General Information 1

Tools and Techniques 2

Troubleshooting and Testing 3

Lubrication, Maintenance and Tune-Up 4

Synchronization and Adjustment 5

Fuel System 6

Electrical and Ignition Systems 7

Power Head 8

Gearcase and Midsection 9

Manual Rewind Starter 10

Power Trim and Tilt Repair 11

Index 12

Wiring Diagrams 13

Contents

QUICK REFERENCE DATA . . . . **IX**

CHAPTER ONE
GENERAL INFORMATION **1**

Manual organization 1
Notes. cautions and warnings 1
Torque specifications 2
Engine operation 2
Fasteners 2
Lubricants 8
Gasket sealant 10
Galvanic corrosion 11
Protection from galvanic corrosion. 13
Propellers 14

CHAPTER TWO
TOOLSANDTECHNIQUES **21**

Safety first 21
Basic hand tools 21
Test equipment 26
Service hints 28
Special tips 30
Mechanics' techniques 31

CHAPTER THREE
TROUBLESHOOTING AND TESTING* **33**

Test equipment 33
Troubleshooting preparation 36
Operating requirements 37
Starting difficulty 37
Ignition system testing 39
Warning system 44
Starting system 45
Charging system 50
Fuses and wire harness 54
Engine speed limiting system 54
Trim system 57
Electrical testing 63
Engine noises 67
Cooling system 69
Gearcase 72

CHAPTER FOUR
LUBRICATION, MAINTENANCE AND TUNE-UP 80

Tune-up 92
Submersion 96
Storage 97

CHAPTER FIVE
SYNCHRONIZATION AND ADJUSTMENT* 101

Fuel system 101
Ignition timing 106
Throttle linkage adjustment (all models) 115

CHAPTER SIX
FUEL SYSTEM 126

Fuel tank 129
Fuel filter replacement 132
Primer bulb 132
Fuel pumps 133
Carburetor 137

CHAPTER SEVEN
ELECTRICAL AND IGNITION SYSTEMS 149

Battery 149
Electric starting system 154
Starter motor 154
Charging system 163
Ignition system 165
Warning system 171

CHAPTER EIGHT
POWERHEAD 181

Flywheel 181
Power head 186
Inspection 202

CHAPTER NINE
GEARCASE AND MIDSECTION 213

Gearcase operation 213
Propeller removal and installation 214
Gearcase removal and installation 216
Water pump 222
Gearcase 228
Inspection 252

CHAPTER TEN
MANUAL REWIND STARTER 257

Removal. repair and installation 257

CHAPTER ELEVEN
POWER TRIM AND TILT REPAIR 263
Fluid filling 269
Air bleeding 269

INDEX. 274

WIRING DIAGRAMS 282

Quick Reference Data

MAINTENANCE SCHEDULE

10 hours (two weeks)	Inspect engine mounting bolts. Inspect lower engine cover bolts. Inspect propeller nut. Inspect propeller shaft housing bolts. Inspect gearcase bolts. Inspect driveshaft-housing bolts. Inspect starter motor bolts (installation). Inspect flywheel nut. Inspect oil pump bolts. Inspect crankcase bolts. Inspect intake manifold bolts. Inspect exhaust cover bolts. Inspect carburetor-mounting bolts. Inspect cylinder head cover bolts. Inspect cylinder head bolts. Check spark plug gap; remove carbon deposits. Disassemble, clean and inspect fuel tank, fuel filters, fuel tank pick-up and fuel pump. Check for leakage. Check all electrical wires for looseness and damage. Check and adjust timing and carburetor linkage. Inspect choke and throttle linkage for loose or bent. Inspect and clean oil tank, hoses, and filter.
30 hours (1 month)	Inspect gearcase for oil level and add as required. Inspect gearcase for water or metallic matter in oil. Inspect and check the function of the warning system. Check and adjust timing and carburetor linkage. Inspect choke and throttle linkage for loose or bent.
50 hours (3 months)	Inspect engine mounting bolts. Inspect lower engine cover bolts. Inspect propeller nut. Inspect propeller shaft housing bolts. Inspect gearcase bolts. Inspect driveshaft-housing bolts. Inspect starter motor bolts (installation). Inspect flywheel nut. Inspect oil pump bolts. Inspect crankcase bolts. Inspect intake manifold bolts. Inspect exhaust cover bolts. Inspect carburetor-mounting bolts. Inspect cylinder head cover bolts. Inspect cylinder head bolts. Check spark plug gap; remove carbon deposits. Disassemble, clean and inspect fuel tank, fuel filters, fuel tank pick-up and fuel pump. Check for leakage. Warm engine and check cylinder compression.

(continued)

MAINTENANCE SCHEDULE (continued)

50 hours (3 months) (continued)	Inspect water pump impeller for wear and or damage. Inspect the amount of erosion on the sacrificial anodes. Check for proper installation and condition of the anode(s). Change the gearcase lubricant. Lubricate the swivel and tilt tube pivot points. Check trim fluid level. Lubricate throttle and shift linkage.
100 hours (6 months)	Remove carburetors clean and inspect float valve. Clean and inspect all fuel hoses and hose connectors. Check all electrical wires for looseness and damage. Inspect and clean oil tank, hoses, and filter. Inspect and remove all deposits from the water pump and impeller, water pipe, exhaust cover, thermostat, exhaust pipe and engine base. Check manual operation of trim/tilt by opening manual relief valve and move engine up and down.
200 hours (1 year)	Clean powerhead by removing carbon deposits from cylinder head, pistons, rings, inner and outer exhaust cover. Replace water pump impeller.
400 hours (2 year)	Replace all fuel hoses. Replace oil mixing check valve and oil hoses.

GEARCASE LUBRICANT CAPACITIES

Model	Capacity
2.5A-3.5A	90 mL (3.0 oz.)
3.5B	180 mL (6.1 oz.)
5	195 mL (6.6 oz.)
8-9.8	320 mL (10.8 oz.)
9.9-15-18	370 mL (12.5 oz.)
25-30	280 mL (9.5 oz.)
40	420 mL (14.2 oz.)
40-50	500 mL (17 oz.)
60B-70B	700 mL (24 oz.)
60C-70C	900 mL (30 oz.)
80-90-115-120-140	900 mL (30 oz.)

SPARK PLUG APPLICATION*

Model	Type
2.5-3.5	NGK BPR6HS-10 Champion RL87YC10
5-9.8	NGK BPR7HS-10 Champion RL82YC10
9.9-40	NGK BR7HS-10 Champion RL82C10
50-140	NGK BR8HS-10 Champion RL-78C

*Spark plug gap is 0.9-1.0 mm (0.035-0.039 in.).

TIMING SPECIFICATIONS

Throttle setting engine	Match line	Fully open RPM range	Fully closed (in gear) Match line	RPM range
2.5A	20° BTDC	3800-5200	20° BTDC	–
3.5A	20° BTDC	4200-5300	20° BTDC	–
3.5B	20° BTDC	4200-5300	20° BTDC	1100
5	30° BTDC	4500-5500	5° BTDC	850
8	22° BTDC	4500-5500	1.5° ATDC	750
9.8	26° BTDC	5000-6000	2.5° BTDC	750
9.9D	22° BTDC	4500-5300	3° ATDC	800
9.9D2	20° BTDC	4500-5300	3° ATDC	800
15D	22° BTDC	4750-5500	3° ATDC	800
15D2	25° BTDC	5200-5800	3° ATDC	800
18E	25° BTDC	4750-5500	3° ATDC	800
18E2	25° BTDC	5200-5800	3° ATDC	800
25C2	20° BTDC	4800-5500	2° ATDC	900
25C3	25° BTDC	5000-6000	4° ATDC	900
30A3	25° BTDC	4800-5500	2° ATDC	900
30A4	25° BTDC	5150-5850	4° ATDC	900
40 two-cylinder	25° BTDC	5200-5800	2° ATDC	850
40D three-cylinder	18° BTDC	4500-5500	3° ATDC	750
40D2	18° BTDC	5000-5700	3° ATDC	750
50D	24° BTDC	5000-5700	3° ATDC	750
50D2	20° BTDC	5150-5850	3° ATDC	750
60B	16° BTDC	4900-5600	3° ATDC	750
60C	17° BTDC	5150-5850	3° ATDC	750
70B	20° BTDC	4900-5600	3° ATDC	750
70C	17° BTDC	5150-5850	3° ATDC	750
80	17° BTDC	5000-5500	5° ATDC	700
90	20° BTDC	5000-5500	5° ATDC	700
115-120	17° BTDC	5200-5700	10° ATDC	700
140	20° BTDC	5200-5700	10° ATDC	700

IGNITION TIMING ADJUSTMENT

Model	Timing link rod	Throttle link rod	High speed stopper
40D-50D	129 mm (5.04 in.)	99 mm (3.86 in.)	–
40D2	101 mm (3.98 in.)	115 mm (4.53 in.)	–
50D2	98 mm (3.86 in.)	115 mm (4.53 in.)	–
60B-70B	133 mm (5.24 in.)	127 mm (5.00 in.)	7 mm (0.28 in.)
60C	146 mm (5.75 in.)	128 mm (5.04 in.)	22 mm (0.87 in.)
70C	146 mm (5.75 in.)	128 mm (5.04 in.)	14 mm (0.55 in.)
80A-90A	124 mm (4.88 in.)	131.5 mm (5.18 in.)	15 mm (0.6 in.)
115-120	127 mm (5.00 in.)	158 mm (6.22 in.)	18 mm (0.71 in.)
140	127 mm (5.00 in.)	158 mm (6.22 in.)	14 mm (0.55 in.)

ENGINE RPM AT IDLE AND TROLLING

Model	Idle RPM (neutral)	Trolling RPM
40-50 hp	900	750
60-70 hp	900	750
80-90 hp	900	750
115-140 hp	900	750

CYLINDER COMPRESSION

Model	kPa	psi
2.5-5 hp	539	78
8-9.8 hp	392	57
9.9-18 hp	760	110
25-30 hp	755	110
40 hp	735	107
40-50 hp	670	102
60-70 hp	833	121
80- 90 hp	804	117
115-140 hp	882	128

Chapter One

General Information

This detailed, comprehensive manual contains complete information on maintenance, tune-up, repair and overhaul. Hundreds of photos and drawings guide you through every step-by-step procedure.

Troubleshooting, tune-up, maintenance and repair are not difficult if you know what tools and equipment to use and what to do. Anyone not afraid to get their hands dirty, of average intelligence and with some mechanical ability, can perform most of the procedures in this book. See Chapter Two for more information on tools and techniques.

A shop manual is a reference. You want to be able to find information fast. Books are designed with you in mind. All chapters are thumb tabbed and important items are indexed at the end of the book. All procedures, tables, photos, etc., in this manual assume that the reader may be working on the machine or using this manual for the first time.

Keep this book handy in your tool box. It will help you to better understand how your machine runs, lower repair and maintenance costs and generally increase your enjoyment of your marine equipment.

MANUAL ORGANIZATION

This chapter provides general information useful to marine owners and mechanics.

Chapter Two discusses the tools and techniques for preventive maintenance, troubleshooting and repair.

Chapter Three describes typical equipment problems and provides logical troubleshooting procedures.

Following chapters describe specific systems, providing disassembly, repair, assembly and adjustment procedures in simple step-by-step form. Specifications concerning a specific system are included at the end of the appropriate chapter.

NOTES, CAUTIONS AND WARNINGS

The terms NOTE, CAUTION and WARNING have specific meanings in this manual. A NOTE provides additional information to make a step or procedure easier or clearer. Disregarding a NOTE could cause inconvenience, but would not cause damage or personal injury.

A CAUTION emphasizes areas where equipment damage could result. Disregarding a CAUTION could cause permanent mechanical damage; however, personal injury is unlikely.

A WARNING emphasizes areas where personal injury or even death could result from negligence. Mechanical damage may also occur. WARNINGS *are to* be *taken* seriously. In some cases, serious injury or death has resulted from disregarding similar warnings.

TORQUE SPECIFICATIONS

Torque specifications throughout this manual are given in foot-pounds (ft.-lb.) and either Newton meters (N•m) or meter-kilograms (mkg). Newton meters are being adopted in place of meter-kilograms in accordance with the International Modernized Metric System. Existing torque wrenches calibrated in meter-kilograms can be used by performing a simple conversion: move the decimal point one place to the right. For example, 4.7 mkg = 47 N•m. This conversion is accurate enough for mechanics' use even though the exact mathematical conversion is 3.5 mkg = 34.3 N•m.

ENGINE OPERATION

All marine engines, whether 2- or 4-stroke, gasoline or diesel, operate on the Otto cycle of intake, compression. power and exhaust phases.

4-stroke Cycle

A 4-stroke engine requires two crankshaft revolutions (4 strokes of the piston) to complete the Otto cycle. **Figure 1** shows gasoline 4-stroke engine operation. **Figure** 2 shows diesel 4-stroke engine operation.

2-stroke Cycle

A 2-stroke engine requires only I crankshaft revolution (2 strokes of the piston) to complete the Otto cycle. **Figure** 3 shows gasoline 2-stroke engine operation. Although diesel 2-strokes exist, they are not commonly used in light marine applications.

FASTENERS

The material and design of the various fasteners used on marine equipment are not arrived at by chance or accident. Fastener design determines the type of tool required to work with the fastener. Fastener material is carefully selected to decrease the possibility of physical failure or corrosion. See Galvanic *Corrosion* in this chapter for more information on marine materials.

Threads

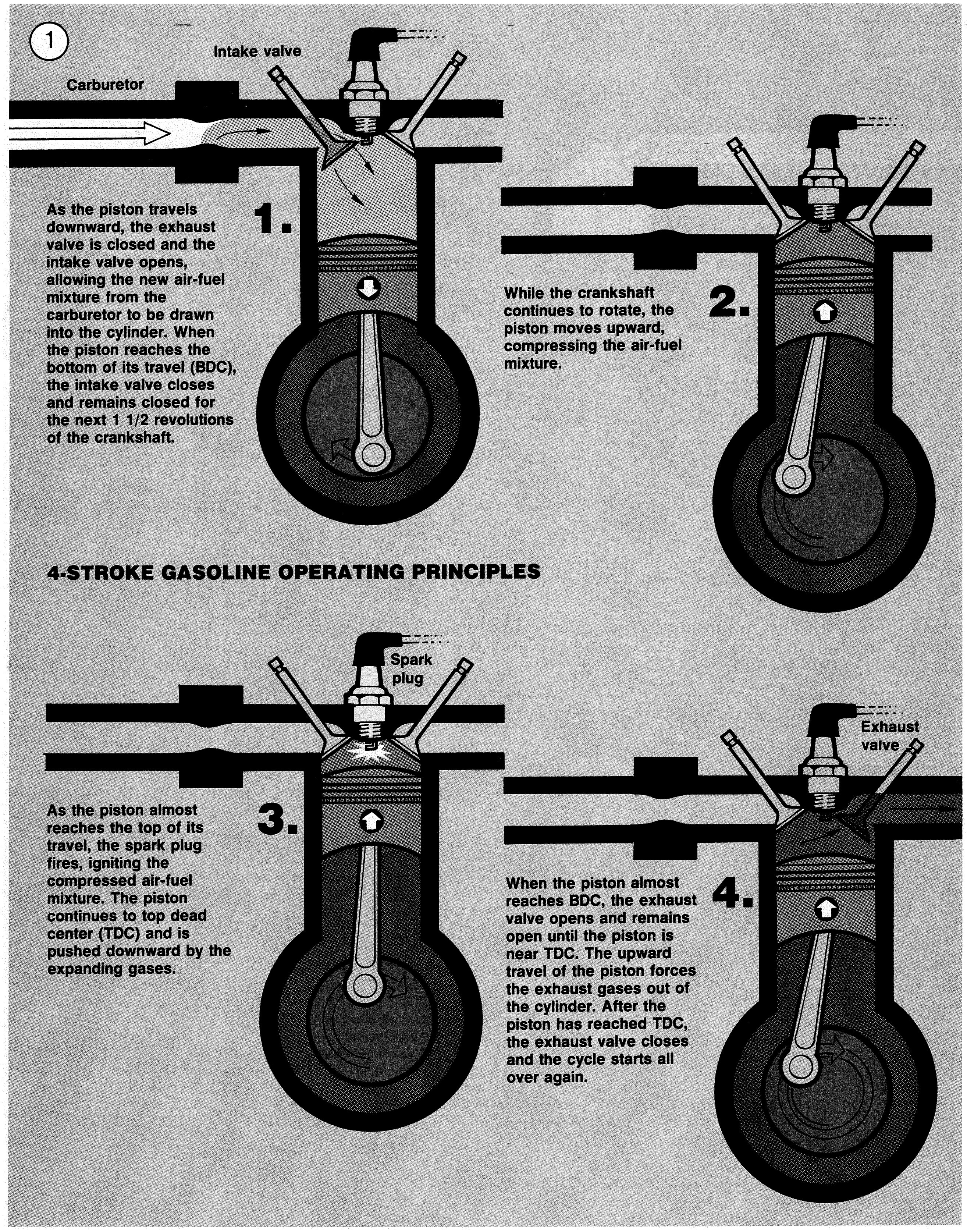
Nuts, bolts and screws are manufactured in a wide range of thread patterns. To join a nut and bolt, the diameter of the bolt and the diameter of the hole in the nut must be the same. It is just as important that the threads on both be properly matched.

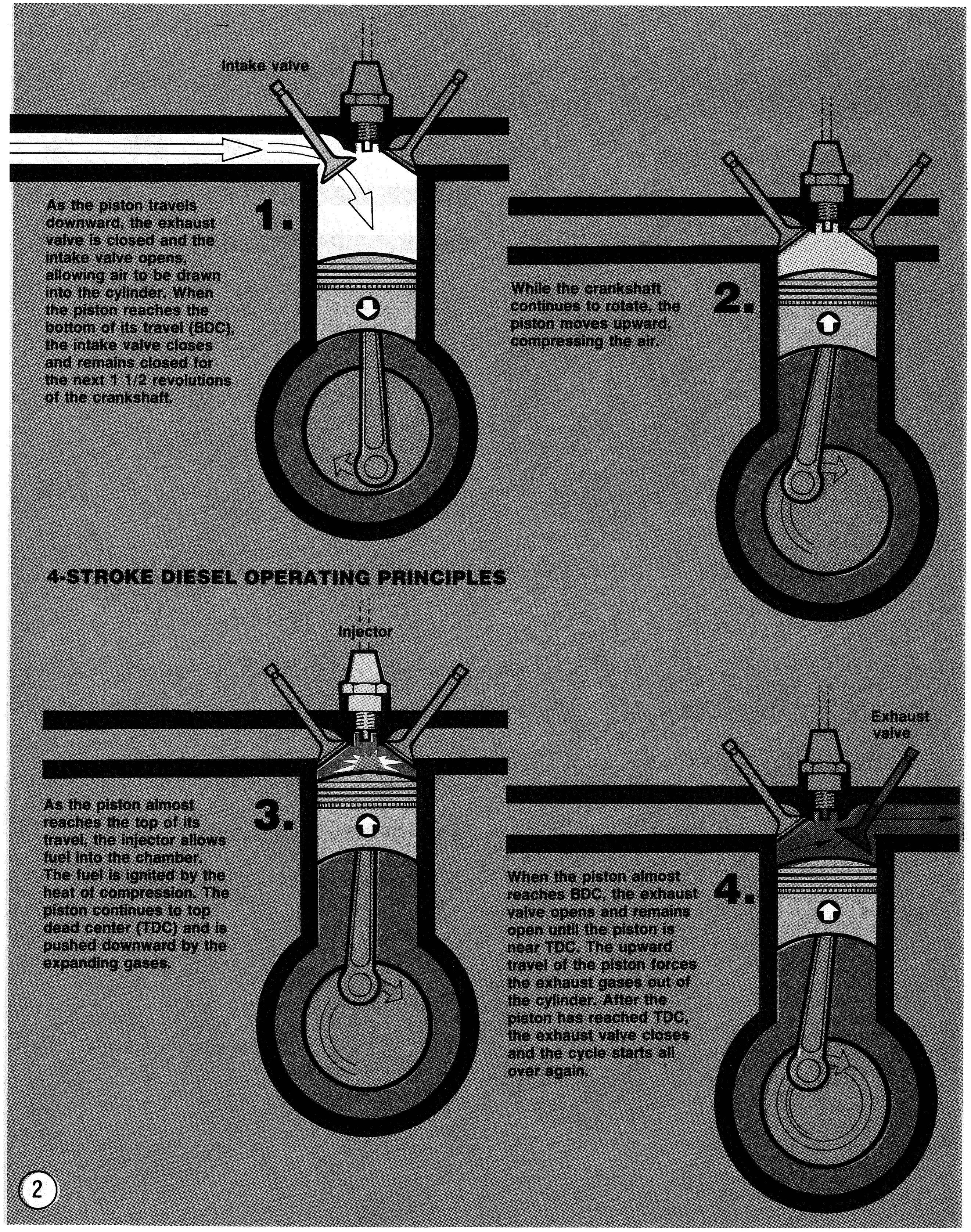
The best way to determine if the threads on two fasteners are matched is to turn the nut on the bolt (or the bolt into the threaded hole in a piece of equipment) with fingers only. Be sure both pieces are clean. If much force is required, check the thread condition on each fastener. If the thread condition is good but the fasteners jam, the threads are not compatible.

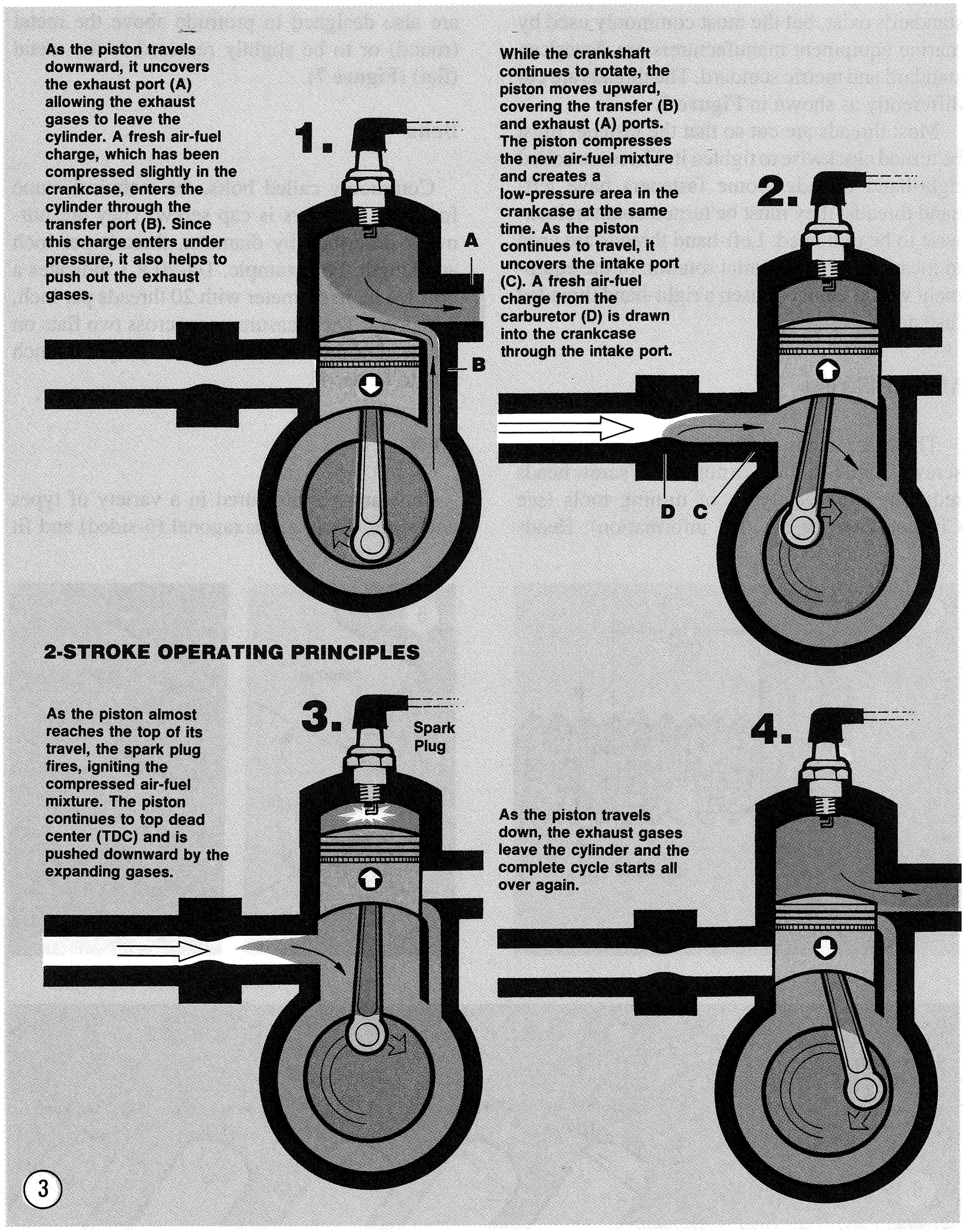
Four important specifications describe every thread:

a. Diameter.
b. Threads per inch.
c. Thread pattern.
d. Thread direction.

Figure 4 shows the first two specifications. Thread pattern is more subtle. Italian and British


1
Intake valve
Carburetor
1.
As the piston travels downward, the exhaust valve is closed and the intake valve opens, allowing the new air-fuel mixture from the carburetor to be drawn into the cylinder. When the piston reaches the bottom of its travel (BDC), the intake valve closes and remains closed for the next 1 1/2 revolutions of the crankshaft.
2.
While the crankshaft continues to rotate, the piston moves upward, compressing the air-fuel mixture.
4-STROKE GASOLINE OPERATING PRINCIPLES
Spark plug
3.
As the piston almost reaches the top of its travel, the spark plug fires, igniting the compressed air-fuel mixture. The piston continues to top dead center (TDC) and is pushed downward by the expanding gases.
Exhaust valve
4.
When the piston almost reaches BDC, the exhaust valve opens and remains open until the piston is near TDC. The upward travel of the piston forces the exhaust gases out of the cylinder. After the piston has reached TDC, the exhaust valve closes and the cycle starts all over again.


Intake valve
1.
As the piston travels downward, the exhaust valve is closed and the intake valve opens, allowing air to be drawn into the cylinder. When the piston reaches the bottom of its travel (BDC), the intake valve closes and remains closed for the next 1 1/2 revolutions of the crankshaft.
2.
While the crankshaft continues to rotate, the piston moves upward, compressing the air.
4-STROKE DIESEL OPERATING PRINCIPLES
Injector
3.
As the piston almost reaches the top of its travel, the injector allows fuel into the chamber. The fuel is ignited by the heat of compression. The piston continues to top dead center (TDC) and is pushed downward by the expanding gases.
Exhaust valve
4.
When the piston almost reaches BDC, the exhaust valve opens and remains open until the piston is near TDC. The upward travel of the piston forces the exhaust gases out of the cylinder. After the piston has reached TDC, the exhaust valve closes and the cycle starts all over again.
2


As the piston travels downward, it uncovers the exhaust port (A) allowing the exhaust gases to leave the cylinder. A fresh air-fuel charge, which has been compressed slightly in the crankcase, enters the cylinder through the transfer port (B). Since this charge enters under pressure, it also helps to push out the exhaust gases.
1.
A
B
While the crankshaft continues to rotate, the piston moves upward, covering the transfer (B) and exhaust (A) ports. The piston compresses the new air-fuel mixture and creates a low-pressure area in the crankcase at the same time. As the piston continues to travel, it uncovers the intake port (C). A fresh air-fuel charge from the carburetor (D) is drawn into the crankcase through the intake port.
2.
D
C
2-STROKE OPERATING PRINCIPLES
As the piston almost reaches the top of its travel, the spark plug fires, igniting the compressed air-fuel mixture. The piston continues to top dead center (TDC) and is pushed downward by the expanding gases.
3.
Spark Plug
4.
As the piston travels down, the exhaust gases leave the cylinder and the complete cycle starts all over again.
3

standards exist, but the most commonly used by marine equipment manufacturers are American standard and metric standard. The threads are cut differently as shown in Figure 5.

Most threads are cut so that the fastener must be turned clockwise to tighten it. These are called right-hand threads. Some fasteners have left-hand threads; they must be turned counterclockwise to be tightened. Left-hand threads are used in locations where normal rotation of the equipment would tend to loosen a right-hand threaded fastener.

Machine Screws

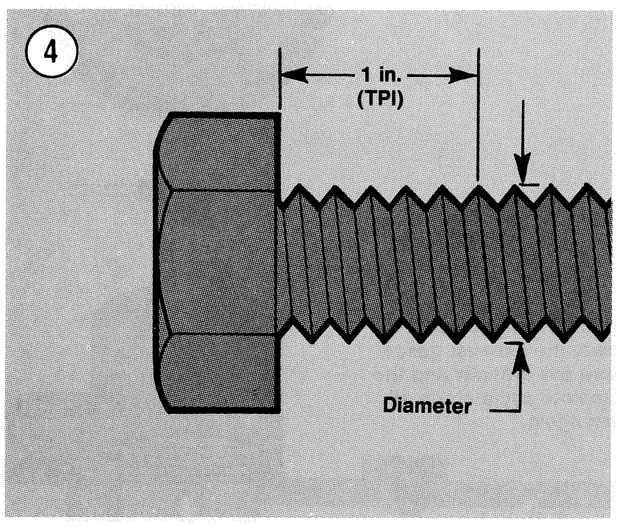
There are many different types of machine screws. Figure **6** shows a number of screw heads requiring different types of turning tools (see Chapter Two for detailed information). Heads are also designed to protrude above the metal (round) or to be slightly recessed in the metal (flat) (Figure **7).**

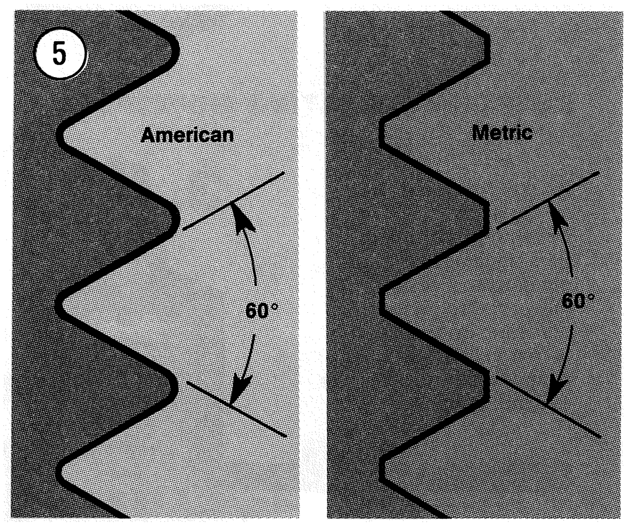
Bolts

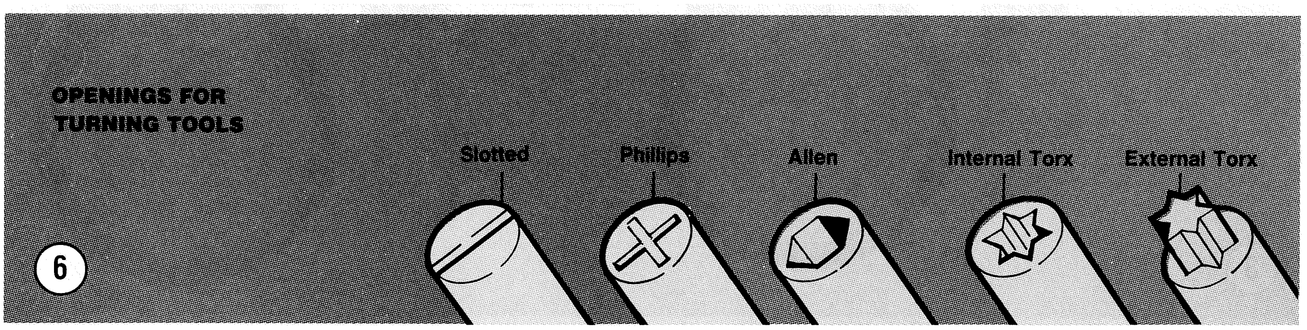
Commonly called bolts, the technical name for these fasteners is cap screw. They are normally described by diameter, threads per inch and length. For example, 1/4-20 × 1 indicates a bolt 1/4 in. in diameter with 20 threads per inch, 1 in. long. The measurement across two flats on the head of the bolt indicates the proper wrench size to be used.

Nuts

Nuts are manufactured in a variety of types and sizes. Most are hexagonal (6-sided) and fit







on bolts, screws and studs with the same diameter and threads per inch.

Figure 8 shows several types of nuts. The common nut is usually used with a lockwasher. Self-locking nuts have a nylon insert that prevents the nut from loosening; no lockwasher is required. Wing nuts are designed for fast removal by hand. Wing nuts are used for convenience in non-critical locations.

To indicate the size of a nut, manufacturers specify the diameter of the opening and the threads per inch. This is similar to bolt specification, but without the length dimension. The measurement across two flats on the nut indicates the proper wrench size to be used.

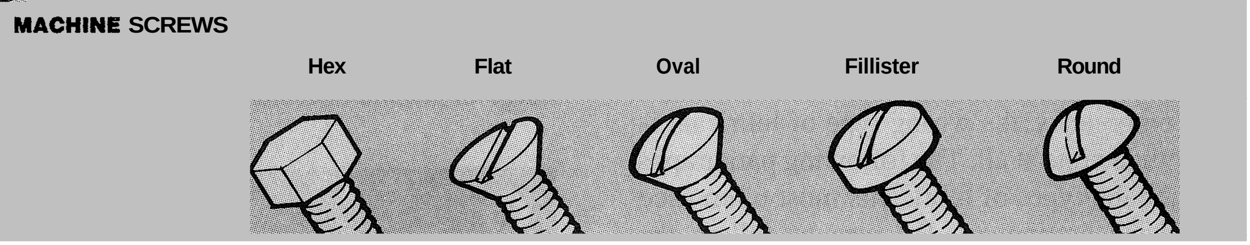
Washers

There are two basic types of washers: flat washers and lockwashers. Flat washers are simple discs with a hole to fit a screw or bolt. Lockwashers are designed to prevent a fastener from working loose due to vibration, expansion and contraction. Figure 9 shows several types of lockwashers. Note that flat washers are often used between a lockwasher and a fastener to provide a smooth bearing surface. This allows the fastener to be turned easily with a tool.

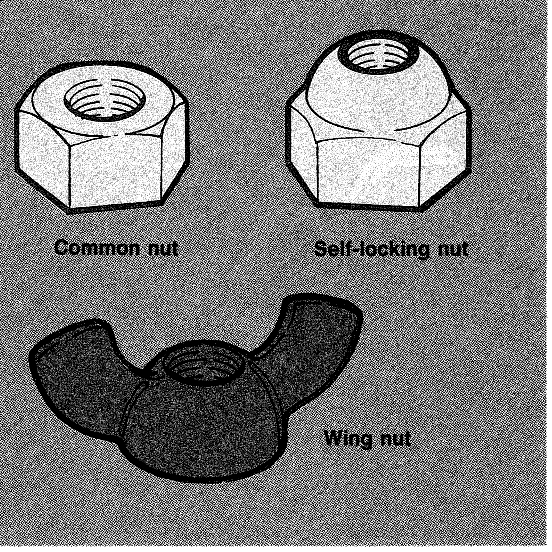
Cotter Pins

Cotter pins (Figure **10)** are used to secure special kinds of fasteners. The threaded stud

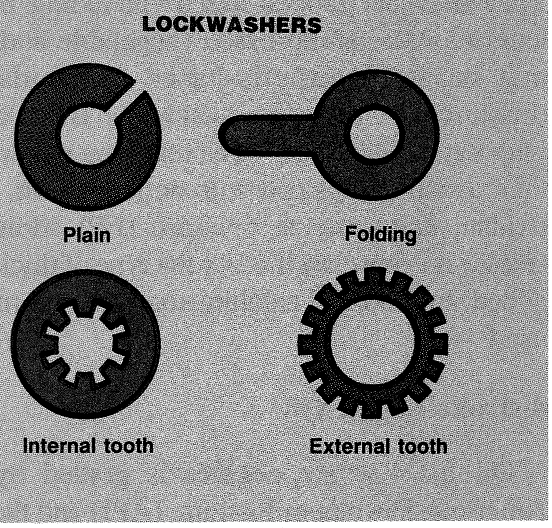
7



8



9



must have a hole in it; the nut or nut lock piece has projections that the cotter pin fits between. This type of nut is called a "Castellated nut." Cotter pins should not be reused after removal.

Snap Rings

Snap rings can be of an internal or external design. They are used to retain items on shafts (external type) or within tubes (internal type). Snap rings can be reused if they are not distorted during removal. In some applications, snap rings of varying thickness can be selected to control the end play of parts assemblies.

LUBRICANTS

Periodic lubrication ensures long service life for any type of equipment. It is especially important to marine equipment because it is exposed to salt or brackish water and other harsh environments. The type of lubricant used is just as important as the lubrication service itself; although, in an emergency, the wrong type of lubricant is better than none at all. The following paragraphs describe the types of lubricants most often used on marine equipment. Be sure to follow the equipment manufacturer's recommendations for lubricant types.

Generally, all liquid lubricants are called "oil." They may be mineral-based (including petroleum bases), natural-based (vegetable and animal bases), synthetic-based or emulsions (mixtures). "Grease" is an oil which is thickened with a metallic "soap." The resulting material is then usually enhanced with anticorrosion, antioxidant and extreme pressure (EP) additives. Grease is often classified by the type of thickener added; lithium and calcium soap are commonly used.

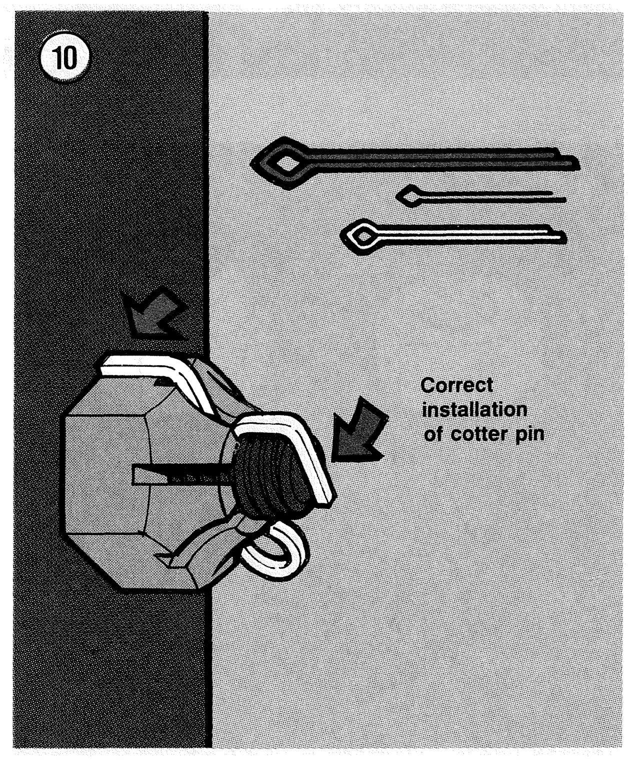
4-stroke Engine **Oil**

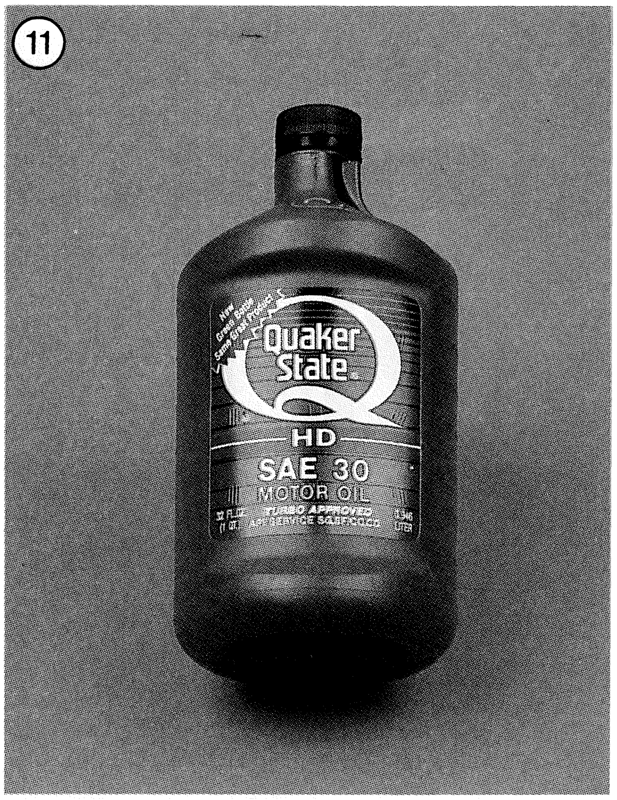
Oil for 4-stroke engines is graded by the American Petroleum Institute (API) and the Society of Automotive Engineers (SAE) in several categories. Oil containers display these ratings on the top or label (Figure **11).**

API oil grade is indicated by letters, oils for gasoline engines are identified by an "S" and oils for diesel engines are identified by a "C." Most modern gasoline engines require SF or SG graded oil. Automotive and marine diesel engines use CC or CD graded oil.

Viscosity is an indication of the oil's thickness, or resistance to flow. The SAE uses numbers to indicate viscosity; thin oils have low numbers and thick oils have high numbers. A "W" after the number indicates that the viscosity testing was done at low temperature to simulate cold weather operation. Engine oils fall into the 5W-20W and 20-50 range.

Multi-grade oils (for example, 10W-40) are less viscous (thinner) at low temperatures and more viscous (thicker) at high temperatures. This allows the oil to perform efficiently across a wide range of engine operating temperatures.





2-stroke Engine Oil

Lubrication for a 2-stroke engine is provided by oil mixed with the incoming fuel-air mixture. Some of the oil mist settles out in the crankcase, lubricating the crankshaft and lower end of the connecting rods. The rest of the oil enters the combustion chamber to lubricate the piston, rings and cylinder wall. This oil is then burned along with the fuel-air mixture during the combustion process.

Engine oil must have several special qualities to work well in a 2-stroke engine. It must mix easily and stay in suspension in gasoline. When burned, it can't leave behind excessive deposits. It must also be able to withstand the high temperatures associated with 2-stroke engines.

The National Marine Manufacturer's Association (NMMA) has set standards for oil used in 2-stroke, water-cooled engines. This is the NMMA TC-W (two-cycle, water-cooled) grade (Figure 12). The oil's performance in the following areas is evaluated:

a. Lubrication (prevention of wear and scuffing).
b. Spark plug fouling.
c. Preignition.
d. Piston ring sticking.
e. Piston varnish.
f. General engine condition (including deposits).
g. Exhaust port blockage.
h. Rust prevention.
i. Mixing ability with gasoline.

In addition to oil grade, manufacturers specify the ratio of gasoline to oil required during break-in and normal engine operation.

Gear Oil

Gear lubricants are assigned SAE viscosity numbers under the same system as 4-stroke engine oil. Gear lubricant falls into the SAE 72-250 range **(Figure** 13). Some gear lubricants are multi-grade; for example, SAE 85W-90.

Three types of marine gear lubricant are generally available: SAE 90 hypoid gear lubricant is designed for older manual-shift units; Type C gear lubricant contains additives designed for electric shift mechanisms; High viscosity gear lubricant is a heavier oil designed to withstand the shock loading of high-performance engines or units subjected to severe duty use. Always use a gear lubricant of the type specified by the unit's manufacturer.

Grease

Greases are graded by the National Lubricating Grease Institute (NLGI). Greases are graded by number according to the consistency of the grease: these ratings range from No. 000 to No. 6, with No. 6 being the most solid. A typical multipurpose grease is NLGI No. 2 (Figure 14). For specific applications, equipment manufacturers may require grease with an additive such as molybdenum disulfide (MOS^2).

GASKET SEALANT

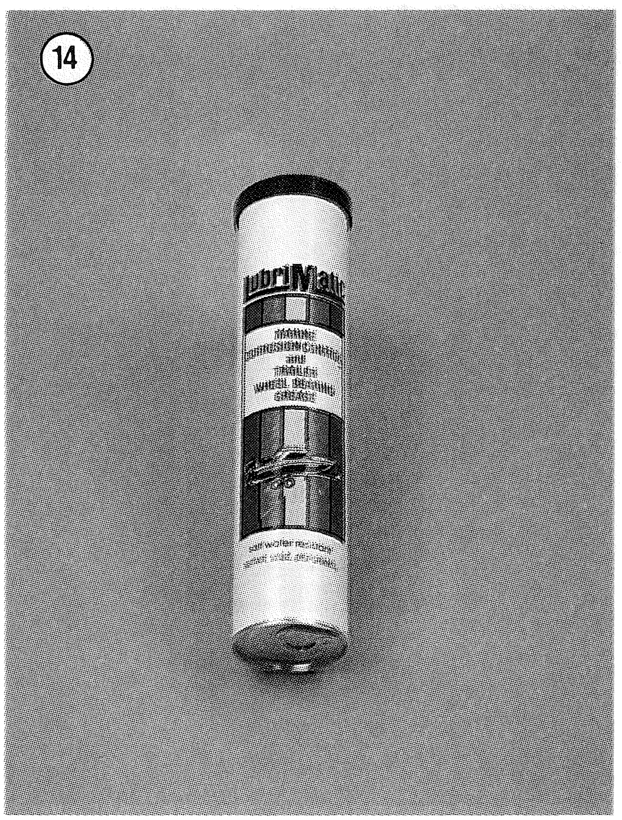
Gasket sealant is used instead of pre-formed gaskets on some applications, or as a gasket dressing on others. Two types of gasket sealant are commonly used: room temperature vulcanizing (RTV) and anaerobic. Because these two materials have different sealing properties, they cannot be used interchangeably.

RTV Sealant

This is a silicone gel supplied in tubes (Figure 15). Moisture in the air causes RTV to cure. Always place the cap on the tube as soon as possible when using RTV. RTV has a shelf life of one year and will not cure properly when the shelf life has expired. Check the expiration date

13

14



on RTV tubes before using and keep partially used tubes tightly sealed. RTV sealant can generally fill gaps up to 1/4 in. **(6.3** mm) and works well on slightly flexible surfaces.

Applying RTV Sealant

Clean all gasket residue from mating surfaces. Surfaces should be clean and free of oil and dirt. Remove all RTV gasket material from blind attaching holes because it can create a "hydraulic" effect and affect bolt torque.

Apply RTV sealant in a continuous bead **2-3** mm **(0.08-0.12** in.) thick. Circle all mounting holes unless otherwise specified. Torque mating parts within **10** minutes after application.

Anaerobic Sealant

This is a gel supplied in tubes **(Figure 16).** It cures only in the absence of air, as when squeezed tightly between two machined mating surfaces. For this reason, it will not spoil if the cap is left off the tube. It should not be used if one mating surface is flexible. Anaerobic sealant is able to fill gaps up to **0.030** in. **(0.8** mm) and generally works best on rigid, machined flanges or surfaces.

Applying Anaerobic Sealant

Clean all gasket residue from mating surfaces. Surfaces must be clean and free of oil and dirt. Remove all gasket material from blind attaching holes, as it can cause a "hydraulic" effect and affect bolt torque.

Apply anaerobic sealant in a 1 mm or less **(0.04** in.) bead to one sealing surface. Circle all mounting holes. Torque mating parts within 15 minutes after application.

GALVANIC CORROSION

A chemical reaction occurs whenever two different types of metal are joined by an electrical conductor and immersed in an electrolyte. Electrons transfer from one metal to the other through the electrolyte and return through the conductor.

The hardware on a boat is made of many different types of metal. The boat hull acts as a conductor between the metals. Even if the hull is wooden or fiberglass, the slightest film of water (electrolyte) within the hull provides conductivity. This combination creates a good environment for electron flow **(Figure** 17). Unfortunately, this electron flow results in galvanic corrosion of the metal involved, causing one of the metals to be corroded or eaten away by the process. The amount of electron flow (and, therefore, the amount of corrosion) depends on several factors:

a. The types of metal involved.

b. The efficiency of the conductor.

c. The strength of the electrolyte.

Metals

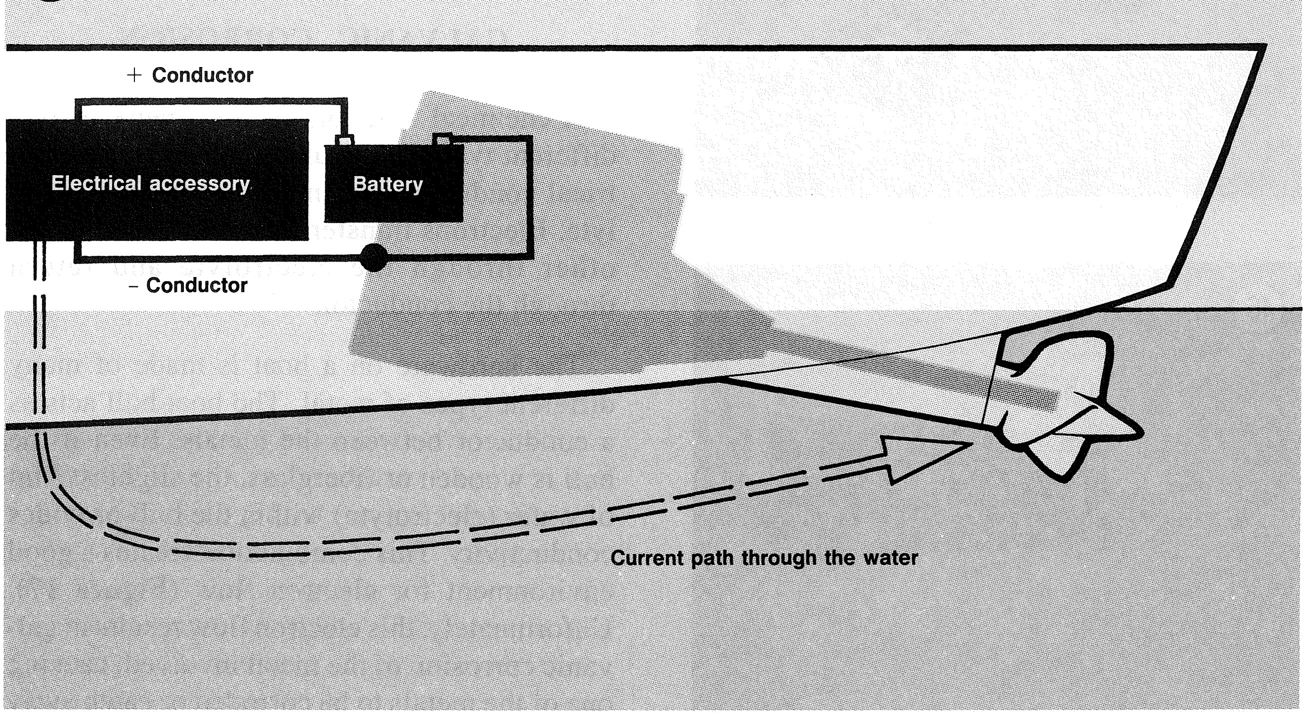
The chemical composition of the metals used in marine equipment has a significant effect on the amount and speed of galvanic corrosion. Certain metals are more resistant to corrosion than others. These electrically negative metals are commonly called "noble;" they act as the cathode in any reaction. Metals that are more subject to corrosion are electrically positive; they act as the anode in a reaction. The more noble metals include titanium, 18-8 stainless steel and nickel. Less noble metals include zinc, aluminum and magnesium. Galvanic corrosion becomes more severe as the difference in electrical potential between the two metals increases.

In some cases, galvanic corrosion can occur within a single piece of metal. Common brass is a mixture of zinc and copper, and, when immersed in an electrolyte, the zinc portion of the mixture will corrode away as reaction occurs between the zinc and the copper particles.

Conductors

The hull of the boat often acts as the conductor between different types of metal. Marine equipment, such as an outboard motor or stern drive unit, can also act as the conductor. Large masses of metal, firmly connected together, are more efficient conductors than water. Rubber mountings and vinyl-based paint can act as insulators between pieces of metal.

17



Electrolyte

The water in which a boat operates acts as the electrolyte for the galvanic corrosion process. The better a conductor the electrolyte is, the more severe and rapid the corrosion.

Cold, clean freshwater is the poorest electrolyte. As water temperature increases, its conductivity increases. Pollutants will increase conductivity; brackish or saltwater is also an efficient electrolyte. This is one of the reasons that most manufacturers recommend a freshwater flush for marine equipment after operation in saltwater, polluted or brackish water.

PROTECTION FROM GALVANIC CORROSION

Because of the environment in which marine equipment must operate, it is practically impossible to totally prevent galvanic corrosion. There are several ways by which the process can be slowed. After taking these precautions, the next step is to "fool" the process into occurring only where *you* want it to occur. This is the role of sacrificial anodes and impressed current systems.

Slowing Corrosion

Some simple precautions can help reduce the amount of corrosion taking place outside the hull. These are *not* a substitute for the corrosion protection methods discussed under *Sacrificial Anodes* and *Impressed Current Systems* in this chapter, but they can help these protection methods do their job.

Use fasteners of a metal more noble than the part they are fastening. If corrosion occurs, the larger equipment will suffer but the fastener will be protected. Because fasteners are usually very small in comparison to the equipment being fastened, the equipment can survive the loss of material. If the fastener were to corrode instead of the equipment, major problems could arise.

Keep all painted surfaces in good condition. If paint is scraped off and bare metal exposed, corrosion will rapidly increase. Use a vinyl- or plastic-based paint, which acts as an electrical insulator.

Be careful when using metal-based antifouling paints. These should not be applied to metal parts of the boat, outboard motor or stern drive unit or they will actually react with the equipment, causing corrosion between the equipment and the layer of paint. Organic-based paints are available for use on metal surfaces.

Where a corrosion protection device is used, remember that it must be immersed in the electrolyte along with the rest of the boat to have any effect. If you raise the power unit out of the water when the boat is docked, any anodes on the power unit will be removed from the corrosion cycle and will not protect the rest of the equipment that is still immersed. Also, such corrosion protection devices must not be painted because this would insulate them from the corrosion process.

Any change in the boat's equipment, such as the installation of a new stainless steel propeller, will change the electrical potential and could cause increased corrosion. Keep in mind that when you add new equipment or change materials, you should review your corrosion protection system to be sure it is up to the job.

Sacrificial Anodes

Anodes are usually made of zinc, a far from noble metal. Sacrificial anodes are specially designed to do nothing but corrode. Properly fastening such pieces to the boat will cause them to act as the anode in *any* galvanic reaction that occurs; any other metal present will act as the cathode and will not be damaged.

Anodes must be used properly to be effective. Simply fastening pieces of zinc to your boat in random locations won't do the job.

You must determine how much anode surface area is required to adequately protect the equipment's surface area. A good starting point is provided by Military Specification MIL-A-818001, which states that one square inch of new anode will protect either:

a. 800 square inches of freshly painted steel.
b. 250 square inches of bare steel or bare aluminum alloy.
c. 100 square inches of copper or copper alloy.

This rule is for a boat at rest. When underway, more anode area is required to protect the same equipment surface area.

The anode must be fastened so that it has good electrical contact with the metal to be protected. If possible, the anode can be attached directly to the other metal. If that is not possible, the entire network of metal parts in the boat should be electrically bonded together so that all pieces are protected.

Good quality anodes have inserts of some other metal around the fastener holes. Otherwise, the anode could erode away around the fastener. The anode can then become loose or even fall off, removing all protection.

Another Military Specification (MIL-A-18001) defines the type of alloy preferred that will corrode at a uniform rate without forming a crust that could reduce its efficiency after a time.

Impressed Current Systems

An impressed current system can be installed on any boat that has a battery. The system consists of an anode, a control box and a sensor. The anode in this system is coated with a very noble metal, such as platinum, so that it is almost corrosion-free and will last indefinitely. The sensor, under the boat's waterline, monitors the potential for corrosion. When it senses that corrosion could be occurring, it transmits this information to the control box.

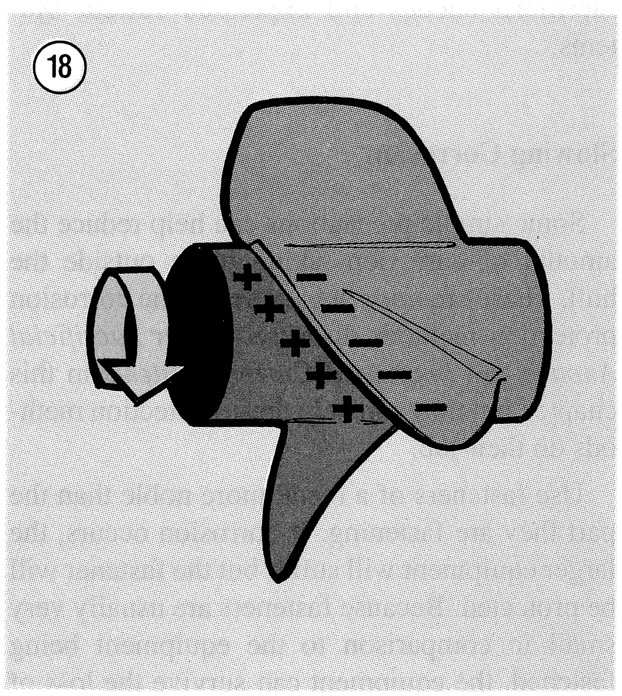
The control box connects the boat's battery to the anode. When the sensor signals the need, the control box applies positive battery voltage to the anode. Current from the battery flows from the anode to all other metal parts of the boat, no matter how noble or non-noble these parts may be. This battery current takes the place of any galvanic current flow.

Only a very small amount of battery current is needed to counteract galvanic corrosion. Manufacturers estimate that it would take two or three months of constant use to drain a typical marine battery, assuming the battery is never recharged.

An impressed current system is more expensive to install than simple anodes but, considering its low maintenance requirements and the excellent protection it provides, the long-term cost may actually be lower.

PROPELLERS

The propeller is the final link between the boat's drive system and the water. A perfectly



maintained engine and hull are useless if the propeller is the wrong type or has been allowed to deteriorate. Although propeller selection for a specific situation is beyond the scope of this book, the following information on propeller construction and design will allow you to discuss the subject intelligently with your marine dealer.

How a Propeller Works

As the curved blades of a propeller rotate through the water, a high-pressure area is created on one side of the blade and a low-pressure area exists on the other side of the blade (Figure 18). The propeller moves toward the low-pressure area, carrying the boat with it.

Propeller Parts

Although a propeller may be a one-piece unit, it is made up of several different parts (Figure 19). Variations in the design of these parts make different propellers suitable for different jobs.

The blade rip is the point on the blade farthest from the center of the propeller hub. The blade tip separates the leading edge from the trailing edge.

The leading edge is the edge of the blade nearest to the boat. During normal rotation, this is the area of the blade that first cuts through the water.

The trailing edge is the edge of the blade farthest from the boat.

The blade face is the surface of the blade that faces away from the boat. During normal rotation, high pressure exists on this side of the blade.

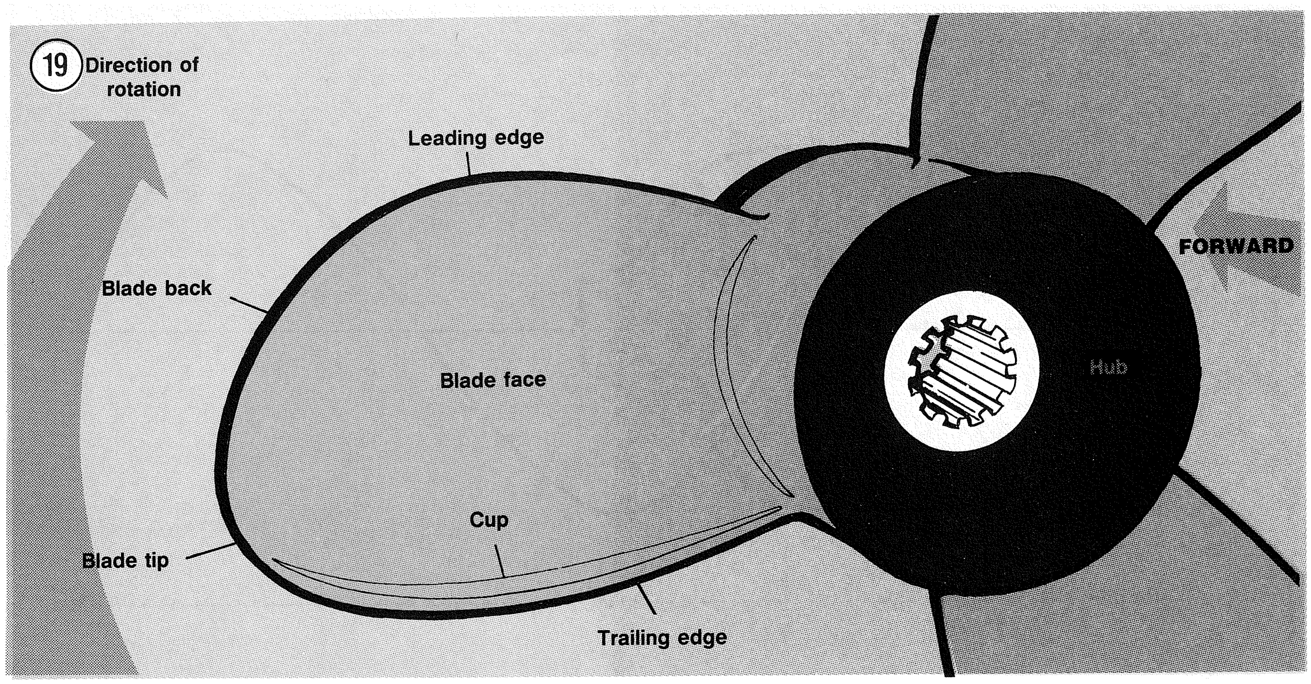
The blade back is the surface of the blade that faces toward the boat. During normal rotation, low pressure exists on this side of the blade.

The cup is a small curve or lip on the trailing edge of the blade.

The hub is the central portion of the propeller. It connects the blades to the propeller shaft (part of the boat's drive system). On some drive systems, engine exhaust is routed through the hub; in this case, the hub is made up of an outer and an inner portion, connected by ribs.

The diffuser ring is used on through-hub exhaust models to prevent exhaust gases from entering the blade area.

19



Propeller Design

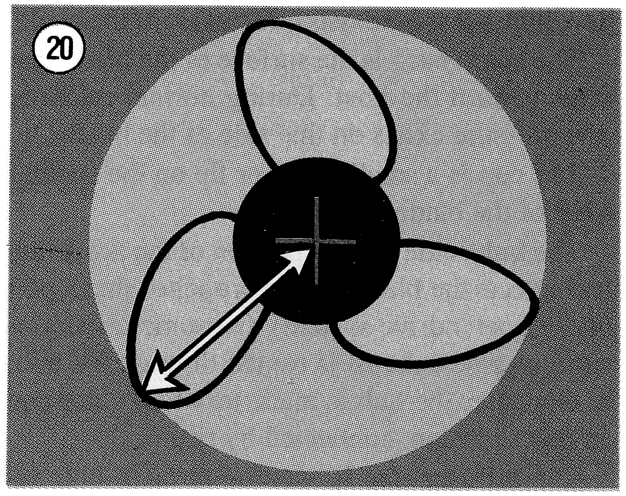
Changes in length, angle, thickness and material of propeller parts make different propellers suitable for different situations.

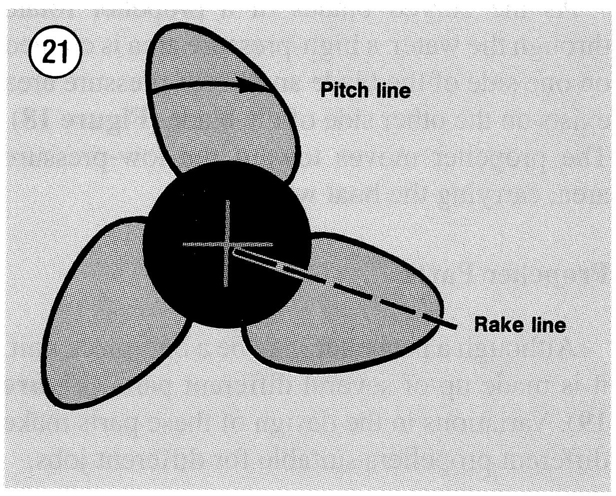
Diameter

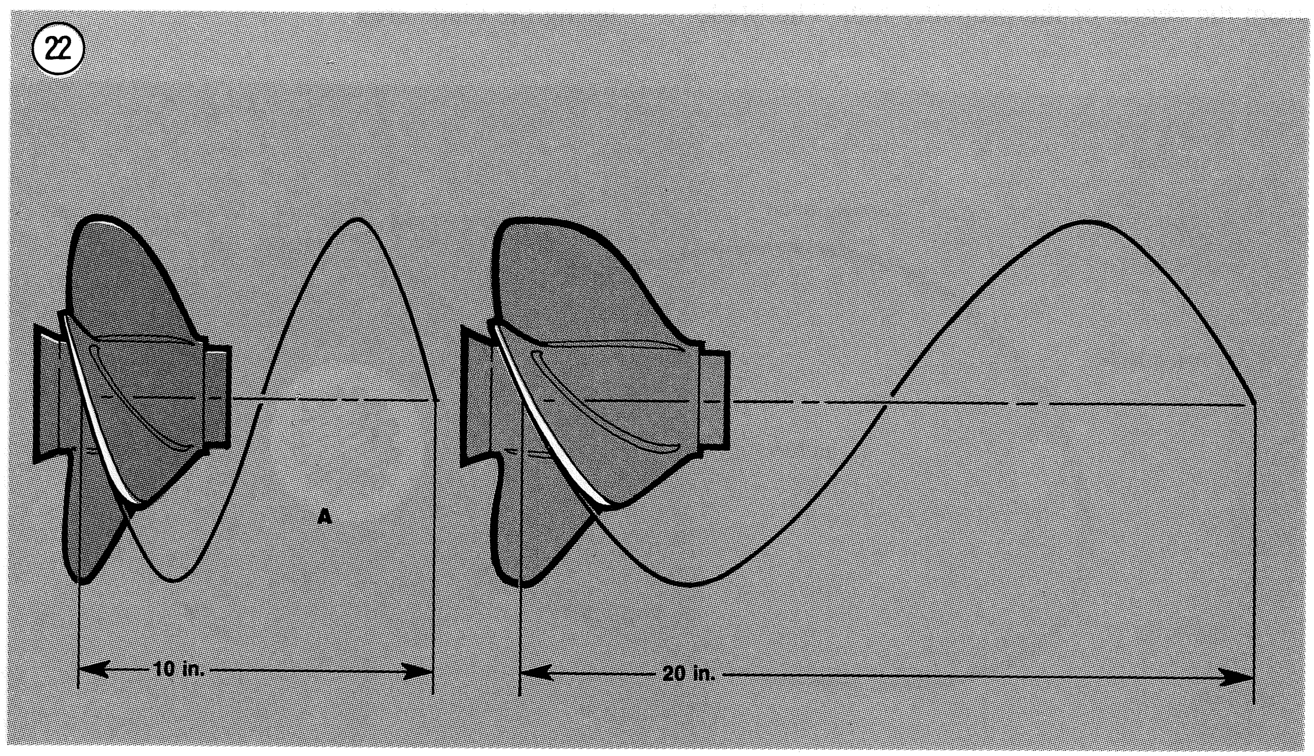
Propeller diameter is the distance from the center of the hub to the blade tip, multiplied by 2. That is, it is the diameter of the circle formed by the blade tips during propeller rotation (**Figure 20**).

Pitch and rake

Propeller pitch and rake describe the placement of the blade in relation to the hub (**Figure 21**).



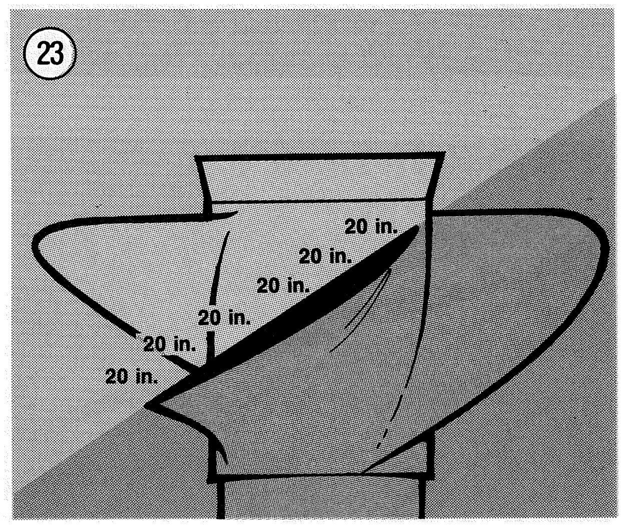


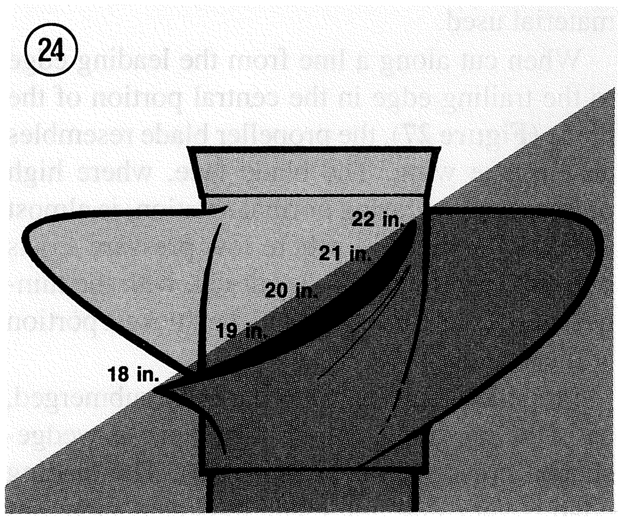


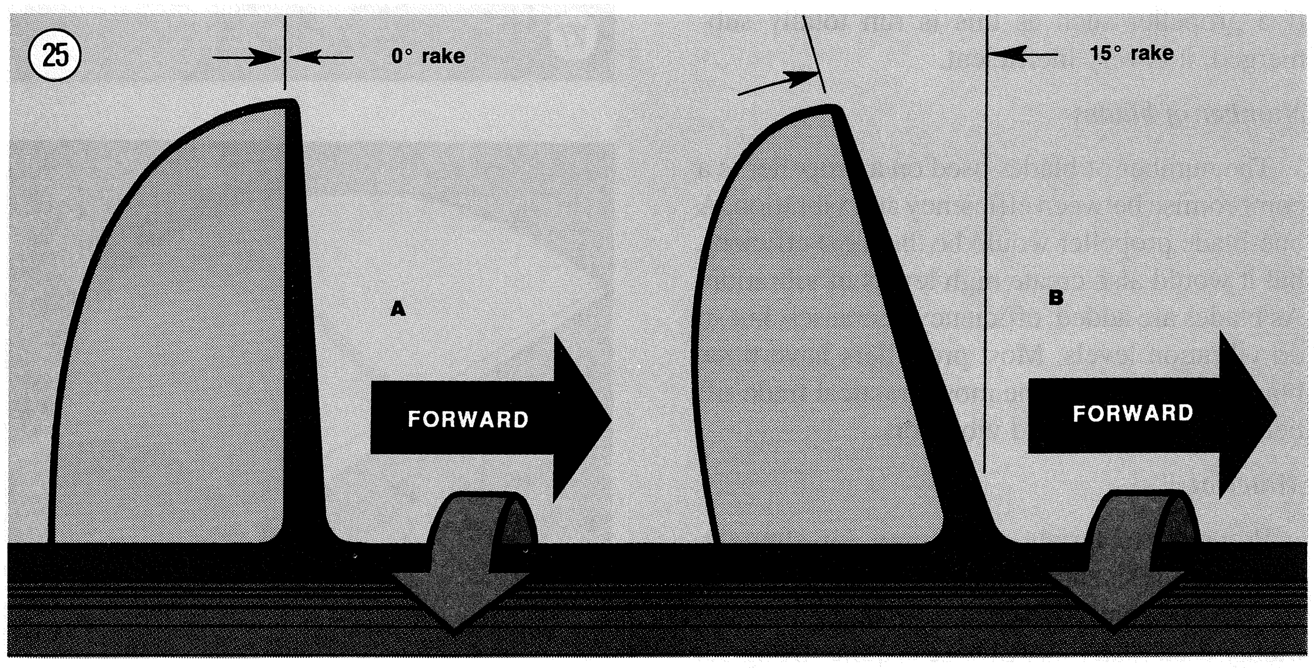
Pitch is expressed by the theoretical distance that the propeller would travel in one revolution. In A, Figure 22, the propeller would travel 10 inches in one revolution. In B, Figure 22, the propeller would travel 20 inches in one revolution. This distance is only theoretical; during actual operation, the propeller achieves about 80% of its rated travel.

Propeller blades can be constructed with constant pitch (Figure 23) or progressive pitch (Figure 24). Progressive pitch starts low at the leading edge and increases toward to trailing edge. The propeller pitch specification is the average of the pitch across the entire blade.

Blade rake is specified in degrees and is measured along a line from the center of the hub to the blade tip. A blade that is perpendicular to the hub (A, Figure 25) has 0° of rake. A blade that is angled from perpendicular (B, Figure 25) has a rake expressed by its difference from perpen-







dicular. Most propellers have rakes ranging from 0-20°.

Blade thickness

Blade thickness is not uniform at all points along the blade. For efficiency, blades should be as thin as possible at all points while retaining enough strength to move the boat. Blades tend to be thicker where they meet the hub and thinner at the blade tip **(Figure** 26). This is to support the heavier loads at the hub section of the blade. This thickness is dependent on the strength of the material used.

When cut along a line from the leading edge to the trailing edge in the central portion of the blade **(Figure 27**), the propeller blade resembles an airplane wing. The blade face, where high pressure exists during normal rotation, is almost flat. The blade back, where low pressure exists during normal rotation, is curved, with the thinnest portions at the edges and the thickest portion at the center.

Propellers that run only partially submerged, as in racing applications, may have a wedge-shaped cross-section **(Figure 28).** The leading edge is very thin; the blade thickness increases toward the trailing edge, where it is the thickest. If a propeller such as this is run totally submerged, it is very inefficient.

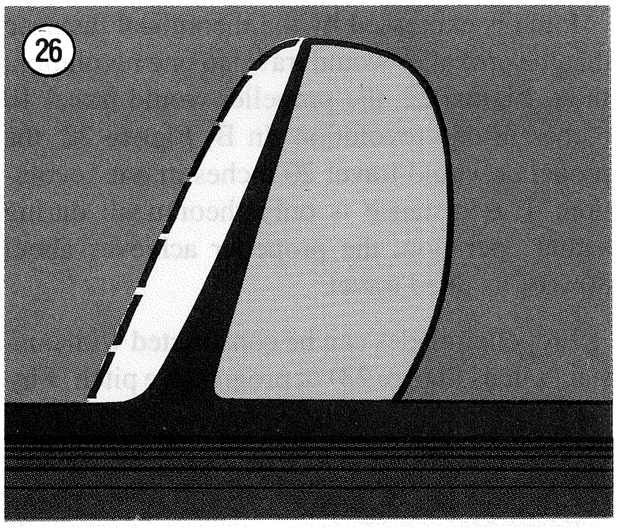
Number of blades

The number of blades used on a propeller is a compromise between efficiency and vibration. A one-blade propeller would be the most efficient, but it would also create high levels of vibration. As blades are added, efficiency decreases, but so do vibration levels. Most propellers have three blades, representing the most practical trade-off between efficiency and vibration.

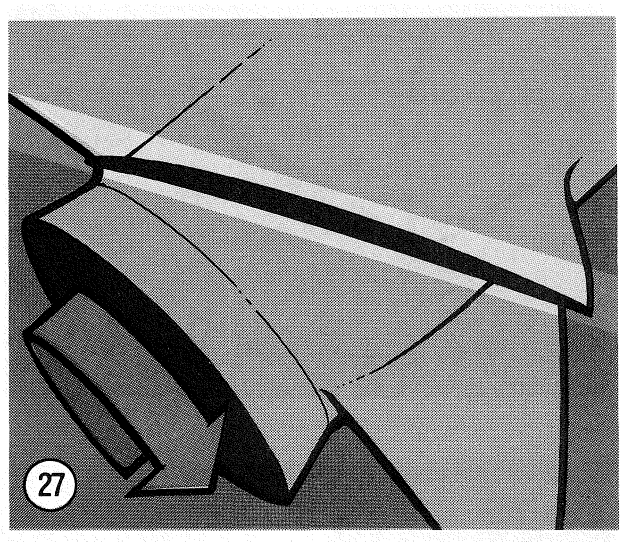
Material

Propeller materials are chosen for strength, corrosion resistance and economy. Stainless steel, aluminum and bronze are the most commonly used materials. Bronze is quite strong but

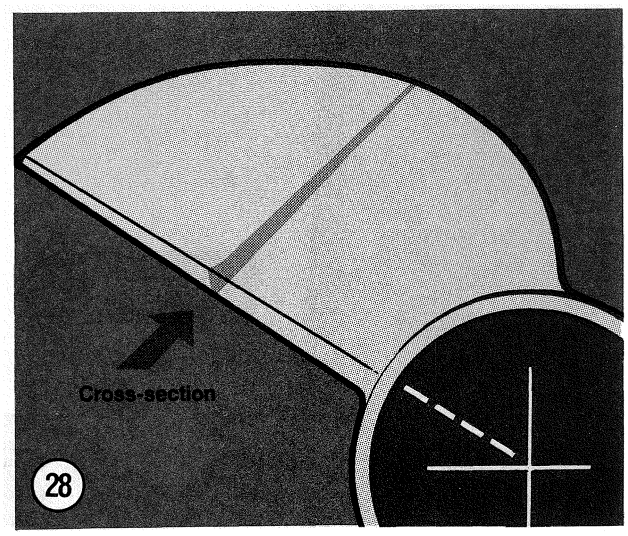
26



27



28



rather expensive. Stainless steel is more common than bronze because of its combination of strength and lower cost. Aluminum alloys are the least expensive but usually lack the strength of steel. Plastic propellers may be used in some low horsepower applications.

Direction of rotation

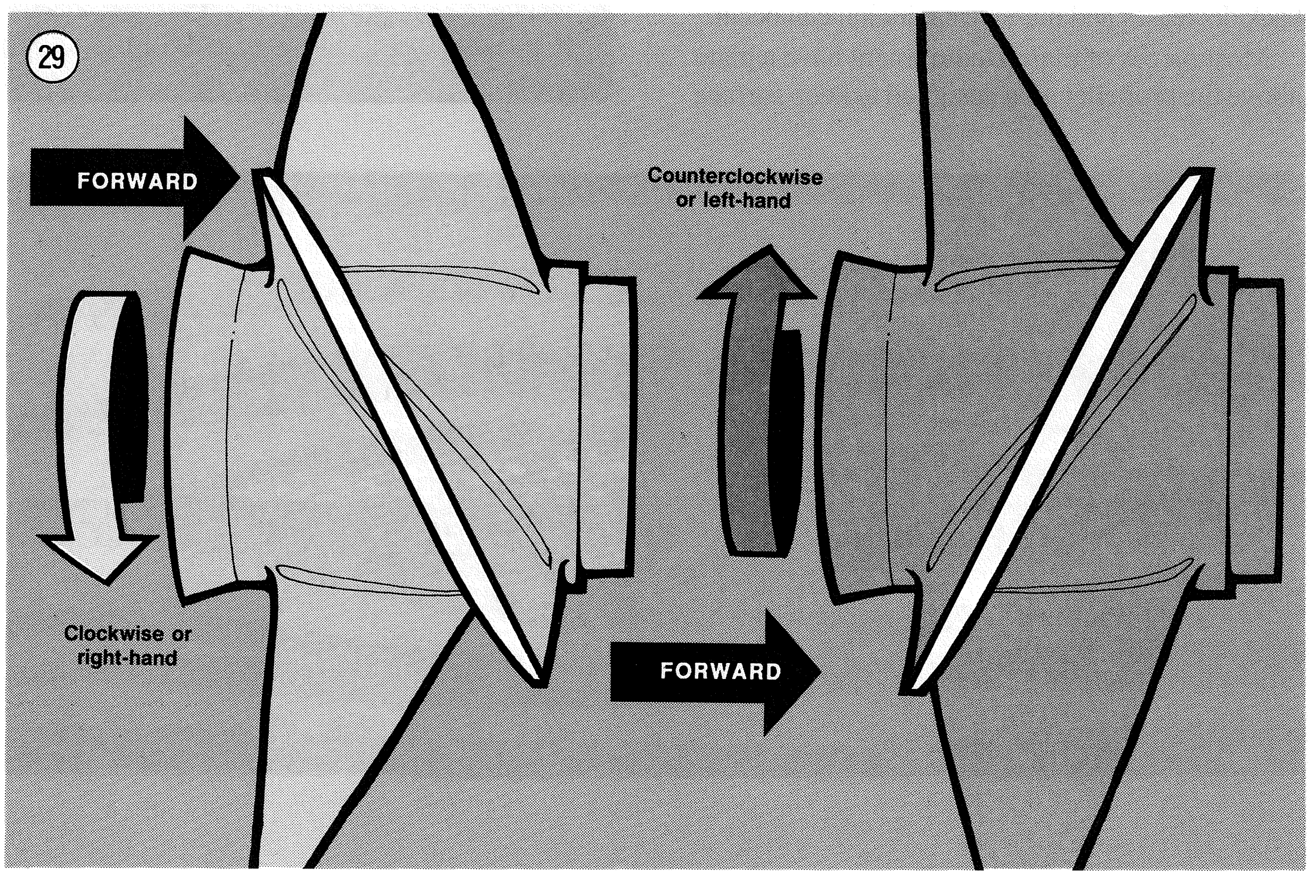
Propellers are made for both right-hand and left-hand rotation although right-hand is the most commonly used. When seen from behind the boat in forward motion, a right-hand propeller turns clockwise and a left-hand propeller turns counterclockwise. Off the boat, you can tell the difference by observing the angle of the blades (**Figure** 29). A right-hand propeller's blades slant from the upper left to the lower right; a left-hand propeller's blades are the opposite.

Cavitation and Ventilation

Cavitation and ventilation are *not* interchangeable terms; they refer to two distinct problems encountered during propeller operation.

To understand cavitation, you must first understand the relationship between pressure and the boiling point of water. At sea level, water will boil at 212° F. As pressure increases, such as within an engine's closed cooling system, the boiling point of water increases—it will boil at some temperature higher than 212" F. The opposite is also true. As pressure decreases, water will boil at a temperature lower than 212° F. If pressure drops low enough, water will boil at typical ambient temperatures of 50-60" F.

We have said that, during normal propeller operation, low-pressure exists on the blade back. Normally, the pressure does not drop low enough for boiling to occur. However, poor blade design



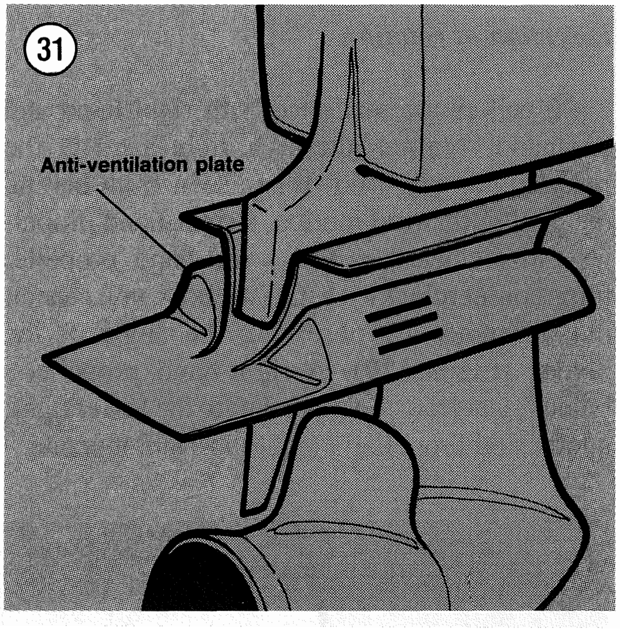
or selection, or blade damage can cause an unusual pressure drop on a small area of the blade **(Figure 30).** Boiling can occur in this small area. As the water boils, air bubbles form. As the boiling water passes to a higher pressure area of the blade, the boiling stops and the bubbles collapse. The collapsing bubbles release enough energy to erode the surface of the blade.

This entire process of pressure drop, boiling and bubble collapse is called "cavitation." The damage caused by the collapsing bubbles is called a "cavitation bum." It is important to remember that cavitation is caused by a decrease in pressure, *not* an increase in temperature.

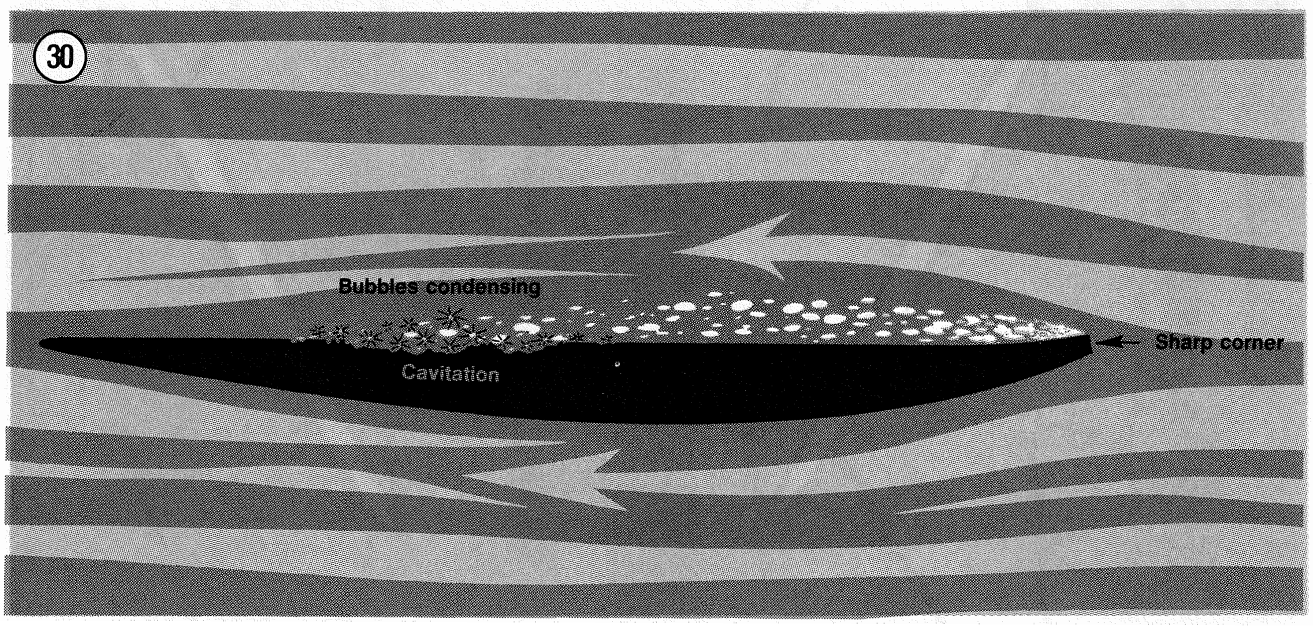
Ventilation is not as complex a process as cavitation. Ventilation refers to air entering the blade area, either from above the surface of the water or from a through-hub exhaust system. As the blades meet the air, the propeller momentarily over-revs, losing most of its thrust. An added complication is that as the propeller over-revs, pressure on the blade back decreases and massive cavitation can occur.

Most pieces of marine equipment have a plate above the propeller area designed to keep surface air from entering the blade area **(Figure 31).** This plate is correctly called an "antiventilation plate," although you will often *see* it called an "anticavitation plate." Through hub exhaust systems also have specially designed hubs to keep exhaust gases from entering the blade area.

31



30



Chapter Two

Tools and Techniques

This chapter describes the common tools required for marine equipment repairs and troubleshooting. Techniques that will make your work easier and more effective are also described. Some of the procedures in this book require special skills or expertise; in some cases, you are better off entrusting the job to a dealer or qualified specialist.

SAFETY FIRST

Professional mechanics can work for years and never suffer a serious injury. If you follow a few rules of common sense and safety, you too can enjoy many safe hours servicing your marine equipment. If you ignore these rules, you can hurt yourself or damage the equipment.

1. Never use gasoline as a cleaning solvent.
2. Never smoke or use a torch near flammable liquids, such as cleaning solvent. If you are working in your home garage, remember that your home gas appliances have pilot lights.
3. Never smoke or use a torch in an area where batteries are being charged. Highly explosive hydrogen gas is formed during the charging process.
4. Use the proper size wrenches to avoid damage to fasteners and injury to yourself.
5. When loosening a tight or stuck fastener, think of what would happen if the wrench should slip. Protect yourself accordingly.
6. Keep your work area clean, uncluttered and well lighted.
7. Wear safety goggles during all operations involving drilling, grinding or the use of a cold chisel.
8. Never use worn tools.
9. Keep a Coast Guard approved fire extinguisher handy. Be sure it is rated for gasoline (Class B) and electrical (Class C) fires.

BASIC NAND TOOLS

A number of tools are required to maintain marine equipment. You may already have some of these tools for home or car repairs. There are also tools made especially for marine equipment repairs; these you will have to purchase. In any case, a wide variety of quality tools will make repairs easier and more effective.

Keep your tools clean and in a tool box. Keep them organized with the sockets and related drives together, the open end and box wrenches together, etc. After using a tool, wipe off dirt and grease with a clean cloth and place the tool in its correct place.

The following tools are required to perform virtually any repair job. Each tool is described and the recommended size given for starting a tool collection. Additional tools and some duplications may be added as you become more familiar with the equipment. You may need all standard U.S. size tools, all metric size tools or a mixture of both.

Screwdrivers

The screwdriver is a very basic tool, but if used improperly, it will do more damage than good. The slot on a screw has a definite dimension and shape. A screwdriver must be selected to conform with that shape. Use a small screwdriver for small screws and a large one for large screws or the screw head will be damaged.

Two types of screwdriver are commonly required: a common (flat-blade) screwdriver (Figure 1) and Phillips screwdrivers (Figure **2).**

Screwdrivers are available in sets, which often include an assortment of common and Phillips blades. If you buy them individually, buy at least the following:

a. Common screwdriver—5/16 x 6 in. blade.
b. Common screwdriver—318 x 12 in. blade
c. Phillips screwdriver—size 2 tip, 6 in. blade.

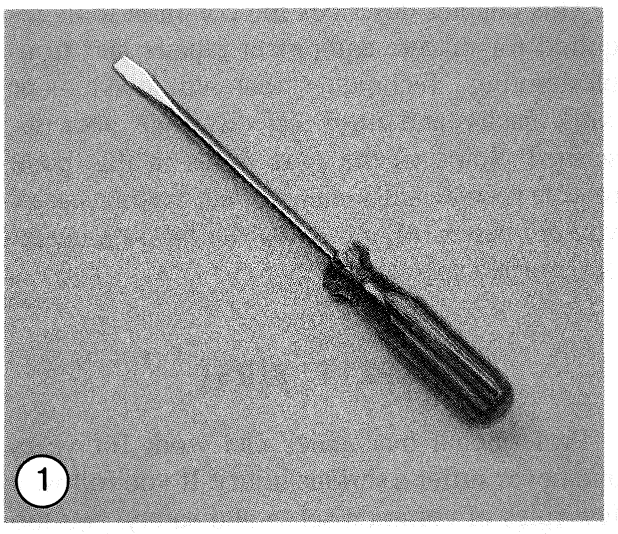
Use screwdrivers only for driving screws. Never use a screwdriver for prying or chiseling. Do not try to remove a Phillips or Allen head screw with a common screwdriver; you can damage the head so that the proper tool will be unable to remove it.

Keep screwdrivers in the proper condition and they will last longer and perform better. Always keep the tip of a common screwdriver in good condition. Figure **3** shows how to grind the tip to the proper shape if it becomes damaged. Note the parallel sides of the tip.

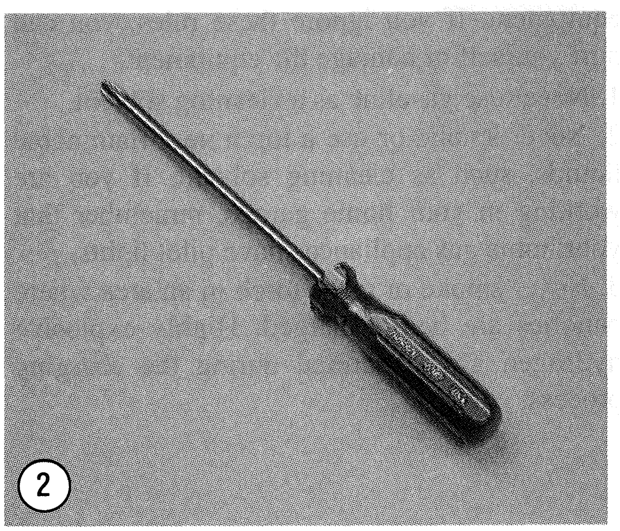
Pliers

Pliers come in a wide range of types and sizes. Pliers are useful for cutting, bending and crimping. They should never be used to cut hardened objects or to turn bolts or nuts. **Figure** 4 shows several types of pliers.

Each type of pliers has a specialized function. General purpose pliers are used mainly for holding things and for bending. Locking pliers are used as pliers or to hold objects very tightly, like a vise. Needlenose pliers are used to hold or bend small objects. Adjustable or slip-joint pliers can



1



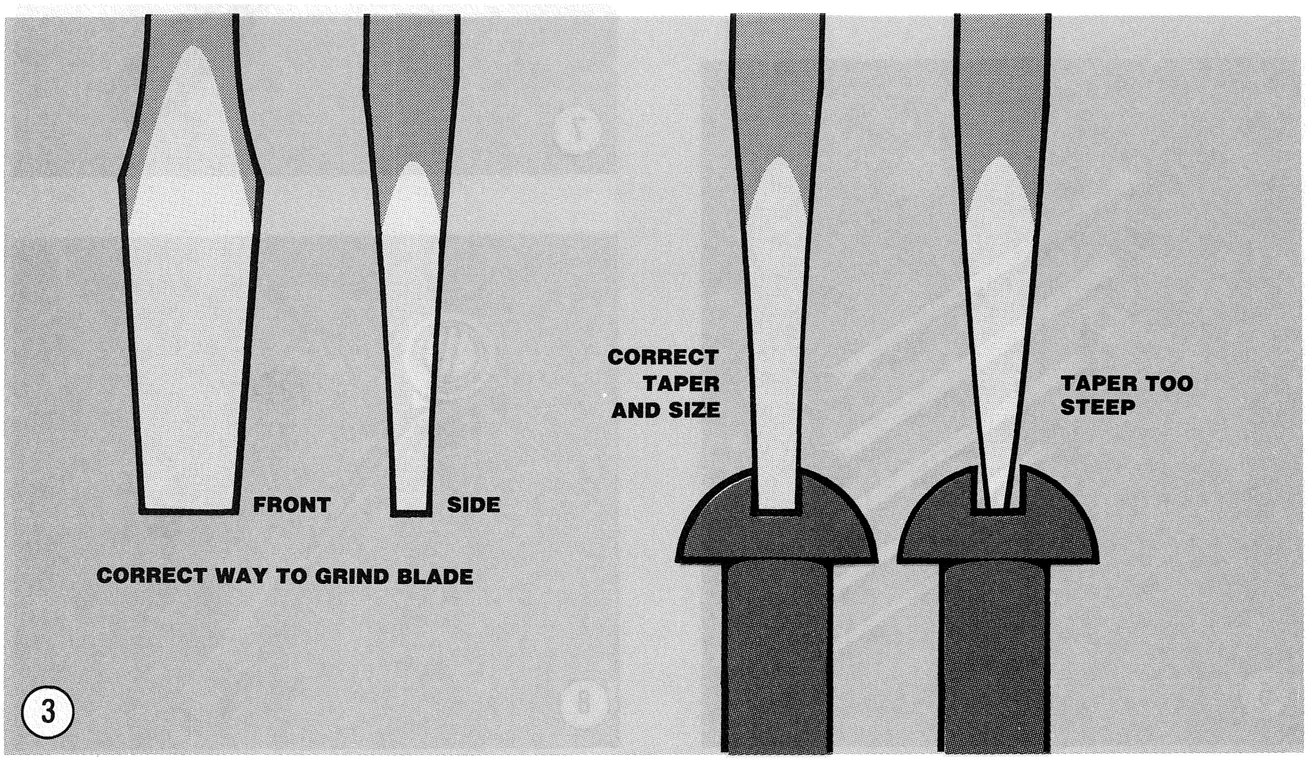
2

be adjusted to hold various sizes of objects; the jaws remain parallel to grip around objects such as pipe or tubing. There are many more types of pliers. The ones described here are the most commonly used.

Box and Open-end Wrenches

Box and open-end wrenches are available in sets or separately in a variety of sizes. See **Figure 5** and **Figure 6.** The number stamped near the end refers to the distance between two parallel flats on the hex head bolt or nut.

Box wrenches are usually superior to open-end wrenches. An open-end wrench grips the nut on only two flats. Unless it fits well, it may slip and round off the points on the nut. The box wrench grips all 6 flats. Both 6-point and 12-point openings on box wrenches are available. The 6-point gives superior holding power; the 12-point allows a shorter swing.



Combination wrenches, which are open on one side and boxed on the other, are also available. Both ends are the same size.

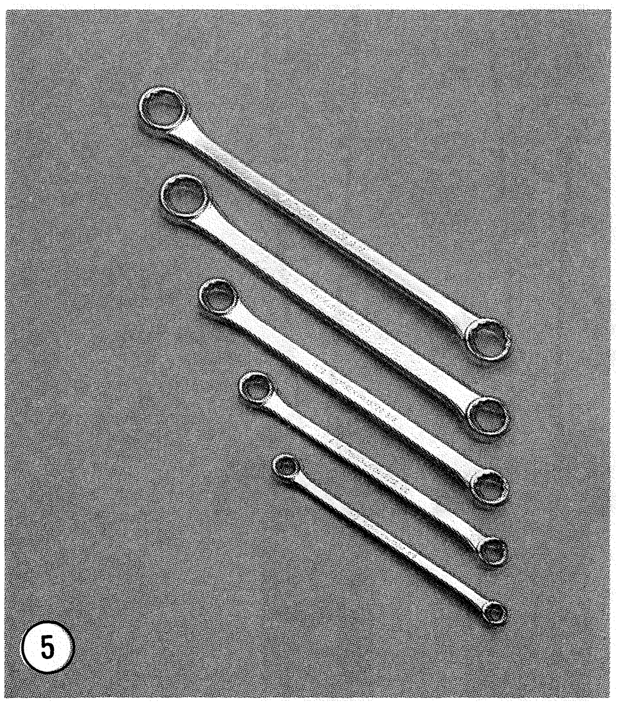
Adjustable Wrenches

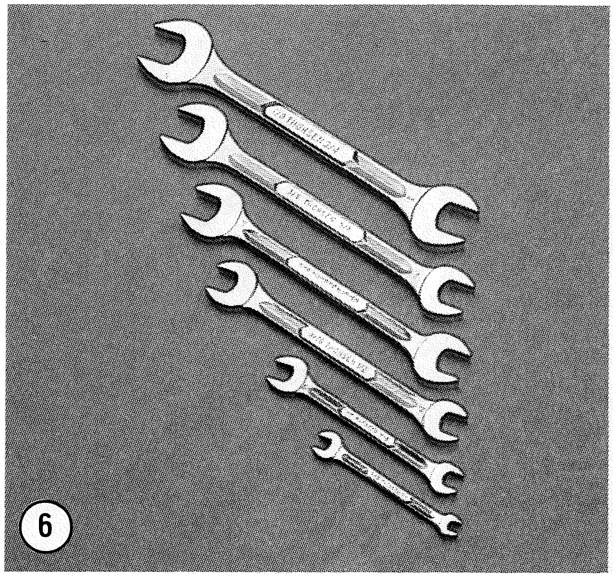
An adjustable wrench can be adjusted to fit nearly any nut or bolt head. See **Figure 7.** However, it can loosen and slip, causing damage to the nut and maybe to your knuckles. Use an adjustable wrench only when other wrenches are not available.

Adjustable wrenches come in sizes ranging from 4-18 in. overall. A 6 or 8 in. wrench is recommended as an all-purpose wrench.

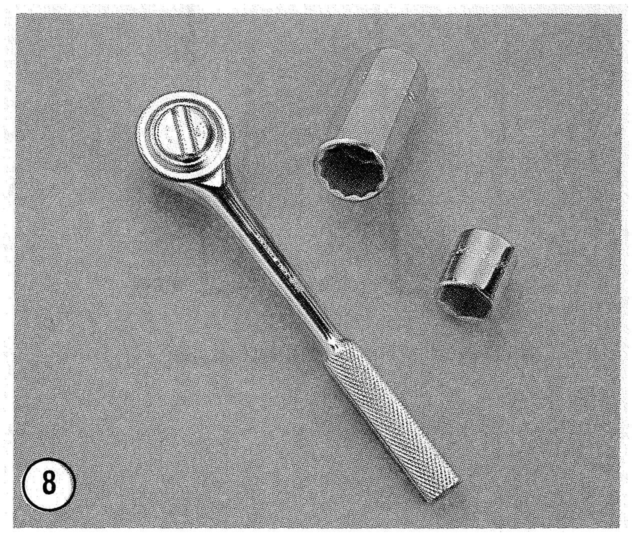
Socket Wrenches

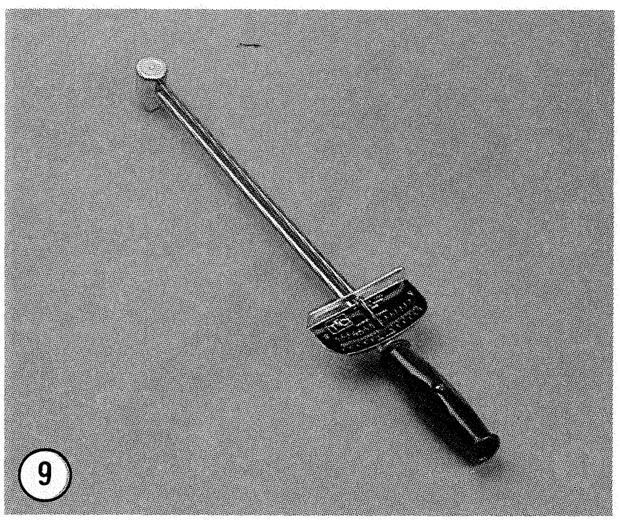
This type is undoubtedly the fastest, safest and most convenient to use. See **Figure 8.** Sockets, which attach to a suitable handle, are available with 6-point or 12-point openings and use 1/4, 3/8 and 3/4 inch drives. The drive size indicates


5

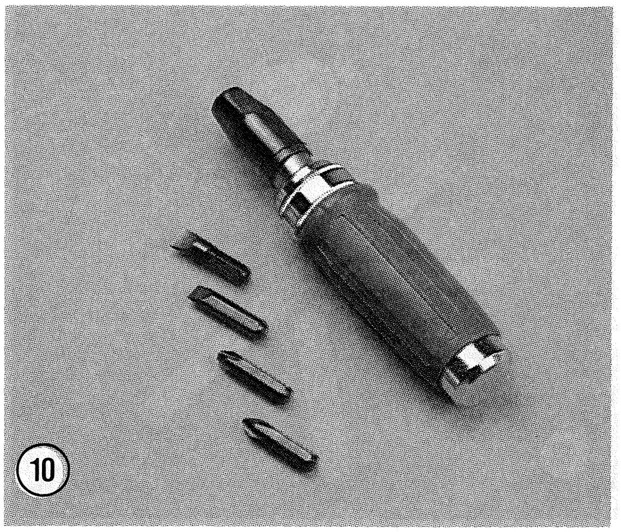

6


7

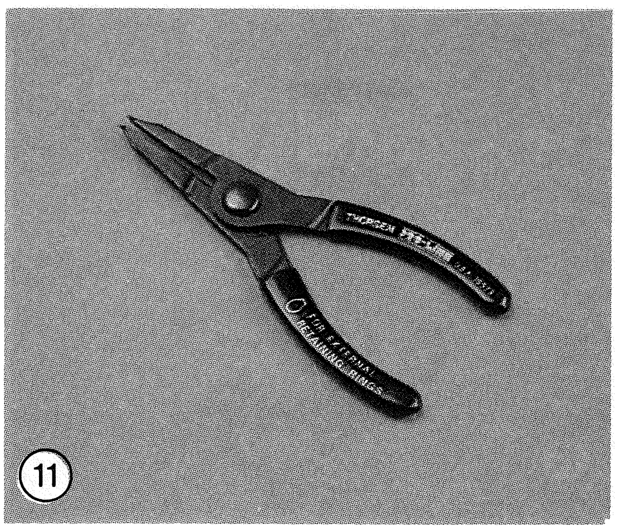

8



9



10



11

the size of the square hole that mates with the ratchet or flex handle.

2

Torque Wrench

A torque wrench **(Figure 9)** is used with a socket to measure how tight a nut or bolt is installed. They come in a wide price range and with either 3/8 or 1/2 in. square drive. The drive size indicates the size of the square drive that mates with the socket. Purchase one that measures up to 150 ft.-lb. (203 N•m).

Impact Driver

This tool **(Figure** PO) makes removal of tight fasteners easy and eliminates damage to bolts and screw slots. Impact drivers and interchangeable bits are available at most large hardware and auto parts stores.

Circlip Pliers

Circlip pliers (sometimes referred to as snap-ring pliers) are necessary to remove circlips. See **Figure** PI. Circlip pliers usually come with several different size tips; many designs can be switched from internal type to external type.

Hammers

The correct hammer is necessary for repairs. Use only a hammer with a face (or head) of rubber or plastic or the soft-faced type that is filled with buckshot **(Figure** 12). These are sometimes necessary in engine tear-downs. Never use a metal-faced hammer as severe damage will result in most cases. You can always produce the same amount of force with a soft-faced hammer.

Feeler Gauge

This tool has either flat or wire measuring gauges (**Figure** 13). Wire gauges are used to measure spark plug gap; flat gauges are used for all other measurements. A non-magnetic (brass) gauge may be specified when working around magnetized parts.

Other Special Tools

Some procedures require special tools; these are identified in the appropriate chapter. Unless otherwise specified, the part number used in this book to identify a special tool is the marine equipment manufacturer's part number.

Special tools can usually be purchased through your marine equipment dealer. Some can be made locally by a machinist, often at a much lower price. You may find certain special tools at tool rental dealers, Don't use makeshift tools if you can't locate the correct special tool; you will probably cause more damage than good.

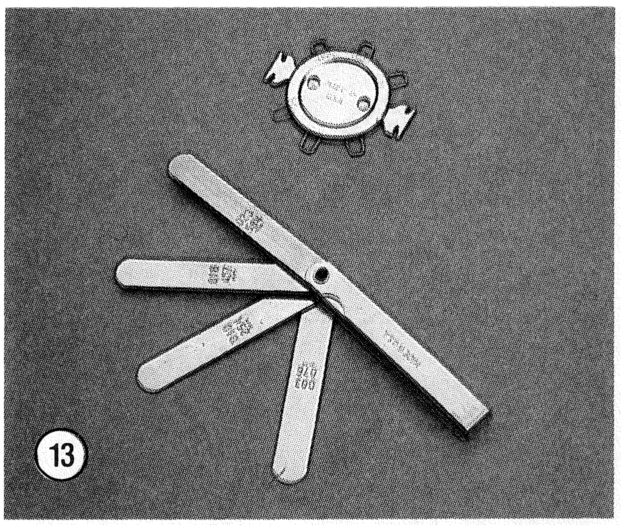
TEST EQUIPMENT

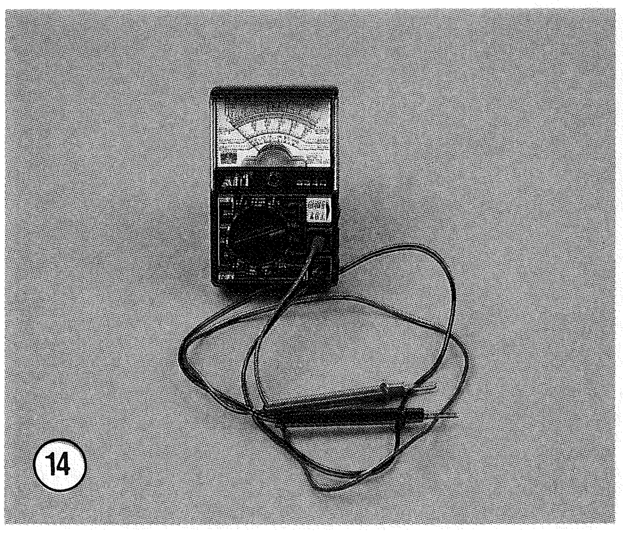
Multimeter

This instrument (**Figure** 14) is invaluable for electrical system troubleshooting and service. It combines a voltmeter, an ohmmeter and an ammeter into one unit, so it is often called a VOM.

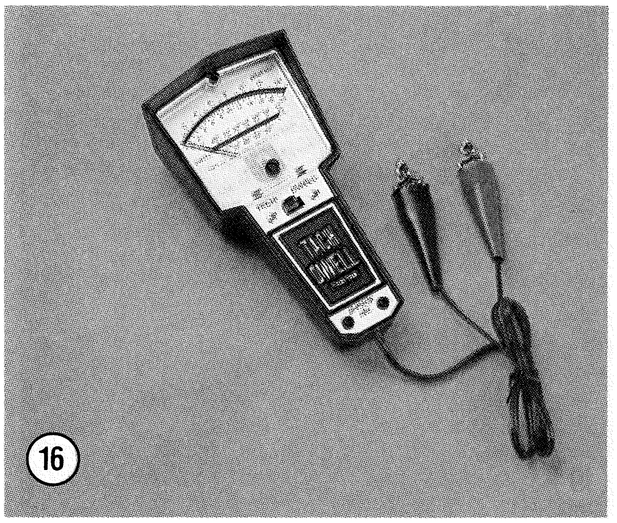
Two types of multimeter are available, analog and digital. Analog meters have a moving needle with marked bands indicating the volt, ohm and amperage scales. The digital meter (DVOM) is ideally suited for troubleshooting because it is easy to read, more accurate than analog, contains internal overload protection, is auto-ranging (analog meters must be recalibrated each time the scale is changed) and has automatic polarity compensation.


12

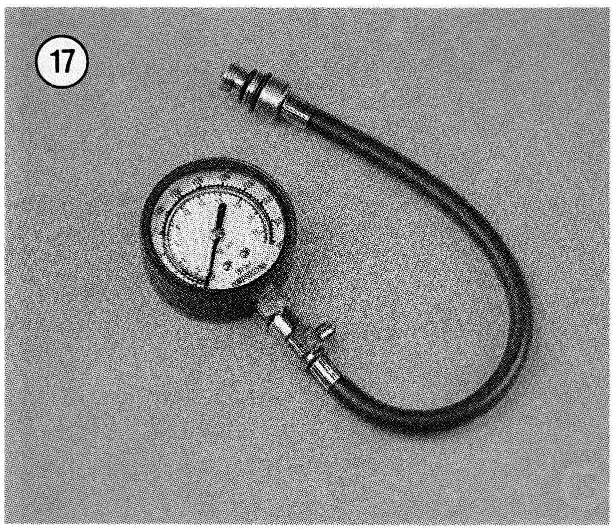

13


14

15



16



17

Strobe Timing Light

This instrument is necessary for dynamic tuning (setting ignition timing while the engine is running). By flashing a light at the precise instant the spark plug fires, the position of the timing mark can be seen. The flashing light makes a moving mark appear to stand still opposite a stationary mark.

