolts (M8 x 25) (2)

Description	Nm	lb-in.	lb-ft
Side cover bolts (M8 x 25) (2)	15.3	135	

20. Install the throttle cables through the hand grip opening. Route the cables towards the outside.
    IMPORTANT: Always use the wiring conduit to protect the wiring from chafing and cuts.
21. Install the wiring inside the wiring conduit.
22. Route the wiring through the hand grip opening and position the conduit so at least 13 mm (1/2 in.) extends past each end of the opening.
23. Fasten the wires together with a cable tie.

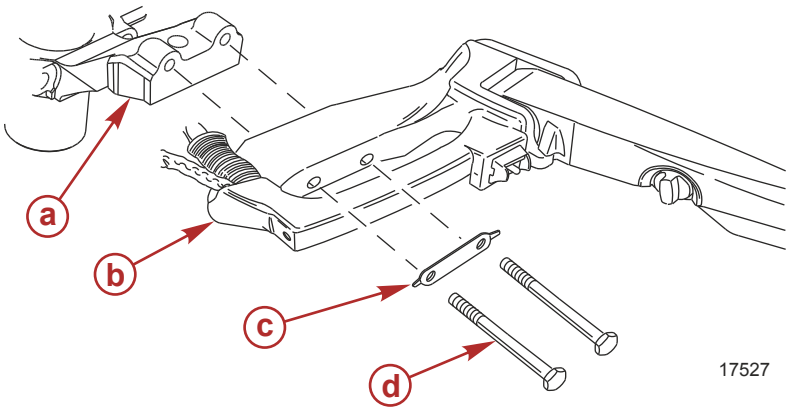
24. Push the wiring and throttle cables into the hand grip and secure with the two clips.



- **a -** Hand grip opening
- **b -** Clip (2)
- **c -** Extension distance
- **d -** Wiring conduit
- **e -** Throttle cables
- **f -** Cable tie

Tiller Handle Installation

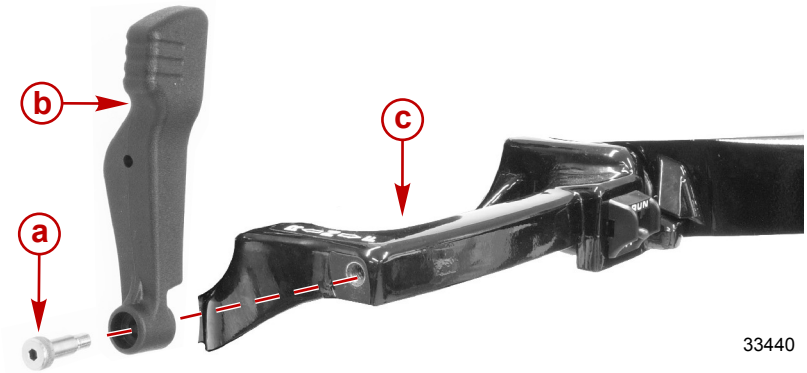
1. Disconnect the outboard battery cables.
2. Install the tiller handle assembly, tab washer, and bolts. Tighten the bolts to specification. Bend the locking tabs on the tab washer onto the flat of each bolt head.



- **a -** Swivel bracket
- **b -** Tiller bracket
- **c -** Tab washer
- **d -** Bolt (M10 x 90) (2)

Description	Nm	lb-in.	lb-ft
Bolt (M10 x 90)	47.5		35

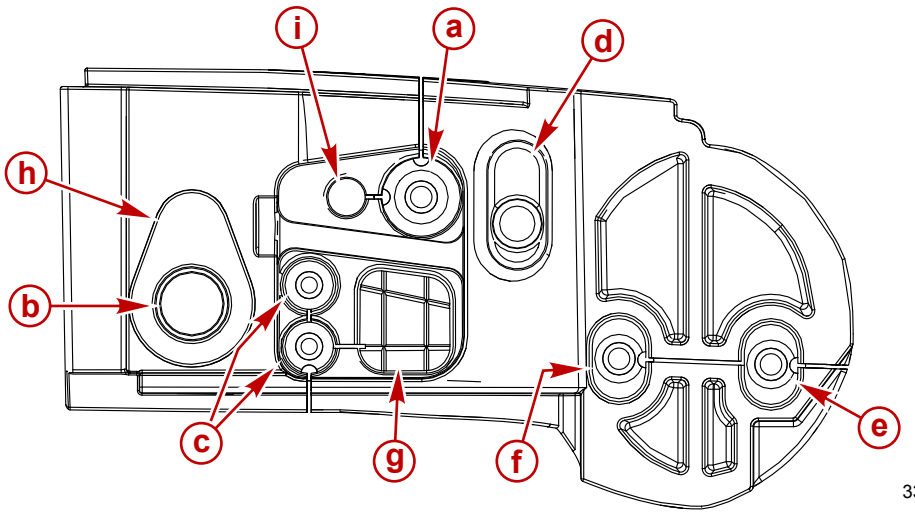
3. Install the shift handle onto the tiller bracket.
4. Install the shoulder bolt securing the shift handle. Tighten the bolt to the specified torque.



- **a -** Shoulder bolt
- **b -** Shift handle
- **c -** Tiller bracket

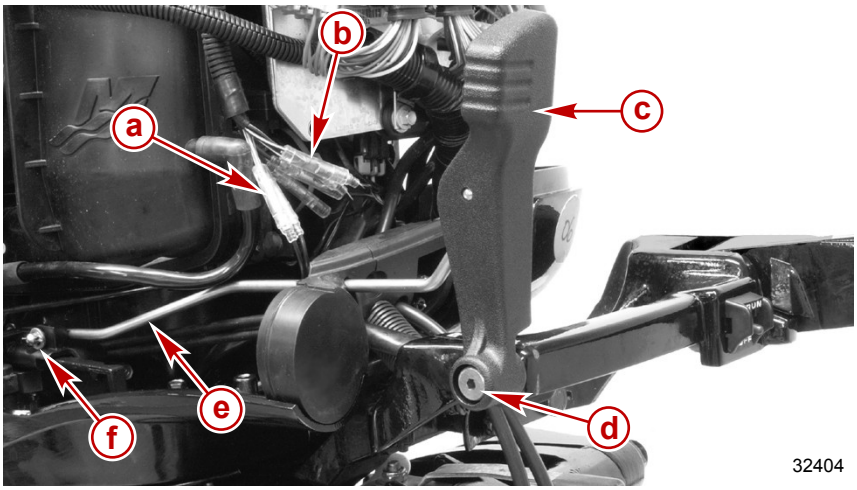
Description	Nm	lb-in.	lb-ft
Shift handle shoulder bolt (M8)	11.3	100	

5. Route cables and wires through the grommet, as shown.



- **a -** Remote wiring harness
- **b -** Remote fuel hose
- **c -** Battery cables
- **d -** Tiller handle shift rod
- **e -** Remote throttle cable
- **f -** Outboard remote shift cable or Jet model remote throttle cable
- **g -** Tiller handle wiring and throttle cables
- **h -** Tiller handle fuel hose
- **i -** Speedometer hose

6. Connect the tiller handle wires to the engine harness and neutral switch. Refer to the **Tiller Handle Wiring Diagram**, following.
7. Install the shift rod into the shift slide.
8. Install the cotter pin and washer through the shift rod.

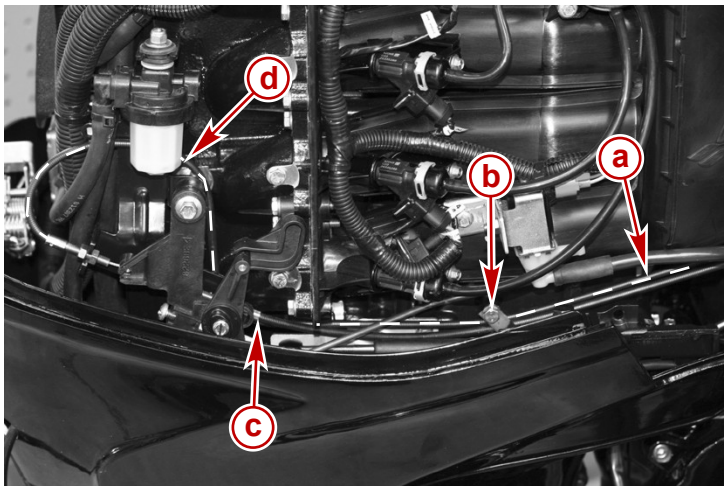


- **a -** Neutral switch wires
- **b -** Engine harness wires
- **c -** Shift handle
- **d -** Shoulder bolt
- **e -** Shift rod
- **f -** Cotter pin and washer

Throttle Cable Installation and Adjustment

1. Route the long throttle cable, as shown.

2. Secure the throttle cables with a J-clip. Tighten the J-clip mounting bolt to the specified torque.



32197

Jet model shown

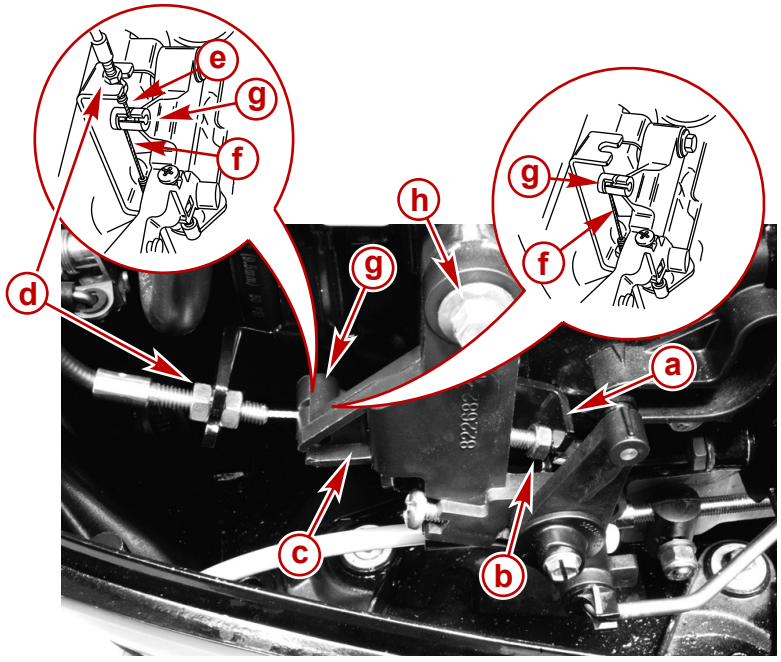
- **a -** Throttle cables routed through the grommet
- **b -** J-clip and bolt
- **c -** Short throttle cable
- **d -** Long throttle cable routed behind the fuel filter

Description	Nm	lb-in.	lb-ft
J-clip mounting bolt	8.5	75	

3. Rotate the throttle grip to the idle position.

   NOTE: *It may be necessary to loosen or remove the throttle lever to install the throttle cables.*

4. Insert the short throttle cable anchor into the anchor boss slot on the throttle lever.
5. Secure the short throttle cable into position by tightening the jam nuts onto the bracket (finger-tighten only).
6. Insert the long throttle cable anchor into the anchor boss slot on the throttle lever.
7. Secure the long throttle cable into position by tightening the jam nuts onto the bracket (finger-tighten only).

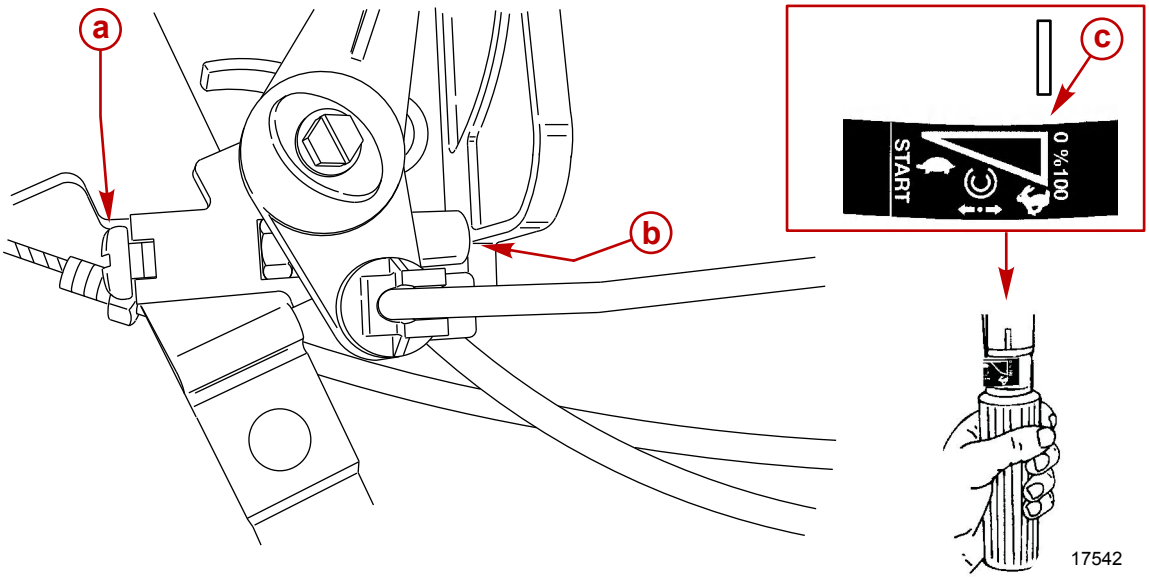


32871

- **a -** Shift cable bracket
- **b -** Short throttle cable jam nut
- **c -** Throttle lever
- **d -** Long throttle cable jam nut
- **e -** Long throttle cable anchor
- **f -** Short throttle cable anchor
- **g -** Anchor boss
- **h -** Throttle lever bolt (M8 x 70)

8. Adjust the throttle stop.
   a. Rotate the throttle grip to the wide-open throttle position.
   b. Turn the throttle stop screw counterclockwise until there is a gap.
   c. Hold the throttle grip in the wide-open throttle position and adjust the throttle stop screw clockwise until it contacts the plate.
9. Rotate the throttle grip to the full throttle position. Keep adjusting until the wide-open throttle stop screw lightly contacts the plate.

NOTE: No free play should exist in the throttle grip handle once the wide-open throttle stop screw has hit the plate. If this condition exists, readjust the jam nuts on the appropriate throttle cable.



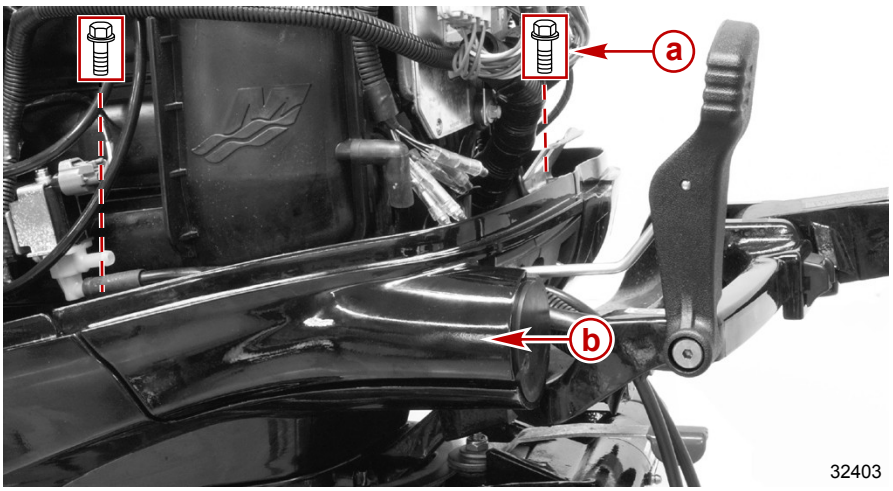
a - Wide-open throttle stop screw
b - Throttle stop touching the plate
c - Wide-open throttle position

IMPORTANT: After installation, cycle the throttle grip several times from the idle position to the wide-open throttle position. Ensure the wide-open throttle stop screw is still contacting the plate. If it is not, readjust the jam nuts.

10. When the cables and throttle stop are adjusted, tighten the throttle cable jam nuts. Tighten the M8 x 70 bolt to the specified torque.

Description	Nm	lb-in.	lb-ft
Bolt (M8 x 70)	11.3	100	

11. Check throttle link operation. Refer to **Section 7A - Throttle Link Setting**.
12. Install the access cover. Tighten the bolts to the specified torque.



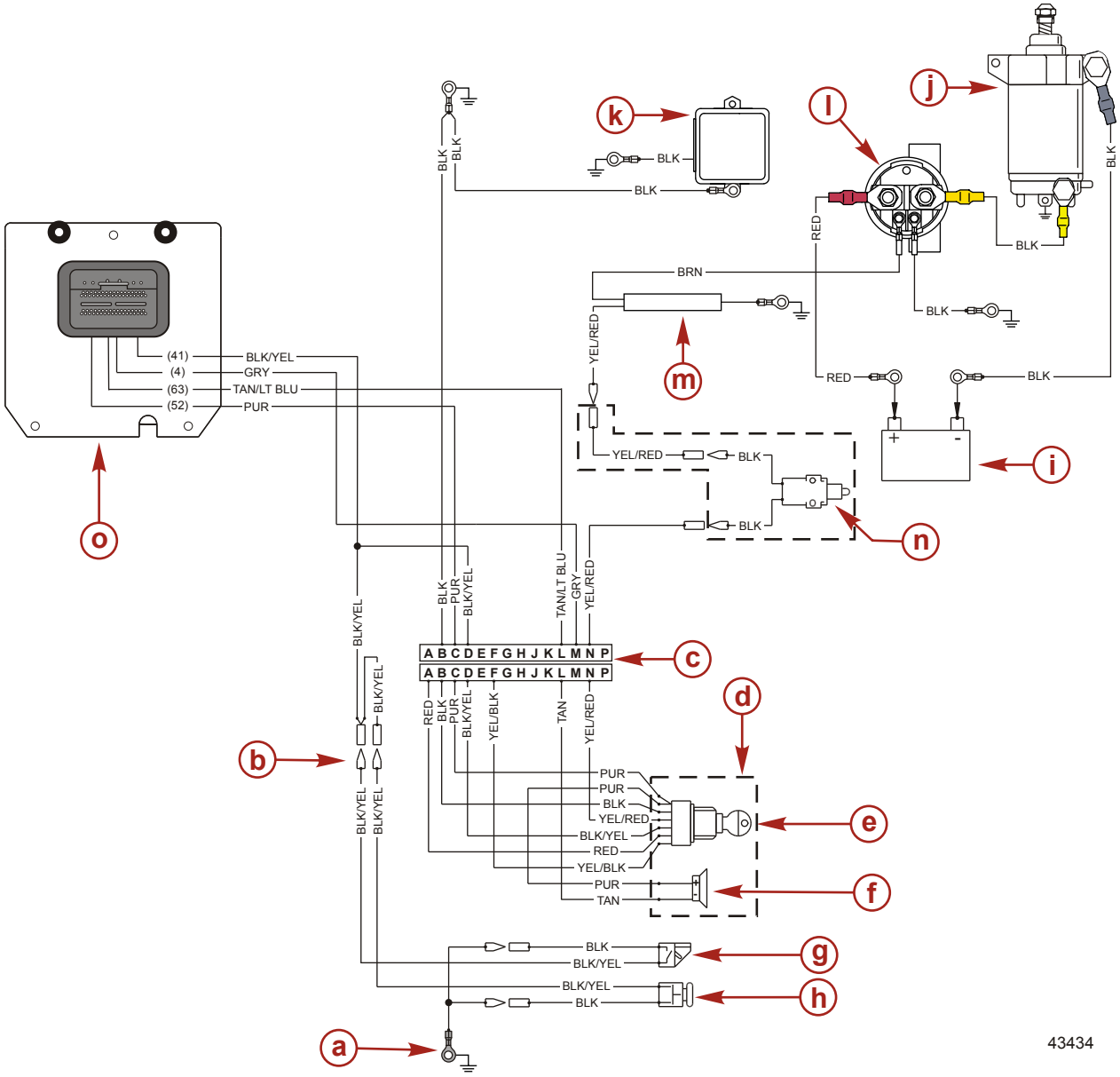
a - Bolt (M6 x 16) (2)
b - Access cover

Description	Nm	lb-in.	lb-ft
Access cover bolts (M6 x 16) (2)	10	88.5	

Wire Color Code Abbreviations

Wire Color Abbreviations				
BLK	Black		BLU	Blue
BRN	Brown		GRY	Gray
GRN	Green		ORN or ORG	Orange
PNK	Pink		PPL or PUR	Purple
RED	Red		TAN	Tan
WHT	White		YEL	Yellow
LT or LIT	Light		DK or DRK	Dark

30/40/50/60 EFI Gen 3 Electric Start Tiller Handle Wiring Diagram - 14 Pin Connector



- **a -** Ground harness below starter bolt (M6 x 16)
- **b -** Harness extension
- **c -** Key switch harness connection
- **d -** Key switch assembly transom mount
- **e -** Key switch
- **f -** Horn
- **g -** Lanyard stop switch
- **h -** Push button stop switch
- **i -** Battery
- **j -** Starter motor
- **k -** Voltage regulator/rectifier
- **l -** Start solenoid
- **m -** In-line diode
- **n -** Neutral start switch

- o - ECM

Jet Drive Outboard

Section 8A - Jet Drive Outboard

Table of Contents

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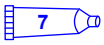
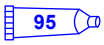
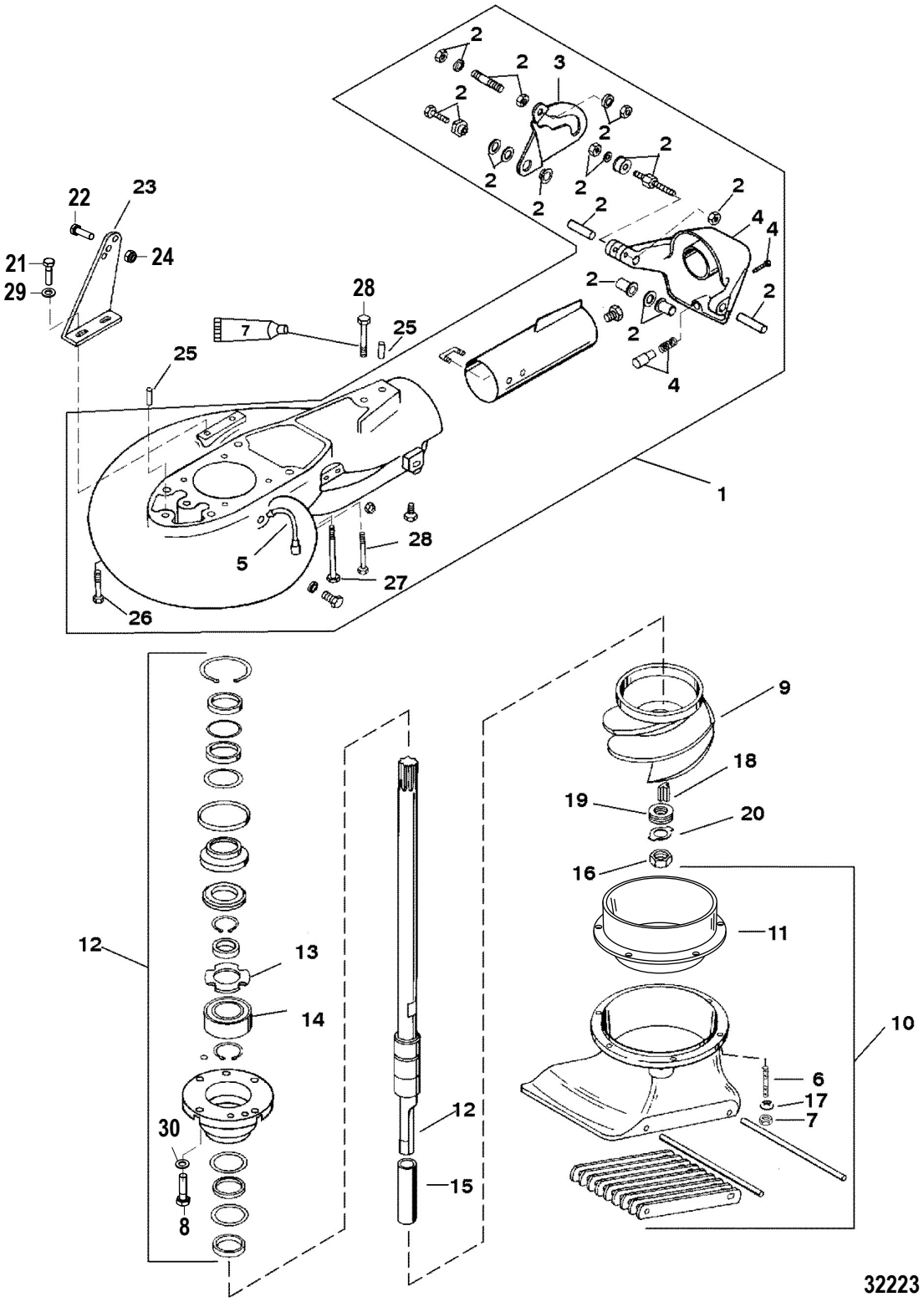
A