Suitable lights range from inexpensive neon bulb types to powerful xenon strobe lights. See **Figure 15.** A light with an inductive pickup is best because it eliminates any possible damage to ignition wiring.

Tachometer/Dwell Meter

A portable tachometer is necessary for tuning. See **Figure 16.** Ignition timing and carburetor adjustments must be performed at the specified idle speed. The best instrument for this purpose is one with a low range of 0-1000 or 0-2000 rpm and a high range of 0-6000 rpm. Extended range (0-6000 or 0-8000 rpm) instruments lack accuracy at lower speeds. The instrument should be capable of detecting changes of 25 rpm on the low range.

A dwell meter is often combined with a tachometer. Dwell meters are used with breaker point ignition systems to measure the amount of time the points remain closed during engine operation.

Compression Gauge

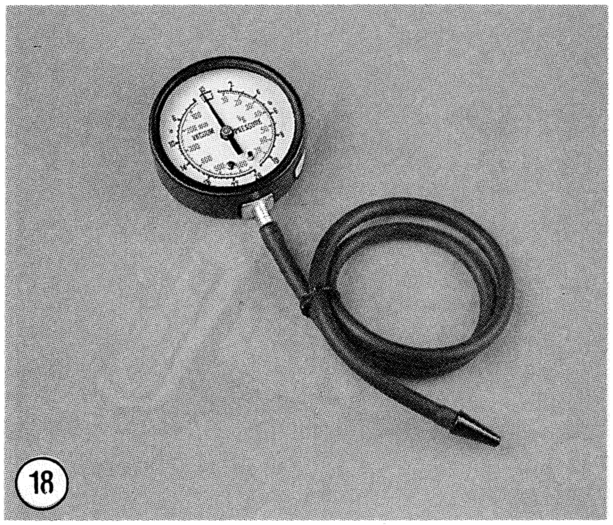
This tool **(Figure** 17) measures the amount of pressure present in the engine's combustion chamber during the compression stroke. This indicates general engine condition. Compression readings can be interpreted along with vacuum gauge readings to pinpoint specific engine mechanical problems.

The easiest type to use has screw-in adapters that fit into the spark plug holes. Press-in rubber-tipped types are also available.

Vacuum Gauge

The vacuum gauge **(Figure 18)** measures the intake manifold vacuum created by the engine's intake stroke. Manifold and valve problems (on 4-stroke engines) can be identified by interpreting the readings. When combined with compression gauge readings, other engine problems can be diagnosed.

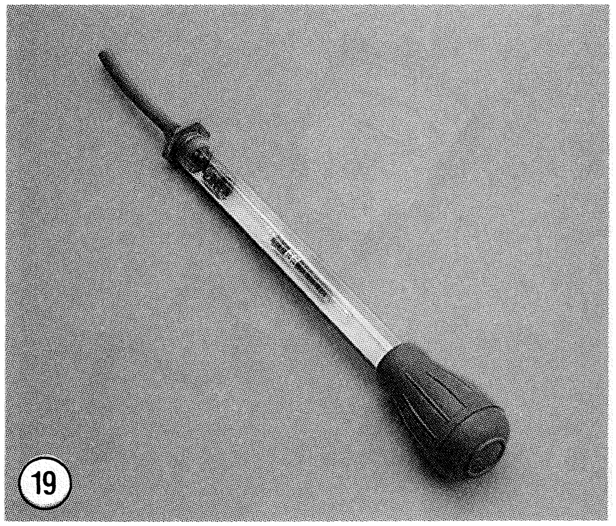
Some vacuum gauges can also be used as fuel pressure gauges to trace fuel system problems.



18

Hydrometer

Battery electrolyte specific gravity is measured with a hydrometer **(Figure** 19). The specific gravity of the electrolyte indicates the battery's state of charge. The best type has automatic temperature compensation; otherwise, you must calculate the compensation yourself.



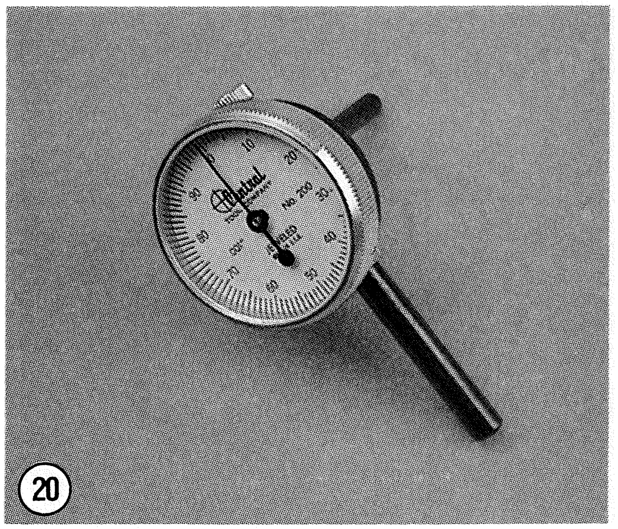
19

Precision Measuring Tools

Various tools are needed to make precision measurements. A dial indicator **(Figure 20**), for example, is used to determine run-out of rotating parts and end play of parts assemblies. A dial indicator can also be used to precisely measure piston position in relation to top dead center; some engines require this measurement for ignition timing adjustment.

Vernier calipers **(Figure** 21) and micrometers **(Figure** 22) are other precision measuring tools used to determine the size of parts (such as piston diameter).

Precision measuring equipment must be stored, handled and used carefully or it will not remain accurate.



20

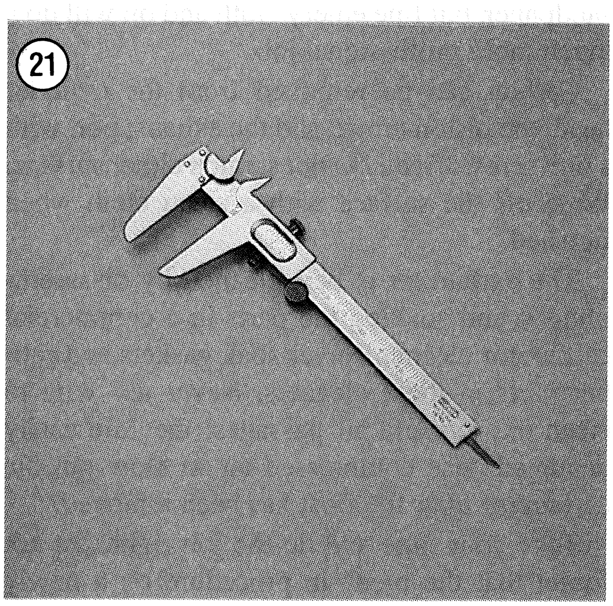
SERVICE HINTS

Most of the service procedures covered in this manual are straightforward and can be performed by anyone reasonably handy with tools.

It is suggested, however, that you consider your own skills and toolbox carefully before attempting any operation involving major disassembly of the engine or gearcase.

Some operations, for example, require the use of a press. It would be wiser to have these performed by a shop equipped for such work, rather than trying to do the job yourself with makeshift equipment. Other procedures require precise measurements. Unless you have the skills and equipment required, it would be better to have a qualified repair shop make the measurements for you.

21



22

Preparation for Disassembly

Repairs go much faster and easier if the equipment is clean before you begin work. There are special cleaners, such as Gunk or Bel-Ray Degreaser, for washing the engine and related parts. Just spray or brush on the cleaning solution, let it stand, then rinse away with a garden hose. Clean all oily or greasy parts with cleaning solvent as you remove them.

WARNING
Never use gasoline as a cleaning agent. It presents an extreme fire hazard. Be sure to work in a well-ventilated area when using cleaning solvent. Keep a Coast Guard approved fire extinguisher, rated for gasoline fires, handy in any case.

Much of the labor charged for repairs made by dealers is for the removal and disassembly of other parts to reach the defective unit. It is frequently possible to perform the preliminary operations yourself and then take the defective unit in to the dealer for repair.

If you decide to tackle the job yourself. read the entire section in this manual that pertains to it, making sure you have identified the proper one. Study the illustrations and text until you have a good idea of what is involved in completing the job satisfactorily. If special tools or replacement parts are required. make arrangements to get them before you start. It is frustrating and time-consuming to get partly into a job and then be unable to complete it.

Disassembly Precautions

During disassembly of parts, keep a few general precautions in mind. Force is rarely needed to get things apart. If parts are a tight fit, such as a bearing in a case, there is usually a tool designed to separate them. Never use a screwdriver to pry apart parts with machined surfaces (such as cylinder heads and crankcases). You will mar the surfaces and end up with leaks.

Make diagrams (or take an instant picture) wherever similar-appearing parts are found. For example. head and crankcase bolts are often not the same length. You may think you can remember where everything came from, but mistakes are costly. There is also the possibility you may be sidetracked and not return to work for days or even weeks. In the interval, carefully laid out parts may have been disturbed.

Cover all openings after removing parts to keep small parts, dirt or other contamination from entering.

Tag all similar internal parts for location and direction. All internal components should be reinstalled in the same location and direction from which removed. Record the number and thickness of any shims as they are removed. Small parts, such as bolts, can be identified by placing them in plastic sandwich bags. Seal and label them with masking tape.

Wiring should be tagged with masking tape and marked as each wire is removed. Again, do not rely on memory alone.

Protect finished surfaces from physical damage or corrosion. Keep gasoline off painted surfaces.

Assembly Precautions

No parts, except those assembled with a press fit, require unusual force during assembly. If a part is hard to remove or install, find out why before proceeding.

When assembling two parts, start all fasteners, then tighten evenly in an alternating or crossing pattern if no specific tightening sequence is given.

When assembling parts, be sure all shims and washers are installed exactly as they came out.

Whenever a rotating part butts against a stationary part, look for a shim or washer. Use new gaskets if there is any doubt about the condition of the old ones. Unless otherwise specified, a thin coat of oil on gaskets may help them seal effectively.

Heavy grease can be used to hold small parts in place if they tend to fall out during assembly. However, keep grease and oil away from electrical components.

High spots may be sanded off a piston with sandpaper, but fine emery cloth and oil will do a much more professional job.

Carbon can be removed from the cylinder head, the piston crown and the exhaust port with a dull screwdriver. *Do not* scratch either surface. Wipe off the surface with a clean cloth when finished.

The carburetor is best cleaned by disassembling it and soaking the parts in a commercial carburetor cleaner. Never soak gaskets and rubber parts in these cleaners. Never use wire to clean out jets and air passages; they are easily damaged. Use compressed air to blow out the carburetor *after* the float has been removed.

Take your time and do the job right. Do not forget that the break-in procedure on a newly rebuilt engine is the same as that of a new one. Use the break-in oil recommendations and follow other instructions given in your owner's manual.

SPECIAL TIPS

Because of the extreme demands placed on marine equipment, several points should be kept in mind when performing service and repair. The following items are general suggestions that may improve the overall life of the machine and help avoid costly failures.

1. Unless otherwise specified, use a locking compound, such as Loctite Threadlocker, on all bolts and nuts, even if they are secured with lockwashers. Be sure to use the specified grade

of thread locking compound. A screw or bolt lost from an engine cover or bearing retainer could easily cause serious and expensive damage before its loss is noticed.

When applying thread locking compound, use a small amount. If too much is used, it can work its way down the threads and stick parts together that were not meant to be stuck together.

Keep a tube of thread locking compound in your tool box; when used properly, it is cheap insurance.

2. Use a hammer-driven impact tool to remove and install screws and bolts. These tools help prevent the rounding off of bolt heads and screw slots and ensure a tight installation.

3. When straightening the fold-over type lock-washer, use a wide-blade chisel, such as an old and dull wood chisel. Such a tool provides a better purchase on the folded tab, making straightening easier.

4. When installing the fold-over type lock-washer, always use a new washer if possible. If a new washer is not available, always fold over a part of the washer that has not been previously folded. Reusing the same fold may cause the washer to break, resulting in the loss sf its locking ability and a loose piece of metal adrift in the engine.

When folding the washer, start the fold with a screwdriver and finish it with a pair of pliers. If a punch is used to make the fold, the fold may be too sharp, thereby increasing the chances of the washer breaking under stress.

These washers are relatively inexpensive and it is suggested that you keep several of each size in your tool box for repairs.

5. When replacing missing or broken fasteners (bolts, nuts and screws), always use authorized replacement parts. They are specially hardened for each application. The wrong 50-cent bolt could easily cause serious and expensive damage.

6. When installing gaskets, always use authorized replacement gaskets without sealer, unless designated. Many gaskets are designed to swell when they come in contact with oil. Gasket sealer will prevent the gaskets from swelling as intended and can result in oil leaks. Authorized replacement gaskets are cut from material of the precise thickness needed. Installation of a too thick or too thin gasket in a critical area could cause equipment damage.

MECHANIC'S TECHNIQUES

Removing Frozen Fasteners

When a fastener rusts and cannot be removed, several methods may be used to loosen it. First, apply penetrating oil, such as Liquid Wrench or WD-40 (available at any hardware or auto supply store). Apply it liberally and allow it penetrate for 10-15 minutes. Tap the fastener several times with a small hammer; do not hit it hard enough to cause damage. Reapply the penetrating oil if necessary.

For frozen screws, apply penetrating oil as described, then insert a screwdriver in the slot and tap the top of the screwdriver with a hammer. This loosens the rust so the screw can be removed in the normal way. If the screw head is too chewed up to use a screwdriver, grip the head with locking pliers and twist the screw out.

Avoid applying heat unless specifically instructed because it may melt, warp or remove the temper from parts.

Remedying Stripped Threads

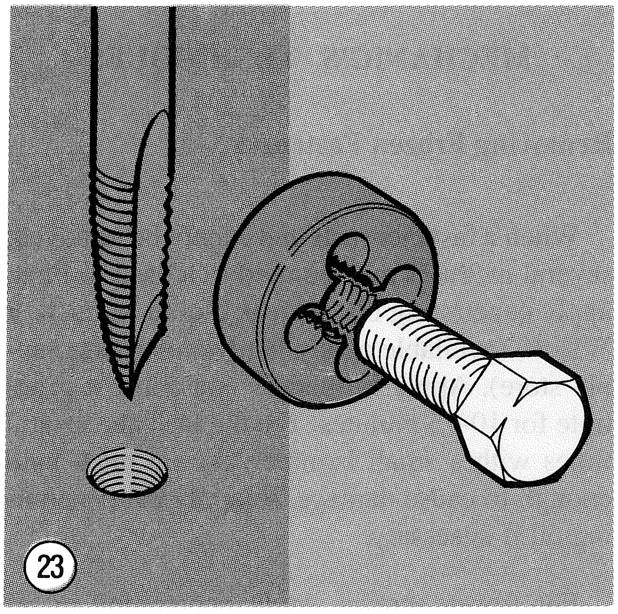
Occasionally, threads are stripped through carelessness or impact damage. Often the threads can be cleaned up by mnning a tap (for internal threads on nuts) or die (for external threads on bolts) through threads. See Figure **23.**

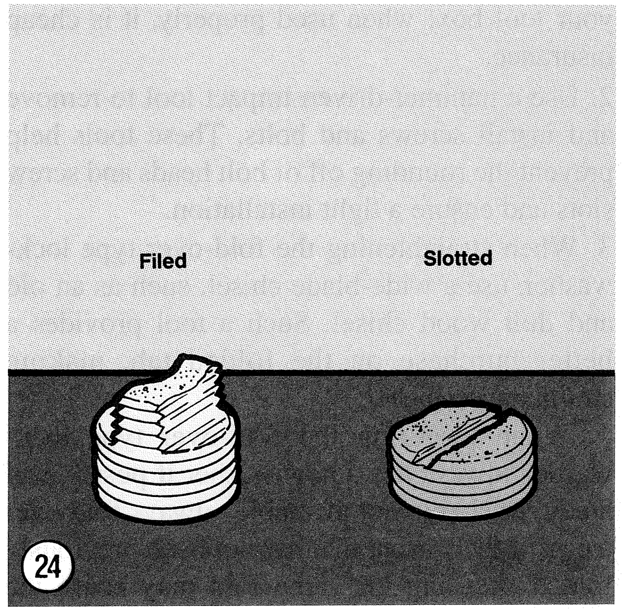
Removing Broken Screws or Bolts

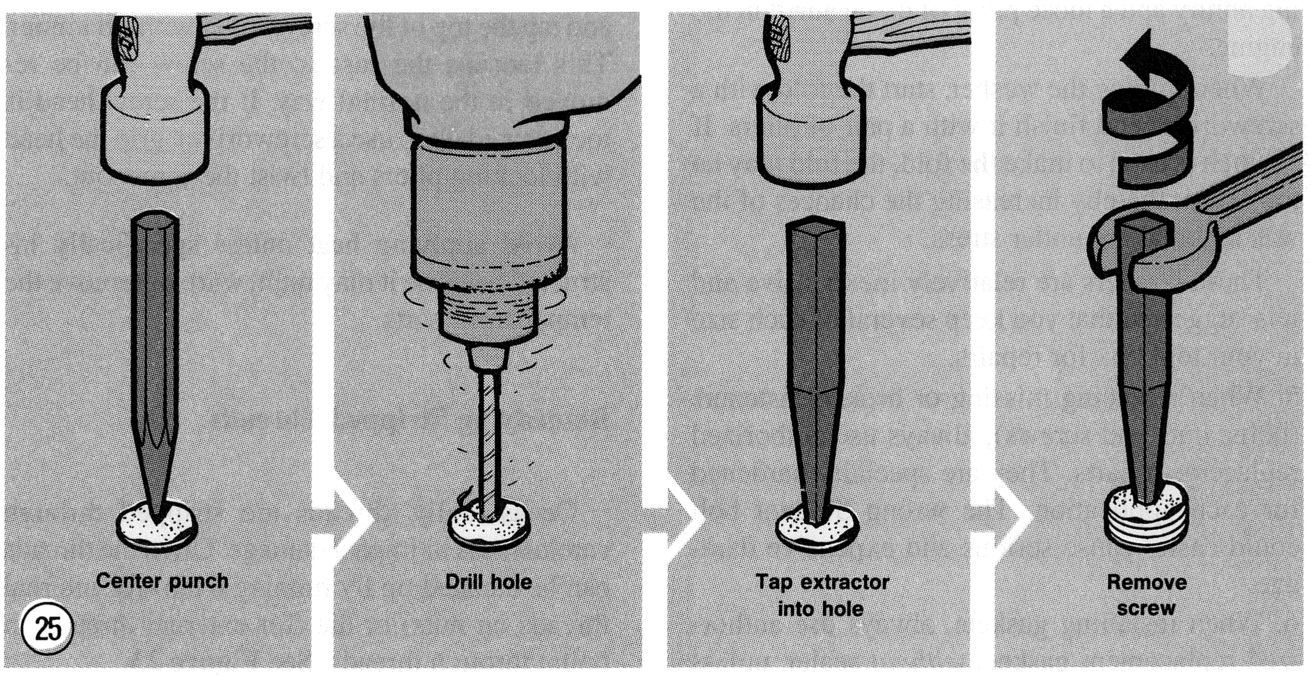
When the head breaks off a screw or bolt, several methods are available for removing the remaining portion.

If a large portion of the remainder projects out, try gripping it with vise-grip pliers. If the projecting portion is too small, file it to fit a wrench or cut a slot in it to fit a screwdriver. See **Figure** 24.

If the head breaks off flush. use a screw extractor. To do this, centerpunch the remaining portion of the screw or bolt. Drill a small hole in the screw and tap the extractor into the hole. Back the screw out with a wrench on the extractor. See **Figure** 25.







Chapter Three

Troubleshooting and Testing

There are three basic requirements for all internal combustion engines to run: proper ignition, unrestricted fuel supply, and adequate compression. When troubleshooting a problem, keep it simple. Define the symptom as closely as possible to one of the three functions, and then isolate the problem.

Expensive equipment or complicated test gear is not necessary to determine whether repairs can be attempted at home. A few simple tests could prevent a large repair bill and lost time while the vehicle sits in a service department. However, do not attempt repairs beyond your abilities. Service departments tend to charge heavily for putting together a disassembled engine that may have been abused.

This chapter covers test equipment, troubleshooting preparation and systems or component testing.

Tables 1-8 are located at the end of this chapter.

NOTE

This manual provides procedures and specifications for standard products. Information may not apply if the product has been modified from its original factory condition or has aftermarket equipment installed. The use of aftermarket equipment or modification of the engine can affect engine performance and tuning requirements. For information on aftermarket equipment, consult a dealership that handles such equipment or is familiar with engine modification. If necessary, contact the manufacturer of the aftermarket equipment for information.

TEST EQUIPMENT

Multimeter

Modern outboards use advanced electronic engine control systems that help optimize the performance, reliability, and fuel economy. A multimeter is necessary to accurately test these control systems. A multimeter combines the functions of a voltmeter, ohmmeter, and ammeter into one unit. Perform all tests using either an analog or digital multimeter. Refer to this section any time a question arises on using a multimeter.

A digital multimeter displays the readings on an LCD screen on the front of the meter. An analog multiineter uses a needle that swings across the face of the meter. In most cases, either type-of meter can be used. Make sure the meter has fresh batteries to avoid inaccurate readings. Refer to the meter's instruction booklet for specific features and instructions. Procedures for using a typical meter are provided in the following instructions.

Meter functions

Most multimeters measure voltage, resistance and amperage. An LCD screen or the selector dial indicates the selected function. For voltage, the meter typically displays *voltage* or *V.* For resistance, the meter displays *ohms* or *resistance.* For amperage, it displays *amps.*

NOTE
To avoid costly errors, always record the meter readings during testing. Note the wire colors, lead connecting location and actual readings. Clean all terminals before connecting test leads to them. It is a good idea to perform the test twice to verify that a fault exists before replacing any component. This important step can save time and unneces-s a y expense.

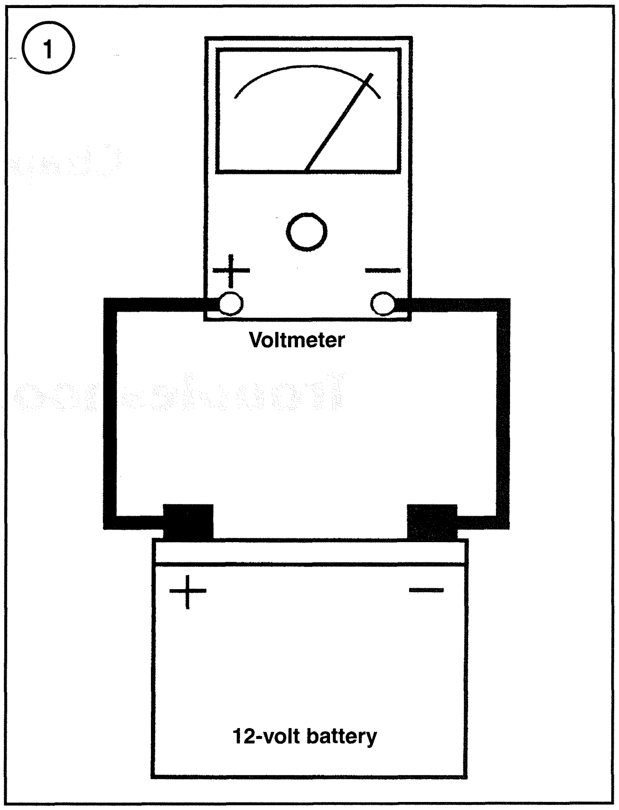
Test range

Before testing with the multimeter, determine the scale or range required for the test. Refer to the information provided in the appropriate table for the test specification. Available ranges vary by model and manufacturer. Refer to the manufacturer's instructions for specific information.

NOTE
Some digital multimeters are auto-scaling, eliminating the need to select the range. Be aware that not all meters provide accurate readings in the nzillivolt, milliohm and millianzp ranges. Refer to the instructions provided with the meter.

Measuring Voltage

Voltage is the potential pressure of the current flowing through a circuit. The more pressure available, the more work that can be accomplished. Voltage is generally measured using a simple parallel connection. Connecting a voltmeter directly to the negative and positive terminals of a battery is an example of a parallel connection (Figure **1).** It is not necessary to disconnect any circuits to measure voltage using a parallel connection.



Direct current (DC) voltage flows through a circuit in one direction only. All circuits associated with a battery are DC circuits.

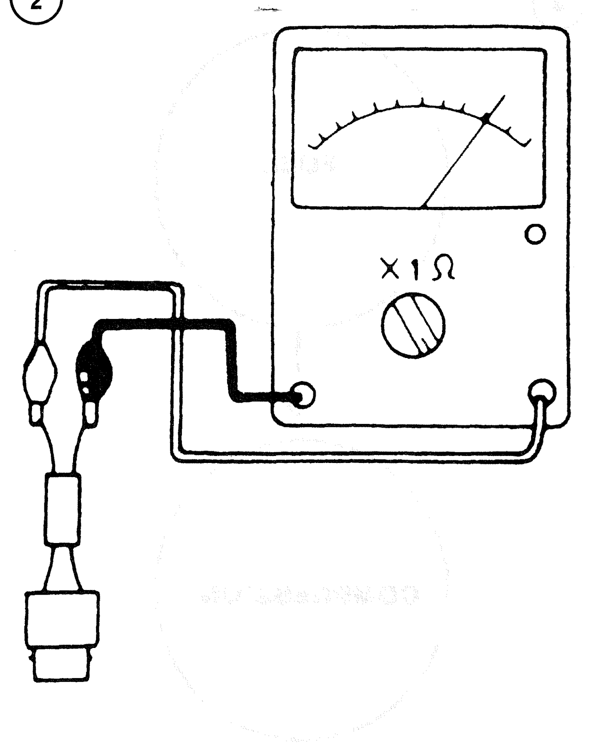
Alternating current (AC) voltage flows in one direction momentarily and then switches to the opposite direction. The frequency at which AC voltage changes direction is referred to as hertz. On an outboard motor, the charging system stator output is usually AC. Shore power and household current is also AC.

Peak Voltage

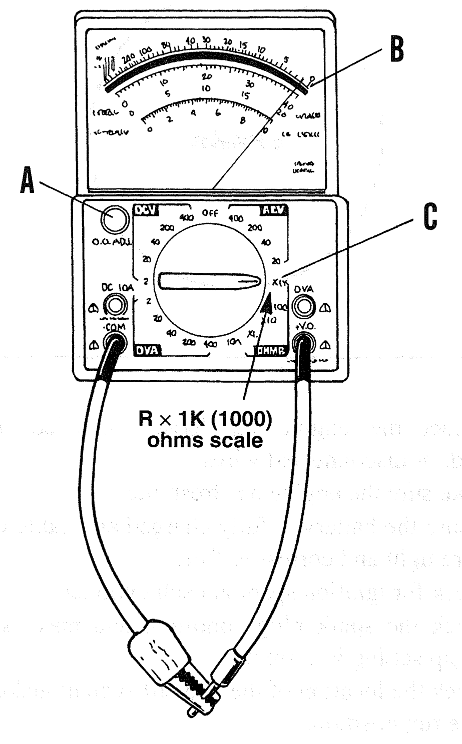
The ignition system on the models covered in this manual typically produces voltage pulses that peak for a very short duration. Aconventional voltmeter is unable to measure such a short-duration voltage pulse. Therefore, to test the output of the various ignition system components, a peak-reading voltmeter (PRV) is necessary. An adapter is available for some multimeters that provides a peak-voltage reading capability. Check with the meter manufacturer to determine if an adapter is available.

To measure peak voltage, the engine must either be cranked or started and all circuits must be intact. Use jumper leads as required to connect the meter while allowing all circuits to remain connected.

2



3



Voltage Drop

Since resistance causes voltage to drop, resistance can be measured on an active circuit using a voltmeter. This is a voltage drop test. Basically, a voltage drop test measures the difference in voltage at the beginning of a circuit and the end of a circuit while the circuit is being operated. If the circuit has no resistance, there will be no voltage drop (the meter will read zero). The more resistance in the circuit, the higher the voltmeter reading will be. Generally, voltage drop readings of one or more volts are considered unsatisfactory. The advantage to the voltage drop test compared to a resistance test is that the circuit is tested during operation. It is important to remember that a zero reading during a voltage drop test is good, while a battery voltage reading would indicate an open circuit.

A voltage drop test is an excellent way to test solenoids, relays, battery cables and high-current electrical leads. To perform a voltage drop test, connect the positive meter lead to the voltage source (where electricity is coming from) and the negative meter lead to the load (where electricity is going).

Resistance

Resistance is the opposition to the flow of current through a circuit. Ohms are the unit of measure for resistance. Use an ohmmeter only on a circuit or component that is isolated (disconnected). The ohmmeter will be damaged if connected to a circuit with voltage present.

To measure resistance, the ohmmeter is typically connected in a series connection (Figure **2).** Because an ohmmeter is self-powered, it is often used as a continuity tester in addition to measuring resistance. Use a continuity tester to check the integrity of a circuit or component and to check diodes. An infinity reading (open circuit) indicates no continuity while any other reading indicates continuity.

An ohmmeter, although useful, is not always a good indicator of ignition system condition. This is primarily because resistance tests do not simulate actual operating conditions. For example, the power source in most ohmmeters is only 6-9 volts. A CDI charge coil, however, commonly produces 100-300 volts during normal operation. Such high voltage can cause coil insulation leakage that cannot be detected with an ohmmeter.

An analog ohmmeter must be calibrated before each use and each time the scale is changed. Digital ohmmeters, however, are usually auto-ranging and auto-scaling and do not require calibration. To calibrate an analog meter, touch the test leads together and turn the adjust knob until the needle points exactly at zero. See Figure **3.**

Because resistance generally increases with temperature, perform resistance tests with the circuit or component cold (room temperature). A resistance test performed on a hot component will indicate increased resistance and may result in unnecessary parts replacement without solving the basic problem.

CAUTION
Do not connect an ohmmeter to a live circuit or conzponent. Always isolate the circuit or component from voltage prior to attaching an olzmmeter or the meter will be damaged.

Amperage

Current is the flow of electricity in a circuit and is measured in amperes (amps). Amps are measured using an ammeter attached in a simple series connection. To connect an ammeter, the circuit usually must be disconnected and ammeter spliced into the circuit. Always connect the positive ammeter lead to the source (where electricity is coming from) and the negative lead to the load (where electricity is going).

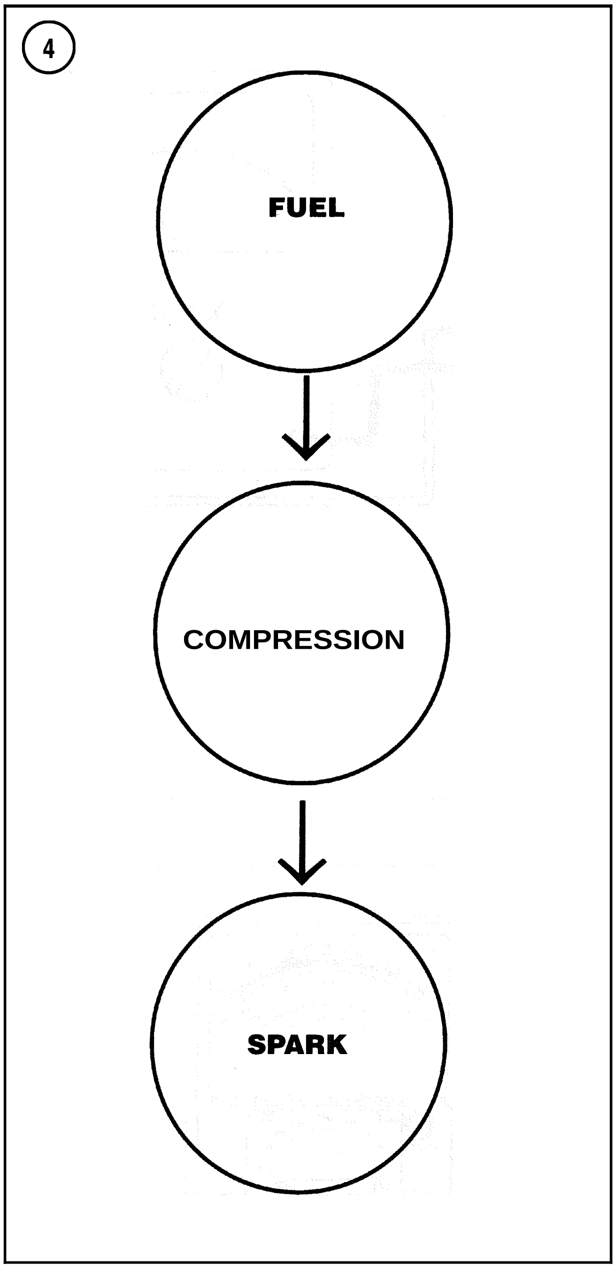
Checking Diodes

An ohmmeter is often used to check diodes within various engine components. Some meters have a diode test option. Diodes function like electrical check valves. First check for continuity by measuring between two leads or terminals. Then reverse the meter test leads and check for continuity again. No continuity when connected one way and continuity when the leads are reversed generally indicates a good diode. Do not be concerned about test lead polarity, as variations exist from one meter to the next.

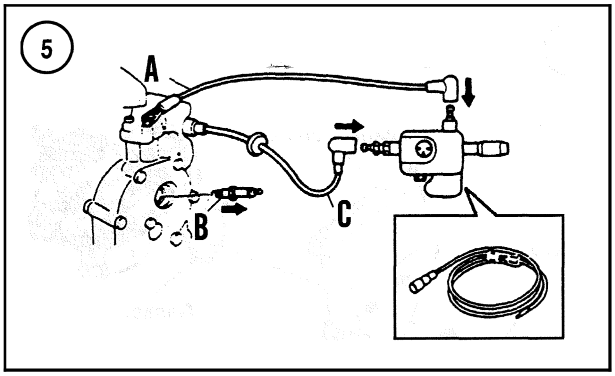
TROUBLESHOOTING PREPARATION

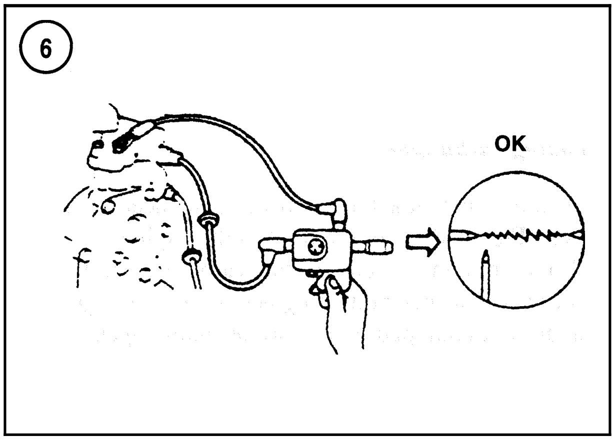
Before troubleshooting, verify the model name, model number, horsepower and serial number of the engine. It is essential that the model be identified correctly before servicing the engine. In many cases, the tables list specifications by horsepower and/or model name. For most models, identification tags may be found on the clamp bracket. The information provided on the tag is required when purchasing replacement parts for the outboard.

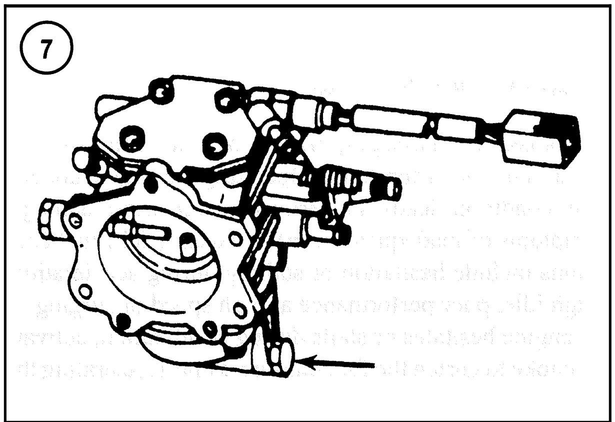
Most engine problems may be resolved by completing a basic inspection. Check the following tips and refer to **Tables 1-5** at the end of this chapter for starting, fuel and ignition troubleshooting. Additional troubleshooting tips are provided in this chapter for the specific system or component.



1. Inspect the engine for loose, corroded, broken, cracked, or disconnected wires.
2. Make sure the engine has fresh fuel.
3. Ensure the battery is fully charged and cable connections are tight and corrosion-free.
4. Check for ignition spark at each cylinder.
5. Check the spark plug condition and make sure the spark gap setting is correct.
6. Check the location of the lanyard switch; make sure it is in the run position.
7. Verify that the boat hull is free of any obstructions.







OPERATING REQUIREMENTS

An internal combustion engine requires three basic things to run properly: an unrestricted supply of fresh fuel to the carburetor, adequate compression in the combustion chamber and ignition at the correct time (**Figure** 4). If any of these are lacking, the engine will not run properly or will not run at all.

STARTING DIFFICULTY

Determining a Fuel or Ignition Fault

Determining if a starting problem is related to fuel, ignition or other causes can be difficult. If the engine cranks but does not start, verify that the ignition system is operating. Use a spark gap tester to make sure ignition (spark) is present at cranking speed. Use Stevens S-13C, S-48 or equivalent. Check the fuel system if the ignition system is operating properly.

Spark test

1. Connect an alligator clip test lead (A, **Figure** 5) to an engine ground.
2. Remove the spark plug(s) (B, **Figure** 5).
3. Attach the spark plug leads to the spark gap tester (C, **Figure** 5).
4. Crank the engine while observing the spark tester **(Figure 6).** A strong blue spark that jumps a 9 mm (0.035 in.) gap indicates adequate spark.
5. Repeat Steps 1-4 for all cylinders. Reinstall the spark plug(s) and connect the leads after the test is complete. Refer to **Table 2** for ignition system testing if spark is weak or absent on any cylinder. Refer to **Table** 4 for fuel system troubleshooting if the ignition system is working properly, but the engine will not start.

Fuel System Inspection

Fuel-related problems are common on outboard engines. Fuel available today has a relatively short shelf life. Gasoline tends to lose some of its potency and becomes sour if it is stored for long periods. A sticky or gummy deposit may form in the carburetor and passages as the fuel evaporates. This deposit may also clog fuel line and fuel filters. Fuel stored in a tank may become contaminated by water from condensation or other sources. The water will cause the engine to run erratically or not run at all.

If the engine has been stored for a period of time and is hard to start, check the condition of the fuel. Carefully drain the fuel from the carburetor float bowl into a suitable container. Drawings that indicate specific locations of the float bowl drain plugs **(Figure** 7) appear in Chapter Six. Contaminated fuel has a unique odor; this is a sure sign of a problem. Debris, cloudiness or water in the fuel is a sure sign of a problem. If any of these signs are found, dispose of the old fuel in an environmentally safe manner. Contact a local marine dealership or automotive repair center for information on proper disposal of fuel. Clean the entire fuel system if contaminants are found in the float bowl; problems are sure to happen if the entire fuel system is not cleaned. Replace all filters in the fuel system if contaminants are found in the fuel system. If no fuel can be drained from the float bowl, the carburetor(s), fuel lines and fuel pump should be inspected. Typically the inlet needle is stuck closed or plugged by debris, preventing fuel from reaching the carburetor. Carburetor repair procedures are provided in Chapter Six.

Fuel Pump and Fuel Tank

Engine surging at higher speeds is usually caused by problems with either the fuel pump or the fuel tank. Boats equipped with built-in fuel tanks have antisiphon valves installed by the boat manufacturer. This antisiphon valve prevents fuel from being siphoned out of the tank and into the boat if a fuel line is cut or pinched. These devices are a necessary safety mechanism, but they may cause problems if they malfunction. To test a suspected fuel tank problem, temporarily run the engine with a portable fuel tank filled with fresh fuel. If the problem no longer exists, check the fuel tank pickup and/or replace the antisiphon valve.

To check for a fuel pump problem, try squeezing the primer bulb gently while the problem is occurring. Completely inspect the fuel pump and fuel lines if the symptom improves while squeezing the primer bulb. Fuel system repair procedures are provided in Chapter Six. Always correct fuel leakage after working with any fuel system component.

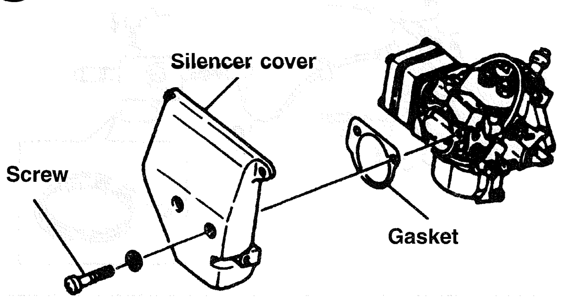
CAUTION
Never run an outboard without providing cooling water. Use either a test tank or flush/test device. Remove the propeller before running the engine. Install a test propeller to run the engine in a test tank.

Carburetor Malfunction

A rough-running engine that smokes excessively usually indicates a rich fuel/air mixture. The typical causes include a flooding carburetor, stuck or closed choke or a faulty puddle drain system. The tnost common cause is a flooding carburetor or improper float level. A weak ignition (spark) can also cause rough running and excessive smoking.

Hesitation during acceleration is another symptom of carburetor malfunction. This typically is caused by a lean condition.

8



Flooding carburetor

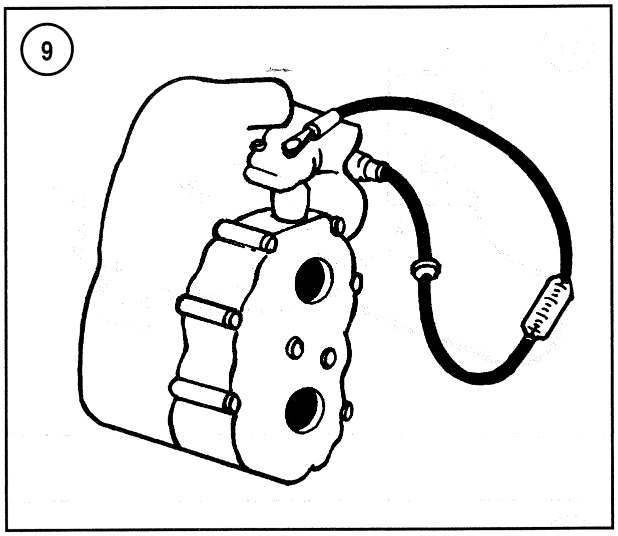
1. Remove the attaching screw(s), silencer/cover and gasket (Figure **8)** from the front of the engine.
2. Look into the throat of the carburetor and gently squeeze the primer bulb. Engines with an integral fuel tank are not equipped with a primer bulb. Open the fuel valve and look into the throat of the carburetor.
3. If fuel is flowing into the throat of the carburetor, remove the carburetor and repair it as described in Chapter Six.
4. Install the gasket, silencerlcover and screw(s) securely.

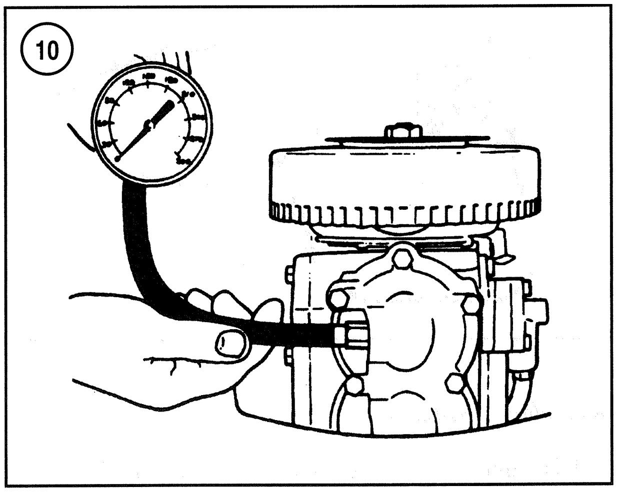
Plugged carburetor passages

Blocked jets, passages, orifices or vents can cause either a rich or lean condition. Operating the engine under a lean condition leads to serious power head damage. Symptoms of inadequate (lean) or excess (rich) fuel conditions include hesitation or stalling during acceleration, rough idle, poor performance at high speed or surging. If the engine hesitates or stalls during acceleration. activate the choke to enrich the fuel mixture while accelerating the engine. The engine is operating under a lean fuel condition if the symptoms improve with the enriched fuel mixture. If the symptoms get worse, the fuel mixture is too rich. In either case, clean and inspect the carburetor(s) as described in Chapter Six.

Altitude adjustments

If the engine is operated at higher elevations, carburetor jet changes may be required. Operation in extreme climates may also require carburetor adjustment or jet





changes. Contact a dealership in the operating area for recommendations.

WARNING
Use extreme caution when working with the fuel system. Fuel vapor is highly flammable.

Compression Test

Older engines or engines with high operation hours often experience hard starting, poor idle quality or poor overall performance Perform a cylinder compression test if the fuel and ignition systems appear to be operating properly.

1. Remove and inspect the spark plug(s). Clean or replace the spark plug(s) as necessary.
2. Connect the spark plug lead(s) to an engine ground using jumper lead(s) (Figure **9).**
3. Install compression gauge into the No. 1 cylinder spark plug hole (Figure **10).**
4. Manually hold the throttle plate(s) in the wide-open position. Operate the electric starter motor or rewind starter and crank the engine at least six rotations.
5. Record the compression readings.
6. Repeat Steps 3-5 for the remaining cylinders.
7. Install original or new spark plugs and torque to the specification in Chapter Four.
8. Compare the highest and lowest compression readings. The lowest reading should be within 10% of the highest reading. If one or more cylinders read significantly lower than the others, examine this before attempting to troubleshoot or tune the engine. Power head repair procedures are provided in Chapter Eight. An engine with inadequate compression cannot be tuned properly or expected to perform correctly.

IGNITION SYSTEM TESTING

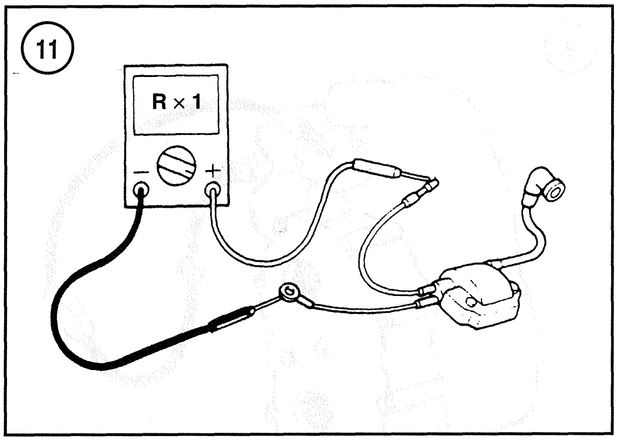
The ignition system is composed of the flywheel, exciter coil, pulser coil, CDI unit, ignition coil and spark plugs. Except for the spark plugs, very little maintenance is required. Use resistance or peak voltage to test all components.

Stop Circuit Test

Engine stopping procedures vary by model. On the tiller handle-controlled models, push the stop button, while on a remote-control model, turn a key switch to activates the stop circuit. In either case, the engine stops running because the current required operating the ignition system is diverted to the engine ground. Some models are equipped with a safety lanyard switch in addition to the button or key switch. Stop circuit or switch failure can cause the engine to not start or not stop.

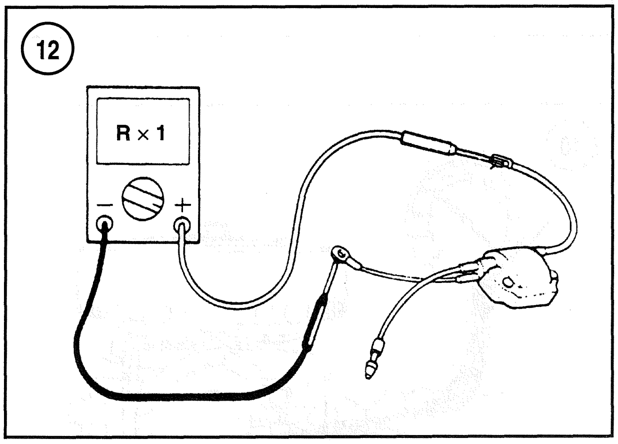
1. Disconnect the brown stop circuit wire from the CDI unit.
2. Connect the ohmmeter between the brown stop circuit wire and a good engine ground.
3. Continuity should be present in each of these circumstances: the key switch is in the OFF position, the lanyards switch is in the OFF position or the stop button is depressed.
4. The meter should show no continuity for the following conditions: the key switch is in the ON position, the lanyard switch is in the RUN position and the stop button is in normal run position.

5. Replace the stop button and harness (tiller model only) if readings are incorrect.
6. Test the key switch and lanyard switch (remote control models) if either test in Step 3 or Step 4 fails. Refer to Chapter Seven for key switch and lanyard switch testing.
7. Repair or replace the harness (remote control models) connecting the controls to the engine if the key switch and lanyard switch function properly.
8. Perform Steps 3 and 4 to verify proper operation before running the engine. Reconnect all leads and operate the engine to verify proper switch operation. Replace the CDI unit if all other components operate properly, but the engine has no ignition or cannot be stopped.



Spark Plug Cap

A problem with the spark plug cap can cause an ignition misfire. Often very humid conditions contribute to the misfire. Replace the spark plug cap if external arcing is noted at the spark plug connection. Corrosion at the connections can cause high resistance and result in an ignition misfire. Visually inspect all spark plug caps. Replace any cap that is corroded, cracked or has breaks in the insulating material. The spark plug caps covered in this manual all screw on and off the secondary lead. To remove the spark plug cap, turn it counterclockwise; to install the spark plug cap, turn it clockwise.



Ignition Coil

A problem with an ignition coil can cause or contribute to an intermittent or constant ignition misfire. Perform a visual inspection on all ignition coils. Replace any coil that has corroded terminals or cracks on its body. A coil resistance test can be performed for all models. Coil removal and installation procedures are provided in Chapter Seven.

Primary resistance

1. Disconnect the primary leads and the secondary lead from the ignition coil.
2. Connect the negative lead of the ohmmeter to the black lead (Figure **11)** of the ignition coil.
3. Connect the positive lead of the ohmmeter to the black/white lead (Figure **11)** of the ignition coil.
4. Compare the reading with primary resistance specification at the end of Chapter Seven.
5. Repeat the test for all ignition coils on the engine. Replace any coil that does not meet the indicated specification.

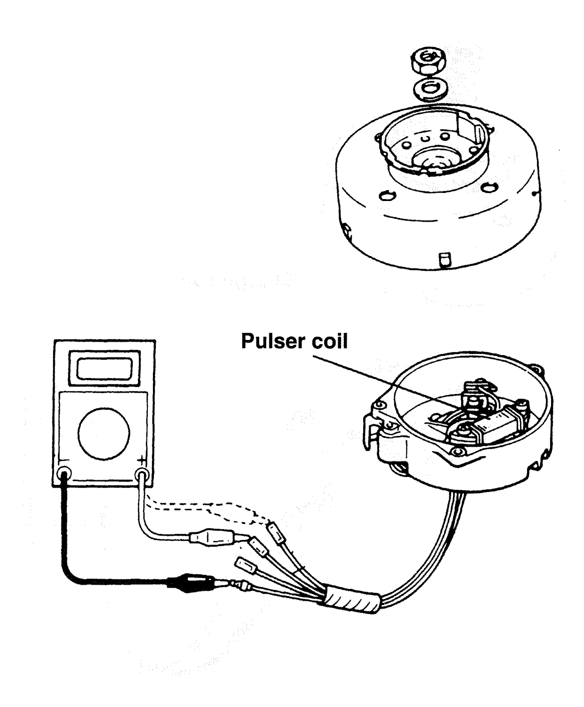
Secondary resistance

1. Disconnect the primary leads and secondary lead from the ignition coil.
2. Connect the negative lead of the ohmmeter to the black lead (Figure 12) of the ignition coil.
3. Connect the positive lead of the ohmmeter to the secondary lead (Figure 12) of the ignition coil.
4. Compare the reading with the secondary resistance specification in the tables at the end of Chapter Seven.
5. Repeat the test for all ignition coils on the engine.
6. Install the coil onto the power head and connect the leads to proper location.

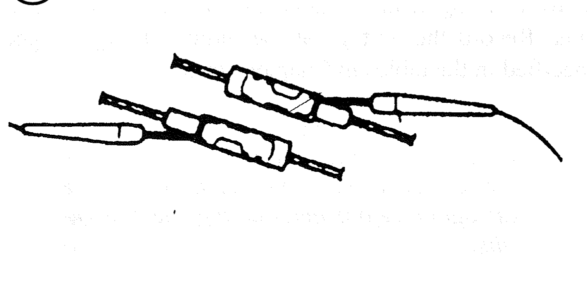
Pulser Coil

The pulser coil is located under the flywheel. An electrical pulse is created as magnets attached to the flywheel pass near the coil. This electrical pulse initiates the spark at the plug. If a pulser coil is faulty, the flywheel (Figure 13) must be removed to access the coil. Flywheel removal

13



14



is not necessary to access the pulse coil leads. A faulty pulser coil can cause an intermittent or constant ignition misfire. Follow the test procedures carefully to avoid misdiagnosis and unnecessary flywheel removal. Refer to Tables **2-24** in Chapter Seven for the pulser coil specifications. A peak-reading voltmeter is needed to test peak voltage on all models.

Pulser coil resistance

1. Disconnect the pulser coil leads from the harness.
2. Connect the positive and negative ohmmeter leads (Figure **13)** to the correct color leads as indicated in the wiring diagrams at the end of this manual.

NOTE
Pulser coil resistance test results are not affected by polarity of the test leads.

4. Compare the pulser coil resistance with the specification provided in Tables **2-24** in Chapter Seven. Replace the pulser coil if the resistance is not within specification. Removal and installation of the pulser coil are provided in Chapter Seven.
5. Attach the leads to the proper location(s) when testing is complete.

Pulser coil peak voltage output

When performing this test, all leads must be connected into the main engine harness. Using a test harness or probing the wire connections (Figure **14)** allows voltage testing while sunning the engine. This test will identify a faulty pulser coil or CDI unit during sunning conditions.

WARNING
Stay clear of the propeller shaft while running an engine on a flush/test device. As a safety precaution, remove the propeller before performing the test.

1. Connect a peak-reading voltmeter to the pulser coil wires. Refer to the appropriate table at the end of this chapter for the wire colors.
2. Run the engine on a suitable testiflush device or in a test tank. Record the voltage output at the indicated engine speed. See Tables **2-24** in Chapter Seven.

NOTE
If the peak voltage reading is excessively low, reverse the meter test leads and run the test again before determining the test results.

3. Compare the output with the specification listed in Tables **2-24** at the end of Chater Seven. Replace the CDI unit if the voltage reading is above the specification. Replace the pulser coil if the reading is below the specification.CDI unit and pulser coil replacement are provided in Chapter Seven.
4. Remove the test harness and attach all leads to the proper locations.

CAUTION
Never run an outboard without providing cooling water; use either a test tank or flush/test device. Install a test propeller to run the engine in a test tank.

Ignition Exciter Coil

The ignition exciter coil powers the ignition system. Current is generated in the coil as magnets attached to the flywheel rotate past the coil. This current is directed to the CDI unit where it is stored for use to create ignition. A faulty ignition exciter coil can cause an intermittent misfire or no spark. On certain models, the engine may operate properly at one speed and misfire at another speed due to a faulty exciter coil. Perform the test carefully, as the flywheel must be removed to remove the exciter coil. The flywheel does not have to be removed during testing since the coil leads are accessible. A digital meter is required for peak voltage resistance tests.

Resistance specifications and peak voltage readings are provided in Chapter Seven. Perform both tests to ensure accurate test results.

Ignition exciter coil resistance

1. Disconnect all ignition exciter coil leads from the engine harness.
2. Connect the meter test leads to the exciter coil leads **(Figure 15)** as indicated in **Tables 2-24,** Chapter Seven.
3. Compare the resistance with the specification listed in **Tables 2-24** in Chapter Seven. Replace the ignition exciter coil if it is not within the specification. Refer to Chapter Seven for removal and installation.
4. Connect all leads to the proper location.

Ignition exciter coil peak voltage output

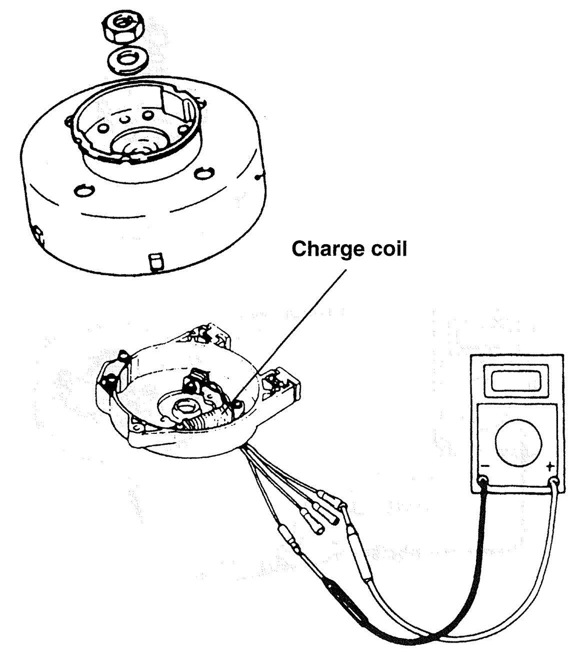
When performing this test, all leads must be connected to the engine harness. Using a test harness or probing the wire connections **(Figure 14)** allows the voltage to be tested while the engine is running. This test can identify a faulty ignition exciter coil during running conditions.

WARNING
Stay clear of the propeller shaft while running an engine on a flush/test device. Remove the propeller before running the engine or performing a test.

1. Connect a peak-reading voltmeter to the pulser coil wires. Refer to the appropriate table at the end of Chapter Seven for the wire colors.

CAUTION
Never run an outboard without providing cooling water; use either a test tank or flush/test device. Install a test propeller to run the engine in a test tank.

15



2. Run the engine in a suitable test/flush device or in a test tank. Record the voltage at the indicated engine speed specified in the tables in Chapter Seven.

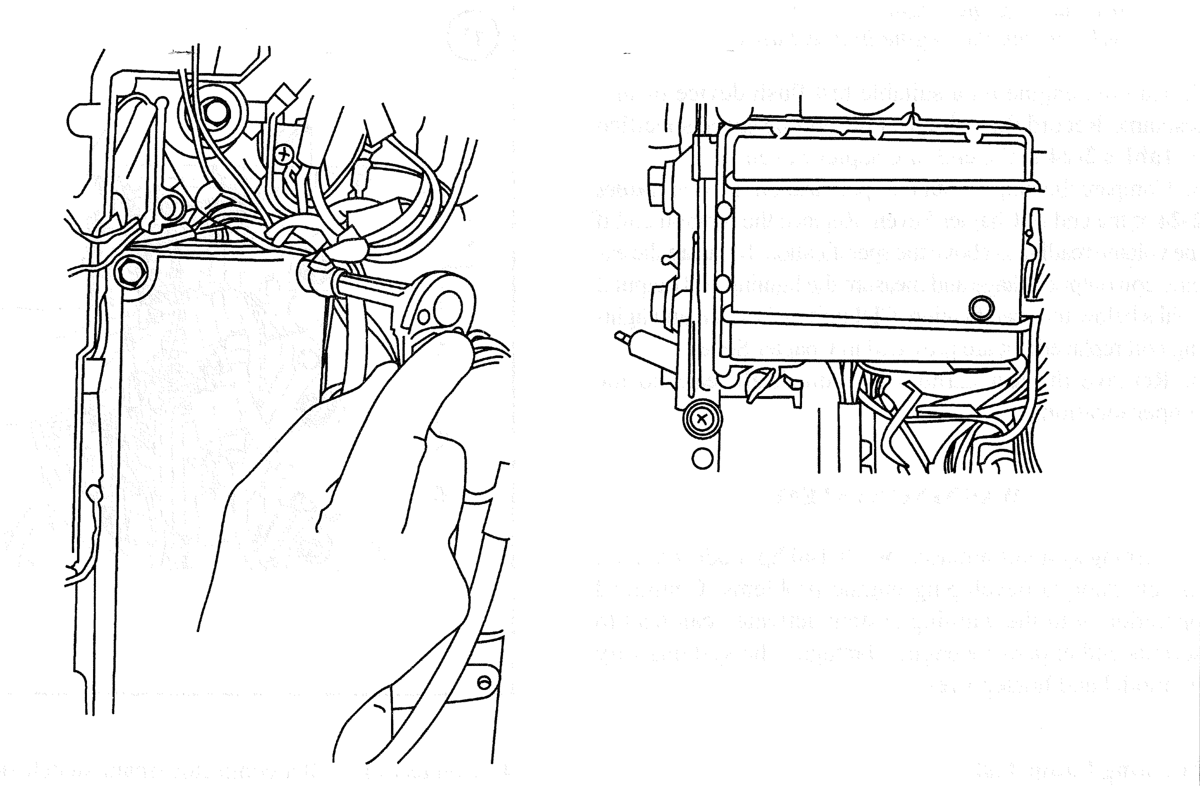
NOTE
If the peak voltage reading is excessively low, reverse the meter test leads and run the test again before determining the test results.

3. Compare the output with the specification(s) listed in Chapter Seven tables. Measure the pulser coil output peak voltage if it is above specification. Replace the exciter coil if the reading is below the specification. CDI unit and exciter coil replacement are provided in Chapter Seven.
4. Remove the test harness and attach all leads to the proper locations.

CDI Unit

The primary function of the CDI unit **(Figure 16)** is to direct spark to the correct cylinder at the correct time. As the flywheel magnet rotates past the exciter coil, current is

16



generated and stored in a capacitor in the CDI unit. Electrical pulses generated by the pulser coil trigger the release of the stored current, which is directed to the ignition coil. The ignition coil amplifies the current to the voltage needed to jump the gap at the spark plug.

The ignition timing is advanced at higher engine speeds to improve engine performance and efficiency. On some models, this is accomplished by rotating the pulser coil in relationship to the triggering magnets in the flywheel. On other models, the CDI unit advances the timing. Automatic spark advance is provided with increased engine speed.

The CDI unit on some models performs other important functions in addition to ignition control. On some models the CDI unit limits the engine speed if it receives an abnormal reading from the overheat sensor, water pressure sensor, or oil level sensor. All three- and four-cylinder models have a special feature of the CDI unit for overspeed limitation. There is a third type of speed limitation used on the 115, 120 and 140 hp models. The CDI unit limits the top engine speed to about 1500 rpm if it does not receive a signal from the remote control box through the red/yellow lead. Testing procedures for these sensors are covered in this chapter. Timing and linkage adjustments for all models are provided in Chapter Five.

A peak-reading voltmeter (Model M-530 or equivalent) is required to test peak voltage on all models.

CDI Unit Peak Voltage Test

When performing this test, all leads must be connected to the engine harness. The use of a test harness or probing wire connections (Figure 14) allows voltage testing while running the engine. This test can identify a faulty CDI unit during running conditions.

WARNING
Stay clear of the propeller shaft while running an engine on a flush/test device. Remove the propeller before running the engine or testing.

1. If necessary, attach a test harness to the engine wiring harness at the CDI unit connector. Connect a peak-reading voltmeter to the CDI unit wires specified in the appropriate table in Chapter Seven.

CAUTION
Never run an outboard without first providing cooling water. Use either a test tank or flush/test device. Remove the propeller be-

fore running the engine. Install a test propeller to run the engine in a test tank.

2. Run the engine on a suitable testiflush device or in a test tank. Record the voltage at the engine speed specified in Tables **2-24** at the end of Chapter Seven.
3. Compare the output with the specification listed in Tables 2-24 at the end of Chapter Seven. Replace the ignition coil if the voltage reading is above the specification. Measure the exciter coil output voltage and measure the lighting coil output if it falls below the specification. CDI unit, pulser coil and lighting coil replacement are provided in Chapter Seven.
4. Remove the test harness and attach all leads to the proper locations.

WARNING SYSTEM

Warning systems are used on 40-140 hp models to alert the operator to developing engine problems. Continued operation with the warning system activated can lead to serious and expensive engine damage. The systems vary by model and horsepower.

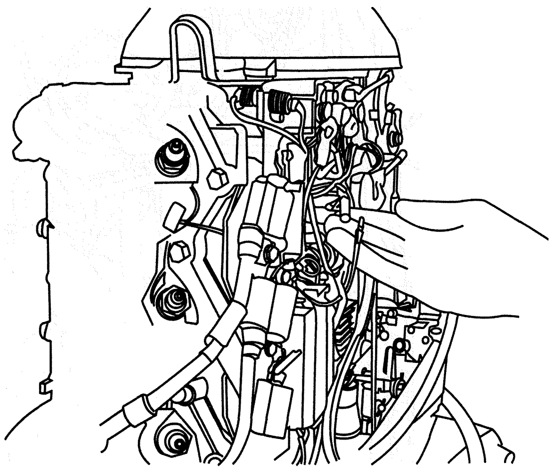
Warning Lamp Test

A warning lamp is used on 40 and 50 hp EFGO/EFTO models to alert the operator that the engine is overheating or that the oil level is low. The warning lamp is mounted on the front surface of the lower engine cowling.
1. Turn the main key switch to the ON position.
2. Remove the electrical box cover.
3. Disconnect the bullet connector from the oil level sensor (Figure 17).
4. Connect the bullet connector (main switch side) to a clean engine ground and verify that the pilot lamp illuminates. Replace the lamp or wiring if the lamp fails to illuminate.

Warning Horn Test

A warning horn is used on 40-140 hp models. On tiller handle models, the horn is mounted in the lower cowling of the engine. The remote control model has the warning horn mounted inside the control box. The horn sounds a constant tone to alert the operator of critical operating conditions such as a clogged or obstructed cooling water intake, overheating engine or low oil level.
1. Turn the main key switch to the ON position.
2. Remove the electrical box cover.
3. Disconnect the bullet connector from the oil level sensor (Figure 17).

17



4. Connect the bullet connector (main switch side) to an engine ground to make sure the warning horn sounds. Replace the horn or wiring if the horn fails to sound.

Oil Level Sensor Test

An oil level sensor is used on all 140 hp engines and is mounted inside the remote oil tank.

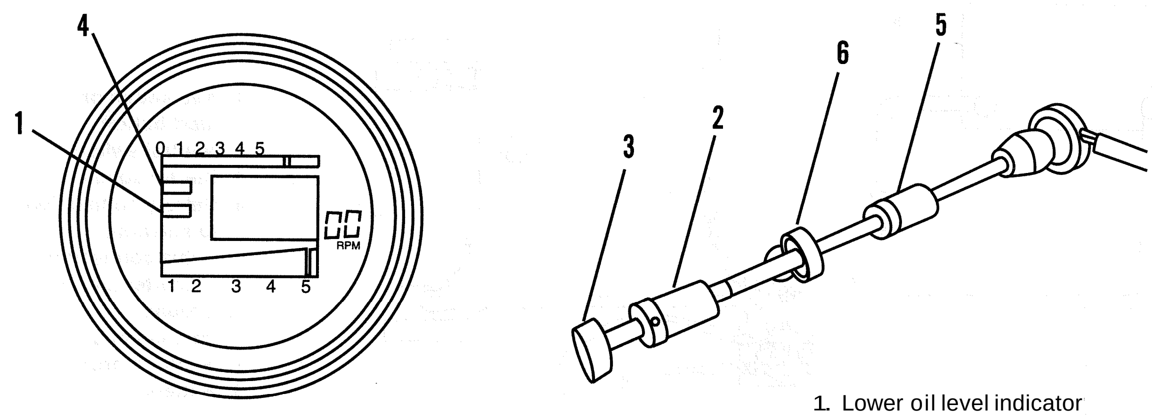
Each engine has an LCD display (Figure **18)** mounted in the boat dash which monitors the engine speed, trim angle, engine temperature and oil level.
1. Disconnect the oil level sensor leads from the electrical box and remove the sensor from oil tank.
2. Reconnect the sensor leads.
3. Place the remote control lever in the forward or reverse gear position.
4. Turn the ignition switch to the ON position. Move the float on the oil level indicator into contact with the sensor switch.

5A. *115-140* hp—When the float (2, Figure 18) contacts the sensor switch (3), the lower oil level indicator (1) should flash and the warning horn should sound. When the float (5, Figure 18) contacts the sensor switch (6), the upper oil level indicator (4) should illuminate.

5B. *60-90* hp—When the float contacts the sensor switch, the warning horn should sound and the oil level indicator on the tachometer should illuminate.

18

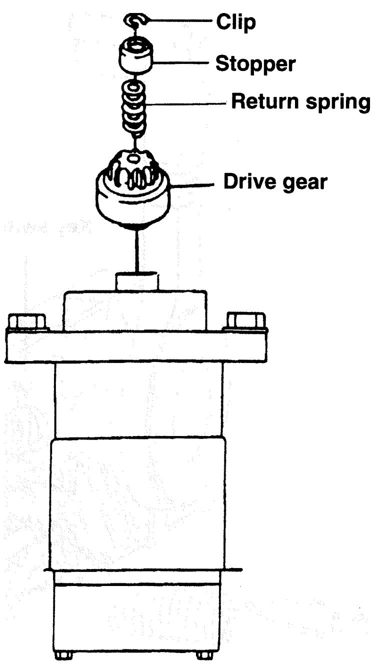
LCD MULTIMETER AND OIL LEVEL SENSOR



1. Lower oil level indicator
2. Float
3. Sensor switch
4. Upper oil level indicator
5. Float
6. Sensor switch

19

STARTER MOTOR AND DRIVE (TYPICAL)



5C. 40 and 50 hp with *remote* control—The warning horn should sound and the low oil indicator on the tachometer should illuminate when the float contacts the sensor switch.

5D. 40 and 50 hp with tiller handle—When the float contacts the sensor switch, the pilot lamp on the lower engine cowl should illuminate.

6. Reinstall the oil level sensor by reversing the removal procedure. Apply RTV sealant to the sensor cap during installation.

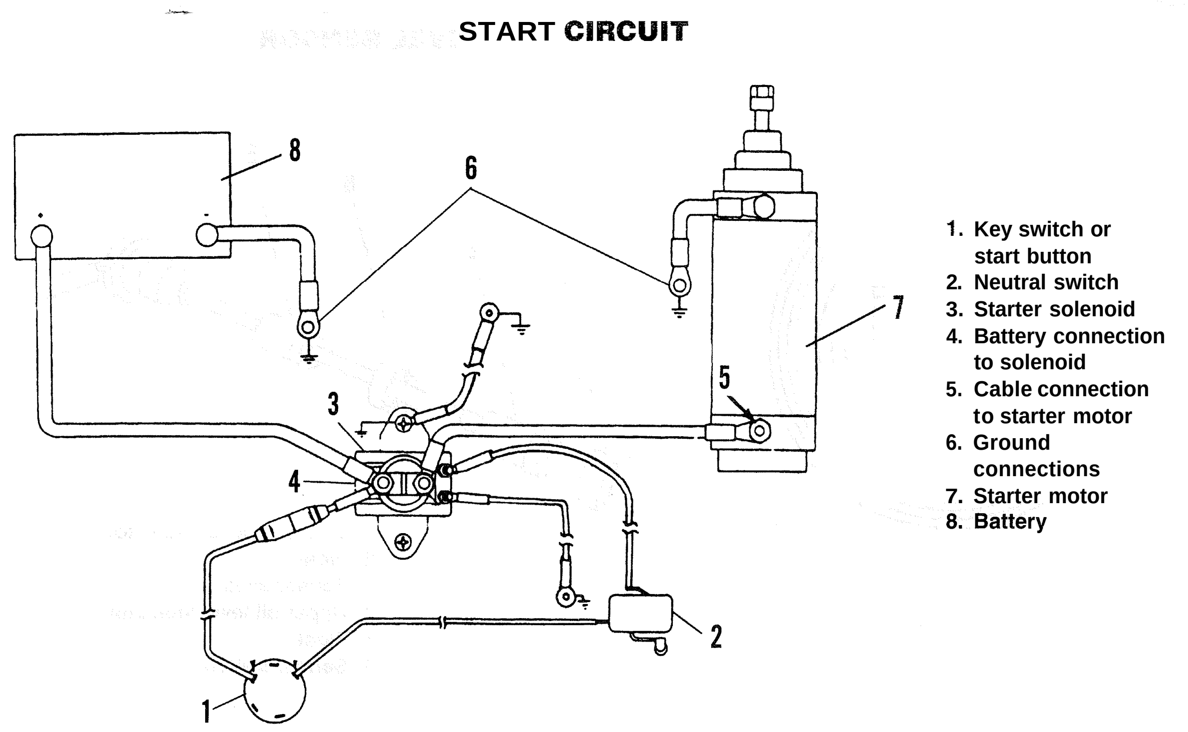
STARTING SYSTEM

The starting system may be either manual or electric start. Manual start is offered on 2.5-18 hp models. Both systems are available on 25-50 hp models. The 70-140 hp models use only electric start.

The common components of the electric starting system include the battery, start button or ignition switch, starter solenoid, starter motor, neutral switch and wires.

The electric starter motor **(Figure 19)** is similar in design to what is commonly used on automotive applications. Its mounting position on the power head allows the starter drive gear **(Figure 19)** to engage a flywheel-mounted ring gear when the starter is operated. The

20

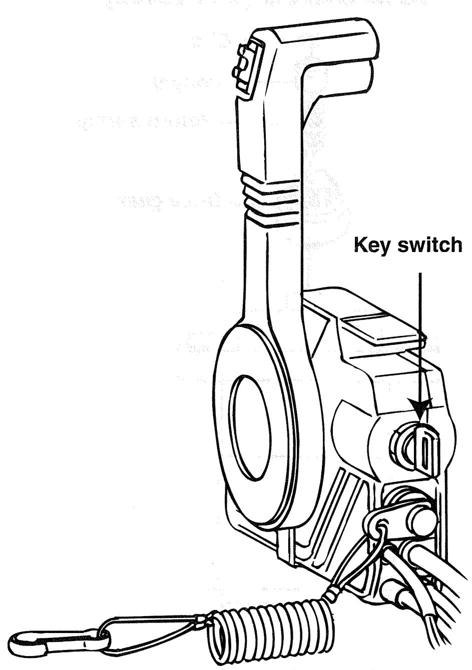


neutral switch prevents the starter motor from operating when the engine is in gear. When the starter is disengaged, the flywheel kicks the starter drive down to the starter motor with the assistance of the return spring (**Figure** 19) mounted on the starter drive.

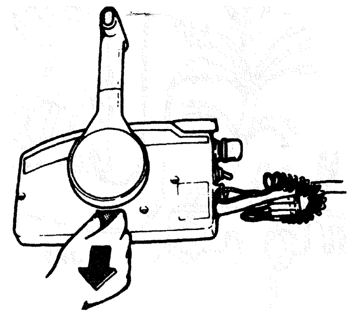
The starter motor is capable of producing a tremendous amount of torque, but only for a short period of time. A fully charged battery of sufficient capacity is necessary to provide the torque required to crank the engine. Battery requirements are 500 minimum cold-cranking amps, (70 amp hour) and a 105-minute reserve. Weak or undercharged batteries are the leading cause of starting system problems. Battery maintenance and testing procedures are provided in Chapter Four.

The operation of the start circuit begins at the ignition switch or start button. When the switch or button is operated, current is directed to the neutral switch (2, **Figure** 20) and then to starter solenoid (3, **Figure** 20). The solenoid is connected to the starter motor (5, **Figure** 20) with a large diameter cable. When current is supplied to the solenoid from the neutral switch, it makes an internal connection that allows the current to flow from the battery directly to the starter motor. Starter motor removal, disassembly, inspection, assembly and installation are found in Chapter Seven. Refer to **Table 1** for starting system trou-

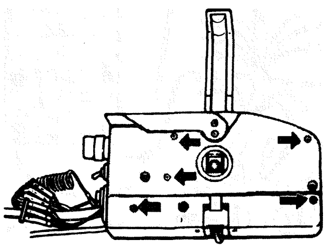
21



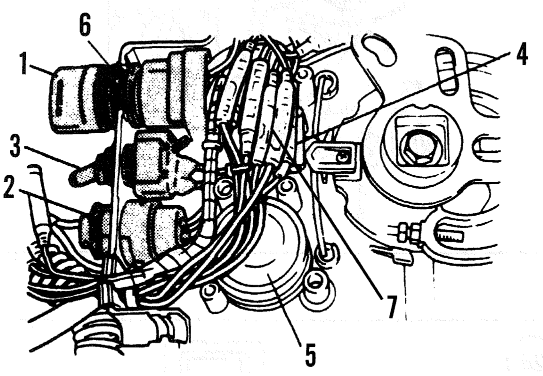
22



23



24



1. Main switch
2. Lanyard switch
3. Choke switch
4. Neutral switch
5. Warning buzzer
6. Key switch retainer
7. Wire connection to harness

bleshooting. Starting system testing is provided in the following sections.

CAUTION
Do not operate the starter motor for more than 10 seconds at a time. Allow at least 2 minutes between starting attempts for the starter to cool toprevent starter motor damage.

Starter Cranking Voltage Test

This test measures the voltage available at the starter motor while cranking. Make sure the battery is fully charged and in good condition prior to performing this test. See Chapter Seven.

1. Connect a voltmeter between the starter motor terminal (5, **Figure 20)** and a good engine ground.
2. Disconnect the spark plug leads and connect them to engine ground. Crank the engine while observing the voltmeter.
3. Repair or replace the starter inotor if the voltage is **9.56** volts or greater, but the engine does not crank.
4. Test the starter solenoid and check all starting system wires for loose or corroded connections if the voltage is less than **9.5** volts. Test the battery again if all connections are in good condition.

Ignition Switch Test

The ignition switch mounts in either the dash or the remote control box **(Figure 21)** on all remote control models. Check the switch if the starter does not crank the engine but the neutral switch, starter solenoid, connections, fuses and battery are in good condition. If the motor is equipped with a dash-mounted switch, remove the switch and perform Steps 4-7. If the ignition switch is located in the control box, it is necessary to partially disassemble the control box to test the switch. Perform Steps 1-7 to test a control box-mounted ignition switch.

1. Remove the control box from its mounting bracket. Remove the access cover **(Figure 22)** from the lower side of the control.
2. Reinove the back cover screws **(Figure 23).** Remove the key from the switch. Loosen and remove the retainer **(6, Figure 24)** from the ignition switch.
3. Disconnect the ignition switch from the harness and remove the switch from the control box.
4. Calibrate an ohmmeter on the R × 1 scale. Connect the ohmmeter between the black and brown switch terminals. See **Figure 25.** With the switch in the OFF position, conti-

nuity should be noted. Place the switch in the ON position. No continuity should now be noted.

5. Connect the ohmmeter between the blue and red terminals **(Figure 26).** Continuity should be present with the switch in the ON and START positions. No continuity should be present with the switch in the OFF position.

6. Connect the ohmmeter between the brown and red terminals **(Figure 27).** Continuity should be noted with the switch in the START position. No continuity should be noted with the switch in the OFF and ON positions.

7. Replace the ignition switch if it fails to function as described.

Start Button Test (Tiller Models)

On electric start tiller handle models, the start button **(Figure 28)** mount to the front of the lower cowl.

1. Disconnect the starter button from the engine wiring harness. Remove the threaded retainer from inside the motor cowl and remove the button.

2. Connect the ohmmeter between the start button wires or terminals. With the button deactivated, the meter should indicate no continuity.

3. With the button activated, the meter should indicate continuity.

4. Replace the start button if it does not function as described.

Starter Solenoid Test

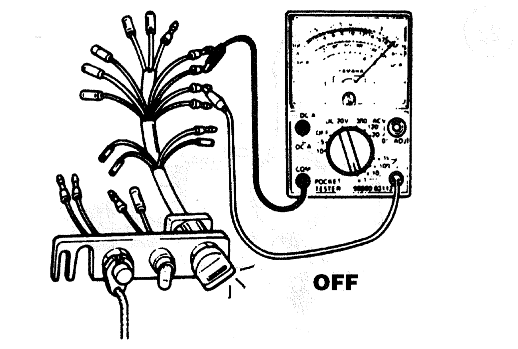
The starter solenoid allows a large amount of current to pass from the battery to the starter motor. When the start switch or button is operated, current flows through the neutral switch and on to the solenoid. This current passes through a coil of wire in the solenoid, creating a strong magnetic force. The magnetic force moves a plunger that closes contact points in the solenoid, allowing current to flow directly from the battery to the starter motor.

1. Remove the solenoid as described in Chapter Seven. Connect the negative meter test lead to one of the large terminals on the solenoid **(Figure 29).** Connect the positive meter test lead to the other large terminal connection. The correct reading is no continuity.

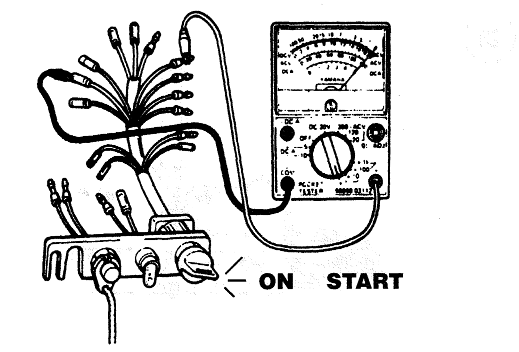
2. Using jumper leads, connect the black lead of the solenoid to the negative terminal of a fully charged battery **(Figure 29).** Connect a jumper lead to the positive terminal of a fully charged battery. While observing the meter, connect the jumper lead to the brown lead of the solenoid **(Figure 29).** The correct reading is continuity.

3. Replace the solenoid if it does not operate as described.

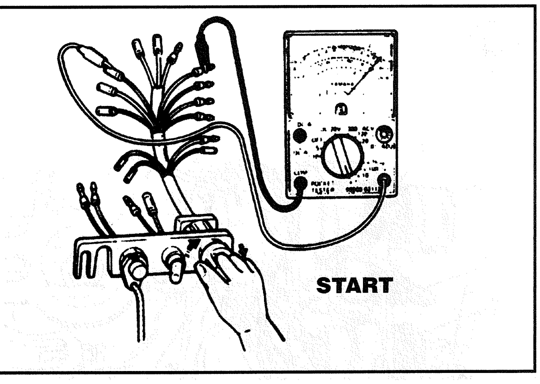
25



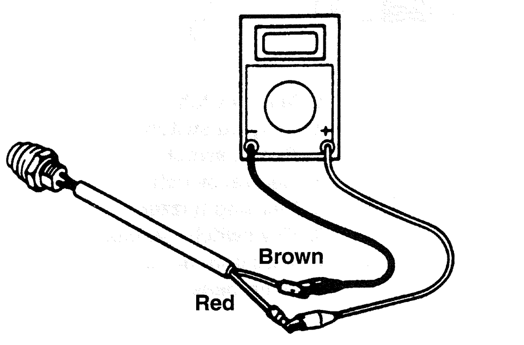
26

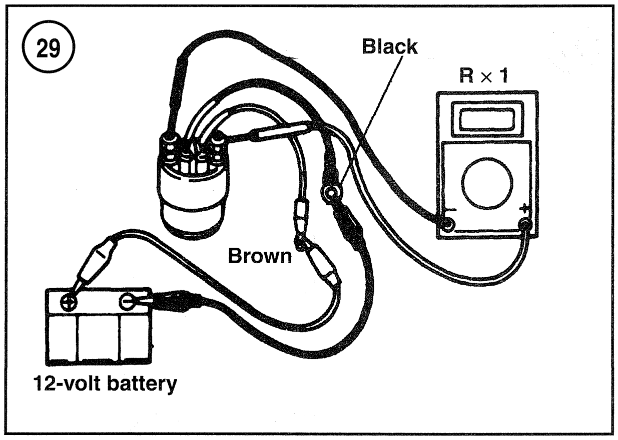


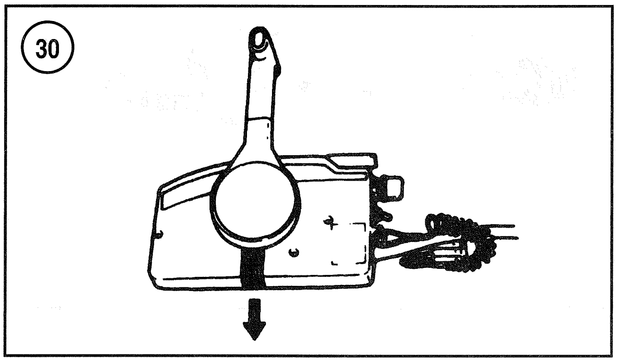
27

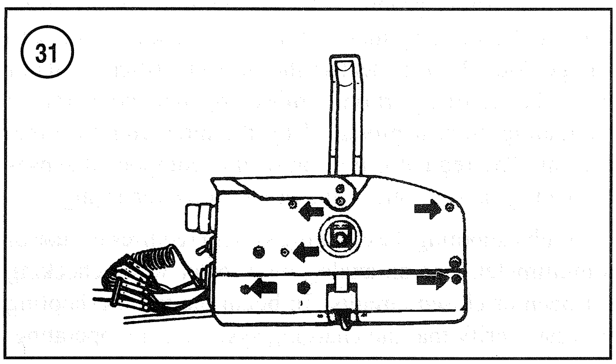


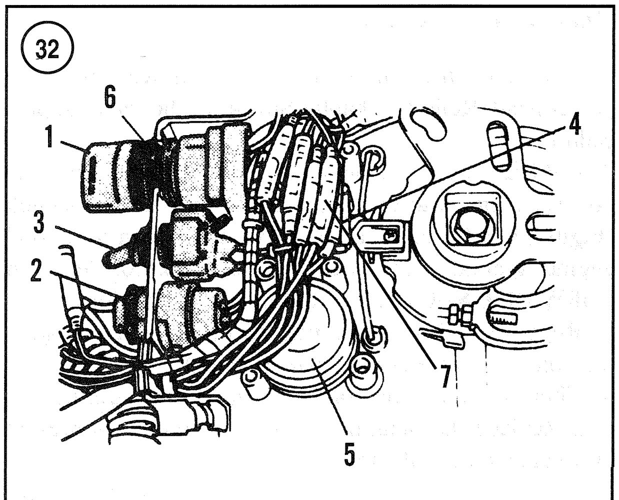
28











1. Main switch
2. Lanyard switch
3. Choke switch
4. Neutral switch
5. Warning buzzer
6. Key switch retainer
7. Wire connection to harness

Neutral Switch Test

The neutral switch is provided to prevent the starter from operating when the engine is in forward or reverse gear. A neutral lockout lever (start-in-gear protection) is provided on 5-40 hp models and a neutral lockout cable is used on 50 hp and larger models with manual start. Repair procedures for these mechanisms are provided in Chapter Ten. Electric start models with tiller handle control are provided with a neutral switch mounted on the engine. Verify proper neutral switch adjustment on tiller models before testing or replacing the switch. On electric start models with remote control, the switch is located inside the control. Partial disassembly of the control is required before testing the switch. An ohmmeter and a ruler are required to perform this test.

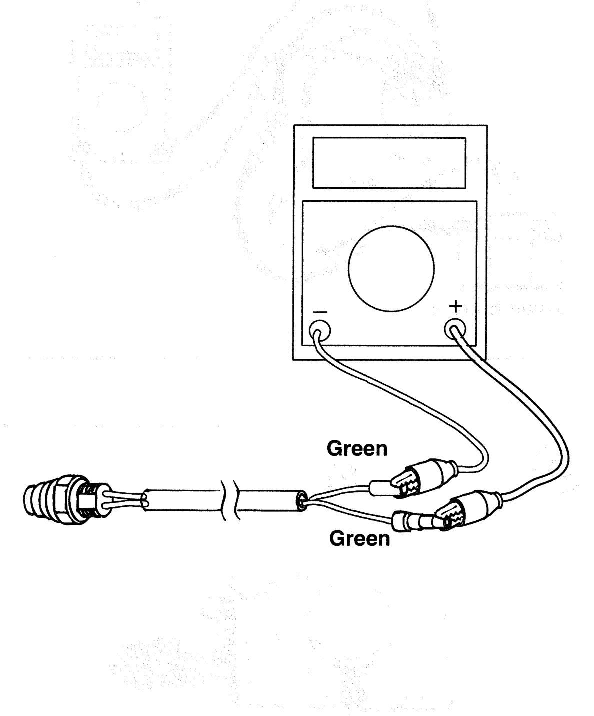
Remote-controlled models

1. Remove the control from its mount. Remove the cover from the lower side of the control (Figure **30).** Remove the screws that retain the back cover (Figure **31).** Disconnect the leads and remove the neutral switch (Figure **32).**
2. Calibrate an ohmmeter on the R × 1 scale. Connect the positive meter lead to one red lead on the switch. Connect the negative meter lead to an engine ground. Test with the control in FORWARD, NEUTRAL and REVERSE positions.
3. Repeat Step 2, connecting the positive meter lead to the green lead on the neutral switch.
4. Repeat Step 2, connecting the positive meter lead to the other red lead on the neutral switch.
5. There should be no continuity at all times during this test. Replace the neutral switch if continuity is present during any part of the test.

Tiller-controlled models

1. Disconnect the neutral switch and remove it from the power head. Refer to Chapter Seven for the removal procedure.
2. Calibrate the ohmmeter on the R × I scale. Connect the positive meter lead to a green lead of the neutral switch **(Figure 33).** Connect the negative meter lead to a good engine ground. Test with the shift control lever in FORWARD, NEUTRAL and REVERSE positions.
3. Repeat Step 2 by connecting the positive meter lead to the other green lead of the neutral switch.
4. There should be no continuity at all times during this test. Replace the neutral switch if continuity is present during any part of the test.
5. Refer to Chapter Seven for the installation procedure.

33



Manual Start System

The manual start components include the recoil pulley, spring, drive pawls, drive pawl spring, rope and handle The most common failure of the system is a frayed or broken rope Before replacing an apparent locked manual starter, verify that the gearcase and power head are not seized and that the starting lockout mechanism is functioning properly Otherwise, refer to Chapter Ten for complete repair procedures

CHARGING SYSTEM

The charging system consists of the flywheel, battery charging coil **(Figure** 34 and **Figure 35**), rectifier/regulator **(Figure 36**), wires and the battery. The charging system maintains the battery charge after starting the engine and when using onboard accessories. The use of accessories, such as depth finders, stereos and fish finders, place additional demands on the charging system, and in some cases, the charging system cannot meet the additional demand leading to a discharged battery. Check all charging system components if the battery discharges. Determine the total amperage of the onboard accessories and compare the total with the charging system output. Remember that the charging system output will be less than the listed maximum if the outboard is consistently operated at low speed. Consider installing an additional battery or a higher capacity battery as a possible solution. Battery maintenance and testing are provided in Chapter Seven.

Engines with a manual starter generally do not use a charging system. Some models have the option of a lighting coil. The lighting coil is positioned under the flywheel and produces alternating current as the flywheel magnets rotate past it. The current produced by the lighting coil is suitable only for operating lights. Adding a rectifier converts the current produced by the lighting coil to direct current. This arrangement allows the cranking battery to charge. Models with electric start use a rectifier/regulator unit. The rectifier portion of this component converts the alternating current produced by the alternator to direct current. The regulator portion of this component senses the voltage at the battery and prevents overcharging.

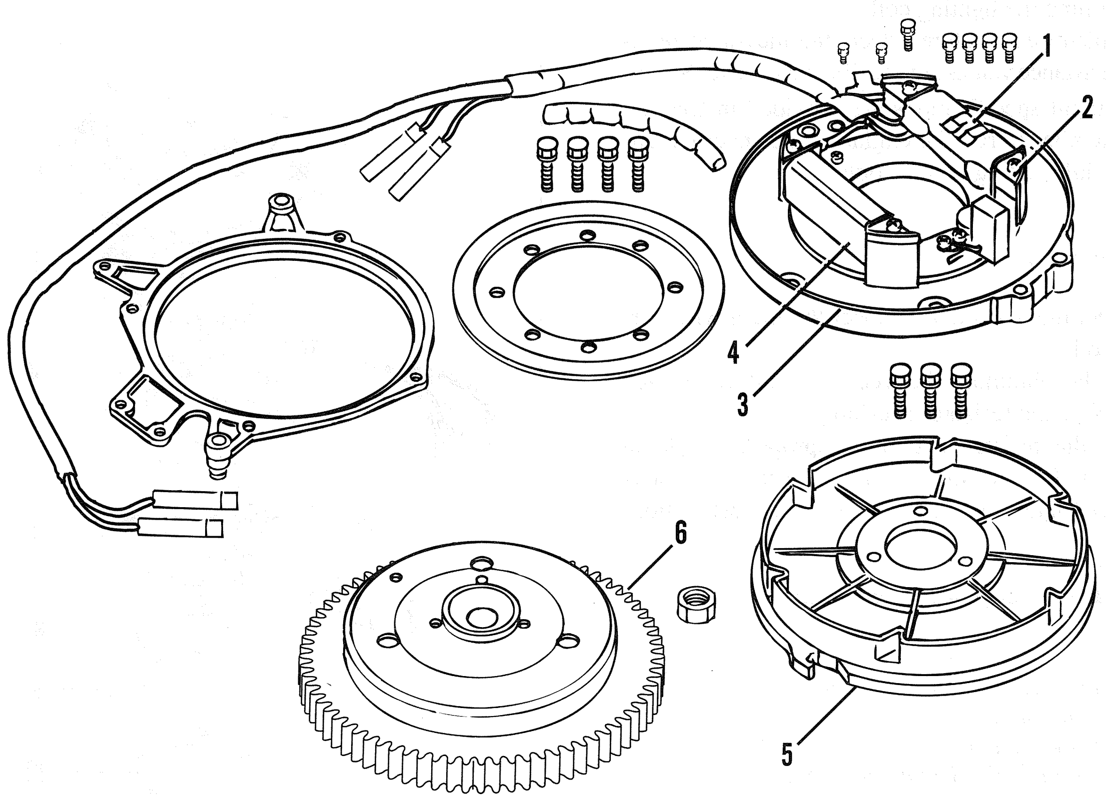
Troubleshooting the charging system requires the use of a multimeter. Use an analog multimeter when checking for open or closed circuits. To begin the troubleshooting process, verify that the charging system is not operating. Test the charging system components after verifying a charging system fault.

Charging System Output

1. Connect a voltmeter to the battery and note the battery voltage.
2. Start the engine and note the voltmeter. If the charging system is functioning, battery voltage will increase over that checked with the engine stopped. A voltage equal to or less than the first measurement indicates that a charging system is not functioning; further testing is required.

34

CHARGING SYSTEM (5-40 HP MODELS)



1. Exciter coil
2. Pulser (trigger) coil
3. Coil plate assembly
4. Alternator coil
5. Flywheel cover
6. Flywheel

3. A voltage exceeding 14 volts indicates a likely overcharge condition that warrants further testing.

WARNING

Stay clear of the propeller shaft while running an engine on a flush/test device. As a safety precaution, remove the propeller before running the engine.

CAUTION

Never run an outboard without first providing cooling water. Use either a test tank or flush/test device. Renzove the propeller before running the engine. Install a test propeller to run the engine in a test tank.

NOTE

In most, but not all, cases the tachometer does not operate if the charging system fails.

4. If a discharge or overcharge is indicated, test all components of the charging system. Many times, both the charging coil and the rectifier/regulator are faulty. Weak, cracked or broken flywheel magnets may cause decreased charging output; however, the same magnets are used to power the ignition system. Problems with magnets in the flywheel will likely also cause ignition problems.

5. Check the resistance or voltage output of the lighting coil, then test the rectifier or rectifierlregulator.

Alternator Charging Coil Test

Resistance specifications are provided for all models. When performing the lighting coil resistance test, remember that ambient temperature affects the measured resistance. The resistance values are specified in Chapter Seven.

Voltage output specifications are provided in Chapter Seven. Remember to run the engine at the specified engine speed while testing voltage output.

Coil resistance test

1. Disconnect the leads that connect the main wire harness to the coil.
2. Connect the ohmmeter between the coil wires. See **Figure 37.** Note the resistance reading.
3. Compare the resistance to the appropriate table in Chapter Seven. Replace the coil if its resistance is not as specified. See Chapter Seven for removal and installation.

Lighting/battery charging coil output test

NOTE
All wires must remain connected during a voltage output test. Back-probe the connectors using jumper leads as required to securely attach the voltmeter to the correct terminals.

1. Connect the negative lead of a peak-reading voltmeter to the white coil wire and the positive meter lead to the yellow coil wire.
2. Start the engine using a testiflush adapter or test tank. Run the engine at the recommended speed specified in the appropriate table in Chapter Seven.
3. Test and/or replace the rectifierlregulator if the output voltage is above the specification. Replace the charging coil if the voltage is below the specification.
4. Refer to Chapter Seven for charging coil and rectifierlregulator removal and installation.

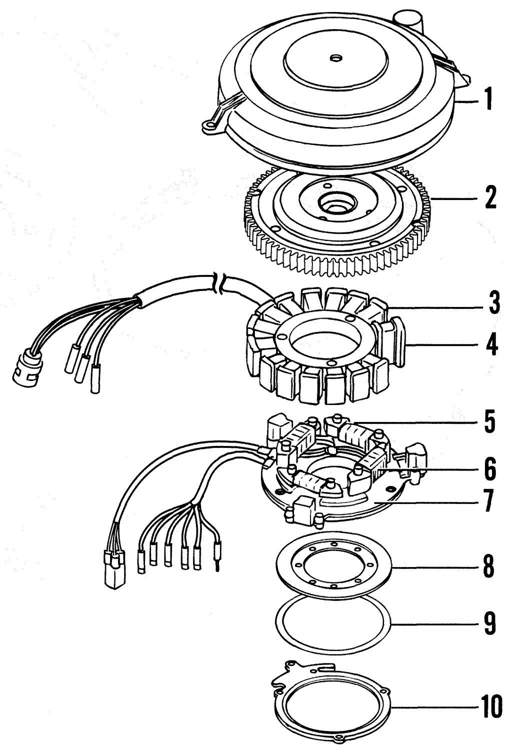
Rectifier/Regulator Test

Use an ohmmeter to check the rectifierlregulator for open or shorted circuits. Refer to **Figure 38** for 8-90 hp models and **Figure 39** for 115-140 hp models. Test specifications are provided in **Table 27** and **Table 28** in Chapter Seven.

1. Connect the ohmmeter to the terminals specified in **Table 27** or **Table 28** in Chapter Seven. Note the meter reading at each connection.

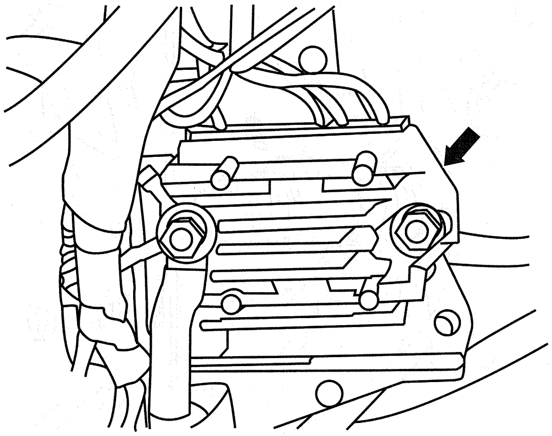
35

CHARGING SYSTEM



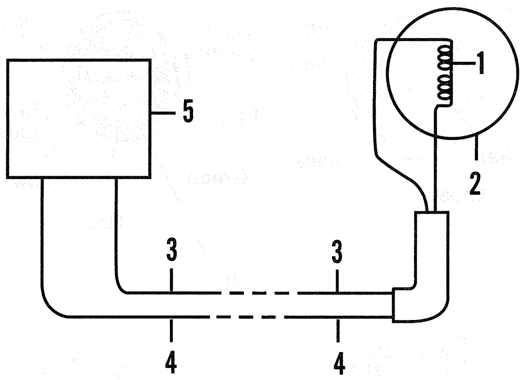
1. **Flywheel cover (40-90 hp models)**
2. **Flywheel (40-90 hp models)**
3. **Alternator coil (115-140 hp models)**
4. **Exciter coil (115-140 hp models)**
5. **Exciter coil (40-90 hp models)**
6. **Alternator coil (40-90 hp models)**
7. **Coil plate assembly (40-90 hp models)**
8. **Guide plate (40-90 hp models)**
9. **Shim (40-90 hp models)**
10. **Set ring (40-90 hp models)**

36



37

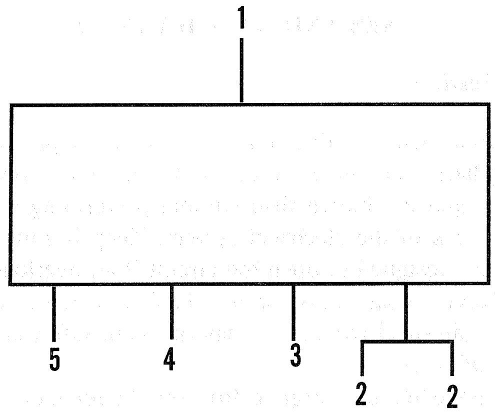
ALTERNATOR COIL TEST



1. Alternator coil
2. Coil plate
3. Alternator white lead
4. Alternator yellow lead
5. Rectifier/regulator

38

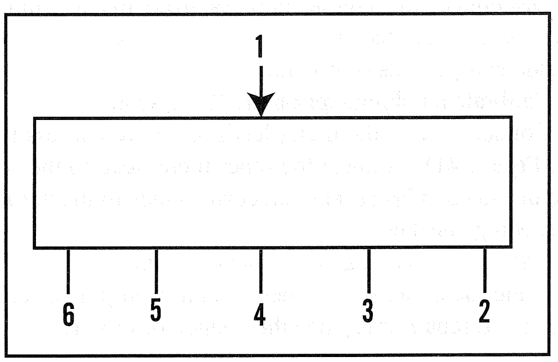
RECTIFIER/REGULATOR TEST
(40-90 HP MODELS)



1. Rectifier/regulator
2. Red leads
3. Yellow lead
4. White lead
5. Black lead

39

RECTIFIER/REGULATOR TEST
(115-140 HP MODELS)



1. Rectifier/regulator
2. BlacWwhite lead
3. BlacWwhite lead
4. BlacWwhite lead
5. Red lead
6. Black lead

2. Replace the rectifier/regulator if any reading is not as specified. Refer to Chapter Seven for removal and installation.

FUSES AND WIRE HARNESS

Fuse Testing

Fuses are used on all electric start models to protect the wiring harness in the event of a short circuit or overload. Never replace a blown fuse without performing a thorough check of the electrical system. Keep in mind that fuses are designed to open the circuit if an overload occurs. Never bypass a fuse or install a fuse with greater capacity than specified, or you may risk your safety and the safety of others.

1. Remove the fuse **(Figure** 40) from the retainer.
2. Calibrate the ohmmeter on the R × 1 scale.
3. Connect the ohmmeter between the fuse contacts.
4. The ohmmeter should indicate 0 ohm. If the fuse is blown or defective, the ohmmeter will indicate no continuity.

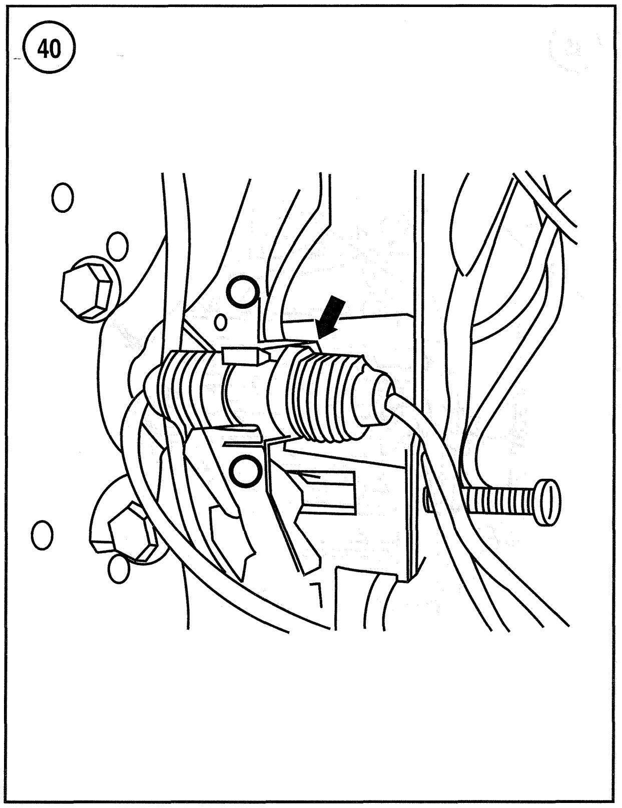
Wire Harness Test

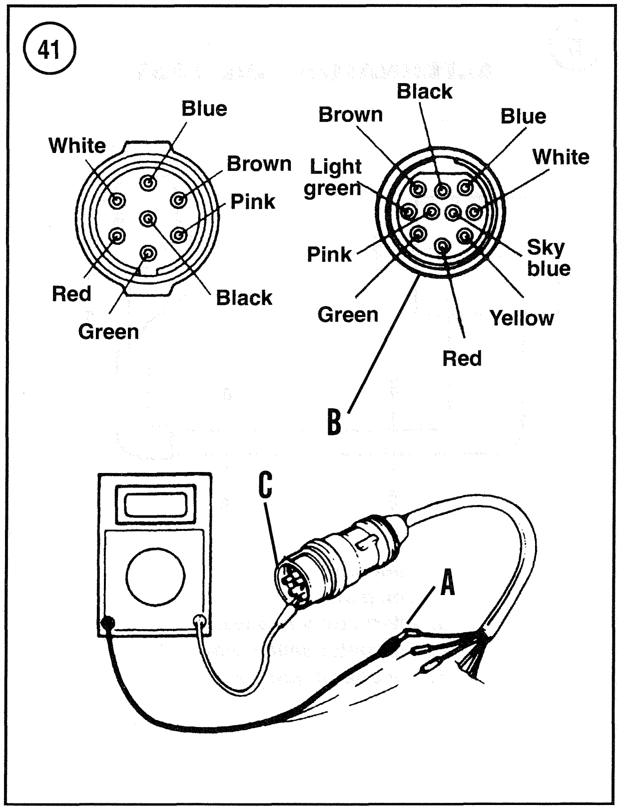
A wire harness problem may occur continuously or only intermittently. If an electrical problem exists and all components test correctly, suspect the wire harness. Check both the engine and instrument harnesses on remote control models. Gently twist and pull on the harness wire connectors when checking the wires for continuity. Often this is the way an intermittent fault can be located.

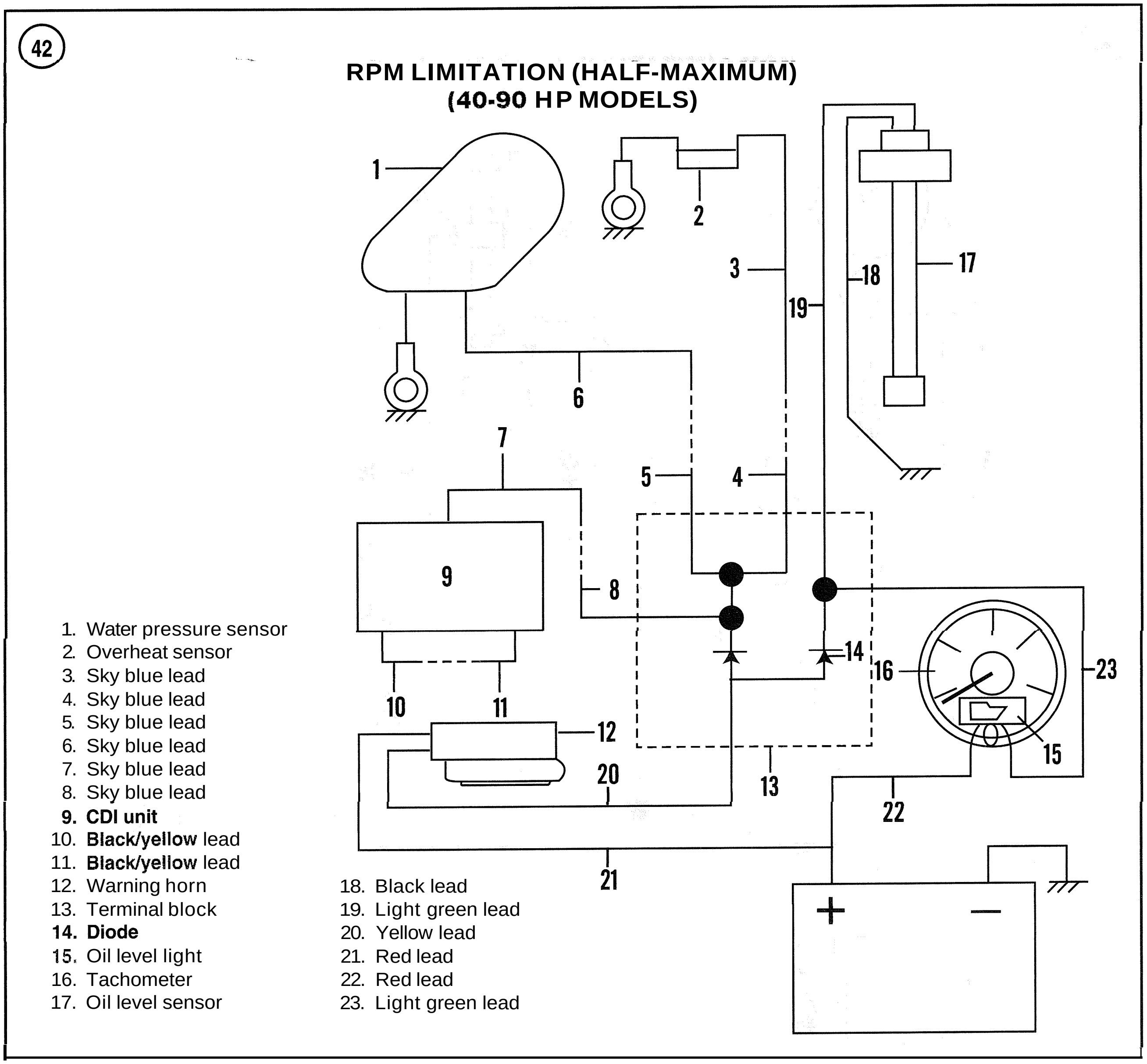
1. Disconnect the engine harness from the instrument harness if used. Disconnect wire harness leads from the engine components or instruments.
2. Calibrate an ohmmeter on the R × 1 scale.
3. Connect one of the meter leads to a wire harness lead (A, **Figure** 41). Connect the other ineter lead to the connector pin (B, **Figure** 41) that corresponds to the harness lead being checked.
4. The correct reading is 0 or nearly 0 ohm.
5. If the meter shows an open circuit or high resistance, check and repair or replace the connector or wire.

ENGINE SPEED LIMITING SYSTEM

All three- and four-cylinder models are equipped with an engine speed limitation system. The speed limiting system is designed to prevent engine damage from low oil, overheating or excessive engine speed by interrupting ignition if a warning system activates or if the engine







speed exceeds a predetermined limit. The speed limiting system has three functions: low speed limit, one half maximum limit and excessive engine speed limit. To test the speed limiting system, the outboard motor must be in a test tank or mounted on a boat in the water. Refer to **Figure 42** and **Figure 43.**

Half-Maximum RPM Limitation

If the overheat sensor, water pressure sensor, or oil level sensor signals an abnormal condition, the CDI unit limits the engine speed to about one-half the maximum rpm.