Lubricants, Sealants, Adhesives

Tube Ref No.	Description	Where Used	Part No.
	Extreme Grease	Flange surfaces on the water intake housing, liner, and pump housing	8M0071842
		Both sides of the water intake liner flange	
	Loctite 271 Threadlocker	Threads of bolt (M10 x 70)	92-809819
		Bearing carrier mounting bolt threads	
		Water pump cover bolts	
		Jet drive mounting bolt threads	
	2-4-C with PTFE	Driveshaft, drive key, and impeller bore	92-802859A 1
		Inside diameter of the water pump cover, gasket bead, and inside diameter of the water tube coupler	
		Driveshaft splines	
		Driveshaft and impeller bore	

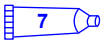
Notes:

Jet Unit Components

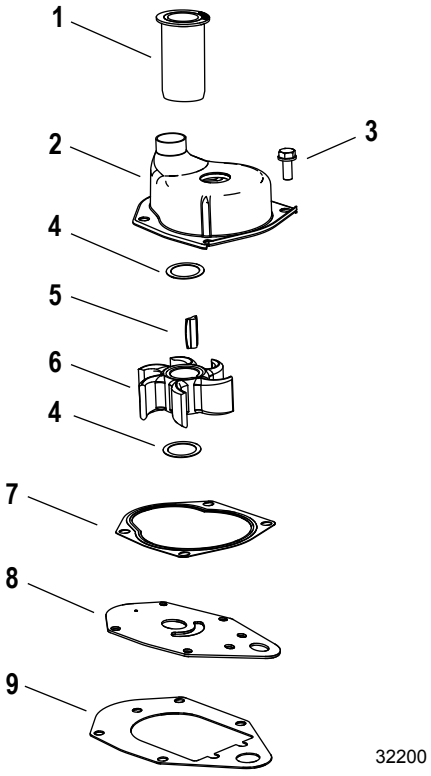


Jet Unit Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Housing			
2	1	Shift linkage kit			
3	1	Shift cam			
4	1	Reverse gate			
5	1	Lube hose			
6	6	Stud (M8 x 45)	17.5	154.8	–
7	6	Locknut (M8)	16	142	–
8	4	Bolt (M8 x 25)	16	142	–
9	1	Impeller			
10	1	Intake housing			
11	1	Liner			
12	1	Driveshaft			
13	1	Thrust washer			
14	1	Ball bearing			
15	1	Sleeve			
16	1	Nut	53	–	39.1
17	6	Washer			
18	1	Key			
19	8	Impeller shim			
20	1	Tab washer			
21	2	Bolt (M6 x 16)	11	97.3	–
22	1	Bolt (M8 x 30) (remote)			
23	1	Cable support bracket			
24	1	Locknut (M8) (remote)	16	142	–
25	2	Dowel pin			
26	2	Bolt (M10 x 60)	54	–	39.8
27	1	Bolt (M10 x 90)	54	–	39.8
28	2	Bolt (M10 x 70)	54	–	39.8
29	1	Washer			
30	1	Washer			

Tube Ref No.	Description	Where Used	Part No.
	Loctite 271 Threadlocker	Threads of bolt (M10 x 70)	92-809819

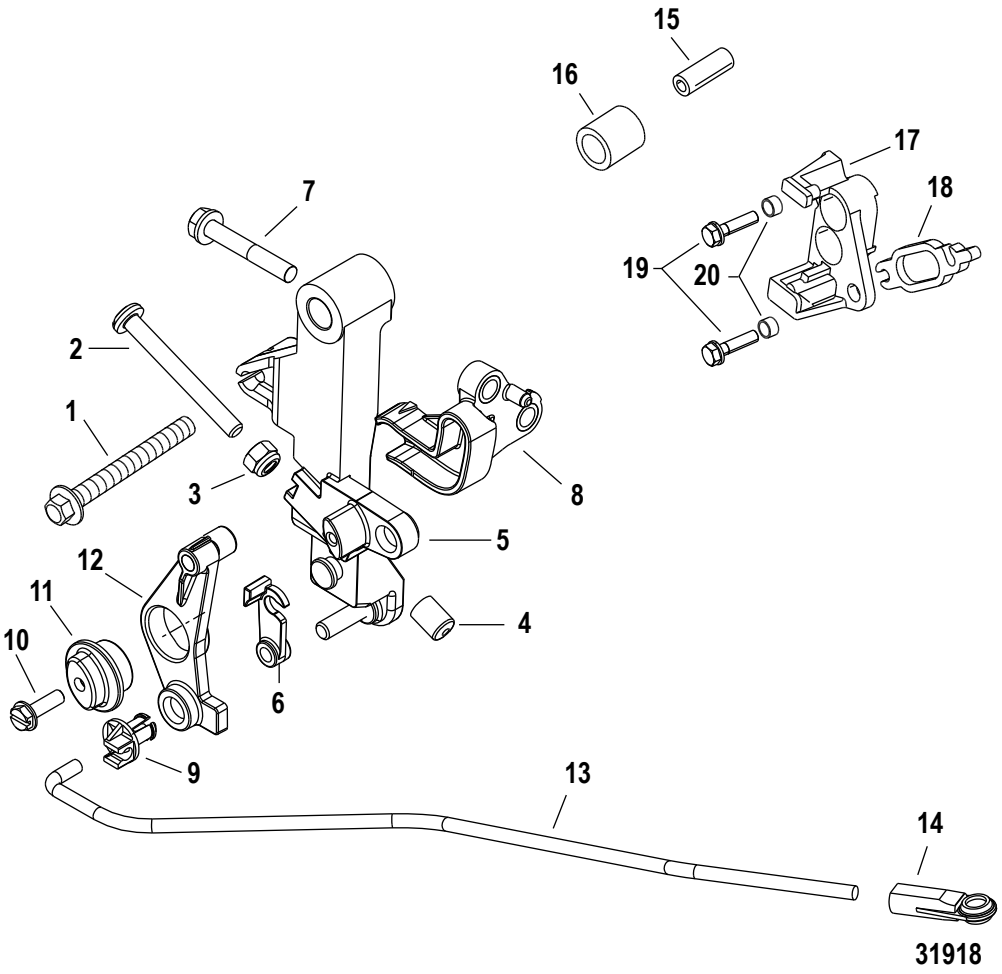
Jet Water Pump Components



Jet Water Pump Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Water tube coupler			
2	1	Housing			
3	4	Bolt (M6 x 16)	7	62	–
4	2	Plastic washer			
5	1	Key			
6	1	Impeller			
7	1	Beaded gasket			
8	1	Face plate			
9	1	Gasket			

Jet Throttle Linkage Components



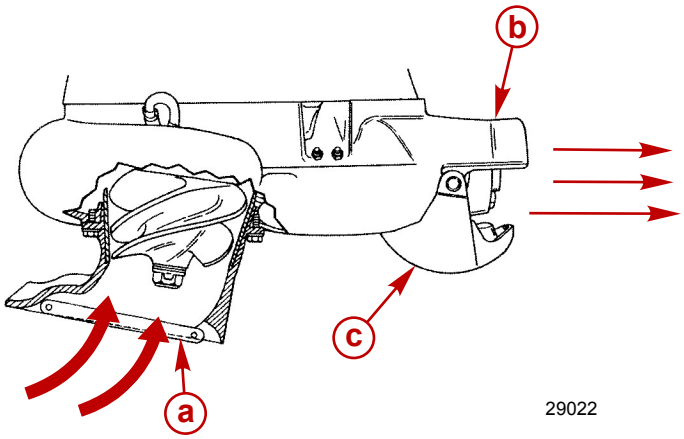
Jet Throttle Linkage Components

Ref. No.	Qty.	Description	Torque		
			Nm	lb-in.	lb-ft
1	1	Bolt (M8 x 70)	11.3	100	–
2	1	Bolt (M6 x 60)			
3	1	Nut (M6)			
4	1	Cap			
5	1	Throttle lever			
6	1	Retainer			
7	2	Bolt (M6 x 40)	8.5	75.2	–
8	1	Throttle cam			
9	1	Bushing			
10	1	Screw (#10-16 x 5/8)	Drive tight		
11	1	Bushing			
12	1	Throttle arm			
13	1	Throttle link assembly			
14	1	Socket			
15	1	Bushing			
16	1	Spacer			
17	1	Bracket			
18	1	Latch			
19	2	Bolt (M6 x 16)	8.5	75.2	–
20	2	Sleeve			

How the Jet Drive Operates

A jet driven boat has substantially different handling characteristics compared to a propeller driven boat. It is recommended that the operator adjusts to these characteristics by experimenting in open water at both high and low speeds.

The driveshaft driven impeller draws water up through the water intake and then directs it at a high pressure through the water outlet nozzle to create forward thrust. To obtain reverse, the reverse gate moves over the outlet nozzle to direct the water in the opposite direction.



a - Water intake
b - Water outlet nozzle
c - Reverse gate

When the jet drive is in neutral, the impeller continues to rotate. However, the reverse gate is positioned so that some of the forward thrust is diverted to create reverse thrust. This approximate balancing of forward and reverse thrust will minimize any boat movement. Because the impeller is always rotating and creating thrust when the engine is running, the boat may tend to move slowly forward or backward. This is normal for a direct-drive jet driven boat. The operator should be aware of this and use caution whenever the engine is running.

⚠ WARNING

Avoid injury resulting from contacting the rotating impeller or having hair, clothing, or loose objects drawn into the water intake and wrapping around the impeller shaft. Stay away from the water intake and never insert an object into the water intake or water outlet nozzle when the engine is running.

The jet drive is always drawing water into the housing when the engine is running. Do not operate the jet drive with the grate removed from the water intake. Keep hands, feet, hair, loose clothing, life jackets, etc., away from the water intake. Never insert an object into the water intake or water outlet nozzle when the engine is running.

Water Testing

Checking for Cavitation

The initial outboard height setting should be close to the optimum setting for the outboard. However, because of the hull design of some boats, obstructions, or imperfections in the hull ahead of the water intake, adjustments may be required to prevent cavitation at running speeds.

When operating the boat, the outboard driveshaft housing should be vertical, or tilted toward the boat, when planing to provide a scooping angle on the water intake. Tilting the outboard out beyond a vertical position reduces the scoop angle and can cause impeller slippage and cavitation.

IMPORTANT: If the angle of the boat transom does not allow the driveshaft housing to be positioned vertical, a wedge kit should be installed behind the transom brackets to increase the tilt-in angle.

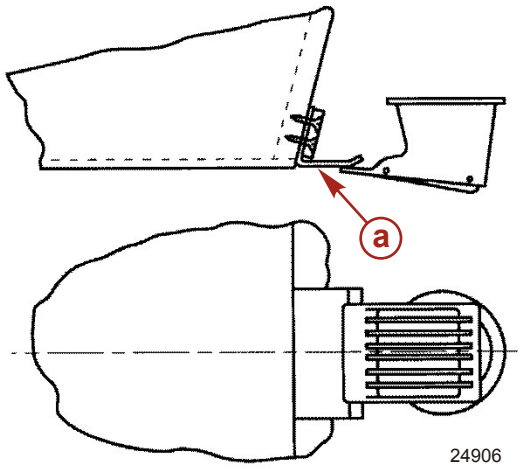
NOTE: *Slight cavitation in sharp turns and rough water is acceptable, but excessive cavitation is harmful to the outboard and should be avoided.*

Test run the boat. If cavitation occurs (air enters the pump), the first thing to try is lowering the outboard mounting height.