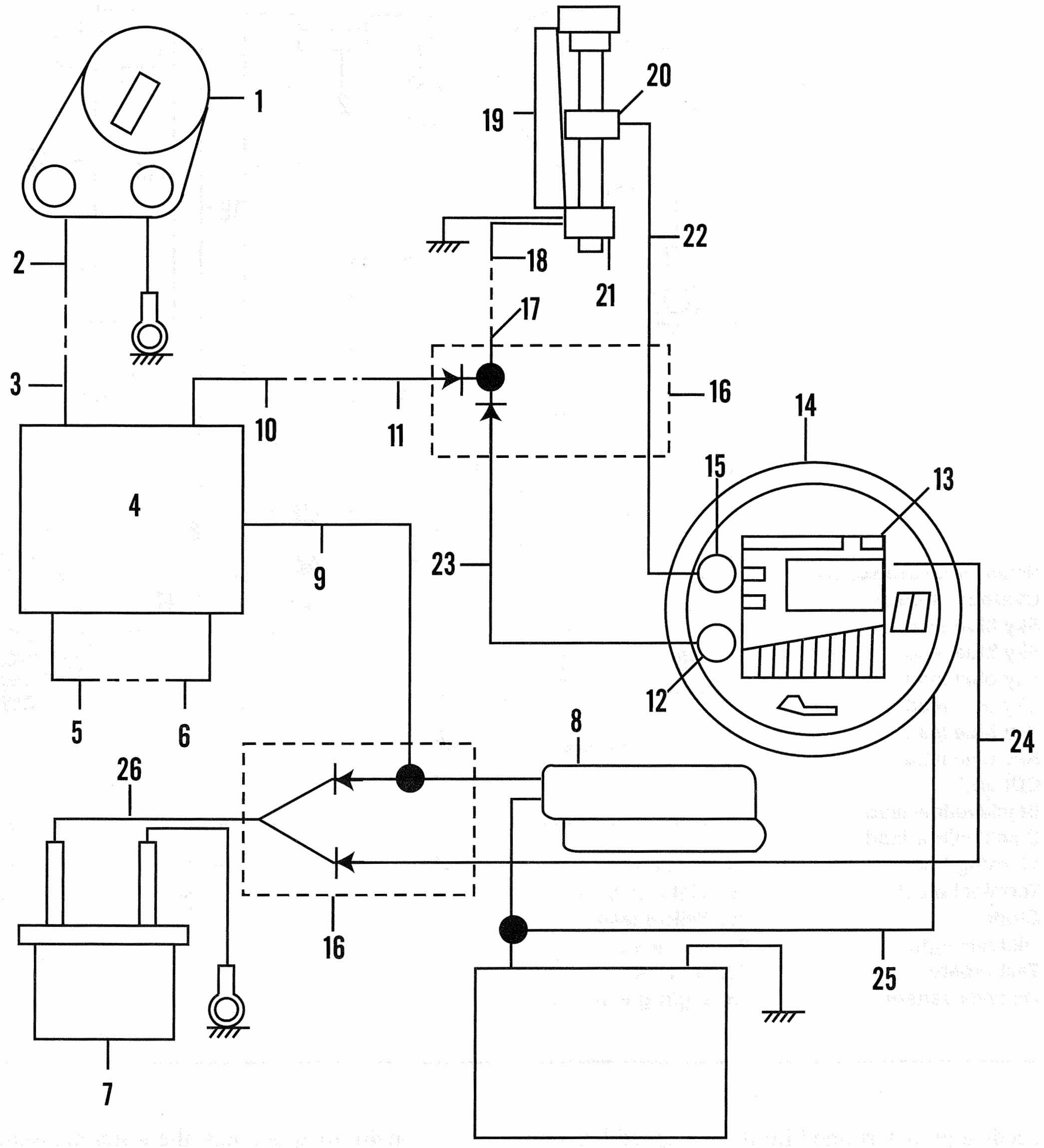
On **40-90** hp models, the water pressure sensor (1, **Figure 42)** and overheat sensor **(2)** control the one-half maximum speed limit input terminal (7) to the CDI unit **(9).** The warning horn **(12, Figure 42)** activates due to the abnormal condition at the same time.

One-Half Maximum Speed Limit Test

Perform this test if the engine misfires at about one half of its maximum recommended engine speed, or if the engine speed is limited to about one-half of its maximum speed.

43

RPM LIMITATION (HALF-MAXIMUM)
(115-140 HP MODELS)



1. Water pressure sensor
2. Red/White lead
3. Red/White lead
4. CD unit
5. Black/Yellow lead
6. Black/Yellow lead
7. Overheat sensor
8. Warning horn
9. Yellow lead
10. Sky blue lead
11. Sky blue lead
12. Lower oil level indicator
13. Overheat indicator
14. LCD multi-purpose meter
15. Upper oil level indicator
16. Terminal block
17. Sky blue lead
18. Sky blue lead
19. Oil level sensor
20. Upper oil level float
21. Lower oil level float
22. Red/green lead
23. Sky blue lead
24. Light green lead
25. Red lead
26. Light green lead

Perform this test after performing a normal tune-up and synchronizing the ignition timing and carburetor. Refer to Chapter Five. Perform tests with the engine in the water, running at operating temperature in forward gear and with the tachometer installed.

1. Verify that the engine water pressure and oil level are at their normal range and that the engine is at normal operating temperature.
2. Disconnect the speed limiter black/yellow wires from the CDI unit. See **Figure 42** and **Figure 43.**
3. Start the engine and run it at approximately one half of its maximum recommended engine speed to determine if the misfire is still present.
   a. If the engine runs properly with the speed limiter circuit disabled, reconnect the speed limiting system black/yellow wires and continue at Step **4.**
   b. If the misfire is still present, the cause is not the speed limiter system. Test the ignition system as described in this chapter.

4A. 40-90 hp—If the engine runs correctly with the speed limiting circuit disabled, disconnect the water pressure sensor (1, **Figure 42)** and start the engine. If the engine now runs correctly, replace the water pressure sensor. If the engine still misfires, reconnect the water pressure sensor and disconnect the overheat sensor (2, **Figure 42).** Start the engine. If the engine now runs correctly, replace the overheat sensor. If the engine still misfires, continue at Step 5.

4B. *115-140 hp—If* the engine runs correctly with the speed limiting circuit disabled, disconnect the water pressure sensor **(1, Figure 43)** and start the engine. If the engine now runs correctly, replace the water pressure sensor. If not, reconnect the water pressure sensor and disconnect the lower float **(21, Figure 43)** on the oil level sensor. If the engine now runs correctly, replace the oil level sensor. If the engine still misfires, continue at Step 5.

5. Disconnect the speed limiter input wires. See **Figure 42 (40-90** hp) or **Figure 43 (115-140** hp).
6. Start the engine. If the engine now runs correctly, replace the wiring harness. See 13, **Figure 42** (40-90 hp) or **16, Figure 43 (115-140** hp).
7. If the engine still misfires, replace the CDI unit as described in Chapter Seven.

Speed Limit System Test

Perform this test if the engine has a high-speed misfire. The excessive speed limit system prevents excessive speed by interrupting the ignition at a predetermined engine speed. The CDI unit controls the system.

NOTE

When the speed limit system activates, the ignition is interrupted to prevent damage to the engine. The engine will over-speed and activate the speed limit system if the engine is under-propped. Make sure the correct propeller is used.

Perform this test with the outboard motor mounted on a boat, in the water, in **FORWARD** gear. Make sure the engine is running at normal operating temperature and all synchronization and adjustment procedures have been performed.

1. Disconnect the speed limiter jumper. See **Figure 42** and **Figure 43.**
2. Start the engine and run at the speed in which the misfire occurs. If the engine now runs correctly, replace the CDI unit as described in Chapter Seven. If the engine continues to misfire, the problem is not the speed limit system. Check the spark plugs and all other ignition components as described in this chapter.

Low-Speed Limit (115-140 hp)

The low-speed limit circuit will prevent engine speed from exceeding 1500 rpm. If the engine will not accelerate beyond 1500 rpm, make sure the red/yellow wire (3, **Figure 44)** is in good condition and is securely connected to the CDI unit and remote control box. If the wire and connections are in acceptable condition, replace the CDI unit as described in Chapter Seven.

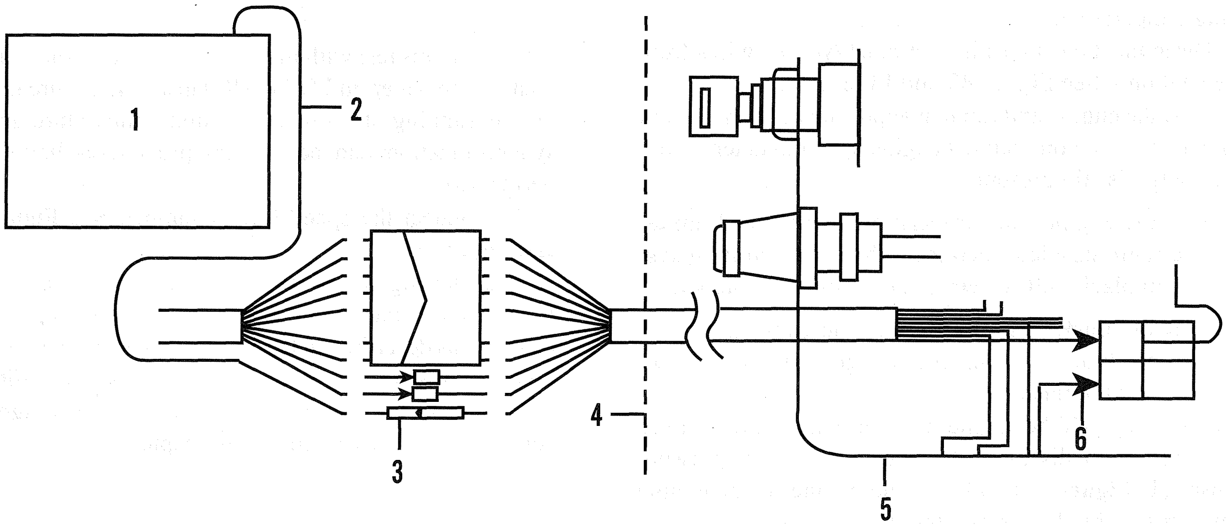
TRIM SYSTEM

Tilt Pin and Lockdown Hook

The trim and tilt systems used vary by model and horsepower. A tilt pin and hold-down hook **(Figure 45)** are used on **5-40** hp models. It allows the engine to run slightly tilted in or out to change the running attitude of the boat or to enhance shallow water operation. The hold-down hook operates when in reverse gear to prevent the propeller thrust from moving the engine outward. If the unit does not hold down when in reverse or cannot tilt up when in forward or neutral, check the adjustment and inspect the system for broken or excessively worn components. See Chapter Eleven for repair procedures and adjustments for these components.

44

RPM LIMITATION (LOW SPEED)
(115-140 HP MODELS)

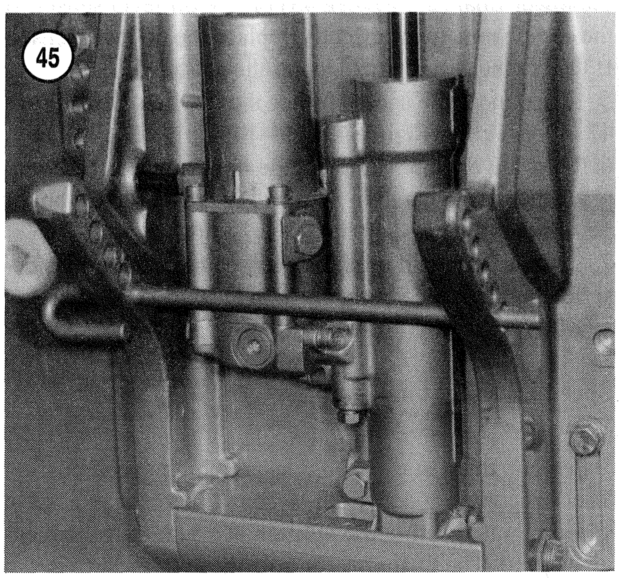


1. CD unit
2. Red/yellow lead
3. Wire connector (red/yellow)
4. Engine housing (inside)
5. Remote control box
6. Wire connector (red/yellow)

Power Trim and Tilt

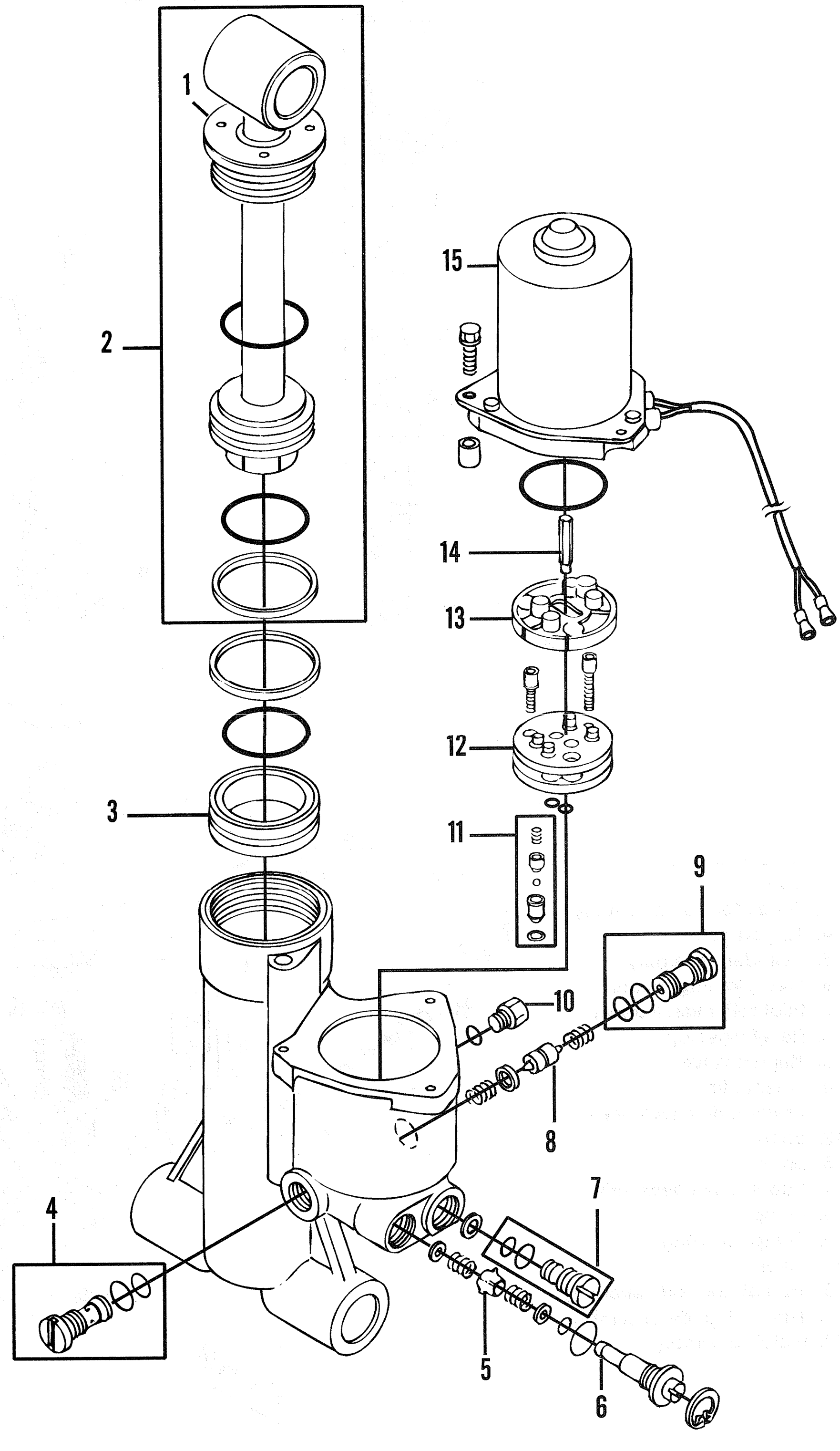
A single cylinder trim and tilt system **(Figure 46)** is used on 40 and 50 hp models, A three-ram system is used on 60-140 hp models. See **Figure 47** (early design) and **Figure 48** (late design). The major components include the electric motor, solenoids, hydraulic pump and hydraulic cylinder. A bidirectional electric motor (15, **Figure 46)** drives the hydraulic pump (12). Reversing the motor direction controls the fluid movement direction between the pump (12, **Figure 46)** and cylinder. Fluid moves from the pump to the up side of the cylinder to trim the unit up. Fluid returns to the pump from the down side of the cylinder. Fluid directed to the down side of the cylinder trims the unit down. Fluid returns to the pump from the up side of the cylinder.

1. A relief valve (6, **Figure 46)** allows the engine to be moved up or down tnanually without running the electric



46

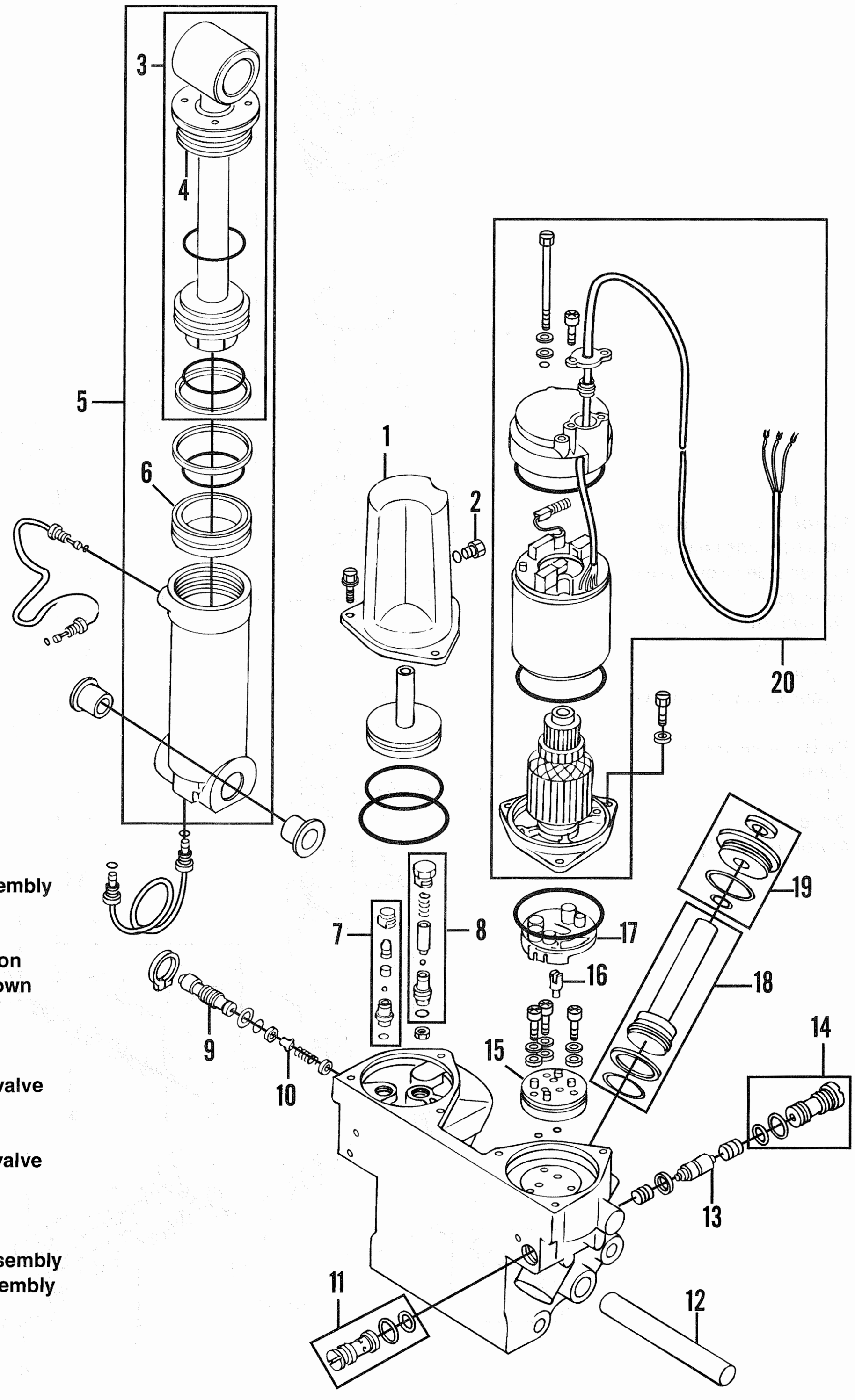
POWER TRIM/TILT
(40 AND 50 HP MODELS)



1. Rod guide
2. Piston rod assembly
3. Free (floating) piston
4. Lower side check valve
5. Inner collar
6. Manual (relief) valve
7. Relief valve up
8. Spool
9. Upper side check valve
10. Cap
11. Relief valve down
12. Pump
13. Filter
14. Drive shaft
15. Motor assembly

(47)

POWER TRIM/TILT (OLD STYLE)
(60-140 HP MODELS)

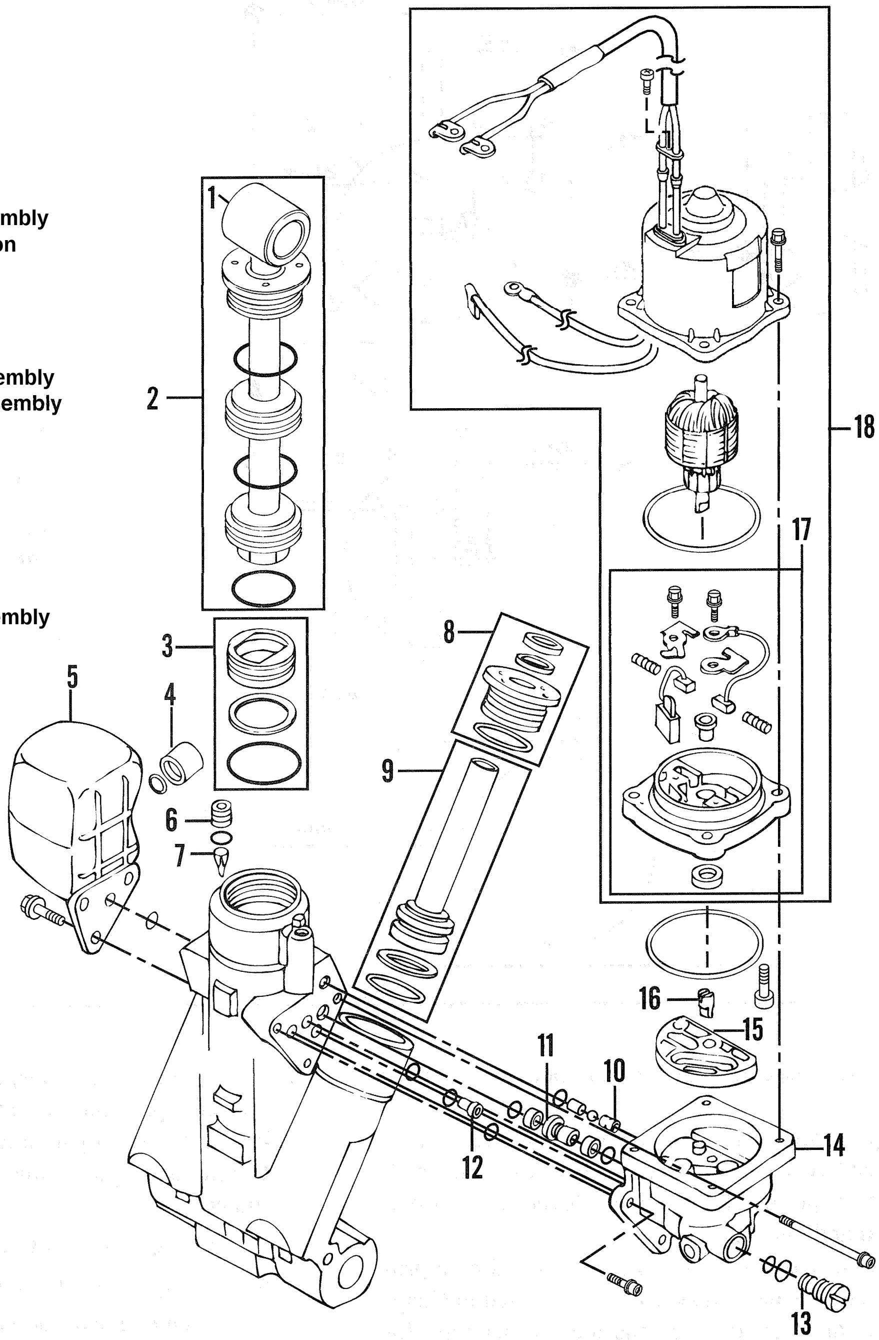


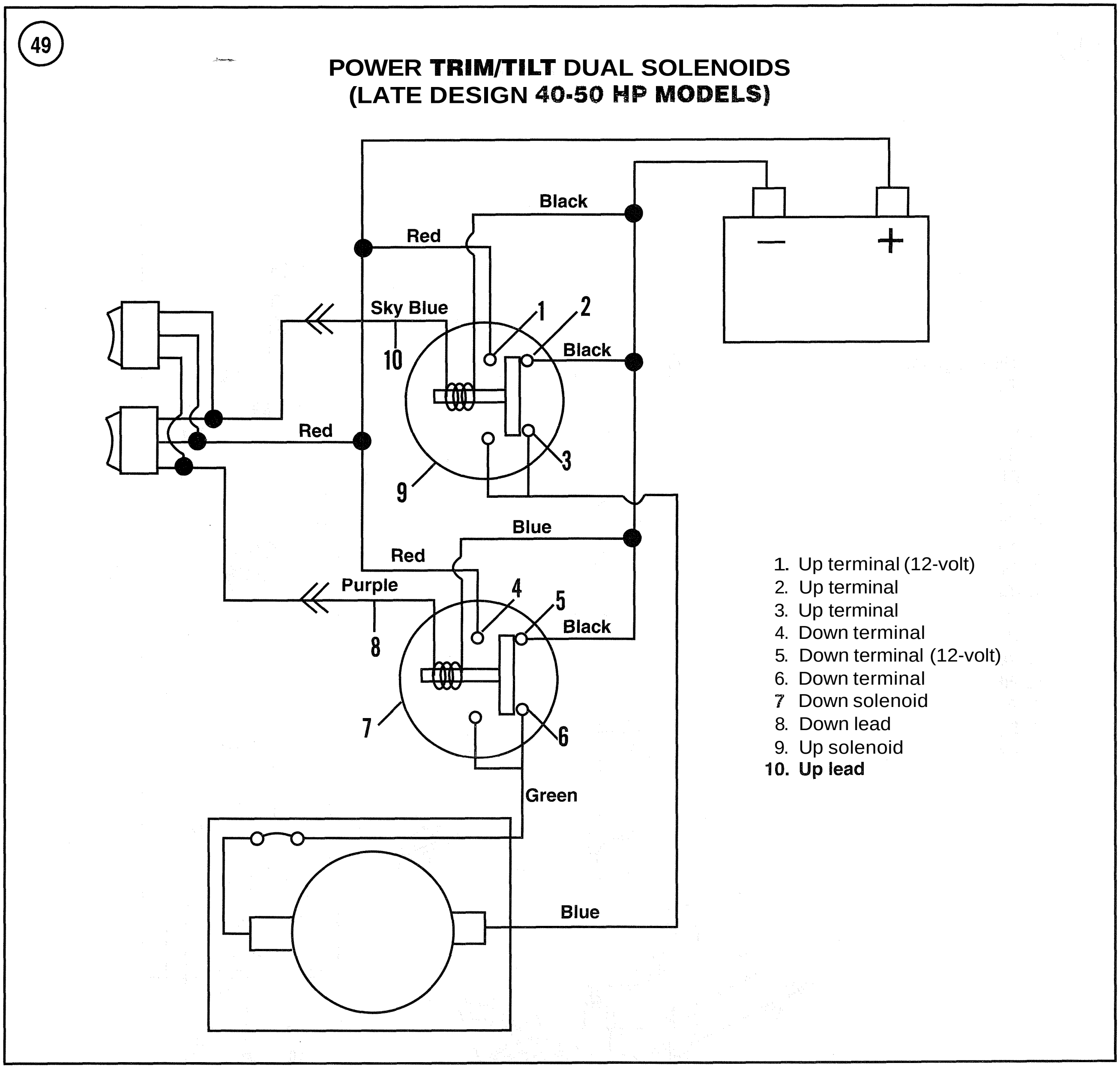
1. Reservoir tank
2. Cap
3. Tilt piston rod assembly
4. Tilt rod guide
5. Cylinder assembly
6. Free (floating) piston
7. Pilot relief valve down
8. Relief valve up
9. Manual valve
10. Inner collar
11. Lower side check valve
12. Shaft
13. Spool
14. Upper side check valve
15. Pump
16. Pump coupling
17. Filter
18. Trim piston rod assembly
19. Trim rod guide assembly
20. Motor assembly

(48)

POWER TRIM/TILT (NEW STYLE)
(40-140 HP MODELS)

1. Tilt rod guide
2. Tilt piston rod assembly
3. Free (floating) piston
4. Cap
5. Reservoir tank
6. Plug
7. Filter
8. Trim rod guide assembly
9. Trim piston rod assembly
10. Orifice
11. Valve seat
12. Orifice
13. Manual valve
14. Pump
15. Filter
16. Pump coupling
17. Bracket brush assembly
18. Motor assembly





motor. Always check this valve before performing other tests.

2. Before performing any test, check the fluid level. Follow the procedure in Chapter Four to check the fluid level. Instructions are provided in Chapter Eleven for trim system removal and installation.

3. Have major hydraulic components repaired by a professional. Remove the trim system as instructed in Chapter Eleven and contact a marine dealership for information. Much expense can be spared when the assembly has been removed from the engine, not to mention the inconvenience of transporting and storing the boat at the dealership. Make sure the electric motor is operating before beginning any hydraulic test.

4. Common symptoms that indicate a possible hydraulic malfunction follow.

   a. The engine will not move up.
   b. The engine will not move down.
   c. The engine leaks down while tilted up or while underway.
   d. The engine trails out when slowing down or when in reverse.

e. Hydraulic fluid is leaking from the system.

WARNING
The hydraulic system fluid may be under high pressure. Use extreme caution when removing valves or fittings. Always use eye protection when working with the hydraulic system. Avoid exposing any portion of the body to areas where a leak is suspected.

ELECTRICAL TESTING

The major electrical components of the trim system are the electric motor, solenoids, trim position sender and switches. When operated in the UP direction, battery voltage is supplied to the blue wire and the green wire connects to ground, causing the motor to turn in the UP direction. When the DOWN direction is selected, the relays reverse the current flow causing the motor to reverse direction. Reversing direction causes the fluid to flow in the opposite direction.

When voltage is applied to either one of the solenoids, it directs voltage to the electric motor while the other solenoid supplies the connection to ground. Both solenoids must make the proper connection for the electric motor to operate.

A trim-sending unit is used with a dash-mounted gauge to give the operator a visual indication of the current trim position. A fuse in the circuit connects the positive battery terminal to the trim switch. Test this fuse if the electric motor will not operate. Refer to *Fuse Testing* in this chapter.

1. Refer to the appropriate wiring diagram **(Figure 49** or **Figure** 50) to locate the solenoid arrangement.
2. Connect the negative meter lead to the black lead at the solenoid terminal and the positive meter lead to the red lead. The correct reading is battery voltage.
3. Check the battery connections and all leads and connections if less than battery voltage, If the voltage is correct, test the solenoids, trim switch, and harness, Refer to *Fuse and Harness Test* in this chapter. Replace the electric motor if it will not operate but all other components test correctly. Refer to Chapter Eleven.

Continuity Test (New Design Dual Solenoids)

Perform this test on **40** and **50** hp models equipped with the late design power trim/tilt system.

1. Disconnect the bullet connectors **(Figure** 49) near the UP and DOWN solenoids.
2. Disconnect the red wires from the solenoids.
3. Disconnect the trim motor wires from the solenoids.
4. Connect an ohmmeter between the tenninals (2 and 3, **Figure** 49) and verify that continuity is present with the solenoid not activated.
5. Using a jumper lead, connect the solenoid terminal **(10, Figure** 49) to the positive battery terminal. No continuity should now be present.
6. Connect the ohmmeter between UP solenoid terminals **(1** and 3, **Figure** 49). No continuity should be noted with the solenoid not activated.
7. Using a jumper lead, connect solenoid terminal **(10, Figure** 49) to the positive terminal of the battery. Continuity should be present with the solenoid activated.
8. Replace the UP solenoid if it fails to function as described.
9. Repeat Steps **4-7** on the DOWN solenoid.

Continuity Test (Old Design Dual Solenoids)

1. Connect an ohmmeter between the UP solenoid terminals **(4** and 5, **Figure** 50) and verify no continuity when the solenoid is off.
2. Place the up solenoid lead (7, **Figure 50)** in contact with the red lead that was disconnected from the tenninal (5) and verify continuity when the solenoid is on.
3. Connect an ohmmeter between the DOWN solenoid terminals **(1** and 3, **Figure** 50) and verify no continuity when the solenoid is off.
4. Place the down solenoid lead (8, **Figure** 50) in contact with the red lead which was disconnected from the terminal (1). Verify that continuity is present when the solenoid is on.
5. Replace the solenoid(s) if it fails to operate as specified.

Trim Switch Test

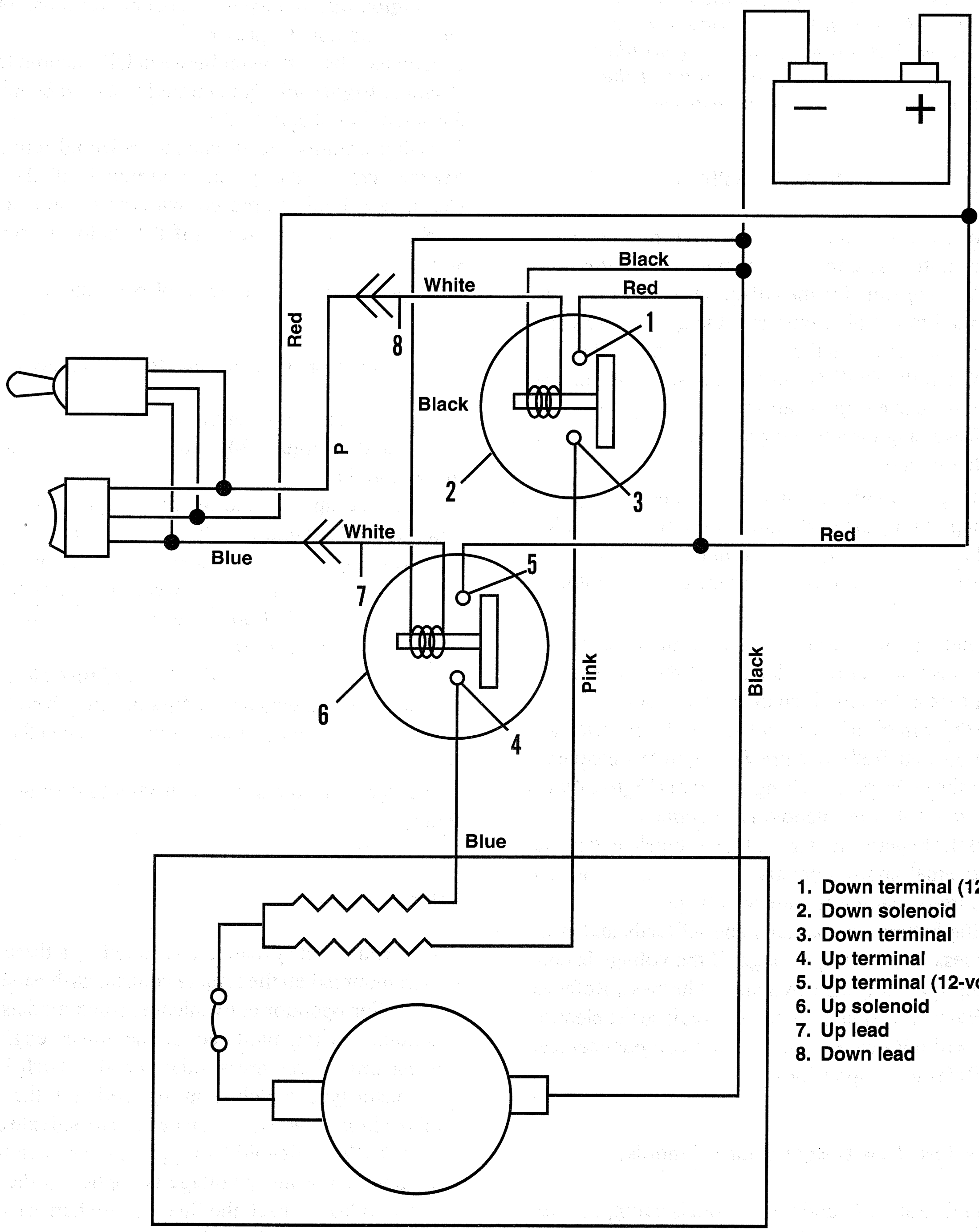
The trim or tilt system is controlled by a three-position switch mounted on the remote control, dash panel or tiller handle. For operator convenience, some models have an additional switch mounted in the lower engine cowl. Testing procedures are similar for all switch locations. The rocker-type switch is spring-loaded in the center or OFF position. The switch can be used to activate either the UP or DOWN solenoid by toggling the switch to the desired position. Battery voltage is applied to the solenoid by a fused lead. Check the fuse or wire harness if voltage is not present at the lead. Refer to *Fuse or Wire Harness Test* in this chapter.

1. Disconnect the UP and DOWN solenoids **(Figure** 49 or **Figure** 50) at the bullet connectors located closest to the solenoids.

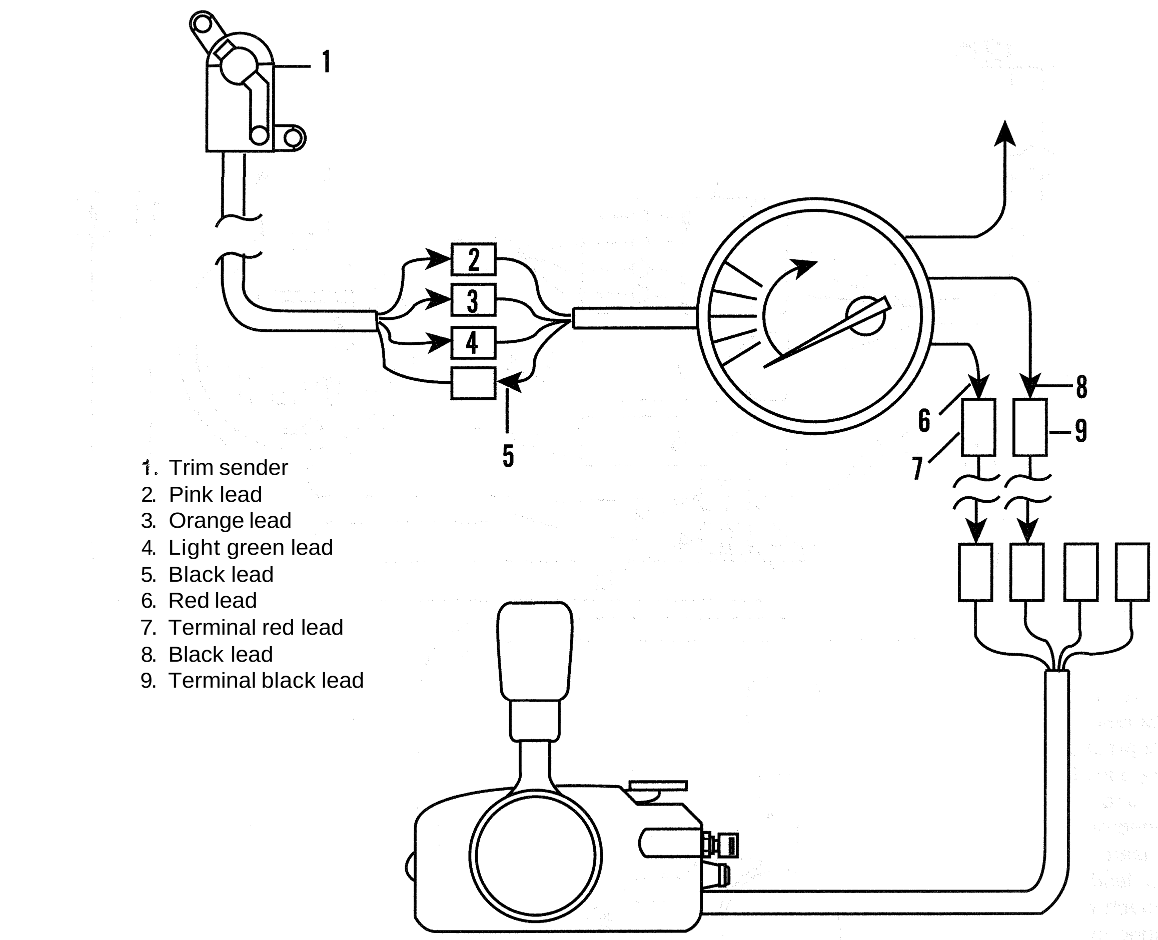
3

50

POWER TRIM/TILT DUAL SOLENOIDS (OLD STYLE)



1. Down terminal (12-volt)
2. Down solenoid
3. Down terminal
4. Up terminal
5. Up terminal (12-volt)
6. Up solenoid
7. Up lead
8. Down lead



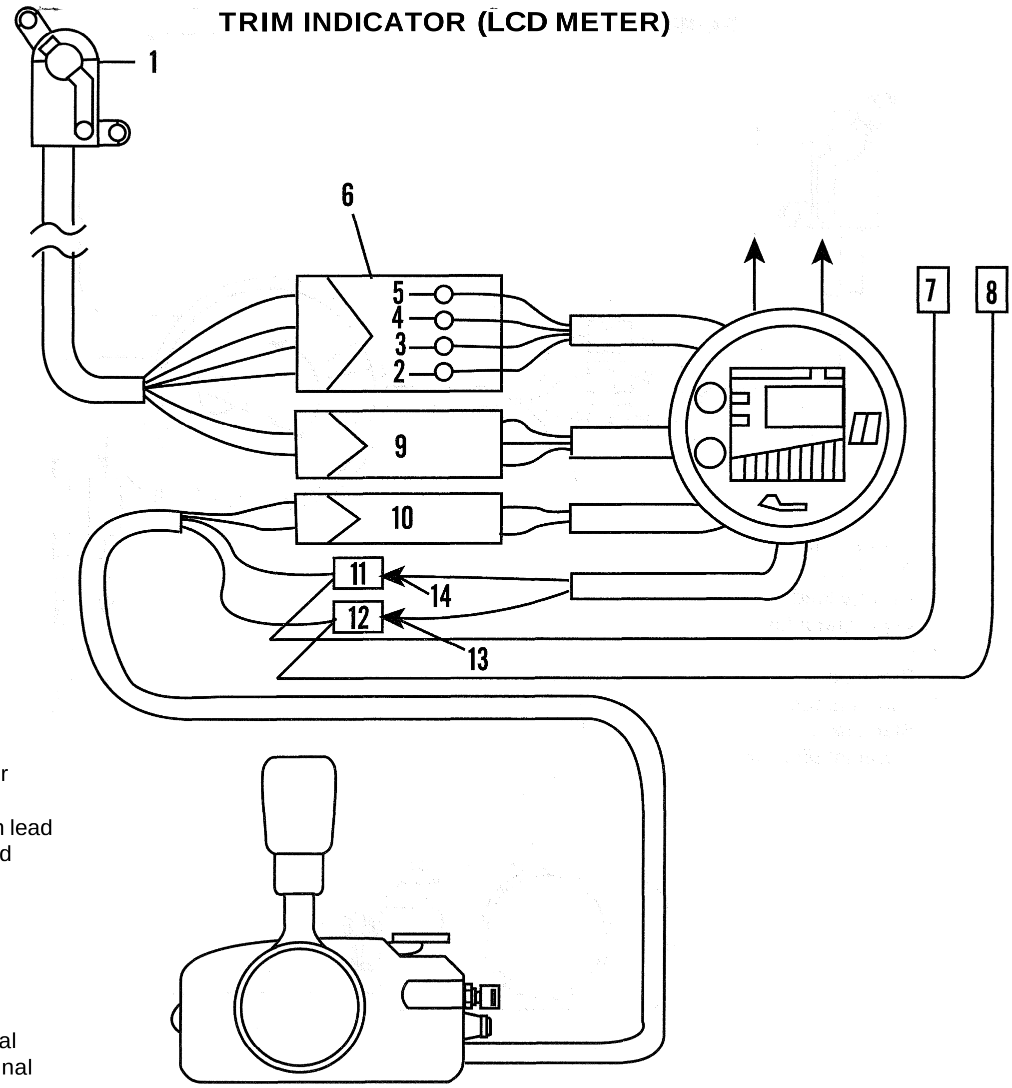
1. Trim sender
2. Pink lead
3. Orange lead
4. Light green lead
5. Black lead
6. Red lead
7. Terminal red lead
8. Black lead
9. Terminal black lead

2. Touch the disconnected wire (10, **Figure** 49 or 8, **Figure 50)** to the solenoid terminal (1, **Figure 49** or 5, **Figure 50).** The solenoid should click when the wire contacts the terminal.
3. Repeat Step 2 on the other solenoid to determine if it clicks.
4. Replace the solenoid if it does not click when the wire touches the terminal. If both solenoids click, inspect the wiring between the trim switch and solenoids and test the switch using an ohmmeter.
5. Connect an ohmmeter between the red and blue trim switch wires. Continuity should be noted with the switch in the UP direction.
6. Connect the ohmmeter between the switch red and pink wires. Toggle the switch to the DOWN direction. Continuity should be noted.
7. Replace the trim switch if it fails to operate as specified.

Trim Indicator Input Voltage

A digital or analog engine trim position gauge is available on 40–140 hp models. A trim position sender mounted on the engine clamp bracket operates the gauge. If the gauge does not read correctly, adjust the trim sender unit as instructed in Chapter Eleven. If adjustment does not correct the problem, perform Steps 1-5 to test the sender unit. Refer to **Figure 51** for models equipped with an analog meter and **Figure** 52 for models equipped with an LCD multipurpose meter.

52



1. Trim sender
2. Black lead
3. Light green lead
4. Orange lead
5. Pink lead
6. Connector
7. Red lead
8. Black lead
9. Connector
10. Connector
11. Red terminal
12. Black terminal
13. Black lead
14. Red lead

1. Disconnect the wires from the trim indicator. See **Figure 51** or **Figure 52.**
2. Connect a voltmeter positive lead to terminal 7, **Figure 51** or terminal 11, **Figure 52.** Attach the negative meter lead to terminal 9, **Figure 51** or terminal 12, **Figure 52.**
3. Battery voltage should be present. If not, inspect the following:

   a. 20-amp engine fuse.

   b. All wiring between the trim sender and trim indicator.

   c. Test the main switch as described in this chapter.

Trim Indicator Output Voltage

1. Disconnect the wires from the trim indicator **(Figure 51** or **Figure 52).**
2. Connect the positive voltmeter lead to terminal 3, **Figure 51** or terminal 4, **Figure 52.** Attach the negative meter lead to terminal 5, **Figure 51** or terminal 2, **Figure 52.**
3. Indicator output should be 9 volts. If the voltage is less than 9 volts, inspect all wiring between the indicator gauge and trim sender. If the wiring is in good condition, replace the indicator gauge.

Trim Sender Output Voltage

1. Operate the trim system and lower engine to fully down position. Using a digital multimeter, connect the red tester lead to the terminal (4, **Figure 51** or **3, Figure 52).** Connect the black tester lead to the terminal (2, **Figure** 51 or 5, **Figure 52).**
2. Operate trim system from down to up and verify that down voltage is between –5 and –15 mV and UP voltage is between –115 and –125 mV. If test results vary, the trim sender unit is defective and must be replaced.
3. Install the trim sender and connect all leads to the proper location. Refer to the instructions provided in Chapter Eleven to install and adjust the trim sender.

ENGINE NOISES

A ticking noise or a knocking noise that intensifies when under load (accelerating) is a reason for concern. Refer to the following information for typical causes of engine noise.

If a worn or damaged component is causing engine noise, consider having a professional technician listen to the engine. In many cases, only the trained ear of the technician can determine what component(s) has failed, if any. Repairs to the power head are time-consuming and costly.

Ticking Noises

WARNING
Use extreme caution when working on or around a running engine. Never wear loose-fitting clothing. Make sure that no one gets near the flywheel or any drive belts. Neverposition anyone near thepropeller or propeller shaft while the engine is running.

A ticking noise may result from a damaged piston. Inspect the spark plug for damage or aluminum deposits and perform a compression test as described in this chapter. Complete power head disassembly and repair is required if metal deposits are found on the spark plug. It is necessary to remove the cylinder head to inspect the piston, cylinder walls and related components if there are any compression problems.

Whirring Noises

A whirring noise that is most pronounced when the throttle is decreased usually relates to a problem with the crankshaft and rod bearings.

Use a mechanic's stethoscope to help identify the cylinder creating the noise. Compare the noise emanating from one area of the engine with the noise from the same area but different cylinder.

Knocking Noises

WARNING
Use extreme caution when working on or around a running engine. Never wear loose-fitting clothing. Make sure that no one gets near the flywheel or any drive belts. Never position anyone near the propeller or propeller shaft while the engine is running.

Use a mechanic's stethoscope to determine if the noise is emanating from the power head or other engine component. If a problem exists in the crankshaft and connecting rod components, the noise is more pronounced in the crankcase area. Special insulated pliers are available that allow spark plug lead removal while running the engine. The noise may lessen when the spark plug lead is removed on the suspect cylinder. This procedure is difficult to perform and may result in electrical system damage if the spark plug leads are not properly grounded. A better method is to remove one spark plug lead and attach it to an engine ground. Start the engine and listen to the noise. Install the spark plug lead and repeat the process for another cylinder. If, with one lead grounded, the noise is quieter than another cylinder, the grounded cylinder may be damaged.

Always check for lack of oil or incorrect oil/fuel mixture. When combined with low or no oil, knocking noises generally indicate a problem with the power head. Major repair may be required.

Lubrication System Failure

If lubrication is insufficient, internal engine component damage will result. Knocking or other noise is almost always present with lubrication system failures. The engine may stop and not crank with the starter. On occasion, the engine cranks after cooling, but it likely slows down and stops again. When the engine is restarted, it may run rough or not idle. Performance is lacking as well. The engine eventually seizes and requires extensive and expensive repair.

If you suspect the engine ran with insufficient lubrication, perform a compression test. The pistons and cylinder walls may be scuffed, scored or damaged.

Lubrication failure can result from insufficient oil in the cylinder block or contamination of the oil with fuel or water. Other causes include running the engine with old or dirty oil and, in some cases, running the engine with the wrong type of oil.

Stop the engine if you suspect a lubrication failure or if the warning system activates. Check the oil level and condition as described in Chapter Four.

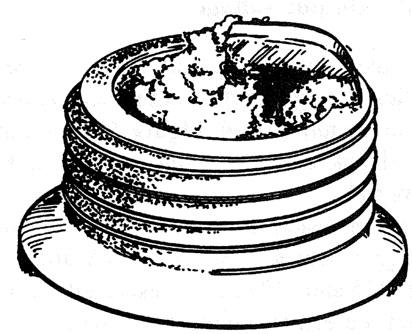
Detonation

Detonation damage is the result of the heat and pressure in the combustion chamber becoming to great for the fuel being used. Fuel normally bums at a controlled rate that causes the expanding gasses to drive the piston down. If heat and pressure get too high, the fuel may explode violently. These violent explosions in the combustion chamber cause serious damage to internal engine components. Carbon deposits, overheating, lean fuel mixture, over-advanced timing and lugging are some of the conditions that may lead to detonation. Never use a fuel with a lower-than-recommended octane rating. Its use may cause detonation under normal operating conditions. The piston suffers most of the adverse effects of detonation. If detonation occurs, the engine has a pinging noise not unlike the pinging sometimes heard in automobiles. Outboards in general are considerably noisier than automobiles, so the pinging noise is seldom detected. The engine likely has a rough idle and may seize. A compression test will probably reveal one or more cylinders low on compression. Inspect the spark plug. The presence of aluminum deposits or melted electrodes **(Figure 53)** indicates probable detonation damage. To avoid repeat failures, address the listed causes for detonation prior to returning the engine to service.

Preignition

Preignition is the result of a glowing object in the combustion chamber that causes early ignition. The wrong heat range spark plugs, carbon deposits and inadequate cooling are some of the causes of preignition. Preignition can lead to severe damage to the internal engine components. The primary component that is damaged is the piston. The damage is very similar to detonation, as the early ignition causes the heat and pressure to become too great for the fuel being used. It explodes violently, causing a melted effect on the piston dome. It is not uncommon to have a hole form in the dome of the piston where preignition has occurred. As with detonation damage, the engine runs poorly, particularly at idle. When the compression test is performed, one or more cylinders may have low compression. Inspecting the spark plugs likely

53



reveals aluminum deposits **(Figure 53)** consistent with detonation failures. Power head repair procedures are in Chapter Eight. To avoid repeat failures, address and correct the causes of preignition before returning the engine to service.

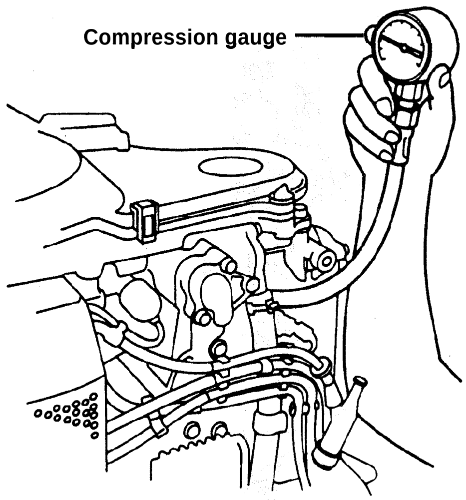
Engine Seizure

The power head can seize at any speed. Normally the engine does not seize up at high speed as the engine typically loses power gradually. Always inspect the gearcase before removing the power head. Gearcase failures can prevent the power head from rotating. Refer to *Gearcase* in this chapter to inspect the gearcase for metal contamination. The gearcase can also be removed to check for gearcase seizure as instructed in Chapter Nine. Repair the gearcase if the power head turns freely with the gearcase removed. Refer to Chapter Eight for power head removal. repair and installation procedures.

Water Entering the Cylinder

Water can enter the cylinder from a number of areas. Water in the fuel, water entering the front of the carburetor, leaking exhaust coverlgaskets, leaking cylinder head and/or gaskets and cylinder block internal leak can allow water to contaminate the engine. The typical symptom of water intrusion, is rough running, particularly at idle. The engine may run correctly at higher speeds. Verify water intrusion when the spark plugs are removed. Water is likely present on the spark plugs, and a white deposit may be present. Remove the cylinder head following the instructions in Chapter Eight. Compare the wet cylinder(s) with the dry cylinder(s). A cylinder with water intrusion usually has significantly less carbon deposits on the piston, cylinder walls and cylinder dome. Rust or corrosion may be present on the reed valves and lor other components. Leakage in the cylinder block can be difficult to

54



find. Casting flaws, pinholes and cracks may or may not be visible. Replacement of the cylinder block and/or cylinder head is required if water is entering the cylinder and no visible gasket leakage can be found. Continued operation with water intrusion will result in engine failure.

Blown Cylinder Head Gasket

A blown cylinder head gasket results from a failure of the gasket that seals the cylinder head to the cylinder block. Symptoms of a blown head gasket include water entering the cylinder(s), overheating (particularly at lower engine speeds), rough running (particularly at lower engine speeds) and noises coming from the cylinder head to cylinder block mating surface. Refer to *Compression Test* in this chapter and perform a compression test if a blown head gasket is suspected. Low or uneven compression may or may not indicate a blown head gasket. A slight leakage can cause the listed symptoms, yet it may not be detected by a compression test. Only removal and inspection of the gasket and mating surfaces will identify a failure. Refer to Chapter Eight for the cylinder head removal procedure.

Compression Test

A compression gauge (**Figure** 54) and adapter are required to perform a compression test.

1. Remove the spark plugs and connect the spark plug leads to an engine ground.
2. Install the adapter and compression gauge (**Figure** 54) into the No. 1 spark plug hole. Position the throttle in the wide-open position during testing.
3. Stand clear of the remaining spark plug openings during testing. Observe the compression gauge and operate the manual or electric starter. Ensure that the engine has made a minimum of 10 revolutions and the cranking speed is at or above 350 rpm. Record the compression reading.
4. Repeat Steps 2 and 3 for the remaining cylinders. Record all cylinder compression readings.
5. Compare the readings with the specification listed in Chapter Eight.
6. Position the throttle in the closed position. Remove the compression gauge and adapter. Install the spark plugs and leads.

COOLING SYSTEM

WARNING
Stay clear of the propeller shaft while running an engine on a flush/test device. For safety, remove the propeller before running the engine or while performing test. Disconnect all spark plug leads and battery connections before removing or installing the propeller.

CAUTION
Never run an outboard without providing cooling water Use either a test tank or flush/test device. Remove the propeller before running the engine on a flush/test device. Use a suitable testpropeller to run the engine in a test tank.

Cooling System Description

The drive shaft in the gearcase drives the water pump, which is mounted on the drive shaft (**Figure** 55). The water is pumped to the exhaust area of the power head, then to the cylinder block and heads. The water exits the power head near the power head mounting surface and travels out through the drive shaft housing. As the water travels through the power head, it absorbs heat and carries it away. If the engine is overheating, the problem is that water is not flowing through the power head with sufficient volume or is not absorbing the heat. All models are equipped with a thermostat (Figure 56) to help maintain a minimum power head temperature and improve low speed running conditions. They work by restricting the exiting water until a minimum water temperature is attained.

A stream of water is visible at the rear of the lower motor cover when water exits the power head. The fitting may become blocked with debris and stop the flow of water. Clean the passage with a small, stiff wire brush. Inspect the cooling system if the water stream is still not present. As with all models, never run the engine without supplying it with cooling water.

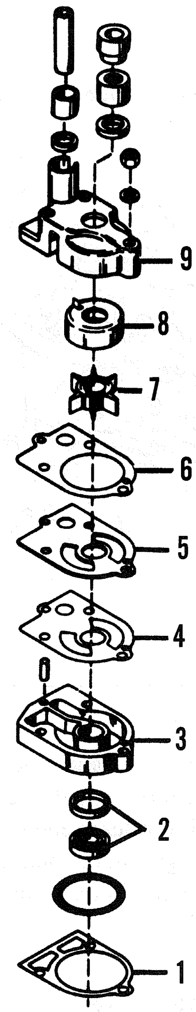
Cooling System Inspection

If the overheat warning horn sounds or the water stream is not present at the rear of the engine, perform the following:

1. Inspect and repair the water pump in the gearcase. Refer to Chapter Nine.
2. Inspect and test the thermostat if overheating occurs and the water pump is in good condition. Refer to *Thermostat* Testing in this chapter.
3. If no faults can be found with the water pump, thermostat or water pressure relief valve (if so equipped), inspect the exhaust water jacket (Figure 57, typical) for debris and deposit buildup. Rocks, pieces of the water pump, sand, shells, or other debris, may restrict water flow. Salt, calcium or other deposits can form in the cooling passages and restrict water flow.
4. Excessive deposit buildup acts as an insulator and prevents the water from absorbing the heat from the power head. Use a cleaner specifically designed to dissolve this type of deposit. Make sure the cleaner used is suitable for use on aluminum material. Always follow the manufacturer's instructions when using these products. These cleaners are usually available at marine specialty stores.
5. It is necessary to remove the water jackets when inspecting cooling passages. Refer to Chapter Eight for water jacket removal and installation.

55

PRESSURE TYPE WATER PUMP

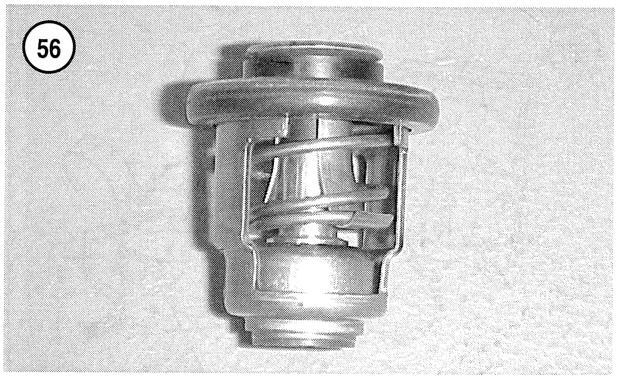


1. Gasket
2. Oil seal
3. Water pump base
4. Gasket
5. Water plate
6. Gasket
7. Impeller
8. Insert
9. Water pump body

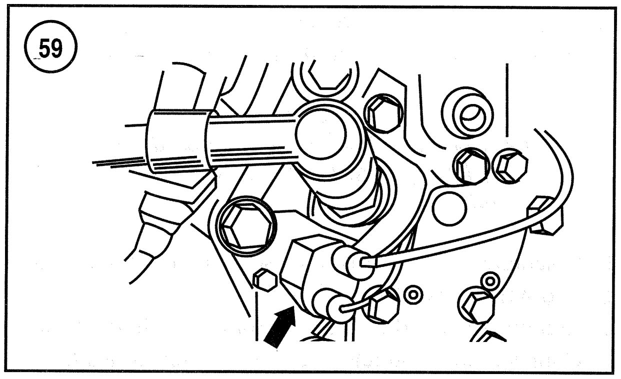
Engine Temperature Verification

If the engine may be overheating, always verify the actual temperature of the engine using Thermomelt sticks (Figure 58). Thermomelt sticks resemble crayons and are designed to melt at a specific temperature. Hold the sticks against the cylinder head near the temperature sender or switch. On smaller engines that are not equipped with an overheat alarm, hold the stick near the spark plug mounting area. Check the temperature immediately after or during the suspected overheat condition. Hold different temperature sticks to the power head to determine the temperature range the engine is reaching. Stop the engine if the temperature exceeds 90° C (194° F) to avoid power head damage. Perform a complete cooling system in-

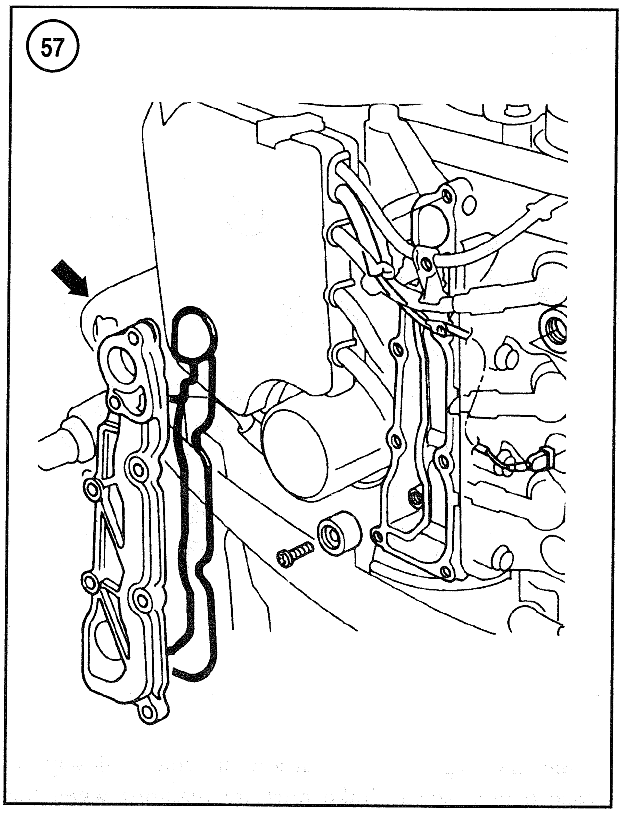
56



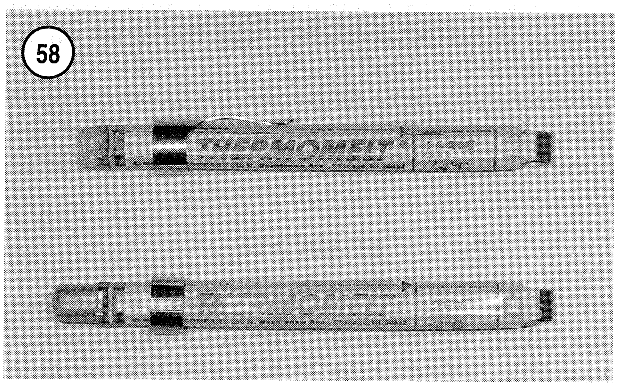
59



57



58



spection if overheating occurs. Test the overheat sensor or water pressure sensor if an alarm or gauge indicates overheating and the Thermomelt sticks indicate normal temperature. Troubleshooting an overheating problem with a flush/test attachment is difficult, as the water supplied through the hose masks cooling system problems. Perform this test with the engine in the water or use a test tank.

Thermostat Testing

Test the thermostat(s) if the engine is overheating or running too cool. Thermostat testing requires a thermometer, piece of string and container of water that can be heated. Refer to Chapter Eight to locate the thennostat cover and related components. Refer to Table **8** at the end of this chapter for thermostat opening temperatures.

1. Remove the thermostat(s) as described in Chapter Eight. Discard the thermostat cover gasket. With a string tied to the thermostat, suspend the thermostat (Figure 56) in a container of water.
2. Begin heating the water. Continue to heat the container while observing the temperature and thermostat.
3. The thermostat should begin to open at approximately 52" C (125° F) on 8-40 hp models and 60° C (140° F) on 40-140 hp models.
4. Replace the thermostat if it opens below or above the specified temverature.
5. Install the thermostat with a new gasket following the instruction in Chapter Eight.

Overheat Sensor Test

The overheat sensor (Figure **59)** is a heat-sensitive switch installed in the cylinder head to monitor engine temperature. The warning horn is connected in series with the overheat sensor. If the sensor detects a temperature greater than a predetermined limit, the sensor contacts close and cause the warning horn to sound a continuous tone when the key switch is on and the remote control lever is in the forward or reverse position. Depending on the model, the engine speed limit function will also activate.

NOTE
The overheat sensor is not standard on 40 hp models prior to 1994, but is available as an option.

1. Disconnect the overheat sensor bullet connector and ground wire at the electrical box.
2. Remove the overheat sensor from the cylinder head.
3. Connect one ohmmeter lead to each sensor lead.
4. Place the thermometer and sensor in a heat-resistant container (Figure **60)** filled with automotive crankcase oil. Slowly heat the oil using an external heat source.
5. Refer to Table **7** to verify sensor switch temperature changes.

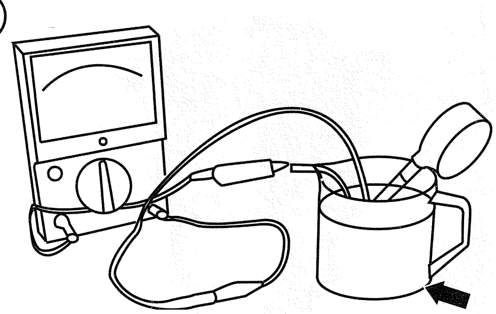
Water Pressure Sensor Test

The water pressure sensor (Figure 61) is a pressure-sensitive switch installed on the power head to monitor the pressure in the cooling system. The sensor is connected in series with the warning horn. If the sensor detects low water pressure at a predetermined engine speed, the contacts close and activate the warning horn. The speed limit function is also activated.

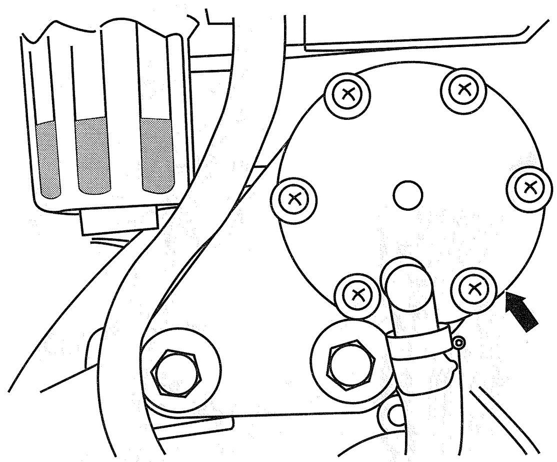
NOTE
The water pressure sensor is standard equipment on 80-140 hp models. It is available as an option on 60 and 70 hp models.

1. Verify that the lower unit water intake screens are not clogged before testing a questionable water pressure sensor. Perform this test with the engine in a test tank or on a boat in the water.
2. Remove the sensor mounting screws and disconnect the sensor ground wire.
3. Disconnect the sensor bullet connector at the electrical box.
4. Connect one ohmmeter lead to each sensor lead (A and B, Figure 62). The ohmmeter should indicate continuity (switch closed).
5. If the ohmmeter indicates no continuity (switch open), loosen the adjustment screw (1, **Figure 63)** just so the switch button makes contact with the diaphragm pressure button. If there is still no continuity, replace the sensor assembly.
6. Disconnect the input hose from the sensor fitting. Using a T-fitting, install a water pressure gauge between the sensor and the hose.

60



61

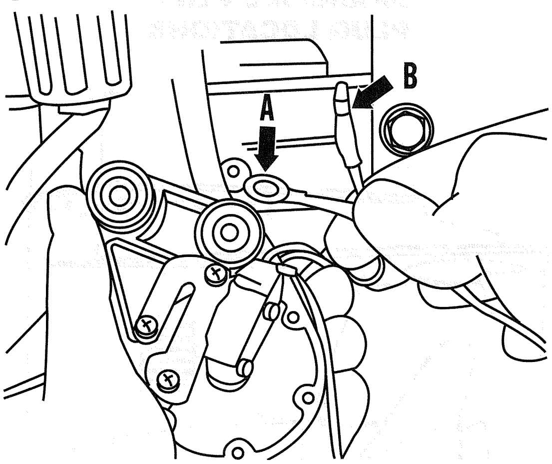


7. Start the engine and run at idle in neutral. Slowly increase engine speed. Take pressure readings when the tester indicates no continuity (switch open). The switch should open at 29.4 kPa (4.3 psi). If the switch opens at lower or higher pressures, then fully loosen the adjustment screw.
8. Set and maintain the throttle position so water pressure is 29.4 kPa (4.3 psi). Gradually tighten the adjustment screw until the tester indicates no continuity (switch open).

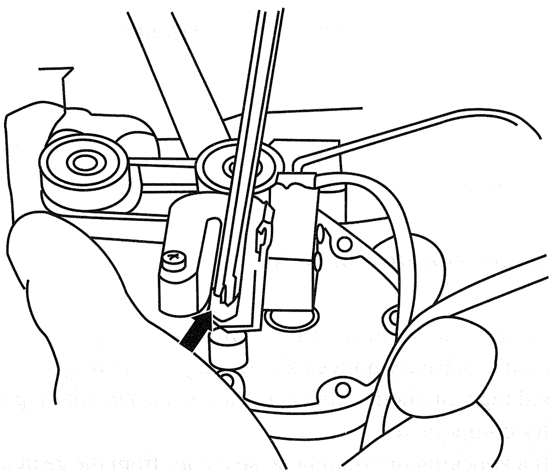
GEARCASE

Problems with the gearcase can include water or lubricant leakage, failed internal components, noisy operation or shifting difficulty. The keys to preventing gearcase

62



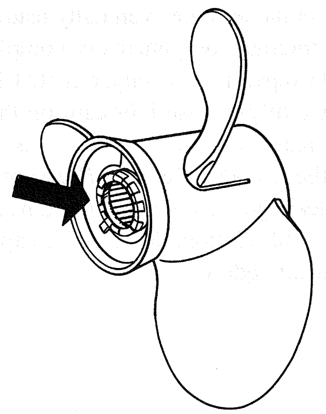
63



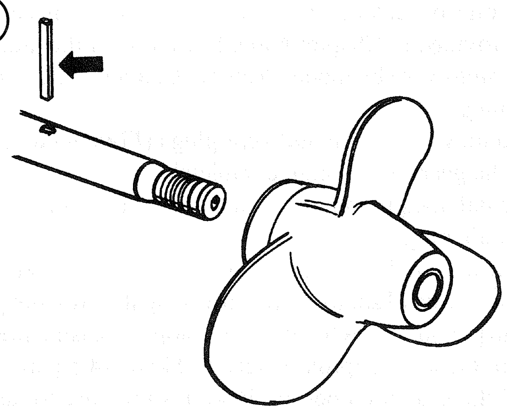
problems are to avoid contact with underwater objects, shifting the engine into gear at idle speed only and perform regular maintenance. Gearcase maintenance procedures are located in Chapter Four.

A slipping propeller hub may lead you to believe that a problem exists with the gearcase when only minor repair to the propeller is required. The typical symptom is an inability to accelerate the boat onto plane without over-speeding the engine. Other times the engine seems as though it is not shifting into gear at all.

64



65



The propeller hub (Figure 44) is installed in the propeller to cushion the shifting action and helps absorb minor impacts. If the propeller hub is spinning in its bore, the engine speed increases as the throttle increases; however, the boat does not increase in speed. In most cases, the boat does not accelerate. Some smaller engines use a cotter (shear) pin (Figure 65) that is designed to break on impact. Symptoms of a broken cotter pin are similar to a spun propeller hub.

1. Make a reference mark on the propeller shaft aligned with a reference mark on the propeller. Operate the boat and compare the reference marks after removing the engine from the water. Have the propeller repaired if the reference marks do not align after running the engine.
2. A small amount of water may be present in the gearcase lubricant if the gearcase has not received normal maintenance for several years and has been stored while submerged in water. Pressure test the gearcase to determine the source of water intrusion any time water is found in the

gearcase lubricant. Refer to *Pressure Test* in this chapter. Failure to correct the leakage eventually leads to extensive damage to the internal components or complete failure of the gearcase. If a repair is necessary, refer to Chapter Nine.
3. The presence of gearcase lubricant on the exterior or around the gearcase requires a pressure test to determine the source of the leakage. Refer to *Pressure Test.* Failure to correct the leakage results in gear and bearing damage due to lack of lubrication. Refer to Chapter Nine for gearcase repair procedures.

Pressure Test

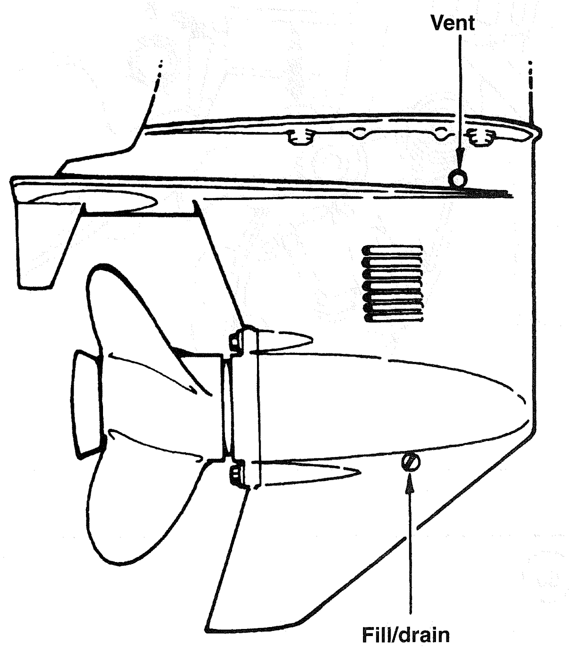
Drain the gearcase lubricant and dispose of it in a responsible manner. Apply air pressure to the gearcase. The pressure gauge indicates if there is leakage. Submerge the entire gearcase in water to check for bubbles to determine the point of leakage. Gearcase removal and installation are provided in Chapter Nine. Locations of the drain and vent plugs vary by model. Refer to Chapter Nine to locate the plugs.
1. Remove the drain and vent plugs **(Figure 66)** and allow the gearcase to drain completely.
2. Install the pressure tester into the vent opening. Install the drain plug.
3. Slowly apply pressure with the pressure tester. Push, pull and turn all shafts while observing the pressure gauge as the pressure slowly increases. Stop increasing pressure when it reaches approximately 100 kPa (14.5 psi).
4. If the gearcase does not hold this pressure for at least 10 seconds, remove the gearcase following the procedure in Chapter Nine. Submerge the gearcase with the pressure applied. Repair the leak at the location that bubbles appear. Refer to Chapter Nine for repair procedures.
5. Loosen the drain plug to allow the air to slowly bleed from the gearcase. Refill the gearcase with fresh lubricant following the procedures listed in Chapter Four.

Metal Contamination in the Lubricant

Fine metal particles form in the gearcase during normal use. The gearcase lubricant may have a *metal flake* appearance when inspected during routine maintenance. The fine metal particles tend to cling to the end of the drain plug, causing great concern to anyone who is performing routine maintenance. Carefully sub some of the material between your finger and thumb. Inspect the gearcase if any of the material is large enough to feel. Removing the propeller shaft-bearing carrier allows a view of the internal components. Refer to Chapter Nine for removal, inspection and assembly procedures.

66

DRAIN/FILL VENT PLUG LOCATIONS



Gearcase Vibration or Noise

Gearcase noise does occur from normal usage. The normal noise is barely noticeable. A rough, growling noise or a loud high-pitched whine is reason to suspect damage or faulty components.
1. If a knocking or grinding noise comes from the gearcase, the cause is likely damaged gears or other components. The gears may be damaged as the result of underwater impact or high speed shifting. Inspect the gearcase lubricant for metal contamination. In most cases, the gearcase lubricant indicates whether internal components have failed. Refer to Chapter Nine for removal and repair procedures.
2. If a high-pitched whine is present, it normally indicates a bearing problem or, in some cases, the gears sunning out of alignment. To verify that a problem exists, disassemble and inspect the internal components. Have a professional mechanic listen to the gearcase before proceeding with a repair.
3. Vibration in the engine can originate in the gearcase. In almost all cases, the vibration is due to a bent propeller

shaft or damaged propeller. A propeller can appear perfect, but still be unbalanced. The best ways to determine this is to have the propeller trued and balanced at a propeller repair shop, or simply try a different propeller for the engine. A bent propeller shaft is normally the result of impact with an underwater object. Always check for a bent propeller shaft if vibration is present following the procedure in Chapter Nine. If the propeller shaft is bent, disassemble and inspect the gearcase, as other internal components may also be damaged. Never operate the outboard motor if severe vibration is occurring. Excessive vibration can compromise the durability of the entire outboard motor.

WARNING
Remove all spark plug leads and disconnect both battery cables before removing, installing or working around the propeller.

Shifting Difficulty

Hard shifting is usually the result of improper shift cable adjustment. Refer to Chapter Five and adjust the shift cables and linkage as described. Gearcase removal, disassembly and inspection are required if shifting problems are not corrected by adjustment. Refer to Chapter Nine for gearcase repair procedures.

Table 1 STARTING SYSTEM TROUBLESHOOTING

Symptom	Causes	Corrective action
Electric starter does not operate	Engine not in neutral	Shift into neutral
	Weak or discharged battery	Fully charge and test battery
	Dirty or corroded terminals	Thoroughly clean battery terminals
	Blown fuse in wire harness	Check all fuses
	Faulty neutral start switch	Test neutral switch operation
	Faulty starter button or switch	Test starter button or switch
	Faulty starter relay	Test starter relay
	Dirty or loose starter wires	Clean and tighten wire connections
	Faulty starter motor	Repair starter motor
	Improperly installed starter	Check for proper installation
	Improperly installed wires	Check for proper wire installation
Starter engages flywheel but rotates slowly	Weak or discharged battery	Fully charge and test battery
	Dirty or corroded battery terminals	Thoroughly clean battery terminals
	Loose or faulty starter wires	Clean, tighten and repair wire connections
	Faulty starter motor	Repair starter motor
	Improperly installed starter	Check for proper installation
	Engine is in gear	Check and correct shift system
	Water or oil in the cylinder(s)	Remove and inspect spark plug(s)
	Seized power head	Check for power head seizure
	Seized gearcase	Check for gearcase failure
Starter engages flywheel but flywheel does not rotate	Weak or discharged battery	Fully charge and test battery
	Dirty or corroded battery terminals	Thoroughly clean battery terminals
	Loose or faulty starter wires	Clean, tighten and repair wire connections
	Faulty starter motor	Repair starter motor
	Improperly installed starter	Check for proper installation
	Seized gearcase assembly	Check for gearcase failure
	Seized power head	Check for manual flywheel rotation
	Water in the cylinders	Check for water in the cylinders
	Oil in the cylinders	Remove and inspect the spark plugs
	Faulty starter motor	Repair starter motor

(continued)

Table 1 STARTING SYSTEM TROUBLESHOOTING (continued)

Symptom	Causes	Corrective action
Noisy starter operation	Dirty or dry starter drive	Clean and lubricate starter drive
	Improperly installed starter	Check for proper installation
	Worn or dry starter bearings	Repair starter motor
	Corroded or damaged flywheel gear	Check condition of flywheel gear teeth
	Worn or damaged starter drive	Check condition of starter drive
	Internal power head damage	Check for problem in power head
	Internal gearcase damage	Check for problem in gearcase

Table 2 IGNITION SYSTEM TROUBLESHOOTING

Symptom	Cause(s)	Solution
Cranks over but will not start	Faulty spark plug (s)	Replace
Will not start and backfires	Faulty ignition system	See ignition system testing this chapter
	Ignition timing incorrect	See timing this chapter
Starts but stops instantly	Faulty spark plug (s)	Replace
	Low water pressure, overheat or faulty RPM limitation	See poweahead troubleshooting this chapter
High or low speed miss	Faulty ignition system	See ignition system testing this chapter
	Faulty spark plug (s)	Replace
	Low water pressure, overheat or faulty RPM limitation	See powerhead troubleshooting this chapter
	Ignition timing incorrect	See timing this chapter
Top end RPM low, poor acceleration	Faulty ignition system	See ignition system testing this chapter
	Faulty spark plug (s)	Replace
	Ignition timing incorrect	See timing this chapter
Engine will not stop running	Faulty ignition system	See ignition system testing this chapter
	Faulty stop circuit	See stop circuit tests this chapter

Table 3 FUEL SYSTEM TROUBLESHOOTING

Symptom	Causes	Corrective action
Engine will not start	Old or contaminated or fuel	Supply the engine with fresh fuel
	Fuel pump malfunction	Check for proper pump operation
	Plugged carburetor jets	See *Plugged Carburetor Jets* (Chapter Three)
	Improper carburetor adjustment	Check carburetor adjustment (Chapter Five)
	Blocked fuel filter	Check all fuel filters
	Closed fuel tank vent	Check for closed vent
	Air leakage in the fuel hoses	Check fuel hoses
	Faulty primer bulb	Test primer bulb
	Fuel leaking from system	Check for fuel leakage
	Flooding carburetor	Check for flooding carburetor
	Improper choke operation	Check for proper choke operation
	Faulty electrothermal valve	Test the electrothermal valve

(continued)

Table 3 FUEL SYSTEM TROUBLESHOOTING (continued)

Symptom	Causes	Corrective action
Rough idle	Old or contaminated fuel	Supply the engine with fresh fuel
	Fuel pump malfunction	Check for proper pump operation
	Plugged carburetor jets	See ***Plugged Carburetor Jets*** (Chapter Three)
	Improper carburetor adjustment	Check carburetor adjustment (Chapter Five)
	Air leakage in the fuel hoses	Check fuel hoses
	Flooding carburetor	Check for flooding carburetor
	Improper choke operation	Check for proper choke operation
Engine dies at idle speed	Old or contaminated or fuel	Supply the engine with fresh fuel
	Fuel pump malfunction	Check for proper pump operation
	Plugged carburetor jets	See ***Plugged Carburetor Jets*** (Chapter Three)
	Improper carburetor adjustment	Check carburetor adjustment
	Blocked fuel filter	Check all fuel filters
	Closed fuel tank vent	Check for closed vent
	Air leakage in the fuel hoses	Check fuel hoses
	Fuel leaking from system	Check for fuel leakage
	Flooding carburetor	Check for flooding carburetor
	Improper choke operation	Check for proper choke operation
	Incorrect idle speed adjustment	Adjust idle speed (Chapter Five)
	Misadjusted throttle position sensor	Adjust sensor (Chapter Five)
	Faulty primer bulb	Test primer bulb
Idle speed too high	Improper carburetor adjustment	Check carburetor adjustment
	Improper idle speed adjustment	Adjust as required
	Improperly adjusted throttle cable	Check cable adjustment
	Binding throttle linkage	Check linkage
	Incorrect idle speed adjustment	Adjust idle speed (Chapter Five)
	Faulty electrothermal valve	Test electrothermal valve
Bogging on acceleration	Faulty accelerator pump	Check accelerator pump
	Old or contaminated or fuel	Supply the engine with fresh fuel
	Fuel pump malfunction	Check for proper pump operation
	Plugged carburetor jets	See ***Plugged Carburetor Jets*** (Chapter Three)
	Improper carburetor adjustment	Check carburetor adjustment
	Blocked fuel filter	Check all fuel filters
	Closed fuel tank vent	Check for and correct closed vent
	Air leakage in the fuel hoses	Check fuel hoses
	Fuel leaking from system	Check for fuel leakage
	Flooding carburetor	Check for flooding carburetor
	Improper choke operation	Check for proper choke operation
	Misadjusted throttle position sensor	Adjust sensor (see Chapter Five)
	Faulty electrothermal valve	Test electrothermal valve
Misfire at high engine speed	Old or contaminated or fuel	Supply the engine with fresh fuel
	Fuel pump malfunction	Check for proper pump operation
	Plugged carburetor jets	See ***Plugged Carburetor Jets*** (Chapter Three)
	Blocked fuel filter	Check all fuel filters
	Closed fuel tank vent	Check for and correct closed vent

(continued)

Table 3 FUEL SYSTEM TROUBLESHOOTING (continued)

Symptom	Causes	Corrective action
Misfire at high engine speed (continued)	Air leaks in the fuel hoses	Check fuel hoses
	Fuel leaking from system	Check for fuel leakage
	Improper choke operation	Check for proper choke operation
	Faulty primer bulb	Test primer bulb
Excessive exhaust smoke	Improper carburetor adjustment	Check carburetor adjustment
	Fuel leaking from system	Check for fuel leaks
	Flooding carburetor	Check for flooding carburetor
	Improper choke operation	Check for proper choke operation

Table 4 GENERAL TORQUE SPECIFICATIONS*

Thread diameter	N•m	in.-lb.	ft.-lb.
5 mm bolt and nut	5	44	–
6 mm bolt and nut	10	88	–
8 mm bolt and nut	22	–	16
10 mm bolt and nut	34	–	25
12 mm bolt and nut	54	–	40
5 mm screw	4	35	–
6 mm screw	9	80	–
6 mm flange bolt with 8 mm head (small flange surface)	9	80	–
6 mm flange bolt with 8 mm head (large flange surface)	12	106	–
6 mm flange bolt with 10 mm head and nut	12	106	–
8 mm flange bolt and nut	26	–	20
10 mm flange bolt and nut	39	–	29

*This table lists general torque specifications for metric fasteners. Use this table when a specific torque specification is not listed for a fastener at the end of the appropriate chapter. The torque specifications listed in this table are for threads that are clean and dry.

Table 5 ENGINE MODEL IDENTIFICATION

Engine	Cylinder(s)	kW (HP)	Idle in gear	Top RPM range
2.5	1	1.8 (2.5)	1100 RPM	3800-5200
3.5	1	2.6 (3.5)	1100 RPM	4200-5300
5	1	3.7 (5)	850 RPM	4500-5500
8	2	5.9 (8)	750 RPM	4500-5500
9.8	2	7.2 (9.8)	750 RPM	5000-6000
9.9	2	7.3 (9.9)	800 RPM	4500-5300
15	2	11.0 (15)	800 RPM	5200-5800
18	2	13.2 (18)	800 RPM	5200-5800
25	2	18.4 (25)	900 RPM	5000-6000
30	2	22.1 (30)	900 RPM	5150-5850
40	2	29.4 (40)	850 RPM	5200-5800
40D	3	29.4 (40)	750 RPM	4500-5500
40D2				5000-5700
50D	3	36.8 (50)	750 RPM	5000-5700
50D2	5150-5850			
60B	3	44.1 (60)	750 RPM	4900-5600
60C	5150-5850			

(continued)

Table 5 ENGINE MODEL IDENIFICATION (continued)

Engine	Cylinder(s)	kW (HP)	Idle in gear	Top RPM range
70B	3	51.5 (70)	750 RPM	4900-5600
70C	5150-5850			
80	3	58.8 (80)	700 RPM	5000-5500
90	3	66.2 (90)	700 RPM	5000-5500
115	4	84.6 (115)	700 RPM	5200-5700
120	4	88.3 (120)	700 RPM	5200-5700
140	4	103 (140)	700 RPM	5200-5700

Table 6 OVER-SPEED LIMITATION

Model	Maximum RPM
40 and 50D hp	5650-6150
40 and 50D2 hp	5800-6300
60 and 708 hp	5900-6300
60 and 70C hp	5950-6350
80 and 90 hp	5650-6150
115/120/140 hp	5750-6250

Table 7 OVERHEAT SENSOR TEST

Model	Switch closed (continuity)	Switch open (no continuity)
2.5-40 hp (two cylinder)	–	–
40-50 hp (three cylinder)	100° C (212° F)	85° C (185° F)
60-70 hp	125° C (257° F)	110° C (230° F)
80-90 hp	80° C (176° F)	69° C (156° F)
115-140 hp	100° C (212° F)	85° C (185° F)

Table 8 THERMOSTAT OPENING TEMPERATURE

Model	C°	F°
8-40 hp	52	125
40-140 hp	60	140

Chapter Four

Lubrication, Maintenance and Tune-Up

When operating properly, the outboard engine provides smooth operation, reliable starting and excellent performance. Regular maintenance and frequent tune-ups help keep it running at its best.

During operation, certain components or fluids in the engine wear or become contaminated. Unless these components or fluids are refreshed, engine performance, reliability and engine life diminish. Performing routine lubrication, maintenance and necessary tune-ups helps ensure that the outboard performs as it should and delivers a long and trouble-free life.

Table 1 lists the maintenance items and intervals for all engine systems and components. **Tables 2-4** provide lubricant capacities and spark plug recommendations. **Tables 1-4** are located at the end of this chapter.

Outboards operate in a corrosive environment and often require special types of lubricants. Using the incorrect type of lubricant can seriously damage the engine or substantially shorten the life of the engine. Lubricant specifications are provided in the maintenance instructions.

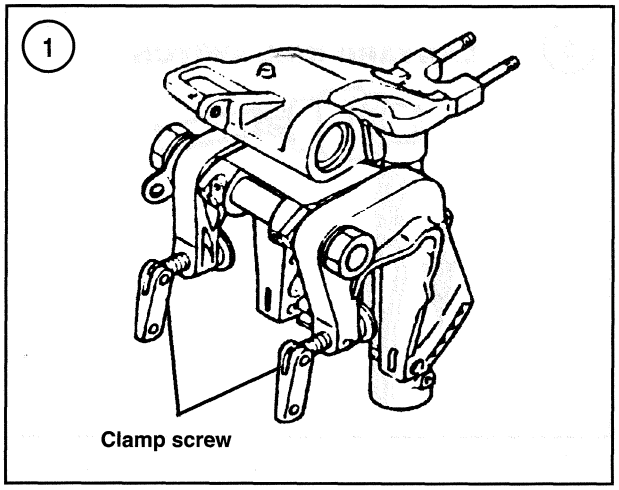
Initial Inspection

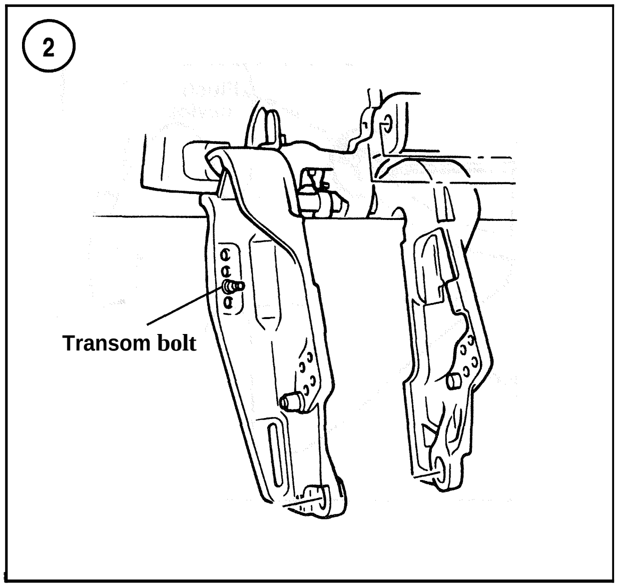
As specified in **Table 1,** certain items must be inspected or checked before each use.

1. Check the propeller.
2. Check the engine mounting fasteners.
3. Check the fuel system for leakage.
4. Check the steering system for looseness or binding.
5. Check the cooling system.
6. Check the operation of the lanyard or stop switch.

Propeller

Inspect the propeller for cracks, damage or missing blades. Operating with a damaged propeller results in ex-





cessive vibration, decreases performance, and increases wear. Small bent areas can be easily straightened using locking pliers. Small nicks can be dressed with a metal file. To prevent an out-of-balance condition, do not remove excessive material from the propeller. Have the propeller repaired at a shop if there is significant damage.

Place the engine in NEUTRAL. Disconnect the battery (on electric start models) and disconnect all spark plug leads. Carefully spin the propeller while observing the propeller shaft. A noticeable wobbling of the shaft indicates a bent propeller shaft or other gearcase damage. Repair the gearcase if this condition is noted. Gearcase repair instructions are provided in Chapter Nine.

Install the spark plug wires. Clean the terminals and connect the cables to the battery (electric start models).

WARNING
Operating the engine with loose clamp screws or engine mounting bolts can result in serious bodily injury and/or loss of the engine. Always check and/or tighten the mounting bolts or screws before operating the engine.

4

Mounting fasteners

Check the tightness of all mounting fasteners before operating the boat. On 2.5-40 hp models with tiller control, the outboard motor mounts to the boat transom with clamp screws **(Figure 1).** All other models mount to the boat with through-transom mounting bolts **(Figure** 2).

Fuel system

Observe all fuel hoses, connections and carburetor(s) while squeezing the primer bulb. Correct the source of any leakage before starting the engine.

After starting the engine, check for fuel odor or a sheen on the water surface around the engine caused by fuel. If either is present, stop the engine and inspect the fuel system for leaks. The fuel system is covered in Chapter Six.

Steering system

Check the operation of the steering components prior to starting the engine.

On tiller control models, move the tiller handle to its full port and starboard limits. Note the presence of looseness or binding. Looseness may indicate a loose tiller arm, tiller arm bracket or engine mounts. Binding can be caused by a misadjusted or faulty steering friction system.

On remote control models, rotate the steering wheel to the clockwise and counterclockwise limits. Note the presence of binding or excessive slack as the wheel changes direction. Binding indicates a faulty steering cable, faulty helm or damaged midsection component(s). Midsection repair procedures are provided in Chapter Nine.

Correct the causes of looseness or binding before operating the outboard.

Cooling system

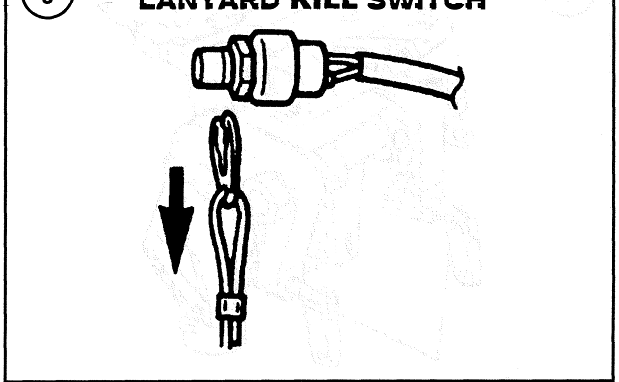
Check for the presence of the water stream immediately after starting the engine. A stream of water exiting the lower back area of the engine indicates that the water pump is operating. This stream may not appear for the first few seconds of operation (especially at idle speed).

Stop the engine and check for cooling system malfunction if the stream fails to appear. Refer to *Cooling System* in Chapter Three. Never run the engine when it is overheating or the water stream fails to appear.

Lanyard or stop switch

Check the operation of the lanyard and/or stop switch before operation. Press the stop button or switch the ignition off on remote key switch models. Start the engine and pull the lanyard cord from the lanyard switch **(Figure 3).** If the engine fails to stop, operate the choke, disconnect the fuel line or squeeze the fuel line until the engine stalls. Repair the faulty stop circuit before restarting the engine. Test the stop circuit as described in Chapter Three.

3

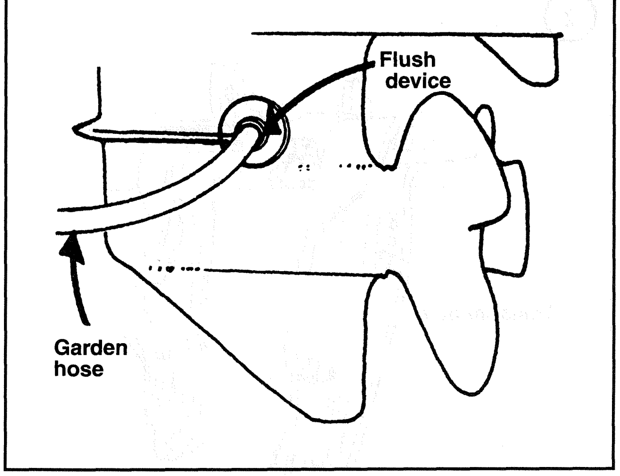


After Each Use

As specified in **Table 1,** certain maintenance procedures must be performed after each use. Following these requirements dramatically reduces engine corrosion and extends the life of the engine.

1. Flush the cooling system.
2. Clean the engine.
3. Check for propeller or gearcase damage.

4



Flush the cooling system

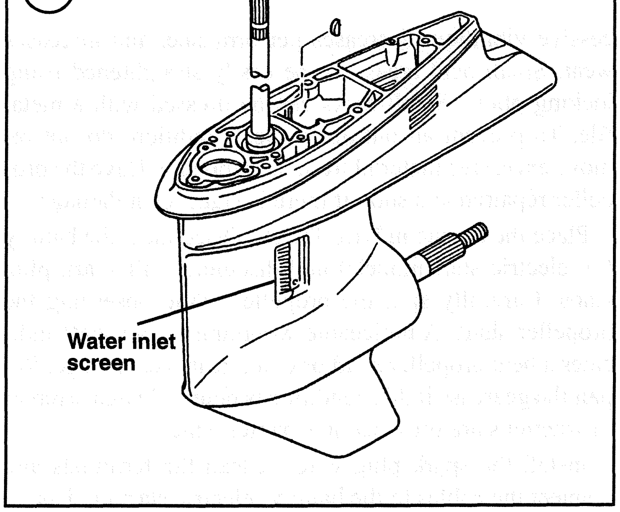
Flush the cooling system after each use to prevent corrosion and deposit buildup in the cooling passages. This is extremely important if the engine is run in salt, brackish or polluted water.

If the engine is stored on a trailer or boatlift, flush the engine using a flush/test adapter **(Figure** 4). This method is preferable, as it flushes the entire cooling system. Operating it in a suitable test tank filled with clean water can also flush the engine.

The type of flushing adapter used is determined by the water screen location. All models except 2.5 and 3.5 hp have the water screens located on the side of the gearcase **(Figure 5).** The 2.5 and 3.5 hp water screens are located in front of the propeller, underneath the cavitation plate.

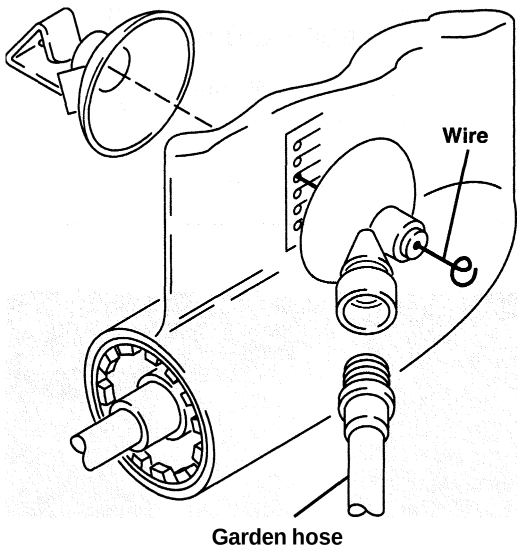
Use a slide-on flushing adapter **(Figure** 4) or a two-piece adapter **(Figure 6)** on all models with side-mounted water screens. The two-piece design is preferred over a slide-on type adapter, as it does not slip out of position during engine operation.

5



NOTE
Water may exit the auxiliary water pickup opening while running the engine on a flushing adapter; this is normal. To ensure

6



adequate engine cooling, use full water pressure and never run the engine at high speed using ajlushing adapter:

Flush the cooling system as follows:

1. Remove the propeller as described in Chapter Nine.
2. Carefully attach the flush adapter to the engine.
   a. If using a slide-on type flush test adapter, connect the garden hose to the adapter. Starting at the front edge of the gearcase, slide the cups onto each side of the gearcase. Position the cups over the water inlet screens.
   b. If using a two-piece adapter **(Figure** 6), connect the garden hose to the adapter. Squeeze the clamp plate (opposite from the hose connection) then pull the cup from the wire. Slide the wire with the cup attached through the water screen openings as indicated in **Figure** 6. Squeeze the clamp plate just enough to pass the wire through the cup and both sides of the clamp plate. Press both cups and the wire loop firmly against the gearcase then release the clamp plate.
3. Turn the water on. Make certain that the flush adapter is firmly positioned over the water screen(s). Start the engine and run it at a fast idle in neutral until the engine reaches normal operating temperature.
4. Continue to run the engine for at least five minutes. Monitor the engine temperature. Stop the engine if it overheats or if water does not exit the water stream fitting.
5. Bring the engine back to idle for a few minutes then stop the engine. Remove the flush adapter. Install the propeller. Allow the engine to remain in the vertical position for a few minutes to completely drain the cooling system.

4

Cleaning the engine

Clean all external engine surfaces after each use to reduce corrosion, wear on gearcase and/or trim system seals and allow easier inspection.

Never use strong cleaning solutions or solvent to clean the motor. Mild soap and pressurized water do a fine job of cleaning the engine. Never direct water toward any engine cover openings. Avoid directly spraying any opening, seals, plugs, wiring or wire grommets with a high-pressure nozzle or pressure washer. The water may bypass the seals and contaminate the trim system, electric trim motor or trim fluid reservoir.

Rinse the external surfaces with clean water to remove any soap residue. Wipe the engine with a soft cloth to prevent water spots.

Scheduled Maintenance

Perform certain maintenance items at specified intervals. This section provides instructions for performing the regular scheduled maintenance or inspections.

Always keep a log of maintenance performed and when it was done. Also, log the number of running hours after each use. Without a maintenance/running hours log or an hour meter **(Figure** 7) it is almost impossible to accurately determine the hours of usage. Be aware that an hour meter may run when the ignition switch is ON, even if the engine is not running. Note this event in the maintenance log if it should occur.

Table 1 lists the normal maintenance schedules. Some maintenance items do not apply to all models. The type of control system, starting system, and trim system used determines the engine's unique maintenance requirements. Perform all applicable maintenance items listed in **Table 1.**

Fuel Requirements

WARNING

Use extreme caution when working with or around fuel. Never smoke around fuel or fuel vapor: Make sure that no flame or source of ignition is present in the work area. Flame or sparks can ignite the fuel or vapor and result in fire or explosion.

Always use a major brand fuel from a facility that sells a large amount of fuel. Fuels available today have a relatively short shelf life. Some fuels begin to lose potency in as little as 14 days. Plan on using the fuel within 60 days or less.

Use premium grade fuel with an average octane rating of 89 or higher and with no more than 10% ethanol by volume. This fuel should meet the requirements for the engine when it is operated under normal operating conditions.

Purchase fuel from a busy fuel station. They usually have a higher turnover of fuel, providing a better opportunity to purchase fresh fuel. Always plan on using the fuel well before it has become old or stale. Refer to *Storage* (in this chapter) for information on fuel additive recommendations.

CAUTION

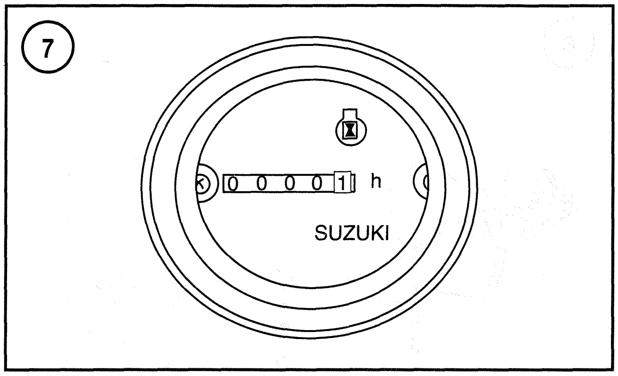
Never run an engine on old or stale fuel. Engine damage could result from using fuel that has deteriomted. Varnish-like deposits form in the fuel system as fuel deteriorates. These deposits can block fuel passages and result in decreased fuel delivery. This can cause a lean condition in the combustion chamber: Damage to the pistons and other power head components may result from operating the engine under a lean fuel condition.

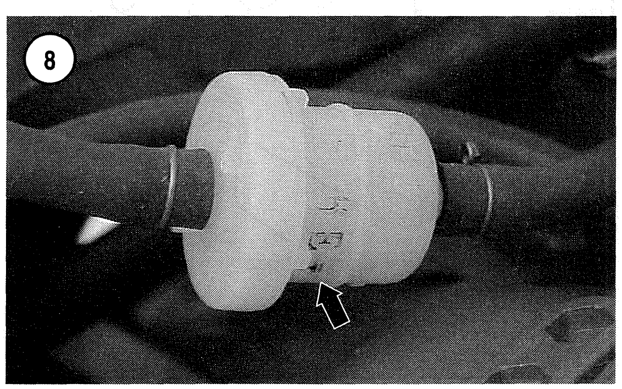
Fuel Filter Inspection

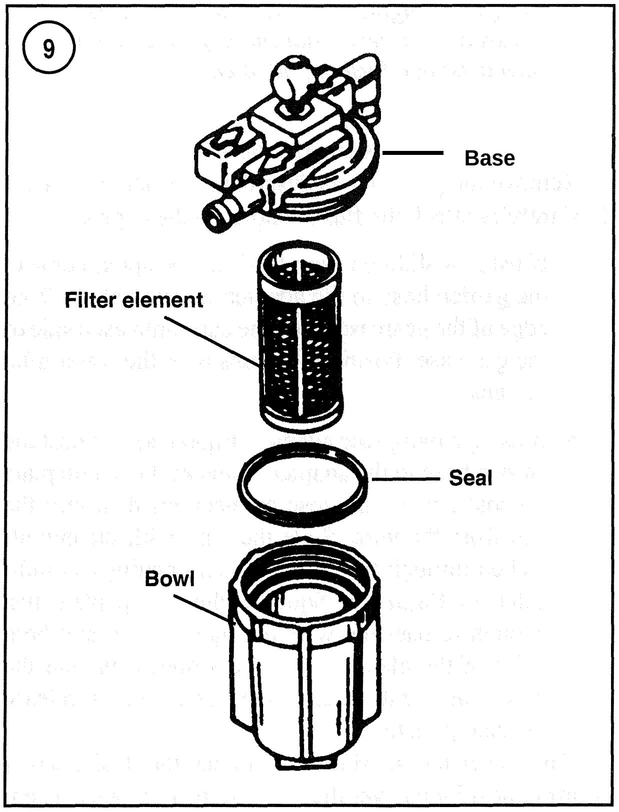
WARNING

Use extreme caution when working with or around fuel. Never smoke around fuel or fuel vapor: Make sure that no flame or source of ignition is present in the work area. Flame or sparks can ignite the fuel or vapor resulting in fire or explosion.

Inspect and/or replace the fuel filter at the intervals specified in **Table 1.** Four types of fuel filters are used: in-tank pickup filters (**2.5** and **3.5** hp models), inline fuel filters **(Figure 8**), bowl-type fuel filters **(Figure 9)** and canister style fuel filters **(Figure 10)** for higher hp mod-

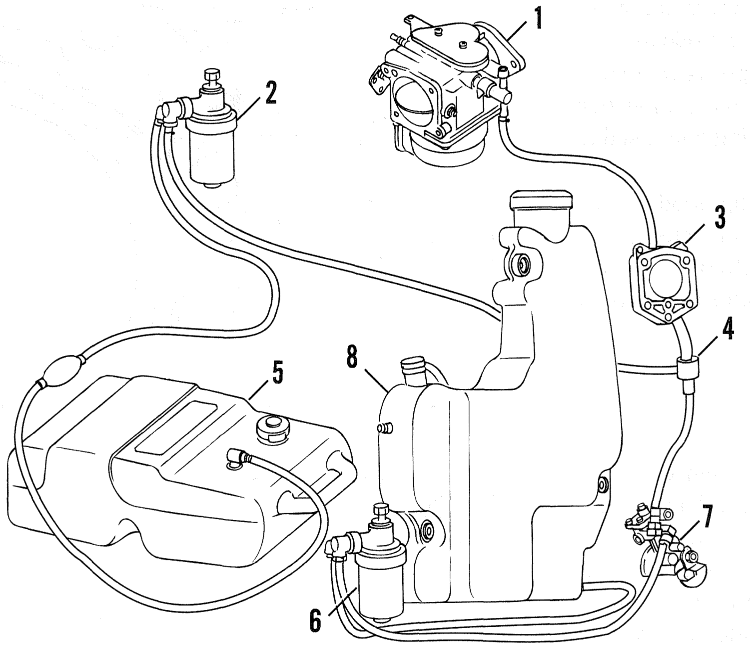






10

FUEL SUPPLY ASSEMBLY



els. The inline and bowl type filters are constructed of translucent material that allows visual detection of material or staining inside its housing.

The inline and bowl-type filter is located along the fuel hose connecting the quick connector fitting or fuel tank connector to the fuel pump (**Figure** 8).

Replace the fuel filter if debris or dark colored staining is noted within the filter body. Fuel filter removal and installation are provided in Chapter Six.

Lubrication System Description

CAUTION

Never use nondetergent oil or four-stroke outboard motor oil in a two-stroke outboard,. it will not adequately lubricate the internal engine components. Operating the engine without adequate lzibrication results in severe power head damage or engine seizure.

Engine oil is drawn from the oil tank (8, **Figure 10)** through the oil filter (6) and into the oil pump. The output from the oil pump (7, **Figure 10)** is directed through the oil hose to the automixing check valve (4). At the same time, the vacuum that is produced on the suction side of the fuel pump (3, **Figure 10)** causes raw gasoline from the fuel tank (5) to be drawn through the fuel filter (2) and directed through the fuel hose to the automixing check valve (4). The automixing check valve ensures the gasoline and oil are mixed before entering the fuel pump. The fuel/oil mixture is directed through the fuel pump to the carburetors (1, **Figure 10)** for proper dispersal to the engine.

Engine Oil Requirements

Use a good quality NMMA-certified TC-W3 two-stroke outboard oil. This oil is acceptable for the automixing system and fuel tank premix applications. This oil can be purchased from a marine dealership.

Removing Carbon Deposits

Remove the carbon from the combustion chamber at regular intervals. Excessive carbon deposits can increase engine compression and promote detonation. To help prevent serious power head damage, decarbonize the engine at the intervals listed in **Table 1.**

Special fuel additives and sprays are very effective at removing most carbon deposits. These additives and sprays are most effective when used regularly. These are available from most marine dealerships and marine supply stores. These products are either added to the fuel or sprayed into the carburetor during engine operation. Always follow the manufacturer's directions when using these products.

Remove stubborn or heavy carbon deposits by manually scraping them from the pistons and combustion chambers. Cylinder head removal. cleaning and installation are provided in Chapter Eight.

Prevent heavy carbon deposits by using good quality fuel and oil. Ensure the propeller used is correct for the engine and boat combination (see Chapter One). Check and correct all applicable carburetor adjustments to minimize carbon deposits.