If cavitation still exists after lowering the outboard, it may be helpful to seek advice from the boat manufacturer.

Another option to further reduce cavitation is a rough water plate.

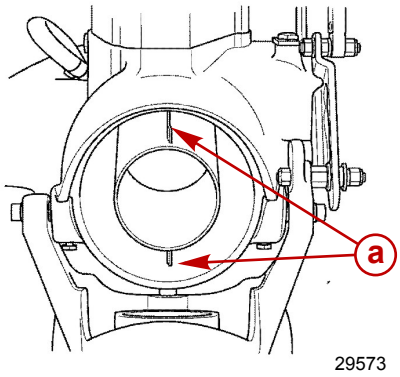
A rough water plate may be helpful in reducing cavitation when running in windy, rough water conditions where air is sucked into the water intake when jumping waves. Install a 0.8 mm (1/32 in.) metal plate that extends from the hull bottom to the top of the water intake housing. This plate tends to reduce air intake as well as reduce spray.



a - Rough water plate

Steering Pull Adjustment

The steering on some boats will have the tendency to pull towards starboard. This pulling condition can be corrected by using a pliers and bending the ends of the exhaust fins 1.5 mm (1/16 in.) toward the starboard side of the outboard.



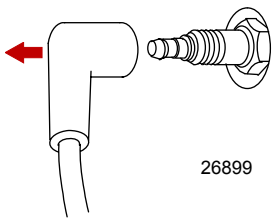
a - Exhaust fins

Impeller Removal and Installation

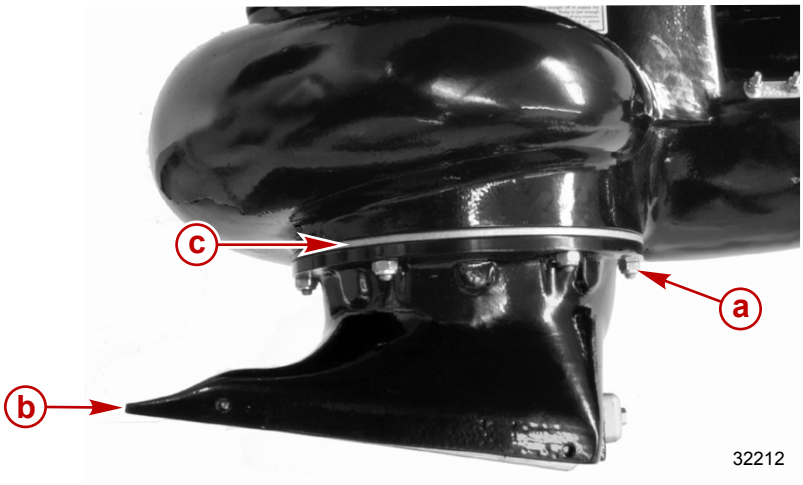
⚠ WARNING

Rotating the driveshaft may cause the engine to crank over and start. To prevent this type of accidental engine starting and possible serious injury caused from being struck by a rotating impeller, always turn the ignition key or lanyard stop switch to the "OFF" position and remove the spark plug leads from the spark plugs while servicing the impeller.

1. Shift the outboard to the neutral position.
2. Position the key switch or lanyard stop switch to the "OFF" position.
3. Remove the spark plug leads to prevent the engine from starting.

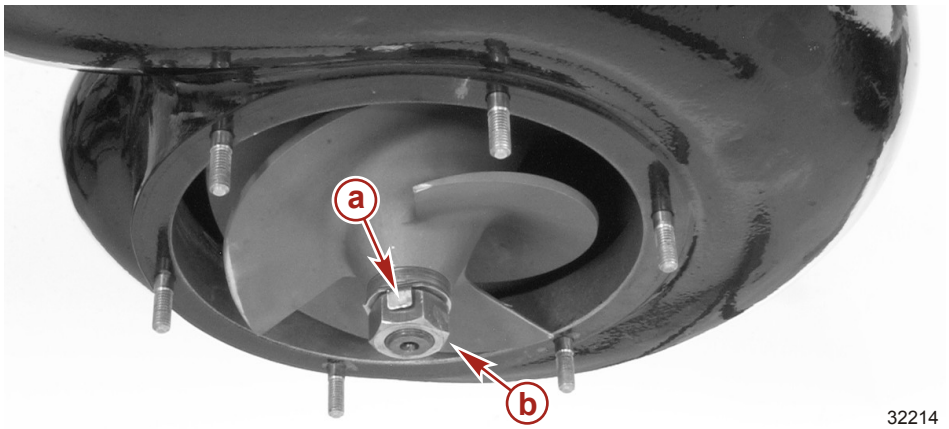


4. Remove the six locknuts and washers securing the water intake housing. Remove the water intake housing and liner.



a - Locknut and washer (6)
b - Front of the water intake housing
c - Liner

5. Straighten the bent tabs on the tab washer and remove the impeller nut.



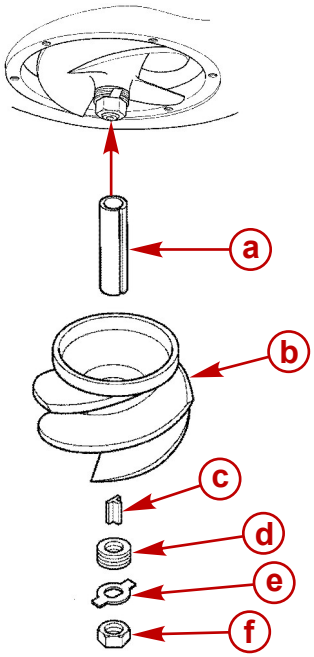
a - Tab
b - Impeller nut

6. Pull the impeller straight off the shaft. If the impeller is tight, use a hammer and a block of wood to rotate the impeller counterclockwise on the shaft until the keyway is directly above the flat on the shaft. This will free the jammed key and allow removal.

Installation

1. Lubricate the driveshaft, drive key, and impeller bore.
2. Place the plastic sleeve into the impeller bore.

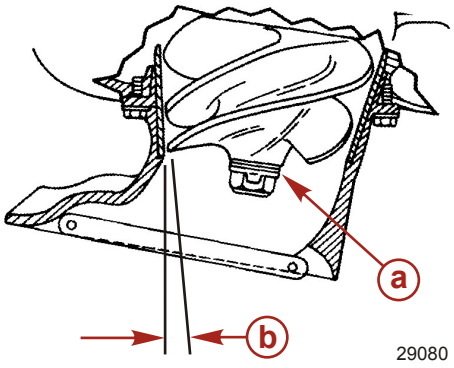
3. Install the drive key, impeller, shims, tab washer, and impeller nut.



a - Plastic sleeve
b - Impeller
c - Drive key
d - Shims
e - Tab washer
f - Impeller nut

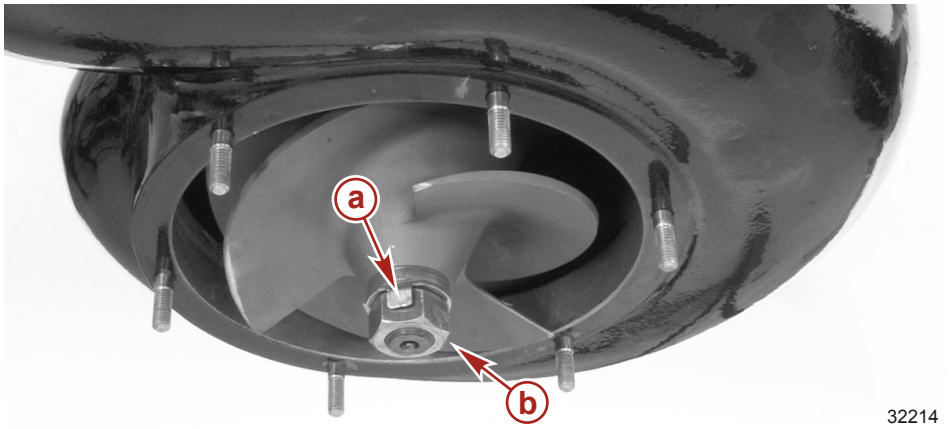
Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Driveshaft, drive key, and impeller bore	92-802859A 1

4. Turn the nut tight on the shaft to remove any play between the impeller and shaft. If the tabs on the tab washer do not line up with the flats on the nut, remove the nut and turn the tab washer over and tighten the nut again.
5. The impeller should be adjusted so there is approximately 0.8 mm (0.030 in.) clearance between the impeller edge and liner. Operating the jet drive in waters that contain sand and gravel can cause wear to the impeller blades, and the clearance will start to exceed 0.8 mm (0.030 in.). As the blades wear, shims located in the stack outside of the impeller can be transferred behind the impeller. This will move the impeller farther down into the tapered liner to reduce the clearance.
6. Check the impeller clearance by sliding a feeler gauge through the intake grate and measure the clearance between the impeller edge and liner.
7. Temporarily install the water intake housing in order to check for impeller clearance. Shim washers can be transferred to either side of the impeller to raise or lower the impeller to the correct clearance setting. The water intake housing can be shifted sideways a small amount in order to center the liner.



a - Shims
b - Impeller clearance

8. After setting the impeller height, install the tab washer and tighten the impeller nut to the specified torque. If the tabs do not align with a flat on the nut, remove the nut and tab washer. Turn the tab washer over and tighten the impeller nut to the specified torque. Secure the impeller nut by bending tabs against the flats on the impeller nut.



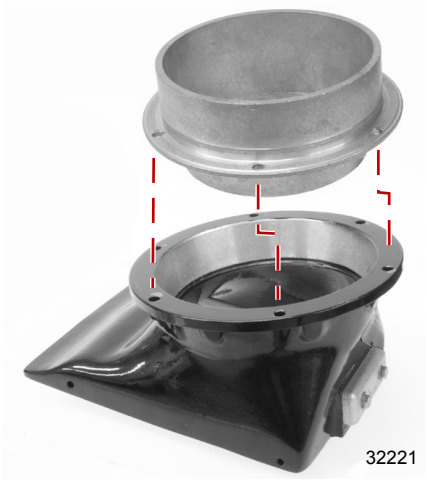
a - Tab
b - Impeller nut

Description	Nm	lb-in.	lb-ft
Impeller nut	53	–	39.1

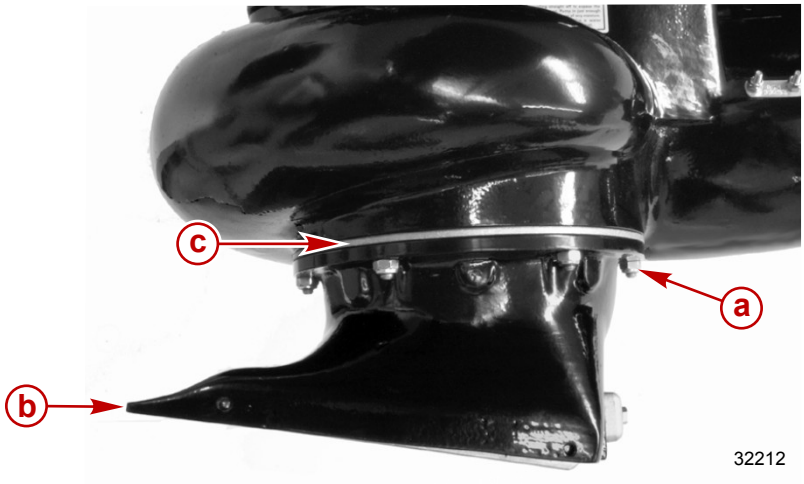
NOTE: *If the outboard is used in saltwater, apply Quicksilver or Mercury Extreme Grease around the entire flange surface on the water intake housing, liner, and pump housing.*

Tube Ref No.	Description	Where Used	Part No.
	Extreme Grease	Flange surfaces on the water intake housing, liner, and pump housing	8M0071842

9. Install the liner into the water intake housing.



10. Attach the water intake housing with the front of the housing facing the front of the outboard. Install a washer and locknut on each mounting stud. Tighten the locknuts to the specified torque.



a - Locknut and washer (6)
b - Front of the water intake housing
c - Liner

Description	Nm	lb-in.	lb-ft
Water intake housing mounting locknuts	16	142	–

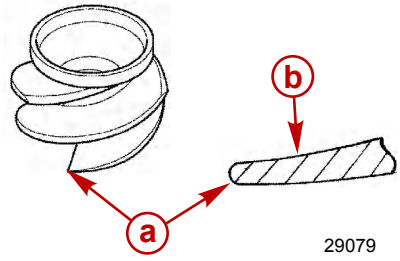
Worn/Dull Impeller

The intake of gravel through the pump can round off and wear the leading edges of the impeller. Some conditions that could be experienced from a worn/dull impeller are as follows:

- Noticeable performance loss, especially on acceleration
- Difficulty getting the boat on plane
- An increase in engine RPM at wide-open throttle

IMPORTANT: Do not sharpen or alter the top side lifting angle.

Check the impeller blades occasionally for damage. Use a flat file to sharpen the leading edges. Sharpen to a 0.8 mm (1/32 in.) radius by removing material from bottom side only.



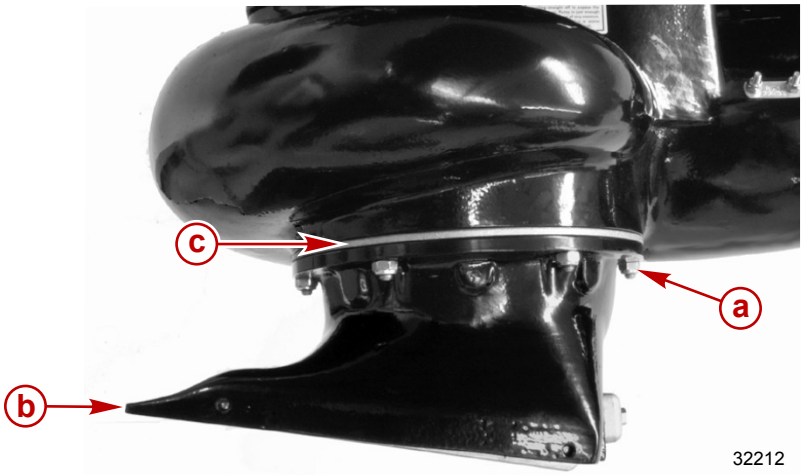
a - Leading edge
b - Top side lifting angle

Jet Drive Disassembly

Jet Drive Removal

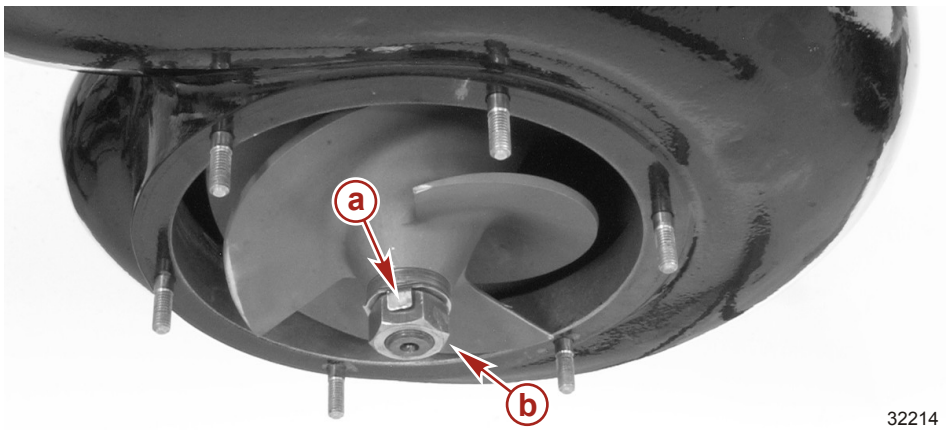
1. Disconnect the shift linkage.

2. Remove the six locknuts and washers securing the water intake housing. Remove the water intake housing and liner.



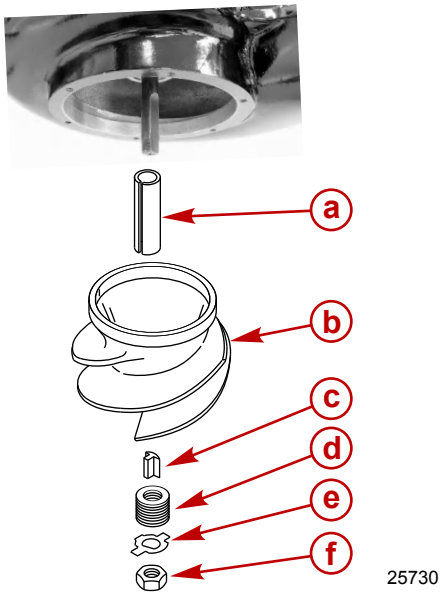
a - Locknut and washer (6)
b - Front of the water intake housing
c - Liner

3. Straighten the bent tabs on the tab washer and remove the impeller nut.



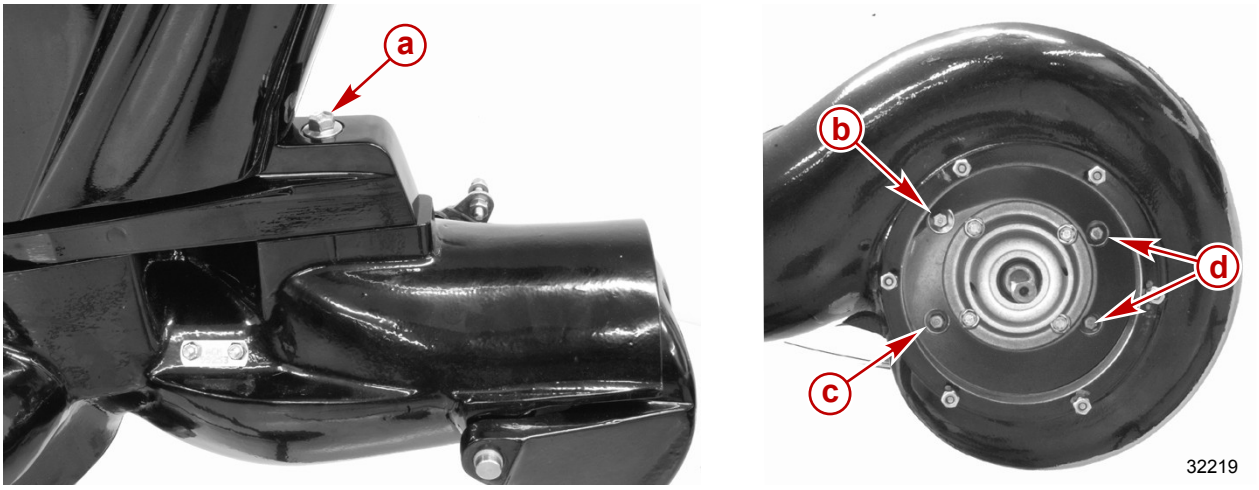
a - Tab
b - Impeller nut

4. Pull the impeller straight off the shaft. If the impeller is tight, use a hammer and a block of wood to rotate the impeller counterclockwise on the shaft until the keyway is directly above the flat on the shaft. This will free the jammed key and allow removal.



a - Plastic sleeve
b - Impeller
c - Drive key
d - Shims
e - Tab washer
f - Impeller nut

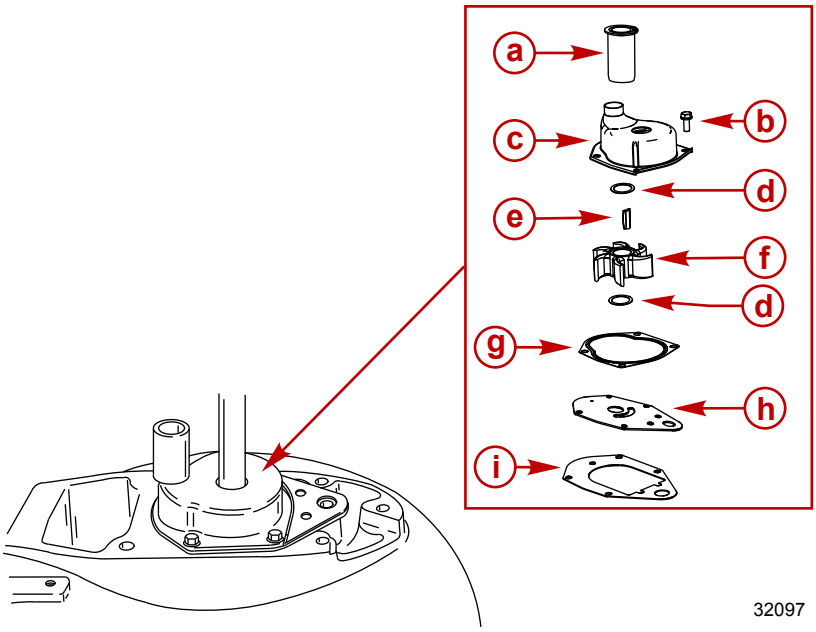
5. Remove the five bolts securing the jet drive to the driveshaft housing. Remove the jet drive.



a - Bolt (M10 x 70)
b - Bolt (M10 x 90)
c - Bolt (M10 x 70)
d - Bolt (M10 x 60) (2)

Water Pump Disassembly

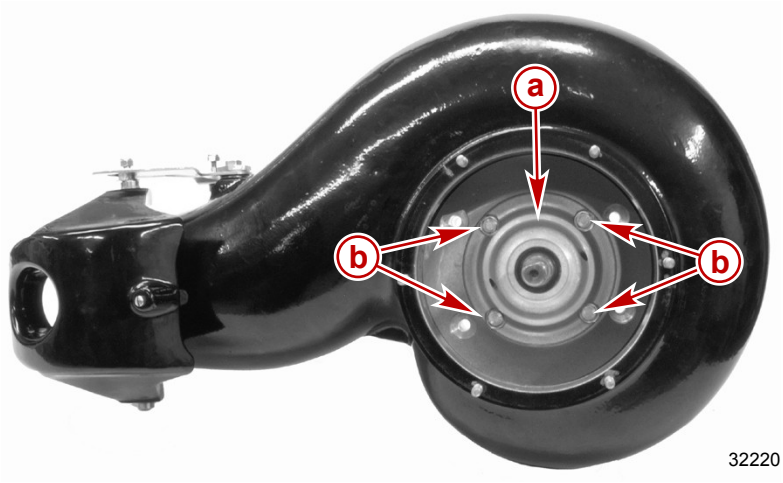
1. Remove the four bolts securing the water pump assembly.
2. Remove the water pump.



a - Water tube coupler
b - Bolt (M6 x 16) (4)
c - Housing
d - Plastic washer (2)
e - Drive key
f - Impeller
g - Beaded gasket
h - Face plate
i - Gasket

Bearing Carrier Removal

Remove the four bolts securing the bearing carrier to the jet drive. Remove the bearing carrier.



a - Bearing carrier
b - Bolt (M8 x 25) (4)

Liner Removal

Remove the liner from the water intake housing.