Sacrificial Anodes

Sacrificial anodes are used to help prevent corrosion damage to the power head cooling passages. The anode is made of a material that is more corrosively active than the cylinder head or cylinder block material. Essentially the anodes sacrifice themselves to protect the power head. Regular inspection and/or replacement helps ensure continued protection against conosion damage. An anode must be replaced if it is 1/3 of its original size.

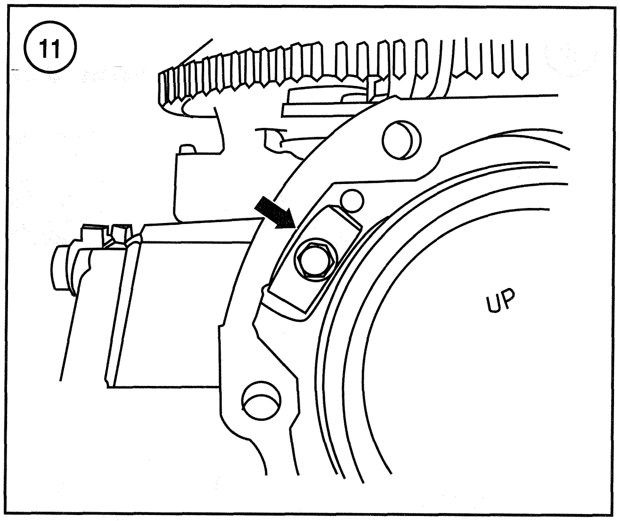
Refer to **Figures** 11-13.

1. Remove the cylinder head from the block and remove anode bolt **(Figure 11)** and remove the anode.
2. To remove the trim tab anode, **(Figure 12)** remove the plastic cover from the top of gearcase and insert an Allen wrench in the opening and turn it counterclockwise to remove the trim tab.
3. Remove the two bolts holding the anode to the stem bracket **(Figure** 13) and remove anode.
4. Clean all corrosion or contaminants from the anode surfaces using a wire brush.
5. Inspect the anode for deep pitting or cracks.
6. Replace the anode if deep pitting is noted or if 1/3 or more of the anode has conoded away.
7. Clean all corrosion or contaminants from the anode mounting surface.
8. Installation is the reverse of removal. Note the following:
   a. To maintain corrosion protection, do not apply paint or protective coatings to the anode or mounting bolts.
   b. Tighten all anode mounting bolts and retainers to the specified torque.

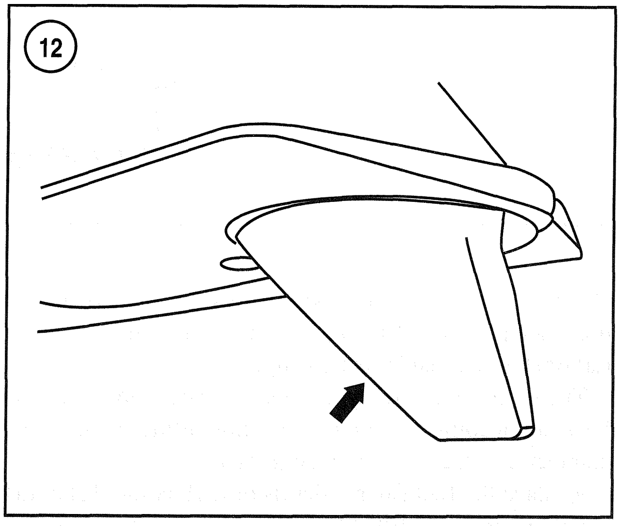
Hose and Clamp Inspection

1. Inspect all fuel and breather hoses and clamps at the intervals listed in **Table** 1.

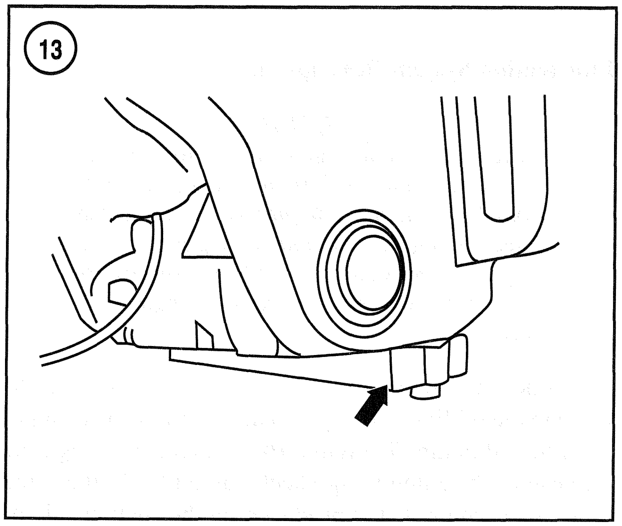
11

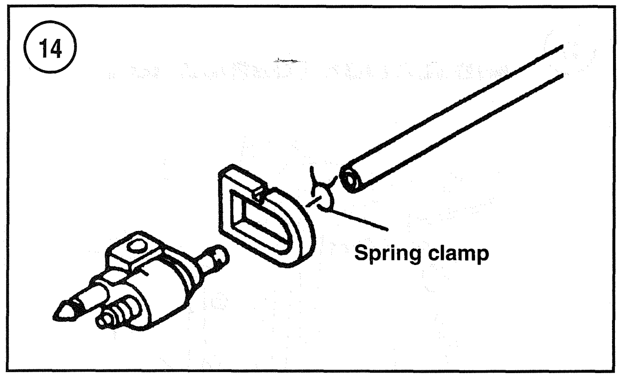


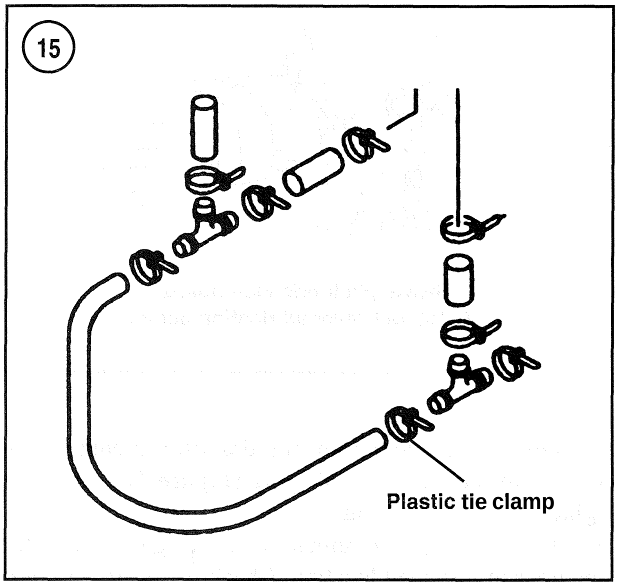
12

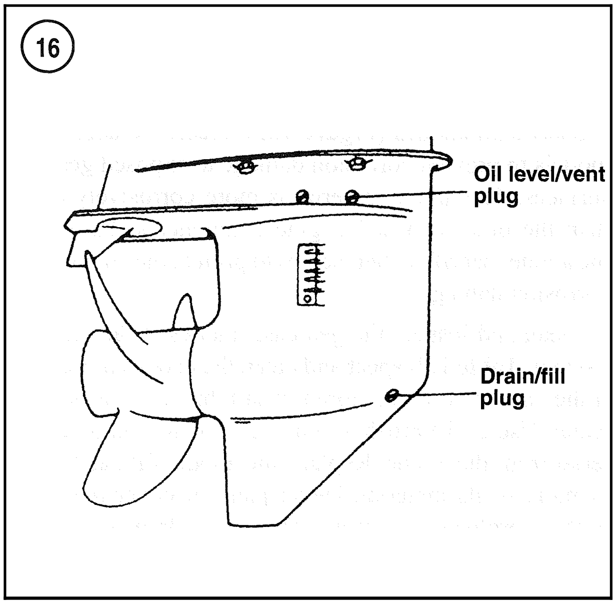


13









2. Carefully squeeze all hoses to check their flexibility. Inspect the entire length of all hoses. Note the presence of leakage, weathered, burned or cracked surfaces.
3. Replace fuel lines that are hard or brittle, are leaking or feel spongy.
4. Replace all fuel and breather hoses on the engine if defects are noted in any of them.
5. Inspect a spring clamp **(Figure** 14) for corrosion or damage. Remove and replace plastic tie clamps **(Figure 15)** if they are old or brittle.
6. Carefully tug on the fuel lines to ensure a tight fit at all connections. Check for loose plastic tie clamps or a faulty spring clamp if a fitting is loose. Replace any faulty clamp before operating the engine.

4

Thermostat Inspection

Inspect and/or replace the thermostat at the intervals listed in **Table 1.** Thermostat removal, inspection and installation are provided in Chapter Eight.

Gearcase Lubricant

CAUTION
Inspect the gaskets on all gearcase plugs. Replace missing or damaged gaskets to prevent water or lubricant from leaking.

NOTE
A small amount of very fine particles are usually present in the gear lubricant. The fine particles form during normal gearcase operation. Their presence does not necessarily indicate a problem. The presence of large particles, however, indicates a potential problem within the gear-case.

Use SAE 80-90 gear lubricant with the API classification GL5 in the gearcase. Refer to **Table 2** for approximate gearcase capacities.

Check the gearcase lubricant level and condition at the intervals listed in **Table 1.** Some models have two oil level/vent plugs. Refer to Chapter Nine to identify the plug location.

1. Position the engine in the upright position for at least an hour before checking the lubricant.
2. Position a suitable container under the gearcase. Slowly remove the drain/fill plug **(Figure 16)** and allow a small sample (a teaspoon or less) of fluid to drain from the gearcase. Quickly replace the drain/fill plug and tighten it securely. Refer to Chapter Three if water or a milky appearance is noted in the fluid sample.

3. Rub a small amount of the fluid sample between your finger and thumb. Refer to Chapter Three if the lubricant is gritty or contains metal particles.
4. Remove the level/vent plug(s) (Figure 16). The lubricant level should be even with the bottom of the threaded level/vent plug opening.
5. Perform the following if the lubricant level is low:
   a. Remove the lubricant draidfill plug, then quickly install the lubricant pump hose or tube into the opening.
   b. Add lubricant into the drainlfill plug opening (Figure 16) until fluid flows from the level/vent plug(s) (Figure 16).
   c. A leak is likely if over an ounce of lubricant is required to fill the gearcase. Pressure test the unit as described in Chapter Three.
   d. Install the level/vent plug(s) then tighten it securely.
   e. Remove the lubricant pump hose or tube, then very quickly install the lubricant drainlfill plug.
6. Tighten the lubricant drainlfill and level/vent plugs securely.
7. Allow the gearcase to remain undisturbed in a shaded area for 1 hour then recheck the lubricant level. Top off the lubricant as necessary.

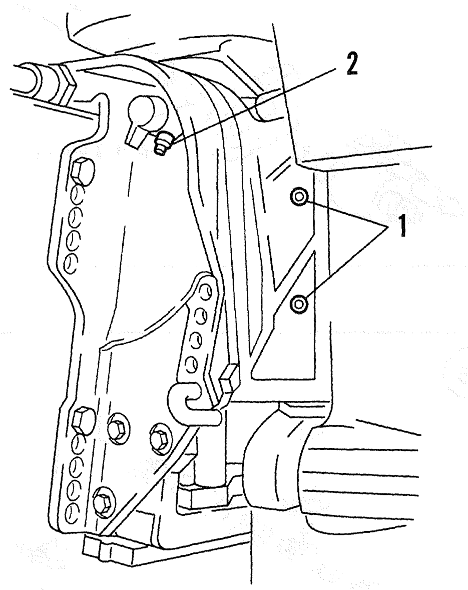
Changing the Gearcase Lubricant

Change the gearcase lubricant at the intervals listed in Table 1. Table 2 lists the approximate gearcase lubricant capacity. Refer to the information provided in Chapter Nine to identify the gearcase. Refer to the exploded views in Chapter Nine to locate the plugs.

Some models have two level/vent plugs. On these models, remove both plugs during gearcase draining and filling.

1. Place a suitable container under the gearcase. Remove the drain/fill plug from the gearcase (Figure 16). Remove the level/vent plug(s).
2. Take a small sample of the geascase lubricant and inspect as described under *Gearcase Lubricant* (in this chapter).
3. Allow the gearcase to drain completely. Tilt the engine so the drain/fill opening is at its lowest point to ensure the gearcase drains completely. After draining, place the engine in the upright position.
4. Use a pump-type dispenser or squeeze tube to *slowly* pump gearcase lubricant into the drain plug opening (Figure **16).** Continue to fill the gearcase until lubricant flows out the levellvent plug(s) opening (Figure 16). Without removing the pump or tube from the drainlfill opening, install the level/vent plug(s). Securely tighten the level plug(s).

17 **MIDSECTION LUBRICATION**



1. Swivel pin lubrication points
2. Tilt lock lever lubrication points

5. Remove the pump from the drain/fill opening, then quickly install the drainlfill plug (Figure 16). Securely tighten the drainlfill plug.
6. Allow the engine to remain in the upright position for one hour in a shaded location. Check the gearcase lubricant level again and top it off if necessary.

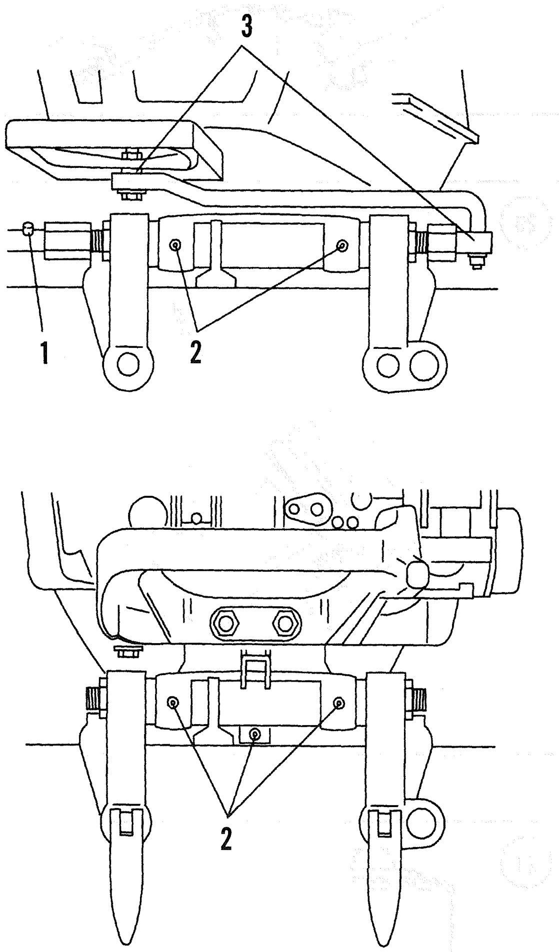
Gearcase Anode Inspection

Sacrificial anodes (Figure 13, typical) are used on all models to prevent corrosion damage to exposed gearcase surfaces. The anode material is more corrosively active than the other exposed engine components. Essentially the anodes sacrifice themselves to protect the engine from corrosion damage.

Clean and inspect the gearcase anodes at the intervals listed in **Table 1.** Inspect and clean the anodes more often if the engine is run or stored in salt, brackish or polluted water. Use a stiff brush to remove deposits and other material from the anode. Replace the anode if it has lost 1/3 or more of its material. Never paint or cover the anode with a protective coating. Doing so dramatically decreases its ability to protect the engine. Clean all debris or contaminants from the mounting area before installing a

18

TILT TUBE AND STEERING LUBRICATION LOCATIONS



1. Steering cable lubrication point
2. Tilt tube lubrication points
3. Steering arm pivoting lubrication points

new anode. The anode must contact a bare metal surface to ensure a proper connection.

Inspect the anode mounting area if corrosion is noted on engine components but the anode is not experiencing corrosion. It is likely that corrosion or contamination is preventing the anode from adequately contacting the mounting surface. Clean the area thoroughly if this condition is noted.

Water Pump Inspection

Inspect the water pump impeller at the intervals listed in **Table 1.** Inspecting the water pump impeller and related components helps ensure reliable cooling system operation. Water pump impeller inspection is covered in Chapter Nine.

Propeller Shaft

Lubricate and inspect the propeller shaft at the interval listed in **Table 1.**

1. Remove the propeller as described in Chapter Nine.
2. Watch the propeller shaft for wobbling while spinning the propeller shaft. Replace the propeller shaft if any wobbling is detected. Propeller shaft replacement is covered in Chapter Nine.
3. Using a solvent and a shop towel, clean the propeller shaft splines, threads and tapered section.
4. Inspect the propeller nut, thrust masher and spacers for wear, cracks or damage.
5. Apply a generous coat of water-resistant grease to the splines of the propeller shaft.
6. Install the propeller as described in Chapter Nine.

Swivel and Tilt Tube Lubrication

CAUTION

The steering cable must be retracted before pumping grease into the fitting. The cable can become hydraulically locked if grease is injected with the cable extended.

Lubricate the swivel and tilt tube pivot points at the intervals listed in **Table 1.** Using a grease pump, pump water-resistant grease into all fittings on the swivel tube **(Figure 17)** and tilt tube **(Figure 18).** Continue to pump until the old grease is expelled from between the pivot points.

Steering System Inspeetion

Some steering cables are provided with a grease fitting. Regular lubrication of the steering cable and linkage dramatically increases their service life. Pump water-resistant grease into the grease fitting until a slight resistance is felt. Avoid overfilling the steering cable with grease. Apply grease to the sliding surfaces and pivot points of all steering linkage and pivot points. Cycle the steering full port and full starboard several times to distribute the lubricant.

WARNING
Always wear suitable eye protection, gloves and protective clothing when working around the trim system. The fluid in the trim system may be under high pressure. Loosen all valves and reservoir plugs slowly to allow any internal pressure to slowly subside.

Trim System Fluid Level

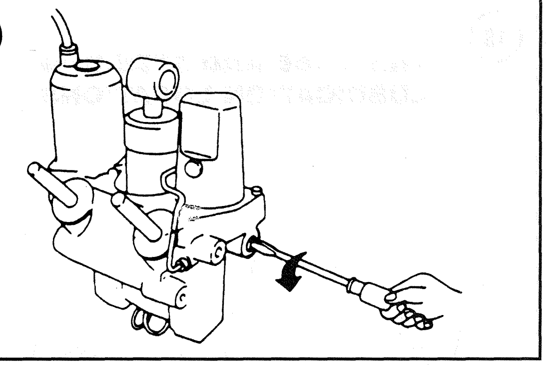
Check and correct the trim fluid level at the intervals specified in **Table 1** or if a trim system malfunction is evident.

Use Nisseki Power Torque Fluid or Dextron II automatic transmission fluid (ATF) in the power trim/tilt system.

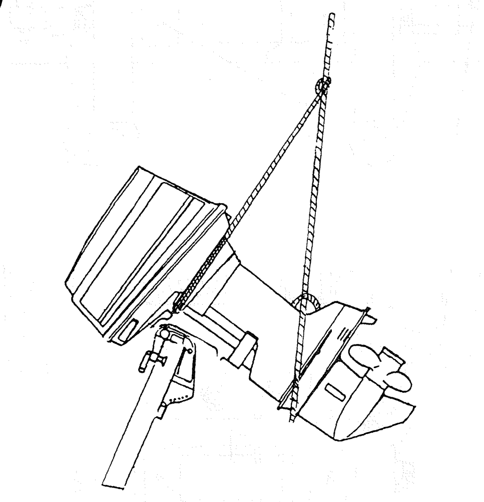
It is necessary to access the manual relief valve **(Figure** 19, typical) when checking the fluid level. The manual relief valve opening is located on the starboard clamp bracket on all models. Use a large screwdriver to prevent damaging the valve. Secure the engine in the full-tilt position to access the trim system fill plug. Secure using an adequate overhead lift **(Figure** 20) or wooden blocks to support the engine while checking and filling the fluid level. Do not rely solely on the tilt lock mechanism to support the engine. Two different types of systems are used on these models. On either type, the trim system fill cap **(Figure** 21) is located on the front side of the pump portion of the trim system. The fluid in the reservoir may be under pressure. Always remove the reservoir plug slowly and allow the pressure to gradually subside.

1. Operate the trim/tilt system or open the manual relief valve and move the engine to the fully up position. Securely tighten the manual relief valve.
2. Secure the engine in position with overhead cables or wooden blocks **(Figure** 20). Use compressed air to clean all debris from the fill cap **(Figure** 21) area. Place a suitable container under the trim system to capture any spilled fluid.
3. Slowly remove the fill cap from the trim system pump or reservoir.
4. Clean all debris from the cap-mounting surface. Take all steps necessary to prevent debris from entering the fluid reservoir.

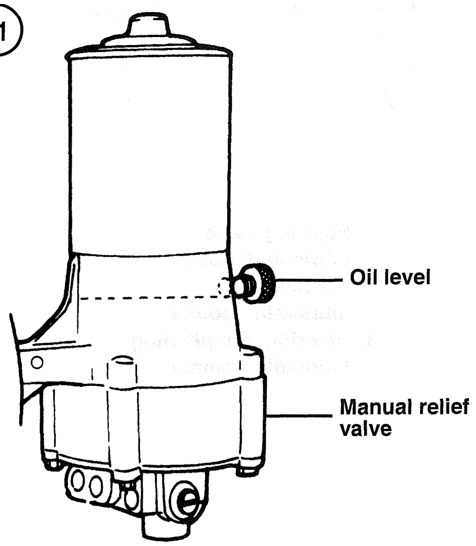
19



20

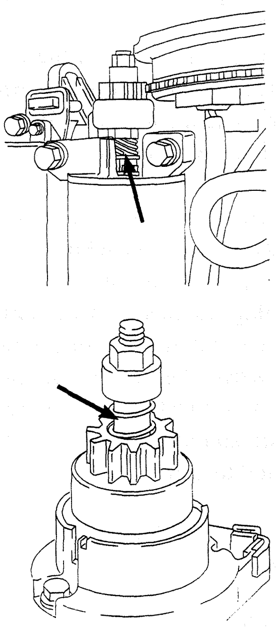


21

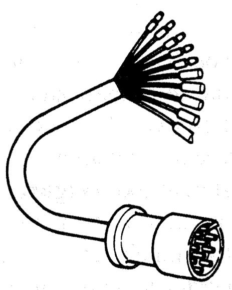


22

STARTER DRIVE
LUBRICATION



23



5. The fluid level should be even with the bottom of the fill cap hole.
6. Add fluid until it is even with the bottom of the fill cap opening **(Figure** 21). Clean the fill cap and carefully thread it onto the reservoir. Securely tighten the fill cap.
7. Maintain the up position for a minimum of five minutes. Remove the overhead cable or supporting block and run the trim motor to lower the engine to fully down position. Maintain this position for a minimum of five minutes. Run the trim system to the fully up position. Engage the tilt stop and check the oil level, adding oil ifnecessary. Maintain the up position for a minimum of five minutes.

Repeat Steps 6 and 7 for at least five cycles to bleed the air from the system.

Starter Motor Maintenance

Clean the electrical terminals and apply water-resistant grease to the starter drive **(Figure 22).** Apply only a light coat of grease to the pinion shaft of the starter motor. Excessive grease may attract dirt, leading to electric starter motor malfunction. Refer to Chapter Seven if electric starter motor removal or disassembly is necessary to access the pinion shaft.

Wiring Inspection

Periodically inspect the main harness connector **(Figure 23)** for corroded or loose pin connections. Carefully scrape corrosion from the contacts. Apply a light coat of water-resistant marine grease to the main harness plug and terminals to seal out moisture and prevent corrosion. Inspect the entire length of all wires and harnesses for worn, burnt, damaged or bare insulation. Repair or replace the wire harness as required.

Battery Inspection

The cranking battery requires more maintenance than any other engine component. Unlike automobiles, boats may sit for weeks without running. Without proper maintenance, the battery will lose its charge and deteriorate. Marine engines are exposed to a great deal more moisture than automobiles, resulting in more corrosion on the battery terminals. Clean the terminals and charge the battery at no more than 30-day intervals. Refer to Chapter Seven for complete battery testing, maintenance and charging instructions.

Throttle and Shift Linkage

Apply all-purpose grease to all pivot points of the throttle and shift linkage at the intervals listed in **Table 1.** This is important to help prevent corrosion and to ensure smooth operation of the throttle and shift mechanisms. Refer to Chapter Five and Chapter Six to determine the location of the shift and throttle linkage. A small amount of grease is all that is required; use just enough to lubricate the connector or pivot point.

TUNE-UP

A complete tune-up involves a series of adjustments, tests, inspection and parts replacement to return the engine to original factory condition. Only a complete tune-up delivers the expected performance, economy and durability. Perform all operations listed in this section for a complete engine tune up.

1. Compression test.
2. Replace spark plugs.
3. Carburetor adjustment.
4. Checking the ignition timing.
5. Water test.

Compression Test

No tune-up is complete without a compression test. An engine with weak compression on one or more cylinder(s) simply cannot be properly tuned. Perform a compression test before replacing any components or performing any adjustments. Correct the causes of low compression before proceeding with the tune up. Compression testing is covered in Chapter Three.

Spark Plug Replacement

Spark plug inspection or replacement is the most important part of a complete tune-up. Spark plugs are repeatedly subjected to very high heat and pressure and exposure to the corrosive by-products of combustion.

All the outboard models use breakerless ignition systems except the 2.5A and 3.5A hp models. These two models use breaker contacts and condenser. The breakerless ignition systems produce higher energy than conventional breaker point systems. A benefit of the higher energy systems is a longer spark plug life and less chance of spark plug fouling. Nevertheless, spark plugs operate in a harsh environment and eventually require replacement.

Replacement spark plugs must be of the correct size, reach and heat range to operate properly in the engine. Refer to the spark plug specifications in Table 4.

1. Inspecting the spark plug can reveal much about the engine condition. Inspection provides the opportunity to correct problems before expensive engine damage occurs. Remove the spark plug(s) and compare them to the ones shown in Figure 24.
2. Mark the cylinder number on the spark plug leads before removing them from the spark plugs. Use compressed air to blow debris from around the spark plugs *before* removing them. If the plug is corroded at the threads, apply penetrating oil to the threads and allow it to soak.
3. Remove the spark plugs using a suitable spark plug socket. Arrange the spark plugs in the order of the cylinder in which removed.
4. Inspect the spark plug holes in the cylinder head. If necessary, clean the plug holes using a special spark plug tap to remove carbon and corrosion. Blow the holes clean using compressed air. Avoid blowing debris into the cylinder.
5. Repair damaged spark plug threads using a threaded insert. The inserts are available in kit form and contain the necessary thread tap, installation tool and instructions.
6. Compare the plugs to those shown in Figure 24. Spark plugs can give a clear indication of problems within the engine, sometimes even before the symptoms occur. Additional inspection and testing may be required if spark plug conditions are abnormal. Refer to Chapter Three for troubleshooting and testing.

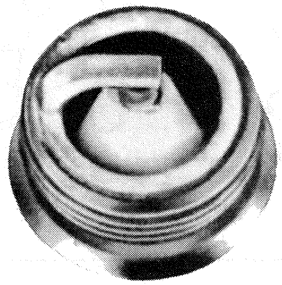
NOTE
Use only resistor-type plugs on all niodels. Using non-resistor spark plugs can cause electrical interference that can affect the operation of the engine control unit. Look for tlze R *mark on the side of the spark plug insulator to verify resistor-type plugs.*

7. If the spark plugs must be reused, clean them using a wire brush and solvent to dissolve the deposits. Special spark plug cleaning devices are available that use a forced abrasive blast, similar to a small sand blaster, to remove stubborn deposits. Remove all debris from the plug using compressed air before reinstallation.
8. Use a gap adjustment tool (Figures 25-27) to adjust the spark plug gap to the specification in Table 4. Never tap the plug against a hard object to close the gap. The ceramic insulator can crack and possibly break away.
   a. Refer to Table 4 to determine the correct spark plug gap.
   b. Check the gap using a feeler or wire gauge (Figure 27) of the same thickness as the specified gap (Figure 28). The gauge should pass between the electrodes with a slight drag.
   c. Inspect the gap for parallel electrode surfaces (Figure 28). Carefully bend the electrode until the surfaces are parallel and the gap is correct.

NOTE
Some sparkplug brands require that the terminal end be installedprior to installation. Thread the terminal onto the spark plug(s) ***(Figure** 29).*

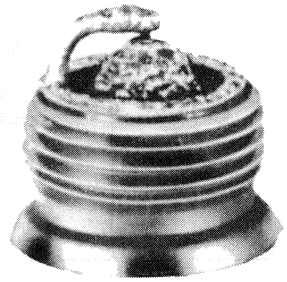
24

SPARK PLUG CONDITION



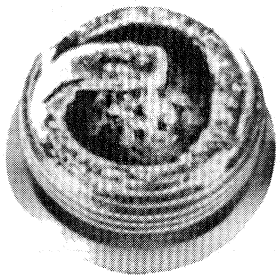
NORMAL

- Identified by light tan or gray deposits on the firing tip.
- Can be cleaned.



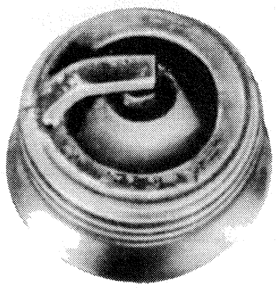
CAP BRIDGED

- Identified by deposit buildup closing gap between electrodes.
- Caused by oil or carbon fouling. If deposits are not excessive, the plug can be cleaned.



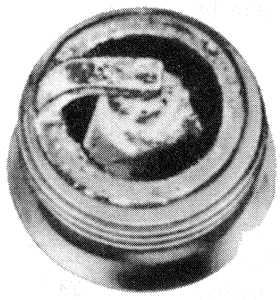
OIL FOULED

- Identified by wet black deposits on the insulator shell bore and electrodes.
- Caused by excessive oil entering combustion chamber through worn rings and pistons, excessive clearance between valve guides and stems or worn or loose bearings. Can be cleaned. If engine is not repaired, use a hotter plug.



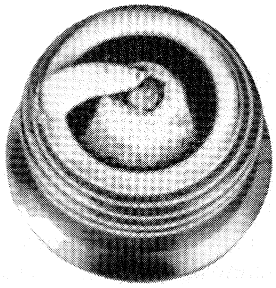
CARBON FOULED

- Identified by black, dry fluffy carbon deposits on insulator tips, exposed shell surfaces and electrodes.
- Caused by too cold a plug, weak ignition, dirty air cleaner, too rich fuel mixture or excessive idling. **Can be cleaned.**



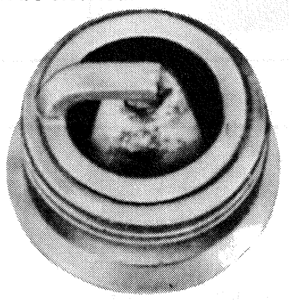
LEAD FOULED

- Identified by dark gray, black, yellow or tan deposits or a fused glazed coating on the insulator tip. Caused by highly leaded gasoline. Can be cleaned.



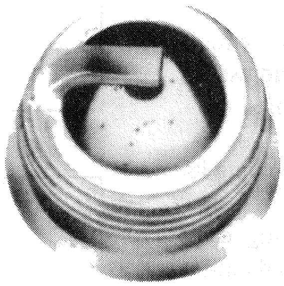
WORN

- Identified by severely eroded or worn electrodes
Caused by normal wear.
Should be replaced.



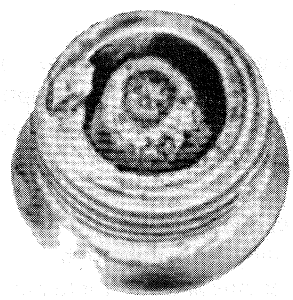
FUSED SPOT DEPOSIT

- **Identified by melted or spotty** deposits resembling bubbles or blisters.
- **Caused by sudden acceleration.** Can be cleaned.



OVERHEATING

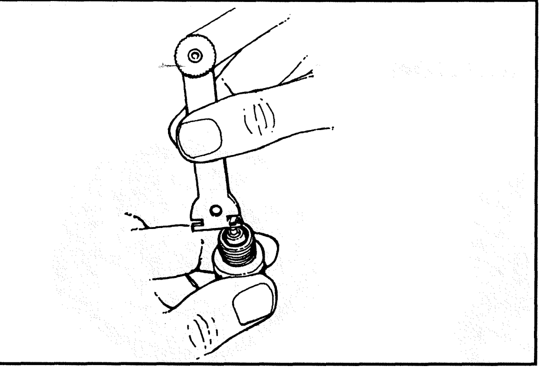
- Identified by a white or light gray insulator with small black or gray **brown spots** with **bluish-burnt appearance of electrodes.**
- Caused by engine overheating, wrong **type of fuel, loose spark plugs, too hot** a plug or incorrect ignition timing. Replace the plug.



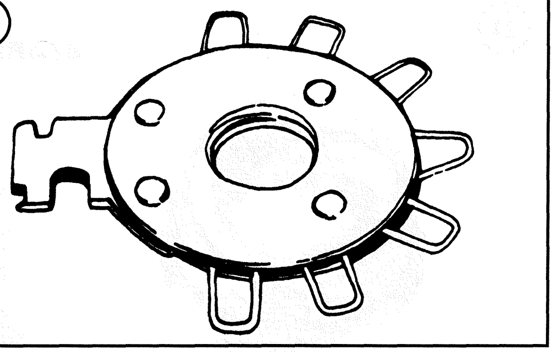
PREIGNITION

- Identified by melted electrodes and possibly blistered insulator. Metallic deposits on insulator indicate engine damage.
- Caused by wrong type of fuel, incorrect ignition timing or advance, too hot a plug, burned valves or engine overheating. Replace the plug.

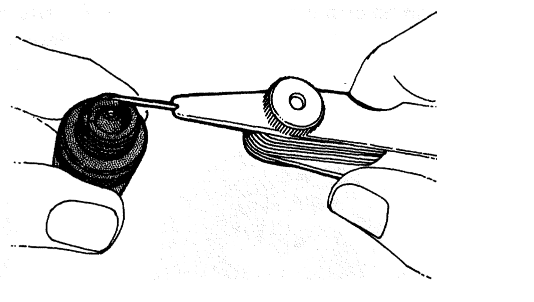
25



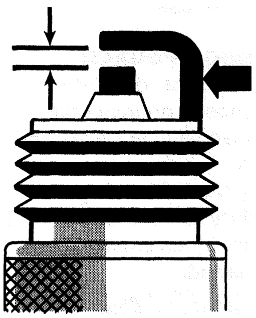
26



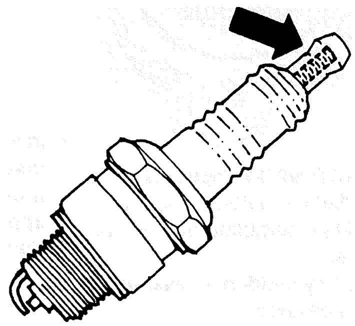
27



28



29



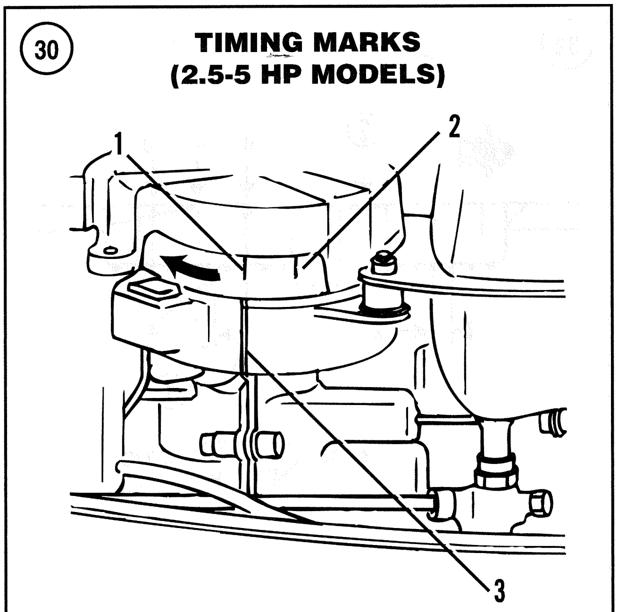
9. Apply a light coat of oil to the spark plug threads and thread them by hand. Use a torque wrench to tighten the spark plugs to the specification in Chapter Seven.
10. Apply a light coat of silicone lubricant to the inner surface of the spark plug cap. Carefully slide the cap over the spark plug. Ensure the spark plug connector is routed to the correct spark plug. Snap the connector fully onto the spark plug.

Carburetor Adjustment

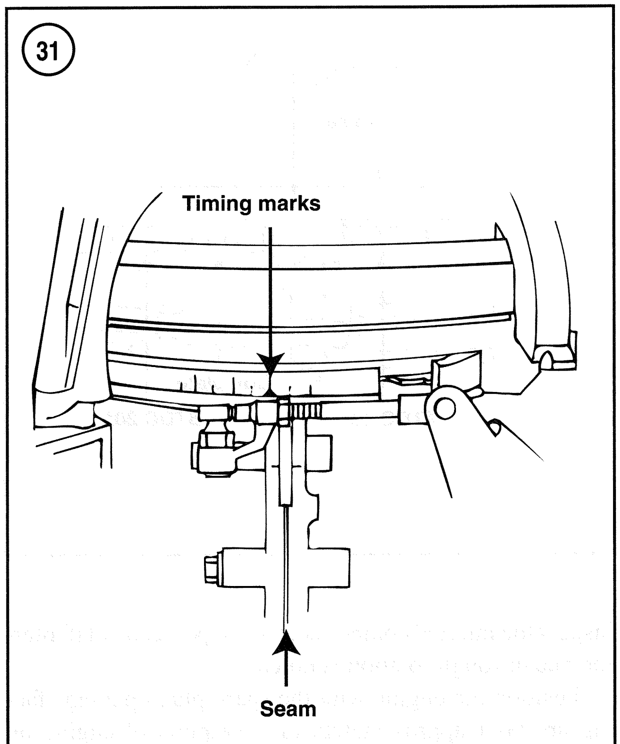
Proper carburetor adjustment is essential for smooth and efficient running. Carburetor adjustment includes carburetor synchronization with the ignition system, mixture adjustment, and idle speed adjustment. Some models also require pilot screw adjustment. To ensure correct operation, perform all applicable carburetor adjustments. Carburetor adjustment is covered in Chapter Five.

Ignition Timing

This section covers checking the timing control circuit of the ignition system. Refer to Chapter Five to adjust the ignition timing. Timing adjustment is not required on 8 and 9.8 hp models.
1. Connect a shop tachometer to the engine following its manufacturer's instructions.
2. Connect the timing light to the No. 1 spark plug lead.
3. Start the engine and allow it to run at idle speed until it reaches normal operating temperatures.
4. Locate the timing pointer, marks or window,
   a. On 2.5-5 hp models, the timing marks are cast into the flywheel **(Figure 30)** on the top side. The timing reference mark is located on the mating surface of the crankcase halves.
   b. On 9.9-40 hp two cylinder models, the timing marks are located on the side of the coil plate **(Figure 31)**



1. Full lead angle marking
2. Top marking
3. Crankcase matching surface



which must align with the seam (Figure 31) of the mating surface of the crankcase halves.

c. On 40-90 hp models, align the flat surface of crankcase mold boss (1, Figure **32)** with the correct calibration of the set ring (2).

d. On 115-140 hp models, the timing pointer is located on the timer base (Figure 33) on the starboard side where the crankcase halves mate. The timing reference marks are located on the coil plate.

5. Refer to Chapter Five for timing adjustment. Direct the timing light at the timing pointer, window or timing mark while an assistant operates the engine at the specified speed. Record the timing mark that aligns with the pointer or reference mark.
6. Compare the ignition timing with the specification listed in Chapter Five. If incorrect timing is indicated, a CDI unit or other ignition system component is faulty.
7. Test the ignition system as described in Chapter Three.

4

Water **Test**

Test-run the outboard before completing a tune-up. Operate the engine on a flush/test device or in a test tank to ensure correct starting and idling prior to running on the water.

1. Connect a shop tachometer to the engine. Follow the manufacturer's instructions when attaching the tachometer to the engine.
2. Note the idle speed as an assistant operates the boat. Refer to Chapter Five for instructions, then adjust the idle speed.
3. Note the tachometer reading as the assistant operates the engine at full speed. Perform this test with the average load in the boat. Operate the trim/tilt system (if so equipped) to reach the correct trim position. Record the maximum engine speed, then refer to Chapter Three to determine the correct engine operating range. Check the propeller for damage or incorrect pitch if the measured engine speed is below or above the recommended speed range. Refer to Chapter Three if the correct propeller for the application is installed but the engine fails to reach the recommended engine speed range. The engine may have a problem that is limiting its power output.
4. Check all fuel system, ignition system and timing adjustments.
5. Try a rapid acceleration and run the engine at various speeds. Refer to Chapter Three if rough operation is noted at any speed range or if the engine hesitates or stalls during rapid acceleration.

SUBMERSION

If the engine has been completely submerged, three questions must be asked. Was the engine running when the submersion occurred? Was the engine submerged in salt, brackish or polluted water? How long has the engine been retrieved from the water?

Complete disassembly and inspection of the power head is required if the engine was submerged while running. Internal damage to the power head (bent connecting rod) is likely if this occurs. Refer to Chapter Eight for power head disassembly and assembly.

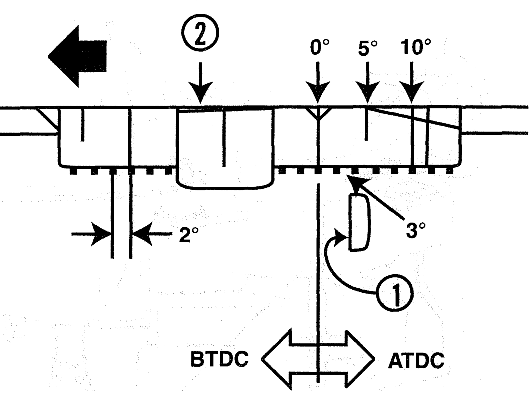
If submerged in saltwater or polluted or brackish water, the wiring harness and connectors are usually damaged quickly by intense corrosion. It is difficult to remove all traces of salt from the harness connectors. Replace the wiring harness and thoroughly clean all electric components to ensure a reliable repair. The starter motor, relays and switch will fail if not thoroughly cleaned of all salt.

Retrieve and service the engine as soon as possible. Vigorously wash the engine with fresh water after retrieval. Complete power head disassembly and inspection is required if sand, silt or other gritty material is found within the engine cover. Refer to Chapter Eight for power head disassembly and assembly.

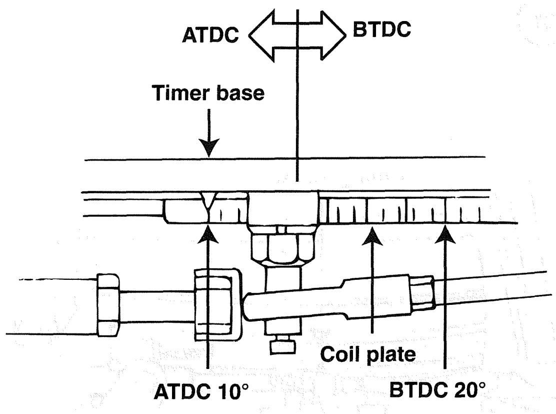
Service the engine quickly to ensure that it can be started within two hours of retrieval. Clean the engine thoroughly and submerge it in a barrel or tank of clean, fresh water if the engine cannot be serviced within this two-hour time frame. This is especially important if the engine was submerged in salt, brackish or polluted water. This protective submersion prevents exposure to air and decreases the potential for corrosion. This will not preserve the engine indefinitely. Service the engine within a few days after beginning protective submersion.

1. Remove the engine cover and vigorously wash all material from the engine with fresh water. Completely disassemble and inspect the power head internal components if sand, silt or gritty material is present inside the engine cover.
2. Dry the engine exterior with compressed air. Remove the spark plugs and ground the leads. Remove the propeller as described in Chapter Nine.
3. Drain all water and fuel from the fuel system. Remove any water from the carburetor cover. Replace all fuel filters on the engine.
4. Drain the oil from the oil tank. Position the engine so the spark plug openings face down.
5. Slowly rotate the flywheel clockwise (as viewed from the flywheel end) using the recoil starter or manually on electric start models to force the water from the cylinder(~)Rotate the flywheel several times, noting whether the engine is turning freely. Completely disassemble and

32



33



inspect the internal components of the power head if interference or rough rotation is noted.
6. Position the engine with the spark plug openings facing up. Pour approximately one teaspoon of engine oil into each spark plug opening. Repeat Step 5 to distribute the oil in the cylinder.
7. Note all wire connections and routing. Disconnect all electrical connections and inspect the terminals. Dry all

exterior surfaces and wire connectors with compressed air. Remove, disassemble and inspect the electric starter motor as described in Chapter Seven.
8. Replace the fuel filter, if so equipped, then fill the engine oil tank with fresh oil. Clean and install the spark plugs. Reconnect all wire harnesses and battery terminals.
9. Provide the engine with a fresh supply of fuel. Start the engine and run it at a low speed for a few minutes. Refer to Chapter Three for troubleshooting if the engine cannot be started. Stop the engine immediately and investigate if any unusual noises are detected. Allow the engine to run at low speed for a minimum of 30 minutes to dry any residual water from the engine. Promptly investigate any unusual noises or unusual running conditions.
10. On manual start models, disassemble, inspect, and then reassemble the manual starter.

STORAGE

When preparing the engine for long-term storage, the aim is to prevent any corrosion or deterioration during the storage period.

All major systems require some preparation before storage. If done correctly, the engine should operate properly after recommissioning.

Perform any maintenance that becomes due during the storage period. Maintenance requirements are listed in **Table 1.**
1. Remove the silencer cover from the carburetors as described in Chapter Six.
2. Run the engine at idle speed in a test tank or on a flushing adapter until the engine reaches operating temperature.
3. Raise the engine speed to approximately 1500 rpm. Spray storage-sealing agent into all carburetor openings. Try to spray the agent evenly into all carburetors on multiple carburetor engines. Spray in 5-10 second intervals. Continue to spray the agent into the engine until the exhaust smokes heavily. This indicates the agent has passed through the engine. Stop the engine at this point.
4. Remove the engine from the test tank or remove the flushing adapter. Remove each spark plug and spray the sealing agent into each spark plug hole. Crank the engine a few revolutions to distribute the sealing agent.
5. Drain each carburetor float bowl. Disconnect the fuel hose from the fuel tank and route it to a container suitable for holding fuel. Slowly pump the primer bulb to move the residual fuel from the fuel hoses. Install the drain plugs and securely tighten them. Disconnect the fuel hose from the engine. Treat any remaining fuel in the fuel tanks with fuel stabilizer.
6. Apply a light coat of engine oil to the spark plug threads and install them. Store the engine in the upright position. Check the speedometer opening at the leading edge of the gearcase and other water drains on the gearcase for the presence of debris. They must be clear to ensure that water is not trapped in the cooling system. Clean the opening with compressed air and a small piece of wire.
7. Inspect the water stream fitting on the lower engine cover for debris. Blow through the opening with compressed air to ensure it is clear. Remove stubborn debris with a small piece of stiff wire.
8. Disconnect the battery cables. Refer to Chapter Seven for battery storage instructions.

Recommissioning the Engine

Perform all required maintenance. Service the water pump and replace the impeller as described in Chapter Nine.

Correct all lubricant levels. Supply the engine with fresh fuel. Check for a flooded carburetor as described in Chapter Three. Flooding is common after extended storage.

Install the battery (on models so equipped) as instructed in Chapter Seven. Supply it with cooling water and then start the engine. Run the engine at low speed until it reaches operating temperature. Check for proper operation of the cooling, electrical and warning systems and correct any problems as required. Avoid continued operation if the engine is not operating properly. Refer to Chapter Three for troubleshooting and testing if problems are noted.

Corrosion Prevention

Corrosion is far more prevalent when the engine is operated in salty or heavily polluted water. Serious engine damage is certain if steps are not taken to protect the engine. A simple and effective way to reduce corrosion in the power head cooling passages is to always flush the cooling system after running the engine. Refer to ***After Each*** Use (in this chapter).

Using a corrosion preventative spray on the external engine components can substantially reduce corrosion damage to the engine wiring, terminals, exposed fasteners and other components. Regular use is highly recommended if the engine is operated in saltwater or polluted water. Corrosion preventative sprays are available from most marine dealerships or marine supply stores. Follow the instructions on the container for the proper use of these products.

Inspect all gearcase and power head anodes at more frequent intervals if the engine is operated in a corrosive environment. Special electronic equipment is available that uses current from the battery to balance or offset galvanic corrosion. Consider installing this type of system if the boat is stored in the water for extended periods of time.

Never charge the battery or connect the boat accessories to AC shore power. Engine components can corrode extremely rapidly under these circumstances. Disconnect the cables from the battery or remove the battery from the boat for charging.

Special isolators are available that allow battery charging or connections to shore power without promoting rapid corrosion. Contact a marine dealership or marine supply store for information on isolators.

Ensure all ground wires on the gearcase, midsection and power head are attached and making a good connection at their terminal. Failure to maintain secure ground connections prevent the sacrificial anodes from protecting the ungrounded components.

Table ▮ MAINTENANCE SCHEDULE

10 hours (two weeks)	**Inspect engine mounting bolts.**
	Inspect lower engine cover bolts.
	Inspect propeller nut.
	Inspect propeller shaft housing bolts.
	Inspect **gearcase** bolts.
	Inspect driveshaft-housing bolts.
	Inspect starter motor bolts (installation).
	Inspect flywheel nut.
	Inspect oil pump bolts.
	Inspect crankcase bolts.
	Inspect intake manifold bolts.
	Inspect exhaust cover bolts.
	Inspect carburetor-mounting bolts.
	Inspect cylinder head cover bolts.
	Inspect cylinder head bolts.
	Check spark plug gap; remove carbon deposits.
	Disassemble, clean and inspect fuel tank, fuel filters, fuel tank pick-up and fuel pump. Check for leakage.
	Check all electrical wires for looseness and damage.
	Check and adjust timing and carburetor linkage.
	Inspect choke and throttle linkage for loose or bent.
	Inspect and clean oil tank, hoses, and filter.
30 hours (1 month)	Inspect **gearcase** for oil level and add as required.
	Inspect **gearcase** for water or metallic matter in oil.
	Inspect and check the function of the warning system.
	Check and adjust timing and carburetor linkage.
	Inspect choke and throttle linkage for loose or bent.
50 hours (3 months)	Inspect engine mounting bolts.
	Inspect lower engine cover bolts.
	Inspect propeller nut.
	Inspect propeller shaft housing bolts.
	Inspect **gearcase** bolts.
	Inspect driveshaft-housing bolts.
	Inspect starter motor bolts (installation).
	Inspect flywheel nut.
	Inspect oil pump bolts.
	Inspect crankcase bolts.

(continued)

Table 1 MAINTENANCE SCHEDULE (continued)

50 hours (3 months) **(continued)**	Inspect intake manifold bolts. Inspect exhaust cover bolts. Inspect carburetor-mounting bolts. Inspect cylinder head cover bolts. Inspect cylinder head bolts. Check spark plug gap; remove carbon deposits. Disassemble, clean and inspect fuel tank, fuel filters, fuel tank pick-up and fuel pump. Check for leakage. Warm engine and check cylinder compression. Inspect water pump impeller for wear and or damage. Inspect the amount of erosion on the sacrificial anodes. Check for proper installation and condition of the **anode(s).** Change the **gearcase** lubricant. Lubricate the swivel and tilt tube pivot points. Check trim fluid level. Lubricate throttle and shift linkage.
100 hours (6 months)	Remove carburetors clean and inspect float valve. Clean and inspect all fuel hoses and hose connectors. Check all electrical wires for looseness and damage. Inspect and clean oil tank, hoses, and filter. Inspect and remove all deposits from the water pump and impeller, water pipe, exhaust cover, thermostat, exhaust pipe and engine base. Check manual operation of **trim/tilt** by opening manual relief valve and move engine up and down.
200 hours (1 year)	Clean powerhead by removing carbon deposits from cylinder head, pistons, rings, inner and outer exhaust cover. Replace water pump impeller.
400 hours (2 year)	Replace all fuel hoses. Replace oil mixing check valve and oil hoses.

Table 2 GEARCASE LUBRICANT CAPACITIES

Model	Capacity
2.5A-3.5A	90 **mL** (3.0 **oz.)**
3.5B	180 **mL** (6.1 **oz.)**
5	195 **mL** (6.6 **oz.)**
8-9.8	320 **mL** (10.8 **oz.)**
9.9-15-18	370 **mL** (12.5 **oz.)**
25-30	280 **mL** (9.5 **oz.)**
40	420 **mL** (14.2 **oz.)**
40-50	500 **mL** (17 **oz.)**
60B-70B	700 **mL** (24 **oz.)**
6OC-70C	900 **mL** (30 **oz.)**
80-90-115-120-140	900 **mL** (30 **oz.)**

Table 3 RECOMMENDED LUBRICANTS AND SEALANTS

Item name	Part number
Threadlocker	Loctite 242
Threadlocker	Loctite 243
Anaerobic gasket maker	Loctite 518
Gasket sealant	Permatex or high tack
Gasket dressing	Permatex, hylomar or aerosol high-temp
Silicone sealant	Permatex hi-temp RTV
Super bond adhesive	Permatex super glue gel
Cleaning pads	Scotch-brite, (abrasive)
Grease	Low-temperature lithium
All-purpose grease	Marine grease
Power trim/tilt fluid	Nisseki or GM approved ATF
Gear lubricant	API grade GL5, SAE 80-90
Engine lubricant	NMMA certified TC-W3
Battery spray protector	Permatex

Table 4 SPARK PLUG APPLICATION*

Model	Type
2.5-3.5	NGK BPR6HS-10
	Champion RL87YC10
5-9.8	NGK BPR7HS-10
	Champion RL82YC10
9.9-40	NGK BR7HS-10
	Champion RL82C10
50-140	NGK BR8HS-10
	Champion RL-78C

*Spark plug gap is 0.9-1.0 mm (0.035-0.039 in.).

Chapter Five

Synchronization and Adjustment

If the engine is to deliver its maximum efficiency and peak performance, the ignition must be correctly timed and the throttle operation synchronized with the ignition. The synchronization procedure should always be the final step of a tune-up. It must also be performed whenever the fuel or ignition systems are serviced or adjusted.

Table 1 lists the recommended test propellers. **Tables 2-7** provide relevant specifications. **Tables 1-7** are located at the end of this chapter.

FUEL SYSTEM

Pilot Screw Adjustment (40-140 hp)

1. Using a thin screwdriver, carefully turn the pilot screw clockwise until it is lightly seated. Do not use excessive force when seating the screw or else the screw and seat will be damaged. Use only enough effort to lightly seat the screw.
2. Back the screw out the number of turns specified in the appropriate table in Chapter Six.

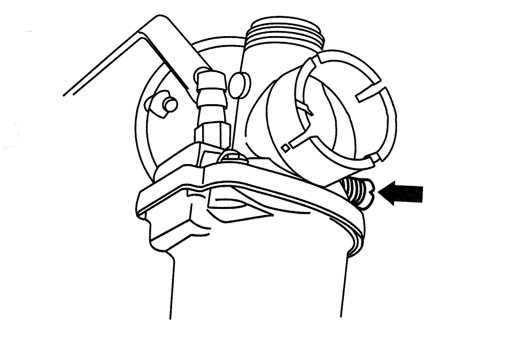
Idle Speed (2.5-30 hp and 40 hp Two-Cylinder Models)

On three- and four-cylinder models, the idle speed is set during carburetor synchronization.

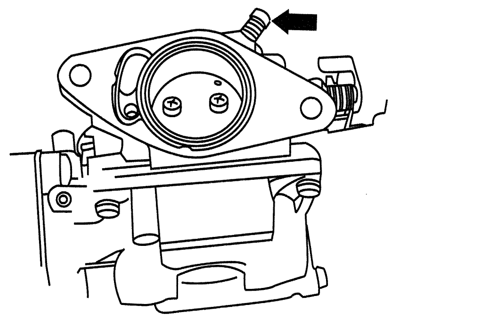
1. Install a shop tachometer to the engine following the instructions provided by the manufacturer. Start the engine and allow it to idle in neutral until it reaches normal operating temperature.
2. Refer to **Figure 1** (2.5-5 hp) or **Figure 2** (8-40 hp two-cylinder models) to identify the idle speed screw.

3. Refer to the appropriate table in Chapter Six for the correct idle speed.
4. Slowly turn the idle speed screw until the idle speed is in the midrange of the specification while running in NEUTRAL.
5. Shift the motor into FORWARD gear and note the idle speed. The idle speed should still be within the specification. Adjust the idle speed screw as required for the best idle performance while remaining within the specification.
6. Check the idle speed again after accelerating several times. Readjust the idle as necessary.

1



2

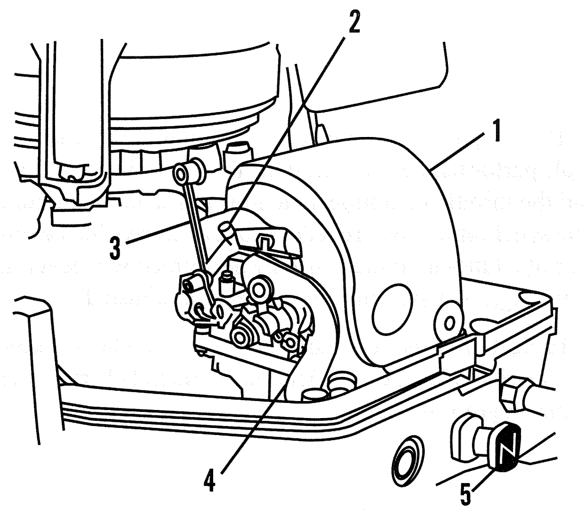


Choke Valve Adjustment (5-140 hp)

1. Push the choke knob (5, **Figure 3)** fully inward.
2. Disconnect the choke knob link rod (4, **Figure 3)** or choke solenoid plunger hook as required. Loosen the adjustment screw on the choke linkage and rotate the choke plate on the linkage until the choke plate is completely closed.
3. With choke valve closed, tighten the adjustment screw. Push the linkage back in to open the choke valve. Pull the choke linkage back out and see if the choke valve is closed. Install the choke linkage and reconnect the choke solenoid or choke knob. Observe the lever while pulling out on the choke knob. If the adjustment is correct, the choke lever should just contact the stop lever. Push in on the choke knob. Verify that the choke returns to the OFF position. Readjust as required.

3

CARBURETOR AND CHOKE LINKAGE (5-40 HP MODELS)



1. Air silencer
2. Idle adjustment screw
3. Throttle linkage
4. Choke linkage
5. Choke knob link rod

Carburetor Synchronization (8-140 hp)

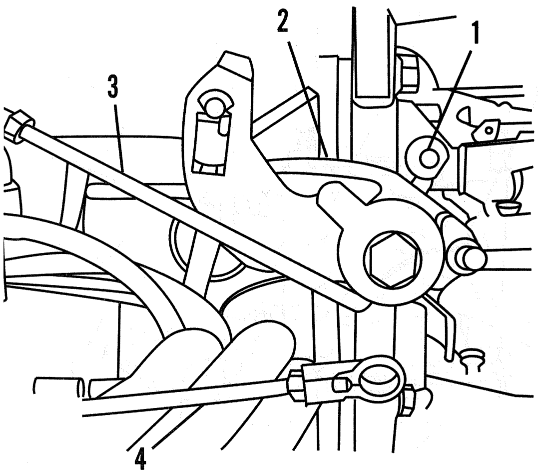
Carburetor synchronization is not required on models equipped with a single carburetor. This procedure is provided for all models equipped with multiple carburetors.

NOTE
The ignition timing must be properly adjusted before synchronizing the carburetors. Adjust the timing as described in this chapter.

1. Remove the air silencer cover.
2. Disconnect throttle link (4, **Figure** 4) and ignition timing link (3) so the throttle lever roller (1) does not contact the throttle cam (2).
3. Adjust each carburetor throttle link (1 and 2, **Figure** 5) to the length specified in **Table** 4.
4. Reconnect the timing link (3, **Figure** 4).
5. Loosen all throttle lever screws (1 and 2, **Figure 6).** The throttle valves should return to a fully closed position.
6. On the top carburetor (middle carburetor on *60* and *70* hp models) loosen throttle stop screw (1, **Figure 7)** so it

4

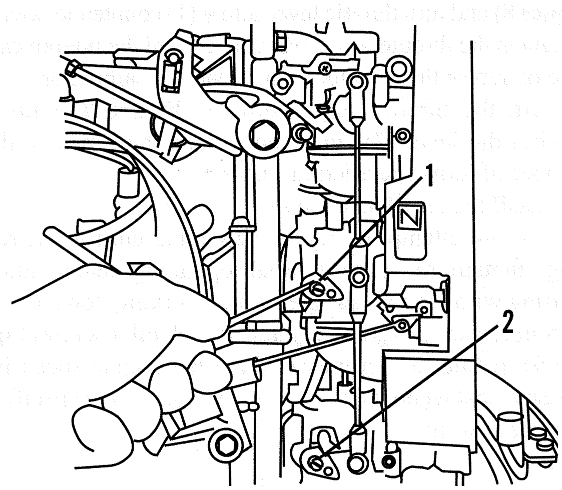
CARBURETOR LINKAGE ADJUSTMENT (40-140 HP MODELS)



1. Throttle lever roller
2. Throttle cam
3. Ignition timing link
4. Throttle link rod

6

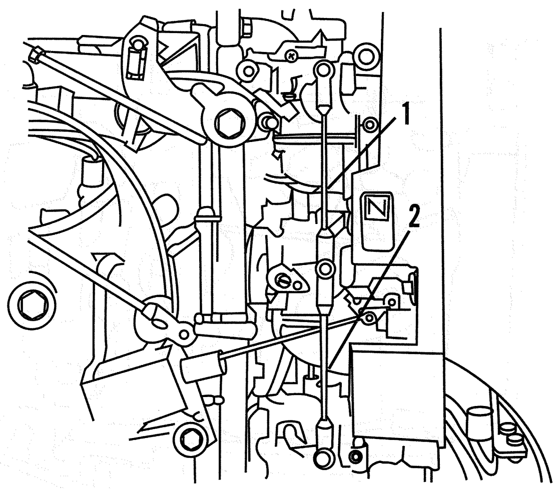
CARBURETOR LINKAGE ADJUSTMENT (40-140 HP MODELS)



1. Throttle lever screw
2. Throttle lever screw

5

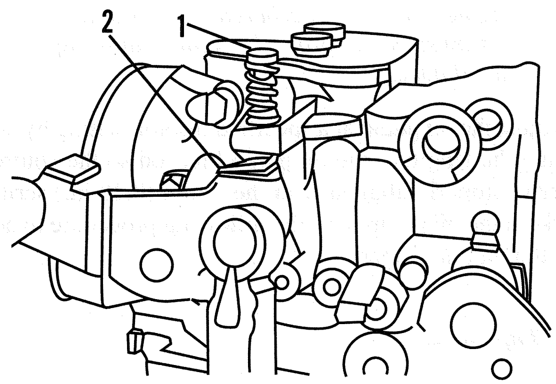
CARBURETOR LINKAGE ADJUSTMENT (40-140 HP MODELS)



1. Throttle link rod
2. Throttle link rod

7

CARBURETOR LINKAGE ADJUSTMENT (40-140 HP MODELS)



1. Throttle stop screw
2. Throttle lever

does not contact the throttle lever (2). The throttle valve should return to the fully closed position.

7. From the top of the engine, starting with the second carburetor, apply light upward pressure to the linkage tab (2, **Figure 8)** and turn throttle lever screw (1) counterclockwise to tighten the throttle lever. Working toward the bottom carburetor, repeat this step for each remaining carburetor.

8. Turn the throttle stop screw (1, **Figure 7)** until it touches the lever (2), and then tighten the screw to the number of turns specified in **Table 5.**

9. Install the air silencer cover.

10. Do not attempt to adjust the engine until it has run long enough to reach normal operating temperature. Starting with the top carburetor and working down to the bottom carburetor, gradually adjust each pilot screw **(Figure** 9) to find the setting at which the engine speed increases most when the pilot screw is opened the specified number of turns.

NOTE

For tlze following step, tlze boat must be free to move. It must be in the water under normal operating conditions with the correct propeller installed

11. With the engine running at normal operating temperature and an accurate tachometer installed, adjust the throttle stop screw to obtain the specified rpm at neutral (idle) and trolling speeds. Refer to **Table** 7.

Oil Pump Adjustment

NOTE

Engine timing and carburetor synchronization must be set properly before adjusting tlze oil pump.

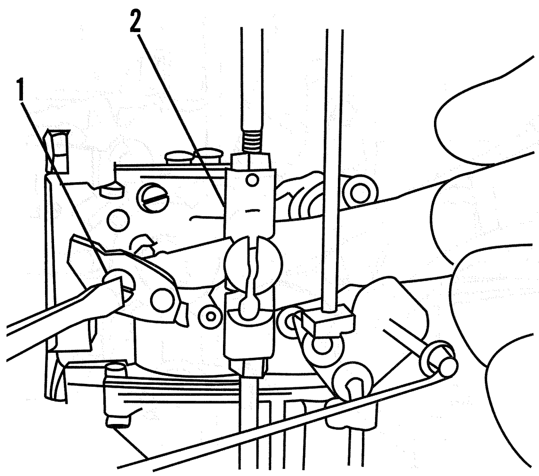
Adjust the oil pump at a specified throttle setting by adjusting the length of the oil pump link rod so the control lever is properly aligned with the 7 mm (0.28 in.) scribe mark on the oil pump. Use the following procedure to adjust the oil pump aperture.

40-50 hp models

1. Set the carburetor throttle to fully open.
2. Check the alignment of the indicator mark (3, **Figure** 10) on the control lever with the scribe mark (2) on the oil pump. The marks must align as shown in **Figure** 10. If not aligned, determine if the link rod (1) needs to be shortened or lengthened to align the marks.
3. Remove the link rod from the oil pump and make the length adjustment. Reinstall the link rod.

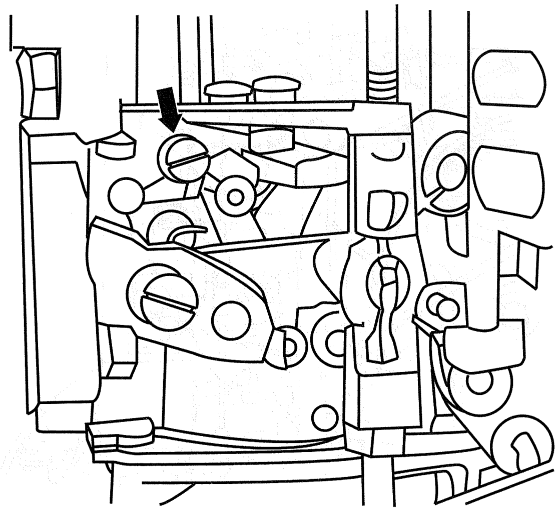
8

CARBURETOR LINKAGE ADJUSTMENT (40-140 HP MODELS)

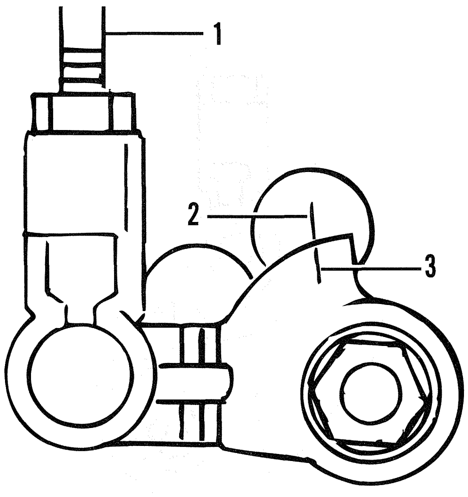


1. Throttle lever screw
2. Linkage tab

9

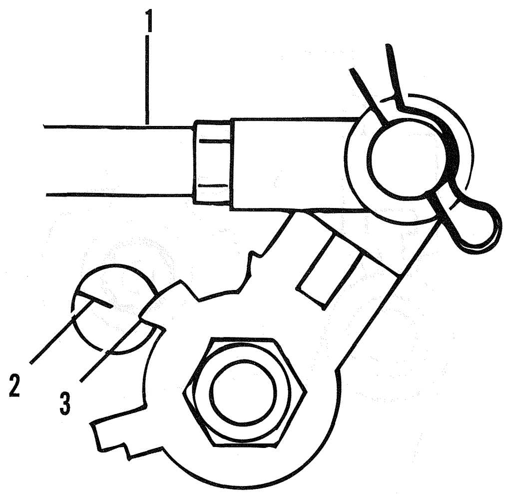


OIL PUMP APERTURE ADJUSTMENT (10)



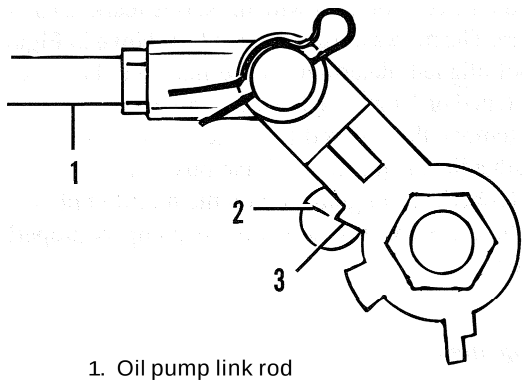
1. Oil pump link rod
2. Oil pump scribe mark
3. Control lever mark

OIL PUMP APERTURE ADJUSTMENT (60-70 HP MODELS) (11)



1. Oil pump link rod
2. Oil pump scribe mark
3. Control lever mark

OIL PUMP APERTURE ADJUSTMENT (70 HP MODELS) (12)



1. Oil pump link rod
2. Oil pump scribe mark
3. Control lever mark

4. Recheck the alignment with the throttle fully open.
5. Repeat Steps 1-4 until the oil pump aperture is properly adjusted.

60-70 hp models

1. Set the carburetor throttle to the fully closed position.
2. Check the alignment of the indicator mark (3, **Figure 11**) on the control lever with the scribe mark (2) on the oil pump. The marks must be aligned as shown in **Figure 11.** If not aligned, determine if the link rod (1) needs to be shortened or lengthened to align the marks.
3. Remove the link rod from the oil pump and make the length adjustment. Reinstall the link rod.
4. Recheck the alignment with the throttle fully closed.
5. Repeat Steps 1-4 until the oil pump is properly adjusted.

70 hp models

1. Set the carburetor throttle to fully open.
2. Check the alignment of the indicator mark (3, **Figure** 12) on the control lever with the scribe mark (2) on the oil pump. The marks must be aligned as shown in **Figure** 12. If not aligned, determine if the link rod (1) needs to be shortened or lengthened to align the marks.
3. Remove the link rod from the oil pump and make the length adjustment. Reinstall the link rod.
4. Recheck the alignment with the throttle fully open.
5. Repeat Steps 1-4 until the oil pump is properly adjusted.

90-140 hp models

1. Set the carburetor throttle to fully closed.
2. Check the alignment of the indicator mark **(3, Figure 13)** on the control lever with the scribe mark **(2)** on the oil pump. The marks must be aligned as shown in **Figure 13.** If not aligned, determine if the link rod **(1)** needs to be shortened or lengthened to align the marks.
3. Remove the link rod from the oil pump and make the length adjustment. Reinstall the link rod.
4. Recheck the alignment with the throttle fully closed.
5. Repeat Steps **1-4** until the oil pump is properly adjusted.

90 hp models

1. Set the carburetor throttle to fully open.
2. Check the alignment of the indicator mark (3, **Figure 14)** on the control lever with the scribe mark **(2)** on the oil pump. The marks must be aligned as shown in **Figure 14.** If not aligned, determine if the link rod **(1)** needs to be shortened or lengthened to align the marks.
3. Remove the link rod from the oil pump and make the length adjustment. Reinstall the link rod.
4. Recheck the alignment with the throttle fully open.
5. Repeat Steps 1-4 until the oil pump is properly adjusted.

IGNITION TIMING

WARNING
To prevent accidental starting, always disconnect the spark plug leads from the spark plugs prior to performing this procedure.

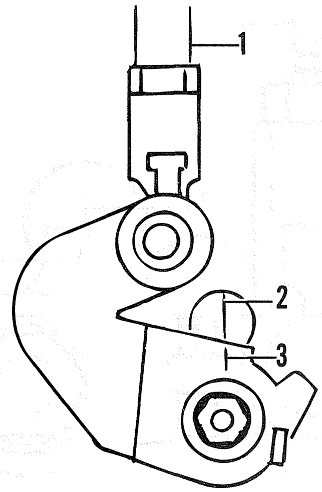
Prior to adjusting the ignition timing, adjust the throttle cable/linkage as described in this chapter. Set the ignition timing by adjusting the length of the linkage **(Figure 15).**

Ignition Timing Adjustment (2.5 and 3.5 hp Models)

1. Remove the spark plug and install a dial indicator **(Figure 16)** into the spark plug hole.
2. Rotate the flywheel in the normal direction of rotation and position the piston at TDC.
3. With the piston at TDC, the TDC mark on the flywheel should align with the cylinder block-to-crankcase cover mating surfaces.
4. If the timing mark and the mating surfaces do not align:
   a. The dial indicator is installed improperly.

13

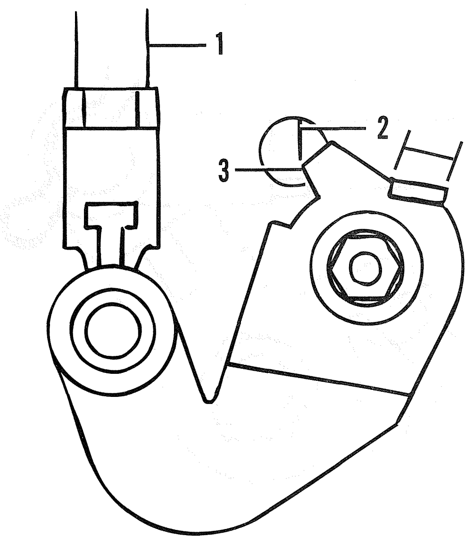
OIL PUMP APERTURE ADJUSTMEWIT (90-140 HP MODELS)



1. Oil pump link rod
2. Oil pump scribe mark
3. Control lever mark

14

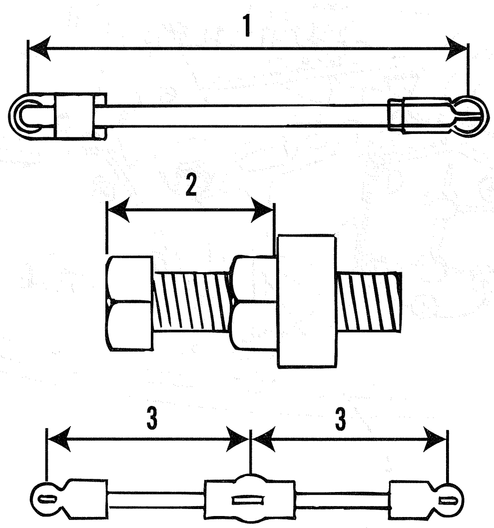
OIL PUMP APERTURE ADJUSTMENT (90 HP MODELS)



1. Oil pump link rod
2. Oil pump scribe mark
3. Control lever mark

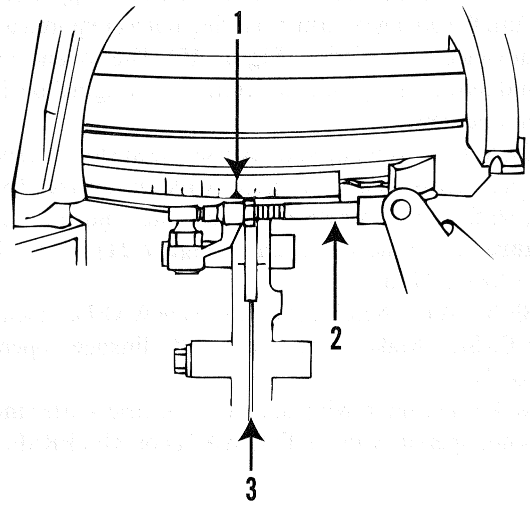
15

ADJUSTMENT LENGTHS (ALL MODELS)



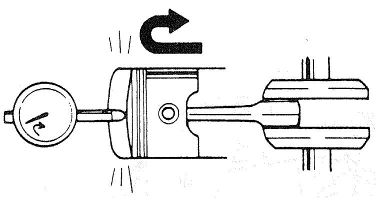
1. Link rod
2. Stopper
3. Carburetor link rod

17



1. Wide open throttle mark
2. Link rod
3. Crankcase mating surfaces

16



b. The flywheel is installed incorrectly or the flywheel key is sheared.

Ignition Timing Adjustment (8 and 9.8 hp Models)

NOTE
On 8 and 9.8 hp models, timing adjustment is only necessary if the power head has been disassembled.

1. Rotate the throttle grip to wide-open throttle.
2. Manually close the throttle valve and adjust the advancer arm so the coil plate turns counterclockwise and contacts the stopper.
3. Mount the throttle wires on the throttle drum and screw the nuts in the throttle wire mounts of the lower motor cover. Make sure the two wires are properly connected and correspond to proper rotation of the grip.
4. Adjust the nuts on the throttle wire mount so the magneto plate turns counterclockwise and contacts the stopper when the grip is turned fully counterclockwise. Make sure the magneto coil plate turns clockwise when the grip is turned clockwise.

Ignition Timing Adjustment (9.9-40 hp Two-Cylinder Models)

1. Rotate the throttle grip to the wide-open throttle position.
2. Adjust the ignition timing link **(Figure 17)** so the wide-open throttle timing mark aligns with the mating line of the crankcase halves.
3. Adjust the stopper bolt **(Figure 18)** so the advancer arm touches the full open stopper bolt when the throttle is at wide-open throttle.

4. Turn the throttle to the fully closed (counterclockwise) position (Figure **19).**

5. Adjust the stopper bolt (Figure 19) so the fully closed timing mark aligns with the mating line of the crankcase halves when the advancer arm touches the stopper bolt.

6. Turn the advancer arm mounting nut as required to set the advancer arm friction (Figure 19). The advancer arm should move lightly, but not return to its original position when released.

7. On 9.9-15 hp models, a reverse speed stop is used to prevent excessive engine speed while in reverse. To adjust, shift into REVERSE and turn the adjusting screw (Figure 20) so the set distance (Figure **21)** is 11.5-12.0 mm (0.45-0.47 in.).

8. Shift from NEUTRAL to FORWARD, then to REVERSE. Make sure the shift linkage operates smoothly.

9. Make sure the rewind starter or electric starter motor does not operate while in FORWARD or REVERSE.

Ignition Timing Adjustment (40D and 50D Models)

1. Adjust the ignition timing link (1, Figure 22) and the throttle link (2) to the specifications in Table 3.

2. Make sure the carburetor throttle plates are fully open when the advancer arm (1, Figure 23) is fully advanced. Adjust the throttle rod (2, Figure 23) if the throttle is not fully open.

3. Adjust the ignition timing link (1, Figure 22) so the ignition timing at wide-open throttle matches the specification in Table 2.

4. After adjusting the maximum engine speed, set the advancer arm (1, Figure 24) to the minimum engine speed and adjust the ignition to 2-4° ATDC using the low-speed side stopper (2).

NOTE

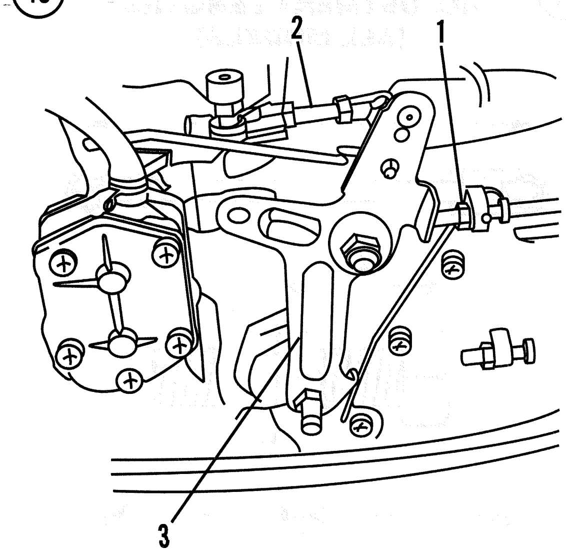
*Align the jlat surface (**Figure** 25) of the crankcase mating surfaces with the calibration marks on the set ring.*

Ignition Timing Adjustment (**40D2** and **50D2** Models)

1. Adjust ignition timing link (1, Figure 22) and throttle link (2) to the specifications in Table 3.

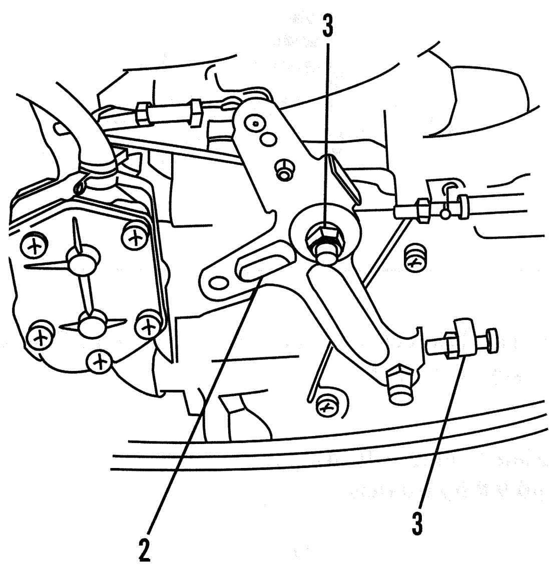
2. Make sure the carburetor throttle plates are fully open when the advancer arm (1, Figure 23) is fully advanced. Adjust the throttle link (2, Figure 23) if the throttle is not fully open.

18



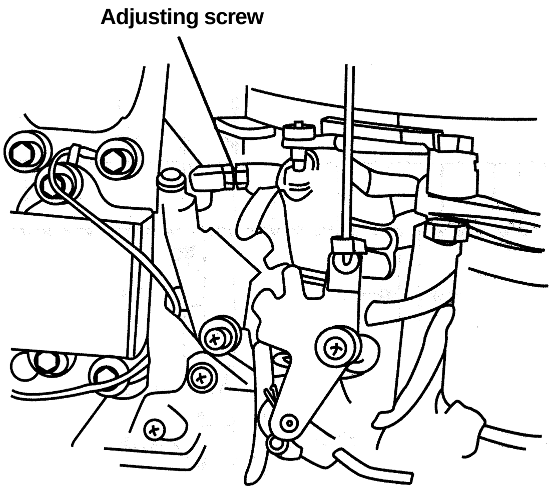
1. **Full open stopper bolt**
2. **Ignition timing link**
3. **Advancer arm**

19



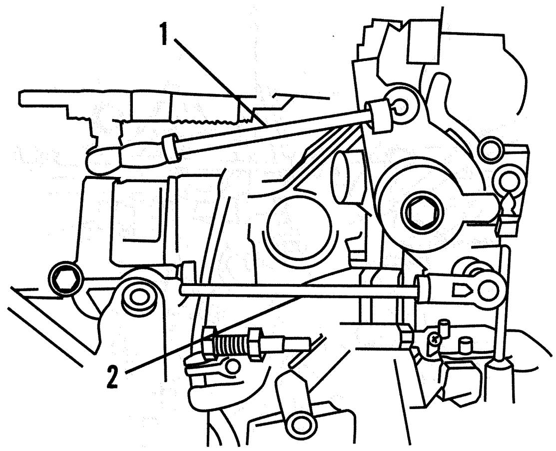
1. **Full closed stopper bolt**
2. **Advancer arm**
3. **Advancer arm nut**

20



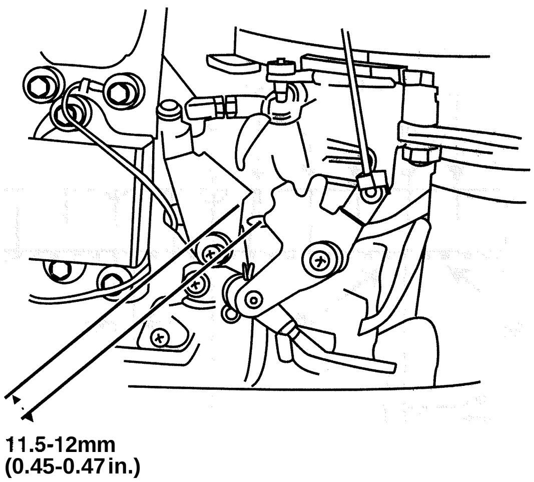
22

TIMING ADJUSTMENT (40D-50D AND 4002-SOD2 HP MODELS)



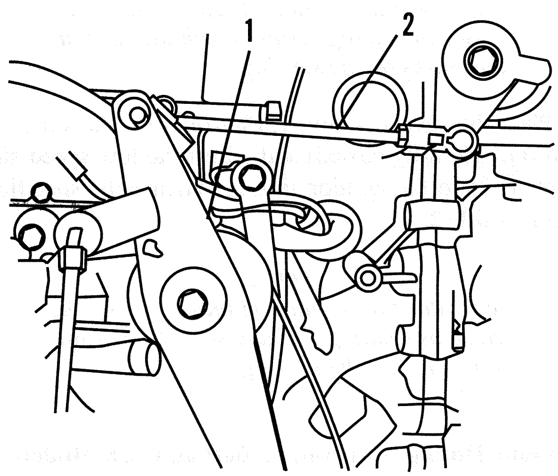
1. Timing link rod
2. Throttle link rod

21



23

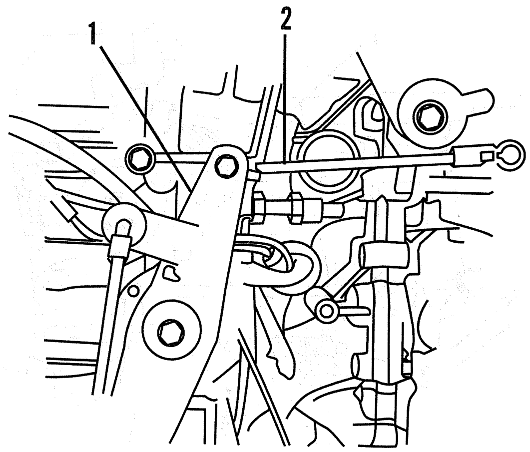
TIMING ADJUSTMENT (40D-50D AND 40D2-50D2 HP MODELS)



1. Advancer arm
2. Throttle link rod

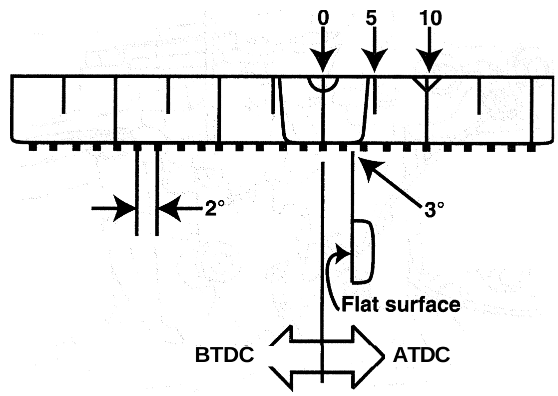
24

TIMING–ADJUSTMENT (40D-50D AND 40D2-50D2 HP MODELS)



1. Advancer arm
2. Low speed stopper

25



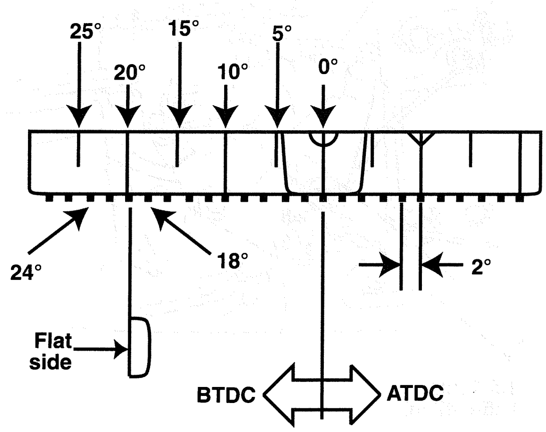
3. Adjust the ignition timing link (1, **Figure 22)** so the ignition timing at wide-open throttle matches the specification in **Table 2.**

NOTE
Align the jlat surface ***(Figure*** *26) of the crankcase mating surfaces with the calibration marks on the set ring.*

4. Place the advancer arm (1, **Figure 24)** in the idle position (throttle fully closed) and adjust the low-speed side stopper *(2)* so the ignition timing matches the specification in **Table 2.**

NOTE
Align the jlat surface ***(Figure*** *25) of the crankcase nzating surfaces with the calibration marks on the set ring.*

26

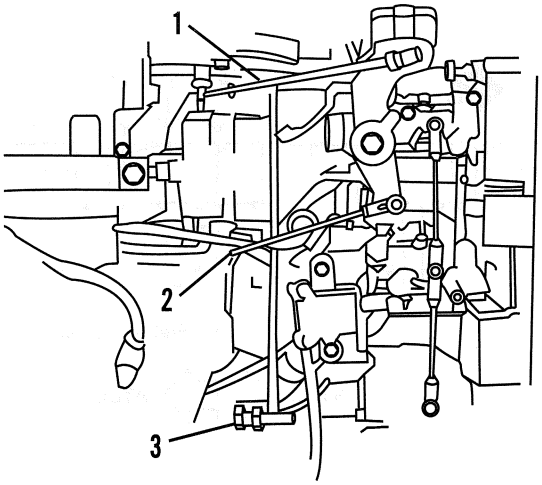


Ignition Timing Adjustment (60B and 70B Models)

1. Adjust the ignition timing link (1, **Figure 27**), throttle link (2), and high-speed side stopper (3) to the specifications in **Table 3.**
2. Make sure the carburetor throttle plates are fully open when the advancer arm *(2,* **Figure 28)** is fully advanced.

27

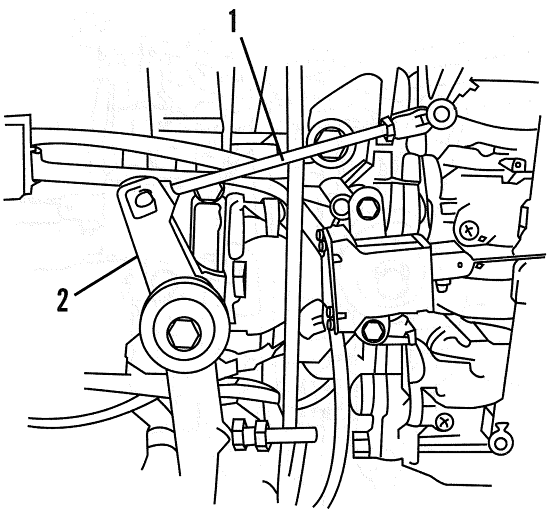
TIMING ADJUSTMENT (60B-70B AND 60C-70C HP MODELS)



1. Timing link rod
2. Throttle link rod
3. High speed stopper

28

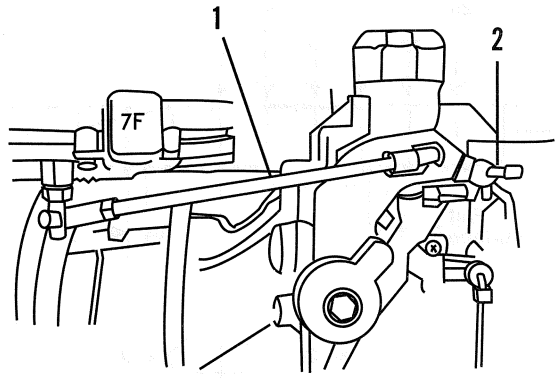
TIMING ADJUSTMENT (60B-70B AND 60C-70C HP MODELS)



1. Throttle link rod
2. Advancer arm

29

TIMING ADJUSTMENT (60B-70B AND 60C-70C HP MODELS)



1. Timing link rod
2. High speed stopper

Adjust the throttle link (1, **Figure** 28) if the throttle is not fully open.

3. With the advancer arm still at the wide-open position (against the stopper), set the ignition timing to the specification in **Table 2** by adjusting the ignition timing link (1, **Figure** 29).

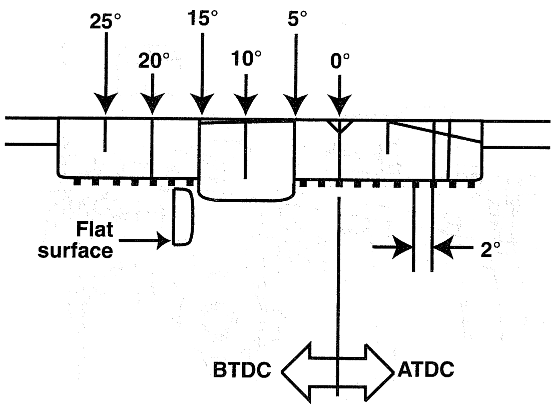
NOTE
*Align the flat surface **(Figure 30)** of the crankcase mating surfaces with the calibration marks on the set ring.*

4. Place the advancer arm (2, **Figure** 31) in the idle position (throttle fully closed). Adjust the throttle link (1, **Figure** 31) so the ignition timing is 2-4° when the advancer arm contacts the low-speed side stopper (3).

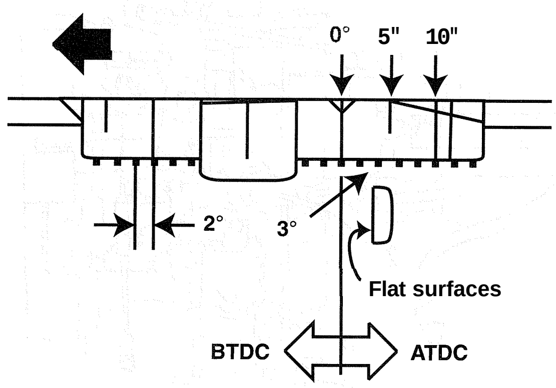
NOTE
*Align the flat surface **(Figure 32)** of the crankcase mating surfaces with the calibration marks on the set ring.*

5. Return the advancer arm (2, **Figure** 33) to the maximum speed position and adjust the length of the high-speed side stopper (1) so it contacts the advancer arm.

30

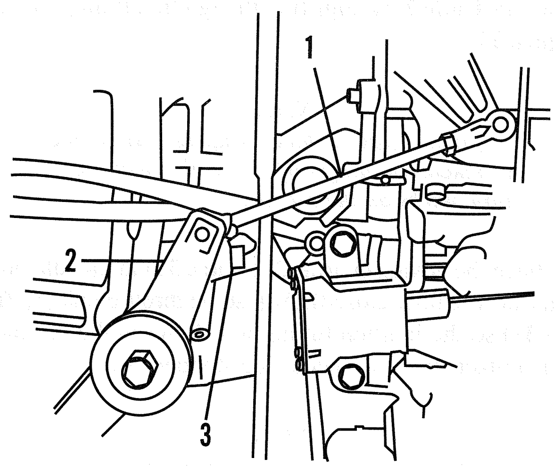


32



31

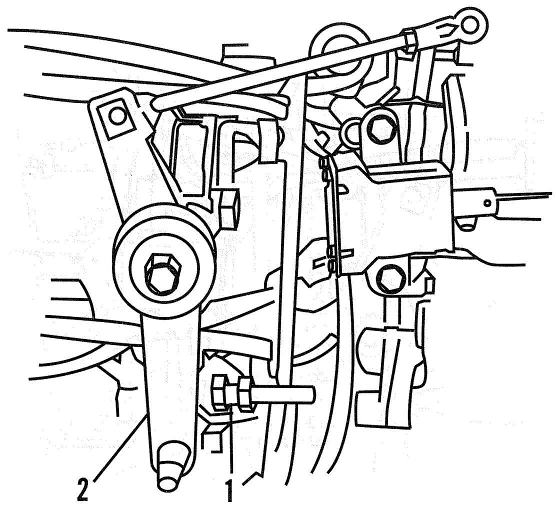
TIMING ADJUSTMENT (60B-70B AND 60C-70C HP MODELS)



1. Throttle link rod
2. Advancer arm
3. Low speed stopper

33

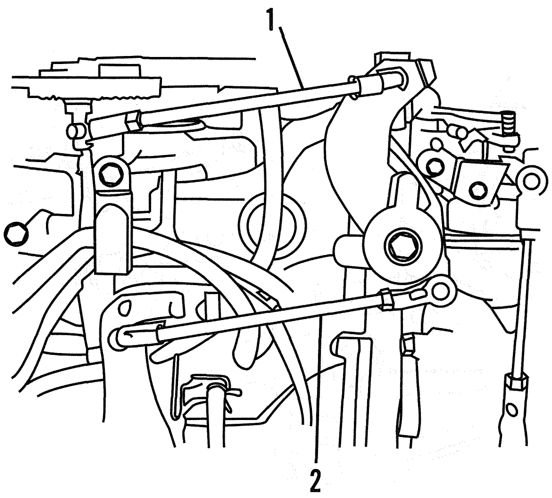
TIMING ADJUSTMENT (60B-70B AND 60C-70C HP MODELS)



1. High speed stopper
2. Advancer arm

(34)

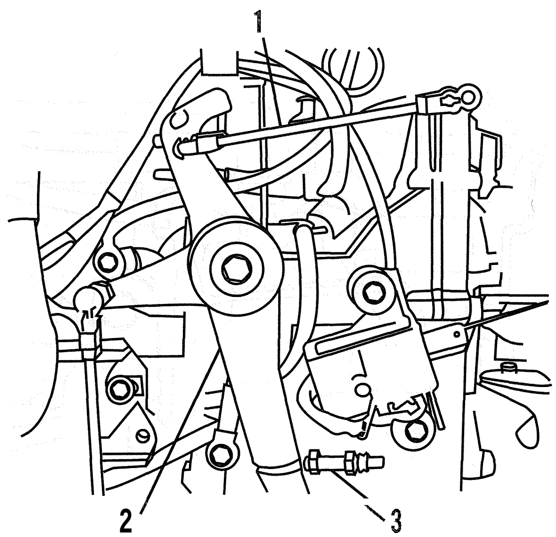
TIMING ADJUSTMENT
(80A-90A AND 145-140 HP MODELS)



1. Timing link rod
2. Throttle link rod

(35)

TIMING ADJUSTMENT
(80A-90A AND 615-140 HP MODELS)



1. Throttle link rod
2. Advancer arm
3. High speed stopper

Ignition Timing Adjustment (60C and 70C Models)

1. Adjust the ignition timing link (1, **Figure 27**), throttle link (2), and high-speed side stopper (3) to the specifications in **Table 3.**
2. Make sure the carburetor throttle plates are fully open when the advancer arm (2, **Figure** 28) is fully advanced. Adjust the throttle link (1, **Figure 28)** if the throttle is not fully open.
3. With the advancer a m still in the wide-open position, set the ignition timing to the specification in **Table** 2 by adjusting the throttle cam stopper (2, **Figure** 29) on the air silencer.

NOTE
Align the flat surface ***(Figure 30)*** *of the crankcase mating surfaces with the calibration marks on the set ring.*

4. Place the advancer a m (2, **Figure 31)** in the idle position (throttle fully closed). Adjust the throttle link (1, **Figure** 31) so the ignition timing is 2-4° when the advancer arm contacts the low-speed side stopper (3).

NOTE
Align the flat surface ***(Figure 32)*** *of the crankcase mating surfaces with the calibration marks on the set ring.*

5. Return the advancer a m (2, **Figure** 33) to the wide-open throttle position and adjust the length of the high-speed side stopper (1) so it contacts the advancer arm.

Ignition Timing Adjustment (80A and 90A Models)

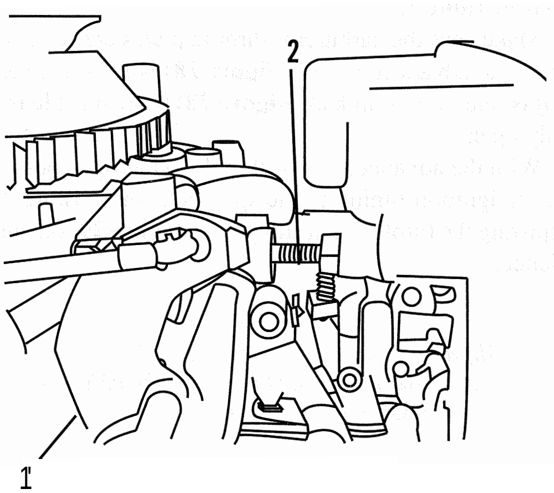
1. Adjust the ignition timing link (1, **Figure** 34) and throttle link (2) to the specifications in **Table 3.**
2. Make sure the carburetor throttle plates are fully open when the advancer a m (2, **Figure** 35) is fully advanced. Adjust the throttle link (2, **Figure** 35) if the throttle is not fully open.
3. With the advancer arm at wide-open throttle, adjust the throttle cam stopper (2, **Figure** 36) on the air silencer to obtain the wide-open throttle timing specification in **Table** 2.

NOTE
When adjusting the stopper; the rubber damper must be installed on stopper.

4. Adjust the high-speed stopper (1, **Figure 37)** to the specification in **Table** 3.

36

TIMING ADJUSTMENT (80A-90A AND 115-140 HP MODELS)



1. Throttle cam
2. Throttle cam stopper

5. Place the advancer arm in the fully closed position and adjust the stopper **(1, Figure 38)** to the specification in **Table 2.**

6. Return the advancer arm **(2, Figure 39)** to the wide-open throttle position and verify that it contacts the high-speed stopper **(3).** If the advancer arm does not make contact with the high-speed stopper, adjust the throttle link (1, **Figure 39)** as required.

7. Adjust the shift link to **24** mm (0.79 in.) **(Figure 40).**

Ignition Timing Adjustment (115-140 hp Models)

1. Adjust the ignition timing link (1, **Figure 34)** and the throttle link **(2)** to the specifications in **Table 3.**

2. Place the advancer arm **(2, Figure 35)** in the fully closed position and set the idle speed ignition timing to 9-11° ATDC. Adjust the throttle link (1, **Figure 35)** if the throttle is not fully closed.

3. Adjust the stopper bolt (3, **Figure 35)** length so it contacts the advancer arm joint at wide-open throttle.

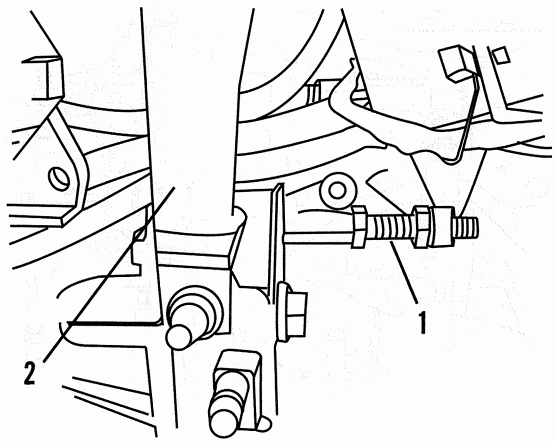
NOTE

The rubber damper must be installed on the stopper when making the adjustment.

4. With the advancer arm at wide-open throttle, adjust the throttle cam stopper (1, **Figure 36)** to obtain the specifica-

37

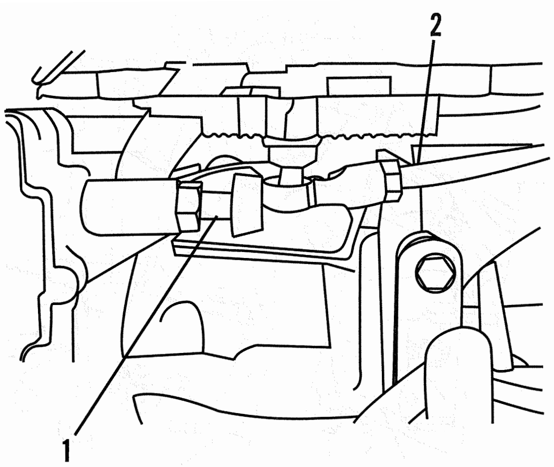
TIMING ADJUSTMENT (80A-90A AND 115-140 HP MODELS)



1. High speed stopper
2. Advancer arm

38

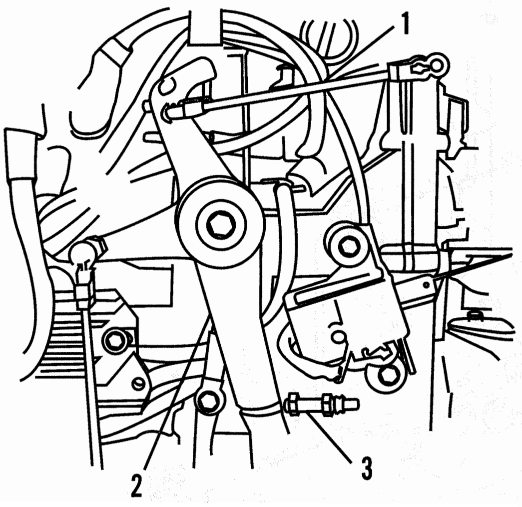
TIMING ADJUSTMENT (80A-90A AND 115-140 HP MODELS)



1. Low speed stopper
2. Timing link rod

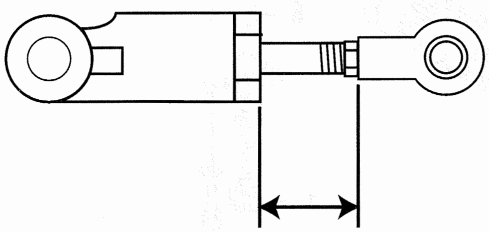
(39)

TIMING ADJUSTMENT (80A-90A AND 115-140 HP MODELS)



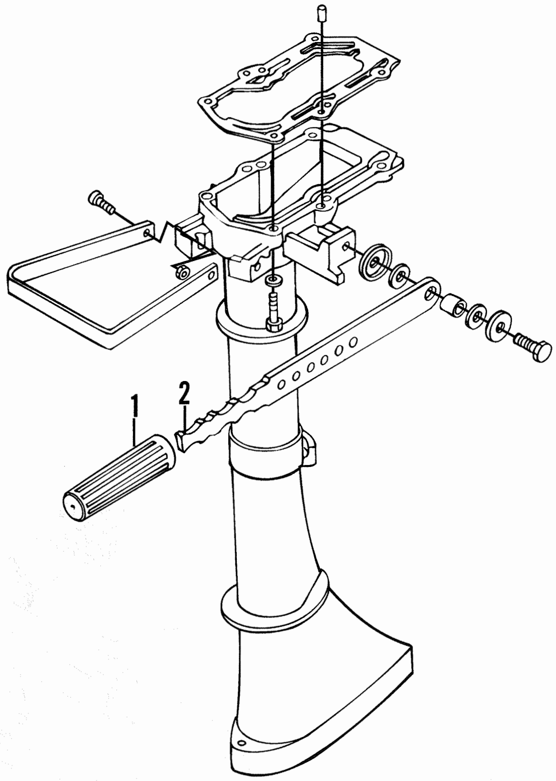
1. Throttle link rod
2. Advancer arm
3. High speed stopper

(40)



(41)

TILLER HANDLE (2.5-3.5 HP MODELS)



1. Grip
2. Steering handle

tion in **Table 2.** The rubber damper must be installed on the stopper when making the adjustment.

5. Adjust the high-speed stopper **(1, Figure 37)** to the length specified in **Table 3.**

6. Place the advancer arm in the fully closed position and adjust the stopper (1, **Figure 38)** to the specification listed in **Table 2.**

NOTE
The rubber damper must be installed on the stopper when making the adjustment.

7. Return the advancer arm **(2, Figure 39)** to the wide-open throttle position and verify that the advancer arm **(2)** contacts the wide-open throttle speed stopper (3). If the advancer arm **(2, Figure 39)** does not contact the stopper (3), adjust the throttle link (1) to make contact.

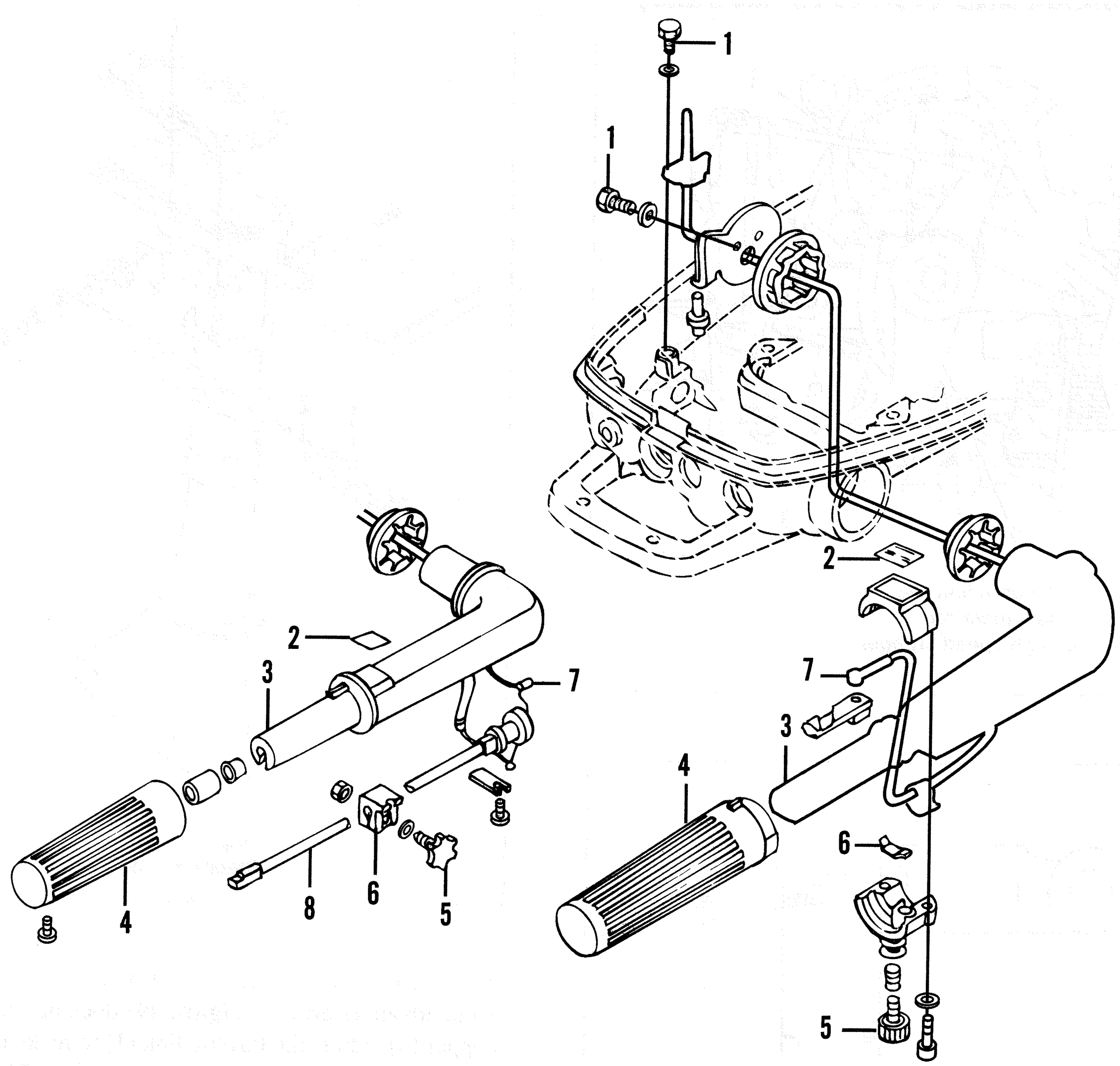
8. Adjust the shift link to **24** mm (0.79 in.) **(Figure 40).**

THROTTLE LINKAGE ADJUSTMENT (ALL MODELS)

1. Disconnect the battery, if so equipped.
2. Turn the tiller control throttle grip to idle.
3. Locate the cable attaching points to the throttle shaft, throttle cam or throttle linkage.
   a. On **2.5-3.5**hp models the tiller steering handle is for steering only and has no cables **(Figure 41).**
   b. On **5** hp models, the tiller arm steers and uses a single cable **(7, Figure 42)** to control the throttle.
   c. On 8-9.8 hp models, the tiller arm steers and uses two cables (1, **Figure 43)** to control the throttle.