Jet Drive Assembly

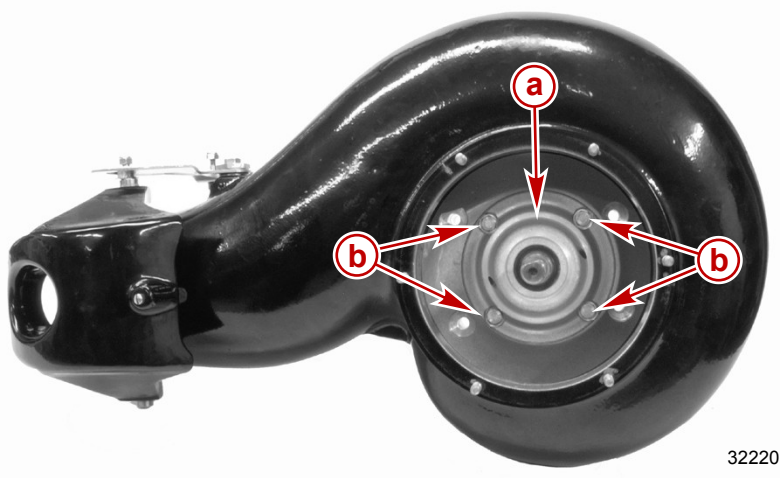
Bearing Carrier Installation

NOTE: *Individual bearing carrier components are not sold separately. The bearing carrier must be serviced as an assembly.*

1. Ensure the three O-ring seals are in place.

a - O-ring seals

2. Place the bearing carrier into the jet drive and fasten with four bolts. Apply Loctite 271 Threadlocker to the bolt threads and tighten the bolts to the specified torque.



a - Bearing carrier
b - Bolt (M8 x 25) (4)

Description	Nm	lb-in.	lb-ft
Bearing carrier mounting bolts	16	142	–

Tube Ref No.	Description	Where Used	Part No.
7	Loctite 271 Threadlocker	Bearing carrier mounting bolt threads	92-809819

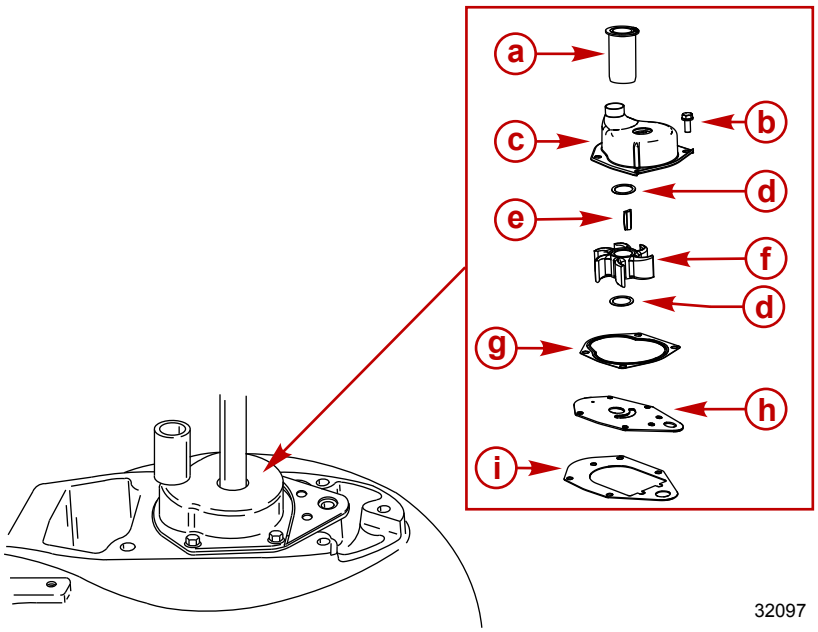
Water Pump Assembly and Installation

NOTE: *Replace the water pump cover if thickness of the steel at the discharge slots is 1.5 mm (0.060 in.) or less, or if the grooves (other than impeller sealing groove) in the cover roof are more than 0.8 mm (0.030 in.) deep.*

1. Replace the impeller if:
   a. Impeller blades are cracked, torn, or worn.
   b. Impeller is glazed or melted (caused by insufficient water supply).
   c. Rubber portion of the impeller is not bonded to the impeller hub.
2. Install the gasket and base plate onto the jet drive housing.
3. Lubricate the gasket bead with 2-4-C with PTFE. Install the gasket with the bead facing toward the cover.
4. Install one plastic washer.
5. Install the drive key, impeller, and plastic washer.

   IMPORTANT: If the impeller was previously used and the vanes have taken a set, do not install the impeller with the vanes reversed from their previous set. The vanes will break shortly after the outboard is returned to service.
6. Apply a light coat of 2-4-C with PTFE to the inside diameter of the cover to ease installation over the impeller. Install the cover. Rotate the driveshaft clockwise while pressing the cover down over the impeller.
7. Apply Loctite 271 Threadlocker to the water pump cover bolts. Install the bolts and tighten to the specified torque.

8. Lubricate the inside diameter of the water tube coupler with 2-4-C with PTFE. Install the water tube coupler onto the water pump assembly.



a - Water tube coupler
b - Bolt (M6 x 16) (4)
c - Housing
d - Plastic washer (2)
e - Drive key
f - Impeller
g - Beaded gasket
h - Face plate
i - Gasket

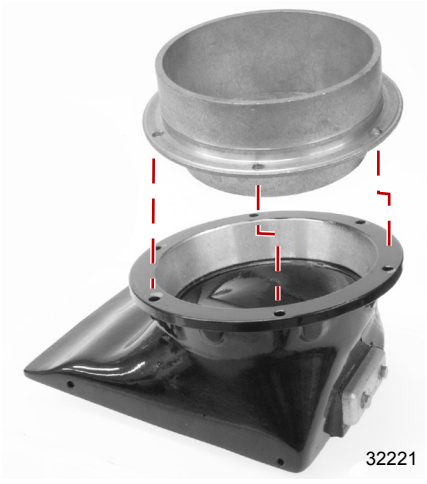
Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Inside diameter of the water pump cover, gasket bead, and inside diameter of the water tube coupler	92-802859A 1
7	Loctite 271 Threadlocker	Water pump cover bolts	92-809819

Description	Nm	lb-in.	lb-ft
Water pump cover bolts (M6 x 16) (4)	7	62	–

Liner Installation

NOTE: *If the outboard is used in saltwater, apply Extreme Grease around both sides of the water intake liner flange.*

Install the liner into the water intake housing.



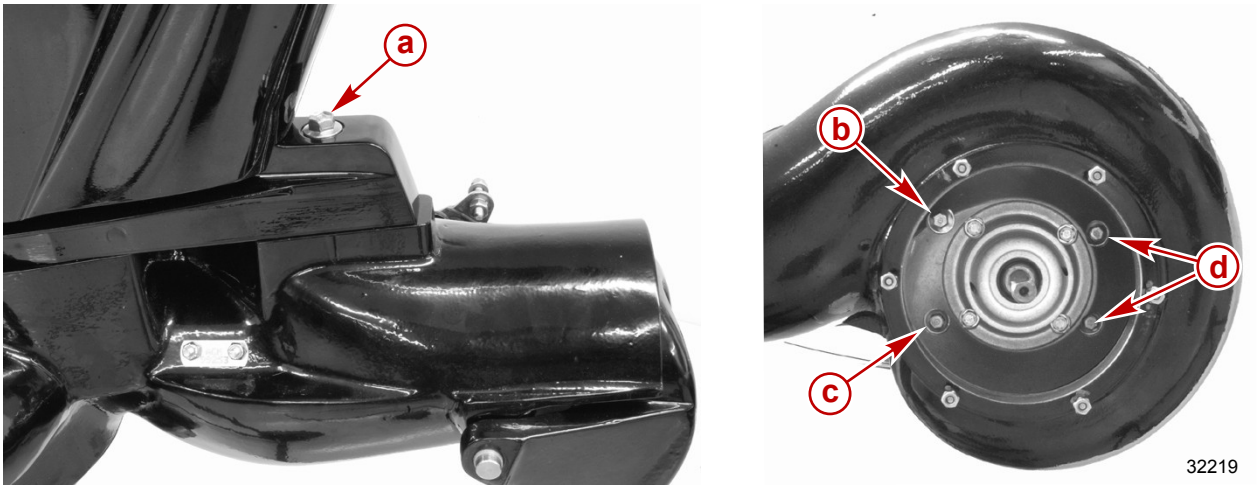
Tube Ref No.	Description	Where Used	Part No.
	Extreme Grease	Both sides of the water intake liner flange	8M0071842

Jet Drive Installation

1. Isolate and remove the spark plug leads from the spark plugs.
2. Lubricate the splines on the driveshaft with 2-4-C with PTFE. Do not apply lubricant on the top surface of the driveshaft.

NOTICE
Installing the jet drive to the powerhead without adequately cleaning the top of the driveshaft can result in severe product damage. Any lubricant trapped in the space between the driveshaft and the engine's crankshaft prevent the two from properly engaging. Always clean the top of the driveshaft before installing the jet drive.

3. Guide the jet drive into the driveshaft housing, making sure the driveshaft engages the crankshaft and the water tube enters the water tube coupler.
4. Install the jet drive to the driveshaft housing with the five bolts shown. Apply Loctite 271 Threadlocker to the bolt threads and tighten the bolts to the specified torque.



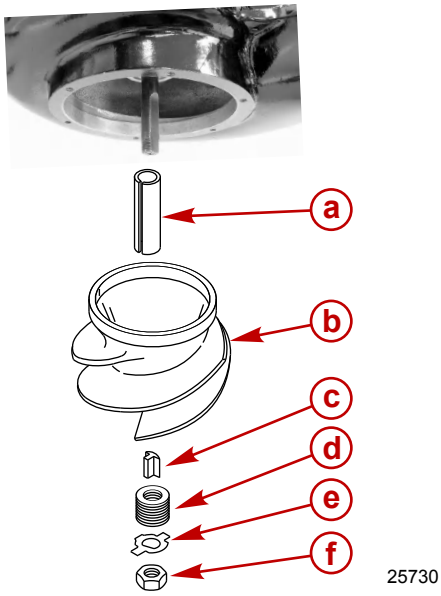
a - Bolt (M10 x 70)
b - Bolt (M10 x 90)
c - Bolt (M10 x 70)
d - Bolt (M10 x 60) (2)

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Driveshaft splines	92-802859A 1
7	Loctite 271 Threadlocker	Jet drive mounting bolt threads	92-809819

Description	Nm	lb-in.	lb-ft
Jet drive mounting bolts (M10) (5)	54	–	40

5. Lubricate the driveshaft and impeller bore with 2-4-C with PTFE.
6. Place the plastic sleeve inside the impeller and install the impeller, as shown.

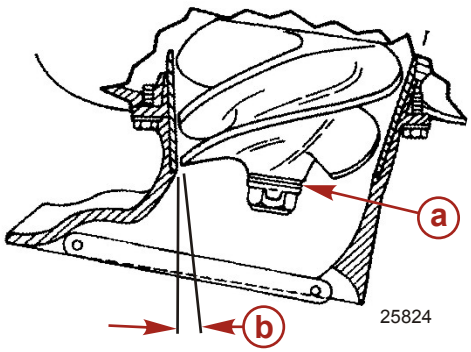
7. Tighten the impeller nut on the shaft to remove any play between the impeller and shaft. If the tabs on the tab washer do not line up with the flats on the nut, remove the nut and turn the tab washer over and tighten the nut again.



- **a -** Plastic sleeve
- **b -** Impeller
- **c -** Drive key
- **d -** Shims
- **e -** Tab washer
- **f -** Impeller nut

Tube Ref No.	Description	Where Used	Part No.
95	2-4-C with PTFE	Driveshaft and impeller bore	92-802859A 1

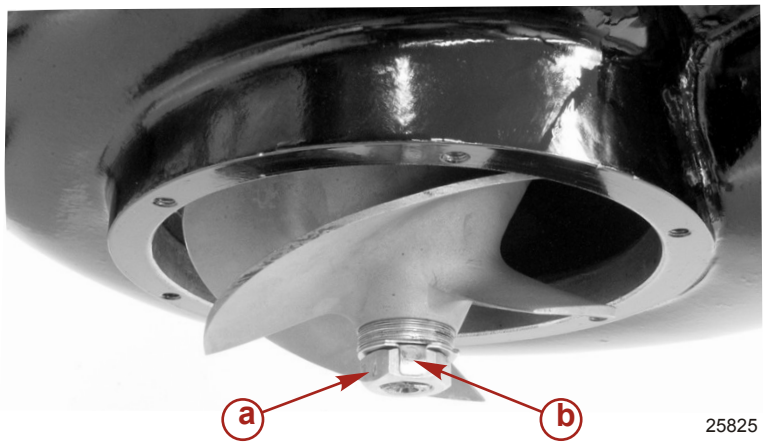
8. Temporarily reinstall the water intake housing in order to check for impeller clearance. The clearance between the impeller and liner should be 0.8 mm (0.030 in.). Shim washers can be transferred to either side of the impeller to raise or lower the impeller to the correct clearance setting.



- **a -** Shim washers
- **b -** Impeller clearance

Impeller clearance	
Clearance between impeller and liner	0.8 mm (0.030 in.)