42

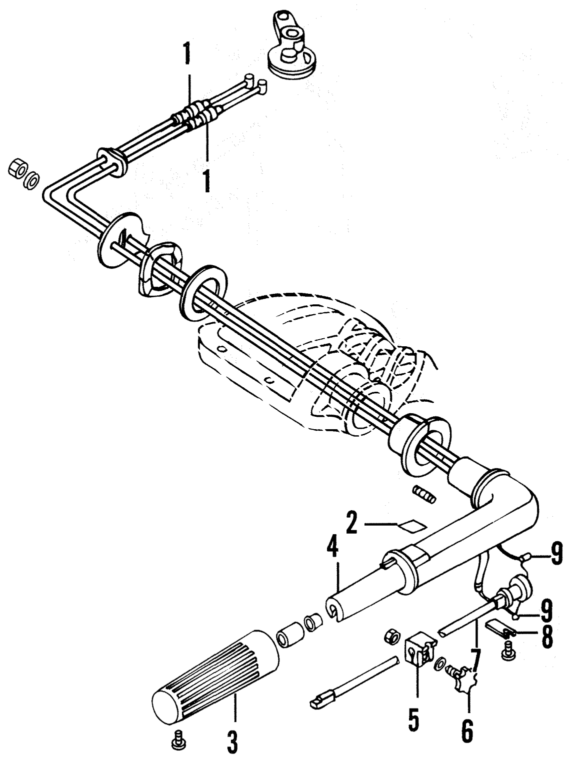
TILLER HANDLE (5 HP MODELS)



1. Bolt
2. Throttle label
3. Steering handle
4. Grip
5. Friction knob
6. Friction piece
7. Throttle cable
8. Throttle shaft

43

TILLER HANDLE (8-9.8 HP MODELS)



1. Throttle cables
2. Throttle label
3. Throttle grip
4. Steering handle
5. Friction plate
6. Friction knob
7. Throttle shaft
8. Bracket

d. On 9.9-40 hp models, the tiller arm steers and uses a pinion throttle linkage (Figure 44) to control the throttle, and can be set up for remote control.

4. Adjust the throttle links (Figure 45 or Figure 46) to the following specifications:

a. On all 9.9-18 hp models, adjust the length of the 5-60L link to 72-73 mm (2.83-2.87 in.).

b. On 9.9C, 9.9D, 9.9D2, 15C and 15D models, adjust the length of the link 5-65L to 75 mm (2.95 in.).

c. On 15D2, 18E and 18E2 models, adjust the length of the 5-65L link to 78 mm (3.07 in.).

5A. On 9.9-18 hp models, rotate the throttle grip to the wide-open throttle position.

a. Adjust the link 5-65L (6, Figure 45) so the coil plate timing mark (1) and the ignition timing mark (7) are aligned. For timing specifications, refer to Table **2.**

b. Adjust the stopper bolt (3, Figure 45) so the advancer arm (5) contacts the stopper bolt.

c. Rotate the throttle grip to the fully closed position. Adjust the stopper bolt (4, Figure **47)** so the timing mark (2) aligns with the 3° ATDC mark and the advancer arm contacts the stopper bolt.

5B. On 25-40 hp models, rotate the throttle grip so the center of the carburetor throttle roller (Figure 48) aligns with the *S* mark on the throttle cam.

a. Adjust the length of the handle rod so the START mark (1, Figure **49)** aligns with the handle grip screw (2).

b. Remove the advance link (2, Figure 50) from the magneto arm. Loosen the locknut and adjust the connector (1) by turning it as necessary to position the magneto advancer to the correct timing position (Table 2) with the throttle at wide open.

c. Tighten the locknut and attach the advancer link to the magneto advancer.

d. Verify that the timing marks align (Figure 51) when the throttle is in the START position.

6. Refer to Figure 52 and Figure 53. Adjust the length of the throttle cable using the adjusting nut (Figure 54) so the throttle grip (1, Figure 55) contacts the stop screw with the throttle in the wide-open position. Return the throttle to idle and make sure there is sufficient freeplay between the throttle grip and stop screw. Adjust the throttle grip friction using the throttle friction block (3, Figure 55).

7. Securely tighten all cable fasteners.

8. Turn the throttle grip to full throttle and back to idle several times to check for free throttle movement, full throttle range and a consistent return to idle. Perform additional adjustments if any binding, inconsistent idle return or insufficient range is noted.

9. Connect the cables to the battery, if so equipped.

Trim Tab Adjustment

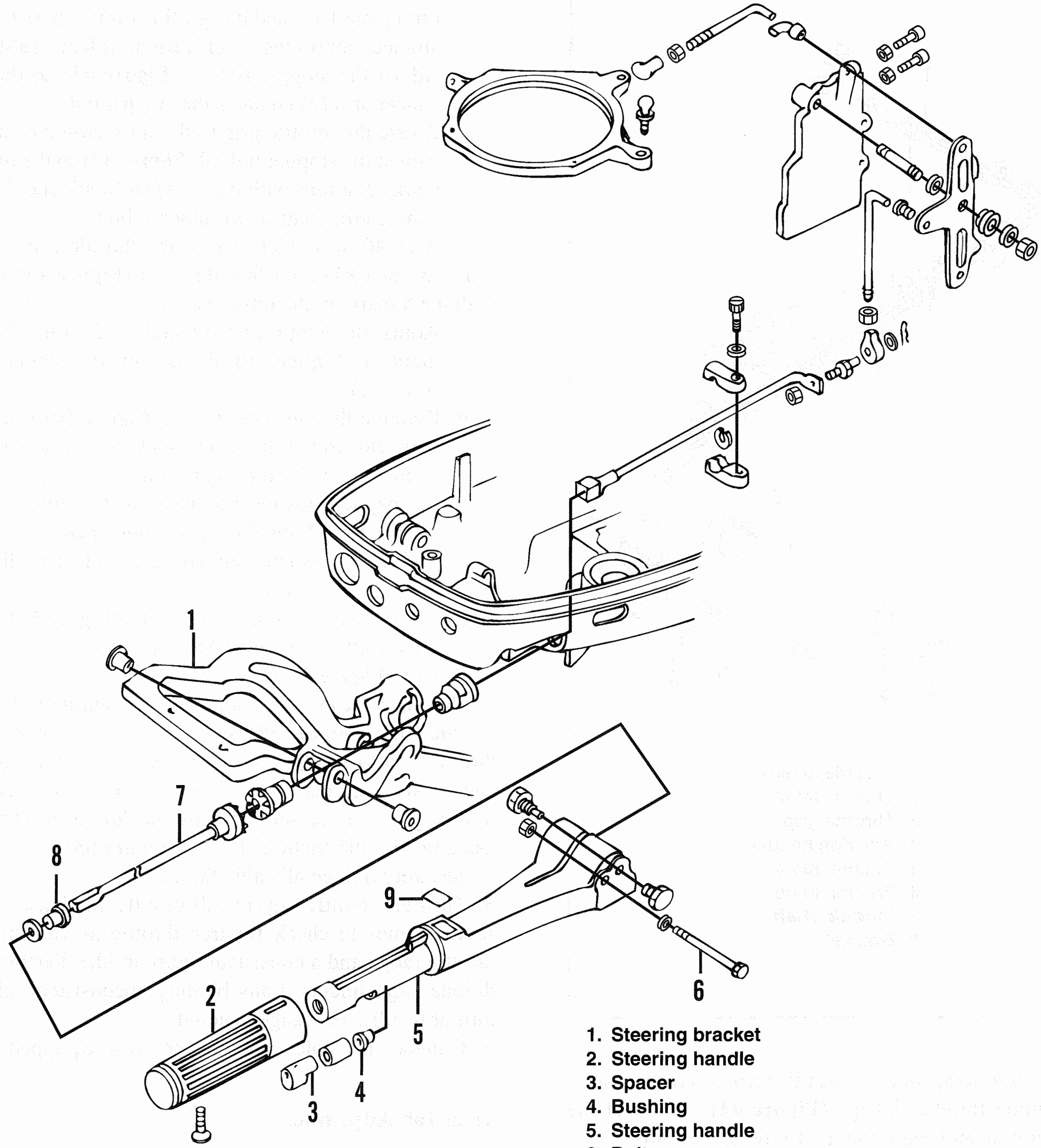
With the boat running at cruising speed and the outboard motor positioned at the optimum trim angle, the boat should track straight forward without pulling to either side. If the boat tends to steer toward one direction, adjust the trim tab to compensate for this tendency.

1. Loosen the trim tab retaining bolt. On some models, the bolt is located just forward of the trim tab fin.

5

(44)

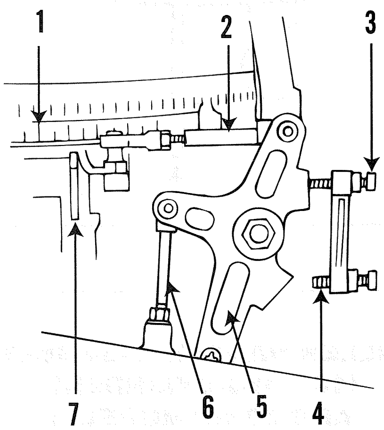
TILLER HANDLE (9.9-40 HP MODELS)



1. Steering bracket
2. Steering handle
3. Spacer
4. Bushing
5. Steering handle
6. Bolt
7. Throttle shaft
8. Bushing
9. Throttle label

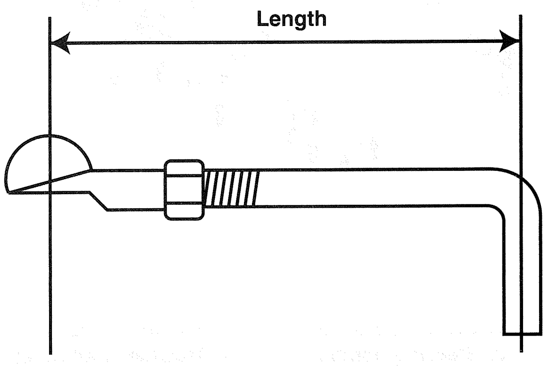
45

LINKAGE ADJUSTMENT FULLY OPEN (9.9-18 HP MODELS)



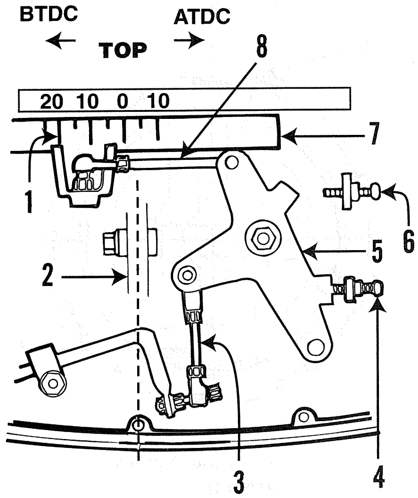
1. Timing mark
2. Link rod (5-60L)
3. Stopper bolt (fully-open)
4. Stopper bolt (fully-closed)
5. Advancer arm
6. Link rod (5-65L)
7. Timing inspection line

46



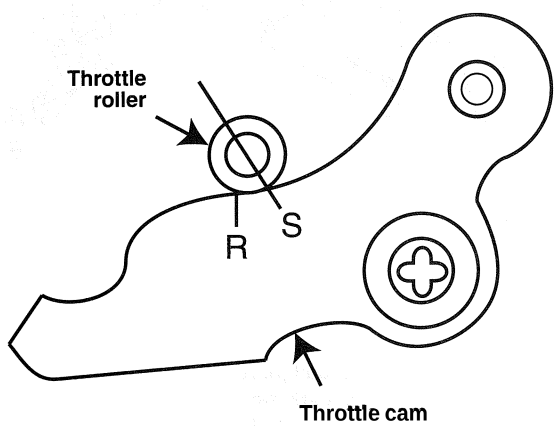
47

LINKAGE ADJUSTMENT FULLY CLOSED (9.9-18 HP MODELS)



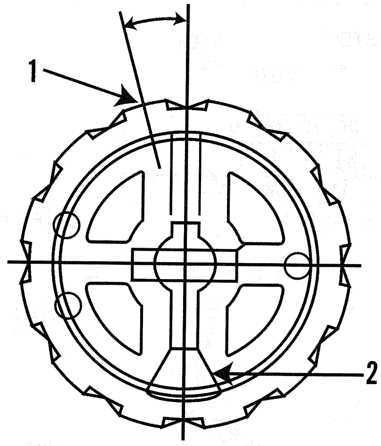
1. Timing marks
2. Timing inspection line
3. Link rod
4. Stopper bolt (fully-closed)
5. Advancer arm
6. Stopper bolt (fully-open)
7. Coil plate
8. Advancer link rod (5-65L)

48



49

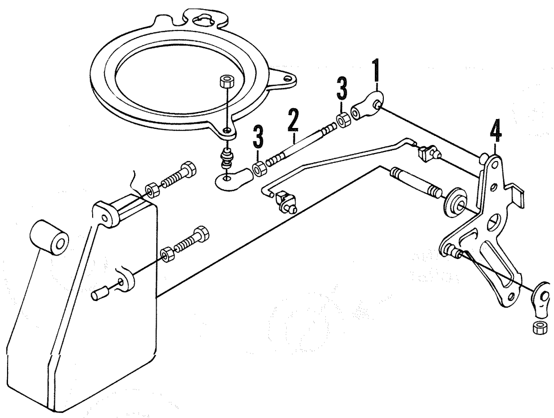
THROTTLE GRIP
(25-40 HP MODELS)



1. Start match mark
2. Grip screw

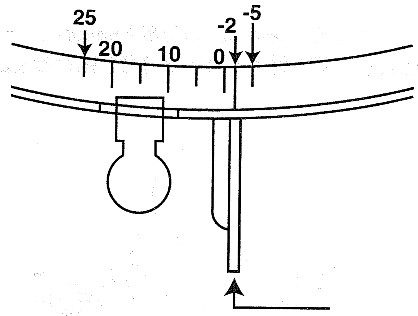
50

LINKAGE ADJUSTMENT
(25-40 HP MODELS)



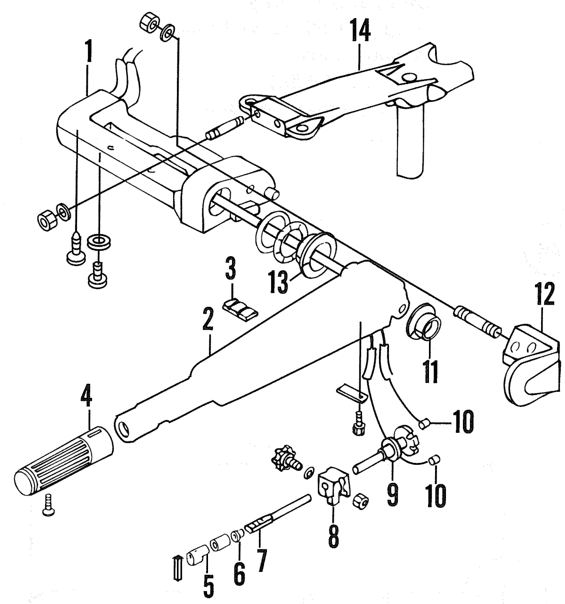
1. Ball joint
2. Link rod
3. Locknut
4. Advancer arm

51



52

TILLER HANDLE ASSEMBLY
(40 [TWO-CYLINDER]
AND 50 HP MODELS)

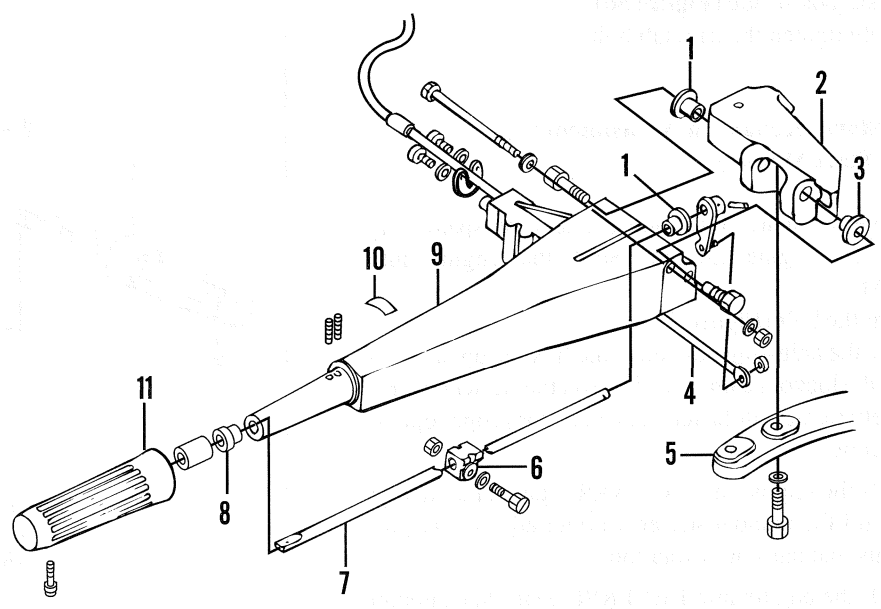


1. Steering bracket
2. Steering handle
3. Throttle label
4. Throttle grip
5. Spacer
6. Bushing
7. Throttle shafi
8. Friction piece
9. Throttle shaft roller
10. Throttle cable
11. Bushing
12. Holder
13. Bushing
14. Steering shaft

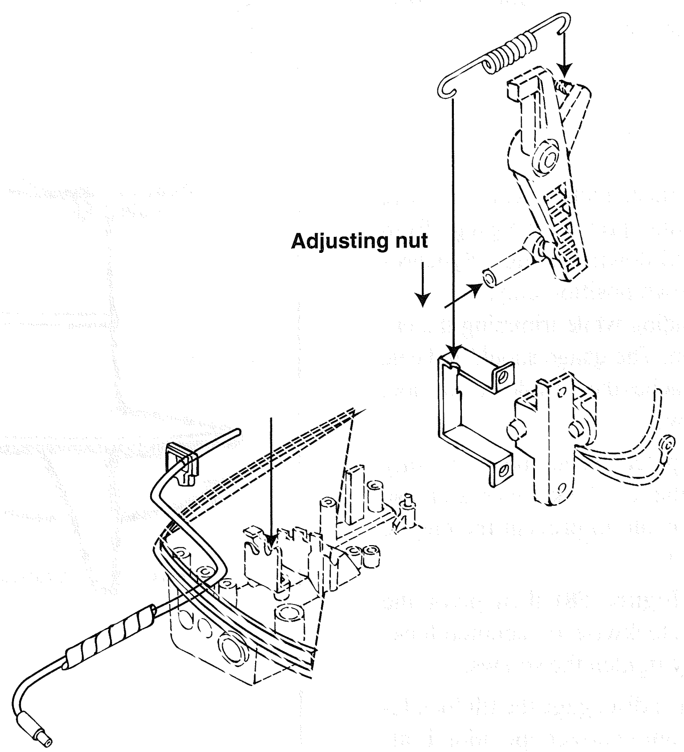
53

TILLER HANDLE ASSEMBLY (60-90 HP MODELS)

1. Bushing
2. Handle
3. Bushing
4. Throttle cable
5. Steering shaft
6. Friction piece
7. Throttle shaft
8. Bushing
9. Throttle handle
10. Throttle label
11. Throttle grip



54



2. If the engine steers toward the port direction, pivot the trailing edge (rear) of the trim tab slightly toward the port side **(Figure 56).** If the engine steers toward the starboard direction, pivot the trailing edge of the trim tab slightly toward the starboard side **(Figure 56).**
3. Securely tighten the trim tab bolt.

Neutral Start Mechanism Adjustment (Manual Start Models)

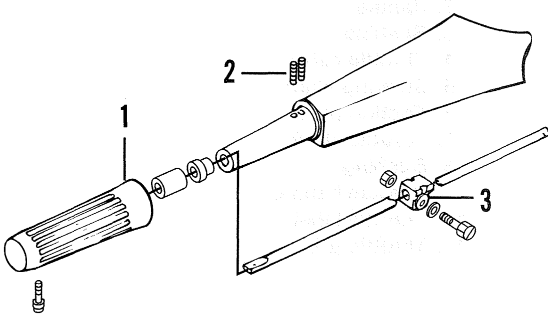
1. Remove the spark plugs and connect the spark plug leads to an engine ground. Shift the engine into NEUTRAL.
2. Loosen the bolt **(Figure 57).**
3. Loosen the adjusting nut, move the linkage up or down and align the lockout cam in position on the starter cover.
4. Securely tighten all fasteners. Check for proper operation as follows:
   a. Shift the engine into FORWARD gear and attempt to pull the manual starter. Correct adjustment prevents manual starter rotation.
   b. Shift the engine into REVERSE gear, then attempt to pull the manual starter. Correct adjustment prevents manual starter rotation.
   c. Shift the engine into NEUTRAL, then attempt to pull the manual starter. Correct adjustment allows rotation of the manual starter.

Trim Position Sender

Variations in gauge resistance, battery voltage, wire length and sender resistance may prevent the gauge from reaching both the fully up and down readings. Synchronize the sender to the fully down position only.
1. Observe the trim gauge reading while trimming the engine to the fully down position. The gauge should indicate fully down just as the engine reaches the fully down position.
2. Adjust the sender as follows:
   a. Using the trim system, place the engine in the fully up position. Engage the tilt lock lever and use blocks or an overhead cable to prevent the engine from moving downward.
   b. Loosen both screws **(Figure 58)** then pivot the sender slightly in the clockwise or counterclockwise direction. Securely tighten the screws.
   c. Remove the supports then disengage the tilt lock lever. Repeat adjustment until correct operation is attained. Several adjustments may be required.

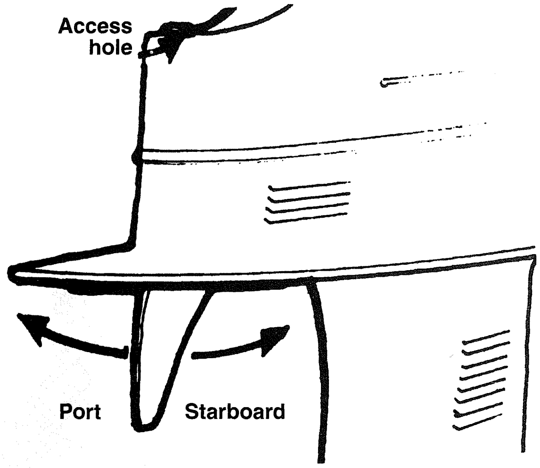
55

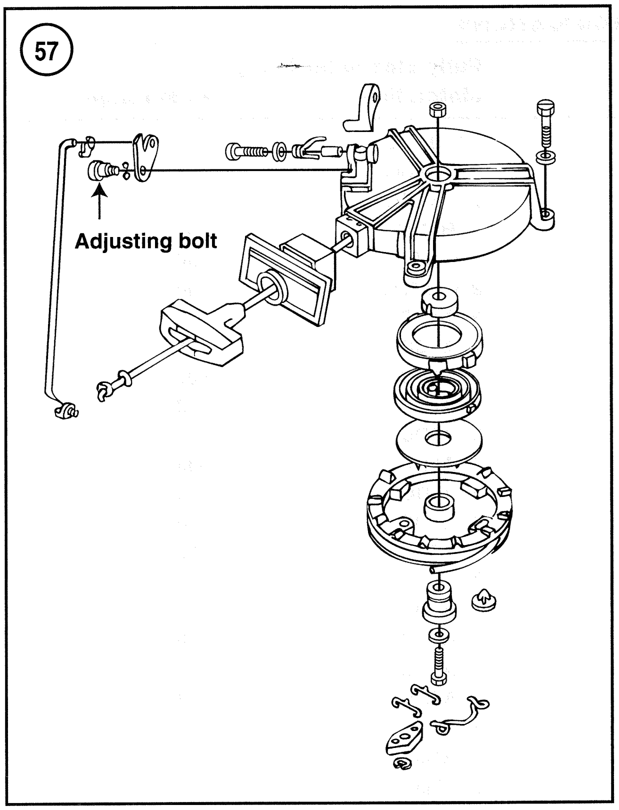
THROTTLE GABLE ADJUSTMENT (60-90 HP MODELS)

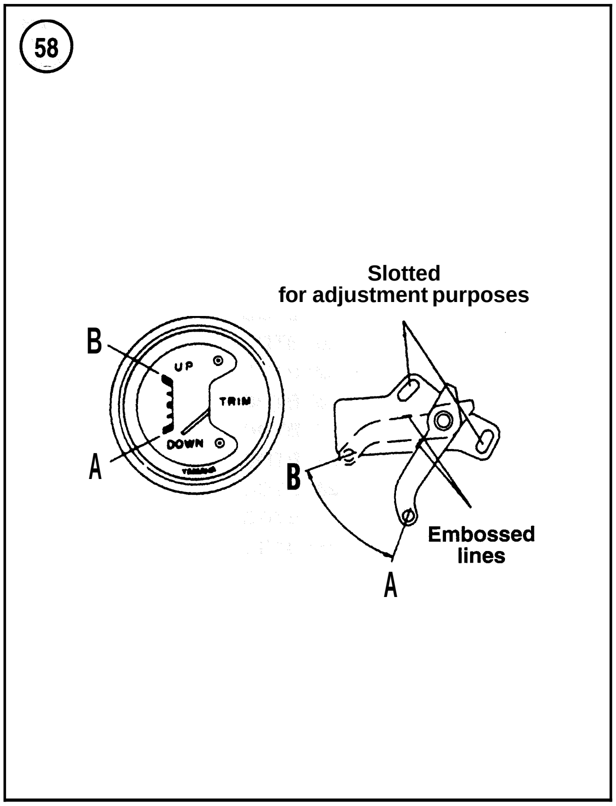


1. *Throttle* grip
2. *Stop screw*
3. *Friction piece*

56







5

Table ▮ TEST PROPELLER RECOMMENDATIONS

Engine	Part No.
2.5-3.5A2	309-64111-0
3.5B2	3FO-64111-0
5	369-64111-0
8-9.8	3B2-64111-0
9.9-15-18	362-64111-0
25-30	364-64111-5
40 (two-cylinder)	348-64111-0
40-50 (three-cylinder)	3C8-64111-0
60B-70B	3F3-64111-0
6OC-70C	3B7-64111-0
80-90	3B7-64111-0
115-120-140	3C7-64111-0

Table 2 **TIMING** SPECIFICATIONS

Throttle setting engine	Match line	Fully open RPM range	Fully closed (in gear) Match line	RPM range
2.5A	20° BTDC	3800-5200	20° BTDC	–
3.5A	20° BTDC	4200-5300	20° BTDC	–
3.5B	20° BTDC	4200-5300	20° BTDC	1100
5	30° BTDC	4500-5500	5° BTDC	850
8	22" BTDC	4500-5500	1.5" ATDC	750
9.8	26° BTDC	5000-6000	2.5" BTDC	750
9.9D	22" BTDC	4500-5300	3" ATDC	800
9.9D2	20" BTDC	4500-5300	3° ATDC	800
15D	22° BTDC	4750-5500	3° ATDC	800
15D2	25" BTDC	5200-5800	3" ATDC	800
18E	25" BTDC	4750-5500	3° ATDC	800
18E2	25" BTDC	5200-5800	3° ATDC	800
25C2	20° BTDC	4800-5500	2° ATDC	900
25C3	25" BTDC	5000-6000	4" ATDC	900
30A3	25° BTDC	4800-5500	2° ATDC	900
30A4	25° BTDC	5150-5850	4° ATDC	900
40 two-cylinder	25° BTDC	5200-5800	2° ATDC	850
40D three-cylinder	18° BTDC	4500-5500	3" ATDC	750
40D2	18° BTDC	5000-5700	3° ATDC	750
50D	24" BTDC	5000-5700	3" ATDC	750
50D2	20° BTDC	5150-5850	3° ATDC	750
60B	16" BTDC	4900-5600	3° ATDC	750
60C	17" BTDC	5150-5850	3° ATDC	750
70B	20° BTDC	4900-5600	3° ATDC	750
70C	17° BTDC	5150-5850	3° ATDC	750
80	17° BTDC	5000-5500	5° ATDC	700
90	20° BTDC	5000-5500	5° ATDC	700
115-120	17° BTDC	5200-5700	10" ATDC	700
140	20° BTDC	5200-5700	10° ATDC	700

Table 3 **IGNITION TIMING** ADJUSTMENT

Model	Timing link rod	Throttle link rod	High speed stopper
40D-50D	129 mm (5.04 in.)	99 mm (3.86 in.)	–
40D2	101 mm (3.98 in.)	115 mm (4.53 in.)	–
50D2	98 mm (3.86 in.)	115 mm (4.53 in.)	–
60B-70B	133 mm (5.24 in.)	127 mm (5.00 in.)	7 mm (0.28 in.)
60C	146 mm (5.75 in.)	128 mm (5.04 in.)	22 mm (0.87 in.)
70C	146 mm (5.75 in.)	128 mm (5.04 in.)	14 mm (0.55 in.)
80A-90A	124 mm (4.88 in.)	131.5 mm (5.18 in.)	15 mm (0.6 in.)
115-120	127 mm (5.00 in.)	158 mm (6.22 in.)	18 mm (0.71 in.)
140	127 mm (5.00 in.)	158 mm (6.22 in.)	14 mm (0.55 in.)

Table 4 CARBURETOR SYNCHRONIZATION

Model	Carburetor link rod	Throttle stop screw
40-50	90 mm (3.54 in.)	2 1/2 turns
60-70	97 mm (3.81 in.)	1 114 turns
80-140	110 mm (4.33 in.)	As needed for opening of 5°

Table 5 CARBURETOR THROTTLE STOP SCREW TURNS

Model	Throttle stop screw
40-50 hp	2 1/2 turns
60-70 hp	1 114 turns
80-140 hp	As needed so throttle valve is open 5°

Table 6 CARBURETOR PILOT SCREW TURNS

Model	Pilot screw
40D hp	112 to 2 turns
40D2 hp	314 to 2 114 turns
50D hp	2 to 3 112 turns
50D2 hp	2 to 3 112 turns
60B-70B hp	1 1/4 to 1 314 turns
60C-70C hp	1 118 to 1 518 turns
80-90 hp	1/4 to 1 314 turns
115-140 hp	1 318 to 1 718 turns

Table 7 ENGINE RPM AT IDLE AND TROLLING

Model	Idle RPM [neutral)	Trolling RPM
40-50 hp	900	750
60-70 hp	900	750
80-90 hp	900	750
115-140 hp	900	750

Chapter Six

Fuel System

Diagrams provide component identification, mounting locations and fuel hose routing. Refer to the appropriate illustration when removing and installing all fuel system components.

Torque specifications and other fuel system specifications are provided in Tables **1-4,** located at the end of this chapter.

WARNING

Use caution when working with the fuel system. Never smoke around fuel or fuel vapor. Make sure that no jlame or source of ignition is present in the work area. Flame or sparks can ignite fuel or vapor and result in fire or explosion.

Always use gloves and eye protection while working with the fuel system. Take all necessary precautions against fire or explosion. Always disconnect the battery cables *before* servicing any outboard.

Pay close attention when removing and installing components (especially carburetors) to avoid installing them in the wrong location.

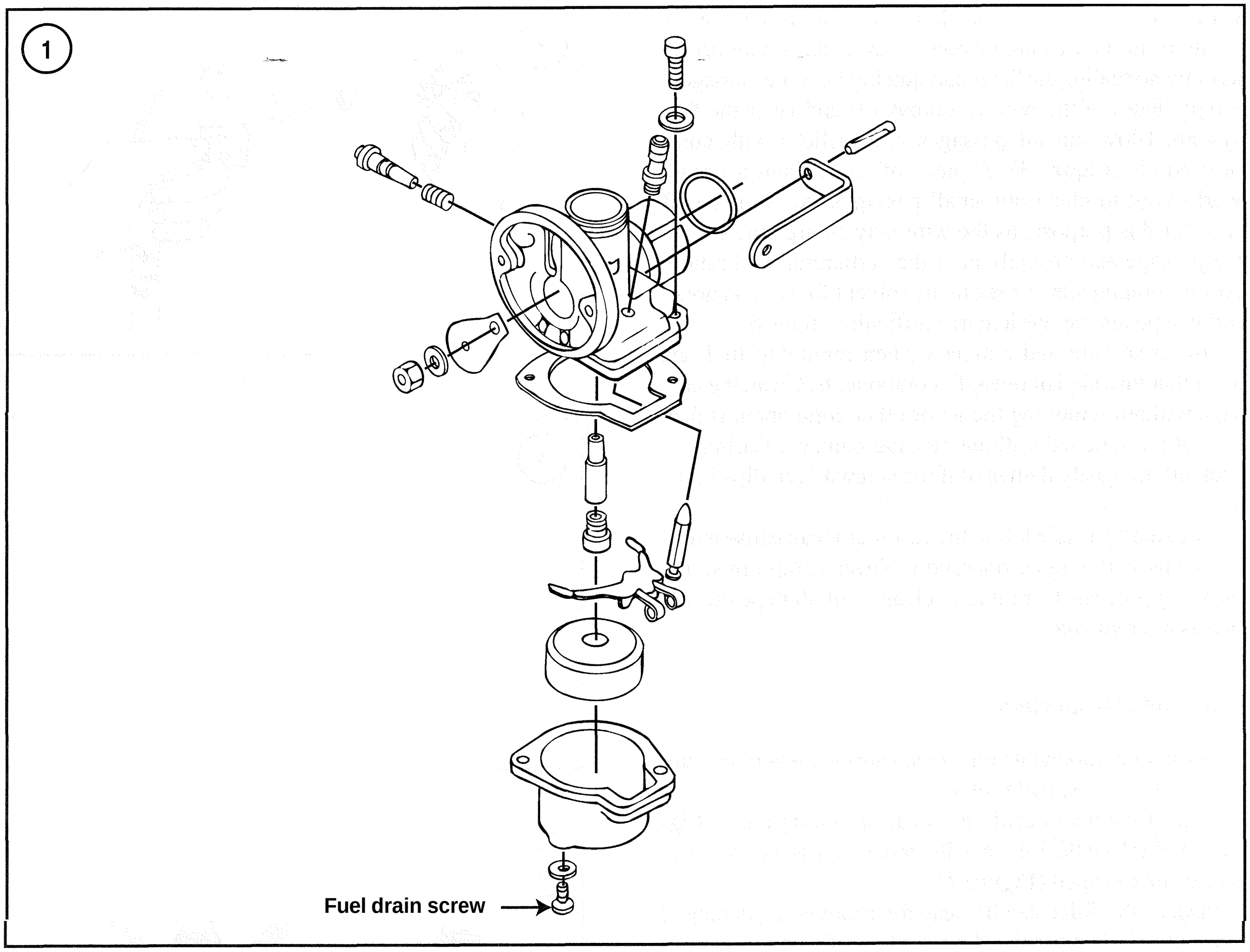
Capture fuel from disconnected hoses or fittings using a small container or a clean shop towel. Try to use a clear container, as it allows a visual inspection of the fuel. The presence of water or other contaminants indicates a need to clean and inspect all fuel system components (especially the fuel tank). Failure to thoroughly clean the system usually results in repeated failure.

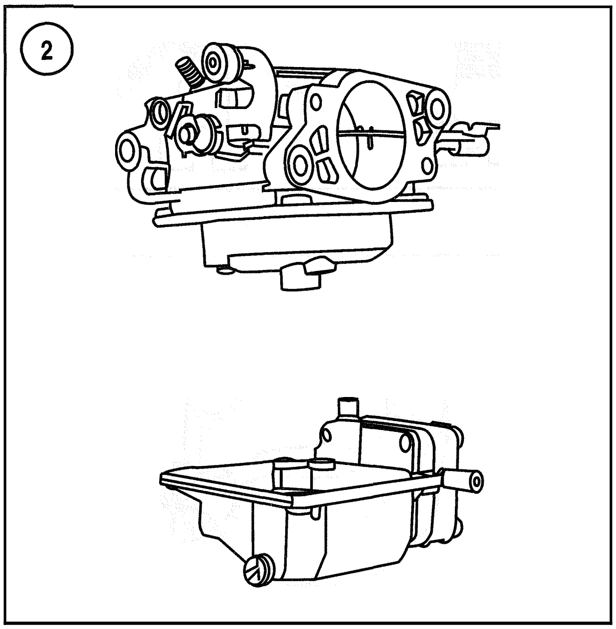
Drain all fuel from the carburetor(s) using the float bowl drain plug (Figure **1** and Figure **2).** Refer to *Carburetors* in this chapter to locate the bowl drain screw.

Inspect all hoses for leakage or deterioration when servicing the fuel system. Damaged fuel hoses pose a safety hazard. In addition, pieces of deteriorated or damaged hoses can break free and block fuel passages. Refer to *Fuel Hoses* in this chapter.

On multiple-carburetor engines, disassemble and assemble one carburetor at a time. Some models have fuel and air jet sizes calibrated to the cylinder in which they supply fuel. Refer to *Carburetor* (in this chapter).

Perform adjustments to all fuel system components upon installation. Many adjustments to the fuel system





must be made under running conditions. Refer to Chapter Five for all adjustment instructions.

Gaskets, seals and O-rings

To avoid fuel or air leakage, replace all gaskets, seals and O-rings during assembly.

Fuel System Cleaning

The most important step in carburetor or fuel pump repair is the cleaning process. Use only solvents suitable for use on carburetors. Some solvents can damage fuel system components. Spray-type carburetor cleaners are available at most auto parts stores. They are effective in removing most stubborn deposits. Avoid using any solvents that are not suitable for aluminum.

Remove all plastic or rubber components from the fuel pump, carburetor or filter assembly before cleaning them with solvent. Use a stiff brush and solvent to remove deposits from the carburetor bowl. Never use a wire brush, as delicate sealing surfaces can quickly become damaged. Small pieces of the wire can break off and enter the fue! system. Blow out all passages and orifices with compressed air **(Figure 3).** A piece of straw from a broom works well to clean out small passages. Never use stiff wire for this purpose, as the wire may enlarge the size of the passage and possibly alter the carburetor calibration. Allow components to soak in the solvent for several hours if the deposits are particularly difficult to remove.

Use great care and patience when removing fuel jets and other threaded or press-fit components. Clean the passage without removing the jet or other component if they cannot be removed without causing damage. Carburetor fuel jets are easily damaged if the screwdriver slips in the slot.

One small particle left in the carburetor can cause major problems with engine operation. Never compromise the cleaning process. Continue to clean until ail deposits and debris are removed.

Carburetor Inspection

Place all components on a clean surface when they are removed from the carburetor.

Inspect the inlet needle for wear or deterioration **(Figure** 4). Replace the inlet needle valve, unless its tip is perfectly cone-shaped **(Figure** 4).

Inspect the inlet needle seat for grooves or damaged surfaces. Carburetor flooding is likely if using a worn or faulty inlet needle or seat.

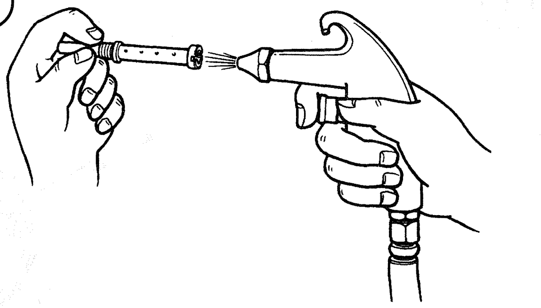
Inspect the tip of the pilot screw (on models so equipped) for wear or damage **(Figure 5).** Damage to the tip usually occurs from improper seating of the screw during adjustment. In many instances, the seat for the tip is also damaged. Damage to the screw or seat usually results in rough idle or improper off idle engine operation. Replace the screw or carburetor if worn or faulty components are noted.

Inspect the float **(Figure 6,** typical) for wear or damage. Some floats are made of a translucent material that allows the detection of fuel inside the float.

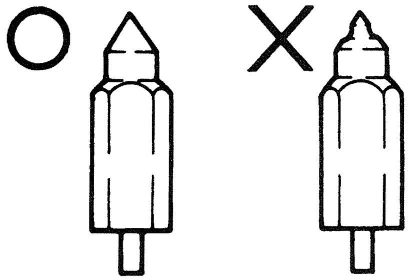
Push your thumbnail gently against the material on non-translucent floats. A fuel-saturated float is indicated if fuel appears at the contact area. Replace the float if it is damaged, leaking or fuel saturated. Check the float for free movement as it moves up and down on the float pin. Replace the float valve if it does not move freely.

Adjust the fuel level **(Figure 7)** prior to assembling the carburetor. Use an accurate ruler or a caliper. Set the float exactly as specified to help ensure proper carburetor oper-

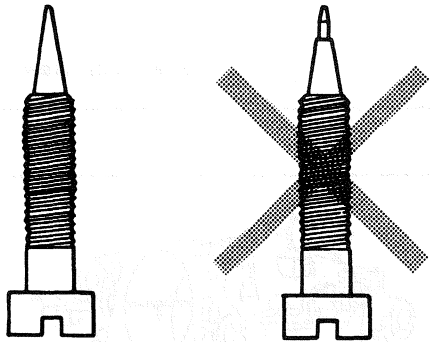
3



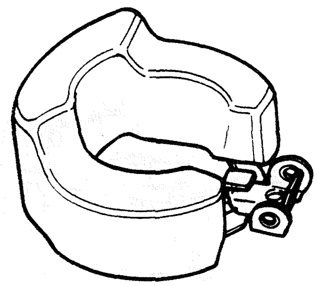
4

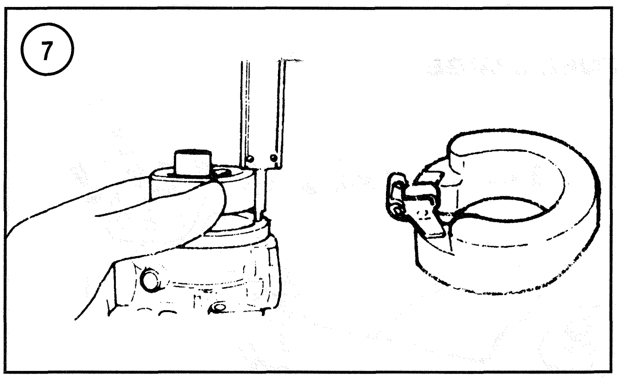


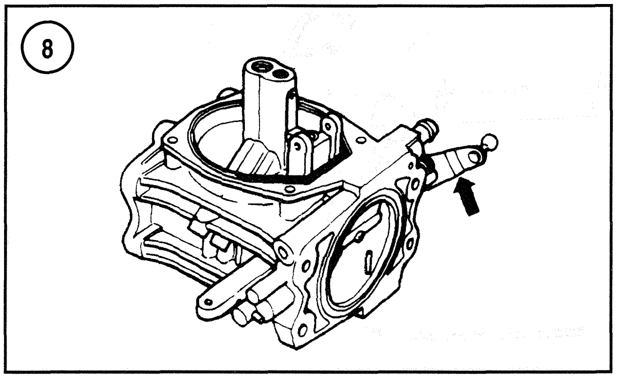
5

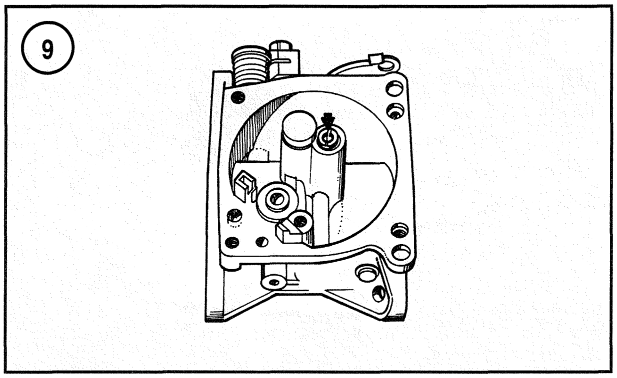


6









ation. Float level specifications and measuring points vary by model. Specific instructions are provided in the carburetor disassembly and assembly instructions. Float level specifications are provided in Table 4.

Move the throttle lever (Figure **8)** from the closed throttle to wide-open positions. Remove the throttle valve and repeat this step if binding or rough operation is noted. Continued binding indicates a bent throttle shaft. If free movement is noted with the valve removed, misalignment or a damaged throttle valve is indicated. Replace the components needed to ensure free throttle movement. Apply a suitable threadlocking compound and stake all throttle plate retaining screws during installation.

Fuel Jets

Fuel jets (Figure **9)** meter the fuel flow through various passages in the carburetor. They, along with other components, allow the carburetor to deliver the precise amount of fuel needed for the engine. Fuel jets normally have a number stamped on the side or opening end. Make notes indicating the fuel jet number and location in the carburetor before removal. Ensure fuel jets and other carburetor components are reinstalled to the correct location.

For proper engine operation, replacement fuel jets must have the same size and shape of opening as the original fuel jets. Improper engine operation, increased exhaust emissions or potentially serious power head damage may result from using incorrect fuel jets.

Using the engine at a high elevation (5000 ft. [1524 m] or higher) may require alternate fuel jets to compensate for the less dense atmosphere. If necessary, contact a marine dealer in the area (similar elevation) for information on fuel jet changes.

FUEL **TANK**

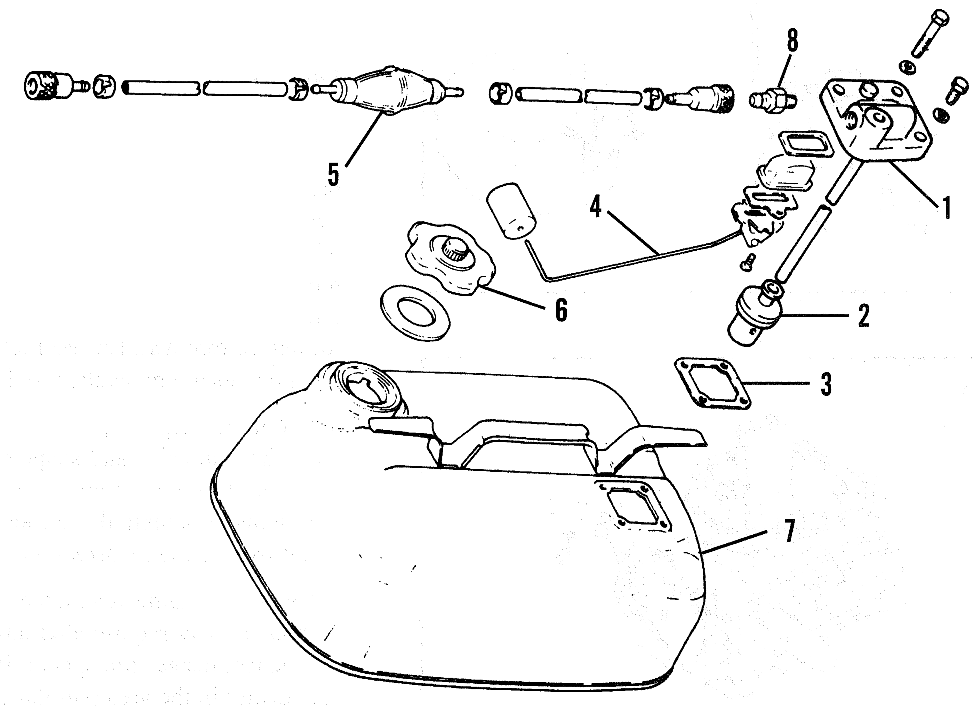
Three types of fuel tanks are used with these manufacturer's two-stroke outboards. They include the portable fuel tank (Figure **10)** and an integral fuel tank (Figure **11).**

Several companies manufacture portable fuel tanks. The engine may be equipped with any one of them. The types of components used, cleaning and repair instructions are similar for all brands of fuel tanks. Refer to a reputable marine repair shop or marine dealership if parts are needed.

Integral fuel tanks may be used on larger models. They are usually located slightly forward of the boat transom. On some boats, the fuel tank is mounted further forward under the deck. Tank access panels are installed in most boats. These panels allow access to fuel line fittings and the fuel level sender assembly. Removing upholstery or major boat structures may be required if the tank requires removal. Proper long-term storage and fuel system inspection is much more important with integral fuel tanks. Long term storage and fuel system inspection are provided in Chapter Four.

10

FUEL TANK WITH FUEL GAUGE



1. Adapter
2. Filter screen
3. Gasket
4. Fuel gauge
5. Primer bulb
6. Cap
7. Tank
8. Fitting

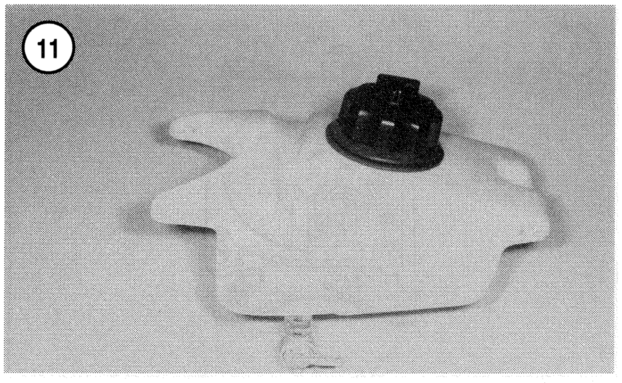
Portable Fuel Tank

Portable remote fuel tanks may require periodic cleaning and inspection. Inspect the remainder of the fuel system for potential contamination if water is found in the tank. The tank used may differ in appearance and component usage from the illustration **(Figure 10).**

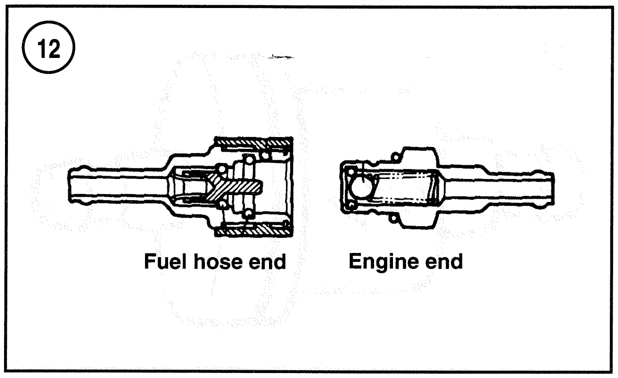
Clean and inspect the tank as follows:

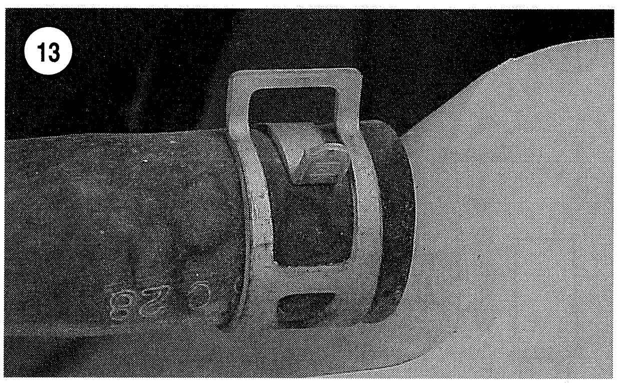
1. Remove the fuel tank cap *(6,* **Figure 10)** from the fuel tank. Carefully pour the fuel from the tank into a suitable container.
2. Remove the screws and washer **(Figure 10)** that retain the connectorladapter (1) to the fuel tank. Carefully lift the fuel gauge assembly (1, **Figure 10)** from the tank. Never force the assembly, as damage may occur. Rotate or tilt the assembly as required for removal. Remove and discard the gasket (3, **Figure 10)** located between the connectorladapter and fuel tank.
3. Check for free movements of the float arm on the fuel gauge assembly (4, **Figure 10).** Replace the assembly if binding cannot be corrected by bending the float arm into the correct position.
4. Inspect and/or replace the float if any physical damage is noted, or if it appears to be saturated with fuel.

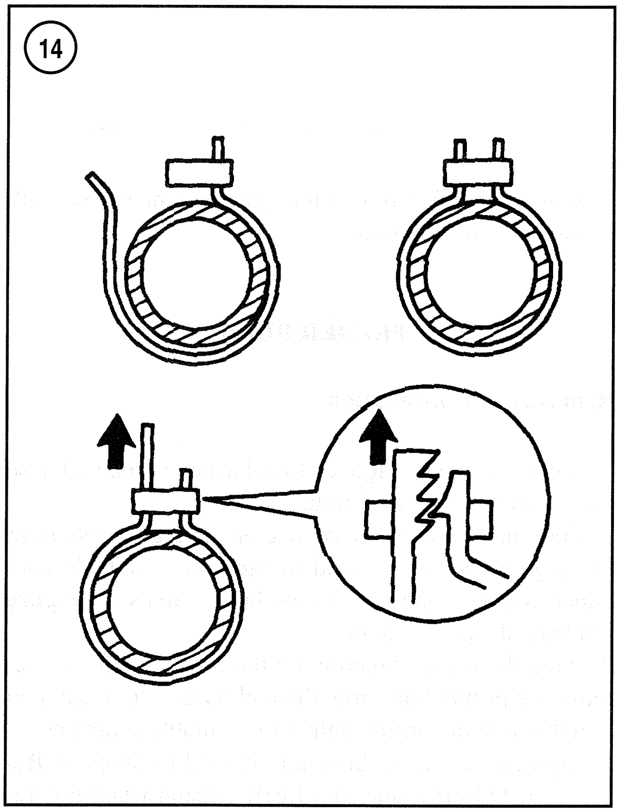
11



5. Carefully pull the screen and pickup tube from the fuel gauge assembly (2, **Figure 10).** Clean the tube and screen using a suitable solvent. Dry them with compressed air. Inspect the screen for tears or damage. Inspect the pickup tube for cracks or deterioration. Replace the screen and/or tube if defects are noted.
6. Remove the fitting **(Figure 10)** from the connectorladapter (8). Clean the fittings and all passages of the connectorladapter using a suitable solvent.
7. Add a small amount of solvent to the fuel tank. Block the gaugelpickup opening with a shop towel. Install the fuel tank cap **(Figure 11).** Shake the tank to distribute the







solvent throughout the tank. Empty the solvent, then dry the tank using compressed air.

8. Inspect the internal and external tank surfaces. Repeat Step 7 if debris remains in the tank. Inspect the tank for cracks, damage, or softened surfaces. Replace the tank if any defects are noted or a possible point of leakage is suspected.
9. Assembly is the reverse of disassembly:
   a. Clean the adapter to gasket surface.
   b. Install a new gasket (3, **Figure 10)** between the connector/adapter and the fuel tank.
   c. Do not bend the fuel gauge rod during installation.
10. Correct all fuel leakage as soon as it is detected.

Integral Fuel Tank

The only components that can be serviced without major disassembly of the boat include the fuel pickup, fuel fill, fuel level sender and antisiphon device. These components are available from most marine dealerships and marine supply stores. Removal and inspection instructions vary by model of fuel tank. Contact the tank or boat manufacturer for specific instructions. Always replace any gasket or seal if they are disturbed or suspected of leaking. Correct all fuel leakage before filling the tank or operating the engine.

Fuel Hose Connectors

Connectors used on fuel hoses include the quick connector **(Figure 12**), spring-type hose clamp **(Figure 13)** and plastic tie clamp **(Figure 14).** Never replace hose clamps with a different type or size of clamp. Improper clamp size or type can result in fuel leakage or physical interference with other engine components. To prevent leakage and ensure a reliable repair, use marine-grade clamps on all hose connections.

Replace both ends of quick connector-type clamps if either side is leaking.

When replacing the quick connector on the fuel tank hose end, simply position the connector over a container suitable for holding fuel. Remove and discard the hose clamp from the connector. Pull the fuel hose from the connector. Slide the hose onto the new connector. Install a new hose clamp onto the hose and tighten it securely.

When replacing the connector at the engine end, remove the screw or clip and then pull the connector and its grommet from the lower engine cover. Position the hose and connector over a container suitable for holding fuel. Remove the clamp and carefully pull the connector from the fuel hose. Drain the fuel from the hose. Carefully slide the hose over the new connector fitting. Install a new clamp over the hose and fitting. Securely tighten the clamp. Place the quick connector and grommet into position on the lower engine cover. Install the screw or clip onto the connector. Securely tighten the retaining screw.

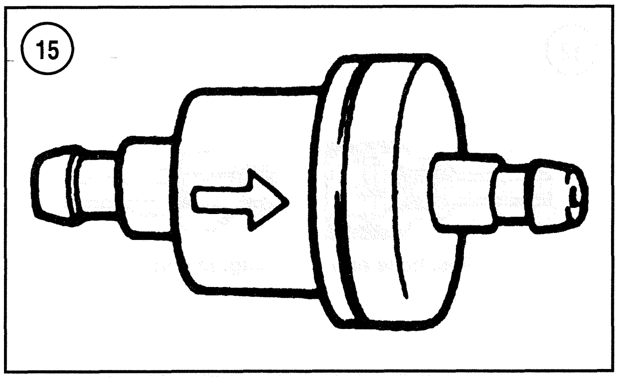
Remove the spring-type clamps (Figure 13) by squeezing the ends together using pliers while carefully moving the clamp away from the fitting. Replace the clamp if it is corroded, bent, deformed or has lost spring tension.

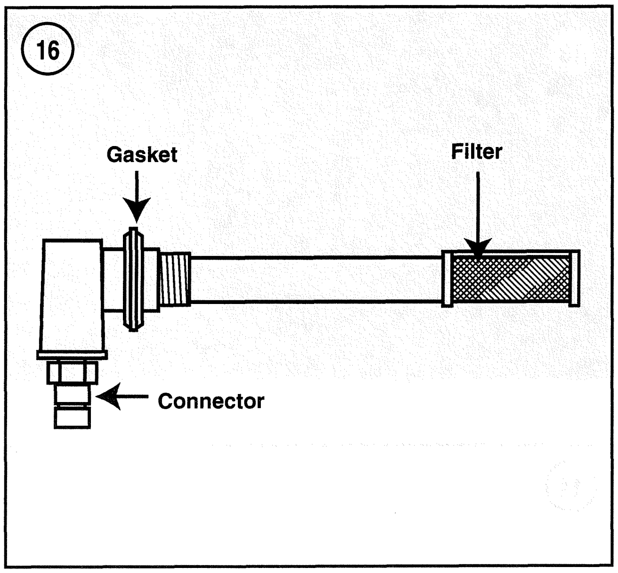
The plastic tie clamp (Figure 14) must be cut for removal. Some commonly available plastic tie clamps are not suitable for the application and may fail. Only use the hose clamps recommended by the manufacturer. After placing the clamp into position, pull the end through the clamp until the hose is securely fastened and will not rotate on the fitting. Avoid pulling the clamp too tight as the clamp may be damaged. Cut off the excess length of clamp.

FUEL FILTER REPLACEMENT

Four types of fuel filters are used. An inline fuel filter (Figure 15) is used on several models. The 2.5 and 3.5 hp models use a serviceable in-tank fuel filter pickup (Figure 16). The third is a bowl-type or canister-type fuel filter (Figure 17). The fourth is an automotive-style fuel filter used on 115-140 hp models. Trace the fuel hose from the inlet side of the fuel pump(s) to the filter. Replace the fuel filter as follows:

1. Note the location and remove any plastic tie clamps that may prevent pulling the filter and hoses away from the engine.
2. Place a suitable container or shop towel under the fuel filter to capture spilled fuel.
3. Move spring-type hose clamps (if so equipped) away from the fuel hose fittings. Carefully remove the plastic tie clamps (if so equipped) from the hoses at each end of the fuel filter.
4. Using a blunt screwdriver, push each hose away from the filter body. Drain any residual fuel from the disconnected hoses. Clean up spilled fuel at once.
5. Note the arrow on the replacement filter (Figure **15).** Note the direction in which the filter (3, Figure 17) and the O-ring (4, Figure 17) are placed into the filter canister (Figure 17). Carefully slide each fuel hose fully over its fitting. Ensure the arrow on the filter body faces the hose leading to the fuel pump(s).
6. Carefully slide the spring clamps (if so equipped) over the fittings on the filter or install new plastic clamps (if so equipped).
7. Place the filter into its original location in the lower engine cover. Route the hoses and filter away from moving components.





8. Observe the fuel filter while pumping the primer bulb to check for fuel leakage.

PRIMER BULB

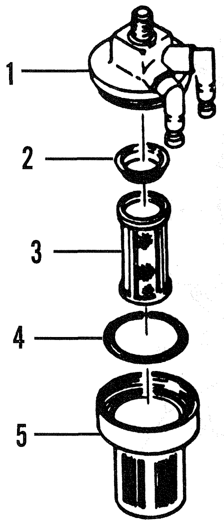
Removal and Installation

The primer bulb (Figure 18) is located in the fuel hose connecting the fuel tank to the engine.

1. Disconnect the quick connector (5, Figure 19) from the engine. Drain any residual fuel into a suitable container. Remove and discard the hose clamps (3, Figure 19) from the primer bulb.
2. Note the arrow direction on the primer bulb then remove the primer bulb from the fuel hoses. Drain any fuel remaining in the primer bulb into a suitable container.
3. Squeeze the primer bulb until it is fully collapsed. Replace the bulb if it does not freely expand when it is re-

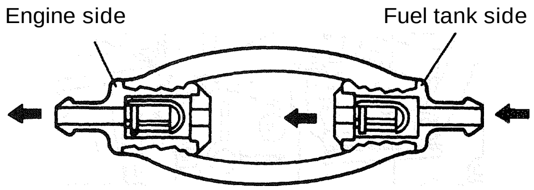
17

CANISTER TYPE FUEL FILTER ASSEMBLY



1. Filter housing
2. Gasket
3. Filter element
4. O-ring
5. Cannister

18



leased. Replace the bulb if it is weathered, has surface cracks or is hard to squeeze.
4. Inspect the fuel hoses (2, **Figure** 19) for wear, damage, or leaks. Replace both fuel hoses if defects are noted.
5. Installation is the reverse of removal. Note the direction of flow while installing the new primer bulb. The arrows must align with the direction of fuel flow toward the engine. Carefully slide the fuel hoses onto the primer bulb fittings.
6. Install new clamps. Ensure that the fuel clamps fit tightly. Squeeze the primer bulb to check for fuel leakage.

FUEL PUMPS

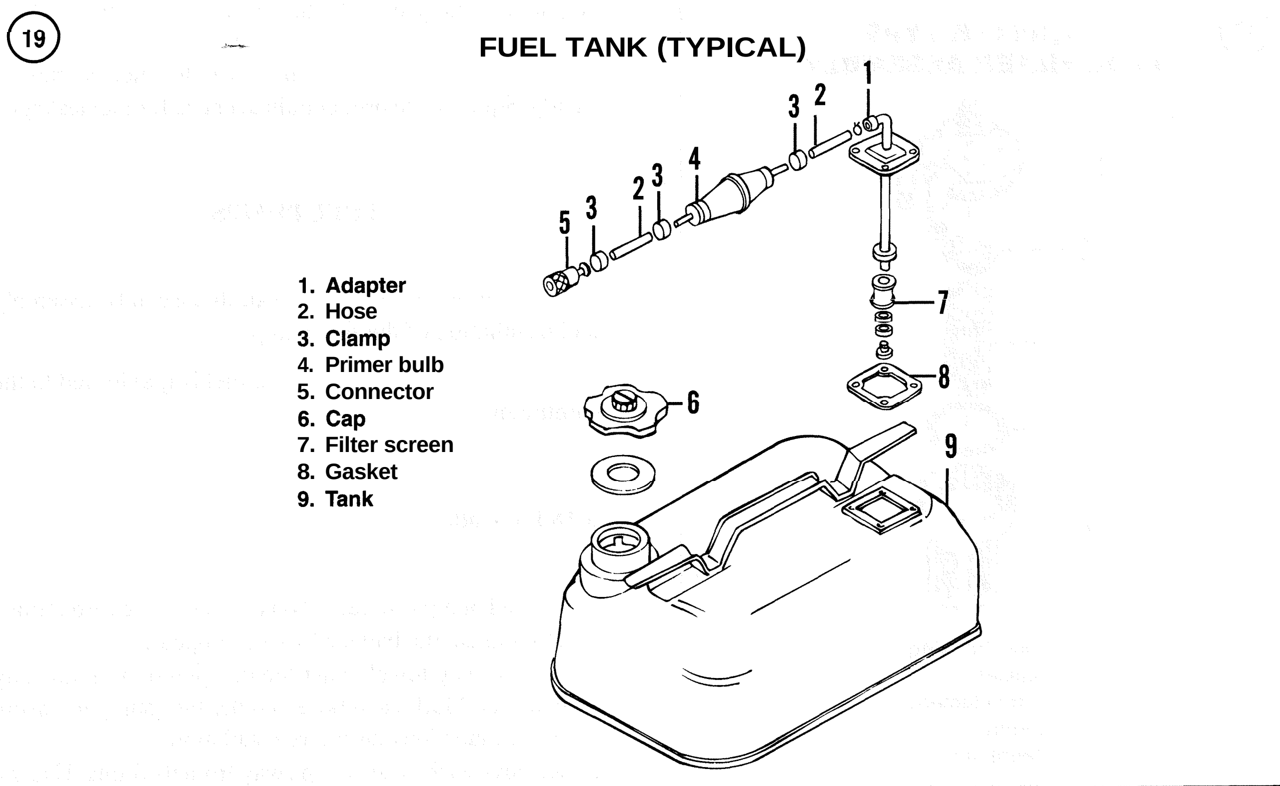
This section provides removal, disassembly, assembly and installation of the fuel pump.

On 2.5 and 3.5 hp models, the fuel is gravity fed to the carburetor.

6

5-18 hp Models

The fuel pump is mounted on the side of the carburetor.
1. Disconnect the battery (if so equipped).
2. Place a shop towel under the fuel pump to capture any spilled fuel. Mark each hose and the fuel pump to ensure correct connections during reinstallation.
3. Remove each hose clamp away from its fitting. Using a blunt screwdriver, carefully push each hose off of its fitting.
4. Remove both screws from the fuel pump. Remove the fuel pump from the carburetor. Direct the fittings into a suitable container then drain all fuel from the pump. Place the pump on a clean work surface. Remove the gasket from the mounting cover or carburetor. Clean all mounting surfaces. Stuff a small shop towel into the opening to prevent contaminating the carburetor.
5. Remove the two screws that retain the cover to the fuel pump body. Lift the cover from the fuel pump body.
6. Remove the cover gasket and diaphragm from the fuel pump.
7. Remove retainer(s) and remove the check valve(s).
8. Inspect the diaphragm for ripped, creased, or stretched surfaces. Replace the diaphragm if there are any defects.
9. Inspect the check valve for wear, cracks or damage. Replace the check valve if defects are noted.
10. Clean the fuel pump body, springs, plunger and covers using a suitable solvent. Dry the parts using compressed air. Direct air through both fuel hose fittings to clear debris.
11. Inspect the fuel pump body, both covers and both springs for corrosion or damage. Replace if any defects are noted. Inspect the plunger for wear or corrosion. Replace the plunger if defects are noted.
12. Reverse Steps 1-7 to assemble the fuel pump.

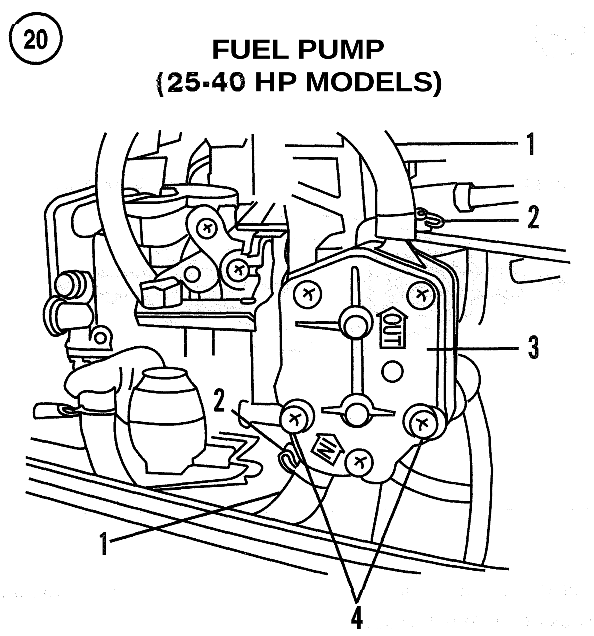


1. Adapter
2. Hose
3. Clamp
4. Primer bulb
5. Connector
6. Cap
7. Filter screen
8. Gasket
9. Tank

25, 30 and 40 hp
(Two-Cylinder) Models

The fuel pump (Figure 20) is mounted to the front half of the crankcase.

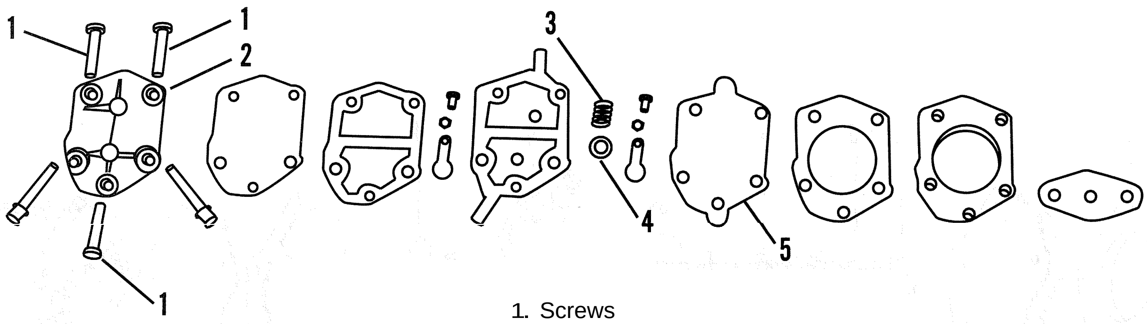
1. Disconnect the battery (if so equipped).
2. Place a shop towel under the fuel pump to capture any spilled fuel. Mark each hose and the fuel pump to ensure correct connections during installation.
3. Remove each hose clamp (2, Figure 20) from its fitting. Using a blunt screwdriver, carefully push each hose off its fitting.
4. Remove both screws (4, Figure 20) from the fuel pump (3). Pull the fuel pump and gasket away from the cylinder block. Direct the fittings into a suitable container and drain all fuel from the pump. Place the pump (3, Figure 20) on a clean work surface. Remove fuel pumps cover screws (1, Figure 21) and cover (2). Gently separate the pump components. Clean the mounting surfaces.
5. Remove and discard all gaskets and diaphragms.
6. Remove the check valves (1, Figure 22) from the pump body.
7. Clean the pump components using solvent or isopropyl alcohol.



1. Fuel hose
2. Clamp
3. Fuel pump
4. Mounting screws

21

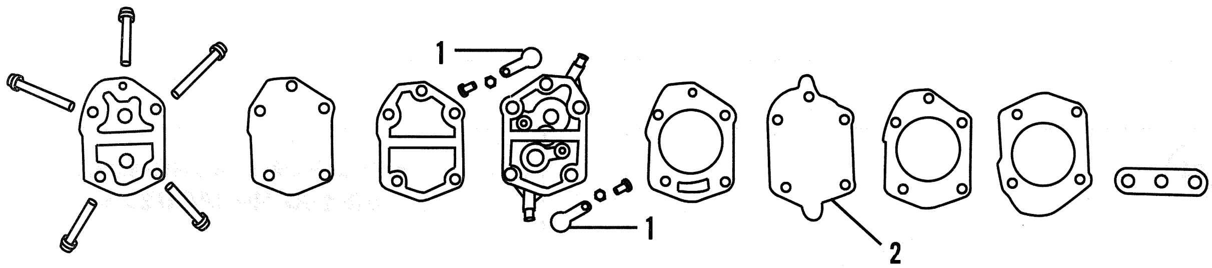
FUEL PUMP ASSEMBLY (25-40 HP MODELS)



1. Screws
2. Cover
3. Spring
4. Guide plate
5. Diaphragm

22

FUEL PUMP ASSEMBLY (25-40 HP MODELS)



1. Check valves
2. Diaphragm (white opaque)

8. Use low-pressure compressed air to dry all components. Direct air through both fuel hose fittings to clear debris.
9. Inspect the pump body (5, Figure **23)** and pump covers (1) for cracks and surface deformation.
10. Ensure the check valves (4, Figure 23) are not deformed. Inspect the guide plate (2) and spring (3) if equipped, for deformation and tension. Replace defective components.
11. Inspect the gasket between the fuel pump and crankcase for brittleness or dryness (crankcase-mounted pumps).
12. Verify that the rear pump cover has a pre-drilled pressure intake hole (Figure 24). The hole diameter must be 2 mm (0.079 in.) on crankcase-mounted pumps. Use a No. 47 drill bit and pass it through the hole.

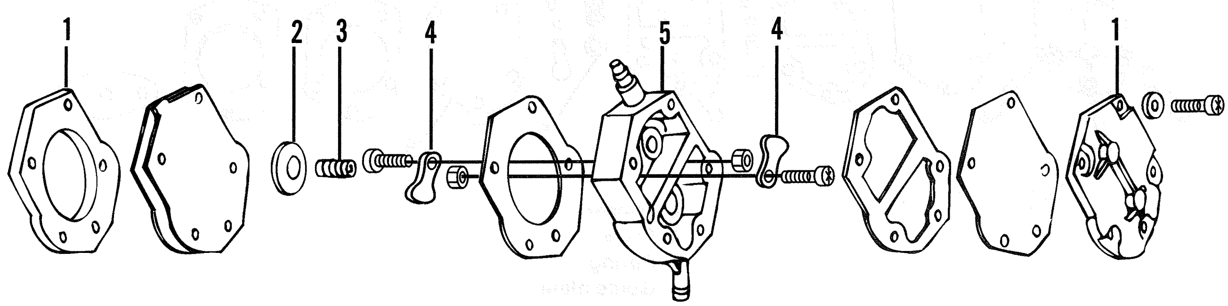
Reverse Steps 1-7 for assembly of the fuel pump.

40-140 hp Models

On these 40 and 50 (three-cylinder) hp models, the fuel pump mounts on the carburetor. On 60-140 hp models, the fuel pump mounts on the side of the front crankcase half (Figure 25).
1. Disconnect the battery (if so equipped).

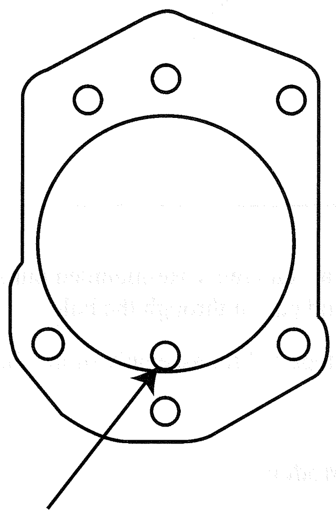
23

FUEL PUMP ASSEMBLY (25-40 HP MODELS)



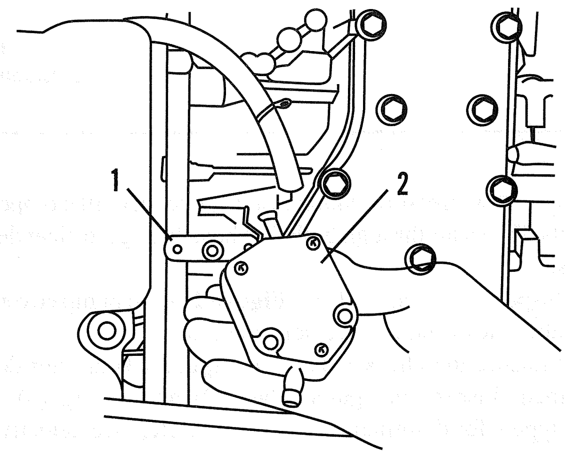
1. Cover
2. Guide plate
3. Spring
4. Check valve
5. Pump body

24

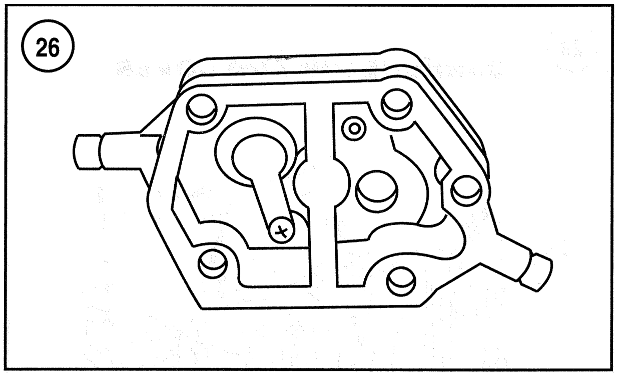


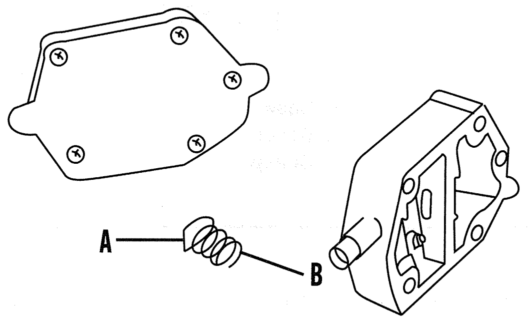
25

FUEL PUMP ASSEMBLY (60-140 HP MODELS)



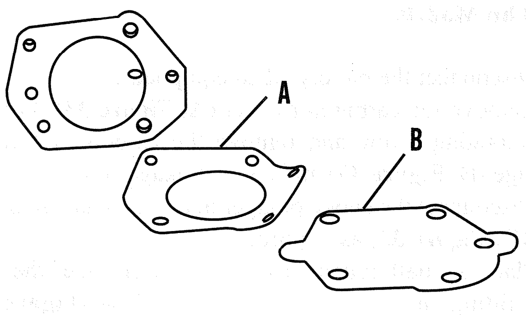
1. Gasket
2. Fuel pump





FUEL PUMP (60-140 HP MODELS)

1. Guide plate
2. Spring



FUEL PUMP (60-140 HP MODELS)

1. Gasket
2. Rubber diaphragm
3. Pump body

2. Place a shop towel under the fuel pump to capture spilled fuel. Mark each hose and the fuel pump to ensure correct connections upon installation.
3. Remove each hose clamp from its hose fitting. Using a blunt screwdriver, carefully push each hose off its fittings.
4. Remove both bolts (4, Figure 20) from the fuel pump (3). Pull the fuel pump away from the cylinder block. Direct the fittings into a suitable container then drain all fuel from the pump. Place the pump (3, Figure 20) on a clean work surface.
5. Remove the three screws that retain the outer cover and mounting cover to the fuel pump body. Gently separate the fuel pump components.
6. Remove and discard all gaskets and diaphragms.
7. Remove the check valves (Figure 26) from the fuel pump body. Inspect the check valves for worn, cracked, or broken surfaces. Replace the check valves if defects are noted.
8. Clean the fuel pump body, springs, plunger and both covers using a suitable solvent. Dry all parts using compressed air. Direct air through both fuel hose fittings to clear debris.
9. Inspect the fuel pump body and both covers for corrosion or damage. Replace defective components. Inspect both springs for corrosion or damage. Inspect the guide plate (A, Figure 27) and spring (B) for deformation and proper tension (115, 120 and 140 hp models).
10. Inspect the gaskets (A, Figure 28) and diaphragms (B) for brittleness or dryness.
11. Verify that the rear pump cover has a pre-drilled pressure intake hole (Figure 24). The hole diameter must be 2 mm (0.079 in.). Use a No. 47 drill bit and pass it through the hole.
12. Reverse Steps 1-7 to assemble the fuel pump.

CARBURETOR

The following sections cover carburetor cover and carburetor removal and installation. Also covered are carburetor disassembly and assembly. If only removing the carburetor(s), perform only the steps necessary for removal, then reverse the removal steps to install the carburetor(~).

2.5 and 3.5 hp Models

1. Disconnect the battery (if so equipped).
2. Turn off the fuel supply fuel valve and place a small container or shop towel under the fuel hose fitting, then carefully pull the fuel hose (1, Figure 29) from carburetor. Remove the cover (2, Figure 29) from the carburetor.

Loosen the clamp (3, **Figure** 29) and remove the carburetor.

3. Place a small container or shop towel under the carburetor. Remove the drain plug **(5, Figure** 30) from the float chamber; allow it to drain.

4. Lift the throttle lever **(1, Figure** 31) up and unscrew the cap **(2)** to remove the throttle assembly (3). If needed, disassemble throttle assembly.

5. Remove the float bowl (6, **Figure** 30) and float (7).

6. Remove the float valve (4, **Figure** 30) and needle valve seat (2).

7. Remove the main jet **(8, Figure** 30) and throttle stop screw (1).

8. Remove and discard the O-ring (3, **Figure** 30).

NOTE

Unless the choke is damaged, do not disassemble it.

CAUTION

Do not submerge or soak the carburetor in a caustic carburetor cleaner or a hot tank. Do not expose plastic parts to any carburetor cleaner.

9. Use a mild aerosol solvent or isopropyl alcohol to clean the metal components. To remove gummy deposits, use a soft bristle brush. Use warm soapy water to clean plastic parts.

10. Use low-pressure cornpressed air to dry all components. Direct the flow of air opposite the direction of fuel flow when drying passages.

11. Check the tip of the needle valve **(Figure** 32) for grooves, nicks, or wear. If any defects are found, replace the needle valve and seat as an assembly.

12. Check the float **(4, Figure** 30) and needle valve seat (2) for damage. Check the float **(7)** for fuel saturation or damage.

13. Check the tension of the throttle stop screw spring (1, **Figure** 30). Do not interchange the springs.

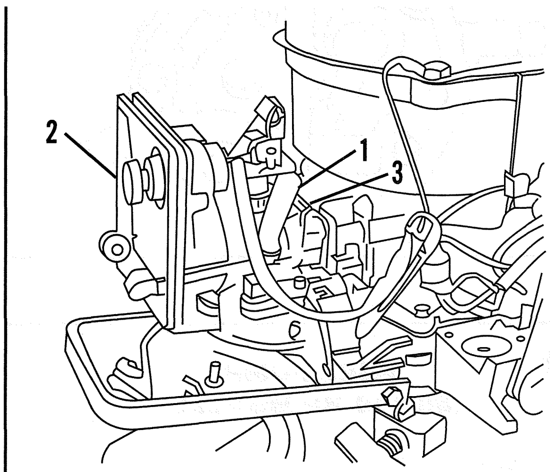
14. Inspect the main jet **(8, Figure** 30) for thread damage and blockage.

15. Check the throttle wire **(4, Figure 31**), return spring (5), spring receiver (6) and jet needle clip (7) for wear or fraying, damage or distortion. The normal clip setting is the second groove from the bottom. Move the clip up to a higher groove to make the air/fuel mixture leaner or down to the lowest groove to make the air/fuel mixture richer.

16. Check for wear or distortion of the jet needle **(8, Figure** 31). Check for nicks, scratches and wear of the slide **(9, Figure** 31).

29

CARBURETOR AND COVER



1. Hose
2. Cover
3. Clamp

17. Inspect all gasket surfaces for damage. Visually inspect the carburetor body, drain screw, float chamber, and all other parts for damage.

18. Reverse Steps **1-8** to reassemble the carburetor and carburetor cover.

19. Observe the carburetor and all fuel fittings while squeezing the primer bulb to check for leakage.

20. Perform all applicable adjustments as described in Chapter Five.

5-40 hp **Models**

1. Disconnect the battery (if so equipped).

2. Remove the carburetor cover (A, **Figure** 33). Loosen the retaining screw and remove the carburetor throttle linkage (B, **Figure** 33) and choke linkage (C).

3. Disconnect the choke plunger hook or choke knob link rod (D, **Figure** 33) as required.

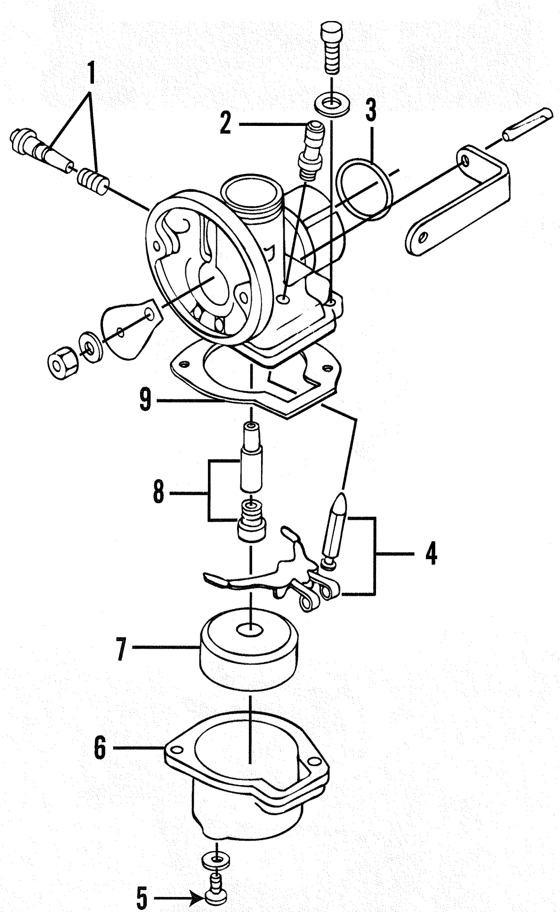
4. Place a small container or shop towel under the fuel hose fitting, then carefully push the fuel hose **(Figure** 34) from carburetor. Loosen two bolts and remove the carburetor. Discard the base gasket or O-ring seal **(Figure** 35).

NOTE

Some models are equipped with an integral fuel pump. To ensure proper cleaning of the

30

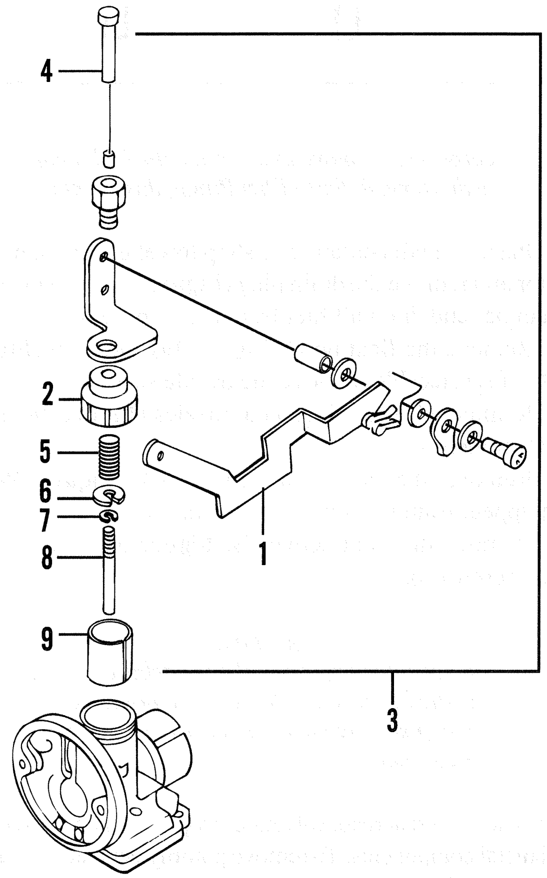
CARBURETOR ASSEMBLY (2.5 AND 3.5 HP MODELS)



1. Throttle stop screw assembly
2. Needle valve seat
3. O-ring
4. Float valve assembly
5. Drain screw
6. Float bowl
7. Float
8. Main jet assembly
9. Gasket

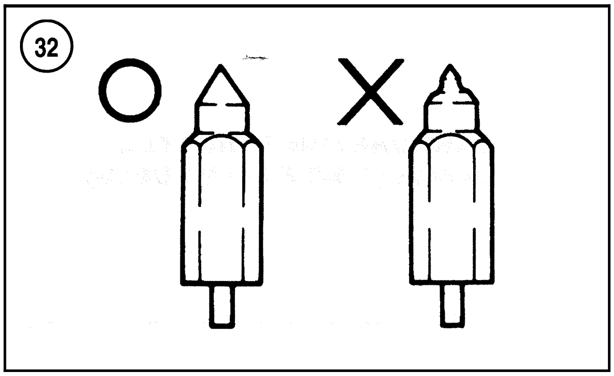
31

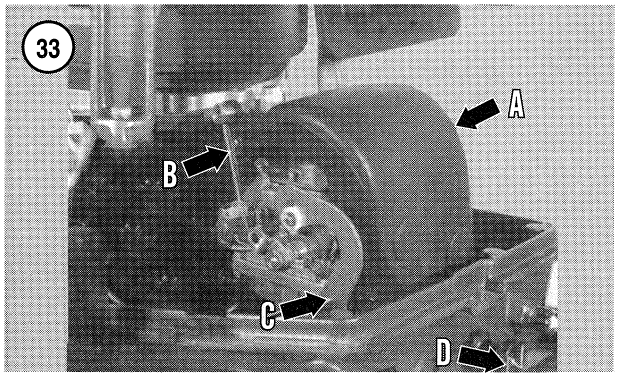
CARBURETOR THROTTLE LINKAGE (2.5-3.5 HP MODELS)



1. Throttle lever
2. Cap
3. Throttle assembly
4. Throttle wire
5. Return spring
6. Spring receiver
7. Jet clip
8. Jet needle
9. Slide

6



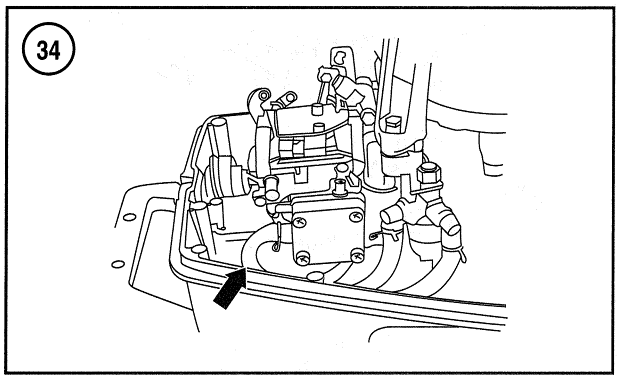


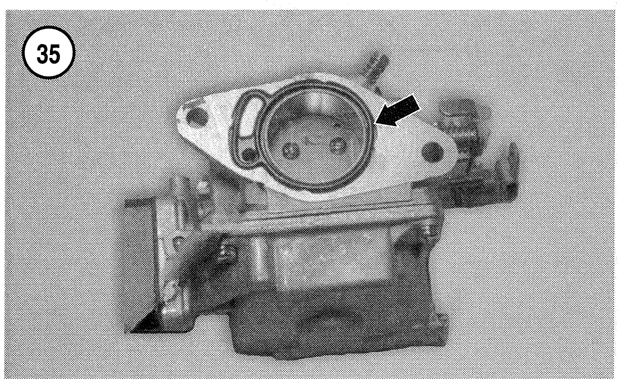
carburetor, remove and service the fuel pump at this time. Refer to ***Fuel Pump,*** *this chapter:*

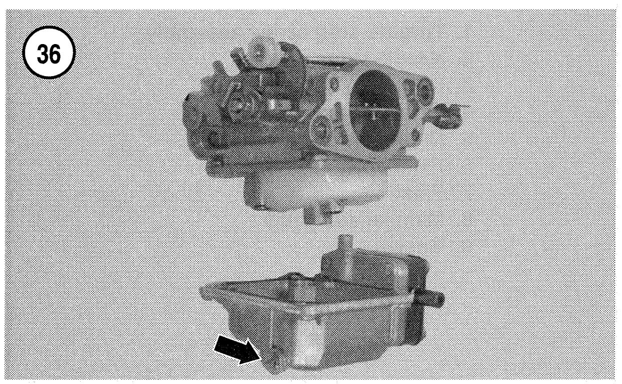
5. Place a small container or shop towel under the carburetor and remove the drain plug (Figure 36) from the float chamber and drain all fuel from the carburetor.
6. Remove the float bowl (Figure 36) and float (Figure 37). If serviceable, remove the needle seat.
7. Remove all jets, plugs and nozzles (Figure 38) from the carburetor.
8. Remove the cover and gasket (A, Figure 39) if equipped, from the top of the carburetor.
9. Remove the pilot screw (B, Figure 39) and throttle stop screw (C).

CAUTION
Do not submerge or soak the carburetor in a caustic carburetor cleaner or a hot tank. Do not expose any plastic parts to any carburetor cleaner:

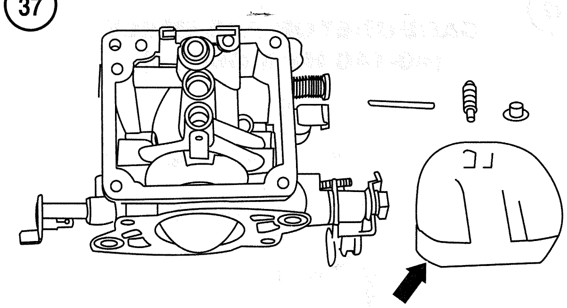
10. Use a mild aerosol solvent or isopropyl alcohol to clean all metal components. To remove gummy deposits, use a soft bristle brush. Use warm soapy water to clean plastic parts.
11. Use low-pressure compressed air to dry all components. Direct the flow of air opposite the direction of fuel flow, when drying passages.
12. Check the tip of the needle valve (Figure 32) for grooves, nicks or wear. If any defects are found, replace the needle valve and seat as an assembly. Replace the carburetor if the seat is not serviceable.
13. Check the float pin (A, Figure 40) and float clip (if applicable) for damage. Check the float (B, Figure 40) for fuel saturation or damage.
14. Inspect the pilot screw **(3,** Figure 41) for thread damage. Check the tip for nicks, grooves, or distortion.
15. Check the tension of the throttle stop screw (5, Figure 41) and throttle stop screw spring (8). Do not interchange the springs.



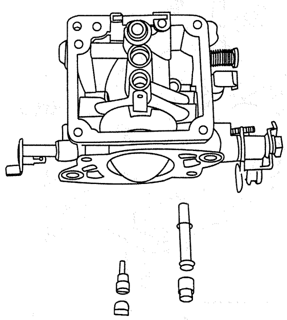




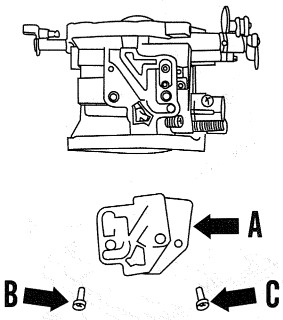
37



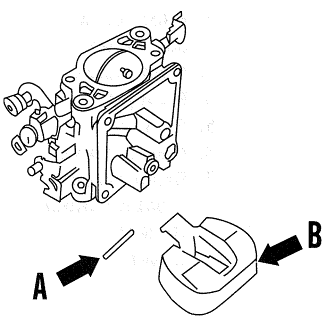
38



39

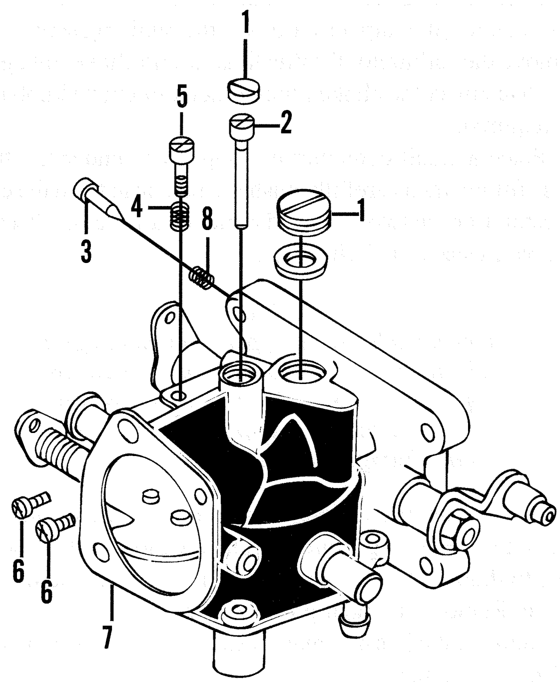


40



41

CARBURETORUPPERBODY ASSEMBLY (5-40 HP MODELS)



1. Plugs
2. Jet
3. Pilot screw
4. Spring
5. Throttle stop screw
6. Jets
7. Carburetor
8. Pilot screw spring

16. Inspect all jets (2 and 6, **Figure 41)** for thread damage and blockage.
17. Inspect all gasket surfaces for damage. Inspect the carburetor body, drain plug, float chamber, and all other parts for damage.
18. Reverse Steps 1-10 to reassemble the carburetor and carburetor cover.
19. Observe the carburetor and all fuel fittings while squeezing the primer bulb to check for leakage.
20. Perform all applicable adjustments as described in Chapter Five.

40-140 hp Models

Refer to **Figures 42-44** during this procedure.

1. Disconnect the battery, if so equipped.
2. Loosen the fasteners and remove the carburetor cover and oil tank (if equipped). Loosen the retaining screw and remove the carburetor throttle linkage and choke linkage.
3. Disconnect the choke plunger hook or choke knob rod as required.
4. Place a small container or shop towel under the fuel hose fitting. then carefully push the fuel hose from the carburetor. Loosen two bolts and remove carburetor. Discard the base gasket or O-ring seal.

NOTE
Some models are equipped with an integral fuel pump (bottom carburetor). To ensure proper cleaning of the carburetor, remove and service the fuel pump at this time. Refer to ***Fuel Pump,*** *this chapter:*

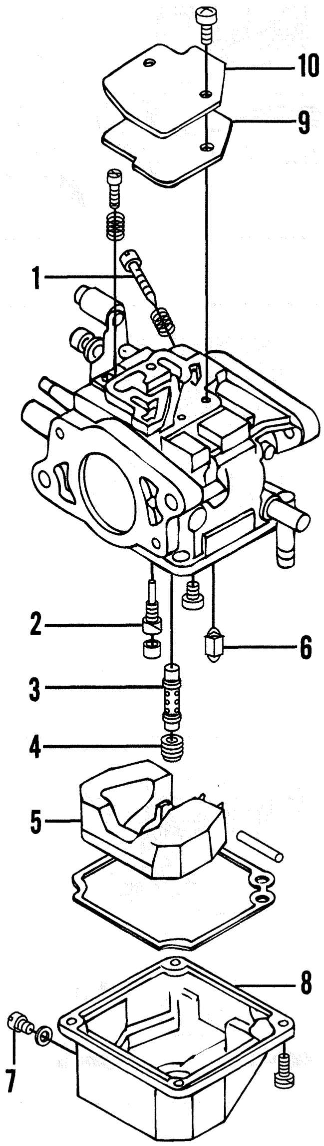
5. Place a small container under the carburetor and remove the drain plug from the float chamber and allow all fuel to drain. Remove the float chamber, float and needle valve. Remove the float pin and float.
6. Remove the jets and main nozzle from the bottom side of the carburetor.
7. Remove the cover and gasket from the top of the carburetor.
8. Remove the pilot screw and throttle stop screw (if equipped). Do not interchange the springs.
9. Remove any serviceable plugs and jets.

CAUTION
Do not submerge or soak the carburetor in a caustic carburetor; cleaner; or hot tank. Do not expose any plastic parts to any carburetor cleaner:

10. Use a mild aerosol solvent or isopropyl alcohol to clean all metal components. To remove gummy deposits, use a soft bristle brush. Use warm soapy water to clean plastic parts.
11. Use low-pressure compressed air to dry all components. When drying passages, direct the flow of air opposite the direction of fuel flow.
12. Check the tip of the needle valve **(Figure 32)** for grooves, nicks, or wear. If any defects are found, replace the needle valve and seat as an assembly. Replace the carburetor if the seat is not serviceable.
13. Check the float pin and the float clip (if applicable) for damage. Check the float for fuel saturation or damage.
14. Inspect the pilot screw for thread damage. Check the tip for nicks, grooves, or distortion.

42

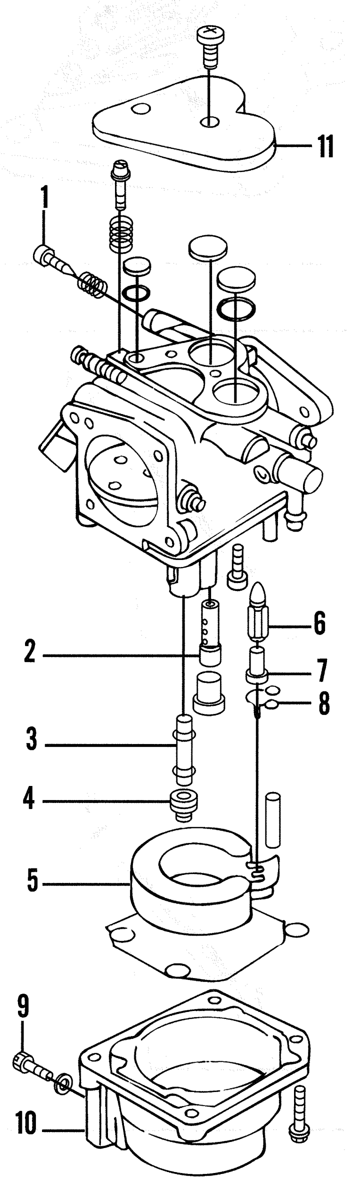
CARBURETOR ASSEMBLY (40-140 HP MODELS)



1. Pilot screw
2. Jet (slow)
3. Main nozzle
4. Main jet
5. Float/pin
6. Needle valve
7. Drain screw
8. Float chamber
9. Gasket
10. Cover

43

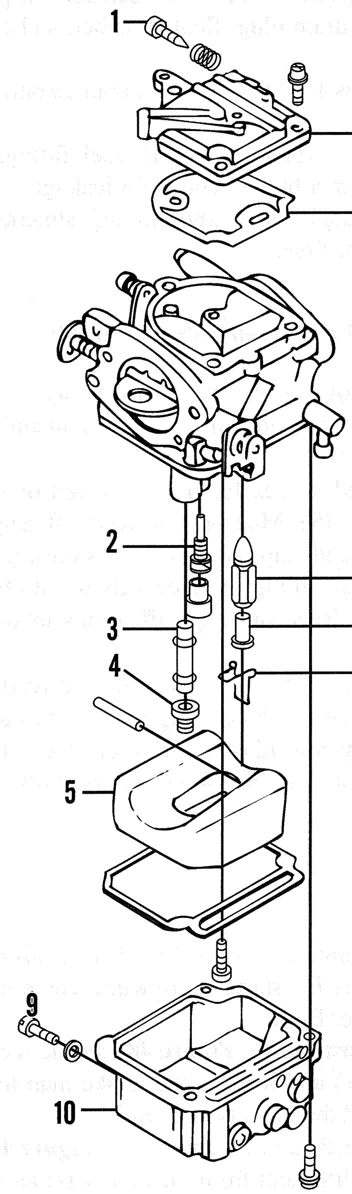
CARBURETOR ASSEMBLY
(40-140 HP MODELS)



1. Pilot screw
2. Jet (slow)
3. Main nozzle
4. Main jet
5. Float
6. Needle valve
7. Needle valve pin
8. Clip
9. Drain screw
10. Float chamber
11. Cover

44

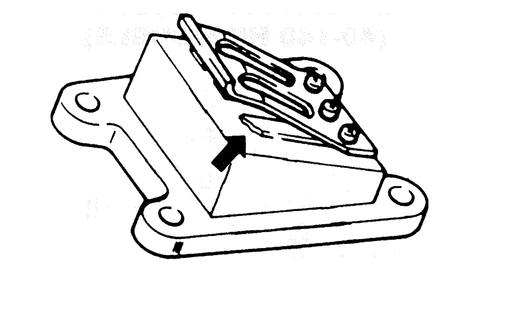
CARBURETOR ASSEMBLY
(40-140 HP MODELS)



1. Pilot screw
2. Jet (slow)
3. Main nozzle
4. Main jet
5. Float
6. Needle valve
7. Needle valve pin
8. Clip
9. Drain screw
10. Float chamber
11. Cover
12. Gasket

15. Check the tension of the pilot screw and the throttle stop screw springs. Do not interchange the springs.
16. Inspect all jets for thread damage and blockage.
17. Inspect all gasket surfaces for damage. Inspect the carburetor body, drain plug, float chamber, and all other parts for damage.
18. Reverse Steps 1-10 to reassemble the carburetor and carburetor cover.
19. Observe the carburetor and all fuel fittings while squeezing the primer bulb to check for leakage.
20. Perform all applicable carburetor adjustments as described in Chapter Five.

45

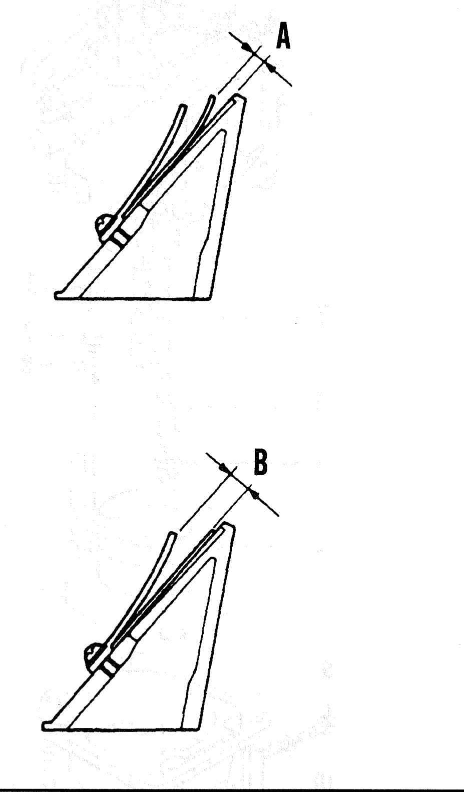


Intake Manifold and Reed Valve Assembly

This section provides removal, disassembly, inspection and assembly instructions for the intake manifold and reed valve assembly.

Inspect all reed valves for bent, cracked or missing sections (Figure 45). Measure the reed lift height (A, Figure 46) and reed stop (B) dimensions during inspection and after assembling the reed valves onto the reed block or housing. Reed valve specifications are provided in Table 5.

46



The one-cylinder (2.5-5 hp) models use reed valves mounted in the cylinder block (Figure 47). Partial disassembly of the power head is required for access. Refer to Chapter Eight for cylinder block disassembly and assembly.

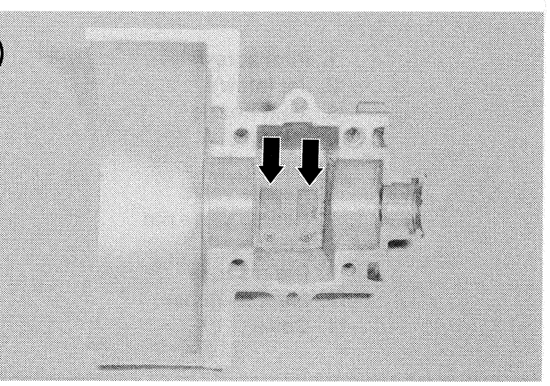
8-40 hp models

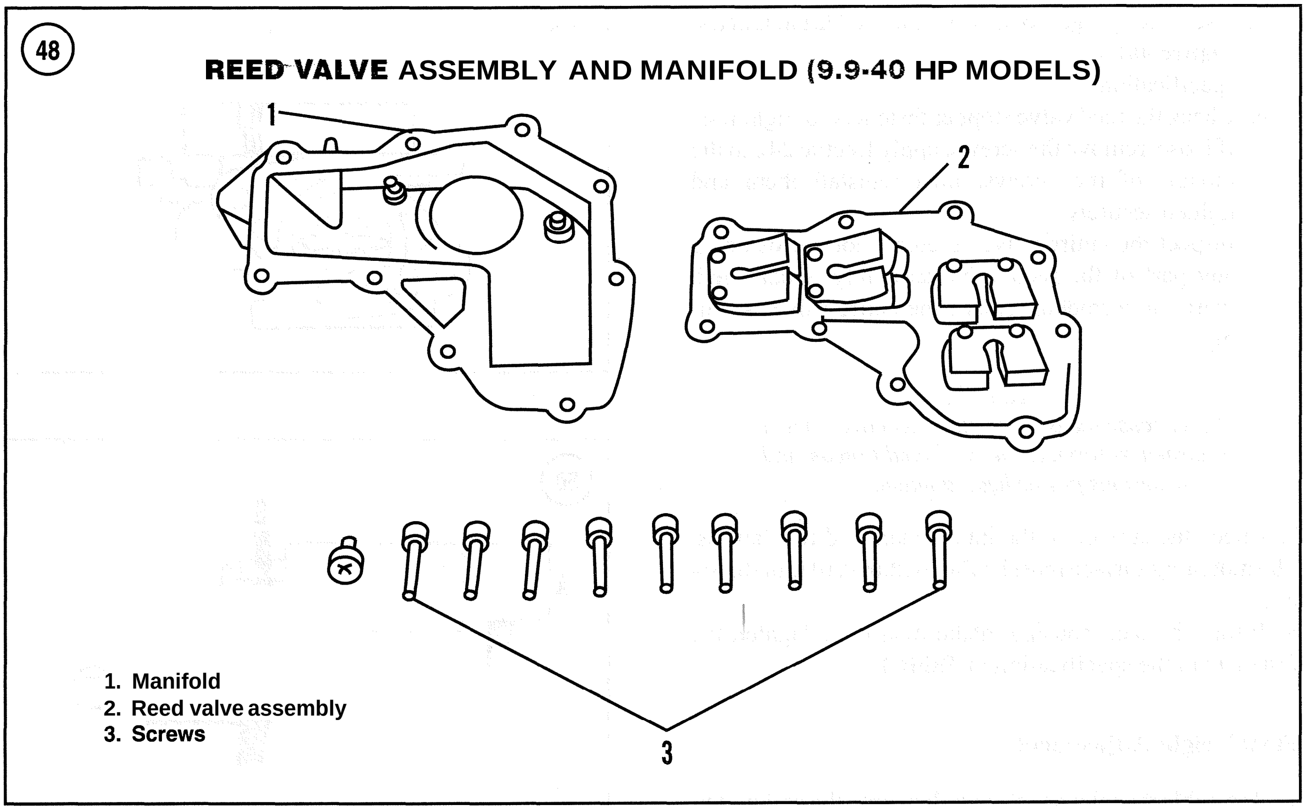
1. Remove the carburetor(s) as described in this chapter.
2. Remove the rewind starter or flywheel cover as applicable. See Chapter Eight.
3. Remove the fastener (3, Figure 48) for the reed valve housinglintake (1) and remove the intake manifold. Remove and discard the gaskets and seals.
4. Remove the reed valve assemblies (2, Figure 48) from the manifold, or lift them from the crankcase as applicable. Do not disassemble the reed valve assemblies.

NOTE
The 9.9-18 hp engine reed valve assemblies are held in place by two 6 mm nuts instead of screws.

5. Inspect the reed valves, reed valve contact surfaces and reed stops for cracks, wear or damage (Figure 45). Reeds must be seated flat without any preload.
6. Assembly is the reverse of disassembly, noting the following:

47





a. Replace all gaskets and seals for the reed housing, intake and reed blocks.
b. Using feeler gauges, measure the reed lift height (A, Figure 46). Compare the reed tip opening with the specification listed in Table 5.
c. Check the reed valve stopper fasteners for tightness. If loose, remove the screws, apply Loctite 242 to the threads of the screws, then reinstall them and tighten securely.
d. Inspect the entire valve assembly for corrosion. If any part of the reed valve assembly is damaged, worn, or corroded, the entire valve assembly must be replaced.

CAUTION

Never reuse reeds by turning them over. When returned to service, the reed could break and cause serious power head damage.

7. Check the surface of intake manifold for flatness. The mounting surface must be flat, within 0.10 mm (0.004 in.).
8. Install the reed housinglintake manifold, gaskets and fasteners. Tighten the fasteners to the specification listed in Table 1.

40-140 hp models

1. Remove the carburetor(s) as described in this chapter.
2. Remove the recoil starter or flywheel cover as applicable. Refer to Chapter Eight.
3. Remove the fasteners for the reed valve housinglintake and remove the intake manifold. Remove and discard the gaskets and seals.
4. Remove the reed valve assemblies from the manifold. Do not disassemble the reed valve assemblies.

NOTE

On 80-140 hp models, the reed valve assemblies are not bolted to the intake manifold. Valve assemblies could fall off the manifold and become damaged while being removed from the engine.

5. Inspect the reed valves (Figure **45**), reed valve contact surfaces and reed stops for cracks, wear or damage. Reeds must be seated flat without any preload. Inspect the valve seat surfaces for wear, burrs or damage.
6. Assembly is the reverse of disassembly, noting the following:

a. Replace all gaskets and seals during assembly.

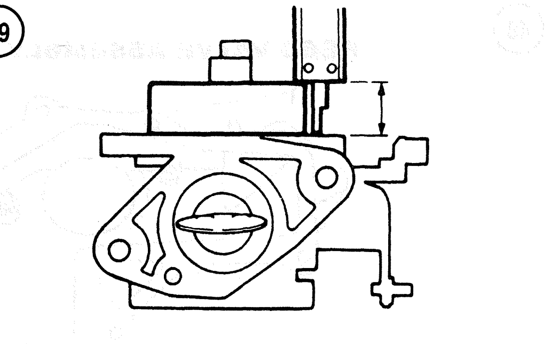
b. Use feeler gauges to measure the reed lift height (A, **Figure 46).** Compare the reed tip opening with the specification listed in **Table** 5.
c. Check the reed valve stopper fasteners for tightness. If loose, remove the screws, apply Loctite 242 to the threads of the screws, then reinstall them and tighten securely.
d. Inspect the entire valve assembly for corrosion. If any part of the reed valve assembly is damaged, worn, or corroded: replace the entire valve assembly.

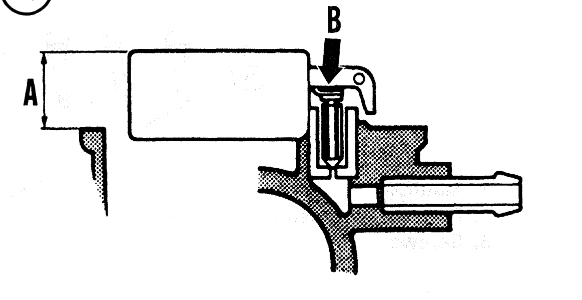
CAUTION
Never reuse reeds by turning them over. When returned to service, the reed could break and cause serious power head damage.

7. Check the surface of the intake manifold for flatness. The mounting surface must be flat, within 0.10 mm (0.004 in.).
8. Install the reed housing/intake manifold. Tighten the fasteners to the specification in **Table 1.**

Float Height Adjustment

1. Assemble the inlet needle and float onto the carburetor. Ensure the needle clip is positioned over the float tab.
2. Turn the carburetor upside down as indicated in **Figure 49.** Allow the tab on the float (B, **Figure** 50) to just rest on the inlet needle.
3. Measure the distance from the carburetor body to the bottom surface of the float (A, **Figure** 50).
4. Compare the measurement with the specification listed in **Table** 5.

49


50


5. Bend the metal tab (B, **Figure** 50) up or down until the specified measurement is attained.

NOTE
On 40 and 50 hp three-cylinder engine models, the float tab cannot be adjusted.

Table 1 FUEL SYSTEM TORQUE SPECIFICATIONS

Description	N•m (in.-lb.)
Carburetor mounting bolt	
5-18 hp	4.6-6.2 (40-55)
40-70 hp three cylinder	5-6 (44-53)
Air silencer bolt	
2.5-5 hp	1.5-2.0 (13.2-16.8)
8-9.8 hp	4.6-6.2 (40-55)
9.9-18 hp	2.5-3.4 (21.6-30.0)
25-30 hp	4.9-6.4 (43.2-54.6)
40 hp two cylinder	4.9-6.4 (43.2-54.6)
60-70 hp	8-10 (71-88)
	(continued)

Table 1 FUEL SYSTEM TORQUE SPECIFICATIONS (continued)

Description	N•m (in.-lb.)
Intake manifold bolts	
8-40 hp two cylinder	4.9-6.4 (43-54)
40-50 hp three cylinder	6 (53)
60-70 hp	9 (80)
80-90 hp	6 (53)
Air silencer cover bolt	
60-90 hp	1 (8.9)
115-140 hp	3-5 (26-44)
Reed valve mounting screw	
2.5-5 hp	4.9-6.4 (43-54)
8-9.8 hp	0.7-0.9 (6-8)
25-40 hp two cylinder	4.9-6.4 (43-54)
Reed valve mounting nut	
9.9-18 hp	4.9-6.4 (43-54)

6

Table 2 CARBURETOR SPECIFICATIONS

Model	Main jet	Main air jet	Idle jet	Idle air jet
2.5A-3.5A	–	–	–	–
3.5B	#92	–	–	–
2.5A2-3.5A2	–	–	–	–
3.5B2	#86	–	–	–
5-30 HP	–	–	–	–
40D	#125	#210	#66	#130
40D2	#122	#190	#66	#130
50D	#135	#230	#74	#130
50D2				
Top and middle	#132	–	–	–
Bottom	#135	#230	#80	#150
60B	#145	#145	#75	#75
60C				
Top and bottom	#138	–	–	–
Middle	#140	#155	#72	#75
70B	#145	#145	#75	#75
70C				
Top and bottom	#138	–	–	–
Middle	#140	#155	#72	#75
80-90	#150	#175	#75	#90
115-120	#162	#160	#75	#70
140	#162	#160	#75	#75

Table 3 PILOT SCREW ADJUSTMENT

Model	Pilot screw turns-out
2.5A-3.5A	–
3.5B	–
2.5A2-3.5A2	–
3.5B2	–
5-30 HP	–

(continued)

Table 3 PILOT SCREW ADJUSTMENT (continued)

Model	Pilot screw turns-out
40D	1/2 to 2
40D2	3/4 to 2 1/4
50D	2 to 3 1/2
50D2	2 to 3 1/2
60B	1 1/4 to 1 3/4
60C	1 1/4 to 1 3/4
70B	1 1/4 to 1 3/4
70C	1 1/4 to 1 3/4
80-90	1/4 to 1 3/4
115-120	1 1/4 to 1 3/4
140	1 1/4 to 1 3/4

Table 4 FLOAT HEIGHT

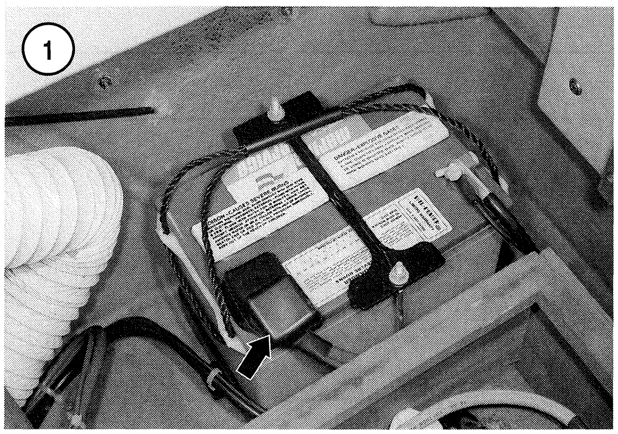
Model	Float height
40D-40D2	15.0 mm (0.591 in.)
50D-50D2	15.0 mm (0.591 in.)
60C-70C	14.0 mm (0.551 in.)
80A-90A-115A2-120A2-140A2	19.5 mm (0.768 in.)

Table 5 REED VALVE LIFT HEIGHT

Model	Lift height limit
8-9.8	5.0-5.2 mm (0.197-0.204 in.)
2.5-40	6.0-6.2 mm (0.236-0.244 in.)
40 three-cylinder	6.5-6.7 mm (0.25-0.26 in.)
50	9.3-9.5 mm (0.36-0.37 in.)
60-90	10.0-10.2 mm (0.39-0.40 in.)
115-140	9.3-9.5 mm (0.36-0.37 in.)

Chapter Seven

Electrical and Ignition Systems



1

BATTERY

Batteries used in marine applications are subjected to considerably more vibration and pounding than automotive applications. Always use a battery designed for use in marine applications. Marine batteries are constructed with thicker cases and plates than typical automotive batteries. This allows them to better withstand the marine environment.

Use a battery that meets or exceeds the cold cranking amperage requirements for the engine. Cold cranking amperage requirements are provided in **Table** 25. Some marine batteries list *marine/deep* ***cycle*** on the label. Deep cycle batteries are constructed to allow repeated discharge and charge cycles. These batteries are excellent for powering accessories such as trolling motors. Always charge deep cycle batteries at a low amperage rate. A deep cycle battery is not designed to be charged or discharged rapidly. Rapid charging rates can significantly reduce the life of a deep cycle battery.

Deep cycle batteries can be used as the starting battery, providing they meet the cold cranking amperage requirements for the engine.

Make sure the battery is securely mounted in the boat to avoid dangerous acid spills or electrical arcing that can cause a fire. The most common types of battery mounting include the bracket mounted to the floor of the boat and the support across the top of the battery **(Figure 1).** The other common type of battery mounting is the battery case and cover that encloses the battery and secures it to the boat structure **(Figure 2).** When properly installed, either of these methods provides secure mounting and protection for the terminals.

Mount the battery in a location that allows easy access for maintenance. Ensure that the battery terminals are not able to contact any component in the mounting area.

WARNING
When mounting a battery in an aluminum boat, take extra precaution to ensure the battery is mounted securely to eliminate the possibility of the battery contacting metal components. Electrical arcing can result in a fire or explosion if a fuel source is present. Batteries produce explosive gasses that can ignite if arcing is present.

Battery Inspection

Inspect the battery case for cracks, leakage: abrasion and other damage when the battery is removed for charging. Replace the battery if any questionable conditions exist. During normal usage, a corrosive deposit forms on the top of the battery. These deposits may allow the battery to discharge at a rapid rate, as current can travel through the deposits from one post to the other.

Make sure the battery caps are properly installed. Remove the battery from the boat and carefully wash any loose material from the top of the battery with clean water.

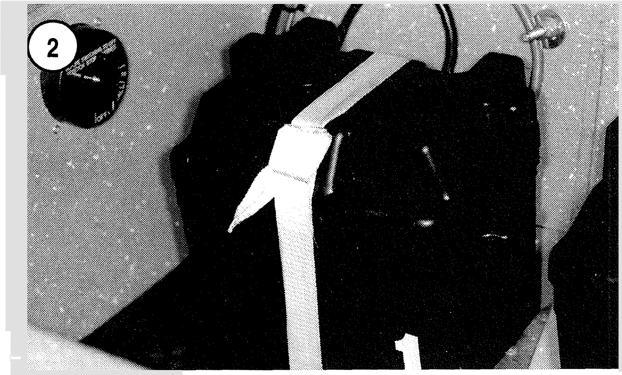
CAUTION
Do not allow the baking soda and water solution to enter the battery cells or the electrolyte will be seriously weakened.

Use a solution of warm water and baking soda along with a soft bristle brush to clean deposits from the battery **(Figure 3).** Again wash the battery with clean water to remove all of the baking soda solution from the battery case.

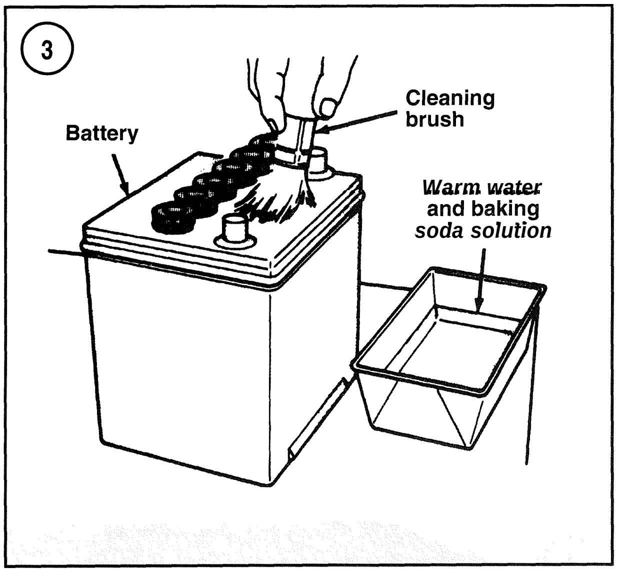
CAUTION
Never overfill the battery. The electrolyte may expand with the heat created during charging and overflow from the battery.

Check the battery electrolyte level on a regular basis. Heavy usage or usage in warm climates increases the need for adding water to the battery. Carefully remove the vent caps **(Figure 4)** and inspect the electrolyte level in each cell. The electrolyte level should be 3116 in. (4.8 mm) above the plates yet below the bottom of the vent well **(Figure 4).** Use distilled water to fill the cells to the proper level. Never use battery acid to correct the electrolyte level.

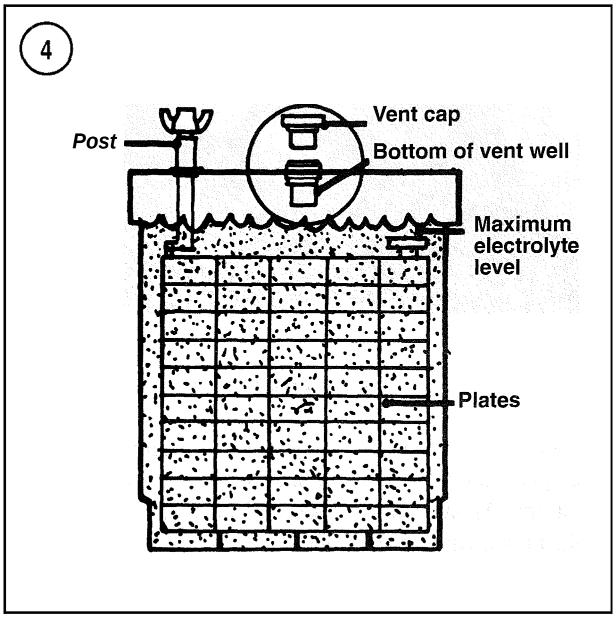
2



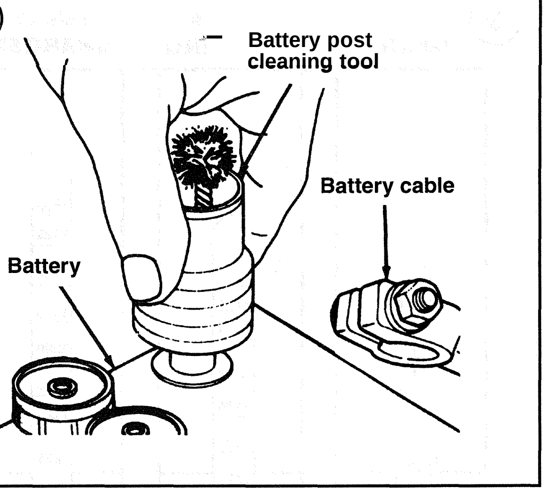
3



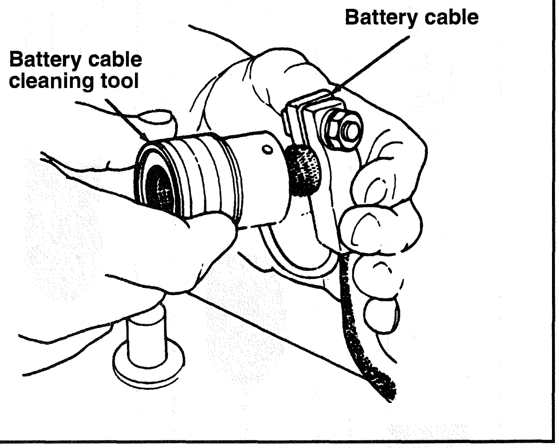
4



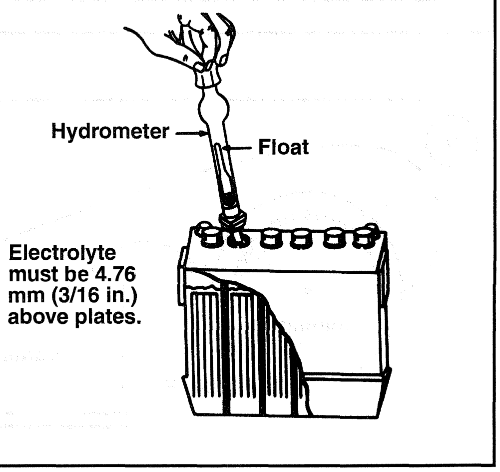
5



6



7



Clean the battery terminals at regular intervals. Use a battery cleaning tool (available at most automotive part stores) to quickly remove stubborn corrosion and deposits. Remove the terminal and clean the post as shown in **Figure** 5. Rotate the tool on the post until the post is free of corrosion. Avoid removing too much material from the post or the terminal may not attach securely to the post.

Use the other end of the tool to clean the cable end terminal. Clean flat-spade type connectors and the attaching nuts with the wire brush end of the tool **(Figure 6).**

Apply a coat ofpetroleum gel (Vaseline) or other corrosion preventative on the battery post and cable terminal. Tighten the fasteners securely. Avoid using excessive force when tightening these terminals.

Battery Testing

NOTE

Inaccurate readings result if the specific gravity is checked immediately ajter adding water to the battey. To ensure accuracy, charge the battey at a high mte for 15-20 minutes.

Two methods are commonly used to test batteries. A load tester measures the battery voltage as it applies a load across the terminals. Follow the instructions provided with the load tester.

Perform the *Cranking Voltage Test* as described in this chapter to check the battery condition if you do not have access to a load tester.

Use a hydrometer to check the specific gravity of the battery electrolyte. This gives an accurate reading of the state of charge. Hydrometers are available at most automotive part stores. Select one that has a number graduation that spans 1.100-1.300 readings.

To use the hydrometer, insert the tip into the vent opening and use the rubber bulb to draw some of the solution from a single cell into the hydrometer **(Figure** 7). Read the specific gravity in all cells. When using a temperature-compensating hydrometer, take several readings in each cell to allow the thermometer to adjust to the electrolyte temperature. Always return the electrolyte to the cell from which it was drawn. With the hydrometer in a vertical position, determine the specific gravity by reading the number on the float that is even with the surface of the electrolyte **(Figure 8).** A specific gravity reading of 1.260 or higher indicates a fully charged battery. Always charge the battery if the specific gravity varies more than 0.050 from one cell to another.

NOTE

Add 0.004 to the reading for every 10° above 25" C (80° F) when the hydronzeter is *not a temperature-compensating model. Subtract 0.004 from the reading for every 10° below 25" C (80° F).*

Cranking Voltage Test

If a load tester is unavailable, use the outboard's starter motor to apply a load to the battery while checking the battery voltage.

1. Connect a voltmeter to the battery.
2. Crank the engine while noting the voltmeter **(Figure 9)**.
3. The battery should maintain at least 9.6 volts under cranking load.
   a. If the cranking voltage is less than 9.6 volts, charge the battery as described in this chapter and repeat this test.
   b. Replace the battery if it cannot maintain 9.6 volts or more cranking voltage after charging.

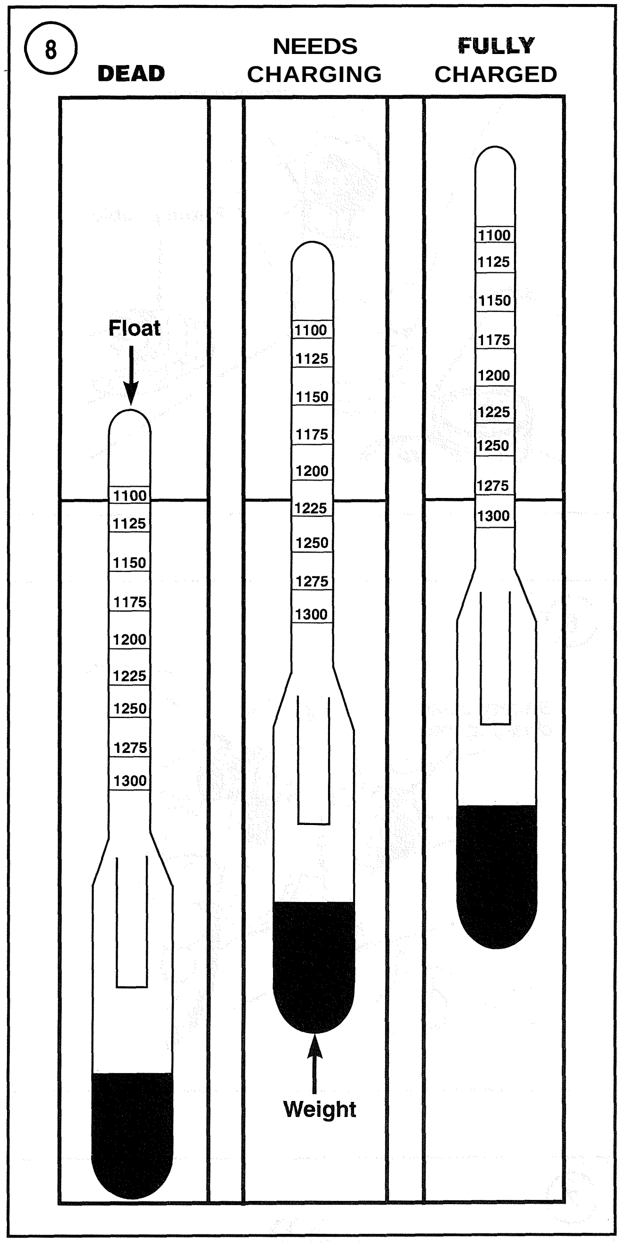
Battery Storage

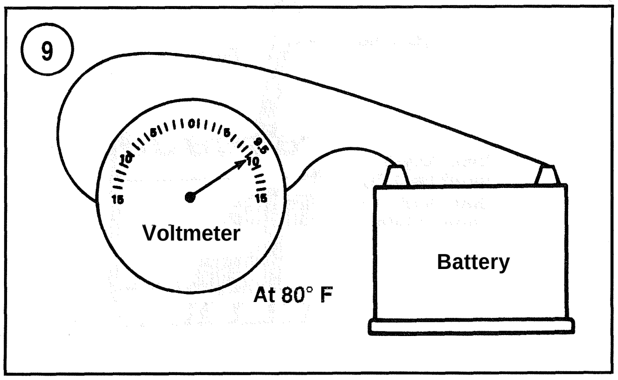
Batteries lose some of the charge during storage. The rate of discharge increases in a warm environment. Store the battery in a cool dry location to minimize the loss of charge. Check the specific gravity every 30 days and charge the battery as required. Perform the maintenance on the battery case and terminals as described in this chapter. Refer to *Battery Charging* (in this chapter) for battery charging times.

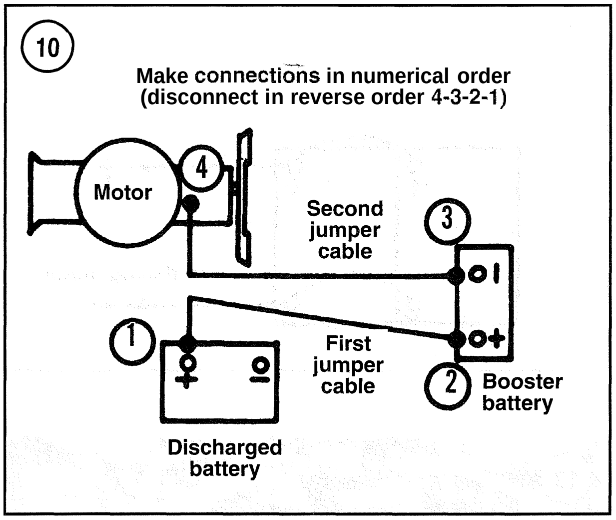
Battery Charging

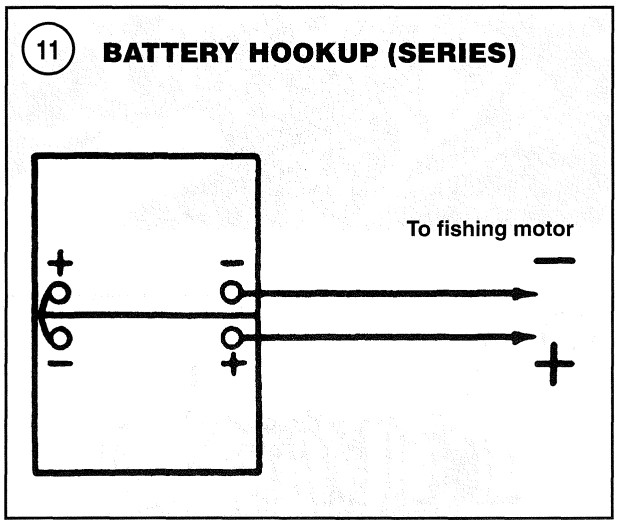
WARNING
Batteries produce explosive hydrogen gas, especially during charging. Charge the battery in a well-ventilated area. Wear protective eyewear and suitable gloves when working around batteries. Never smoke or allow any source of ignition in the area where batteries are stored or charged. Never allow any non-insulated conzponents to contact the battery terminals, as arcing can occur and ignite the hydrogen gas.

Although removal is not necessary to charge the battery, always remove it from the boat for charging. The battery produces explosive hydrogen gas during charging and in addition to the explosion hazard, the gas causes accelerated corrosion of metal components in and around the battery compartment. Removal also allows more effective battery inspection and cleaning.









1. Connect the charger to the battery before switching the charger on. Attach the positive charger cable to the positive battery terminal and the negative cable to the negative battery terminal. Be certain that the charger is connected in the correct polarity.

2. Set the charger voltage to 12 volts.

3. Charging the battery at a slow rate (low amperage) results in a more efficient charge and helps prolong the life of the battery. With a severely discharged battery, it may be necessary to charge the battery at a higher amperage rate for a few minutes before starting the lower rate charge. A severely discharged battery may not allow the chemical process to begin without first *boost* charging at the high rate.

4. Battery charging times vary by the battery capacity and the state of charge. Check the specific gravity often and halt the charging process when the battery is fully charged. Severely discharged batteries may require as long as eight hours to recharge. Check the temperature of the electrolyte during the charging process. Halt the charging process if the electrolyte temperature reaches or exceeds 53" C (125° F).

Jump Starting

Jump-starting can be dangerous if perfonned incorrectly. Never attempt to jump-start a frozen battery. Always check and correct the electrolyte level in each battery before making any connection. A significant risk of explosion exists if the electrolyte level is below the top of the plates. Always use a good pair of jumper cables with clean clamps. Keep all clamps totally separate from any metallic or conductive material. Never allow the clamps to contact other clamps.

1. Connect the jumper cable to the positive terminal of the discharged battery (1, Figure 10).
2. Connect the same jumper cable to the positive terminal of the fully charged battery (2, Figure 10).
3. Connect the second jumper cable to the negative terminal of the fully charged battery (3. Figure 10).
4. Connect the second jumper cable remaining to a good engine ground such as the starter ground cable (4, Figure 10).
5. Make sure the cables and clamps are positioned so they will not become trapped or interfere with moving components.
6. Start the engine, then remove the cables in exactly the reverse of the connection order (Steps 4-1).

Wiring for 12- and 24-Volt Electric Trolling Motors

Many fishing boats are equipped with an electric trolling motor that requires 24 volts to operate. Two or more batteries are necessary with these applications. A series battery hookup (Figure 11) provides 24 volts for the trolling motor.

A series connection provides the approximate total of the two batteries (24 volts). The amperage provided is the approximate average of the two batteries.

Connect the trolling motor batteries in a parallel arrangement (Figure 12) if the accessory requires 12 volts to operate.

The voltage provided is the approximate average of the two batteries (12 volt). The amperage provided is the approximate total of the two batteries.

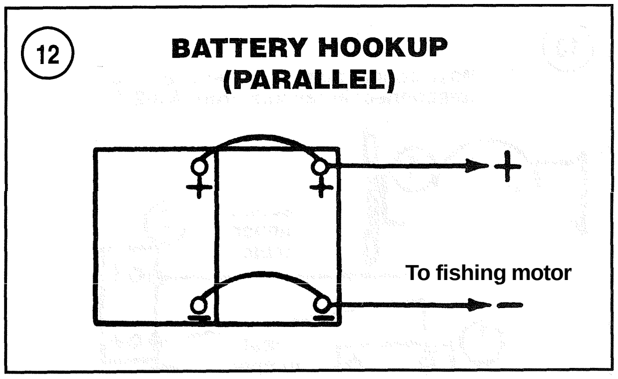
Dedicate a battery for cranking the gasoline motor if at all possible.

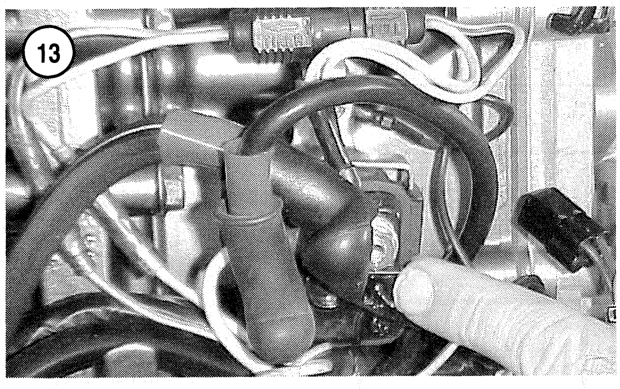
ELECTRIC STARTING SYSTEM

Starter Relay Removal and Installation

All electric start models use a rubber mounted type starter relay **(Figure 13).**

1. Disconnect the battery.
2. Note the wire routing and connections, then disconnect both large diameter wires from the starter relay. Trace the smaller diameter wires to their bullet connections and disconnect both bullet connectors.
3. Carefully tug the starter relay from the rubber mount.
4. Inspect the mount for damage or deterioration. Remove the mount by carefully tugging it from the mounting bracket. Replace the mount by slipping the elongated openings over the mounting arms.
5. Slide the relay fully into the rubber mount.
6. Connect one large wire to each large terminal of the relay. Securely tighten the terminal nuts. Ensure the wire terminals are not touching each other or other components.
7. Connect the smaller wires to the engine wire harness. Route all wires away from moving components.
8. Clean the terminals and connect the cables to the battery. Check for proper starting system operation.



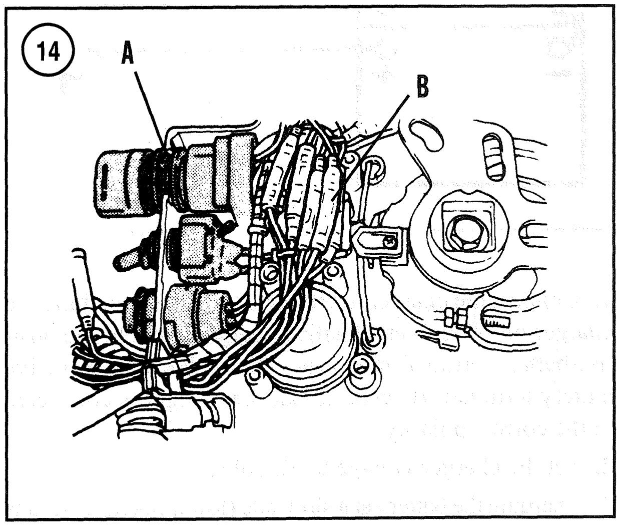


Ignition Switch Removal and Installation

This section provides instructions for replacing the remote control and dash-mounted ignition key switch.

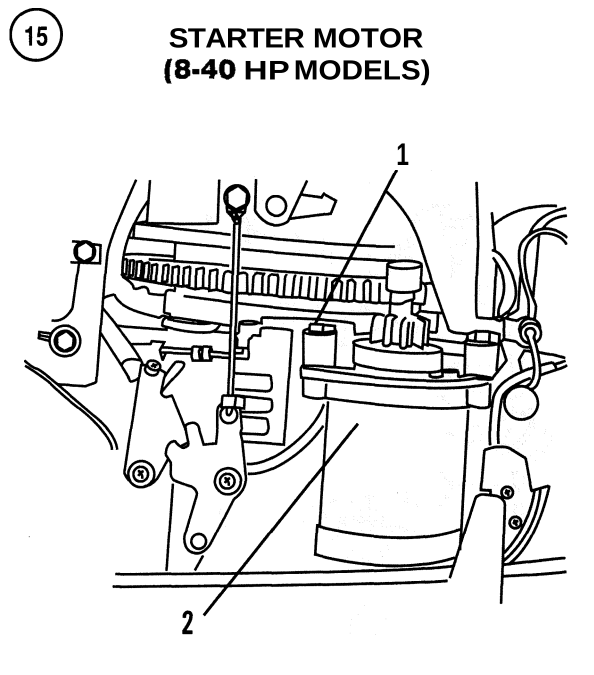
Follow Steps 1-8 if the switch is mounted in the remote control. Follow Steps 3-5 if the switchmounts in the dash.

1. Disconnect the battery cables. Remove the remote control from its mounting location.
2. Disassemble the remote control to the point that the ignition switch leads and retainer (A, **Figure 14)** are accessible.
3. Disconnect the ignition switch wires (B, **Figure** 14) and remove the switch retaining nut.
4. Install the ignition key into the switch, then mark the UP side of the switch and ignition key.
5. Using the manufacturer's marks on the ignition key, identify the UP side of the replacement ignition switch. Install the replacement switch and securely tighten the retaining nut.
6. Attach the switch wires to the wire harness. Route the wires away from moving components.
7. Assemble and install the control.

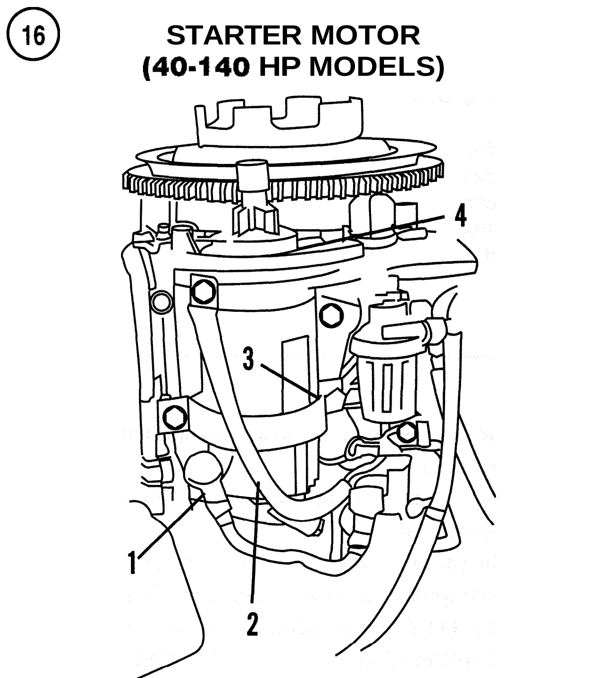


STARTER MOTOR

This section provides removal, repair and installation instructions for the electric starter motor. The first part of this section covers removal and installation. If only the removal or installation of the electric starter motor is necessary, perform the instructions in the first section.



1. Bolts
2. Starter motor



1. Cable
2. Ground cable
3. Band
4. Bracket

The second part of this section covers the complete repair of the electric starter motor. In many cases, complete repair is not required. If this is the case, disassemble as necessary to access the worn or failed components. Reverse the disassembly steps to assemble the electric starter motor. Refer to the instructions for the selected model.

Removal and Installation (8-40 **hp Models)**

1. Disconnect the battery.
2. Remove starter solenoid cable and ground cable.
3. Remove the flywheel cover (Chapter Eight). Remove the two starter motor bolts (1, **Figure** 15).
4. Support the electric starter motor (2, **Figure** 15) while removing the starter mounting bolts and lift the electric starter motor out of the bracket.
5. Installation is the reverse of removal noting the following:
   a. Position the large wire away from other components. To prevent damage to the insulator, do not overtighten the wire terminal nut.
   b. Install all insulating boots over the large diameter wire terminals.
   c. Tighten the starter mounting bolts to standard torque specification.
   d. Route all wires away from moving components.
6. Connect the cables to the battery.

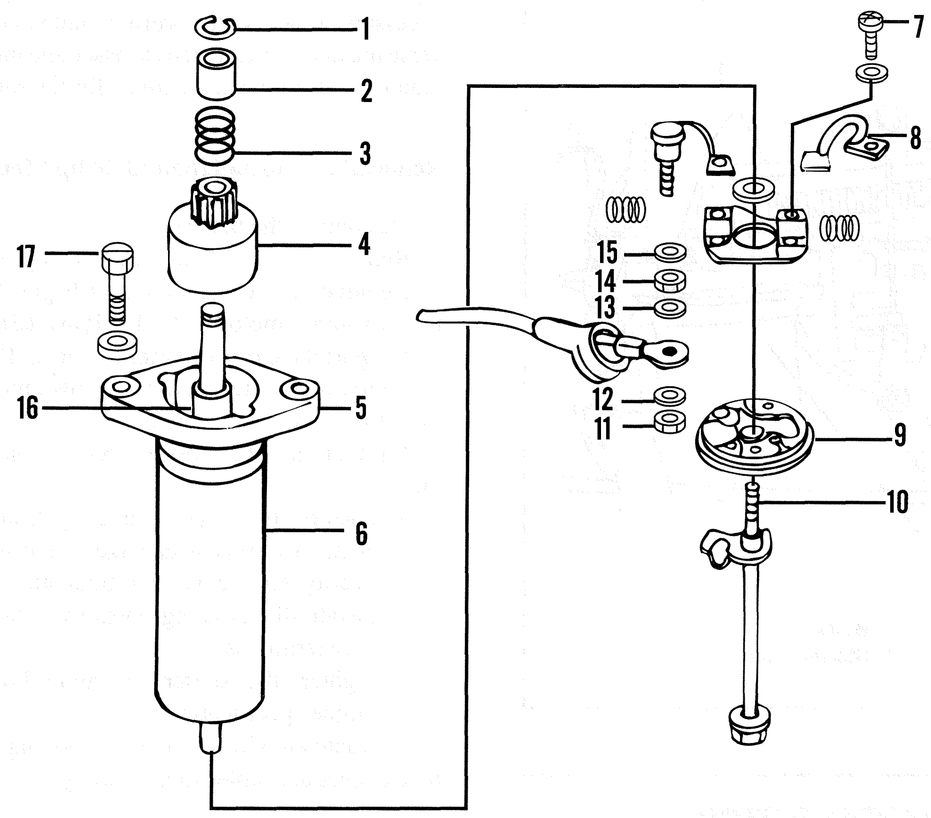
7

Removal and Installation (40-140 **hp Models)**

1. Remove the flywheel cover as described in Chapter Eight.
2. If necessary, move the oil tank out of the way to access the starter motor.
3. Slip the insulating boot (1, **Figure** 16) from the wire terminal and remove the terminal nut. Lift the large wire from the electric starter motor.
4. Support the starter motor while removing two band bolts and the band (3, **Figure** 16). Remove the mounting bolts and slide the starter motor out of the bracket (4, **Figure** 16). Clean the starter mounting surfaces and bolt holes.
5. Installation is the reverse of removal. Note the following:
   a. Attach the large diameter ground wire to the front mounting bolt.
   b. Position the large wire terminal away from other components. To prevent damaging the insulator, do not overtighten the wire terminal nut.
   c. Install all insulating boots over the large diameter wire terminals.

17

STARTER MOTOR ASSEMBLY (8-40 HP MODELS)



1. Lock ring
2. Collar
3. Spring
4. Pinion gear
5. Bracket
6. Starter
7. Screw
8. Brush
9. Motor base
10. Throughbolt
11. Nut
12. Washer
13. Washer
14. Spacer
15. Washer
16. Shaft
17. Bolt

d. Tighten the starter mounting bolts to 32 N•m (24 ft.-lb.).

e. Route all wires away from moving components.

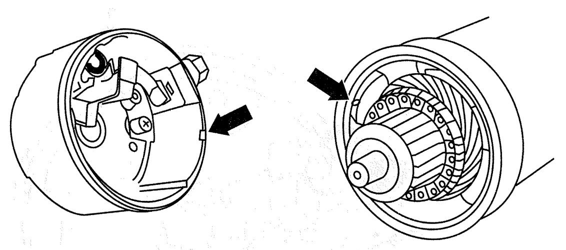
6. Install the flywheel cover (Chapter Eight). Connect the cables to the battery.

Disassembly and Assembly (8-40 hp Models)

Refer to **Figure 17** during this procedure.

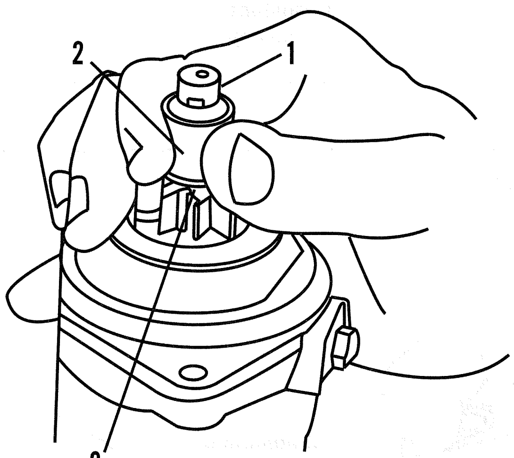
1. Note the marks on the starter covers and frame mating surfaces **(Figure 18)** prior to disassembling the starter motor. The marks ensure correct component orientation during assembly.
2. Secure the starter motor into a vice with soft jaws. Do not overtighten the vice.
3. Push the pinion collar (2, **Figure 19)** toward the pinion gear (3) to expose the locking clip (1). Carefully pry the locking clip (1) from the armature shaft. Pull the pinion collar and spring (2 and 3, **Figure** 17) from the armature shaft. Rotate the starter pinion counterclockwise and remove it from the armature shaft.
4. Remove both throughbolts (10, **Figure 17**), then tap the lower cover to free it from the frame. Pull the lower

18



19

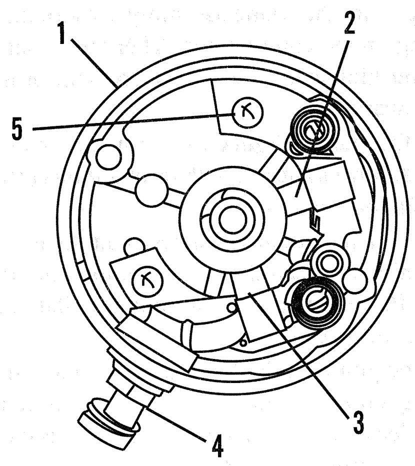
STARTER MOTOR (8-40 HP MODELS)



1. Lock ring
2. Collar
3. Pinion gear

20

STARTER MOTOR BASE ASSEMBLY (8-40 HP MODELS)



1. Motor base
2. Brush
3. Brush
4. Terminal nut
5. Screw

cover from the starter. Pull the armature shaft washer from the lower cover or armature shaft.

5. Tap the lower end of the armature shaft (not the commutator surface) with a plastic mallet to free the front cover from the frame.

6. Pull the upper cover and washers from the frame. Pull the armature from the frame.

7. Remove the terminal nuts (4, **Figure** 20) and all insulating washers from the terminal.

8. Remove the screw (5. **Figure** 20) and lift the brush plate from the lower cover.

9. Clean the upper cover, lower cover. armature and frame assembly using a quick-drying solvent, such as isopropyl alcohol and fine emery cloth.

10. Inspect all components for wear or damage as described in this chapter.

11. Place the brush plate **(Figure** 21) into the lower cover with the terminal inserted through the bushing. Install the screws (5, **Figure** 20) through the brush plate and into the lower cover. Securely tighten the screws.

12. Place the insulating washers onto the terminal and install the terminal nut (4, **Figure** 20). To prevent damaging the insulating washers. do not overtighten the nut.

13. Place the washers over the upper end of the armature shaft. Apply a light coat of water-resistant grease to the bearing surface in the upper cover. Slide the armature into the upper cover. Place a new O-ring onto the upper cover.

14. Slide the frame assembly over the armature and mate the frame assembly to the upper cover.

15. Apply a drop or two of engine oil to the bushing in the lower cover. Do not allow any oil to contact the brushes or commutator.

16. Install both brushes and springs into the brush plate. Make a brush holder from a bent piece of stiff wire (**Fig-**

7

ure 22). Place the ends of the wire in contact with the brush surfaces as shown in **Figure** 22.

17. Place a washer over the lower armature shaft. Install a new O-ring onto the lower cover. Carefully position the lower cover onto the frame assembly. Ensure the brushes do not hang on the commutator. After the armature shaft enters the bushing in the lower cover, pull the brush holder from the lower cover.

18. Align the marks **(Figure** 18). Ensure both O-rings remain in position and install both throughbolts **(10, Figure** 17). Tighten the bolts to **8** N•m (71 in.-lb.).

19. Apply a light coat of water-resistant grease to the armature shaft and thread the starter pinion onto the armature shaft. Place the spring and pinion collar (2, **Figure** 19) over the armature shaft.

20. Push the pinion collar toward the starter and position the locking clip **(1, Figure** 19) in the armature shaft groove. Release the pinion collar and inspect the locking clip. The clip must be positioned in the groove with the pinion collar fully over the clip as indicated in **Figure** 19. Use pliers to shape the locking clip if it was distorted during installation.

Disassembly and Assembly (40-140 **hp Models)**

Refer to **Figure** 23 **(40-70** hp) or **Figure 24 (80-140** hp) during this procedure.

1. Note the match marks on the starter covers and frame **(Figure** 18). The marks ensure correct component orientation during assembly.

2. Clamp the starter motor in a vise with soft jaws. Do not overtighten the vice.

3. Push the pinion collar **(2, Figure** 19) toward the starter pinion (3) to expose the locking clip (1). Pry the locking clip from the armature shaft. Pull the pinion collar and spring from the armature shaft. Rotate the starter pinion counterclockwise and remove it from the armature shaft.

4. Remove both throughbolts and tap the lower cover to free it from the frame. Pull the lower cover from the starter.

5. Remove the terminal nut, insulating washers, bushing and O-ring from the terminal.

6. Remove the brush plate screws and brush plate **(Figure** 25).

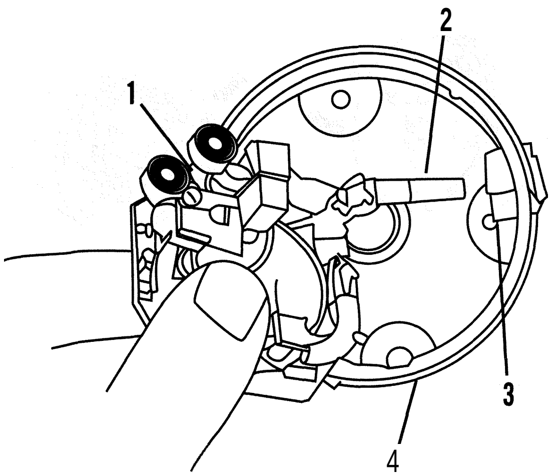
7. Clean all components using isopropyl alcohol.

8. Inspect all components for excessive wear or damage as described in this chapter.

9. Insert the brush plate terminal (A, **Figure** 26 or **Figure** 27) through the bushing (B) in the lower cover. Seat the brush plate in the lower cover and install the brush plate screws. Tighten the screws securely.

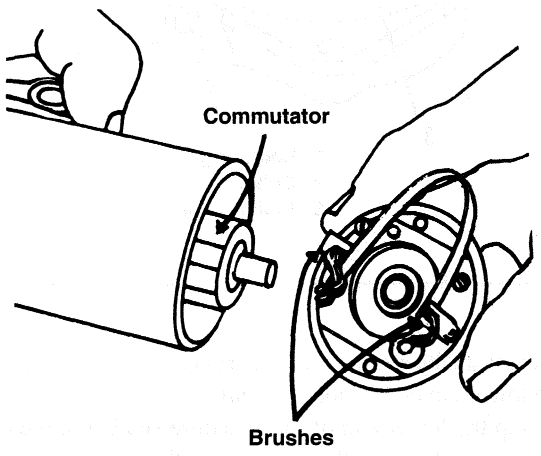
21

STARTER MOTOR END CAP (8-40 HP MODELS)



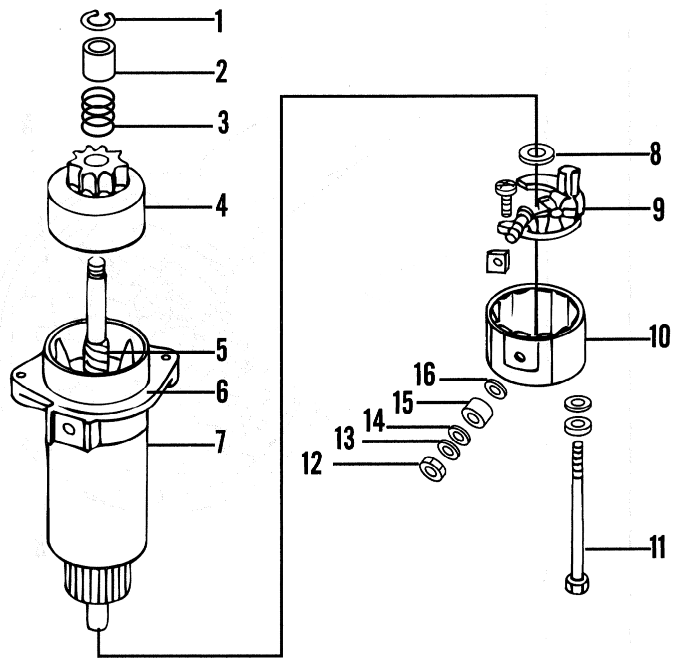
1. Brush assembly
2. Terminal
3. Bushing
4. End cap

22



23

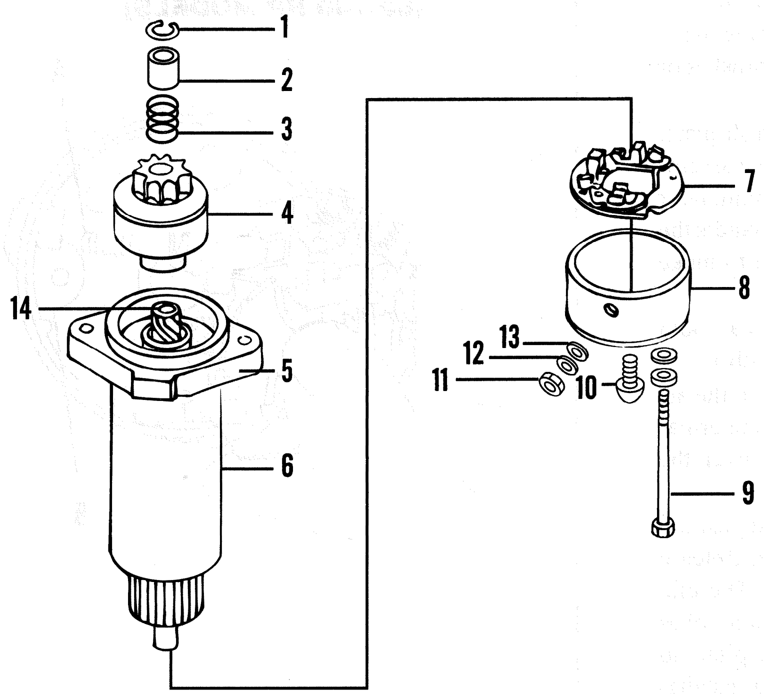
STARTER MOTOR ASSEMBLY (40-70 HP MODELS)



1. Lock ring
2. Collar
3. Spring
4. Pinion gear
5. Shaft
6. Bracket
7. Frame
8. Washer
9. Brush assembly
10. End cap
11. Bolt
12. Nut
13. Washer
14. Washer
15. Bushing
16. Washer

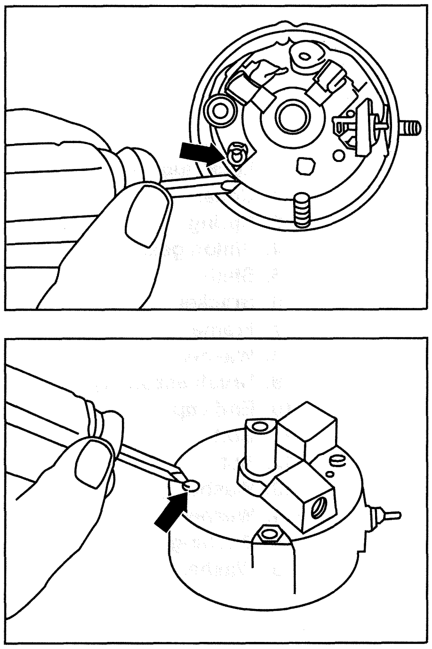
24

STARTER MOTOR ASSEMBLY (80-140 HP MODELS)



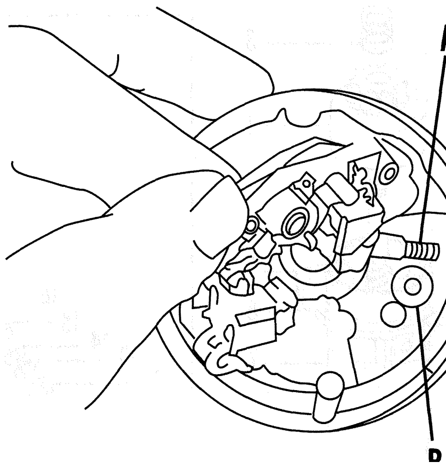
1. Lock ring
2. Collar
3. Spring
4. Pinion gear
5. Bracket
6. Frame
7. Brush assembly
8. End cap
9. Bolt
10. Screw
11. Nut
12. Washer
13. Washer
14. Shaft

25



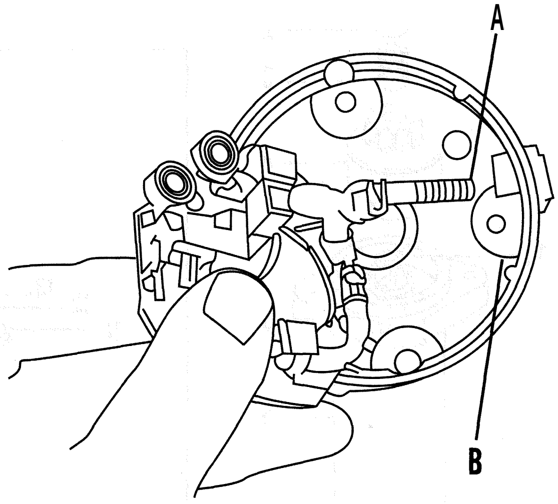
26

STARTER BRUSH PLATE (40-70 HP MODELS)

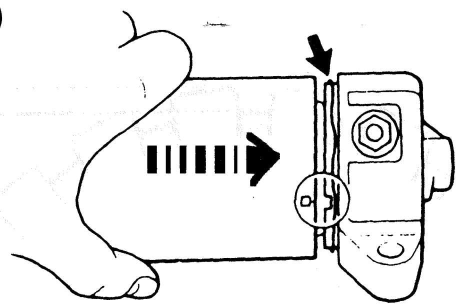


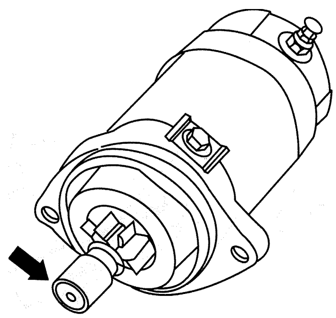
27

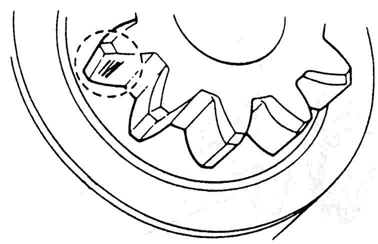
STARTER BRUSH PLATE (80-140 HP MODELS)

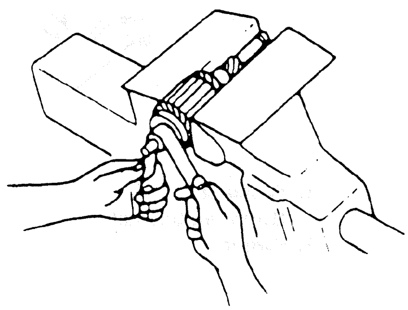


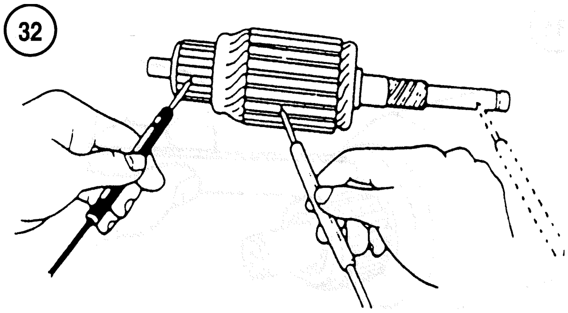
10. Place the O-ring, bushing, and insulating washers onto the terminal and install the terminal nut. To prevent damaging the insulating washers, do not overtighten the nut.
11. Apply a drop or two of engine oil to the bushing in the lower cover. Do not allow any oil to contact the brushes or commutator.
12. Install the brushes and springs into the brush plate. Carefully position the lower cover onto the frame assembly. Ensure the brushes do not hang on the commutator portion of the armature. After the armature shaft enters the bushing in the lower cover, rotate the armature to make sure the brushes are in the correct position.
13. Align the match marks **(Figure 28)** and install both throughbolts. Tighten the bolts to 8 N•m (70 in.-lb.).
14. Apply a light coat of water-resistant grease to the armature shaft and thread the starter pinion onto the armature shaft. Place the spring and pinion collar over the armature shaft.
15. Push the pinion collar toward the starter and position the locking clip into the armature shaft groove. Release the pinion collar and inspect the locking clip. The clip must be positioned in the groove with the pinion collar fully over the clip as shown in **Figure 29.** Use pliers to shape the locking clip if it was distorted during installation.

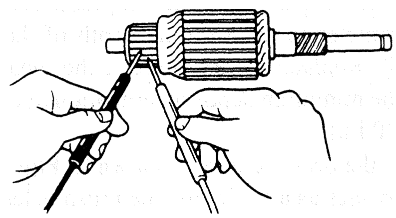
28


29


30


31


32


33


Starter Motor Inspection

1. Inspect the pinion for chipped cracked or worn teeth **(Figure 30).** Replace the pinion if any of these conditions are noted. Inspect the helical splines at the pinion end of the armature. Replace the armature if it is corroded, damaged or worn.

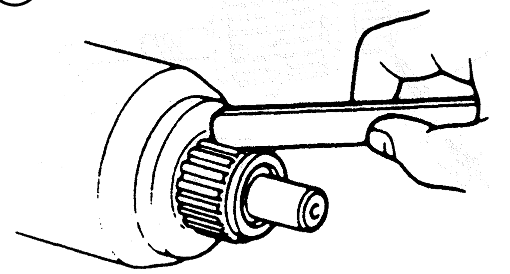
2. Install the pinion drive onto and off of the armature shaft. Replace the pinion drive and/or armature if the pinion drive does not turn smoothly on the shaft.

3. Carefully clamp the armature in a vise with soft jaws **(Figure 31).** Tighten the vise only enough to secure the armature. Carefully polish the commutator using 600-grit carburundum cloth **(Figure 31).** Thoroughly clean the commutator, but do not remove excess material. Rotate the armature often to polish the surfaces evenly.

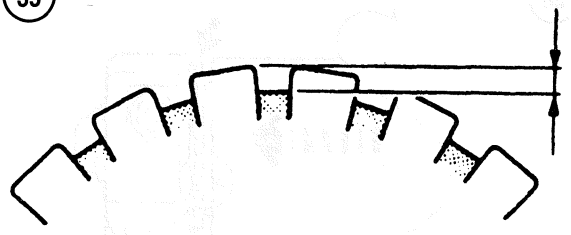
4. Using an ohmmeter, check for continuity between each commutator segment and the armature lamination **(Figure 32).** Also check for continuity between each segment and the armature shaft. No continuity should be noted between the segments and shaft or lamination. If continuity is noted, replace the armature.

5. Check for continuity between pairs of commutator segments **(Figure 33).** Continuity must be present between any two pairs of segments. If not, replace the armature.

34

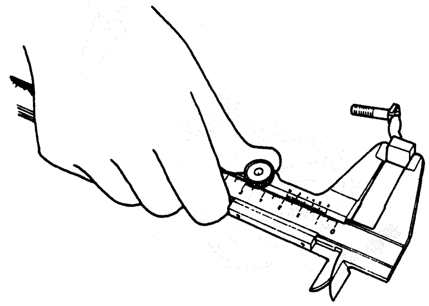


35



6. Use a thin file (Figure 34) to remove the metal and mica particles from the undercut area between the commutator segments.
7. Blow away any particles with compressed air and use a depth micrometer to measure the depth of the undercut (Figure 35). Replace the armature if the measurements are below the minimum depth specification of 0.2-0.5 mm (0.008-0.020 in.).
8. Measure the brush length as shown in Figure **36.** Replace the brushes as a set if any one brush is less than the minimum length:
   a. 40-70 hp—9.5 mm (3/8 in.).
   b. 80-140 hp—12 mm (15132 in.).
9. Inspect the magnets in the frame assembly for corrosion or other contamination and clean as required. Inspect the frame assembly for cracked or loose magnets. Replace the frame assembly if it cannot be adequately cleaned or damaged magnets are noted.
10. Inspect the bearing surfaces on the armature and the bushings for discoloration and excessive or uneven wear. Remove and replace any questionable bearings/bushings using a suitable pulling tool and driver. Replace the armature if rough or uneven surfaces are present on the bearing surfaces.

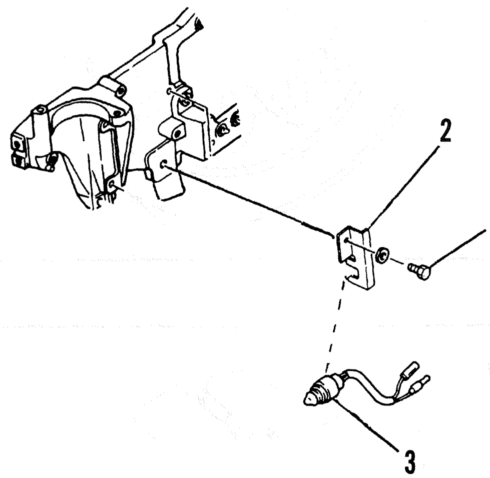
36



Neutral Start Switch Removal and Installation

Refer to Figure **37** (tiller handle) or Figure 38 (remote control) during this procedure.
1. Disconnect the cables from the battery and shift the motor into NEUTRAL.
2. Disconnect both neutral switch wires.
3. Remove the switch-mounting screws, then lift the switch and mounting plate from its mounting boss. Clean the switch mounting surface and the cam portion of the shift linkage.
4. Apply a light coat of water-resistant grease to the portion of the shift linkage that contacts the switch plunger.

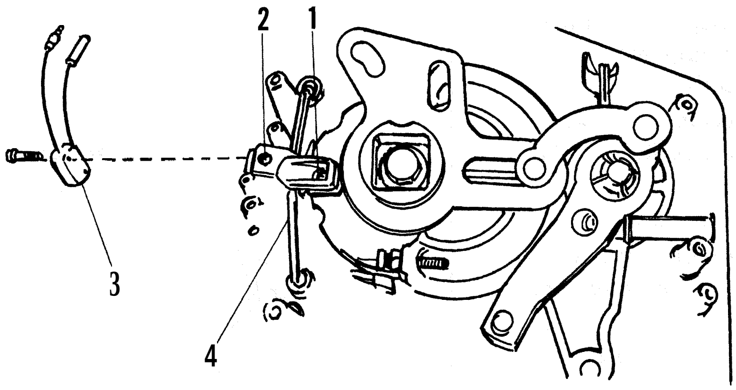
37



1. Fastener
2. Mounting bracket
3. Switch

38

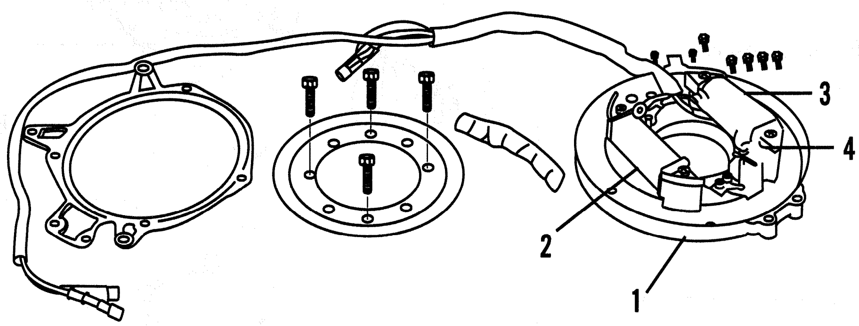
-REMOTE CONTROL-MOUNTED NEUTRAL SWITCH



1. Switch operating arm
2. Switch retainer
3. Neutral switch
4. Leaf spring

39

COIL PLATE ASSEMBLY (9.9-40 HP MODELS)



1. Coil plate
2. Alternator coil
3. Exciter coil
4. Pulser (trigger) coil

5. Position the replacement switch onto its mounting bosses with the plunger in contact with the shift linkage. Place the mounting plate onto the switch, then install both mounting screws. Securely tighten the screws.
6. Route the switch wires away from moving components and reconnect the switch.
7. Check switch operation as described in Chapter Three. Make sure the switch operates correctly before returning the unit to service.

CHARGING SYSTEM

CAUTION
It may be necessary to use an impact driver to remove the battery charge coil and exciter coil mounting screws. Work carefully and avoid using excessive force. The cylinder block can sustain considerable damage ifexcessive force is used.

Battery Charge Coil Removal and Installation

Flywheel removal is required to access the battery charge coil. Refer to Chapter Eight for flywheel removal and installation. The charge coil and exciter coil on 2.5-90 hp models are similar in appearance. Refer to the wiring diagrams at the end of the manual and the illustrations in this chapter to identify the components. On 115-140 hp models, the battery charge coil and ignition exciter coil are integrated into a one-piece stator assembly. Prior to removal, take a photograph or make a sketch of the coil, wiring routing and wire clamps for reference during installation.

Refer to **Figures 39-41** during this procedure.
1. Disconnect the cables from the battery.
2. On models so equipped, remove the rewind starter as described in Chapter Ten.

3A. 9.9-40 *(two-cylinder)* models—Disconnect the charge coil wires. Remove the coil mounting screws and remove the battery charge coil from the coil plate. See **Figure 39.**

3B. 40 *(three-cylinder) and* 50-90 *hp models*—Disconnect the battery charge coil from the voltage rectifier/regulator. Remove any clamps securing the wires, remove the coil mounting screws and remove the coil.

3C. 115 and 140 *hp* models—Disconnect the stator wires and remove the three stator mounting screws. Remove the stator from the engine.

4. Clean the coil mounting surface screw holes.

5. Place the battery charge coil(s) in position on the cylinder block or mounting bracket. Ensure the wires are routed as noted prior to removal.

6. Install all mounting screws. Securely tighten the mounting screws.

7. Route the wires to the lighting harness, rectifier or rectifier/regulator. Route the wires away from any moving components (especially the flywheel). Retain the wires with plastic locking clamps as required.

8. Connect the coil wires to the lighting harness, rectifier or rectifier/regulator.

9. Install the flywheel in Chapter Eight as described.

10. Connect the cables to the battery.

Rectifier or Rectifier/Regulator Removal and Installation

1. Disconnect both battery cables from the battery.

2. Remove the retaining clamp when the rectifier/regulator mounting bolts are removed.

3. Disconnect the wires leading to the rectifier or rectifierlregulator (**Figure** 42). Remove the screw and ground wire connector from the mounting plate (if so equipped).

4. Remove the screw(s) that retain the rectifier or rectifier/regulator to the mounting plate. Carefully route the disconnected wires away from other components and lift the rectifier or rectifierlregulator from the engine.

5. Clean and inspect the threads in the mounting plate. Clean all corrosion or contamination from the mounting surface.

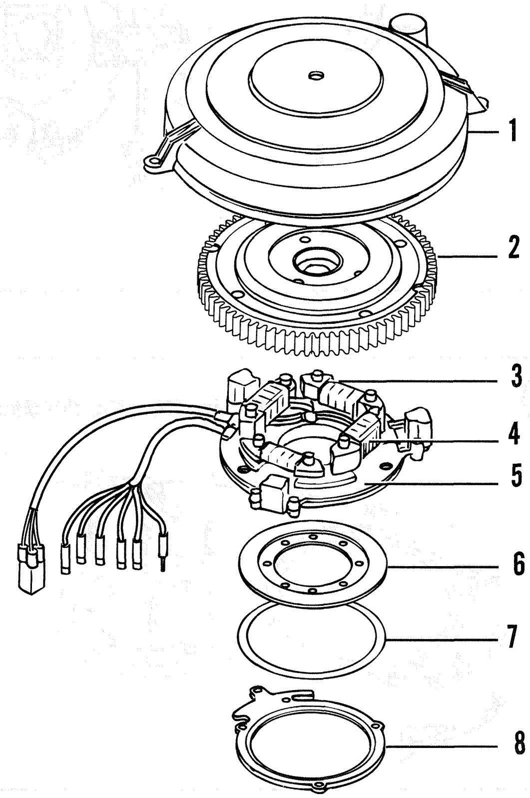
6. Carefully route the rectifier or rectifierlregulator unit wires and position the unit on the power head. Install the mounting screws and securely tighten them. Ensure that the ground wire terminal is positioned below the mounting plate screw (on models so equipped).

7. Connect all wire harness and/or battery charge coil wires to the rectifier or rectifierlregulator.

8. Clean the terminals then connect the cables to the battery. Check for proper charging and ignition system operation immediately after starting the engine.

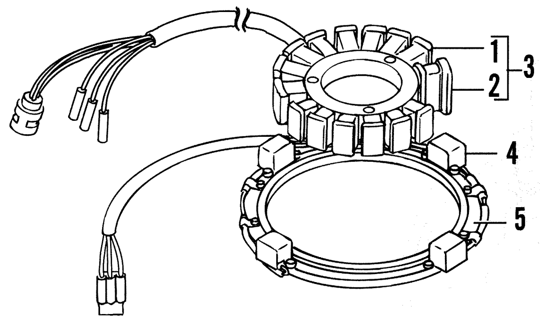
40

COIL PLATE ASSEMBLY (40-90 HP MODELS)



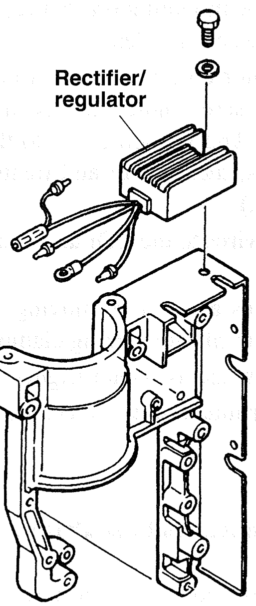
1. Flywheel cover
2. Flywheel
3. Exciter coil
4. Alternator coil
5. Coil plate
6. Guide plate
7. Shim
8. Set ring

41 ALTERNATOR, PULSER COIL ASSEMBLY (115-140 HP MODELS)

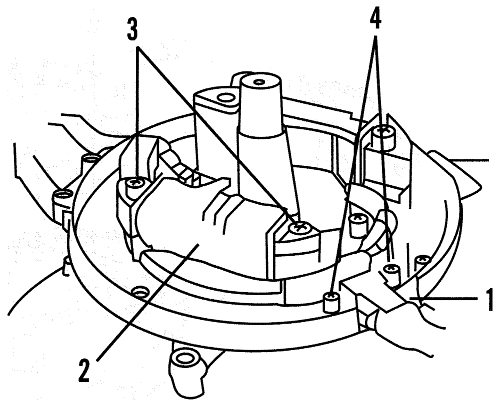


1. Alternator coil
2. Exciter coil
3. Alternator assembly
4. Pulser coil
5. Pulser coil assembly

42 RECTIFIER/REGULATOR MOUNT



43 EXCITER CHARGE COIL (2.5-90 HP MODELS)



1. Cable clamp
2. Exciter coil
3. Screws
4. Screws

IGNITION SYSTEM

NOTE
The battery charge coil and exciter charge coil appear almost identical on some models. Use the wire colors and illustrations to identify the proper component.

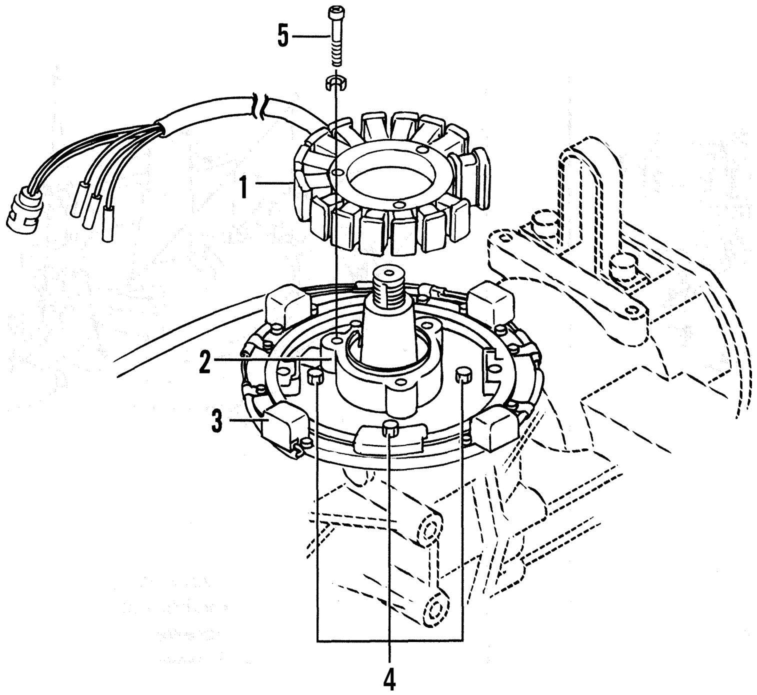
Exciter Coil Removal and Installation

2.5-90 hp models

1. Disconnect the battery.
2. Remove the flywheel following the instructions provided in Chapter Eight.
3. Remove the screws from the clamp (4, **Figure 43)** holding the wire bundle to access the wire connectors. Disconnect both exciter coil wires from the engine control unit harness.
4. Remove the mounting screws *(3,* **Figure 43)** then lift the exciter coil (2) from the power head.
5. Clean the exciter coil mounting surface. Ensure all corrosion or contaminants are removed from the mounting screw openings.

44

ALTERNATOR AND PULSER COIL ASSEMBLY



1. Alternator coil
2. Bracket
3. Pulser coil
4. Bolts
5. Screw

6. Place the exciter coil in position on the cylinder block or mounting bracket. Route the wires as noted prior to removal. Install all mounting screws and tighten them to 18 N•m (13 ft.-lb.).

7. Connect the exciter coil wires to the engine control unit harness. Route the wires away from moving components (especially the flywheel). Bundle the wires together, then retain them with a clamp and screws.

8. Install the flywheel (Chapter Eight).

9. Clean the terminals and connect the cables to the battery.

Stator Removal and Installation

115/120 and 140 hp models

The exciter coil and battery charge coil are combined into a single component **(Figure** 44).

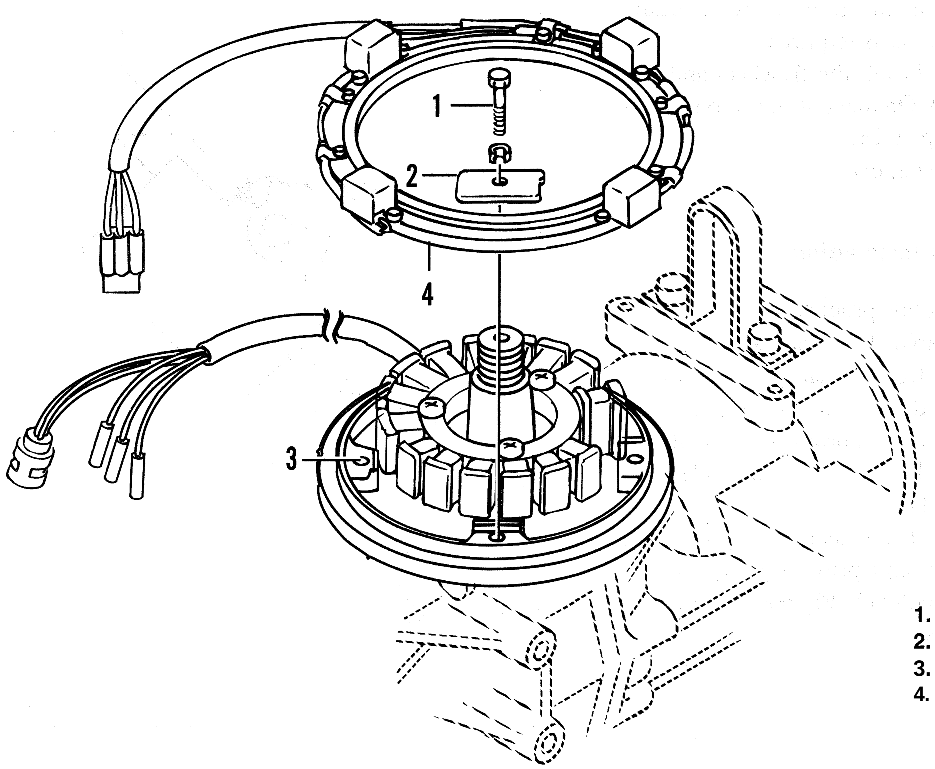
1. Disconnect both cables from the battery.
2. Remove the flywheel as described in Chapter Eight.
3. Disconnect the stator wires from the CDI or engine control unit and rectifier/regulator.
4. Mark the power head to indicate the alignment of the coil wire position relative to the power head. This step is important to ensure correct wire routing of the components.
5. Remove the mounting screws (5, **Figure 44**), then lift the stator from the mounting bracket (2). Clean the stator mounting surface screw holes.
6. Install the stator onto the power head (2, **Figure** 44). Align the stator screw holes and position the wires as noted in Step 4. Apply Loctite 242 to the threads of the mounting screws, then install and tighten the screws to 5 N•m (44 in.-lb.).
7. Connect the wires to the CDI unit and rectifier/regulator.
8. Route all wires away from moving components. Retain the wires with plastic locking clamps as required.
9. Install the flywheel (Chapter Eight).
10. Clean the terminals and connect the cables to the battery.

Pulser Coil Removal and Installation

A single pulser coil is used on one- and two-cylinder models. Three-cylinder models are equipped with three pulser coils and four pulser coils are used on four-cylinder models. The pulser coils on three- and four-cylinder mod-

45

PULSER COIL ASSEMBLY (TYPICAL) (40-140 HP MODELS)



1. Screw
2. Clamp
3. Bracket
4. Pulser coil assembly

els are integrated onto a single pulser coil plate and must be replaced as an assembly.

Two-cylinder models

Refer to **Figure 39** during this procedure.

1. Disconnect the battery (if so equipped).
2. On electric start models, remove the flywheel cover and flywheel as described in Chapter Eight. On manual start models, remove the rewind starter as described in Chapter Ten.
3. Note the pulser coil wire routing and disconnect the wires from the CDI unit.
4. Remove the pulser coil mounting screws and the pulser coil from the mounting base.
5. Clean the mounting base and screw holes.
6. Install the pulser coil on the power head. Apply Loctite 242 to the threads of the pulser coil screws. Install the screws and tighten them securely.
7. Connect the pulser coil wires to the CDI unit. Route all wires away from moving components (especially the flywheel). Retain the wires with plastic locking clamps as required.
8. On electric start models, install the flywheel and flywheel cover (Chapter Eight). On manual start models, install the rewind starter (Chapter Ten).
9. Clean the terminals and connect the cables to the battery, if so equipped.

Three- and four-cylinder models

Refer to **Figure** 45 during this procedure.

1. Disconnect the battery (if so equipped).
2. On electric start models, remove the flywheel cover and flywheel as described in Chapter Eight. On manual start models, remove the rewind starter as described in Chapter Ten.
3. Disconnect the pulser coil harness from the engine wire harness.
4. Remove the mounting screws (1, **Figure** 45) and clamps (2) and remove the pulser coil (4) from its mounting boss (3). Clean the pulser coil mounting boss and screw holes.
5. Place the pulser coil onto its mounting boss (3). Install the washers and mounting screws (1, **Figure** 45). Tighten screws to 4 N•m (35 in.-lb.).

6. Connect the pulser coil wire harness to the engine wire harness. Route all wires away from moving components (especially the flywheel). Retain the wires with plastic locking clamps or metal clainps as required.
7. On electric start models, install the flywheel and flywheel cover (Chapter Eight). On inanual start models, install the rewind starter (Chapter Ten).
8. Connect the cables to the battery.

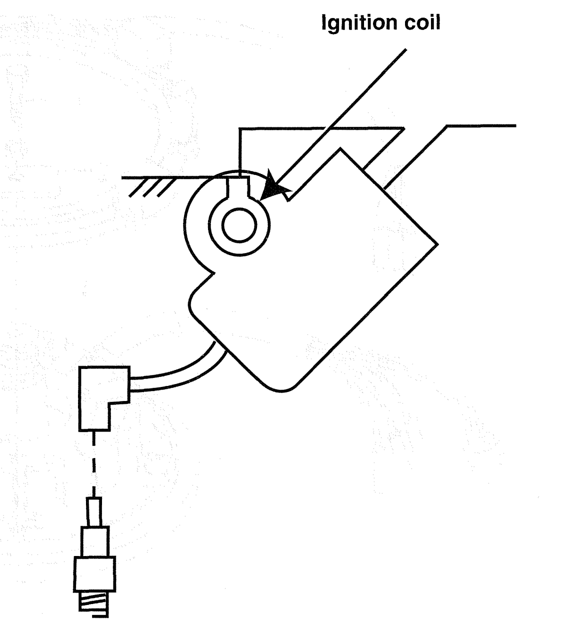
Ignition Coil Removal and Installation

Refer to **Figure** 46 during this procedure.
1. Disconnect the battery cables from the battery.
2. Remove the ignition coil from the engine as follows:
   a. On 2.5-40 hp models, disconnect the CDI unit output lead from the ignition coil primary terminal. Remove the mounting bolts (1, **Figure** 47). and remove the coil from the engine.
   b. On 40-140 hp models, disconnect the CDI unit output lead from ignition coil primary terminal. Remove both mounting bolts (1, **Figure 48**), then lift the coil from the block.
3. Clean the coil mounting surface. Thoroughly clean the coil and ground wire screw holes.
4. Installation is the reverse of removal. Note the following:
   a. Ensure that all coil ground wires are connected to the common terminal or harness connection.
   b. Install the spark plug cap as described in Chapter Three.
   c. Tighten the ignition coil mounting bolts to 7 N•m (62 in.-lb.).
   d. Route all wires away from other components. Retain the wires with plastic locking clainps or the metal clamp as required.
5. Connect the cables to the battery (if so equipped).

CDI Unit Removal and Installation

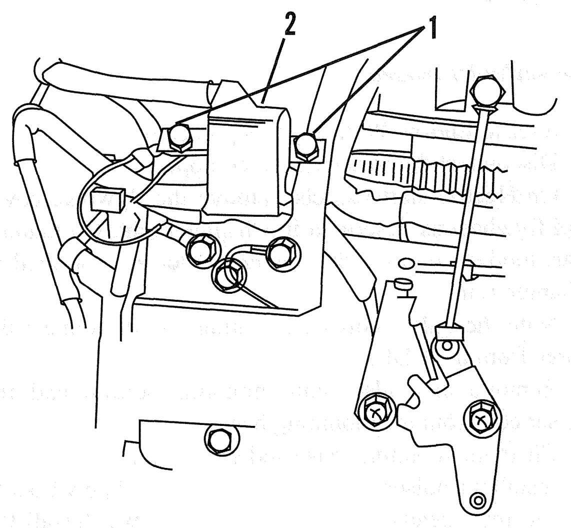
1. Disconnect the cables from the battery, if so equipped.
2. Note the wire connections and routing to ensure proper installation.
3A. On 2.5-40 (two-cylinder) hp models, the CDI unit is mounted below the ignition coil on the starboard side of the engine. Unplug all leads from the CDI unit and remove the bolts securing it to the block. All leads are color-coded and have male or feinale connectors to distinguish them.
3B. On 40 (three-cylinder) and 50-90 hp models, the CDI unit is mounted on the starboard side of the engine toward the aft end. Carefully stretch the elastic CDI unit hold

46

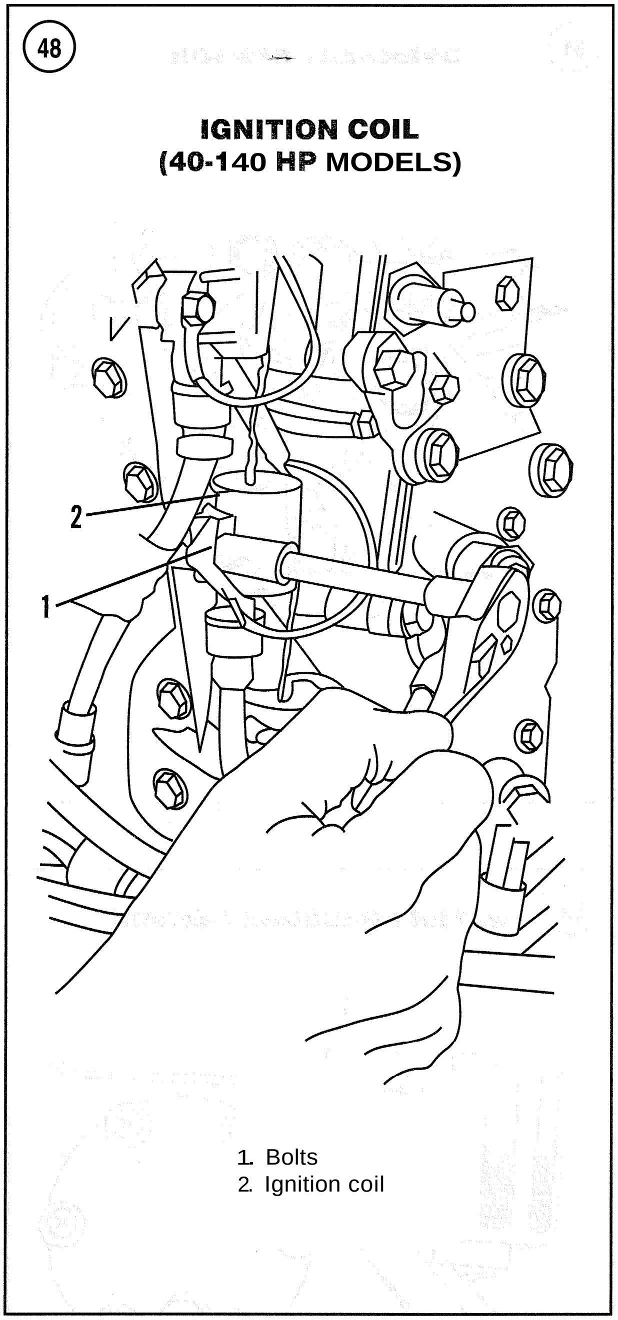


47

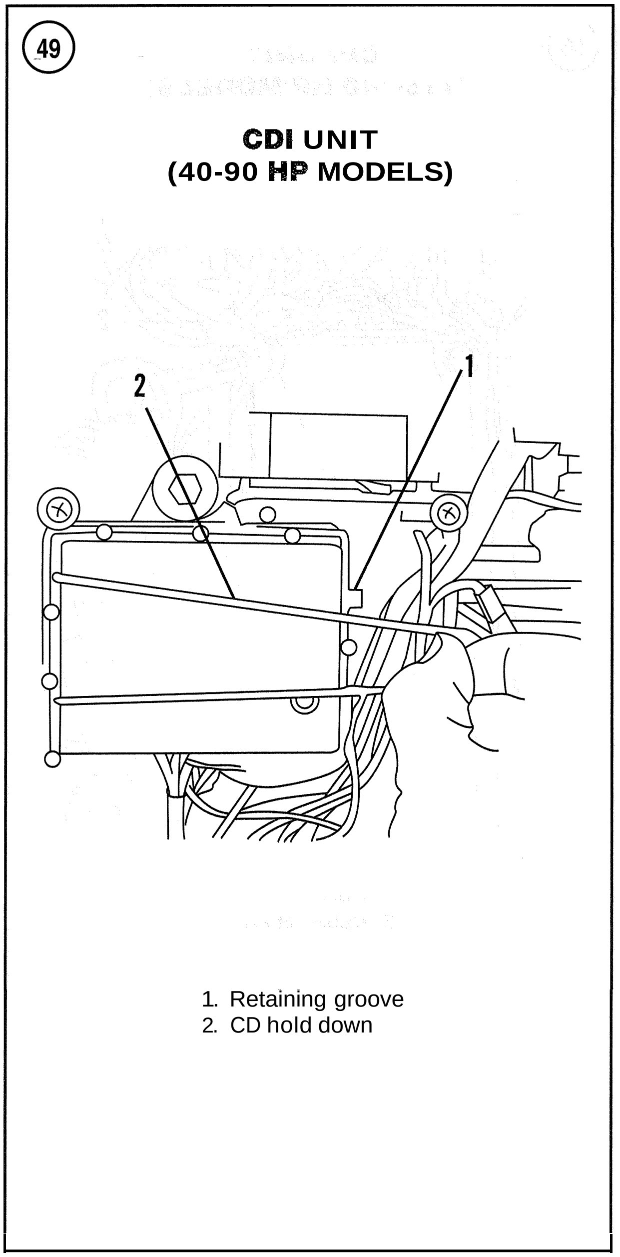
IGNITION COIL
(2.5-40 HP MODELS)



1. Bolts
2. Ignition coil



1. Bolts
2. Ignition coil



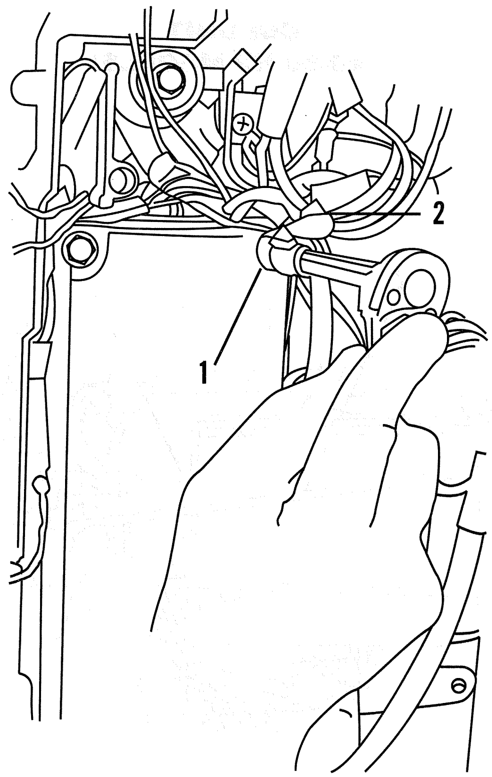
1. Retaining groove
2. CD hold down

down (2, **Figure 49)** and remove it from the retaining groove (I). Unplug all the leads from the CDI unit. Remove the CDI unit from holding fixture.

3C. On 115, 120 and 140 hp models, the CDI unit is mounted on the starboard side of the engine toward the aft end. Remove the bolts (1, **Figure** 50) that secure the CDI unit. Remove the bolt (2, **Figure** 50) that secures the cable harness. Unplug all leads from CDI unit and remove the unit.

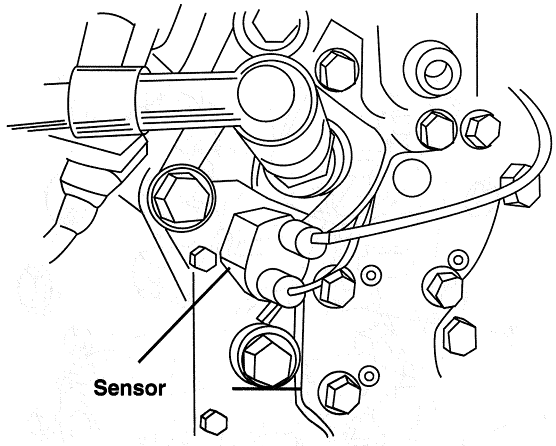
4. Inspect and clean all terminals in the wire harness and CDI unit.
5. Clean the CDI unit and the fastener holes.
6. Installation is the reverse of removal. Note the following:
   a. Tighten all mounting screws to 8 N•m (71 in.-lb.).
   b. Ensure all wires are securely attached to the CDI unit and the wire harness.
   c. Ensure all ground wires are securely attached to their mounting screws.
7. Connect the cables to the battery (if so equipped).

50 **CDI UNIT (115-140 HP MODELS)**

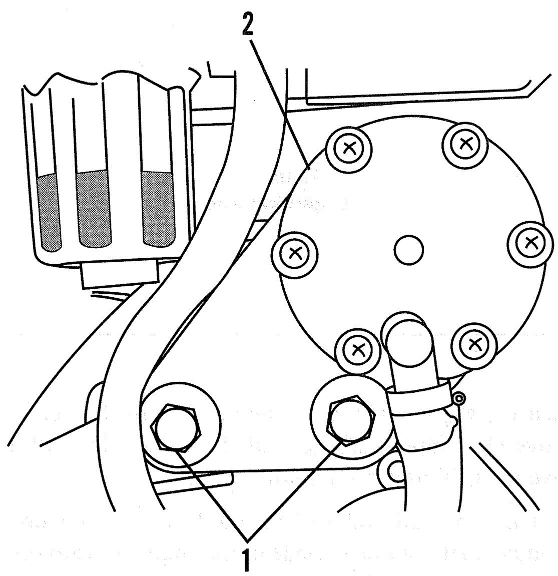


1. Bolts
2. Cable retainer

51 **OVERHEAT SENSOR**



52 **WATER PRESSURE SENSOR**



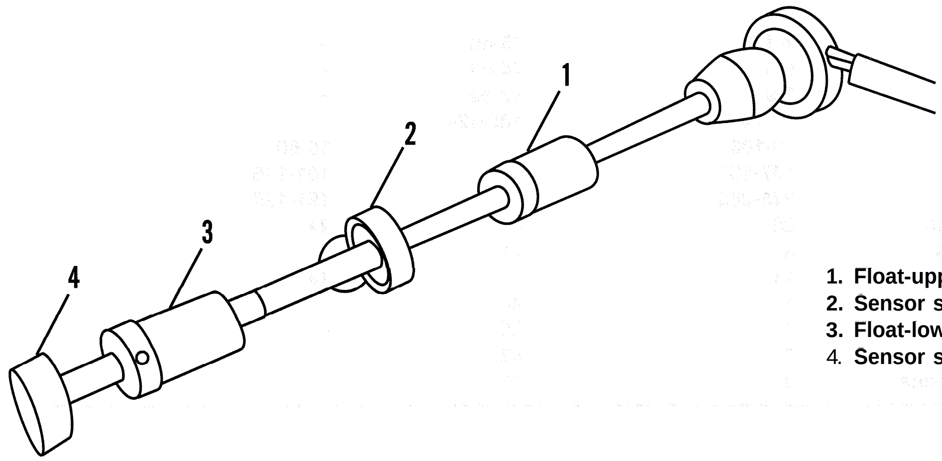
1. Bolts
2. Sensor

Lanyard Switch Removal and Installation (Tiller Handle Models)

1. Disconnect the cables from the battery, if so equipped.
2. Note the wire routing, then disconnect the lanyard switch wires.
3. Carefully pry up on the switch retaining clip while slipping it from the switch. Pull the switch from the lower engine cover.
4. Route the wire through the opening when installing the replacement switch. Ensure the run mark faces up, then slide the retaining clip into its groove on the lanyard switch.
5. Connect the lanyard switch wires. Route the wires away from moving components. Retain the wires with plastic locking clamps as required.
6. Connect the cables to the battery, if so equipped.
7. Check for proper operation of the switch.

53

OIL LEVEL SENSOR (115-140 HP MODELS)



1. Float-upper
2. Sensor switch-upper
3. Float-lower
4. Sensor switch-lower

WARNING SYSTEM

Overheat Sensor Removal and Installation

An overheat sensor is used on 40-140 hp models to activate the warning horn and power reduction system.

1. Disconnect the battery.
2. Disconnect the sensor **(Figure 51)** and the ground wire.
3. Remove the retaining bolt and clamp and pull the switch from its opening. Wipe the switch opening clean.
4. Insert the replacement sensor fully into its opening. Rotate the switch to position its wires opposite the clamping surface. Install the clamp and bolt. Securely tighten the bolt.
5. Connect the sensor wires to the engine wire harness and ground wire.
6. Connect the cables to the battery.

Water Pressure Sensor Removal and Installation

On 80-140 hp models, the sensor is located on the port side of the power head just below the inline fuel filter **(Figure 52).**

1. Disconnect the cables from the battery (if so equipped).
2. Remove the two bolts (1, **Figure 52)** and disconnect the ground wire from the back of the water pressure sensor. Disconnect the sensor bullet connector at the electrical box.
3. Remove water pressure sensor from the power head.
4. Install the new water pressure sensor by installing the two retaining bolts and attaching the ground wire to one of the two bolts on the backside of the sensor.
5. Connect the sensor bullet connector to the electrical box. Verify that no wires are pinched between the water pressure sensor and block.
6. Route the wires away from moving components. Secure the wires with plastic locking clamps as required.
7. Connect the cables to the battery, if so equipped.

Oil Level Sensor Removal and Installation

The oil level sensors (2 and 4, **Figure 53)** and floats (1 and **3)** are mounted to the oil tube located in the oil tank.

1. Note the wire routing and disconnect the oil level sensor leads from the electrical box.
2. Remove the retaining clip and remove the sensor from the oil tank.
3. Remove the Allen screw and the sensor.
4. Wipe the tank opening clean and install the replacement sensor. Install the retaining clip. Securely tighten the nut. Connect the wires to their wire harness. Route all wires away from moving components. Retain the wires with plastic locking clamps as required.

7

Table 1 TORQUE SPECIFICATIONS

Description	N•m	in.-lb.	ft.-lb.
Spark plug	25-29	–	19-22
Flywheel nut			
2.5-3.5	4-4.5	35-40	–
5-8-9.8	5-6	44-53	–
9.9-18	7-9	62-80	–
25-40	12-14	106-124	–
40-50	88-108	–	65-80
60-90	137-157	–	101-116
115-140	245-265	–	181-195
Starter mounting bolt	32	–	24
Starter throughbolts	8	71	–
Exciter coil mounting screws	18		13
Stator mounting screws	5	44	–
Pulser mounting screws	4	35	–
Ignition mounting bolts	7	62	–
CDI unit mounting bolts	8	71	–

Table 2 IGNITION SYSTEM SPECIFICATIONS (2.5 HP)

Ignition timing	20° BTDC
Exciter coil resistance	280-420 ohms
Ignition coil resistance	
Primary	0.18-0.24 ohm
Secondary	2700-3700 ohms
Spark plug type	NGK BPR6HS-10 or Champion RL87YC10
Spark plug gap	0.9-1.0 mm (0.035-0.039 in.)

Table 3 IGNITION SYSTEM SPECIFICATIONS (3.5B)

Ignition timing	20" BTDC
Exciter coil output cranking speed	135-150 peak volts
Pulser coil output cranking speed	4.75-5.0 peak volts
CDI output cranking speed	198-220 peak volts
Exciter coil resistance	280-420 ohms
Ignition coil resistance	
Primary	0.18-0.24 ohms
Secondary	2700-3700 ohms
Spark plug type	NGK BPR6HS-10 or Champion RL87YC10
Spark plug gap	0.9-1.0 mm (0.035-0.039 in.)

Table 4 IGNITION SYSTEM SPECIFICATIONS (5B)

Ignition timing	
Idle speed	5° ATDC
Wide-open throttle	30" BTDC
Exciter coil output cranking speed	135-150 peak volts
Pulser coil output cranking speed	4.75-5.0 peak volts
CDI output cranking speed	198-220 peak volts
Exciter coil resistance	93-140 ohms
Pulser coil resistance	80-117 ohms
Ignition coil resistance	
Primary	0.26-0.38 ohm
Secondary	3000-4400 ohms
Alternator coil resistance	0.2-0.38 ohm
Spark plug type	NGK BPR7HS-10 or Champion RL82YC10
Spark plug gap	0.9-1.0 mm (0.035-0.039 in.)

Table 5 IGNITION SYSTEM SPECIFICATIONS (8 HP)

Ignition timing	–
Idle speed	1.5" ATDC
Wide-open throttle	22" BTDC
CDI output cranking speed	198-220 peak volts
Exciter coil resistance	224-336 ohms
Ignition coil resistance	
Primary	–
Secondary	2100-3100 ohms
Alternator coil resistance	0.3 ohm
Spark plug type	NGK **BPR7HS-10** or Champion **RL82YC10**
Spark plug gap	0.9-1.0 mm (0.035-0.039 in.)

Table 6 TION SYSTEM SPECIFICATIONS (9.8)

Ignition timing	
Idle speed	2.5" BTDC
Wide-open throttle	26" BTDC
CDI output cranking speed	198-220 peak volts
Exciter coil resistance	224-336 ohms
Ignition coil resistance	
Primary	–
Secondary	2100-3100 ohms
Alternator coil resistance	0.3 ohm
Spark plug type	NGK **BPR7HS-10** or Champion **RL82YC10**
Spark plug gap	0.9-1.0 mm (0.035-0.039 in.)

Table 7 IGNITION SYSTEM SPECIFICATIONS (9.9D)

Ignition timing	
Idle speed	3° ATDC
Wide-open throttle	22" BTDC
Exciter coil output cranking speed	135-150 peak volts
Pulser coil output cranking speed	4.75-5.0 peak volts
CDI output cranking speed	198-220 peak volts
Exciter coil resistance	168-252 ohms
Pulser coil resistance	30-46 ohms
Ignition coil resistance	
Primary	0.2-0.3 ohm
Secondary	4100-6100 ohms
Alternator coil resistance	0.24-0.36 ohm
Spark plug type	NGK **BR7HS-10** or Champion **RL82C10**
Spark plug gap	0.9-1.0 mm (0.035-0.039 in.)

Table 8 IGNITION SYSTEM SPECIFICATIONS (9.9D2)

Ignition timing		
Idle speed	3° ATDC	
Wide-open thottle	20" BTDC	
Exciter coil output cranking speed	135-150 peak volts	R-B-L
Pulser coil output cranking speed	4.75-5.0 peak volts	R-B-L
CDI output cranking speed	198-220 peak volts	B/W-B/W
Exciter coil resistance	168-252 ohms	R-B-L
Pulser coil resistance	30-46 ohms	R-B-L
Ignition coil resistance		
Primary	0.2-0.3 ohm	B-B/W
Secondary	4100-6100 ohms	B-spark plug lead cap
Alternator coil resistance	0.24-0.36 ohm	
Spark plug type	NGK BR7HS-10 or Champion RL82C10	
Spark plug gap	0.9-1.0 mm (0.035-0.039 in.)	

Table 9 IGNITION SYSTEM SPECIFICATIONS (15D)

Ignition timing		
Idle speed	3° ATDC	
Wide-open thottle	22" BTDC	
Exciter coil output cranking speed	135-150 peak volts	R-B-L
Pulser coil output cranking speed	4.75-5.0 peak volts	R-B-L
CDI output cranking speed	198-220 peak volts	B/W-B
Exciter coil resistance	168-252 ohms	BIR-W
Pulser coil resistance	30-46 ohms	R-B-L
Ignition coil resistance		
Primary	0.2-0.3 ohm	
Secondary	4100-6100 ohms	
Alternator coil resistance	0.24-0.36 ohm	W/Y
Spark plug type	NGK BR7HS-10 or Champion RL82C10	
Spark plug gap	0.9-1.0 mm (0.035-0.039 in.)	

Table 10 IGNITION SYSTEM SPECIFICATIONS (15D2)

Ignition timing		
Idle speed	3° ATDC	
Wide-open thottle	25" BTDC	
Exciter coil output cranking speed	135-150 peak volts	R-B-L
Pulser coil output cranking speed	4.75-5.0 peak volts	
CDI output cranking speed	198-220 peak volts	
Exciter coil resistance	130-195 ohms	
Ignition coil resistance		
Primary	0.2-0.3 ohm	B/W-B
Secondary	4100-6100 ohms	
Alternator coil resistance	0.24-0.36 ohm	
Spark plug type	NGK BR7HS-10 or Champion RL82C10	
Spark plug gap	0.9-1.0 mm (0.035-0.039 in.)	

Table 11 IGNITION SYSTEM SPECIFICATIONS (18E)

Ignition timing		
Idle speed	3" ATDC	
Wide-open thottle	25" BTDC	
Exciter coil output cranking speed	135-150 peak volts	R-B-L
Pulser coil output cranking speed	4.75-5.0 peak volts	R-B-L
CDI output cranking speed	198-220 peak volts	BNV-B
Exciter coil resistance	168-252 ohms	R-B
Pulser coil resistance	30-46 ohms	R-B-L
Ignition coil resistance		
Primary	0.2-0.3 ohm	B/W-B
Secondary	4100-6100 ohms	B- spark plug lead cap
Alternator coil resistance	0.24-0.36 ohm	W-Y
Spark plug type	NGK **BR7HS-10** or Champion **RL82C10**	
Spark plug gap	0.9-1.0 mm (0.035-0.039 in.)	

Table 12 IGNITION SYSTEM SPECIFICATIONS (18E2)

Ignition timing		
Idle speed	3° ATDC	
Wide-open thottle	25° BTDC	
Exciter coil output cranking speed	135-150 peak volts	R-B-L
Pulser coil output cranking speed	4.75-5.0 peak volts	NIA
CDI output cranking speed	198-220 peak volts	BMI-B
Exciter coil resistance	130-195 ohms	R-L
Ignition coil resistance		
Primary	0.2-0.3 ohm	W/B-B
Secondary	4100-6100 ohms	B- spark plug lead cap
Alternator coil resistance	0.24-0.36 ohm	W-Y
Spark plug type	NGK **BR7HS-10** or Champion **RL82C10**	
Spark plug gap	0.9-1.0 mm (0.035-0.039 in.)	

Table 13 IGNITION SYSTEM SPECIFICATIONS (25C2)

Ignition timing		
Idle speed	2" ATDC	
Wide-open thottle	20° BTDC	
Exciter coil output cranking speed	135-150 peak volts	R-B-L
Pulser coil output cranking speed	4.75-5.0 peak volts	B-L
CDI output cranking speed	198-220 peak volts	B/W-B
Exciter coil resistance	200-300 ohms	R-L
Pulser coil resistance	30-46 ohms	B-L
Ignition coil resistance		
Primary	0.2-0.3 ohm	BNV-B
Secondary	4100-6100 ohms	B-spark plug lead cap
Alternator coil resistance	0.24-0.36 ohm	W-Y
Spark plug type	NGK **BR7HS-10** or Champion **RL82C10**	
Spark plug gap	0.9-1.0 mm (0.035-0.039 in.)	

Table 14 IGNITION SYSTEM SPECIFICATIONS (25C3)

Ignition timing		
Idle speed	4° ATDC	
Wide-open thottle	25° BTDC	
Exciter coil output cranking speed	135-150 peak volts	R-B-L
Pulser coil output cranking speed	4.75-5.0 peak volts	R-B-L
CDI output cranking speed	198-220 peak volts	B/W-B
Exciter coil resistance	130-195 ohms	R-6
Ignition coil resistance		
Primary	0.2-0.3 ohm	B/W-B
Secondary	4100-6100 ohms	6-spark plug lead cap
Alternator coil resistance	0.24-0.36 ohm	W-Y
Spark plug type	NGK BR7HS-10 or Champion RL82C10	
Spark plug gap	0.9-1.0 mm (0.035-0.039 in.)	

Table 15 IGNITION SYSTEM SPECIFICATIONS (30A)

Ignition timing		
Idle speed	3° ATDC	
Wide-open thottle	25° BTDC	
Exciter coil output cranking speed	135-150 peak volts	R-B-L
Pulser coil output cranking speed	4.75-5.0 peak volts	R-B-L
CDI output cranking speed	198-220 peak volts	B/W-B
Exciter coil resistance	130-195 ohms	R-B
Ignition coil resistance		
Primary	0.2-0.3 ohm	B/W-B
Secondary	4100-6100 ohms	B-spark plug lead cap
Alternator coil resistance	0.24-0.36 ohm	W-Y
Spark plug type	NGK BR7HS-10 or Champion RL82C10	
Spark plug gap	0.9-1.0 mm (0.035-0.039 in.)	

Table 16 IGNITION SYSTEM SPECIFICATIONS (40 HP TWO CYLINDER)

Ignition timing		
Idle speed	2" ATDC	
Wide-open thottle	25° BTDC	
Exciter coil output cranking speed	135-150 peak volts	R-B-L
Pulser coil output cranking speed	4.75-5.0 peak volts	R-B-L
CDI output cranking speed	198-220 peak volts	B/W-B
Exciter coil resistance	200-300 ohms	R-6
Pulser coil resistance	30-46 ohms	B-L
Ignition coil resistance		
Primary	0.2-0.3 ohm	B/W-B
Secondary	4100-6100 ohms	6-spark plug lead cap
Alternator coil resistance	0.22-0.38 ohm	W-Y
Spark plug type	NGK BR7HS-10 or Champion RL82C10	
Spark plug gap	0.9-1.0 mm (0.035-0.039 in.)	

Table 17 IGNITION SYSTEM SPECIFICATIONS (40D HP THREE CYLINDER)

Ignition timing		
Idle speed	3° ATDC	
Wide-open thottle	18° BTDC	
Exciter coil output cranking speed	135-150 peak volts	WIG-Or
Pulser coil output cranking speed	4.75-5.0 peak volts	B-W/R-W/B-L/W
CDI output cranking speed	198-220 peak volts	B-BNV-BIR-BIG
Ignition coil resistance		
Primary	0.16-0.24 ohm	B-BNV
Secondary	2700-3700 ohms	B-spark plug lead cap
Alternator coil resistance	0.3-0.5 ohm	W-Y
Spark plug type	NGK BR7HS-10 or Champion RL-82C	
Spark plug gap	0.9-1.0 mm (0.035-0.039 in.)	

Table 18 IGNITION SYSTEM SPECIFICATIONS (50D)

Ignition timing		
Idle speed	3° ATDC	
Wide-open thottle	24" BTDC	
Exciter coil output cranking speed	135-150 peak volts	WIG-Or
Pulser coil output cranking speed	4.75-5.0 peak volts	B-W/R-W/B-L/W
CDI output		
Cranking speed	198-220 peak volts	B-B/W-B/R-B/G
Ignition coil resistance		
Primary	0.16-0.24 ohm	B-B/W
Secondary	2700-3700 ohms	B-spark plug lead cap
Alternator coil resistance	0.3-0.5 ohm	W-Y
Spark plug type	NGK BR8HS-10 or Champion RL-78C	
Spark plug gap	0.9-1.0 mm (0.035-0.039 in.)	

Table 19 IGNITION SYSTEM SPECIFICATIONS (50D2)

Ignition timing		
Idle speed	3" ATDC	
Wide-open thottle	20° BTDC	
Exciter coil output cranking speed	135-150 peak volts	WIG-Or
Pulser coil output cranking speed	4.75-5.0 peak volts	B-W/R-W/B-L/W
CDI output cranking speed	198-220 peak volts	B-BNV-BIR-BIG
Exciter coil resistance	NIA	
Pulser coil resistance	N/A	
Ignition coil resistance		
Primary	0.16-0.24 ohm	B-B/W
Secondary	2700-3700 ohms	B-spark plug lead cap
Alternator coil resistance	0.3-0.5 ohm	W-Y
Spark plug type	NGK BR8HS-10 or Champion RL-78C	
Spark plug gap	0.9-1.0 mm (0.035-0.039 in.)	