9. After setting the impeller height, install the tab washer and tighten the impeller nut to the specified torque. If the tabs do not align with a flat on the nut, remove the nut and tab washer. Turn the tab washer over and tighten the impeller nut to the specified torque. Secure the impeller nut by bending tabs against the flats on the impeller nut.



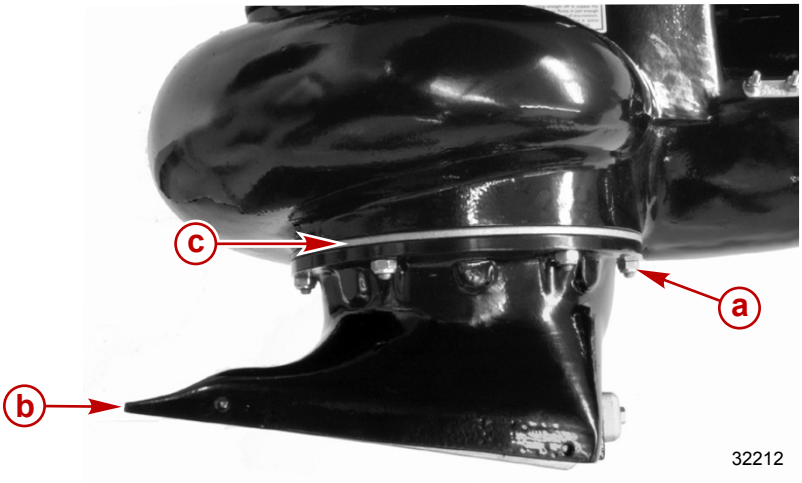
a - Impeller nut
b - Tab

Description	Nm	lb-in.	lb-ft
Impeller nut	53	–	39.1

NOTE: *If the outboard is used in saltwater, apply Quicksilver or Mercury Precision Extreme Grease around the entire flange surface on the water intake housing, liner, and pump housing.*

Tube Ref No.	Description	Where Used	Part No.
	Extreme Grease	Flange surfaces on the water intake housing, liner, and pump housing	8M0071842

10. Install the water intake housing with the front of the housing facing towards the front of the outboard. Attach the water intake housing with six locknuts. Tighten the locknuts to the specified torque.



a - Locknut and washer (6)
b - Front of the water intake housing
c - Liner

Description	Nm	lb-in.	lb-ft
Water intake housing mounting locknuts	16	142	–

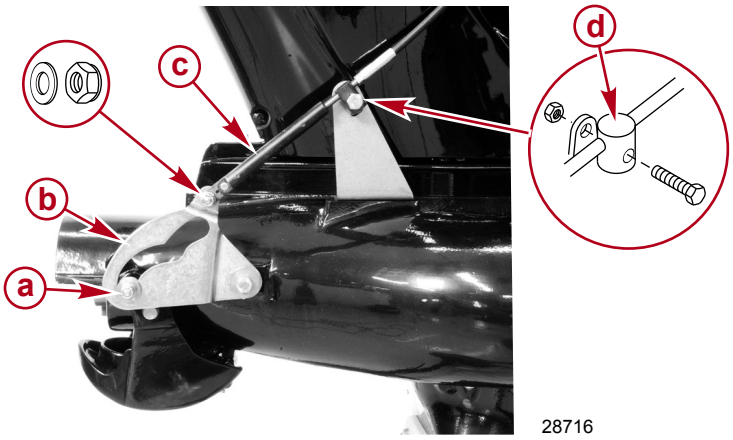
Shift Cable (Remote Control Models)

⚠ WARNING

The shift cable must be adjusted to lock the reverse gate against unexpected engagement caused by water pressure hitting the gate while operating the boat in forward. Activation of the reverse gate will cause sudden unexpected stopping of the boat. This can cause serious injury or death from occupants being thrown within or out of the boat.

1. Attach the shift cable to the shift cam with a flat washer and a self-locking nylon insert locknut as shown. Tighten the locknut against the flat washer, then back-off the locknut 1/4 turn.

2. Place the remote control handle into full forward position.
3. Adjust the shift cable adjustment barrel so that the roller is at the full end of travel (bottom) in the shift cam.
4. Attach the shift cable adjustment barrel to the bracket with a bolt and locknut. Tighten the bolt until it seats against the adjustment barrel, then back-off the bolt 1/4 turn. Hold the bolt from turning, and tighten the locknut on the bolt. The adjustment barrel must be free to pivot.



28716

a - Roller
b - Shift cam
c - Shift cable
d - Shift cable adjustment barrel

5. Recheck the shift cable adjustment in forward shift position. The correct shift adjustment will position the shift cam far enough on the roller to lock the reverse gate into forward position. Push on the reverse gate by hand to verify it is locked into position. The reverse gate should not move when pushed toward the neutral position.

IMPORTANT: The reverse gate must lock into the forward position. If not, readjust the shift cable.

Shift Cable Connection to the Shift Cam and Adjustment (Tiller Models)

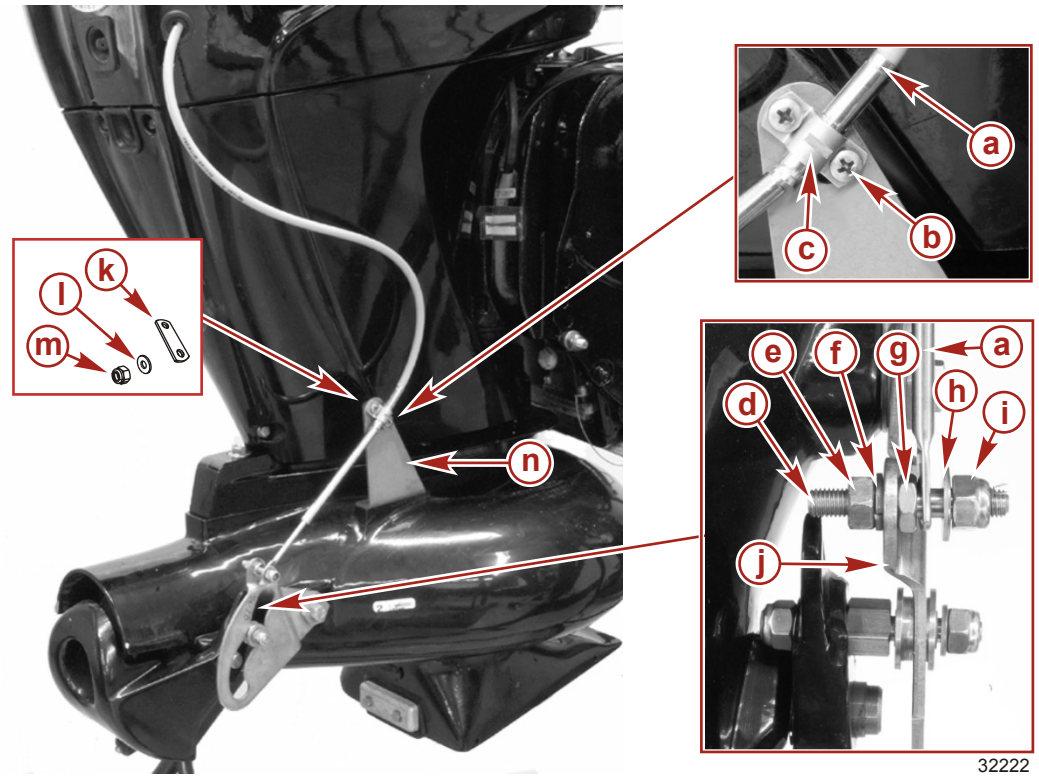
Installation

⚠ WARNING

The shift cable must be adjusted to lock the reverse gate against unexpected engagement caused by water pressure hitting the gate while operating the boat in forward. Activation of the reverse gate will cause sudden unexpected stopping of the boat. This can cause serious injury or death from occupants being thrown within or out of the boat.

1. Attach the shift cable stud to the shift cam with the hardware shown. Install the thin nut onto the shift cable stud and tighten against the shoulder. Install the stud through the shift cam. Install the lockwasher and nut. Drive tight.
2. Install the shift cable onto the stud with a washer and locknut. Tighten the locknut against the shoulder.

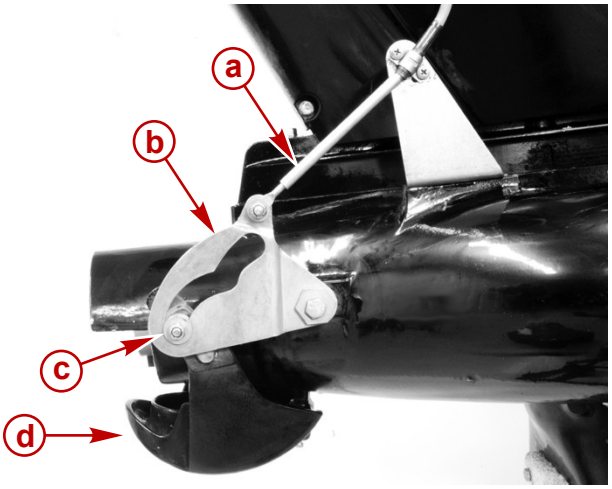
3. Center the cable clamp over the retaining groove on the shift cable. Secure the cable clamp and shift cable to the bracket with the plate, two screws, washers, and locknuts.



- **a -** Shift cable
- **b -** Screw (M4 x 16) (2)
- **c -** Cable clamp
- **d -** Shift cable stud
- **e -** Nut
- **f -** Lockwasher
- **g -** Thin nut
- **h -** Washer
- **i -** Locknut
- **j -** Shift cam
- **k -** Plate
- **l -** Washer
- **m -** Locknut
- **n -** Bracket

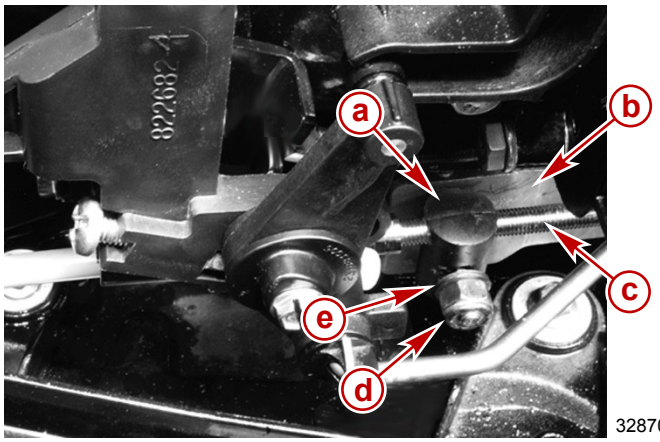
Adjustment

1. Place the shift handle into the full forward position. The roller should be at the full end of travel (bottom) in the shift cam.



- **a -** Shift cable
- **b -** Shift cam
- **c -** Roller
- **d -** Reverse gate

2. If adjustment is required, adjust the shift cable adjustment barrel so that the roller is at the full end of travel (bottom) in the shift cam in the forward position.



32870

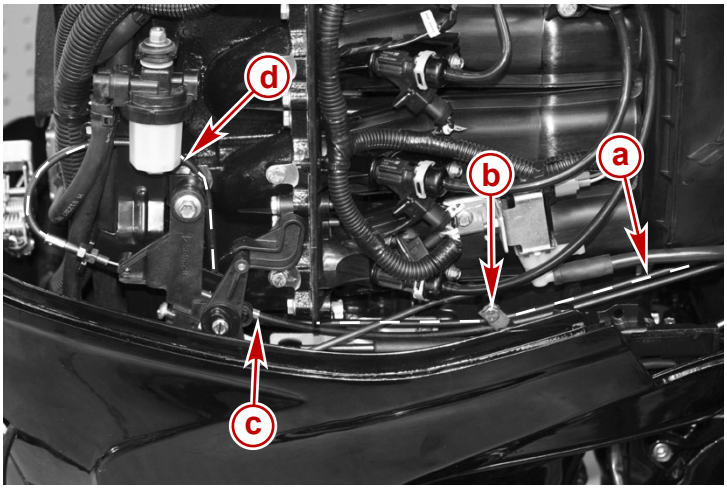
- **a -** Shift cable adjustment barrel
- **b -** Shift cable bracket
- **c -** Shift cable
- **d -** Locknut
- **e -** Washer

3. Recheck the shift cable adjustment in forward shift position. The correct shift adjustment will position the shift cam far enough on the roller to lock the reverse gate into forward position. Push on the reverse gate by hand to verify it is locked into position. The reverse gate should not move when pushed toward the neutral position.