Table 20 IGNITION SYSTEM SPECIFICATIONS (60B AND 60C)

Ignition timing		
Idle speed	3° ATDC	
Wide-open thottle	17° BTDC	
Exciter coil output		
Cranking speed		
60B	8.1- 9.9 peak volts	WIG to Br/W
	34.2-41.8 peak volts	WIG to W N
	35.1-42.9 peak volts	Br/W to W N
60C	135-150 peak volts	WIG-WY
Pulser coil output cranking speed	4.75-5.0 peak volts	B-WIR-WIB-WIL
CDI output cranking speed	198-220 peak volts	B-B/W-B/W-B/W
Ignition coil resistance		
Primary	0.16-0.24 ohm	B-B/W
Secondary	3300-5000 ohms	B-spark plug lead cap
Alternator coil resistance	0.21-0.31 ohm	W-Y
Spark plug type	NGK BR8HS-10 or Champion RL-78C	
Spark plug gap	0.9-1.0 mm (0.035-0.039 in.)	

Table 21 IGNITION SYSTEM SPECIFICATIONS (70B AND 70C)

Ignition timing		
70B		
Idle speed	3° ATDC	
Wide-open thottle	20° BTDC	
70C		
Idle speed	3° ATDC	
Wide-open thottle	17.5" BTDC	
Exciter coil output cranking speed		
70B	8.1- 9.9 peak volts	WIG to Br/W
	34.2-41.8 peak volts	WIG to W N
	35.1-42.9 peak volts	Br/W to W N
70C	135-150 peak volts	WIG-WY
Pulser coil output cranking speed	4.75-5.0 peak volts	B-WIR-WIB-WIL
CDI output cranking speed	198-220 peak volts	B-B/W-B/W-B/W
Ignition coil resistance		
Primary	0.16-0.24 ohm	B-B/W
Secondary	3300-5000 ohms	B-spark plug lead cap
Alternator coil resistance	0.21-0.31 ohm	W-Y
Spark plug type	NGK BR8HS-10 or Champion RL-78C	
Spark plug gap	0.9-1.0 mm (0.035-0.039 in.)	

Table 22 IGNITION SYSTEM SPECIFICATIONS (80 HP)

Ignition timing		
Idle speed	5° ATDC	
Wide-open thottle	17.5" BTDC	
Exciter coil output cranking speed	135-150 peak volts	WIG-WY
Pulser coil output cranking speed	4.75-5.0 peak volts	B-W/R-W/B-W/L
CDI output cranking speed	198-220 peak volts	B-B/W-BIR-BIG

(continued)

Table 22 IGNITION SYSTEM SPECIFICATIONS (80 HP) (continued)

Ignition coil resistance		
Primary	0.19-0.25 ohm	B-BMI
Secondary	3600-4800 ohms	B-spark plug lead cap
Alternator coil resistance	0.19-0.29 ohm	W-Y
Spark plug type	NGK BR8HS-10 or Champion RL-78C	
Spark plug gap	0.9-1.0 mm (0.035-0.039 in.)	

Table 23 IGNITION SYSTEM SPECIFICATIONS (90 HP)

Ignition timing		
Idle speed	5° ATDC	
Wide-open thottle	20° BTDC	
Exciter coil output		
Cranking speed	135-150 peak volts	WIG-WY
Pulser coil output cranking speed	4.75-5.0 peak volts	B-W/R-W/B-W/L
CDI output cranking speed	198-220 peak volts	B-BMI-BIR-BIG
Ignition coil resistance		
Primary	0.19-0.25 ohm	B-B/W
Secondary	3600-4800 ohms	B-spark plug lead cap
Alternator coil resistance	01 9-0.29 ohm	W-Y
Spark plug type	NGK BR8HS-10 or Champion RL-78C	
Spark plug gap	0.9-1.0 mm (0.035-0.039 in.)	

7

Table 24 IGNITION SYSTEM SPECIFICATIONS (115.1 40 HP)

Ignition timing		
115-120 hp		
Idle speed	10° ATDC	
Wide-open thottle	17.5" BTDC	
140 hp		
Idle speed	10° ATDC	
Wide-open thottle	20° BTDC	
Exciter coil output cranking speed	135-150 peak volts	WIG-Or
Pulser coil output cranking speed	4.75-5.0 peak volts	B-W/R-W/B-W/L-W/Y
CDI output cranking speed	198-220 peak volts	B-B/W-B/R-B/G-B/L
Ignition coil resistance		
Primary	01 8-0.24 ohm	B-BMI
Secondary	2700-3700 ohms	B-spark plug lead cap
Alternator coil resistance	0.26-0.39 ohm	
Spark plug type	NGK BR8HS-10 or Champion RL-78C	
Spark plug gap	0.9-1.0 mm (0.035-0.039 in.)	

Table 25 BATTERY REQUIREMENTS

Model	Battery
2.5-3.5	None
5	None (optional 12 V 30-35 AH recommended)
8-30	None (optional 12 V 40 AH recommended)
40	None (optional 12 V 70 AH recommended)
40-140	12 V, 500 CCA with 105 minutes (70 AH) reserve capacity

Table 26 ALTERNATOR SPECIFICATIONS

Model	Alternator	Volts	Watts	Output at 1500 RPM	Ouput at 5500 RPM
5	None (optional)	12V	60W	–	4 amp
8-9.8	None (optional)	12V	BOW	–	5 amp
9.9-40	Yes	12V	80W	–	5 amp
40-90	Yes	12V	130W	3 amp	9-11 amp
115-140	Yes	12V	330W	12 amp	24-27 amp

Table 27 RECTIFIERIREGULATOR SPECIFICATIONS (8-90 HP)

		POSITIVE OHMMETER LEAD			
		Black	White	Yellow	Red
NEGATIVE	Black	—	Continuity	Continuity	Continuity
	White	No continuity	—	No continuity	Continuity
	Yellow	No continuity	No continuity	—	Continuity
	Red	No continuity	No continuity	—	—

Table 28 RECTIFIER/REGULATOR SPECIFICATIONS (115-140 HP)

		POSITIVE OHMMETER LEAD				
		Black	Red	Black/white	Black/white	Black/white
NEGATIVE	Black	—	Continuity	Continuity	Continuity	Continuity
	Red	No continuity	—	No continuity	No continuity	No continuity
	Black/white	No continuity	Continuity	—	Continuity	No continuity
	Black/white	No continuity	Continuity	No continuity	—	No continuity
	Black/white	No continuity	Continuity	No continuity	No continuity	—

Chapter Eight

Power Head

Table 1 provides torque specifications for most power head fasteners. **Tables 2-6** provide tolerances and dimensions for cylinder head and cylinder block components. **Tables 1-6** are located at the end of this chapter.

FLYWHEEL

Mount the engine securely to the boat or workbench before removing the flywheel. If removing both the flywheel and power head, remove the flywheel before loosening the power head fasteners.

Flywheel removal requires a spanner-type wrench or strap wrench and puller. The manufacturer's part number for these tools is listed in the removal and installation instructions.

CAUTION
Use only the appropriate tools and instructions to remove the flywheel. Never strike theflywheel with a hard object. The magnets may break and result in poor ignition system performance or potential damage to other engine components.

Removal and Installation (2.5 and 3.5 hp Models)

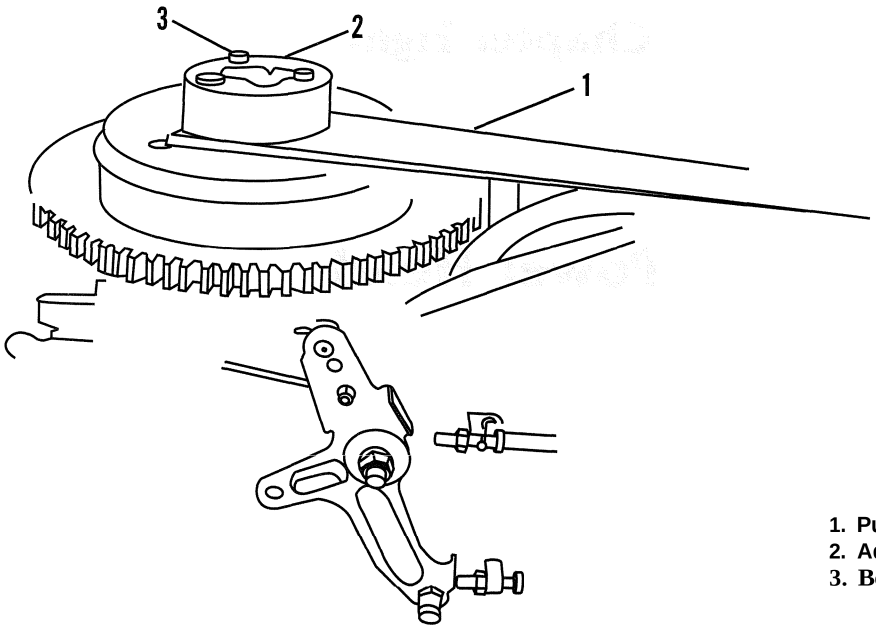
1. Disconnect the cables from the battery, if so equipped.
2. On manual start models, remove the rewind starter as described in Chapter Ten.
3. Remove the internal fuel tank. Determine the direction of rotation for removing flywheel nut.

NOTE
On some models, the flywheel nut has left-hand threads.

4. Attach the flywheel holding tool (part No. 309-72214-0) to the holes in the flywheel **(Figure 1).** Using **a** breaker bar and socket **(Figure 2),** loosen the flywheel nut until its top surface is flush with the upper end of the crankshaft.

1

FLYWHEEL REMQVAL (2.5-40 HP MODELS)



1. Puller arm
2. Adapter
3. Bolts

5. Install the pressing bolt (1, Figure **3)** in the adapter (2). Using a breaker bar, socket and holding arm, tighten the pressing bolt until the flywheel releases (Figure 4). Wipe the flywheel and crankshaft surfaces clean.

6. Pull the flywheel drive key (Figure 5) from its slot in the crankshaft or flywheel. Inspect the key for wear or damage. Replace the key if it is bent. worn or damaged.

7. Remove all metal filings from the flywheel magnets. Inspect the magnets and flywheel surfaces for cracks or corrosion. Clean corrosion using fine sandpaper. Replace the flywheel if deep pitting, cracks or damaged magnets are noted.

8. Place the flywheel key (Figure 5) into the crankshaft slot with the rounded side facing in. Place the flywheel (Figure 4) over the end of the crankshaft and align the flywheel key slot with the flywheel key. Lower the flywheel onto the crankshaft taper. Ensure the key enters the slot.

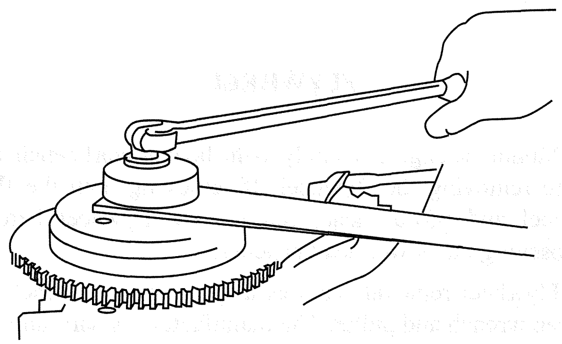
9. Place the washer over the crankshaft. Thread the flywheel nut onto the crankshaft.

10. Attach the flywheel holding tool (Figure **1)** to the flywheel. Tighten the flywheel nut to the specification in **Table 1.**

11. On manual start models, install the rewind starter (Chapter Ten).

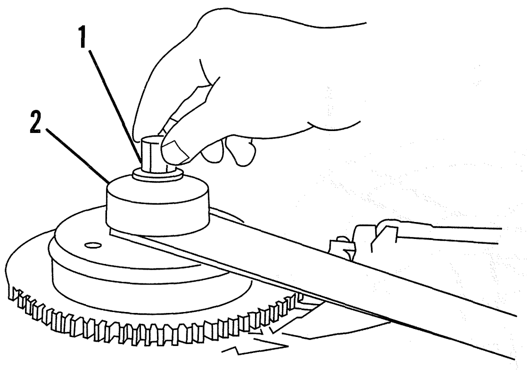
12. Connect the cables to the battery (if so equipped).

2



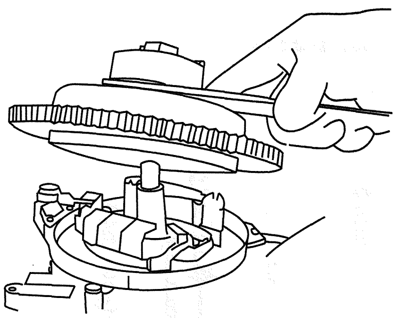
3

FLYWHEEL REMOVAL (2.5-40 HIP MODELS)

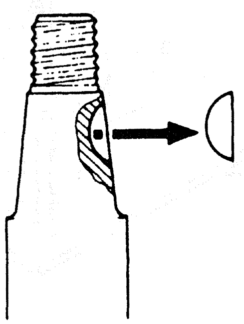


1. Pressing bolt
2. Adapter

4



5



Removal and Installation
(5-40 **hp Models)**

1. Disconnect the cables from the battery, if so equipped.
2. On manual start models, remove the rewind starter as described in Chapter Ten.
3. On electric start models, remove the mounting bolts **(1, Figure 6)** and lift the flywheel cover (2) from the power head.

CAUTION
The flywheel nut may have left-hand threads. Be sure to turn tlze nut in the correct direction to loosen it.

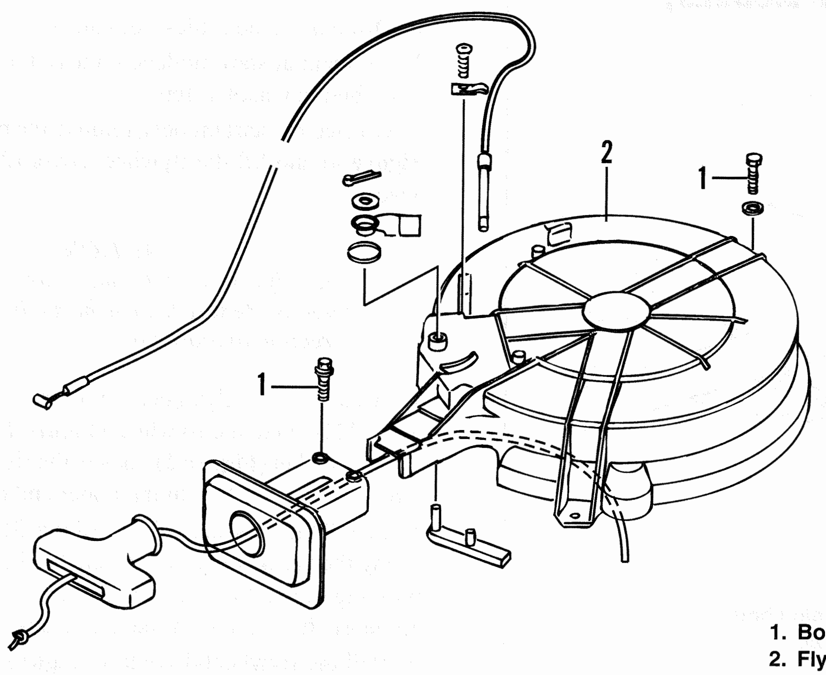
4. Attach the flywheel, holding tool (part No. 336-72214-1) to the flywheel **(Figure** 1). Using a breaker bar and socket **(Figure 2),** loosen the flywheel nut until its top surface is flush with the upper end of the crankshaft.
5. Install the pressing bolt (1, **Figure 3)** in the adapter (2). Using the breaker bar, socket and holding arm, tighten the pressing bolt until the flywheel releases **(Figure** 4). Clean all debris from the flywheel and crankshaft surfaces.
6. Pull the flywheel drive key **(Figure** 5) from its slot in the crankshaft or flywheel. Inspect the key for wear or damage. Replace the key if it is bent, worn or damaged.
7. Remove all metal filings from the flywheel magnets. Inspect the magnets and flywheel surfaces for cracks or corrosion. Clean corroded surfaces using fine sandpaper. Replace the flywheel if deep pitting, cracks or damaged magnets are noted.
8. Place the flywheel key **(Figure 5)** into the crankshaft slot with the rounded side in. Place the flywheel **(Figure** 4) over the end of the crankshaft, then align the flywheel key slot with the flywheel key. Lower the flywheel onto the crankshaft taper. Ensure the key enters the slot.
9. Place the washer over the crankshaft. Thread the flywheel nut onto the crankshaft.
10. Attach the flywheel holding tool **(Figure 1**) to the flywheel. Tighten the flywheel nut to the specification in **Table** 1.
11. On manual start models, install the rewind starter (Chapter Ten).
12. Connect the cables to the battery (if so equipped).

Removal and Installation
(40-140 **hp Models)**

1. Disconnect the cables from the battery, if so equipped.
2. On manual start models, remove the rewind starter as described in Chapter Ten.

6

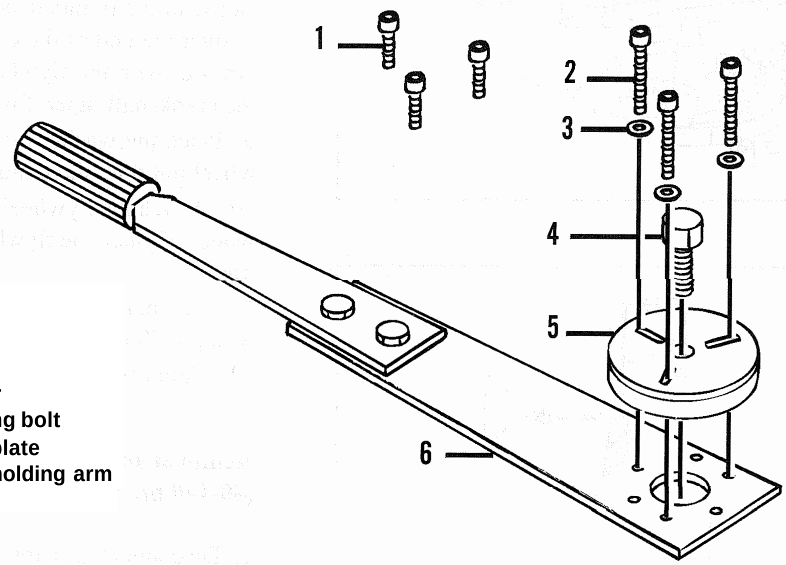
FLYWHEEL COVER (5-40 HP MODELS)



1. Bolts
2. Flywheel cover

7

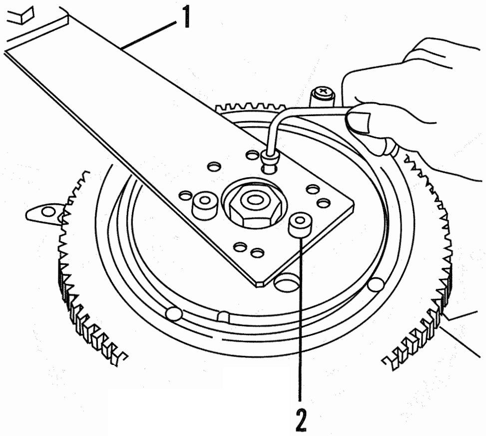
FLYWHEEL PULLER (40-140 HP MODELS)



1. Bolts
2. Bolts
3. Washer
4. Pressing bolt
5. Puller plate
6. Puller holding arm

8

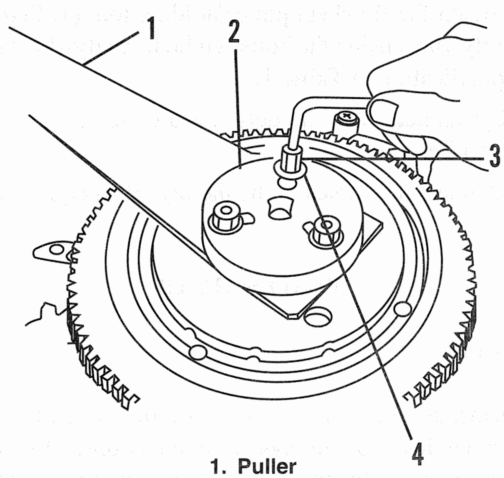
FLYWHEEL PULLER (40-140 HP MODELS)



1. Puller
2. Bolt

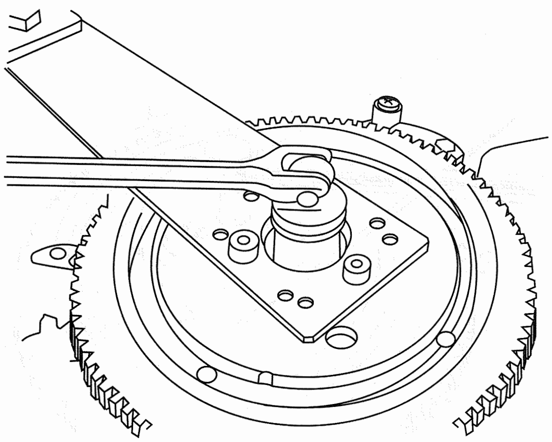
10

FLYWHEEL PULLER (40-140 HP MODELS)



1. Puller
2. Plate
3. Bolt
4. Washer

9



3 On electric start models, remove the mounting bolts (1. **Figure** 6) and lift the flywheel cover (2) from the power head

4 Attach the flywheel, puller/holding tool (Figure 7) (part No 3C7-72211-0) to the flywheel with the bolts (2) as indicated in **Figure** 8. Using a breaker bar and socket (Figure 9), loosen the flywheel nut until its top surface is flush with the upper end of the crankshaft

5 Install the flywheel puller (1, **Figure 10**) and plate (2) Use puller part No 3B7-72781-2 on 40-90 hp models or part No 3C7-72783-0 on 115-140 hp models

6. Install the pressing bolt (1, Figure 11) in the plate (2) Using a breaker bar. socket and holding arm, tighten the pressing bolt until the flywheel releases (Figure 12) Wipe all debris from the flywheel and crankshaft surfaces

7 Pull the flywheel drive key (Figure 5) from its slot in the crankshaft or flywheel Inspect the key for wear or damage Replace the key if it is bent, worn or damaged

8 Remove all metal filings from the flywheel magnets Inspect the magnets and flywheel surfaces for cracks or corrosion Clean corroded surfaces using fine sandpaper Replace the flywheel if deep pitting, clacks or damaged magnets are noted

9 Place the flywheel key (Figure 5) into the crankshaft slot with the rounded side in. Place the flywheel (Figure

4) over the end of the crankshaft and align the flywheel key slot with the flywheel key. Lower the flywheel onto the crankshaft taper. Ensure the key enters the slot.

10. Place the washer over the crankshaft. Thread the flywheel nut onto the crankshaft.

11. Attach the flywheel puller/holding tool (1, Figure 8) to the flywheel using the bolts. Tighten the flywheel nut to the specification in **Table 1.**

12. On manual start models, install the rewind starter (Chapter Ten).

13. Connect the cables to the battery (if so equipped).

POWER HEAD

Removal

Locate the fuel supply hose, throttle and shift cables, battery cables and trim system connections. Most hoses and wires must be removed if performing a complete power head disassembly. Many of the hoses and wires are much more accessible after the power head is removed. Disconnect only the hoses, wires and linkage required for power head removal. Disconnect the remaining hoses and wires after removal.

Diagrams of the fuel and electrical systems are provided to assist with hose and wire routing. To help ensure correct connections, always take pictures or make drawings of all wires and hoses *before* beginning the removal process.

Secure the proper lifting equipment **(Figure 13)** before attempting to remove the power head. Use assistance when lifting or moving any power head.

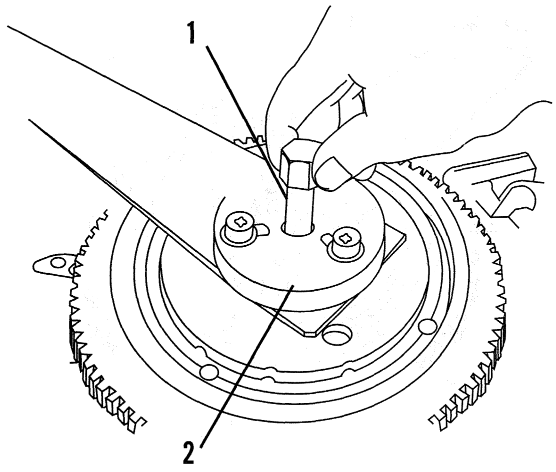
Lifting hooks are provided on 40-140 hp models. On 115-140 hp models, there is a lifting eye at the front of the power head and one just behind the flywheel.

CAUTION
Use care when lifting the power head from the midsection. Corrosion may form at the power head and midsection mating surfaces and prevent removal. To prevent damage to the mating surfaces, avoid using sharp objects to pry the components apart.

WARNING
The power head may abruptly separate from the midsection during removal. Avoid using excessive lifting force. Using pry bars, carefully pry the power head loose from the midsection before lifting.

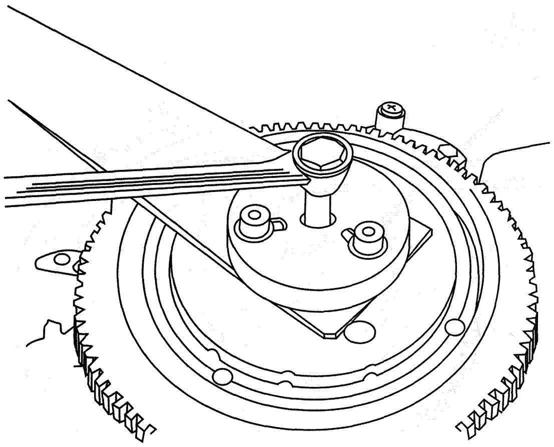
11

FLYWHEEL PULLER (40-140 HP MODELS)

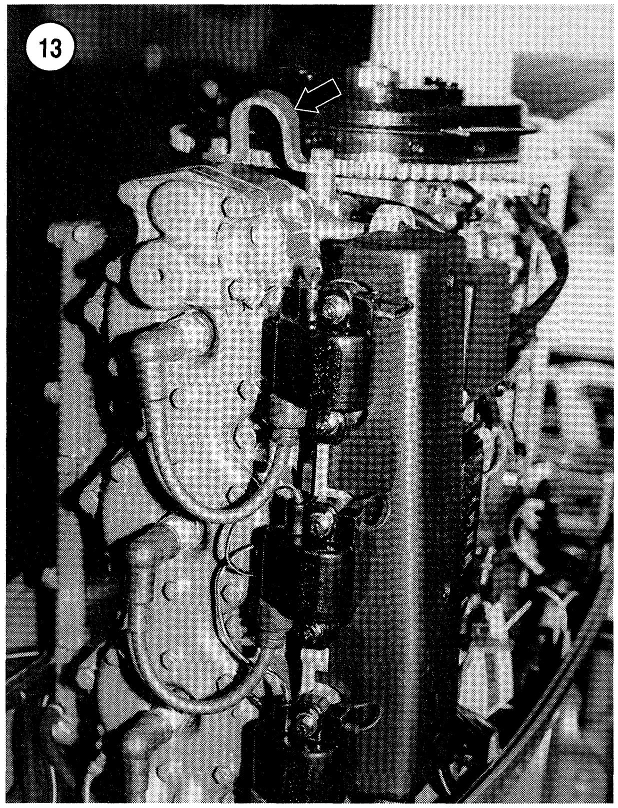


1. Pressing bolt
2. Plate

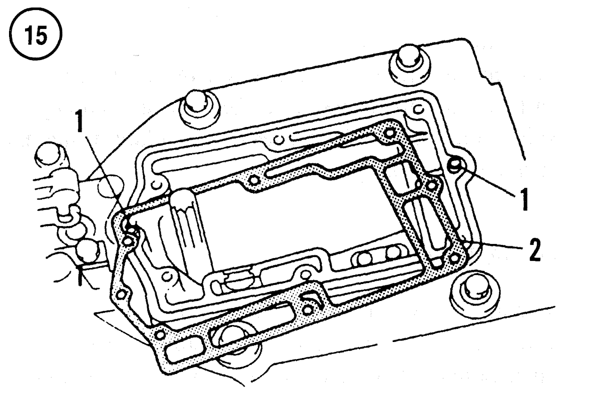
12



13

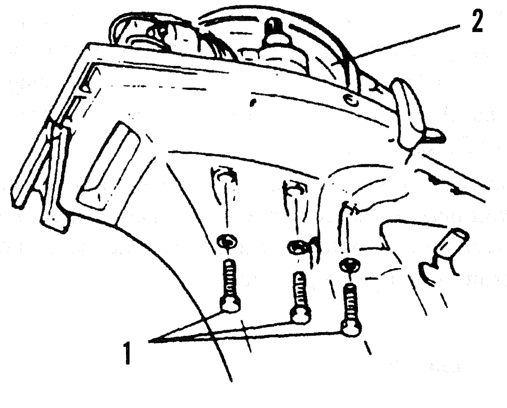


15



1. Locating pins
2. Power head mounting gasket

14



1. Power head mounting bolts
2. Power head

2.5-40 hp models

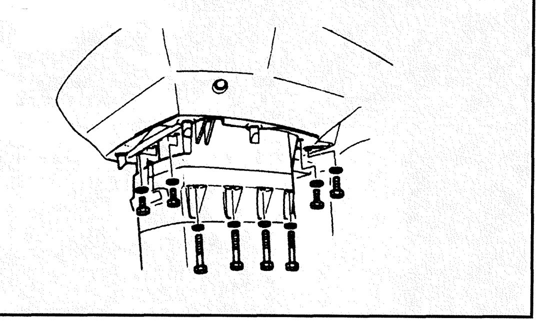
1. Disconnect the battery and fuel tank.
2. Disconnect the ignition system main harness.
3. On remote control models, perform the following:
   a. Disconnect the throttle and shift cables.
   b. Disconnect the battery cables from the battery and the engine.
   c. Disconnect the remote control harness from the engine harness.
4. On tiller control models, perform the following:
   a. Disconnect the throttle cables from the throttle lever.
   b. Disconnect the battery cables (if so equipped) from the battery first, then the engine.
   c. Disconnect the stop button wires from the engine wire harness.
   d. Disconnect the choke linkage.
   e. Disconnect the neutral start switch and starter switch leads (electric start models).
   f. Disconnect the pilot water hose from the exhaust cover.
5. Remove the gearcase as described in Chapter Nine.
6. Disconnect the fuel supply hose from the fuel pump.
7. On manual start models, remove the rewind starter and disconnect the neutral start mechanism as described in Chapter Ten.
8. On electric start models, remove the flywheel cover as described in this chapter.
9. Remove the six engine mounting bolts and washers (1, **Figure** 14) and lift the power head *(2)* from the midsection. Place the power head on a suitable work surface.
10. Remove the power head gasket *(2,* **Figure** 15) from the midsection or bottom of the power head.

11. Carefully scrape all gasket material from the power head mounting surfaces.
12. Inspect the mating surfaces (on the midsection and power head) for pits or damage. Replace any damaged or defective components. Water leakage is likely if the mating surfaces are damaged.

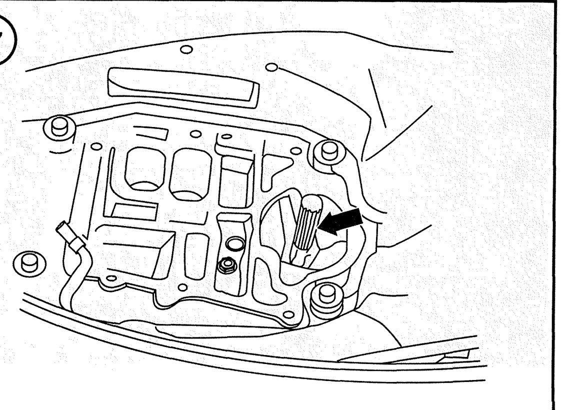
40-140 hp models

1. Disconnect the battery and fuel tank.
2. Disconnect the ignition system main harness.
3. On remote control models, perform the following:
   a. Disconnect the throttle and shift cables.
   b. Disconnect the battery cables from the battery, then the engine.
   c. Disconnect the remote control harness from the engine harness.
   d. Disconnect the ground wires between the lower engine cover and cylinder block.
   e. Disconnect the power trim/tilt harness from the power head.
4. On tiller control models, perfonn the following:
   a. Disconnect the throttle cables from the throttle lever.
   b. Disconnect the battery cables from the battery, then the engine.
   c. Disconnect the stop button wires from the engine wire harness.
   d. Disconnect the choke linkage.
   e. Disconnect the neutral start switch and starter switch leads (electric start models).
   f. Disconnect the pilot water hose from the exhaust cover.
5. Remove the gearcase as described in Chapter Nine.
6. Disconnect the fuel supply hose from the fuel pump.
7. On manual start models, remove the rewind starter and disconnect the neutral-only start mechanism as described in Chapter Ten.
8. On electric start models, remove the flywheel cover as described in this chapter.
9. Remove the engine mounting bolts and washers **(Figure 16)**, then lift the power head from the midsection. Place the power head on a suitable work surface.
10. Remove the power head gasket (2, **Figure** 15) from the midsection or bottom of the power head.
11. Carefully scrape all gasket material from the power head mounting surfaces.
12. Inspect the mating surfaces (on the midsection and power head) for pits or damage. Replace damaged or defective components. Water leakage is likely if the mating surfaces are damaged.

16



17



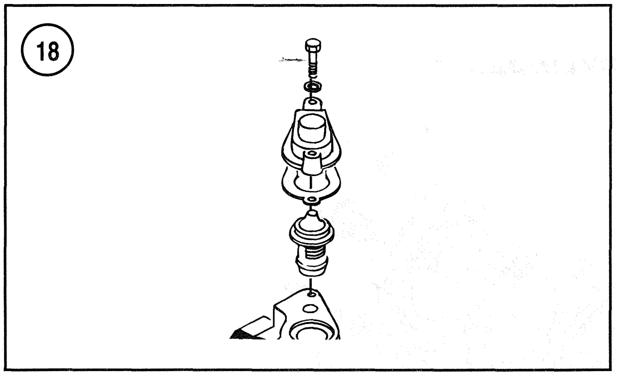
Installation

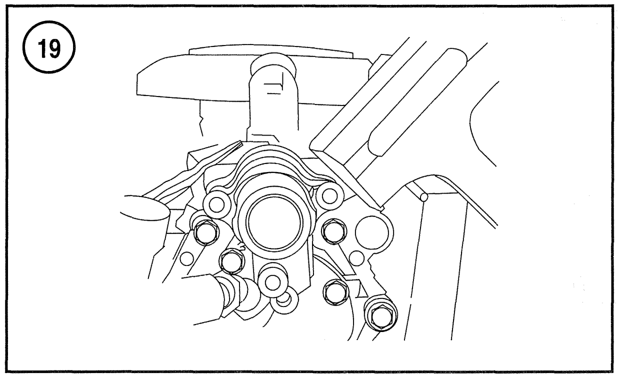
Look for potential interference with linkage, wising and hoses before lowering the power head. Always install a new power head gasket prior to mounting the power head. Lower the power head slowly and keep the power head-to-midsection mating surfaces parallel until they mate. This step greatly reduces the chance of damaging the gasket.

Observe all hoses, wiring and linkage while lowering the power head to ensure they are not pinched or bound by the power head. Route all wires, fuel and water hoses away from moving components.

2.5-40 hp models

1. Clean the engine base surface and coat the driveshaft splines **(Figure** 17) with engine oil.
2. Apply high-temperature gasket sealant to the bottom surface of the power head base gasket and place the gasket onto the midsection.
3. Lower the power head onto the midsection while guiding the drive shaft into the power head. Align the dowel pins with the holes in the gasket.





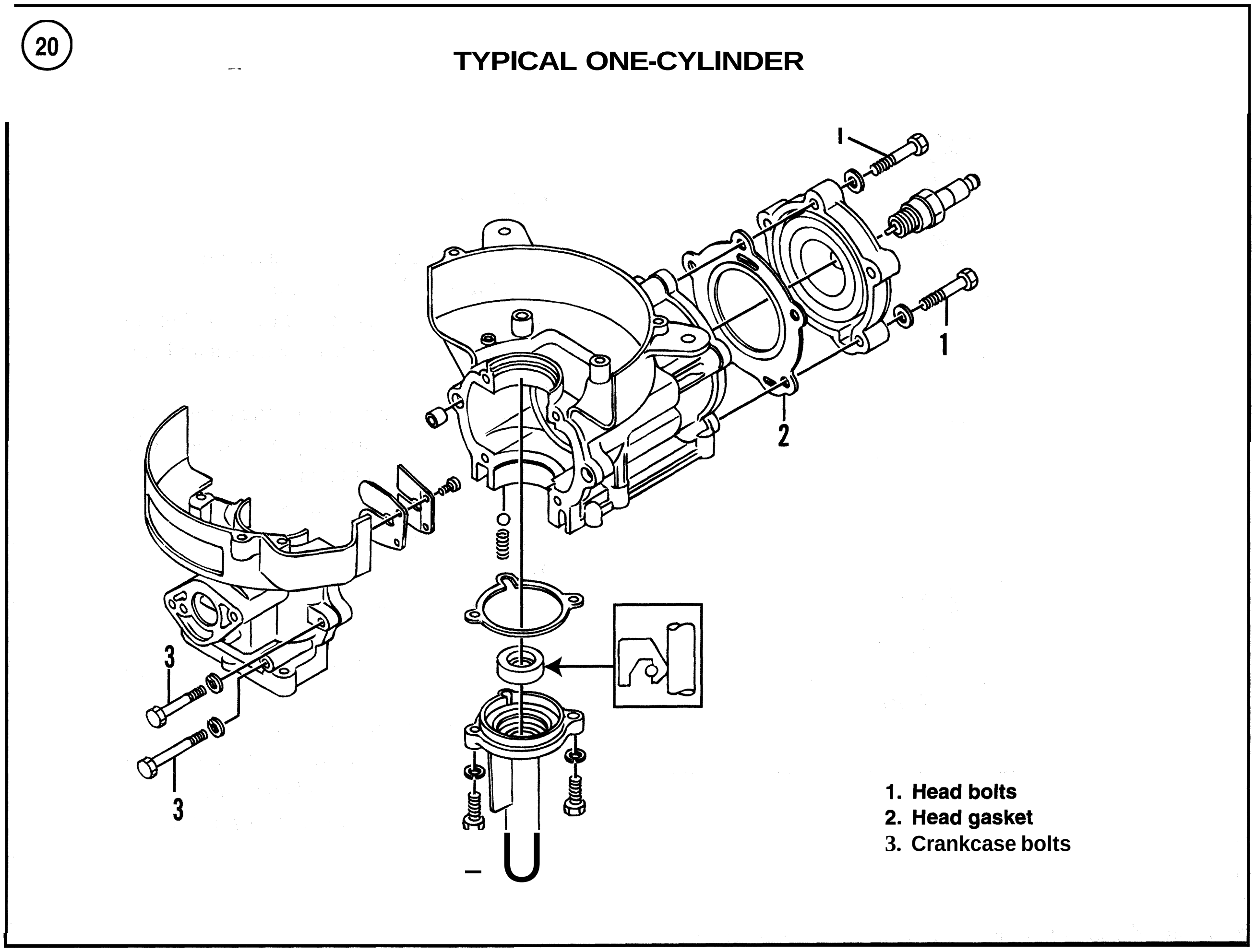
4. Install the mounting bolts and washers (1, Figure 14) into the power head. Tighten the bolts in a crossing pattern to the specification in Table 1.
5. Install the covers onto the port and starboard sides of the drive shaft housing. Securely tighten the cover bolts.
6. On electric start models, install the flywheel cover as described in this chapter.
7. On manual start models, install the rewind starter and connect the neutral start mechanism as described in Chapter Ten.
8. On remote control models, perform the following:
   a. Connect the throttle and shift cables.
   b. Connect the batteiy cables to the engine then the battery.
   c. Connect the remote control harness to the engine harness.
9. On tiller control models, perform the following:
   a. Connect the throttle cables to the throttle lever.
   b. Connect the battery cables (if so equipped) to the engine then the battery.
   c. Connect the stop button wires to the engine wire harness.
   d. Connect the oil pressure warning light to the engine wire harness.
   e. Connect the choke linkage to the carburetor.
   f. Connect the neutral start switch and starter switch leads (electric start models).
10. Connect the fuel supply hose to the fuel pump.
11. Install the gearcase (Chapter Nine).
12. Perfonn all applicable adjustments as described in Chapter Five.

40-140 hp models

1. Clean the engine base surface and coat the driveshaft splines (Figure 17) with engine oil.
2. Apply high-temperature gasket sealant to the bottom surface of the power head base gasket and place the gasket onto the midsection.
3. Lower the power head onto the midsection while guiding the drive shaft into the power head. Align the dowel pins with the holes in the gasket.
4. Install the mounting bolts and washers (Figure 16) into the power head. Tighten the bolts in a crossing pattern to the specification in Table 1.
5. Install the covers onto the port and starboard sides of the drive shaft housing. Securely tighten the cover bolts.
6. On electric start models. install the flywheel cover (this chapter).
7. On manual start models, install the rewind starter and connect the neutral start mechanism (Chapter Ten).
8. On remote control models perfonn the following:
   a. Connect the throttle and shift cables.
   b. Connect the battery cables to the engine then the battery.
   c. Connect the remote control harness to the engine harness.
9. On tiller control models, perform the following:
   a. Connect the throttle cables to the throttle lever.
   b. Connect the battery cables (if so equipped) to the engine then the battery.
   c. Connect the stop button wires to the engine wire harness.
   d. Connect the oil pressure warning light to the engine wire harness.
   e. Connect the choke linkage to the carburetor.
   f. Connect the neutral start switch and starter switch leads (electric start models).
10. Connect the fuel supply hose to the fuel pump.
11. Install the gearcase (Chapter Nine).
12. Perfonn all applicable adjustments as described in Chapter Five.

Thermostat Removal

Refer to Figure 18 and Figure 19 during this procedure.
1. Disconnect the cables from the battery, if so equipped.



2. On 8-140 hp models, remove the thermostat screws from the cover **(Figure 18).**

3. Remove the thermostat cover from the power head. If necessary, carefully tap the cover loose with a rubber mallet **(Figure 19).**

4. Using needlenose pliers, pull the thermostat from the opening. Inspect it for obvious damage and corrosion.

5. Carefully scrape all gasket material from the thermostat cover and power head. Use a stiff brush to clean the thermostat cover, thermostat and thermostat opening.

6. Test the thermostat/pressure relief valve as described in Chapter Three.

Thermostat Installation

1. Carefully slide the thermostat into the power head with the spring side facing in. Seat the thermostat in the opening.

2. Place a new gasket on the thermostat cover. Slip the bolts through the holes to help retain the gasket.

3. Apply a very light coat of water-resistant grease to the bolt threads and install the cover onto the power head.

4. Install the cover bolts. Tighten the bolts evenly to the specification in **Table 1.**

Cylinder Head Removal and Installation

Refer to **Figures 20-23** during the cylinder head removal and installation process.

Removal (2.5-5 *hp models)*

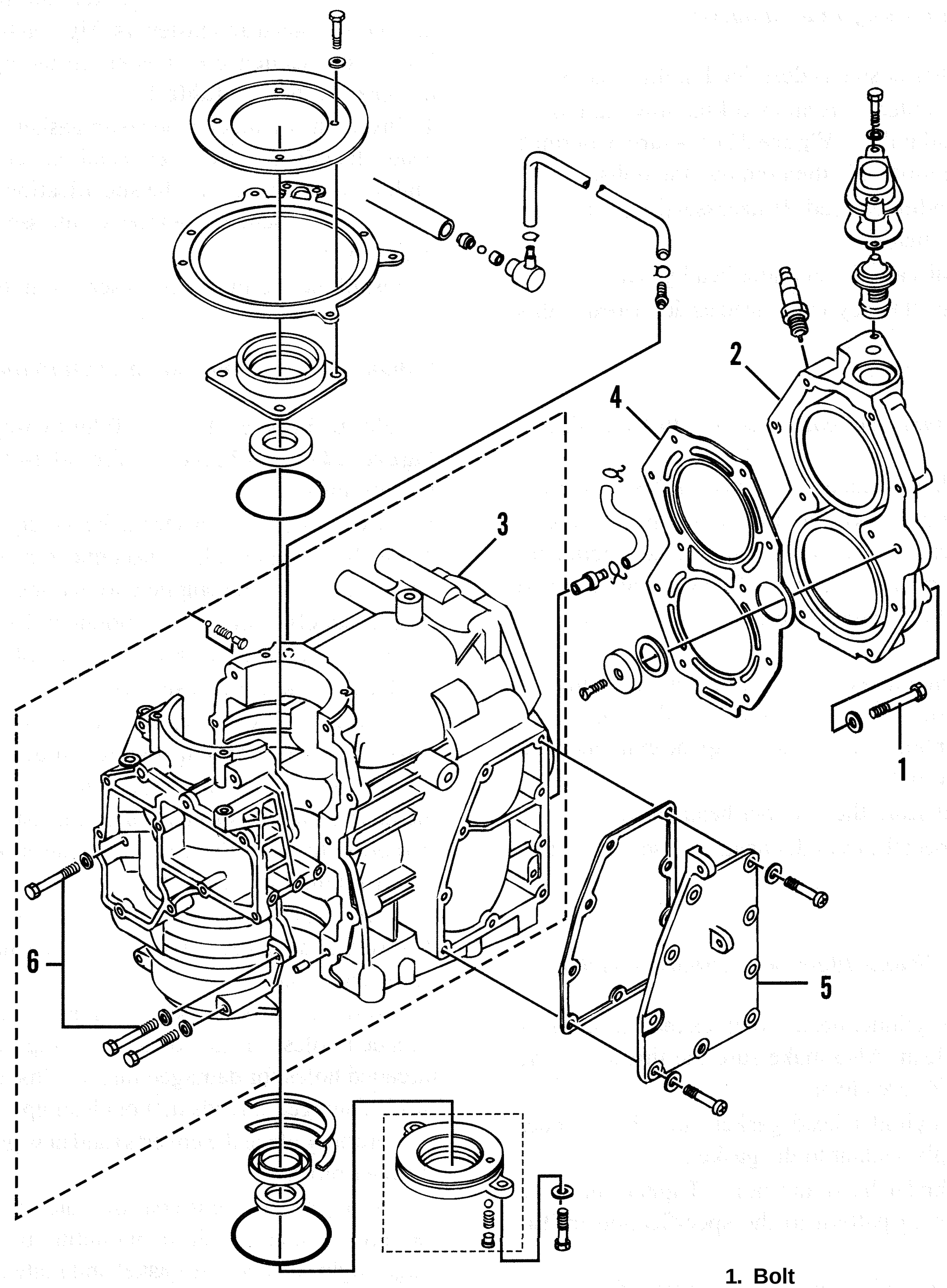
1. Remove the five cylinder head bolts (1, **Figure 20).**

2. Remove the cylinder head. If necessary, tap the cylinder head loose using a soft mallet.

3. Remove and discard the cylinder head gasket.

21

TYPICAL TWO-CYLINDER



1. Bolt
2. Head
3. Cylinder block
4. Head gasket
5. Exhaust cover
6. Bolt

4. Clean and inspect the cylinder head as described in this chapter.

Removal (8-40 hp two-cylinder models)

1. Remove the thermostat as described in this chapter.
2. Starting at the outer bolts and working inward, loosen each cylinder head bolt (1, **Figure 21)** 1/4 turn. Continue until all bolts are loose and then remove the bolts.
3. Remove the cylinder head. If necessary, tap the head loose using a soft mallet.
4. Remove and discard the cylinder head gasket.
5. Clean and inspect the cylinder head as described in this chapter.

Removal (40 hp three-cylinder and 50-140 hp models)

1. Remove the thermostat as described in this chapter.
2. Starting at the outer bolts and working inward, loosen each cylinder head cover bolt. Continue to alternately loosen each bolt until all are loose. Remove the bolts and cylinder head cover. Remove and discard the cover gasket.
3. Loosen the remaining cylinder head bolts reversing the order of the numbers embossed on the head. Remove the bolts and cylinder head. If necessary, tap the cylinder head loose using a soft mallet.
4. Remove and discard the cylinder head gasket.
5. Clean and inspect the cylinder head as described in this chapter.

Installation (2.5-30 and 40 hp two-cylinder models)

1. Make sure the cylinder head and block mating surfaces are completely clean. Also make sure the threads of the bolts and bolt holes are clean.
2. Install a new cylinder head gasket onto the cylinder block. Do not apply sealant to the gasket.
3. Install the cylinder head and bolts. Tighten the bolts following a crossing pattern to the specification in **Table 1.**
4. Install the thermostat on models so equipped.

Installation (40 hp three-cylinder and 50-140 hp models)

1. Make sure the cylinder head and block mating surfaces are completely clean. Also make sure the threads of the bolts and bolt holes are clean.
2. Apply a light coat of high-temperature sealant to both sides of the cylinder head and cylinder head cover gaskets.
3. Install the cylinder head gasket onto the block. Install the cylinder head and fasteners. Tighten the fasteners, following the sequence embossed on the cylinder head, to the specification in **Table 1.**
4. Install the cylinder head cover gasket onto the cylinder head. Install the cylinder head cover and fasteners. Tighten the fasteners to the specification in **Table 1,** following the sequence of numbers embossed on the cylinder head cover.
5. Install the thermostat as described in this chapter.

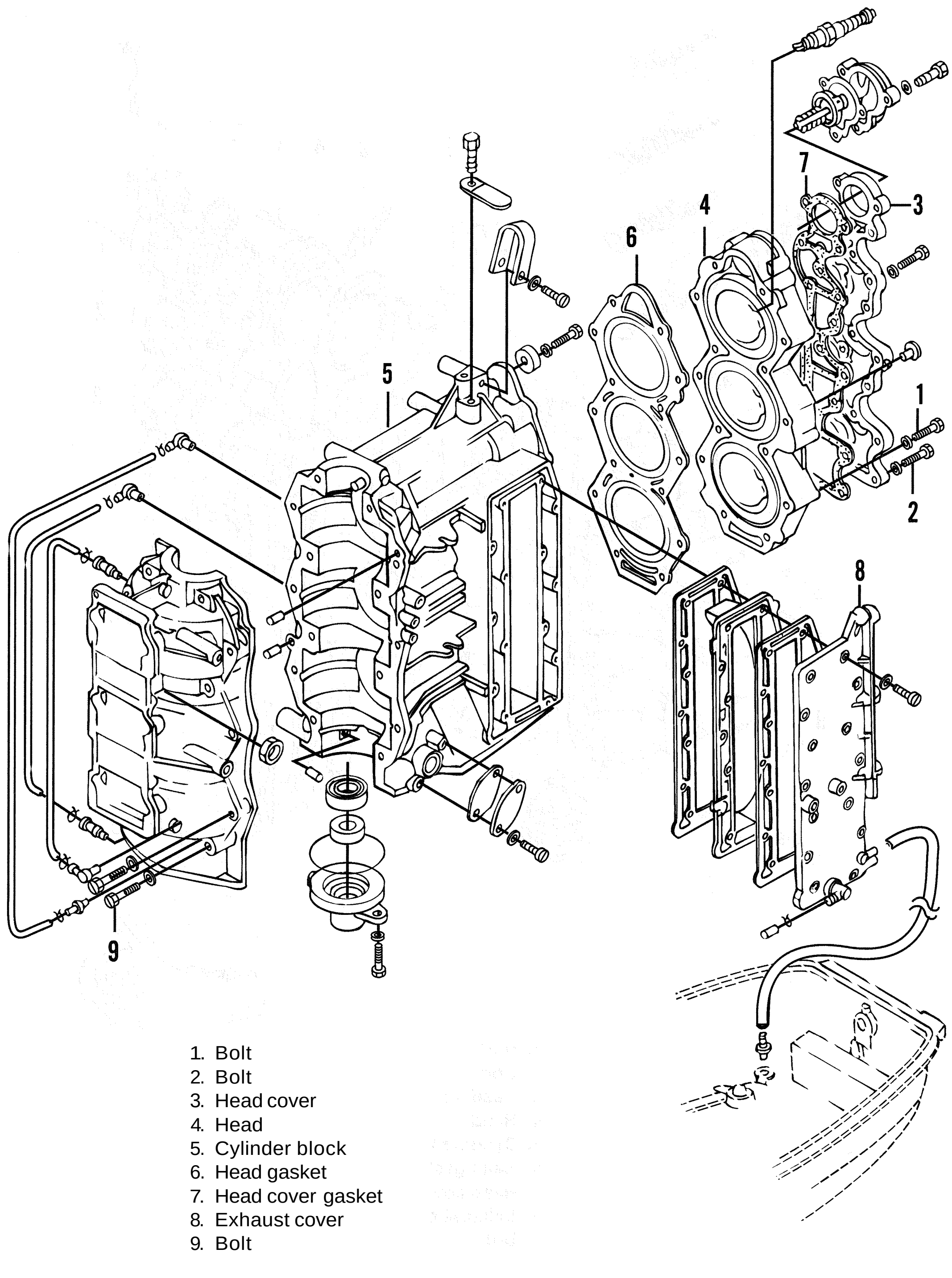
Exhaust Cover Removal and Installation

Refer to **Figure 21** for 8-40 hp two-cylinder models, **Figure 22** and **Figure 23** for 40-140 hp three- and four-cylinder models.

1. Disconnect the cables from the battery, if so equipped.
2. On 40-140 hp models, disconnect the engine temperature sensor from the engine wire harness.
3. On models with a cover-mounted thermostat, remove the thermostat as described in this chapter.
4. Remove the cover fasteners.
5. Carefully pry the waterjacket and exhaust cover loose. Lift the cover(s) from the cylinder block.
6. Carefully scrape all carbon and gasket material from the cover, mating surfaces and exhaust passages. Use a stiff brush to clean all corrosion, scale or other contamination from the exposed water passages.
7. Inspect the cover(s) for holes or signs of leakage and distorted or damaged surfaces. Replace the cover(s) if any defects are noted.
8. Using a properly sized thread chaser, clean the threaded holes for the cover mounting bolts. Inspect the threaded holes for damaged threads. Install a threaded insert if damaged threads do not clean up with the chaser.
9. Carefully place the cover(s) and new gasket(s) onto the cylinder block.
10. Apply a very light coat of water-resistant grease to the threads, then install the mounting bolts until they are finger-tight. Inspect the gasket and plate for proper alignment. Correct if required.
11. Tighten the bolts following the sequence embossed on the cover. Tighten the bolts a second time in sequence to the torque specification in **Table 1**.
12. On 40-140 hp models, connect the engine wire harness to the engine temperature sensor.
13. Install the thermostat as described in this chapter.
14. Reconnect the cables to the battery.

22

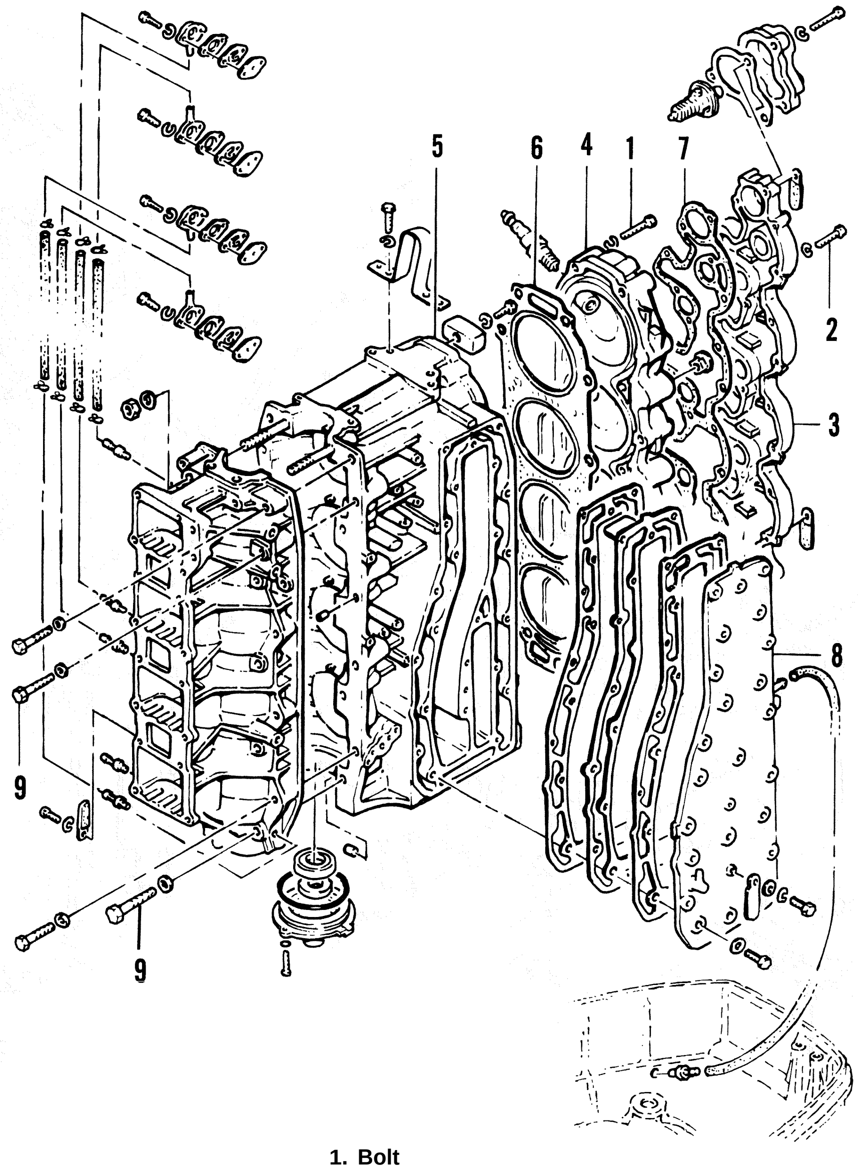
TYPICAL THREE-CYLINDER



1. Bolt
2. Bolt
3. Head cover
4. Head
5. Cylinder block
6. Head gasket
7. Head cover gasket
8. Exhaust cover
9. Bolt

23

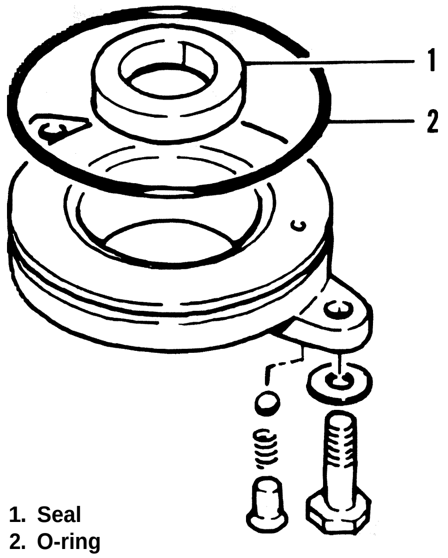
TYPICAL FOUR-CYLINDER



1. Bolt
2. Bolt
3. Head cover
4. Head
5. Cylinder block
6. Head gasket
7. Head cover gasket
8. Exhaust cover
9. Bolt

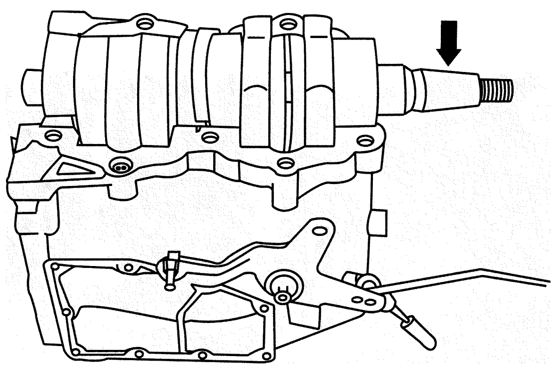
24

LOWER END CAP ASSEMBLY
(8-40 HP MODELS)



1. Seal
2. O-ring

25



15. Inspect the cover for water or exhaust leakage after starting the engine.

Cylinder Block Disassembly and Assembly

Always make notes, drawings and photographs of all external power head components before beginning power head disassembly.

Correct hose and wire routing is important for proper engine operation. An incorrectly routed hose or wire may interfere with linkage operation. Hoses or wires may chafe and short to ground or leak if allowed to contact sharp or moving parts.

Mark the UP and FORWARD direction before removing any components. If possible, remove a cluster of components that share common wires or hoses. This will reduce the time to disassemble and assemble the power head. This method also reduces the chance of improper connections during assembly.

Use muffin tins or egg cartons to organize the fasteners as they are removed. Tag or mark all fasteners to ensure they are installed in the correct location.

8

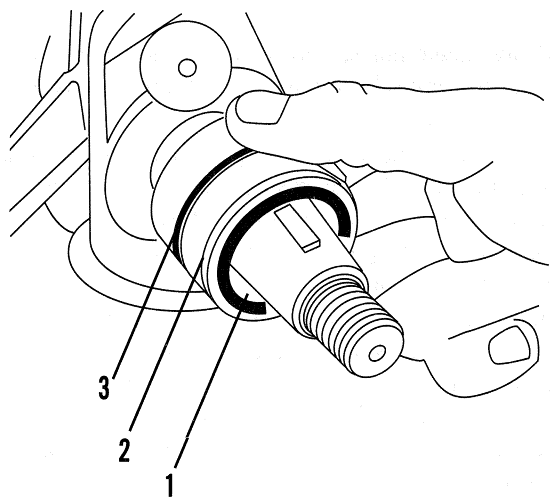
Disassembly (2.5-40 two-cylinder hp models)

Refer to **Figure** 20 and **Figure 21** during this procedure.

1. Remove the cylinder head as described in this chapter.
2. Remove all electrical components as described in Chapter Seven.
3. Remove any remaining fuel system components (Chapter Six).
4. Remove the exhaust covers and thermostat as described in this chapter.
5. Remove the breather housing or cover from the cylinder block. Refer to Chapter Six. Thoroughly clean the housing or element with a suitable solvent.
6. Remove and discard the seal and O-ring **(Figure 24)** from the lower crankcase or bottom of crankshaft.
7. Loosen the crankcase cover bolts 1/4 turn at a time, following in reverse the tightening sequence numbers until all bolts turn freely.
8. Locate the pry points at the top and bottom corners of the cover. Carefully pry the cover from the crankcase. Check for additional bolts if removal is difficult.
9. To loosen the crankshaft, tap the tapered end of the crankshaft **(Figure** 25) with a rubber mallet. Lift the crankshaft assembly from the cylinder block and place it on a workbench for disassembly.

26

UPPER MAIN BEARING ASSEMBLY (8-40 HP MODELS]



1. Oil seal
2. Main bearing
3. O-ring

10. Remove the upper main bearing **(Figure 26)** from the top of the crankshaft. Remove and discard the seal and O-ring.

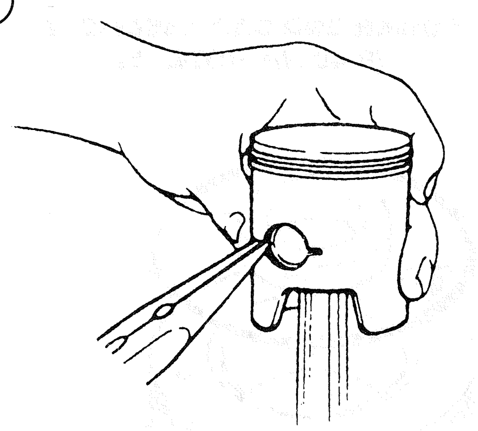
NOTE
The crankshaft for 25 and 30 hp models has a bearing race that blocks removal of the bottom piston. To remove the crankshaft assembly, lift up and remove the race.

NOTE
Mark all parts and make sure they are kept together so they can be returned to their original positions during assembly.

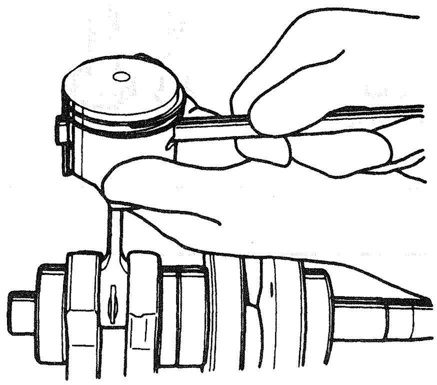
11. Remove one piston assembly at a time. Mark the cylinder number on the piston (using masking tape) before removing the piston from the rod. Remove the piston as follows:

a. Remove and discard the piston pin clip **(Figure 27)** from both sides of each piston.
b. Remove the piston pins by taping the piston pin out of the piston **(Figure 28)** using a suitable driver.
c. Remove the piston and slide the rod bearing **(Figure 29)** out of the connecting rod.
d. Remove each piston ring using a piston ring expander **(Figure 30).**

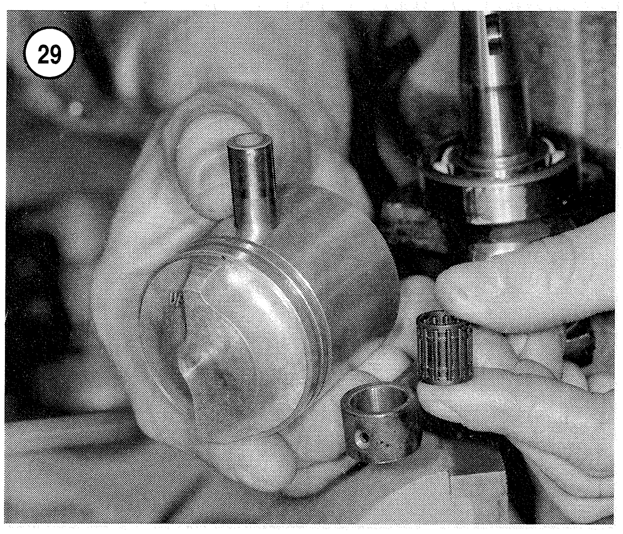
27

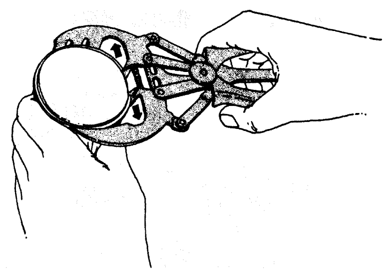


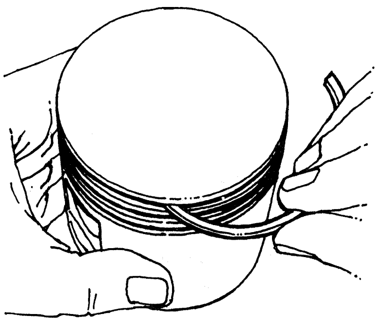
28

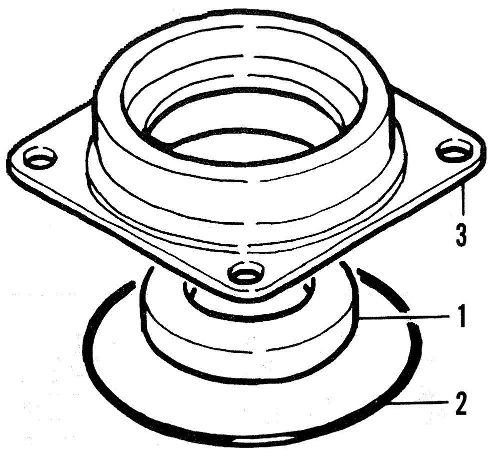


29



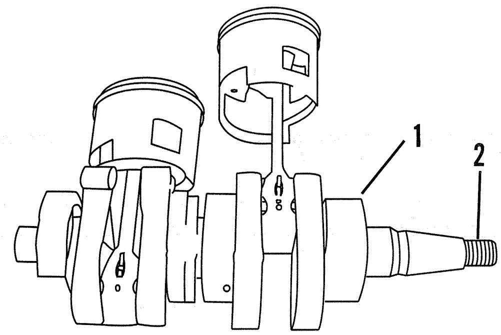






LOWER END CAP ASSEMBLY (MODELS 8-40 HP)

1. Oil seal
2. O-ring
3. End cap



UPPER MAIN BEARING ASSEMBLY (8-40 HP MODELS)

1. Oil seal
2. Crankshaft (threaded end)

e. Clean the piston ring grooves using a piece of broken ring (Figure 31).

12. Thoroughly clean the cylinder block with hot soapy water. Clean other components with solvent. Clean carbon from the piston dome with a stiff (nonmetallic) brush and solvent. Dry all components with coinpressed air. Apply a light coat of engine oil to the piston, piston pin, cylinder bore, bearings, connecting rod and crankshaft to prevent corrosion.

13. Inspect all components as described in this chapter.

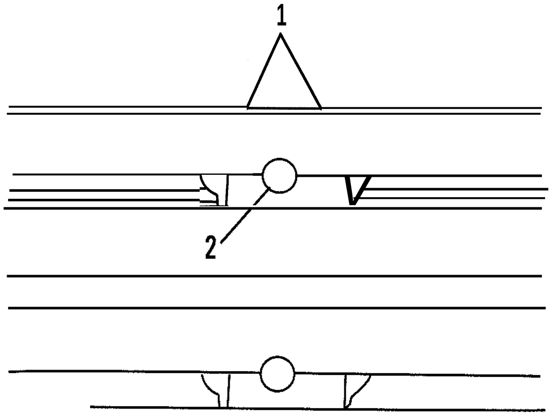
Assembly (2.5-40 two-cylinder hp models)

Refer to Figure 20 and Figure 21 during this procedure.

1. Apply bearing grease to the seal lips. Using an appropriate size seal installer, press fit the seals into place to avoid damaging the seal or base.
2. Install a new seal (1, Figure 32) and a new O-ring (2) in the lower crankcase and cap (3) and upper magneto base. Fully seat the seals in the cylinder block.
3. Apply TC-W3 oil to all surfaces of the crankshaft and connecting rod bearings, bearing thrust plates (40 hp models) and bearing washers.
4. Install the upper main bearing (Figure 33) on the crankshaft so the seal (1) faces the threaded end of the crankshaft (2).

34

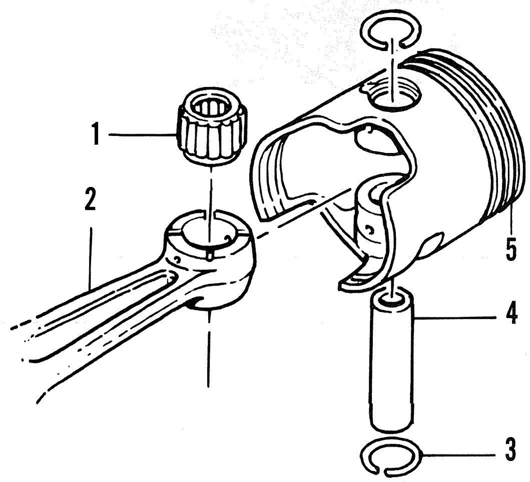
PISTON RING INSTALLATION (8-140 HP MODELS)



1. End notches
2. Locating pin

35

CONNECTING ROD ASSEMBLY (MODELS 8-4Q HP)



1. Rod bearing
2. Connecting rod
3. Piston pin keeper
4. Piston pin
5. Piston

5. If removed, apply engine oil to the inner diameter of the lower main bearing and lower end of the crankshaft. Press the bearing onto the crankshaft using a suitable driver and press. Install the snap ring, making sure it fully seats in its groove.

6. Install the piston rings using a piston ring expander (Figure 30). Install each ring so the end gaps (1, Figure 34) fit around the ring locating pin (2) when the ring is compressed.

7. Install the connecting rod bearings (1, Figure 35) into the small end of the connecting rod. Lubricate the bearings using clean engine oil.

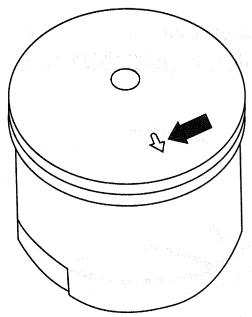
8A. *2.5, 3.5, 25 and 30* hp—Install the piston(s) on the connecting rod(s) so the arrow on the piston crown (Figure **36)** faces toward the exhaust port.

8B. *5, 8, 9.8, 9.9, 15, 18 and 40* hp—Install the pistons on the connecting rods so the UP mark faces toward the flywheel.

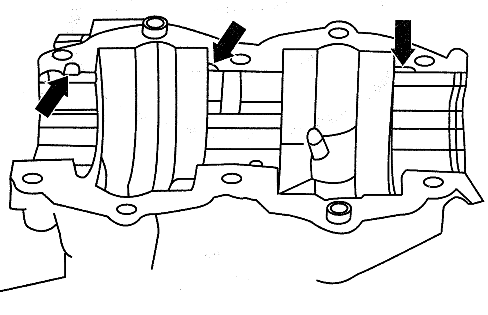
9. Install the piston pin(s) and new piston pin clips.

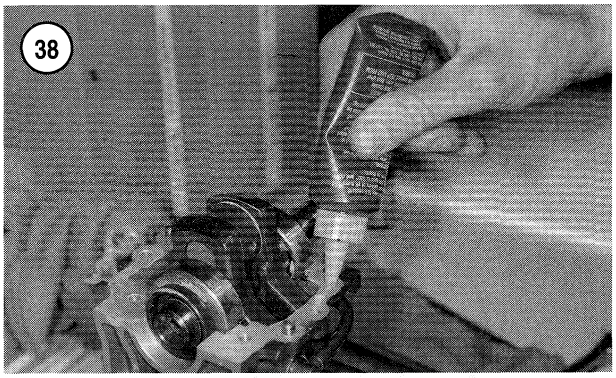
10. Apply a coat of TC-W3 oil to the cylinder walls, piston(s), rings, oil pump drive gear and driven gear. Install the thrust plates (40 hp models) or bearing washers and lower the crankshaft into the cylinder block, guiding each piston into its cylinder.

36



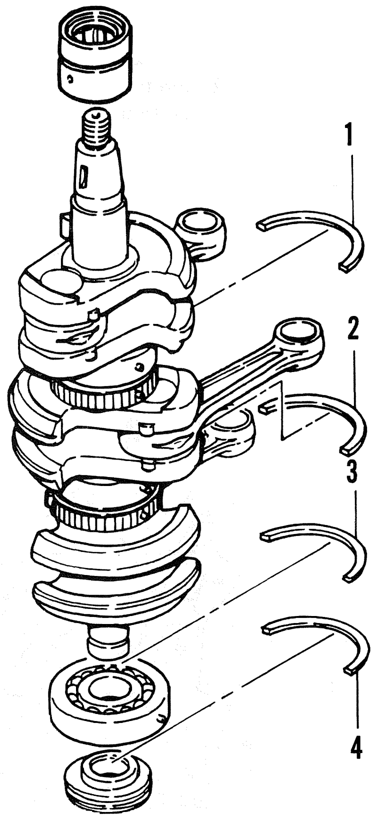
37





39

CRANKSHAFT AND BEARING THRUST PLATES (40 HP [THREE CYLINDER] AND 50 HP MODELS)



1. Bearing thrust plate
2. Bearing thrust plate
3. Crankshaft thrust plate
4. Crankshaft thrust plate

11. Position the main bearings so the bearing locating pins **(Figure 37)** engage the slots in the cylinder block.

12. Apply an even coat of anaerobic sealant to the cylinder block mating surface **(Figure 38).**

13. Install the crankcase cover onto the cylinder block. Make sure that all locating pins in the main bearing are properly aligned in the crankcase.

14. Install the crankcase mounting bolts and torque them to the specification in **Table 1.** Start the torque sequence with the bolt closest to the center of the crankcase and work outward.

15. Install the exhaust cover and thermostat as described in this chapter.

16. Install all electrical and ignition system components as described in Chapter Seven.

17. Install the cylinder head and flywheel as described in this chapter.

18. Install the fuel system components as described in Chapter Six.

8

Disassembly (40 hp three-cylinder and 50-140 hp models)

Refer to **Figure 22** and **Figure 23** during this procedure.

1. Remove the cylinder head as described in this chapter.
2. Remove all electrical components as described in Chapter Seven.
3. Remove any remaining fuel system components as described in Chapter Six.
4. Remove the exhaust cover and thermostat as described in this chapter.
5. Remove the breather housing or cover from the cylinder block. Refer to Chapter Six. Thoroughly clean the housing or element with solvent.

NOTE

On 40 and 50 hp models, the crankshaft is equipped with bearing thrust plates (1 and 2, ***Figure 39****) and crankshaft thrust plates (3 and 4). Identify tlzeseparts so tlzey may be returned to their original positions during assembly.*

6. Remove and discard the oil seals (1 and 3, **Figure 40)** and O-ring **(2)** from the lower crankcase or bottom of crankshaft. Use a seal puller to prevent damaging the crankcase.
7. Loosen the crankcase cover bolts 1/4 turn at a time, following in reverse the tightening sequence numbers embossed on the cover until all bolts turn freely. Remove the bolts from the crankcase cover.

8. Locate the pry points at the top and bottom corners of the cover. Carefully pry the cover from the crankcase. Check for additional bolts if removal is difficult.
9. To loosen the crankshaft, tap the top end of the crankshaft with a rubber mallet. Lift the crankshaft assenibly from the cylinder block and place it on a workbench for disassembly.
10. Remove the oil pump driven gear and the bushing (Figure 41) from the cylinder block.
11. Remove the upper main bearing (2, Figure 42) from the top of the crankshaft. Remove and discard the bearing seal (3) and O-ring.
12. Remove one piston assembly at a time. Mark the cylinder number on the piston using masking tape before removing the piston from the rod. This step ensures the same piston is in the same orientation during assembly. Remove the piston as follows:
   a. Remove and discard the piston pin clips (Figure 43) from both sides of each piston.
   b. Tap the piston pin out of the piston (Figure 44) using a suitable driver.
   c. Remove the piston (8, Figure 45), bearing washers (3 and 4) and slide the needle bearing (2) out of the connecting rod.
   d. Remove each piston ring using a piston ring expander (Figure 46).
   e. Clean the piston ring grooves using a piece of broken ring (Figure 47).
13. Thoroughly clean the cylinder block with hot soapy water. Clean other components with solvent. Clean carbon from the piston dome with a stiff (nonmetallic) brush and solvent. Dry all components with compressed air. Apply a light coat of engine oil to the piston, piston pin, cylinder bore, bearings, connecting rod and crankshaft to prevent corrosion.
14. Inspect and measure all components as described in this chapter,

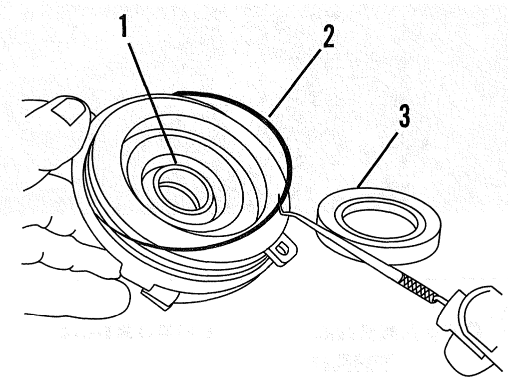
Assembly (40 hp three-cylinder and 50-140 hp models)

Refer to Figure 22 and Figure 23 during this procedure

1 Before installation, apply engine oil lightly to the outside surfaces of the new seals and O-rings Apply grease to the seal lips
2 Install new oil seals (1 and 3, Figure 40) and a new O-ring (2) in the lower crankcase head. Install a new seal and O-ring (Figure 48) in the upper main bearing. Ensure the seal is fully seated in its groove or bore in the cylinder block

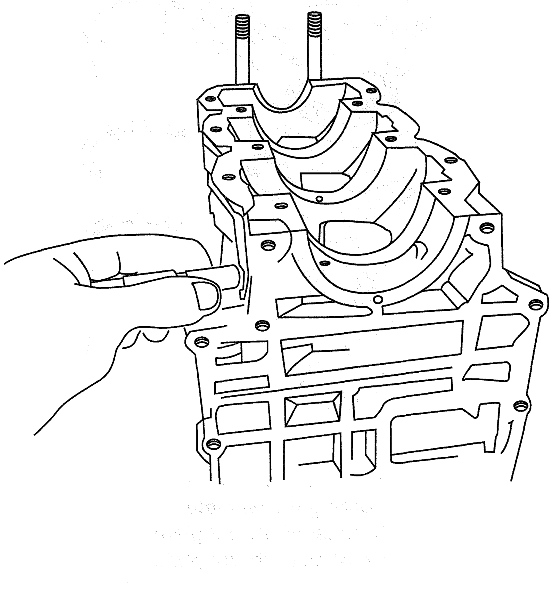
40

LOWER CRANKCASE HEAD ASSEMBLY (40-140 HP MODELS)



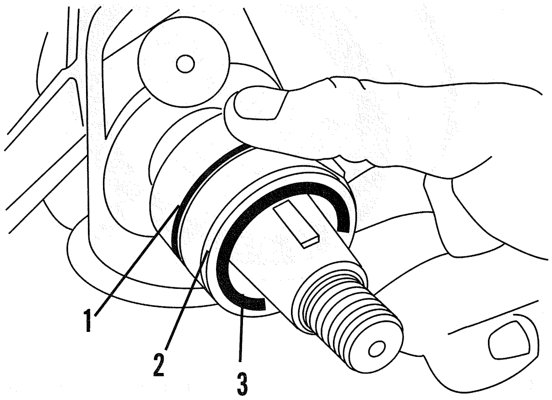
1. Oil seal
2. O-ring
3. Oil seal

41



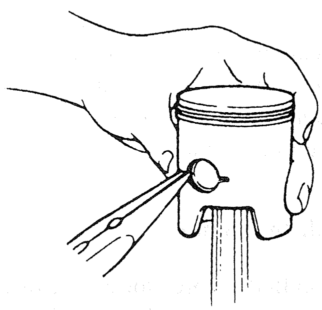
42

UPPER MAIN BEARING ASSEMBLY (40-140 HP MODELS)

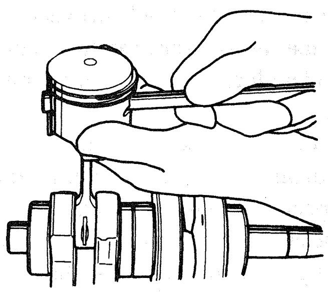


1. O-ring
2. Bearing
3. Oil seal

43

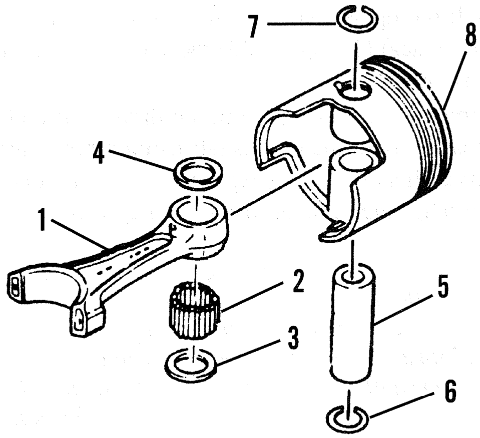


44



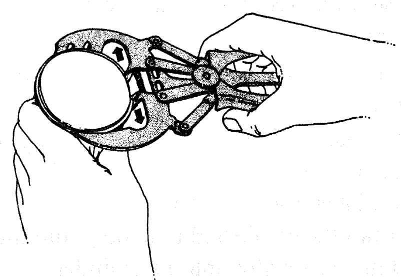
45

ROD AND PISTON ASSEMBLY (40-140 HP MODELS)

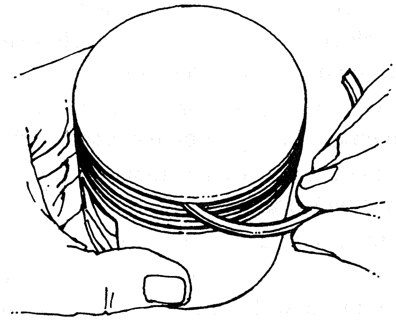


1. Connecting rod
2. Caged needle bearing
3. Lower washer
4. Upper washer
5. Piston pin
6. Lower lock ring
7. Upper lock ring
8. Pison

46



47



8

3. Apply engine oil to all rotating surfaces of the crankshaft and connecting red bearings, bearing thrust plates (40 and 50 hp models) and bearing washers.

4. Install the upper main bearing onto the crankshaft so the bearing seal (1, Figure 33) faces the flywheel end of the crankshaft.

5. If removed, install the oil pump drive gear and lower main bearing onto the crankshaft using a press and suitable driver. Install a new snap ring (3, Figure **49).** Make sure the snap ring seats properly in its groove.

NOTE

On 80-140 hp models, measure the clearance between the oil pump drive gear (2, ***Figure 49)*** *and snap ring (3) with all lower crankshaft components properly seated. If the clearance exceeds 0.09 mm (0.0035 in.), install the correct size shim (4).*

6. Install new piston rings using a piston ring expander (Figure 46). Install the rings so the end gaps (1, Figure 34) fit around the piston ring locating pins (2) when the ring is compressed.

7. Lubricate a piston pin bearing with engine oil and insert the bearing into the connecting rod. Position the correct piston onto the connecting rod with the UP mark (Figure 50) on the piston crown facing the flywheel.

8. Install the piston pin using a suitable driver and install new piston pin clips (Figure 51).

9. Repeat Step 7 and Step 8 for each remaining piston and connecting rod.

10. Install the bushing and oil pump driven gear into the cylinder block.

11. Apply a coat of engine oil to the cylinder walls, piston(s), rings and oil pump drive gear and driven gear. Install thrust plates (40 and 50 hp models) or bearing washers. Install the crankshaft assembly into the cylinder block, guiding each piston into its cylinder.

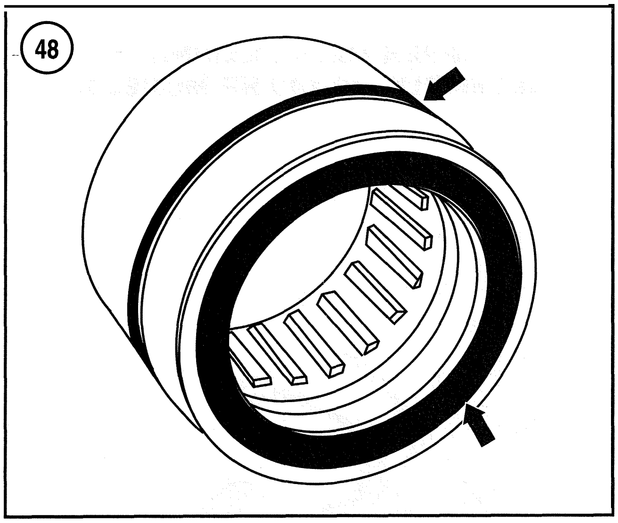
12. Ensure that the bearing locating pin (Figure 52) in the cylinder block aligns with the locating hole in the upper main bearing. Also, make sure all main bearing locating pins (Figure 53) are properly seated in the notches in the cylinder block. On 40 and 50 hp models, make sure the thrust plates are properly seated in the cylinder block.

13. Make sure the oil pump driven gear properly meshes with the oil pump drive gear on the crankshaft.

14. Apply an even coat of anaerobic sealant to the cylinder block mating surface.

15. Install the crankcase cover onto the cylinder block.

16. Install the crankcase cover bolts and torque to the specification in Table **1.** Begin the torque sequence with the center bolts and work outward.



17. Install the exhaust cover and thermostat as described in this chapter.

18. Install all electrical and ignition system components (Chapter Seven).

19. Install the cylinder head and flywheel as described in this chapter.

20. Install the fuel system components (Chapter Six).

INSPECTION

Measuring the cylinder block components requires precision equipment and experience in its use.

All components must be clean and dry before measuring. Keep the components at room temperature for several hours before measuring them.

Cylinder Block Inspection

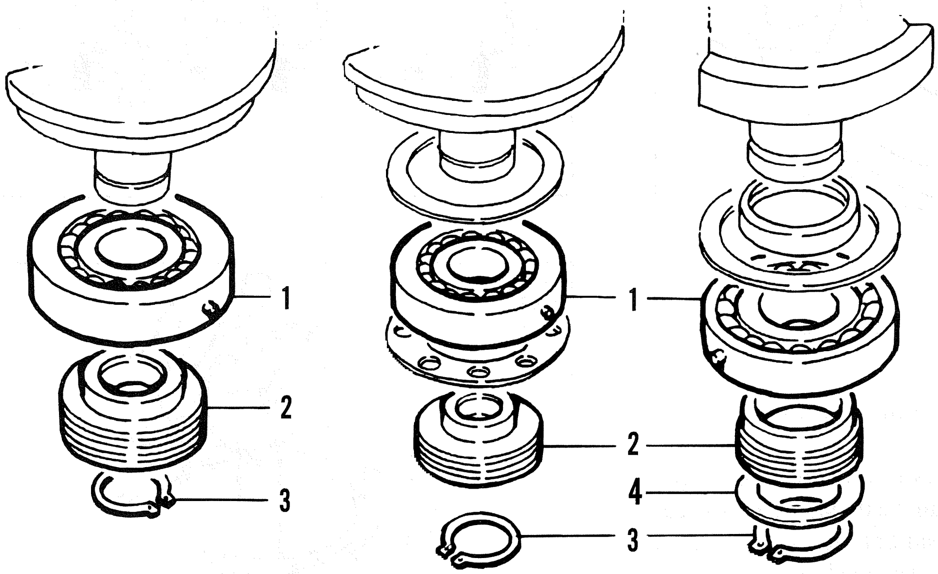
1. Inspect the cylinder bores for cracks or deep grooves. Deep grooves or cracks in the cylinder bores indicate damage that cannot be repaired by boring and installing oversize pistons. Replace the cylinder block or have a sleeve installed if a cracked or deeply scratched cylinder bore is found. Contact a marine dealership or machine shop to locate a source for block sleeve(s).

2. Inspect all mating surfaces for cracks or damage. Replace the cylinder block if cracks, deep scratches or gouging are noted.

3. White powder-like deposits in the combustion chamber usually indicate that water is entering the combustion chamber. Inspect the cylinder walls and cylinder head thoroughly for cracks if this type of deposit is noted. Inspect the head gasket and mating surfaces for discolored areas. Discolored or corroded sealing surfaces indicate a

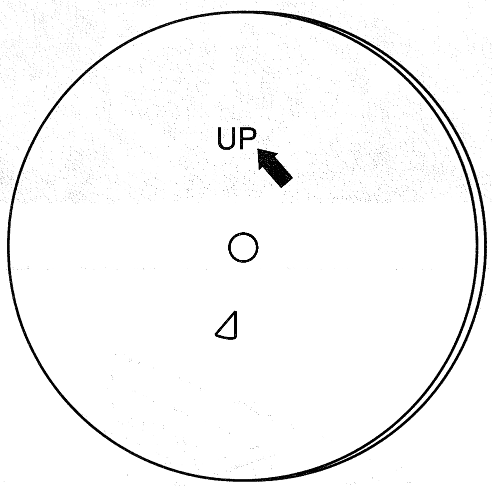
49

LOWER MAIN BEARING AND OIL PUMP DRIVE GEAR (MODELS 40-140 HP)



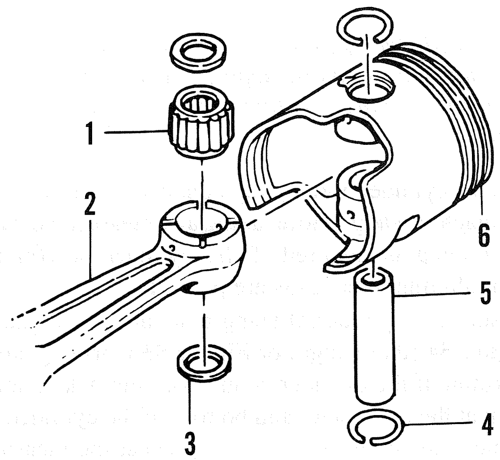
1. Main bearing
2. Oil pump drive gear
3. Snap ring
4. Shim

50

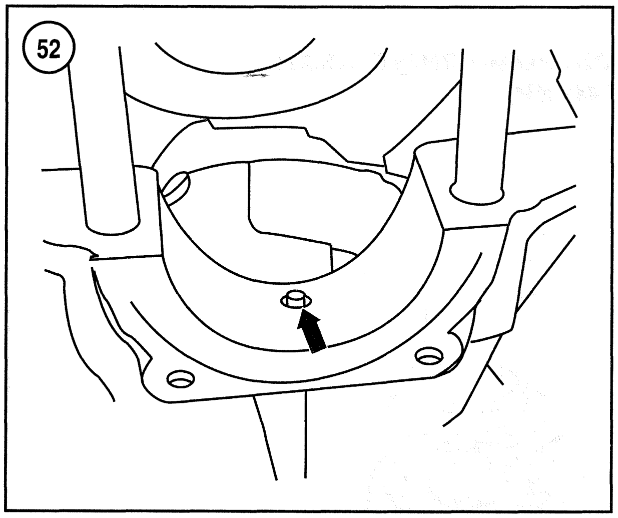


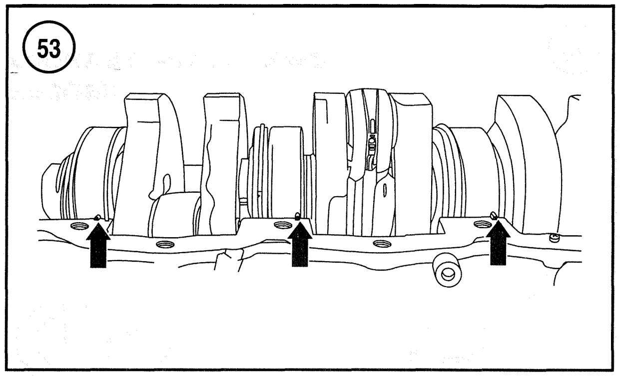
51

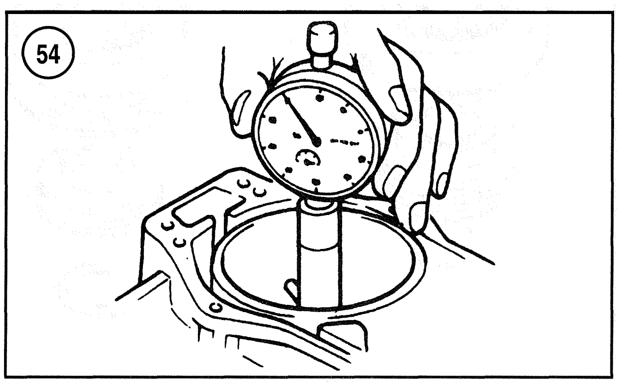
CONNECTING ROD ASSEMBLY (MODELS 40-140 HP)

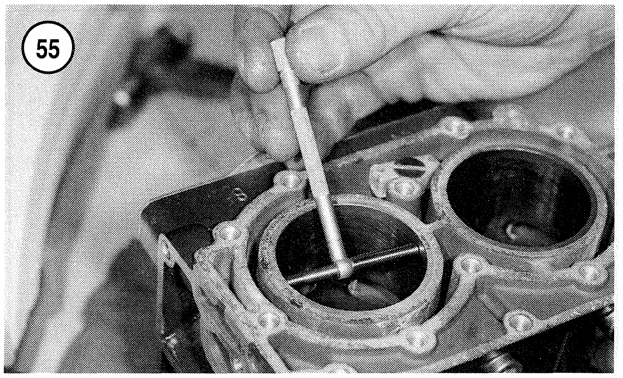


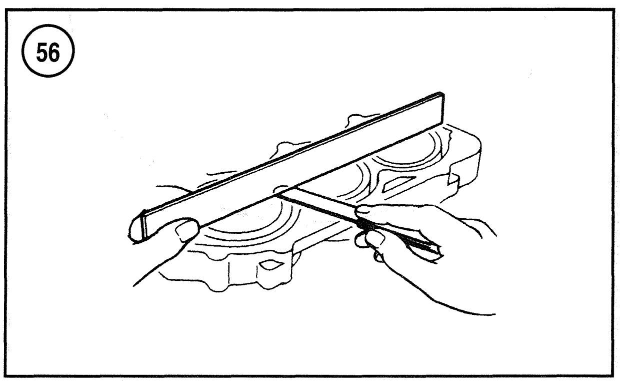
1. Bearing
2. Connecting rod
3. Spacer
4. Clip
5. Piston pin
6. Piston











likely source of leakage. Replace any defective or suspect components.

4. Inspect all bolt holes for cracks, corrosion or damaged threads. Use a thread tap to clean the threads. Pay particular attention to the cylinder head bolt holes. Installing a threaded insert can often repair damaged thread.

5. Clean and inspect all bolts, nuts and washers. Replace any bolts or nuts with damaged threads or a stretched appearance. Replace any damaged or cup-shaped washers.

6. Inspect the alignment pins and alignment holes for bent pins or damaged openings. Replace damaged pins or components that have damaged alignment pin holes.

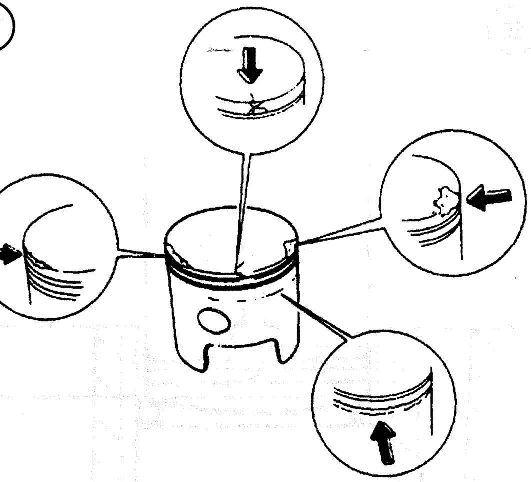
NOTE
The cylinder block and crankcase cover are a matched assembly. Replace the entire assembly if either portion requires replacement.

7. Have the cylinder bore lightly honed at a marine repair shop or machine shop before taking any measurements. A heavier honing is required if the cylinder bore(s) are glazed or aluminum deposits are present.

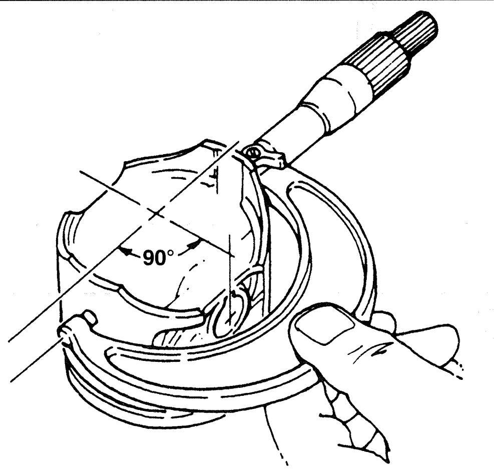
8. Measure the cylinder(s) using a suitable bore gauge. See **Figure** 54 (dial gauge) or **Figure** 55 (spring gauge). To determine if the cylinder is out-of-round, take a measurement at the top, center and bottom of the cylinder. To determine if the cylinder is tapered, repeat the measurements at 90° to the first measurement. Record the diameter of each cylinder bore **(Figure** 55). If the bore diameter exceeds the specification in **Table** 4, bore the cylinder to the next oversize and install an oversize piston.

9. Measure the piston diameter as described under *Piston Inspection* in this chapter. Then refer to *Piston Clearance* in this chapter.

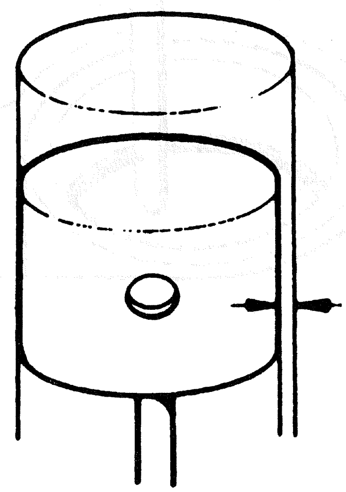
57



58



59



10. Have the cylinder bored to the next oversize diameter and install an oversize piston if excessive bore size is indicated. Replace the cylinder block or have a sleeve installed if the bore diameter exceeds the specification in **Table 4.** Contact a marine dealership or machine shop for machine work.

Cylinder Head Inspection

Inspect the cylinder head for warpage. Use a straightedge and a feeler gauge **(Figure** 56). Replace the cylinder head if warpage exceeds 0.10 mm (0.004 in.).

Piston Inspection

1. Inspect the piston for erosion at the edge of the dome, cracks near the ring grooves and cracks or missing portions of the piston dome. Inspect for erosion in the ring groove and scoring or scuffing on the piston skirt.
2. Inspect the piston pin for wear, discoloration or a scrubbed appearance. Inspect the lockring groove for damage or erosion. Replace the piston if any of these defects are noted. See **Figure 57.**
3. Replace the rings if the piston is removed from the cylinder. Low compression, high oil consumption and other problems will occur if used rings are installed.
4. Using an outside micrometer, measure and record the diameter of the piston at a point 90° from the piston pin bore **(Figure** 58). Measure and record the piston diameter for the remaining pistons.

Piston Clearance

1. Perform this calculation for each cylinder using the recorded piston and cylinder bore diameters.
2. Subtract the piston diameter from the largest cylinder bore measurement for the given cylinder. The result is the largest piston clearance **(Figure** 59).
3. Subtract the piston diameter from the smallest cylinder bore diameter for the given cylinder. The result is the smallest piston clearance. Compare the largest and smallest clearance with the specification in **Table 4.**
4. Excessive clearance indicates excessive cylinder bore diameter and/or below minimum piston diameter.
5. Insufficient clearance indicates too small of bore diameter or too large of piston diameter. Replace the piston and/or bore the cylinder to the next oversize to correct the clearance.

8

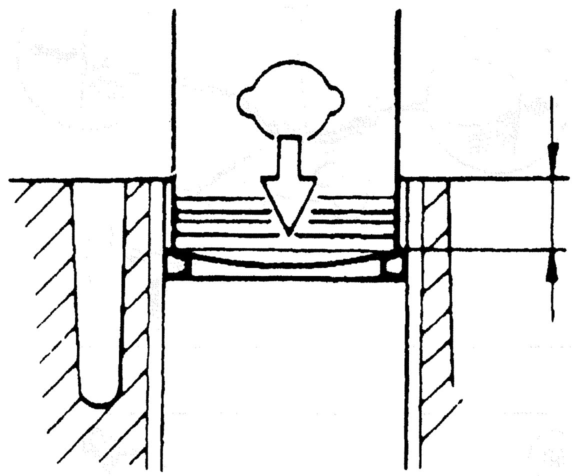
Piston Ring End Gap

1. Using a piston without rings (Figure **60**), push a new piston ring into the cylinder bore to a depth of 20 mm (0.8 in.) from the cylinder head mating surface.

2. Using feeler gauges, measure the width of the ring gap (Figure 61).

3. Select a feeler gauge that passes through the gap with a slight drag. Compare the thickness of the selected feeler gauge with the specification in Table 4. Measure the cylinder bore diameter again if an incorrect gap is noted. Install a different ring if the cylinder bore diameter is within specification. Continue until a correct ring gap is found. Repeat this measurement for all rings on the piston. Tag these rings to ensure they are installed on the correct piston and into the correct cylinder.

60



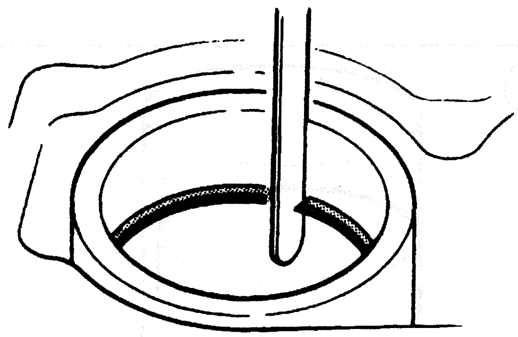
Connecting Rod Inspection

1. Inspect the connecting rod(s) for bending, twisting, discoloration and worn or damaged bearing surfaces. Replace the connecting rod if any defects are noted.

2. Inspect the connecting rod small end bearing (Figure **62)** for pits, corrosion, excessive wear or discoloration. Replace the bearing(s) if in questionable condition. Do not reuse the small end bearing(s) unless it is in perfect condition.

3. Rotate the connecting rod and check for radial and axial play. If excessive play or rough rotation is evident, replace the crankshaft assembly.

61



Crankshaft Inspection

1. Inspect the crankshaft bearing surfaces for cracks, corrosion, etching, bluing or discoloration.

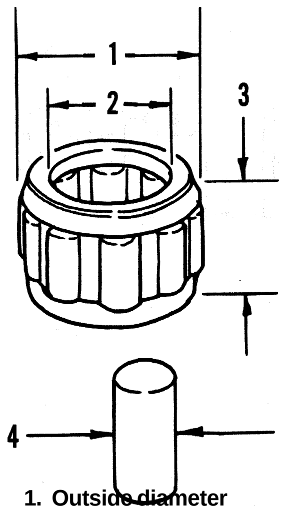
2. Also check for rough or irregular surfaces or transferred bearing material. Replace the crankshaft if any of these defects are noted.

3. Grinding the crankshaft and installing undersize bearings is not recommended. Grinding or machining the crankshaft can result in power head failure.

NOTE

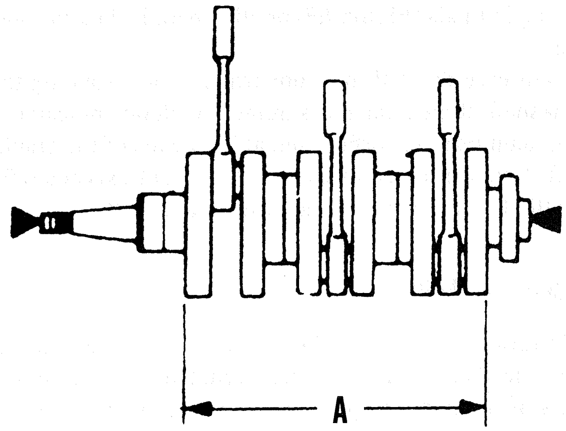
Some minor surface corrosion or minor scratches can be cleaned using crocus cloth or 320-grit carburundum. Polish the surfaces enough to remove the deposits. Excessive polishing can remove a considerable amount of material from the connecting rod and crankshaft surfaces.

62 CONNECTING ROD BEARING SMALL END (MODELS 40-140 HP)

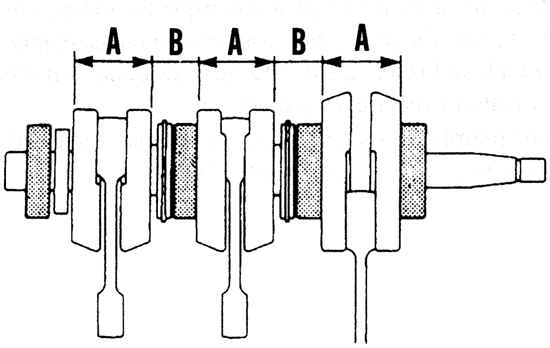


1. Outside diameter
2. Inside diameter
3. Height
4. Needle roller diameter

64



63



4. Measure the distance between the outside edges of each pair of crankshaft webs **(A, Figure 63).** Measure at both ends of the webs.

5. Measure the distance between each pair of webs (B, **Figure 63).**

6. Measure the distance between the outside edges of the last and first crankshaft webs **(A, Figure 64).**

7. Compare the measurements with the specification in **Table 3.** Replace the crankshaft if the measurements are not within specification.

8. Thrust plate inspection is required on 40 and 50 hp models. Inspect the thrust plates for wear, discoloration, or roughness. Replace the thrust plates if they are worn or damaged.

9. Inspect the oil pump drive gear any time the crankshaft is removed. Inspect oil pump drive gear teeth for damage. Drive teeth should not have any wear and the edges of the teeth should not be rolled over.

10. The lower main bearing and oil pump drive gear are replaceable parts. Refer to *Cylinder Block Disassembly and Assembly* in this chapter.

11. A V-block or balance wheel and dial indicator is required to check crankshaft runout. Have the inspection performed at a machine shop if you do not have access to

the required measuring instruments or are unfamiliar with their use.

12. Support the crankshaft on the top and bottom main bearing journals with a V-block or a balance wheel.

13. Position a dial indicator to one of the remaining main bearing journals (Figure 65) or other parallel bearing surface.

14. Observe the dial indicator while slowly rotating the crankshaft. Repeat the measurement with the indicator at each main bearing surface and at both ends of the crankshaft. Replace the crankshaft if the runout exceeds 0.05 mm (0.002 in.) on either end of the crankshaft.

Engine **Break-In**

Perform the break-in procedures any time internal power head components are replaced. During the first few hours of running, many of the components of the power head must avoid full load until wear patterns are established. Failure to properly break the engine in can result in power head failure, decreased performance, shorter engine life and increased oil consumption.

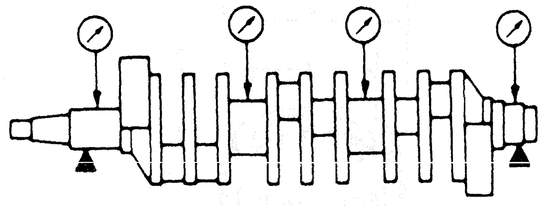
Full break-in is achieved in approximately 10 hours of running time. Increased oil consumption can be expected during this period. Check the oil frequently during break-in. Refer to Chapter Four for instructions. Check and correct the tightness of all external fasteners during the break in period. During break-in of engines with oil injection, a 50:1 gasolineloil mixture is required in the fuel tank in addition to oil in the oil tank. Refill the fuel tank with pure gasoline *only* after the 10 hours of break-in are complete.

Premix engines require a 25:1 gasolineloil mixture in the fuel tank during the 10-hour break-in period. A 50:1 ratio is required after the break-in.

Break the engine in as follows:

1. For the first 10 minutes, operate the engine at fast idle speed *only*. Verify that a steady stream of water is exiting the cooling check port and idle port on the engine, which indicates the water pump is working properly.

65



2. For the next 50 minutes, do not exceed 3000 rpm or 112 throttle. Do not run more than a few minutes at a given throttle setting. Vary engine speed every 15 minutes.

3. During the second hour of operation, advance the engine to full throttle to quickly accelerate the boat onto plane, and then reduce throttle to 314 (approximate 4000 rpm) and maintain this speed.

4. Run the engine at full throttle for 1-10 minutes at intervals; then return to 314 throttle for a cooling period.

5. Vary the engine speed every 15 minutes. Check for cooling water discharging from ports.

6. During the next eight hours, operate the engine at full throttle for short periods of time. Every 15 minutes, vary the engine speed. Do not operate the engine over the recommended speed. Refer to Chapter Three.

After break-in is complete, retorque the cylinder head bolts to specification. On oil-injected models, empty the fuel tank and replenish it with pure gasoline. Fill the oil tank with the recommended oil.

For premix applications, empty the fuel tank and replenish with a 50:1 gasoline/oil mixture.

Table 1 POWER HEAD TORQUE SPECIFICATIONS*

Fastener	N•m	in.-lb.	ft.-lb.
Thermostat bolts			
40-140 hp	5-6	44-53	–
Electrical box cover bolts			
60-90 hp	0.5-1	5-9	–
115-140 hp	3-5	26-44	–
Spark plug	25-29	–	18-21
Engine mount bolts			
40-70 hp	19-21	—	14-15
80-90 hp	24-26	–	17-19
115-140 hp	34-41	–	25-30
Exhaust cover bolts			
40-70 hp	8-10	71-88	–
80-140 hp	13-15	115-133	–
Flywheel nut			
2.5-3.5 hp	0.40-0.45	4-4.5	35-40
5-9.8 hp	0.51-0.61	5-6	44-53
9.9-18 hp	0.71-0.91	7-9	62-80
25-40 hp	1.22-1.42	12-14	106-124
40-50 hp	88-108	–	65-80
60-90 hp	137-157	–	101-116
115-140 hp	245-265	–	181-195
Cylinder head cover bolts			
60-140 hp	5-6	44-53	–
Cylinder head bolts			
40-140 hp			
M8	29-34	–	21-25
40-50 hp			
M6	5-6	44-53	–
Crankcase bolts			
40-140 hp			
M8	24-26	–	17-19
60-140			
M10	37-41	-	27-30
Carburetor mounting bolt			
40-70 hp	5-6	44-53	–
Intake manifold bolts			
60-70 hp	5-6	44-53	–

* If a torque specification is not listed in this table, determine the size of the bolt and refer to the general torque specification in Table 6.