   IMPORTANT: The forward locking of the reverse gate must be met. If not, readjust the shift cable.

Throttle Cable Installation and Adjustment

1. Route the long throttle cable, as shown.
2. Secure the throttle cables with a J-clip. Tighten the J-clip mounting bolt to the specified torque.



32197

Jet model shown

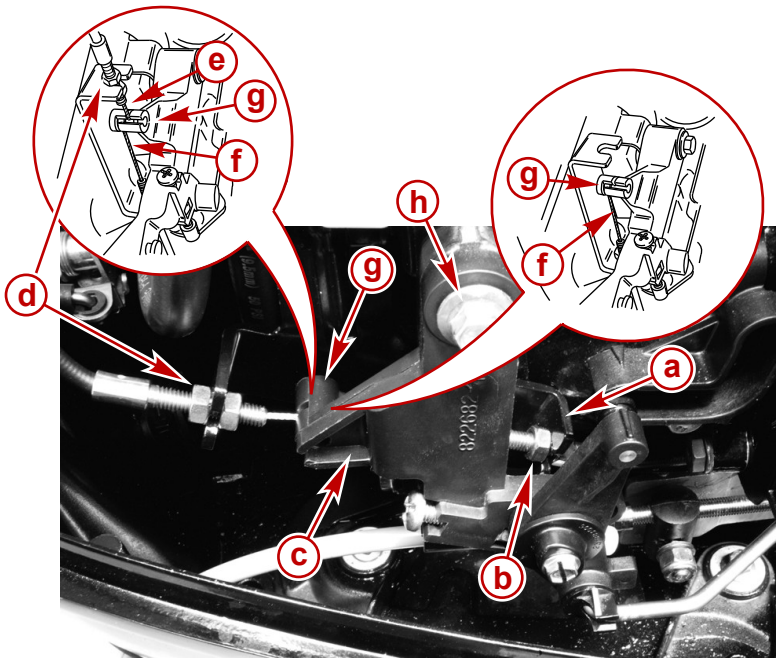
- **a -** Throttle cables routed through the grommet
- **b -** J-clip and bolt
- **c -** Short throttle cable
- **d -** Long throttle cable routed behind the fuel filter

Description	Nm	lb-in.	lb-ft
J-clip mounting bolt	8.5	75	

3. Rotate the throttle grip to the idle position.

   NOTE: *It may be necessary to loosen or remove the throttle lever to install the throttle cables.*
4. Insert the short throttle cable anchor into the anchor boss slot on the throttle lever.
5. Secure the short throttle cable into position by tightening the jam nuts onto the bracket (finger-tighten only).
6. Insert the long throttle cable anchor into the anchor boss slot on the throttle lever.

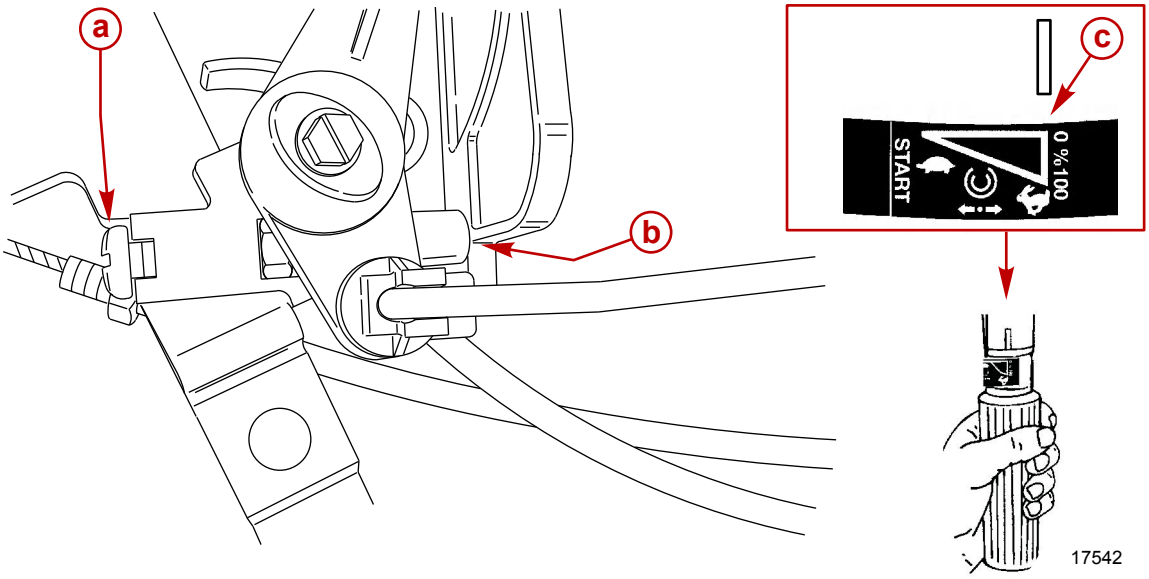
7. Secure the long throttle cable into position by tightening the jam nuts onto the bracket (finger-tighten only).



- **a -** Shift cable bracket
- **b -** Short throttle cable jam nut
- **c -** Throttle lever
- **d -** Long throttle cable jam nut
- **e -** Long throttle cable anchor
- **f -** Short throttle cable anchor
- **g -** Anchor boss
- **h -** Throttle lever bolt (M8 x 70)

8. Adjust the throttle stop.
   a. Rotate the throttle grip to the wide-open throttle position.
   b. Turn the throttle stop screw counterclockwise until there is a gap.
   c. Hold the throttle grip in the wide-open throttle position and adjust the throttle stop screw clockwise until it contacts the plate.
9. Rotate the throttle grip to the full throttle position. Keep adjusting until the wide-open throttle stop screw lightly contacts the plate.

   NOTE: *No free play should exist in the throttle grip handle once the wide-open throttle stop screw has hit the plate. If this condition exists, readjust the jam nuts on the appropriate throttle cable.*



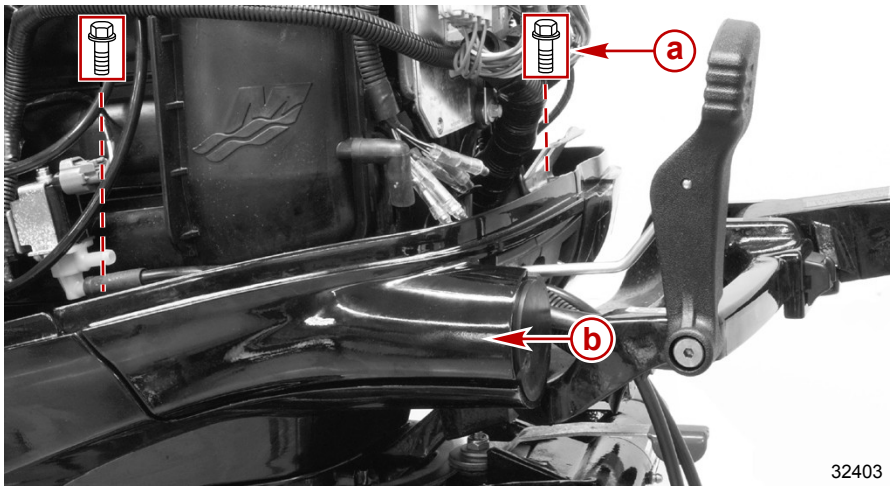
- **a -** Wide-open throttle stop screw
- **b -** Throttle stop touching the plate
- **c -** Wide-open throttle position

IMPORTANT: After installation, cycle the throttle grip several times from the idle position to the wide-open throttle position. Ensure the wide-open throttle stop screw is still contacting the plate. If it is not, readjust the jam nuts.

10. When the cables and throttle stop are adjusted, tighten the throttle cable jam nuts. Tighten the M8 x 70 bolt to the specified torque.

Description	Nm	lb-in.	lb-ft
Bolt (M8 x 70)	11.3	100	

11. Check throttle link operation. Refer to **Section 7A - Throttle Link Setting**.
12. Install the access cover. Tighten the bolts to the specified torque.



a - Bolt (M6 x 16) (2)
b - Access cover

Description	Nm	lb-in.	lb-ft
Access cover bolts (M6 x 16) (2)	10	88.5	

Color Diagrams

Section 9A - Color Diagrams

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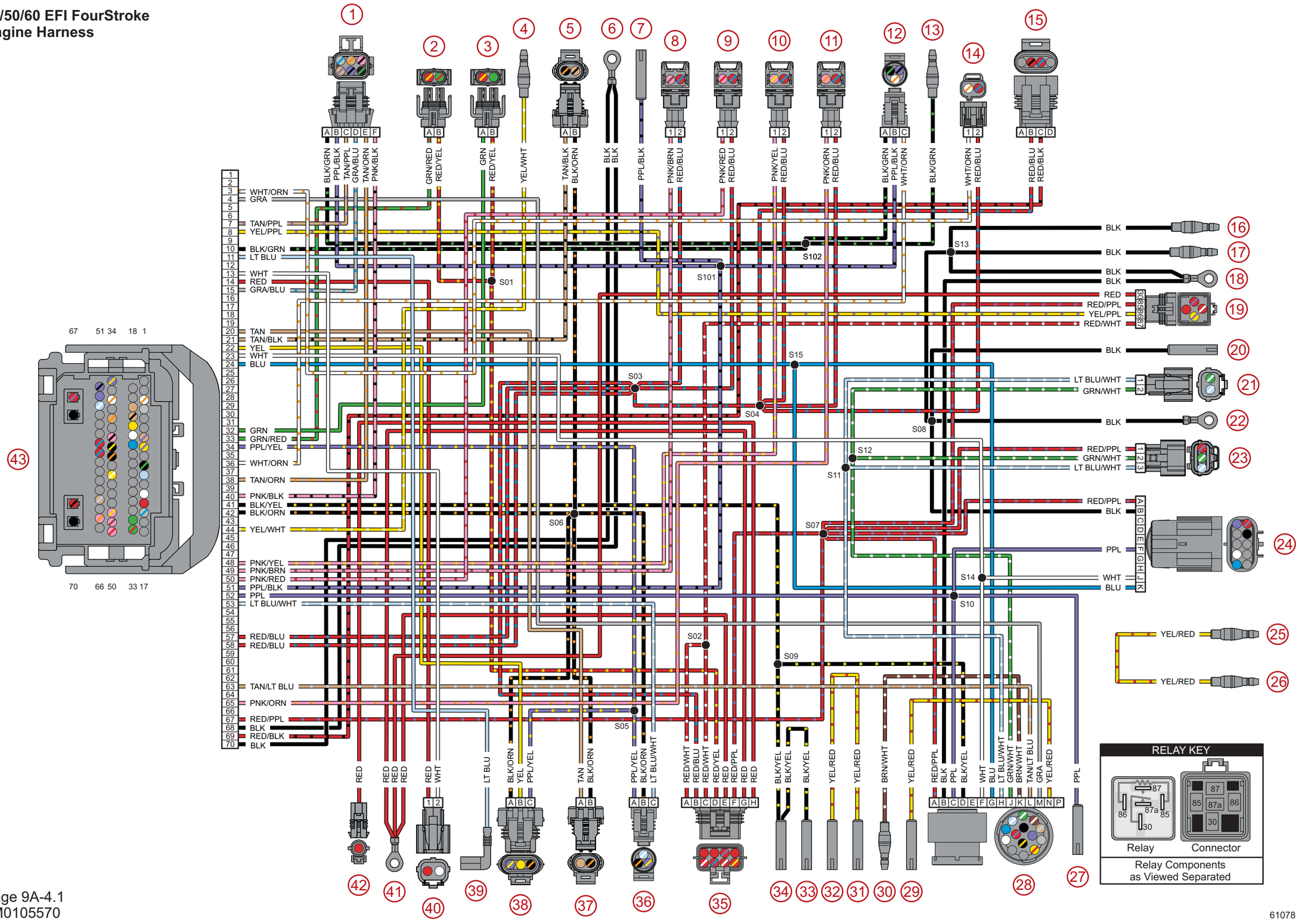
40/50/60 EFI FourStroke
Engine Harness



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