Table 2 CYLINDER COMPRESSION

Model	kPa	psi
2.5-5 hp	539	78
8-9.8 hp	392	57
9.9-18 hp	760	110
25-30 hp	755	110
40 hp	735	107
40-50 hp	670	102
60-70 hp	833	121
80- 90 hp	804	117
115-140 hp	882	128

Table 3 CRANKSHAFT DIMENSIONS

	Specifications	
Outside single journal		
2.5-3.5 hp	36 mm	(1.417 in. ± 0.002 in.)
5 hp	40 mm	(1.575 in. ± 0.002 in.)
8-9.8 hp	42 mm	(1.654 in. ± 0.002 in.)
9.9-18 hp	48 mm	(1.890 in. ± 0.004 in.)
25-30 hp	52 mm	(2.047 in. ± 0.001 in.)
40 hp (two cylinder)	52 mm	(2.071 in. ± 0.002 in.)
40-50 hp (three cylinder)	53 mm	(2.087 in. ± 0.001 in.)
60-70 hp	60 mm	(2.362 in. ± 0.008 in.)
80-140 hp	68 mm	(2.677 in. ± 0.001 in.)
80-90 hp (only top two)	66 mm	(2.598 in. ± 0.001 in.)
Between journal		
8-9.8 hp	25 mm	(0.984 in. ± 0.002 in.)
9.9-18 hp	33 mm	(1.299 in. ± 0.002 in.)
25-30 hp	38 mm	(1.496 in. ± 0.002 in.)
40 hp (two cylinder)	40 mm	(1.591 in. ± 0.002 in.)
40-50 hp (three cylinder)	37 mm	(1.457 in. ± 0.002 in.)
60-70 hp	37 mm	(1.467 in. ± 0.002 in.)
80-90 hp	44 mm	(1.732 in. ± 0.002 in.)
115-140 hp	42 mm	(1.654 in. ± 0.002 in.)
Outside all journals		
40-50 hp (three cylinder)	233 mm	(9.173 in.)
60-70 hp	254 mm	(10.020 in.)
80-90 hp	288 mm	(11.339 in.)
115-140 hp	398 mm	(15.669 in.)

Table 4 CYLINDER BORE

Model	Cylinder bore	Piston clearance	Piston ring end gap
2.5-3.5 hp	47 mm (1.850in.)	0.06-0.09 mm	0.18-0.33 mm
	(0.0024-0.0035 in.)	(0.007-0.013 in.)	
5 hp	55 mm (2.165 in.)	0.02-0.05 mm	0.2-0.4 mm
	(0.0008-0.0020 in.)	(0.008-0.016 in.)	
8-9.8 hp	50 mm (1.969 in.)	0.02-0.05 mm	0.18-0.33 mm
	(0.0008-0.0020 in.)	(0.007-0.013 in.)	
9.9-18 hp	55 mm (2.165 in.)	0.05-0.09 mm	0.20-0.40 mm
	(0.0008-0.0035 in.)	(0.008-0.016 in.)	
25-30 hp	68 mm (2.677 in.)	0.06-0.10 mm	0.33-0.48 mm
	(0.0024-0.0039 in.)	(0.013-0.019 in.)	
40 hp	70 mm (2.756 in.)	0.05-0.10 mm	0.20-0.40 mm
	(0.0024-0.0039 in.)	(0.008-0.016 in)	
40-50 hp	68 mm (2.677 in.)	0.03-0.07 mm	0.22-0.37 mm (top ring)
	(0.0012-0.0028 in.)	(0.008-0.015 in.)	
60-70 hp	74 mm (2.913 in.)	0.04-0.08 mm	0.22-0.37 mm
	(0.0016-0.0031 in.)	(0.009-0.015 in.)	
80-90 hp	86 mm (3.386 in.)	0.08-0.13 mm	0.25-0.40 mm
	(0.0031-0.0051 in.)	(0.010-0.016 in.)	
115-140 hp	88 mm (3.465 in.)	0.10-0.14 mm	0.28-0.49 mm
	(0.0039-0.0055 in.)	(0.011-0.019 in.)	

Table 5 CONNECTING ROD SPECIFICATIONS

Connecting rod bearing (small end)	
Inside diameter	
2.5B-3.5B hp	10.5 mm (0.413 in.)
5-18 hp	14 mm (0.551 in.)
25-50 hp	17 mm (0.669 in.)
60-140 hp	20 mm (0.787 in.)
Outside diameter	
2.5B-3.5B hp	14 mm (0.551 in.)
5-18 hp	18 mm (0.709 in.)
25-50 hp	21 mm (0.827 in.)
60-140 hp	25 mm (0.984 in.)
Bearing height	
2.5B-3.5B hp	15 mm (0.591 in.)
5-18 hp	20 mm (0.787 in.)
25-50 hp	27 mm (1.063 in.)
60-70 hp	24 mm (0.945 in.)
80-140 hp	28 mm (1.102 in.)
Connecting rod bearing (large end)	
Inside diameter	
2.5B-3.5B hp	16 mm (0.630 in.)
5 hp	20 mm (0.787 in.)
8-9.8 hp	17 mm (0.669 in.)
9.9-30 hp	20 mm (0.787 in.)
40-50 hp	25 mm (0.984 in.)
60-70 hp	27 mm (1.063 in.)
80-90 hp	30 mm (1.181 in.)
115-140 hp	32 mm (1.260 in.)
Outside diameter	
2.5B-3.5B hp	22 mm (0.866 in.)
5 hp	26 mm (1.024 in.)
8-9.8 hp	23 mm (0.906 in.)
9.9-18 hp	26 mm (1.024 in.)
25-30 hp	28 mm (1.102 in.)
40-50 hp	32 mm (1.260 in.)
60-70 hp	36 mm (1.417 in.)
80-90 hp	39 mm (1.535 in.)
115-140 hp	41 mm (1.614 in.)
Bearing height	
2.5B-5 hp	12 mm (0.472 in.)
8-9.8 hp	14 mm (0.551 in.)
9.9-18 hp	16 mm (0.630 in.)
25-30 hp	18 mm (0.709 in.)
40 hp	20 mm (0.787 in.)
40-50 hp (three cylinder)	19.8 mm (0.778 in.)
60-70 hp	18 mm (0.709 in.)
80-90 hp	21.8 mm (0.858 in.)
115-140 hp	22 mm (0.866 in.)

Table 6 GENERAL TORQUE SPECIFICATIONS

Thread diameter	N.m	in.-lb.	ft.-lb.
5 mm bolt and nut	5	44	–
6 mm bolt and nut	10	88	–
8 mm bolt and nut	22	–	16
10 mm bolt and nut	34	–	25
12 mm bolt and nut	54	–	40
5 mm screw	4	35	–
6 mm screw	9	80	–

(continued)

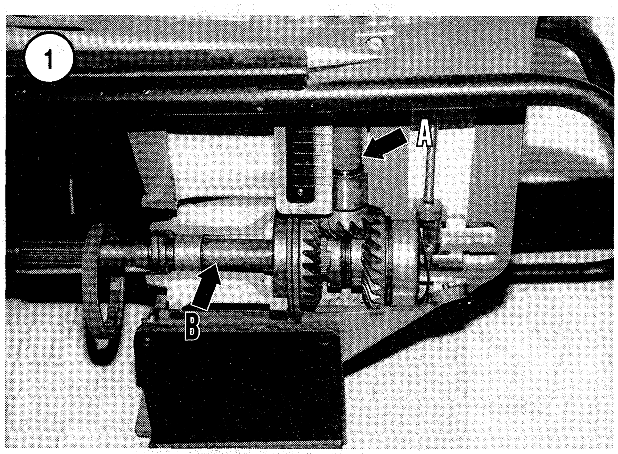
Table 6 GENERAL TORQUE SPECIFICATIONS (continued)

Thread diameter	N.m	in.-lb.	ft.-lb.
6 mm flange bolt with 8 mm head (small flange surface)	9	80	–
6 mm flange bolt with 8 mm head (large flange surface)	12	106	–
6 mm flange bolt with 10 mm head and nut	12	106	–
8 mm flange bolt and nut	26	–	20
10 mm flange bolt and nut	39	–	29

*This table lists general torque specifications for metric fasteners. Use this table when a specific torque specification is not listed for a fastener at the end of the appropriate chapter. The torque specifications listed in this table are for threads that are clean and dry.

Chapter Nine

Gearcase and Midsection

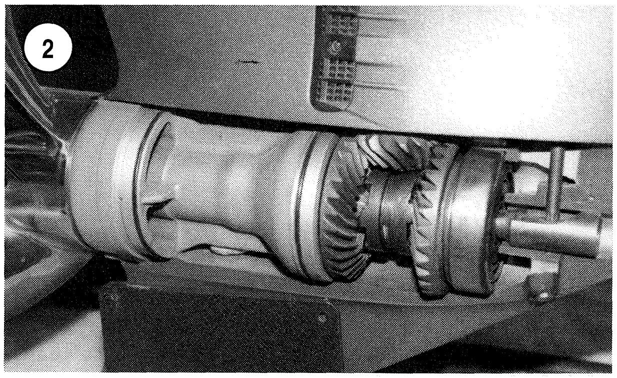


Special tools and accurate measuring devices are required to correctly install many of the gearcase components. Using makeshift tools may result in irreparable damage to the housing or internal gearcase housing components. Part numbers for these tools are included in the repair instructions. Contact a marine dealership to purchase these special tools. Some dealerships will rent or loan special tools.

Improper repair can result in extensive and expensive damage to the gearcase. Have a reputable marine repair shop perform the repair if the required tools and measuring devices are unavailable. Proper use of some of the special tools and measuring devices requires considerable mechanical expertise. Have a reputable shop perform these operations if the ability to perform the required measurements or repair operations is in question.

GEARCASE OPERATION

The gearcase transfers the rotation of the vertical drive shaft (A, **Figure 1)** to the horizontal propeller shaft (B). The forward and reverse gears along with the sliding clutch **(Figure 2)** transfer the rotational force to the horizontal propeller shaft. The shift selector and linkage moves the clutch.



The pinion and both driven gears (**Figure** 2) rotate any time the engine is running. A sliding clutch (**Figure** 2) engages the propeller to either the front or rear driven gear.

If neutral gear (**Figure** 3) is desired, the propeller shaft remains stationary as the gears rotate. No propeller thrust is delivered.

If forward gear (**Figure** 3) is desired, the sliding clutch engages the forward gear. The propeller shaft rotates in the direction of the forward gear as the clutch dogs (raised bosses) engage the gear. This provides the clockwise propeller shaft rotation necessary for forward thrust.

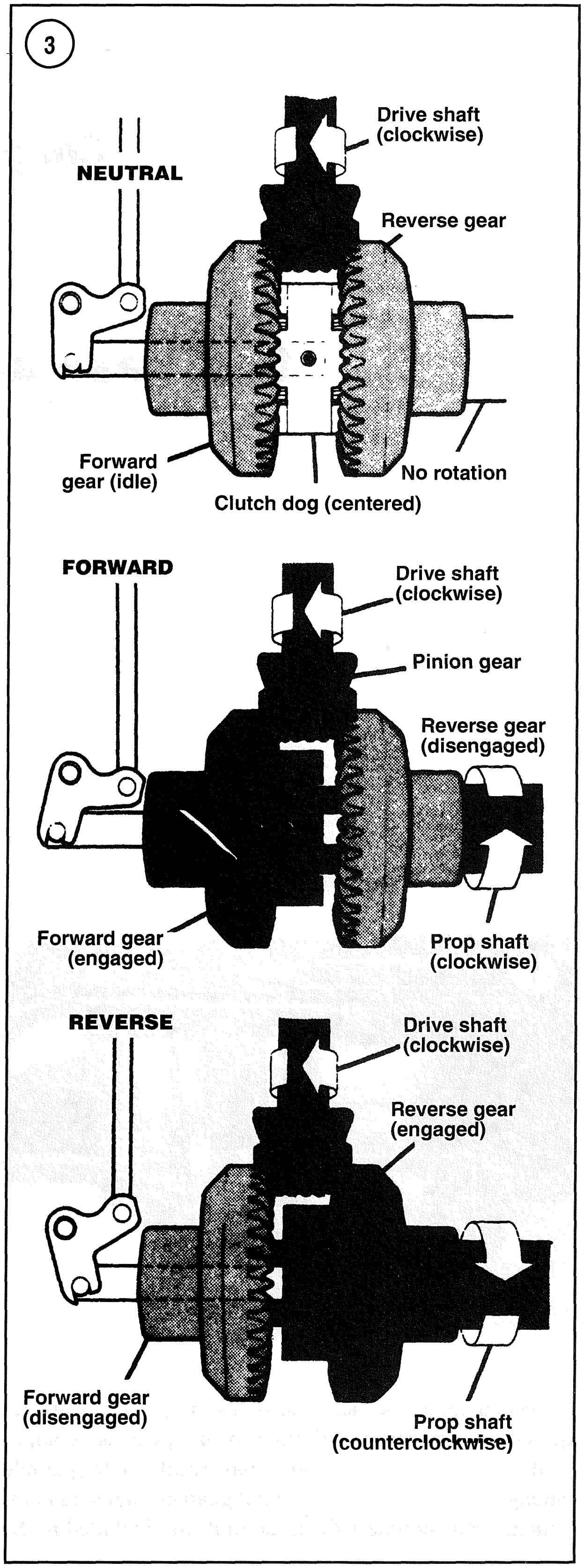
If reverse gear is desired (**Figure** 3), the sliding clutch engages the reverse gear. The propeller shaft rotates in the direction of the reverse gear as the clutch dogs engage the dogs of the reverse gear. This provides the counterclockwise propeller shaft rotation necessary for reverse thrust.

PROPELLER REMOVAL AND INSTALLATION

Two methods are used to mount the propeller. A shear pin design is used on 2.5-5 hp models. A thrust hub design is used on **8-140** hp models.

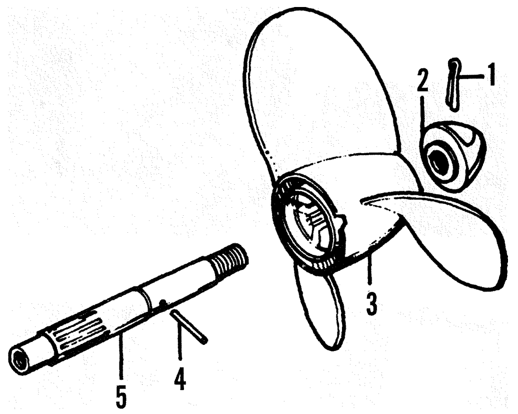
With the shear pin design, the propeller is held to the propeller shaft with the propeller nut (2, **Figure** 4) and cotter pin (1). A shear pin (**4, Figure** 4) is positioned in the propeller shaft (5). The shear pin engages and drives the propeller. The shear pin is designed to break if an underwater impact occurs and provides some protection for the gearcase components.

With the thrust hub design, the propeller is driven by splines in the propeller and on the shaft. The rubber thrust hub is pressed into the propeller and provides a cushion effect when shifting. It also provides some protection for the gearcase during an underwater impact. The propeller is held to the propeller shaft with the propeller nut (5, **Figure 5)** and cotter pin (6). A spacer (1, **Figure 5)** directs the propeller thrust to a tapered area of the propeller shaft.



4

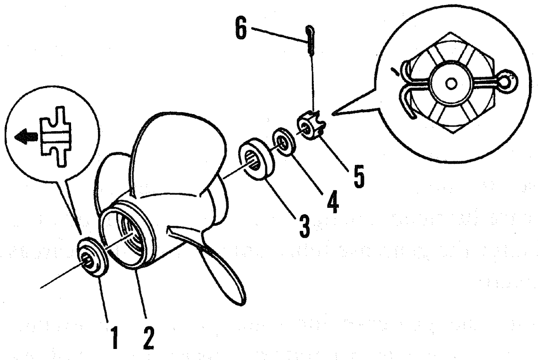
SHEAR PIN TYPE



1. Cotter pin
2. Propeller nut
3. Propeller
4. Shear pin
5. Propeller shaft

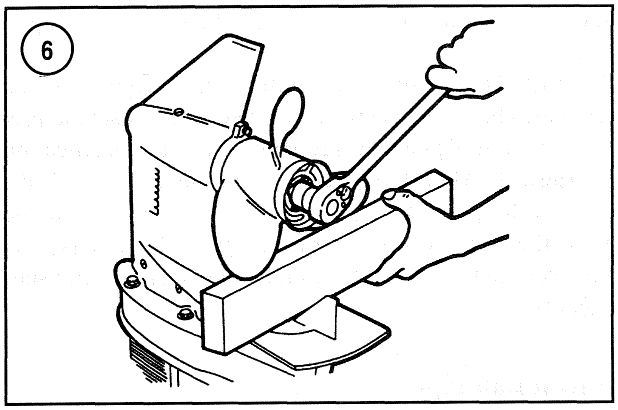
5

THRUST HUB TYPE



1. Spacer
2. Propeller
3. Spacer
4. Washer
5. Propeller nut
6. Cotter pin

6



Shear Pin Type

Always replace the cotter pin and shear pin during installation. Purchase the replacement pins at a marine dealership and select the proper size and material. The cotter pin is made of stainless steel. Use a shear pin designated for the correct model to ensure it will shear at the required load.

1. Disconnect the spark plug lead(s) and disconnect the battery cables from the battery on electric start models.
2. Straighten and remove the cotter pin using pliers. To prevent propeller rotation, place a wooden block between the propeller and the gearcase above the propeller.
3. Turn the propeller nut counterclockwise to remove the nut.
4. Pull the propeller from the propeller shaft. Use a wooden block as a cushion and carefully drive the propeller rearward if necessary. Inspect the propeller for damage or erosion. Repair or replace the propeller if defects are noted.
5. Gently drive the shear pin in until it is flush on one side of the propeller shaft. Twist and pull the shear pin from the propeller shaft using pliers.
6. Inspect the shear pin hole for burrs or elongation. Dress burrs down with a file. Attempt to fit the new shear pin in the shear pin hole. Check the pin for the correct size if the pin fits loosely. Propeller shaft replacement is required to correct a loose fit if the correct shear pin is installed.
7. Clean the propeller shaft and propeller bore. Inspect the shear pin engagement slot in the propeller for damage or wear. Replace the propeller if defects are noted in these areas.
8. Position a new shear pin into the shear pin hole **(Figure 4).** Use a small hammer and gently drive the pin into the propeller shaft until the same amount of the pin protrudes from each side of the propeller shaft.
9. Apply a light coat of all-purpose grease to the shear pin and propeller shaft threads. Apply grease to the propeller shaft and the bore in the propeller. Slide the propeller onto the propeller shaft. Rotate the propeller while pushing it

forward until the shear pin engages the slot in the propeller.

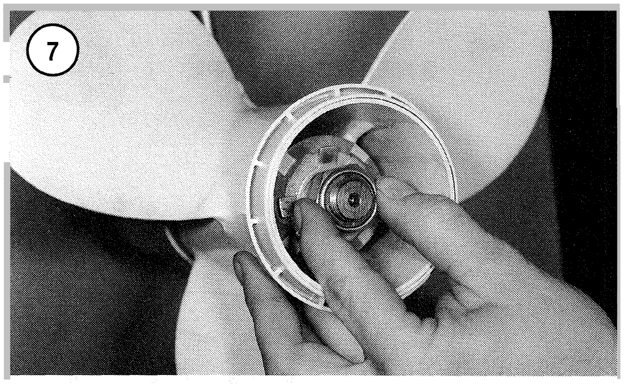
10. Install the propeller nut until it is hand-tight. Position a wooden block between the propeller and housing to prevent rotation. Tighten the propeller nut to the specification in Table **1.** Align the hole in the propeller nut with the hole in the propeller shaft. Install a new cotter pin and bend the ends over. Connect the spark plug lead(s) and connect the battery cables to the battery on electric start models.

Thrust Hub Type

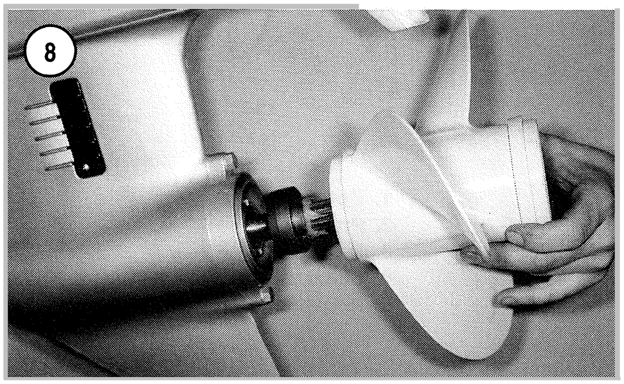
A cotter pin and castellated nut is used on all 8-140 hp models.

1. Remove the spark plug lead(s) and attach them to a suitable engine ground. Disconnect the battery.
2. Shift the engine into NEUTRAL. Straighten the ends of the cotter pin *(6,* Figure 5) and pull it from the castellated nut and propeller shaft.
3. Place a wooden block between the propeller blade and the antiventilation plate (Figure 6). Loosen the propeller nut by turning counterclockwise.
4. Remove the propeller nut, washer (if equipped), and splined spacer (Figure **7),** then pull the propeller from the propeller shaft (Figure **8).**
5. Tap lightly on the spacer (1, Figure 5) to free it from the propeller shaft. Clean the propeller shaft splines, propeller shaft threads and the spacer.
6. Apply a coat of water-resistant grease to the propeller shaft (except the threads).
7. Slide the spacer (1, Figure 5) over the propeller shaft with the larger diameter side facing the gearcase. Align the splines of the propeller (2) with the splines of the propeller shaft and then slide the propeller fully onto the propeller shaft. Seat the propeller against the spacer (1, Figure **5).**
8. Install the splined spacer (3, Figure 5) and washer (4) (if equipped) over the propeller shaft. Thread the propeller nut (5) onto the propeller shaft with the slots facing outward. Place a wooden block between the propeller blade and the antiventilation plate (Figure 6). Tighten the propeller nut to the specification in Table **1.**
9. Inspect the alignment of the slots in the nut with the cotter pin opening in the propeller shaft. Tighten the nut an additional amount if necessary to align the slot and opening. Install the cotter pin *(6,* Figure 5) through the slot and the propeller shaft, then bend over both ends of cotter pin.
10. Install the spark plug lead(s) and connect the cables to the battery. Check for proper shift operation before operating the engine.

7



8



GEARCASE REMOVAL AND INSTALLATION

Refer to Figures **9-11** for typical gearcase assemblies.

To help prevent injury, always remove the propeller, spark plug leads and both battery cables prior to removing the gearcase.

Routine maintenance of the water pump and other gearcase components requires removing the gearcase. These maintenance items often coincide with the gearcase lubricant change intervals. It is a good practice to change the gearcase lubricant any time the gearcase is removed.

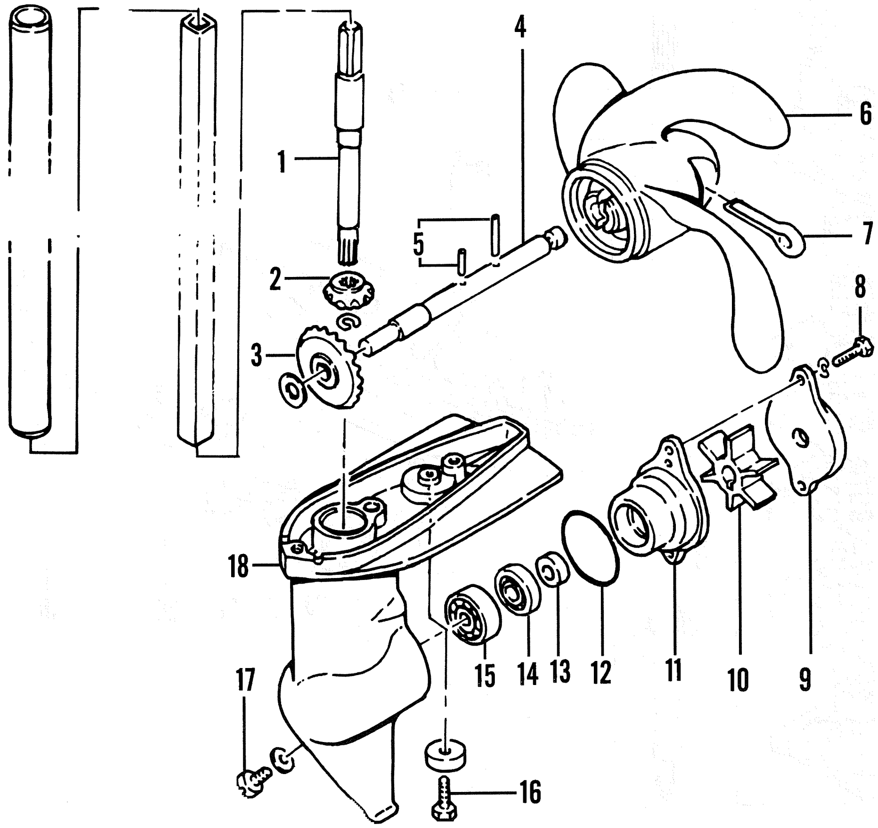
Drain the gearcase lubricant prior to removing the gearcase if the gearcase requires disassembly. Follow the gearcase draining and filling instructions provided in Chapter Four.

CAUTION

Avoid directing pressurized water at exposed seals or exhaust openings. Pressurized water can blow past seals and contaminate the gearcase lubricant or possibly damage the seal. Pressurized water can reach the internal power head components when directed into the exhaust openings.

9

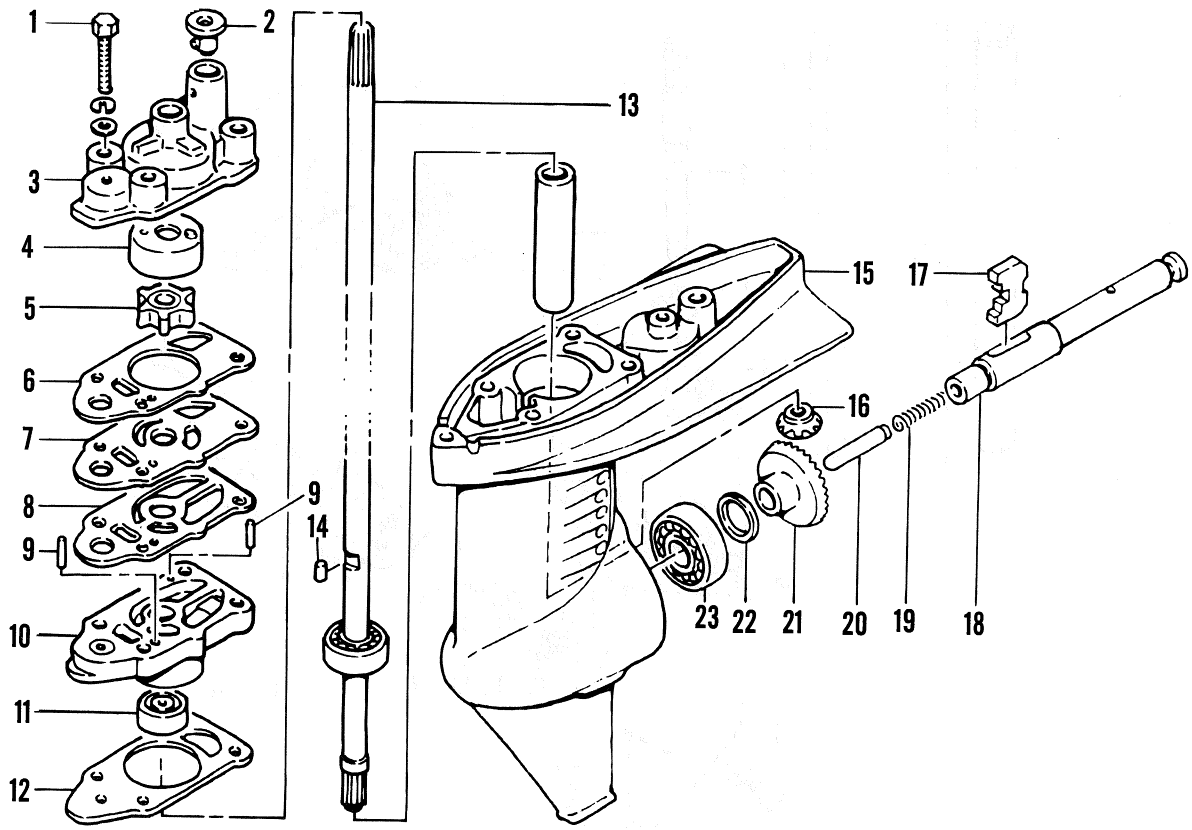
TYPICAL **GEARCASE** (MODELS 2.5/3.5 HP)



1. Driveshaft
2. Pinion gear
3. Forward gear
4. Propeller shaft
5. Drive pin
6. Propeller
7. Cotter pin
8. Bolt
9. Outer pump case
10. **Impeller**
11. **Inner** pump case
12. O-ring
13. Seal
14. Seal
15. Bearing
16. Bolt
17. Drain screw
18. **Gearcase**

(10)

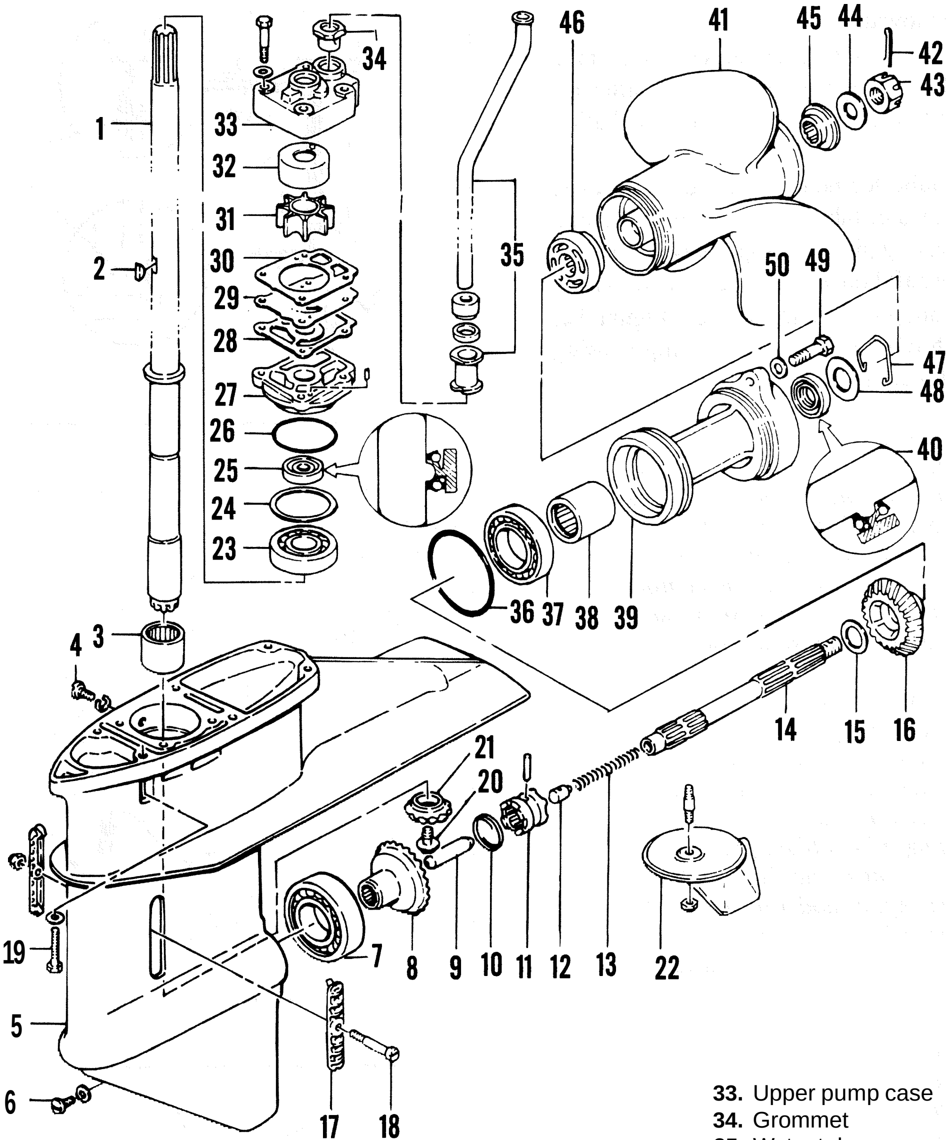
GEARCASE ASSEMBLY (3.5B HP MODELS)



1. Bolt
2. Grommet
3. Upper pump case
4. Liner
5. Impeller
6. Gasket
7. Plate
8. Gasket
9. Pin
10. Lower pump case
11. Seal
12. Gasket
13. Driveshaft
14. Driveshaft key
15. Gearcase housing
16. Pinion gear
17. Clutch
18. Propeller shaft
19. Clutch spring
20. Cam
21. Forward gear
22. Washer
23. Ball bearing

11

GEARCASE ASSEMBLY (8-40 HP MODELS)



1. Driveshaft
2. Driveshaft key
3. Roller bearing
4. Upper drain screw
5. **Gearcase** housing
6. Drain screw
7. Roller bearing
8. Forward gear
9. Clutch push rod
10. Clutch spring
11. Clutch
12. Retainer
13. Spring
14. Propeller shaft
15. Spacer
16. Reverse gear
17. Screen
18. Screw
19. Bolt
20. Pinion bolt
21. Pinion gear
22. Trim tab
23. Roller bearing
24. Shim
25. Seal
26. O-ring
27. Lower pump case
28. Gasket
29. Plate
30. Gasket
31. Impeller
32. Liner
33. Upper pump case
34. Grommet
35. Water tube
36. O-ring
37. Roller bearing
38. Needle bearing
39. Propeller housing
40. Seal
41. Propeller
42. Cotter pin
43. Castle nut
44. Washer
45. Spacer
46. Spacer
47. Spring keeper
48. Washer
49. Bolt
50. Washer

After gearcase removal. clean the drive shaft, shift shaft and gearcase mating surfaces. Dirt or debris left on the shaft can contaminate the gearcase lubricant as external seals or covers are removed.

Inspect the grommet or seal that connects the water tube to the water pump for damage or deterioration after removal. Apply grease to the grommet prior to installation of the gearcase.

Inspect the water tube for bent, corroded, or cracked surfaces. Replace the water tube if it is defective. Ensure that the dowels or locating pins are properly positioned in the gearcase or driveshaft housing during installation.

Apply water-resistant grease to the splines **(Figure 12)** and the water pump grommet in the water pump housing prior to gearcase installation.

CAUTION
Never apply grease to the top of the drive shaft or fill the crankshaft with grease. The grease may promote a hydraulic lock on the shaft that can cause failure of the power unit, gearcase or both. Apply a light coating of marine grease to the sides or spline section of the drive shaft on installation.

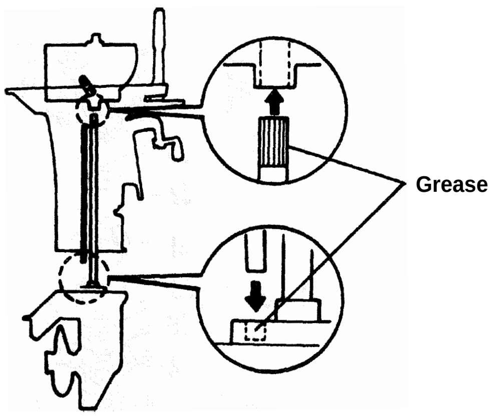
CAUTION
Use caution if using a pry bar to separate the gearcase ,from the driveshaft housing. Remove all fasteners before attempting to pry the driveshaft housing from the gearcase housing. Use a blunt pry bar and locate a pry point near the front and rear mating surfaces. Apply moderate heat to the gearcase-to-driveshaft housing mating surfaces if corrosion prevents easy removal.

CAUTION
Work carefully when installing the upper end of the driveshaft into the crankshaft. The lower seal on the crankshaft may dislodge or become damaged by the driveshaft. Never force the driveshaft into position. Rotate the driveshaft clockwise to install the gearcase into the driveshaft housing if difficulty occurs.

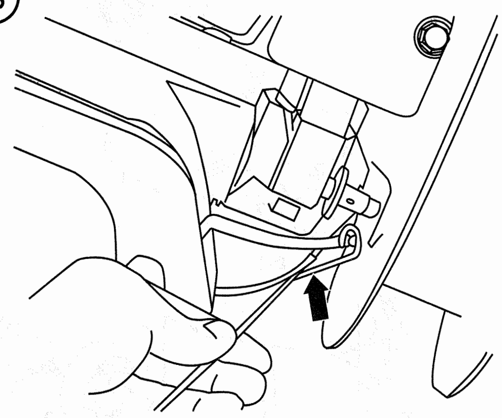
Removal (All Models)

1. Remove the spark plugs lead from the spark plugs. Disconnect both cables from the battery, if so equipped.
2. Remove the propeller and attaching hardware as described in this chapter.
3. On all models except 2.5 hp and 3.5A, shift the engine into FORWARD gear so the shift rod coupler **(Figure 13)**

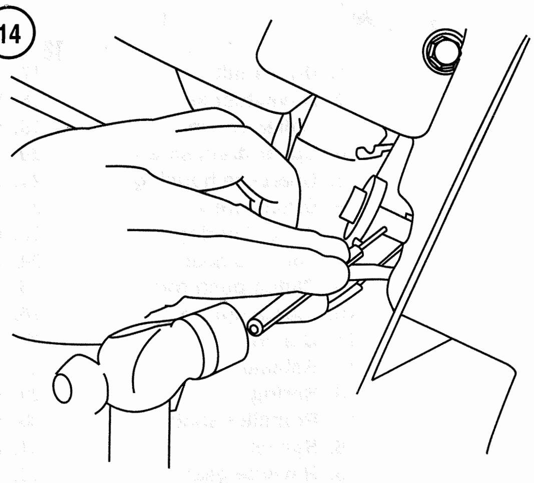
12



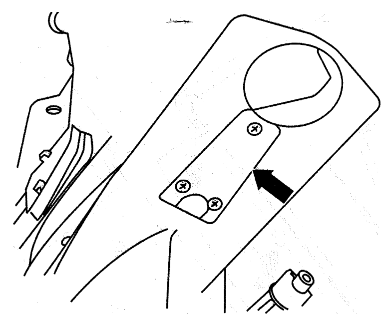
13



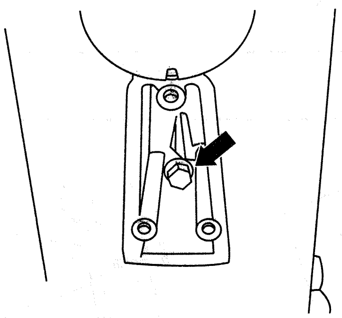
14



15

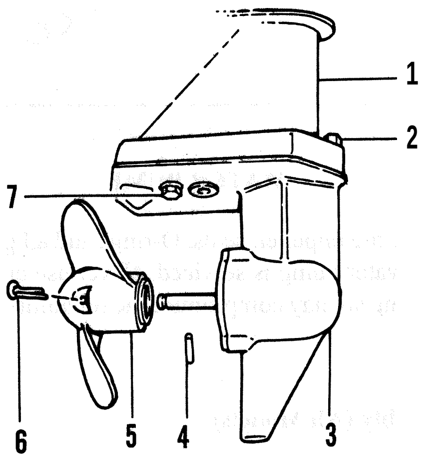


16



17

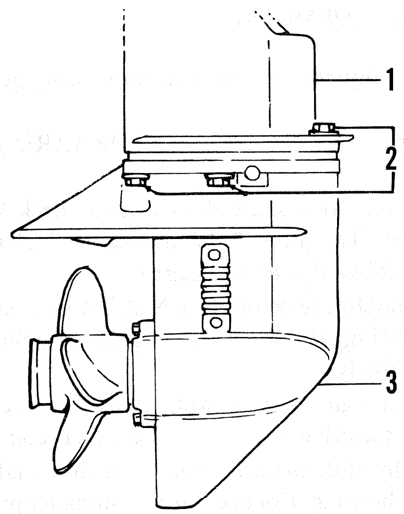
OEARCASE REMOVAL (MODELS 2.5-5 HP)



1. Driveshaft housing
2. Bolt
3. Gearcase
4. Shear pin
5. Propeller
6. Cotter pin
7. Bolt

18

GEARCASE REMOVAL (MODELS 8-40 HP)



1. Driveshaft housing
2. Bolts
3. Gearcase

is accessible. Place the engine in the fully up position and engage the tilt lock mechanism.

4. To remove upper spring pin from shift rod joint use correct size punch **(Figure** 14) and tap out and discard spring pin.

5. On **60-140** hp models, remove the gearcase plate **(Figure** 15) and remove the bolt **(Figure 16).**

6. Support the gearcase and remove the gearcase mounting bolts. Refer to **Figure** 17 (2.5-5 hp), **Figure** 18 **(8-40** hp two-cylinder) or **Figure** 19 **(40** hp three-cylinder and **50-140** hp).

7. Carefully tug or pry the gearcase from the driveshaft housing. Lower the gearcase down only 2 in. **(5** cm), then disconnect the speedometer pickup tube **(Figure 20)** if equipped. Pull the gearcase straight from the driveshaft housing to prevent damaging the shift shaft, lower crankshaft seals and/or water tube.

8. Place the gearcase in a suitable holding fixture or securely clamp the skeg in a bench vise. Use wooden blocks or padded jaws to prevent damaging the skeg or housing.

CAUTION

Never rotate the propeller shaft to align the drive shaft with the crankshaft. The water

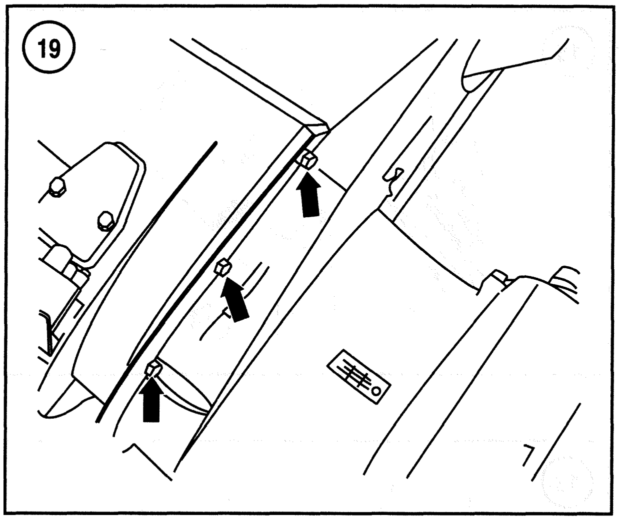
9

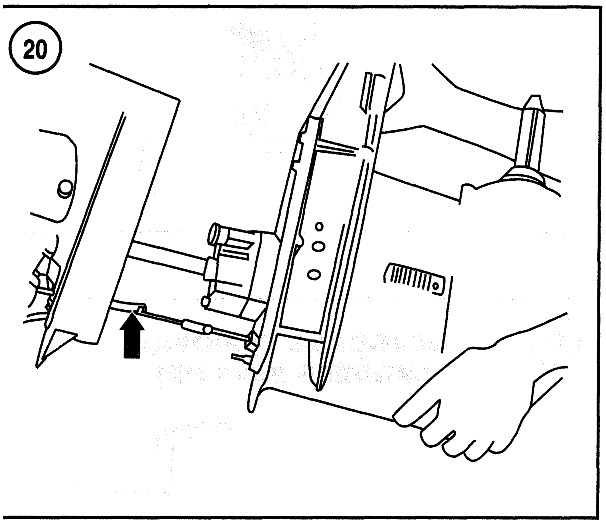
pump impeller can suffer damage that leads to engine overheating.

Installation (All Models)

Refer to Figures **9-17** as necessary during gearcase installation.

1. Place the shift selector in the FORWARD gear position.
2. Rotate the drive shaft clockwise to check for proper engagement. The propeller shaft rotates clockwise (Figure 21) if forward gear is engaged.
3. Place the shift selector in the NEUTRAL position. Verify neutral (Figure 21) by spinning the propeller shaft. It must spin freely.
4. Apply a light coat of water-resistant grease to the splines on the drive shaft and to the water tube grommet.
5. Carefully slide the drive shaft and shift shaft into the driveshaft housing. Connect the speedometer pickup tube (Figure **20**), if equipped, and align the water tube with the lower seal (Figure 20) before seating the gearcase on the driveshaft housing.
6. Keep the gearcase and driveshaft housing mating surfaces parallel when aligning the bolt holes in the gearcase with the holes in the driveshaft housing.
7. Align the lower shift shaft with the shift shaft coupling (Figure 14) as the gearcase is installed.
8. The gearcase will mate to the driveshaft housing when the drive shaft and crankshaft align. If the housings will not mate, refer to the following instructions:
   a. Drop the gearcase slightly, then rotate the drive shaft clockwise a slight amount.
   b. Repeat Steps 5-9 until the drive shaft engages the crankshaft.
   c. Align the water tube with the grommet each time installation is attempted.
9. Hold the gearcase in position while installing the mounting bolts. Tighten the bolts to the specification in Table **1.**
10. On 60-140 hp models, install the internal coupling bolt (Figure **16).** Install the gearcase plate (Figure 15) using Loctite 242 on the screw threads. Install a new upper spring pin into the shift rod joint (Figure 22). Use the correct size spring pin tool and tap the pin into the coupler.
11. Check and adjust the shift and reverse hold-down linkage as described in Chapter Five.
12. Fill the gearcase with lubricant as described in Chapter Four. Install the propeller as described this chapter.
13. Install the spark plug leads. Check for proper cooling and shifting operation immediately after starting the engine. Correct any faults before operating the engine.





WATER PUMP

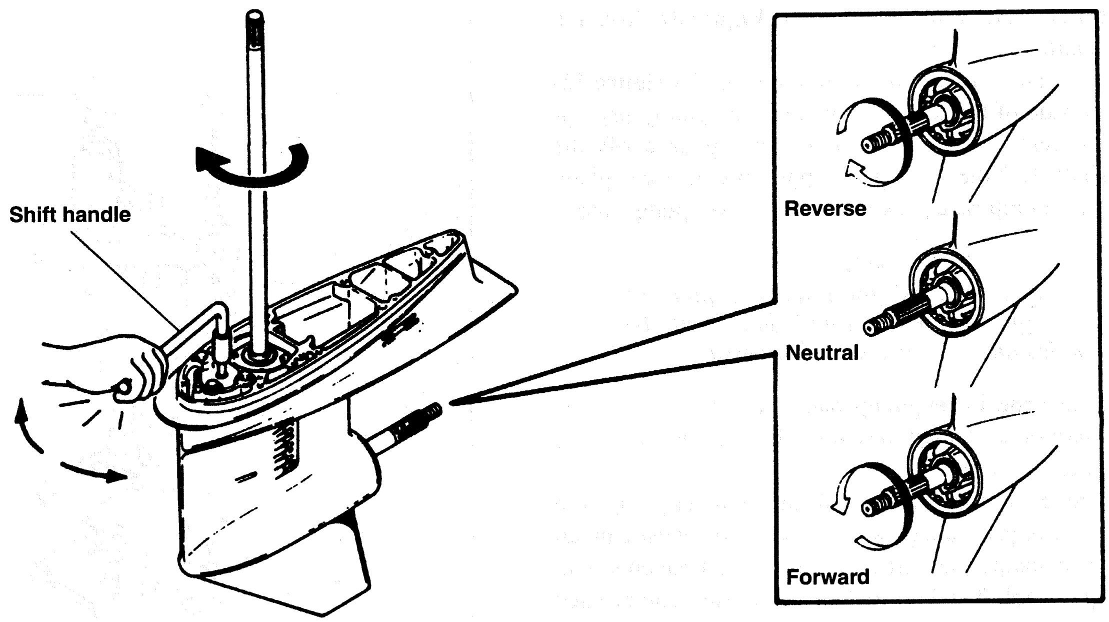
Replace the impeller, seals, O-rings and all gaskets any time the water pump is serviced. Never use questionable parts. Doing so may compromise the reliability of the water pump.

Disassembly (All Models)

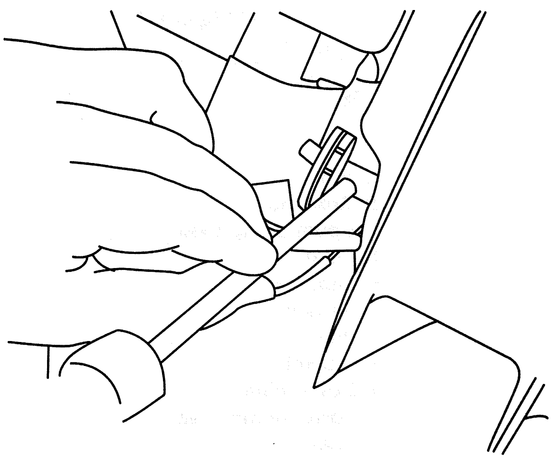
Refer to Figures 23-30 during this procedure.

1. Drain the gearcase as described in Chapter Four. Remove the gearcase as described in this chapter.
2. Remove retaining bolts and lift the upper pump case from the gearcase. Pull the lower case and remove the impeller from the upper case. Pull the water tube grommet (if equipped) from the upper pump case.

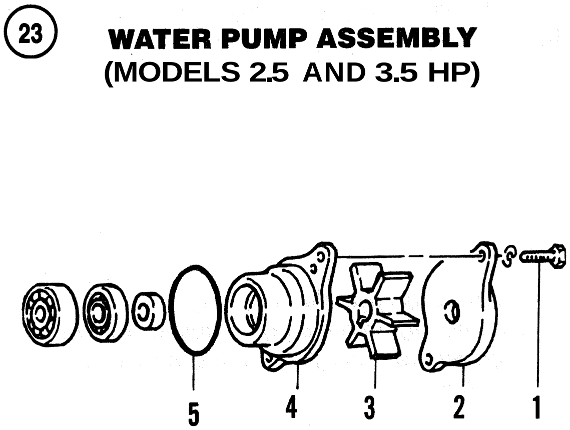
21



22



23



1. Bolt
2. Lower pump case
3. Impeller
4. Upper pump case
5. O-ring

3. Carefully pry the water pump impeller away from the wear plate. Slide the impeller up and off of the drive shaft. Pry the impeller from the water pump housing if not found on the drive shaft. Pull the drive key **(Figure 31)** from the drive shaft.
4. Insert a slotted screwdriver into the notch **(Figure 32)** on each side of the lower pump case and gently pry upward to remove. Slide the lower pump case off the driveshaft. Lift the wear plate upper gasket, wear plate, and lower pump case gasket from the lower pump case.

NOTE
Lower pump case dowel pins (if equipped) are difficult to remove and should only be pulled out if replacement is necessary.

5. Remove the lower pump base only if removing the drive shaft or shift shaft, resealing the gearcase, or if it is damaged.
6. Remove all gasket material from the lower pump case with abrasive pads and gasket remover. Do not use a metal scraper to scrape the gasket. Clean all components with isopropyl alcohol and dry with low-pressure compressed air.
7. Inspect the lower and upper pump cases for cracks and melting. Replace as needed.
8. If it is necessary to replace seals, use the appropriate size seal puller and installer to avoid damaging the new seals and lower pump case seating surfaces.
9. Inspect all water pump components for wear or damage as described in this chapter.

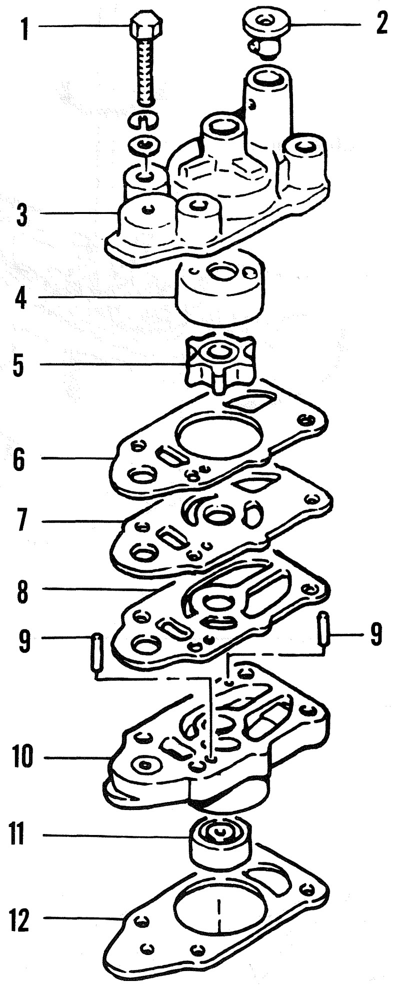
CAUTION
To prevent water and/or gear lubricant leakage, always replace gaskets, seals and O-rings if they are removed or disturbed.

NOTE
Thoroughly clean the drive shaft prior to installing any water pump components. The impeller must slide freely along the length of the shaft.

Assembly (All Models)

Refer to **Figures 23-30** during this procedure.
1. Use a socket or section of tubing as a seal installation tool. The tool must contact the outer diameter of the seal, but not the seal bore in the lower pump case.
2. Apply marine grease to the seal lips and O-ring prior to installing them into the lower pump case. Apply gasket sealant to the flanged surface of the lower pump case to provide a good seal between the lower pump case and gearcase. Position the first seal into the opening at the bot-

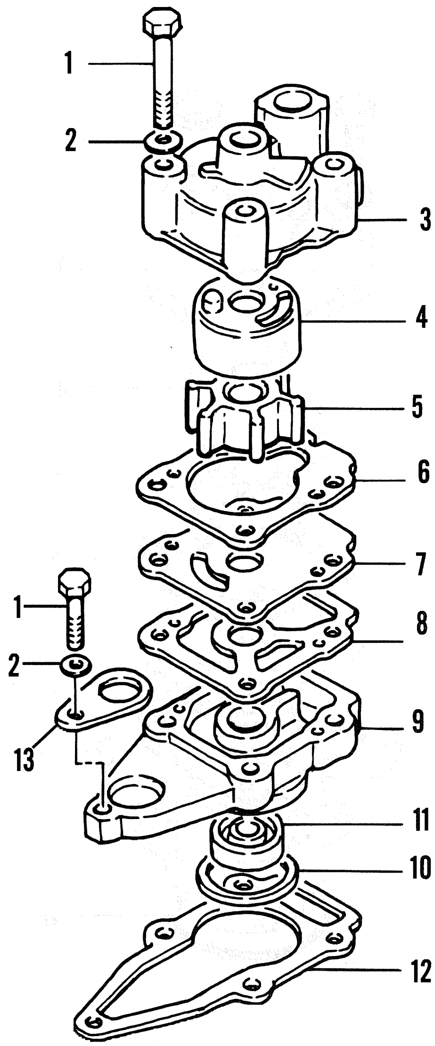
(24) **WATER PUMP ASSEMBLY (MODELS 3.5 HP)**



1. Bolt
2. Grommet
3. Upper pump case
4. Liner
5. Impeller
6. Gasket
7. Plate
8. Gasket
9. Dowel pins
10. Lower pump case
11. Seal
12. Gasket

25

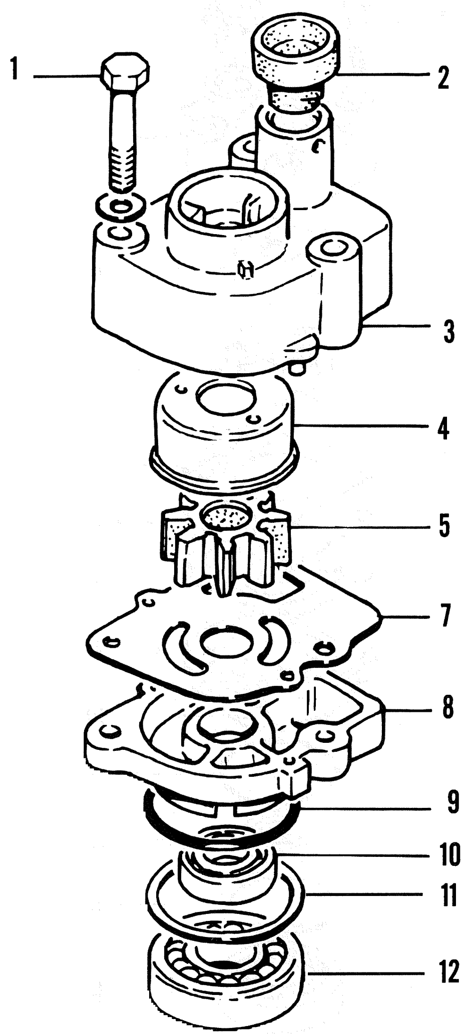
WATER PUMP ASSEMBLY (5-9.8 HP MODELS)



1. Bolt
2. Washer
3. Upper pump case
4. Liner
5. Impeller
6. Gasket
7. Plate
8. Gasket
9. Lower pump case
10. O-ring
11. Seal
12. Gasket
13. Holding bracket

26

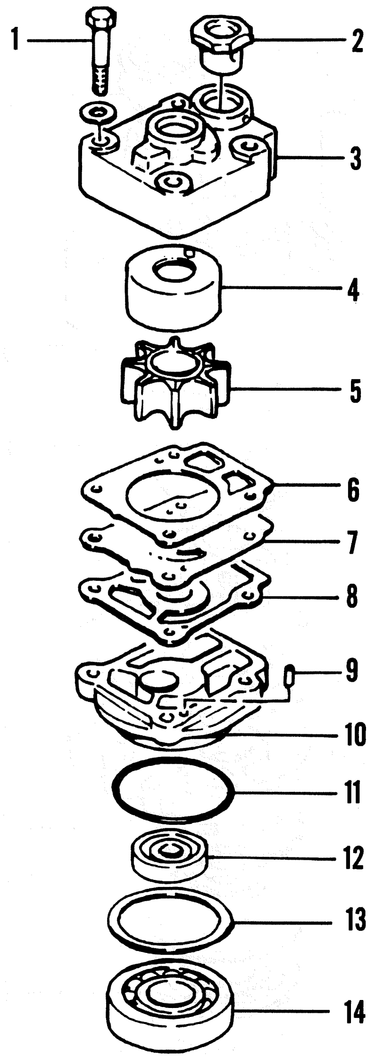
WATER PUMP ASSEMBLY (25-30 HP MODELS)



1. Bolt
2. Grommet
3. Upper pump case
4. Liner
5. Impeller
7. Plate
8. Lower pump case
9. O-ring
10. Seal
11. O-ring
12. Ball bearing

27

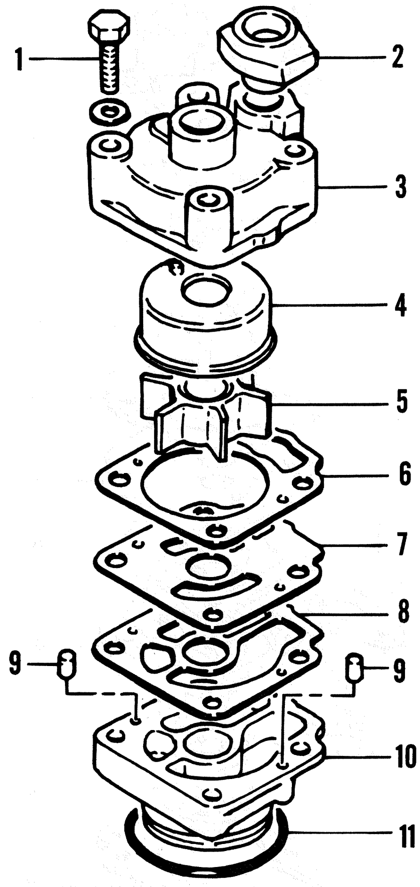
WATER W M P ASSEMBLY (40 HP MODELS)



1. Bolt
2. Grommet
3. Upper pump case
4. Liner
5. Impeller
6. Gasket
7. Plate
8. Gasket
9. Dowel pin
10. Lower pump case
11. O-ring
12. Seal
13. O-ring
14. Ball bearing

28

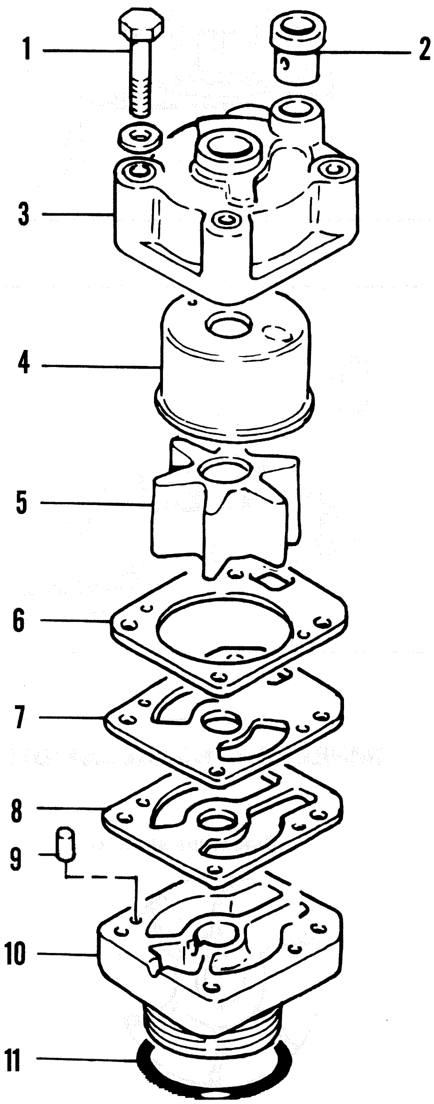
WATER PUMP ASSEMBLY (40-50 HP MODELS)



1. Bolt
2. Grommet
3. Upper pump case
4. Liner
5. Impeller
6. Gasket
7. Plate
8. Gasket
9. Dowel pin
10. Lower pump case
11. O-ring

(29)

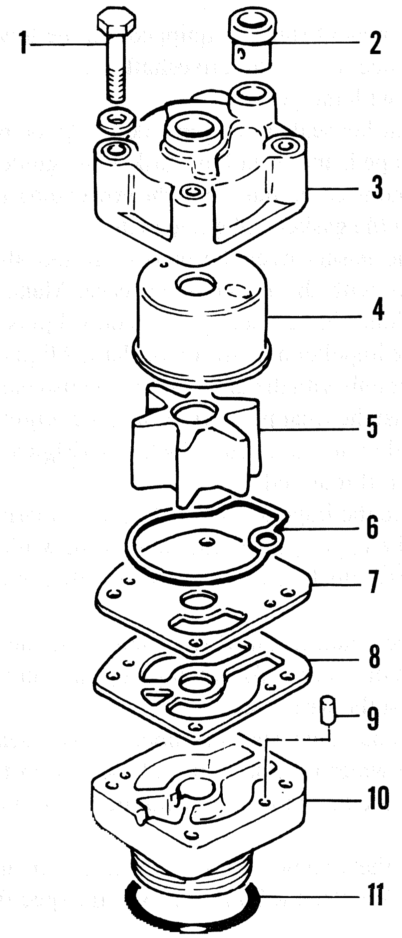
WATER PUMP ASSEMBLY (60-90 HP MODELS)



1. Bolt
2. Grommet
3. Upper pump case
4. Liner
5. Impeller
6. Gasket
7. Plate
8. Gasket
9. Dowel pin
10. Lower pump case
11. O-ring

(30)

WATER PUMP ASSEMBLY (115-140 HP MODELS)



1. Bolt
2. Grommet
3. Upper pump case
4. Liner
5. Impeller
6. Gasket
7. Plate
8. Gasket
9. Dowel pin
10. Lower pump case
11. O-ring

9

tom of the lower pump case with the lip side facing outward. Using the installation tool, push the seal into the bore until it bottoms. Place the second seal into the opening with the seal lip facing outward. Push the seal into the bore until it contacts the first seal.

3. Place a new gasket, if equipped, onto the bottom of the lower pump case. Gasket sealing compound is not required.

4. Install a new O-ring, if equipped, on the lower pump case and place it over the driveshaft and align the lower pump case with the gearcase.

5. Apply gasket sealant to both sides of guide plate gasket, if equipped, and install the gasket and guide plate on the lower pump case. Make sure the dowel pins align with the holes in the gasket and guide plate.

6. Slide the gasket over the driveshaft and align these components with the lower pump case. Make sure the dowel pin holes in gasket align with dowel pins.

7. Slide the impeller over the drive shaft. Align the slot in the impeller hub with the drive key, then push the impeller down against the wear plate. If reusing the original impeller, ensure that the vanes curl clockwise (Figure **33).** Flip the impeller, if required.

8. Lubricate the impeller fins lightly with marine grease and slide the upper pump case downward while rotating the driveshaft clockwise to seat the impeller in the pump case.

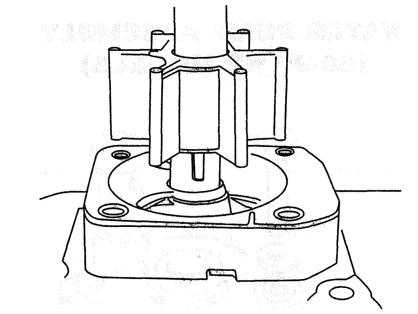
9. Continue rotating the drive shaft until the impeller fully enters the liner in the water pump case and the body seats against the wear plate.

10. Apply anaerobic gasket compound to the seating surface of the water tube seal. Install the seal in the upper case so the locking tabs align with the holes in the housing.

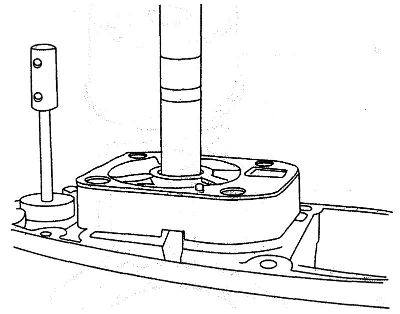
11. Install the retainer bolts into the upper and lower pump base. Tighten the bolts evenly to the specification in Table **1.**

12. Install the gearcase (this chapter). Fill the gearcase with lubricant (Chapter Four). Check for proper cooling system operation and correct any problems before operating the engine.

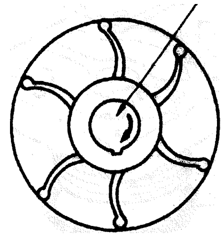
31



32



33 **IMPELLER INSTALLATION**



GEARCASE

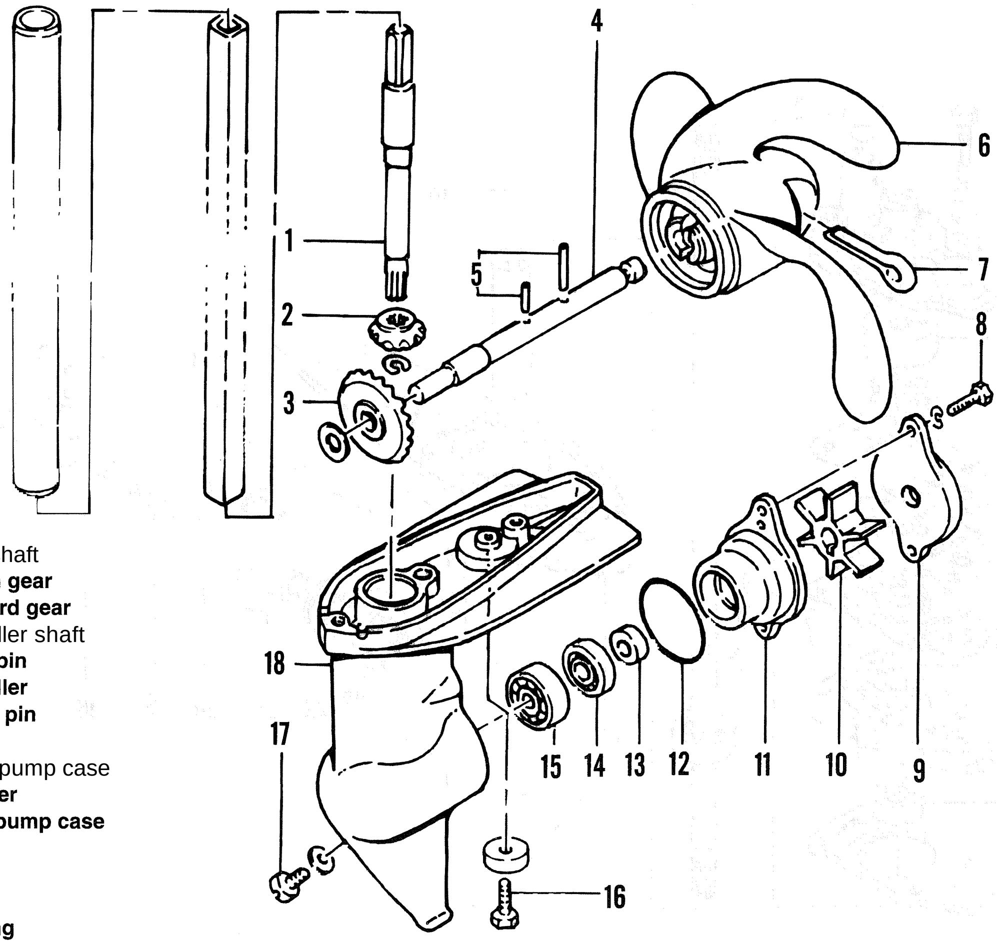
If complete disassembly is not required, follow the disassembly instructions until the required component(s) is accessible. Refer to the corresponding assembly instructions to install the component(s).

If the drive shaft, propeller shaft or any gear or bearing is replaced, the gearcase internal components must be properly positioned in the gearcase housing. Proper gear alignment is essential for quiet operation and long gearcase service life. Special tools and measuring instruments are required to check gear alignment. Purchase special tools from a local marine dealership.

Some models use shims to position bearings and gears. Note the location and thickness of all shims as they are removed. Using a micrometer, measure and record each shim or spacer thickness as they are removed from the gearcase. Wire the shims together and tag them or place them in an envelope. Note the shim location in the gearcase on the envelope or tag.

34

GEARCASE ASSEMBLY (MODELS 2.5/3.5 HP)



1. Driveshaft
2. Pinion gear
3. Forward gear
4. Propeller shaft
5. Drive pin
6. Propeller
7. Cotter pin
8. Bolt
9. Outer pump case
10. Impeller
11. Inner pump case
12. O-ring
13. Seal
14. Seal
15. Bearing
16. Bolt
17. Drain screw
18. Gearcase

Mount the gearcase in a suitable holding fixture or a sturdy vise. Use padded jaws or wooden blocks to protect the gearcase. Clamp the gearcase on the skeg (lower fin) when using a vise. Have an assistant provide additional support for the gearcase when removing large or tight fasteners.

Disassembly (2.5-3.5 hp Models)

Refer to **Figure 34** during this procedure.

1. Disassemble the water pump as described in this chapter.

2. Remove the propeller and attaching hardware as described in this chapter.

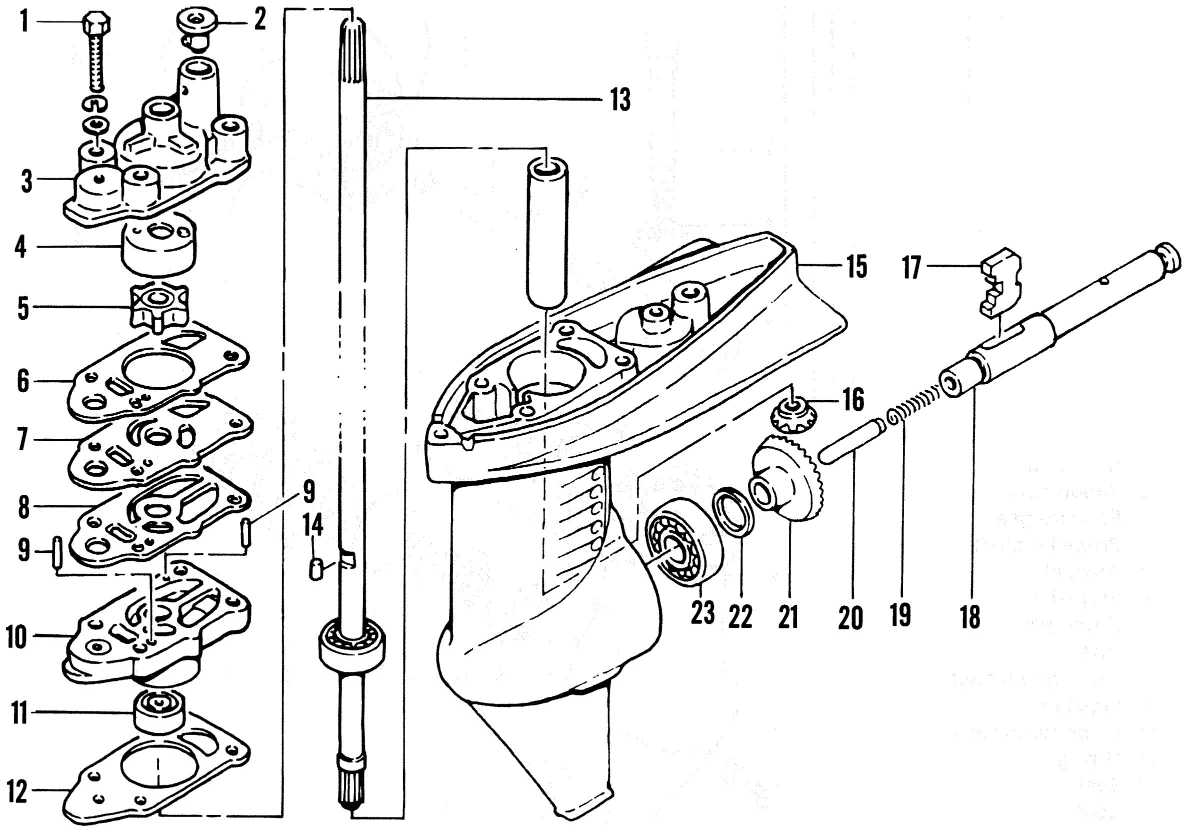
3. Drain the oil into a container and inspect the oil for metal chips.

4. Remove the two bolts (8, **Figure 34)** securing the water pump housing and propeller shaft housing to the gearcase housing.

5. Remove the water pump impeller (10. **Figure 34)** and key from water pump case. Remove the water pump case by turning it counterclockwise to loosen.

35

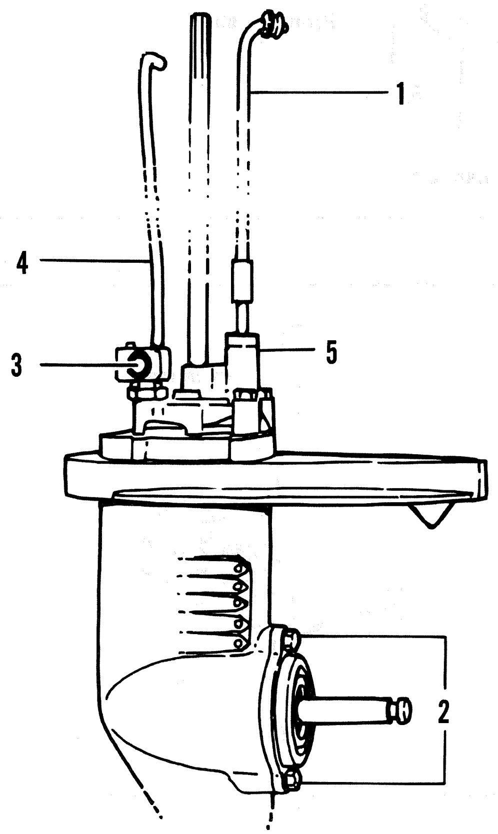
GEARCASE ASSEMBLY **(3.5B** HP MODELS)



1. Bolt
2. Grommet
3. Upper pump case
4. Liner
5. Impeller
6. Gasket
7. Plate
8. Gasket
9. Pin
10. Lower pump case
11. Seal
12. Gasket
13. Driveshaft
14. Driveshaft key
15. Gearcase housing
16. Pinion gear
17. Clutch
18. Propeller shaft
19. Clutch spring
20. Cam
21. Forward gear
22. Washer
23. Ball bearing

36

GEARCASE ASSEMBLY (3.5B HP MODELS)



1. Water tube
2. Bolts
3. Shift rod joint bolt
4. Shift rod
5. Water pump housing

6. Pull up on the driveshaft **(1, Figure 34)** and remove the pinion gear **(2).** Remove the propeller shaft **(4)** and forward gear **(3).**

7. Clean and inspect all components as described in this chapter.

Assembly (2.5-3.5 hp Models)

Refer to **Figure 34** during this procedure.

1. Install the washer and forward gear **(3, Figure 34)** onto the propeller shaft **(4).** Install the propeller shaft assembly into the gearcase.
2. Install the bearing (15, **Figure 34**), seals (**13** and 14), and O-ring **(12)** into the water pump case **(11)** and install assembly into the gearcase **(18).**
3. Install the water pump impeller key into the propeller shaft. Align the slot in the impeller with the key and slide the impeller onto the propeller shaft.
4. Install the outer pump case (9, **Figure 34)** and two bolts **(8).** Tighten the bolts to the specification in **Table 2.**

9

Disassembly (3.5B hp Models)

Refer to **Figures 35-40** during this procedure.

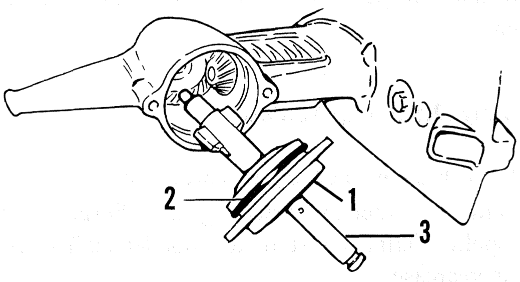
1. Disassemble the water pump as described this chapter.
2. Drain the gearcase into a container by removing both the lower and upper plugs from the starboard side of the gearcase. Inspect the oil for metal chips.

NOTE

Very fine metal shavings may indicate normal wear of internal parts. Large metal chips usually indicate extensive internal damage.

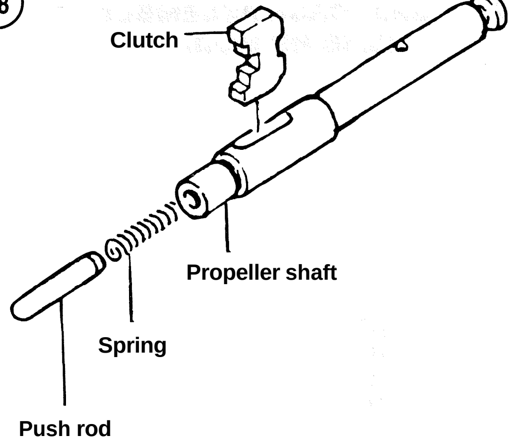
3. Remove the upper shift rod **(4, Figure 36)** from the shift lever.
4. Remove the water tube **(1, Figure 36)** from the water pump housing.
5. Remove the bolts **(2, Figure 36)** that secure the propeller shaft housing. Remove the propeller shaft housing **(1, Figure 37).**
6. Remove the clutch **(Figure 38)** and clutch spring **(Figure 38)** from the propeller shaft.
7. Pull upward on the drive shaft and lower shift rod at the same time and remove the drive shaft, shift rod and water pump lower case together.
8. Remove the pinion gear and forward gear **(Figure 40).**
9. Clean and inspect all components as described in this chapter.

37 **PROPELLER SHAFT HOUSING (3.5B HP MODELS)**

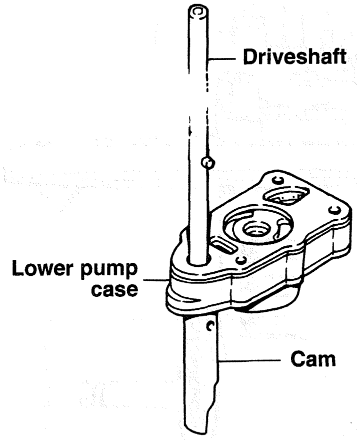


1. Propeller shaft housing
2. O-ring
3. Propeller shaft

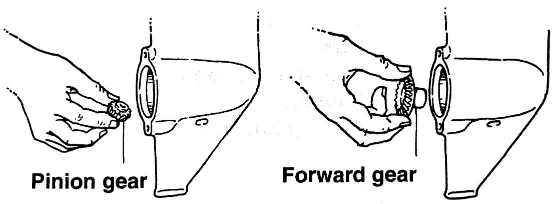
38



39



40



Assembly (3.5B hp Models)

Refer to **Figures 35-40** during this procedure.

1. Install the clutch, clutch spring and clutch push rod **(Figure 38)** into the propeller shaft.
2. Install forward gear **(Figure 40)** into the gearcase.
3. Hold the pinion gear **(Figure 40)** in position in the gearcase housing and install the drive shaft. Make sure the drive shaft properly engages the pinion gear. Install the propeller shaft into the housing.
4. Install the propeller shaft housing (1, **Figure 37)** and mounting bolts (2, **Figure 36).** Tighten the bolts to the specification in **Table 2.**
5. Install the water tube **(1, Figure 36)** into the water pump housing.
6. Install the shift rod **(4, Figure 36)** onto the shift rod lever.
7. Install the water pump as described in this chapter.

Disassembly (8-40 hp Two-Cylinder Models)

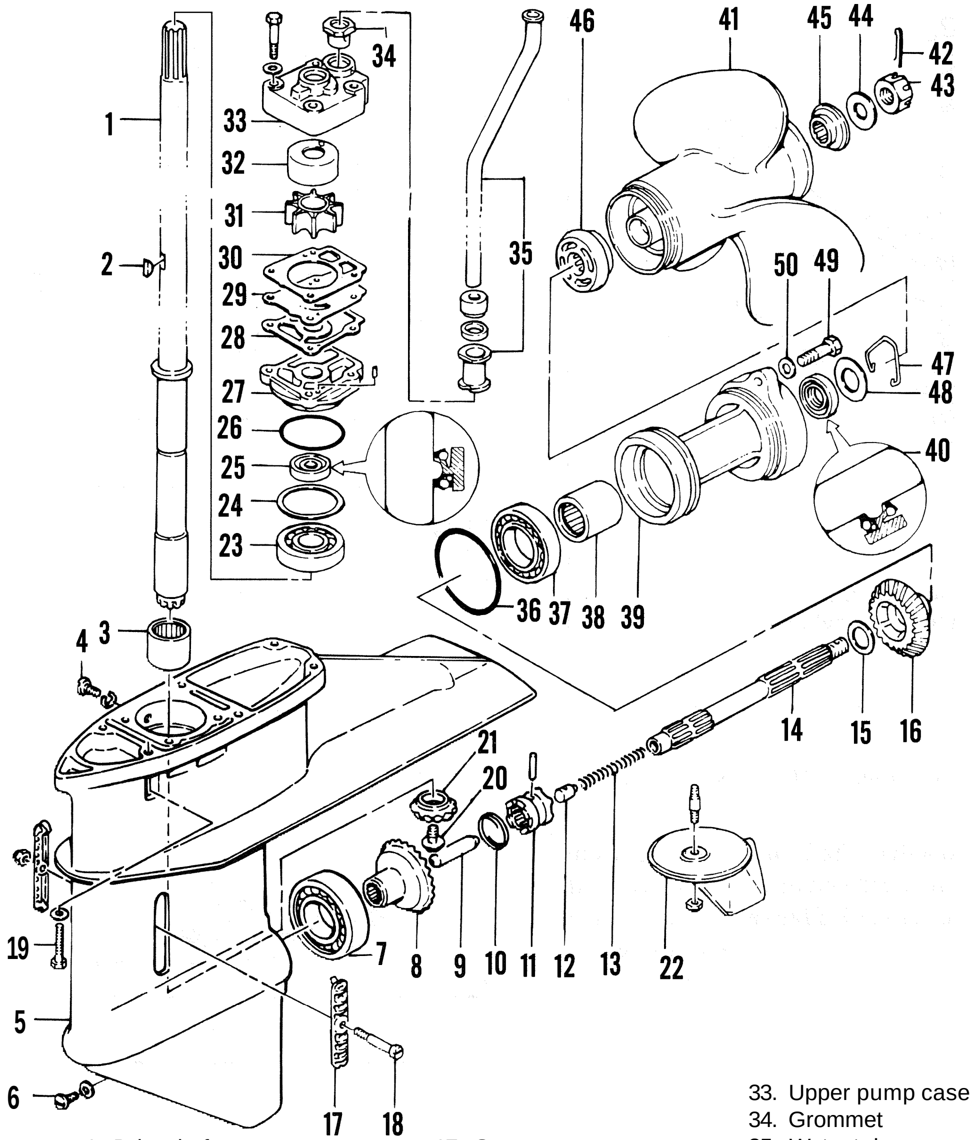
Refer to **Figure 41** during this procedure.

1. Disassemble the water pump as described in this chapter.
2. Remove the propeller and attaching hardware as described in this chapter.
3. Drain the gearcase into a container by removing the lower drain plug (6, **Figure 41)** and vent plug **(4)** from the starboard side of the gearcase.

NOTE
Very fine metal shavings may indicate normal internal part wear. Large metal chips usually indicate extensive internal damage.

41

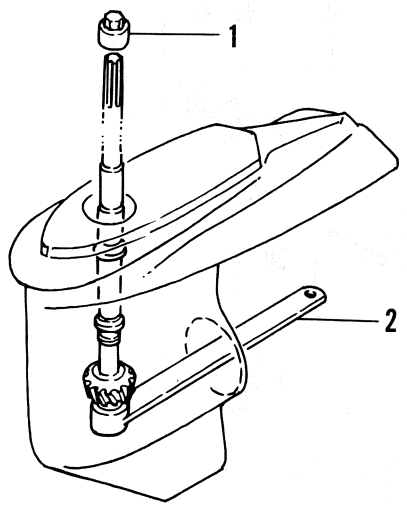
GEARCASE ASSEMBLY (8-40 HP MODELS)



1. Driveshaft
2. Driveshaft key
3. Roller bearing
4. Upper **drain/vent** screw
5. **Gearcase** housing
6. Drain screw
7. Roller bearing
8. Forward gear
9. Clutch push rod
10. Clutch spring
11. Clutch
12. Retainer
13. Spring
14. Propeller shaft
15. Spacer
16. Reverse gear
17. Screen
18. Screw
19. Bolt
20. Pinion bolt
21. Pinion gear
22. Trim tab
23. Roller bearing
24. Shim
25. Seal
26. O-ring
27. Lower pump case
28. Gasket
29. Plate
30. Gasket
31. Impeller
32. Liner
33. Upper pump case
34. Grommet
35. Water tube
36. O-ring
37. Roller bearing
38. Needle bearing
39. Propeller housing
40. Seal
41. Propeller
42. Cotter pin
43. Castle nut
44. Washer
45. Spacer
46. Spacer
47. Spring keeper
48. Washer
49. Bolt
50. Washer

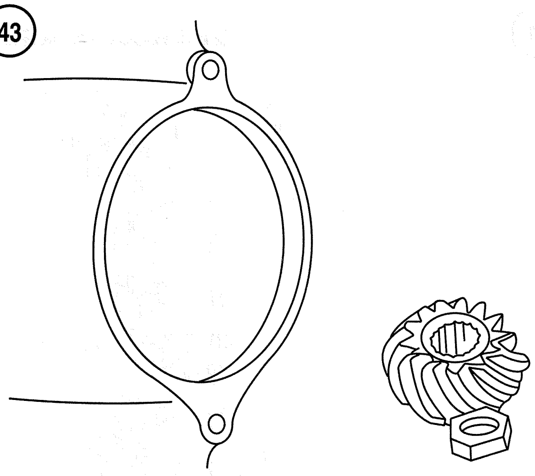
42

DRIVESHAFT REMOVAL (8-140 HP MODELS)

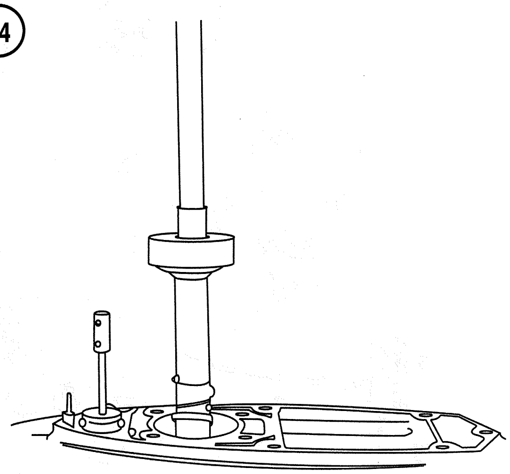


1. Driveshaft tool
2. Pinion gear nut tool

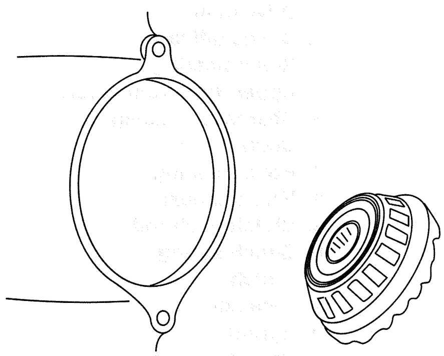
43



44



45



4. Remove the bolts **(49, Figure 41)** that secure the propeller shaft housing.

5. Remove the propeller shaft and housing from gearcase. Check the forward end of the propeller shaft to see if the clutch push rod **(9, Figure 41)** remained in propeller shaft. If not, remove it from inside the gearcase.

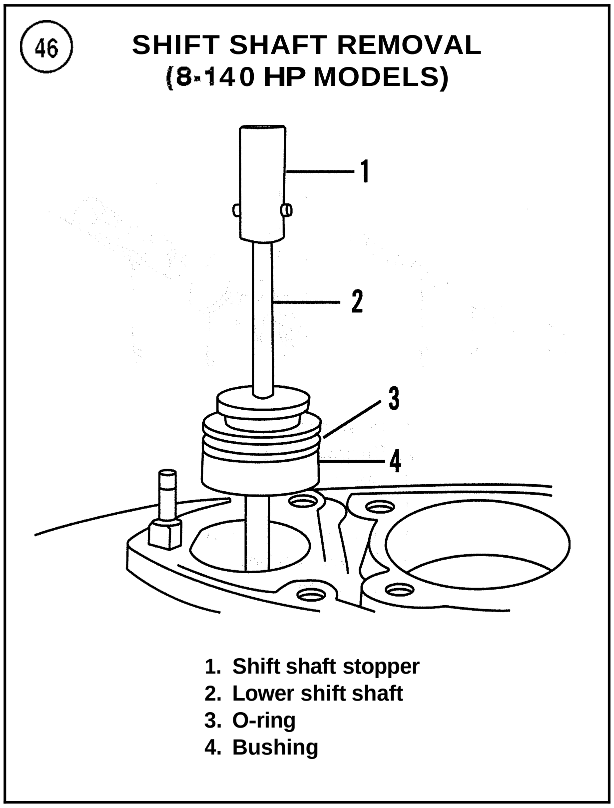
6. Install the driveshaft adapter **(1, Figure 42)** and hold the pinion nut with a wrench and turn the driveshaft counterclockwise to loosen the nut. Remove the pinion nut and pinion gear **(Figure 43)** from the gearcase.

7. Remove the driveshaft from the gearcase **(Figure 44).**

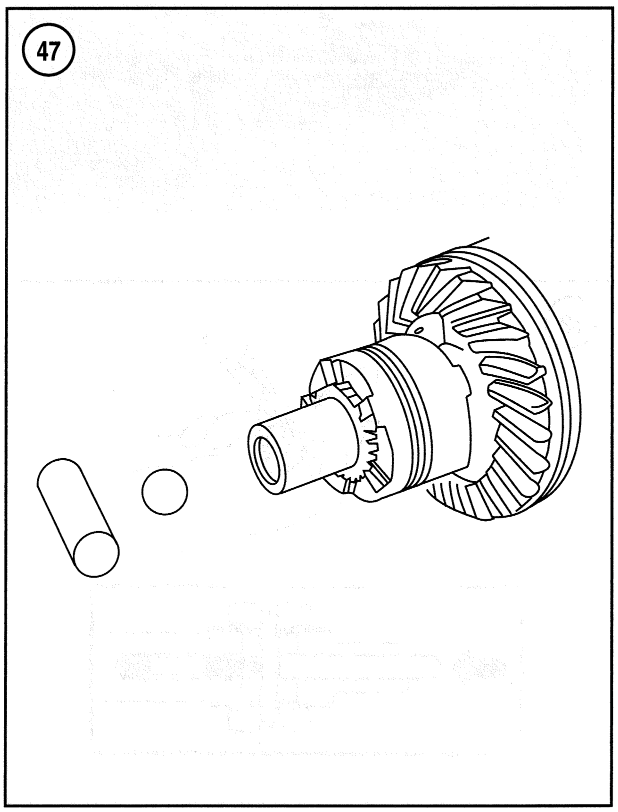
8. Remove the forward gear and forward gear roller bearing **(Figure 45)** from the gearcase.

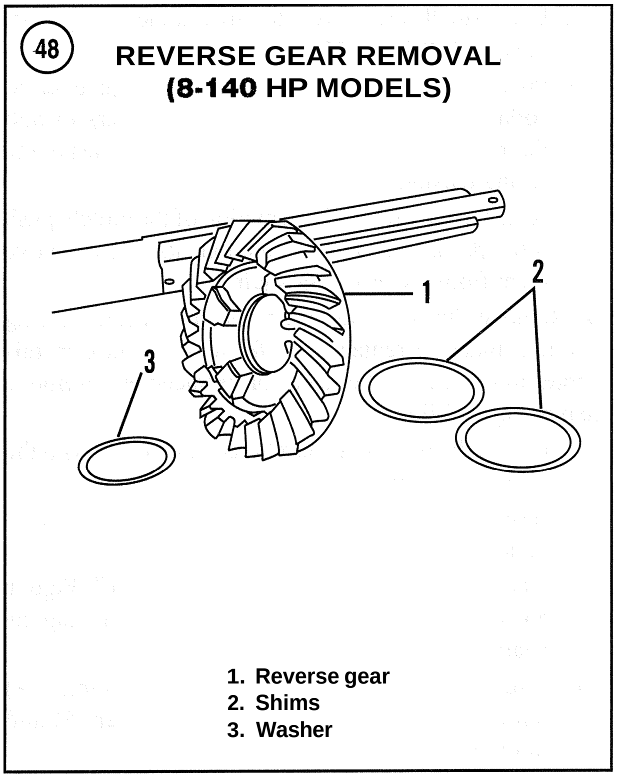
NOTE
A tapered forward gear roller bearing is used on 40 hp models only.

9. Remove the shift shaft stopper (1, **Figure 46)** from the lower shift shaft (2) and lift the lower shift shaft from the gearcase. Fully disassemble the shift shaft components, including the shift shaft bushing (4) and the internal and external O-rings (3, **Figure 46).**

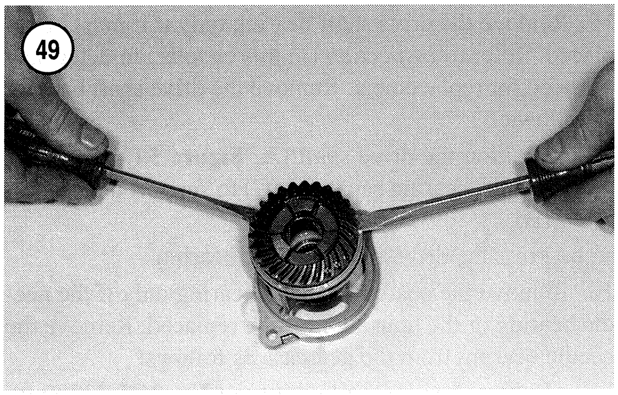


1. Shift shaft stopper
2. Lower shift shaft
3. O-ring
4. Bushing





1. Reverse gear
2. Shims
3. Washer



10. Remove the clutch push rod and detent ball (Figure 47) from the end of the propeller shaft. Pull the propeller shaft from the propeller shaft housing.

11. Remove the washer (3, Figure 48), reverse gear (1), and all shims (2) (25, 30 and 40 hp models) from the propeller shaft.

12. Remove the reverse gear from the propeller shaft housing (Figure 49).

13. A spring-loaded clutch push rod (1, Figure 50) is used to move the clutch (4). The cross pin retaining spring (5) is wrapped around the clutch to retain the cross pin (7). Disassemble the propeller shaft as follows:

9

a. Use a small screwdriver to unwind the spring from the clutch (Figure 51).

b. Press inward on the clutch push rod (Figure 52) to collapse the spring. Use needlenose pliers to pull the cross pin from the clutch. Slowly release the spring tension.

c. Note the location and orientation of the clutch, push rod, spring and related components, then remove them from the propeller shaft.

14. Remove the propeller shaft housing needle bearing only if it must be replaced. Refer to *Inspection* in this chapter to determine the need for replacement. Remove the bearing as follows:

a. Clamp the propeller shaft housing in a vise with the threaded end facing up.

b. Insert a suitable driver (1, Figure 53) into the propeller shaft housing through the bearing.

c. Attach a retainer (2) to the shaft groove (7, Figure 53) with the raised surface of the retainer facing the bearing.

d. Slide the guide (3, Figure 53) and flange (4) onto the shaft and secure with a washer (5) and nut (6).

e. Tighten the nut (6, Figure 53) until the needle bearing releases from the housing.

15. Remove the drive shaft bearing only if it must be replaced. Refer to *Inspection* (in this chapter) to determine the need for replacement. Remove the drive shaft bearing as follows:

a. Position the drive shaft (A, Figure 54) in a press, using a bearing separator (C) to support the bearing (B).

b. Press the driveshaft from the bearing.

16. Remove the gearcase needle bearing only if the needle bearing or the housing must be replaced. Remove the needle bearing from the gearcase as follows:

a. Using a bearing puller kit (part No. 3C7-72700-0), insert the shaft (5, Figure 55) through the needle bearing from the water pump side of gearcase.

b. Enter from the propeller shaft side of gearcase and attach the retainer (7, Figure 55) to the shaft groove (6). Make sure the retainer (7, Figure 55) with the raised side facing the bearing is fully seated.

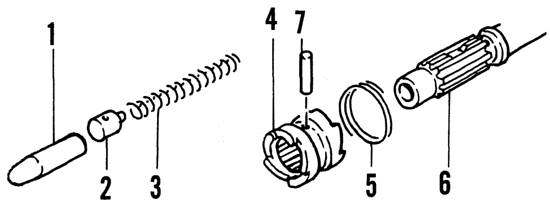
c. Install the guide (4, Figure 55) onto the shaft and make sure the guide is seated in the bearing.

d. Install a flange/plate (3, Figure **55**), washer (2), and nut (1) onto the shaft.

e. Hold the end of the threaded shaft (5, Figure 55) with a wrench and tighten the nut (1) until the bearing is free of the gearcase housing.

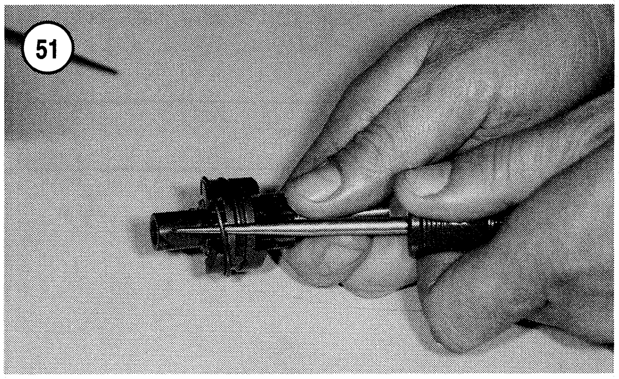
50

PROPELLER SHAFT ASSEMBLY (8-40 HP MODELS)

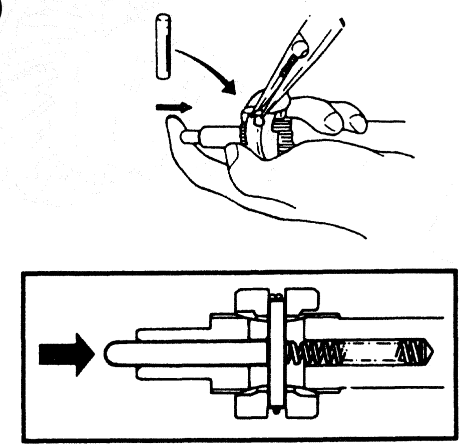


1. *Push rod*
2. *Spring holder*
3. *Spring*
4. *Clutch*
5. *Spring (cross pin)*
6. *Propeller* shaft
7. *Cross pin*

51

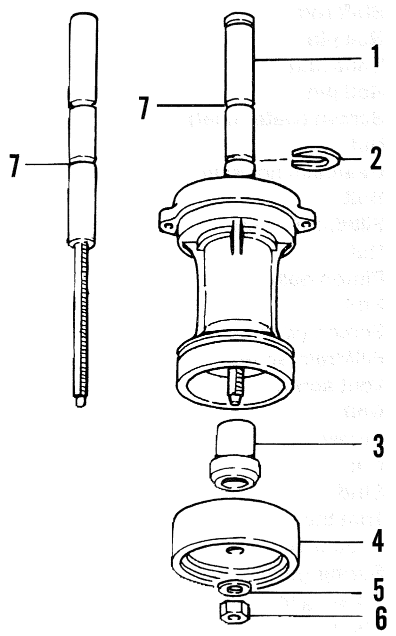


52



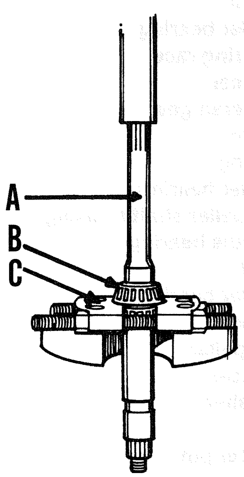
53

PROPELLER SHAFT NEEDLE BEARING REMOVAL (8-50 HP MODELS)



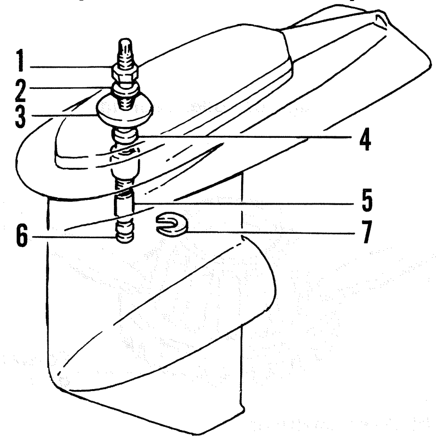
1. Shaft (tool)
2. Retainer
3. Slide guide
4. Flange
5. Washer
6. Nut
7. Groove (tool shaft)

54



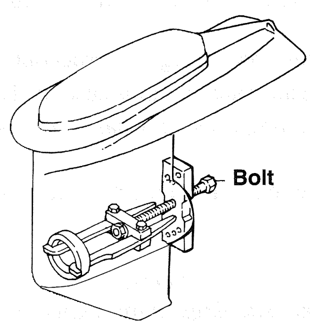
55

GEARCASE NEEDLE BEARING REMOVAL (25-40 HP MODELS)



1. Nut
2. Washer
3. Plate/flange
4. Guide
5. Shaft
6. Shaft groove
7. Retainer

56



17. Install the forward gear bearing puller as shown in Figure **56.** Tighten the bolt until the bearing race releases from the housing.

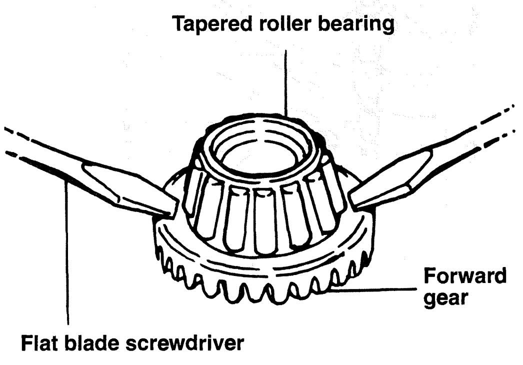
18. Remove the tapered roller bearing from the forward gear (Figure **57)** only if it must be replaced. If removal is necessary, insert two pry bars into the forward gear notches (Figure **57)** and pry the gear and bearing apart.

19. Remove the screw(s) and nut(s) (18, Figure **41**), then pull the water screen (17) from the gearcase housing.

20. Clean and inspect all components as described in this chapter.

9

57



Disassembly (40 hp Three-Cylinder-140 hp Models)

Refer to **Figure 58** during this procedure.

1. Disassemble the water pump as described in this chapter.
2. Remove the propeller and hardware as described in this chapter.
3. Drain the gearcase **(Figure 58)** as described in Chapter Four.

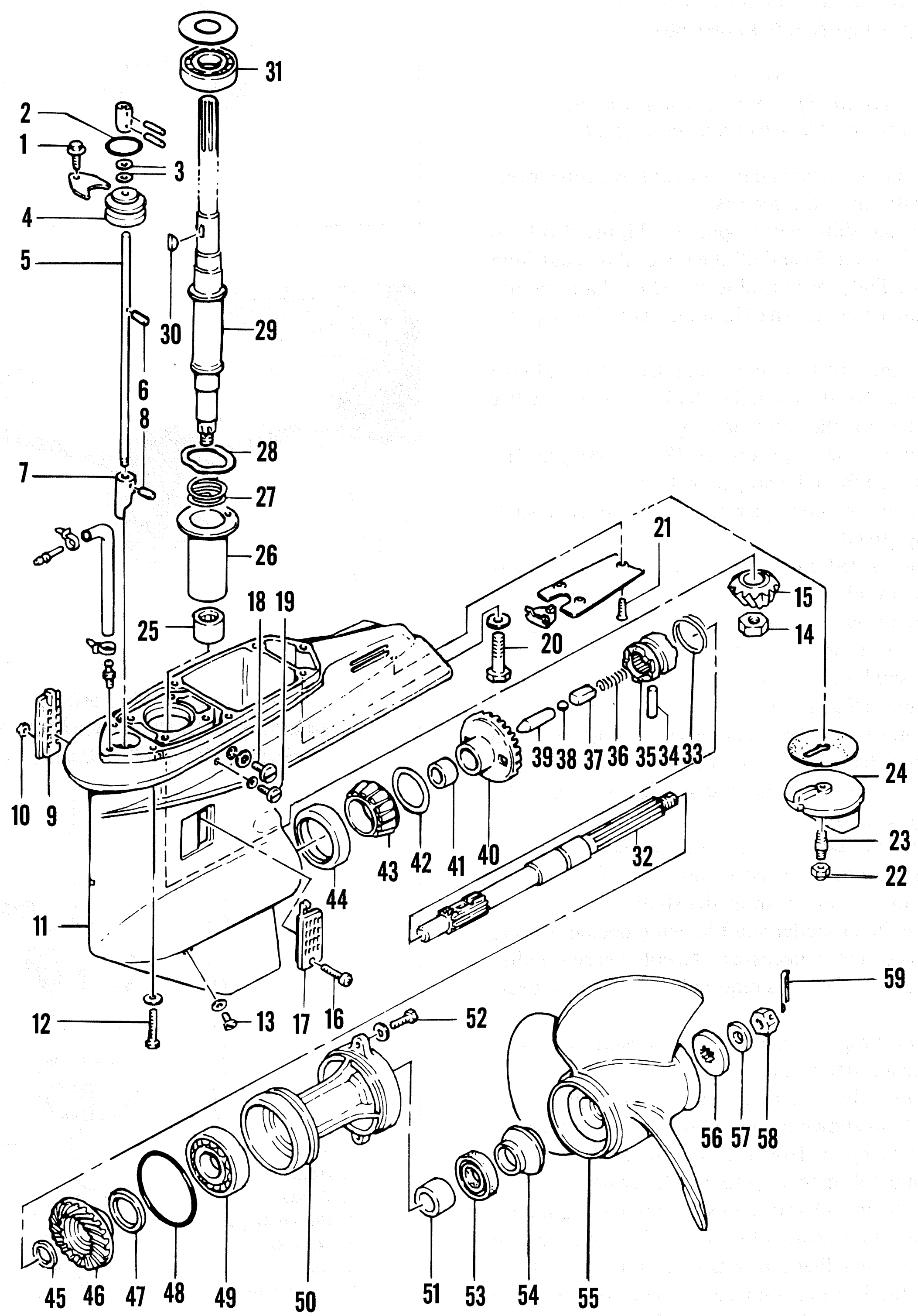
NOTE
Very fine shavings may indicate normal wear of internal parts. Large metal chips usually indicate extensive internal damage.

4. Remove the bolts **(52, Figure 58)** that secure the propeller shaft housing.
5. Install the propeller shaft housing puller **(Figure 59).** Tighten the pressing bolt **(Figure 59)** until the propeller housing separates from gearcase. Remove the propeller shaft and housing from the gearcase. Check the forward end of propeller shaft to see if the clutch push rod (39, **Figure 58)** remained in the propeller shaft. If not, locate it inside the gearcase and remove it.
6. Install the drive shaft adapter (1, **Figure 42)** onto the drive shaft. Hold the pinion nut with a wrench and turn the drive shaft counterclockwise to remove the pinion nut.

58

1. Screw
2. O-ring
3. Seals
4. Bushing
5. Shift rod
6. Roll pin
7. Shift cam
8. Roll pin
9. Screen (water inlet)
10. Nut
11. Gearcase housing
12. Bolt
13. Fill/drain screw
14. Nut
15. Pinion gear
16. Bolt
17. Screen (water inlet)
18. Fill/drain screw
19. Vent screw
20. Bolt
21. Screw
22. Nut
23. Stud
24. Trim tab
25. Needle bearing
26. Spring guide
27. Oil slinger
28. Shim
29. Driveshaft
30. Key
31. Roller bearing
32. Propeller shaft
33. Cross pin spring
34. Clutch
35. Cross pin
36. Spring
37. Retainer
38. Detent ball bearing
39. Push rod
40. Forward gear
41. Needle bearing
42. Shim
43. Roller bearing
44. Bearing race
45. Spacer
46. Reverse gear
47. Shim
48. O-ring
49. Roller bearing
50. Propeller shaft housing
51. Needle bearing
52. Bolt
53. Roller bearing
54. Spacer
55. Propeller
56. Spacer
57. Washer
58. Nut
59. Cotter pin

TYPICAL GEARCASE ASSEMBLY (40-140 HP MODELS)



9

Remove the pinion nut **(14, Figure 58)** and pinion gear **(15)** from the gearcase..

7. Lift the drive shaft from the gearcase.

8. Use a piece of wire or hooked tool to remove the driveshaft spring guide **(26, Figure 58).**

NOTE
Forty and fifty hp models are not equipped with a removable driveshaft spring guide.

9. Remove forward gear and the forward gear roller bearing **(Figure 45)** from the gearcase.

10. Remove the shift shaft stopper (1, **Figure 46)** from the lower shift shaft (2) and lift the lower shift shaft from the gearcase. Fully disassemble the shift shaft components, including the shift shaft bushing **(4)** and O-rings **(3, Figure 46).**

11. Remove the clutch push rod and detent ball **(Figure 47)** from the end of the propeller shaft. Pull the propeller shaft from the propeller shaft housing.

12. Remove the washer (3, **Figure 48**), reverse gear (1), and all shims (2) from the propeller shaft.

13. Remove the reverse gear from the propeller shaft housing **(Figure 60).**

14. A spring-loaded clutch push rod (1, **Figure 50)** is used to move the clutch (4). The cross pin retaining spring (5) is wrapped around the clutch to retain the cross pin **(7).** Disassemble the propeller shaft as follows:

a. Use a small screwdriver to unwind the spring from the clutch **(Figure 51).**

b. Press inward on the clutch push rod **(Figure 52)** to collapse the spring. Use needlenose pliers to pull the cross pin from the clutch. Slowly release the spring tension.

c. Note the location and orientation of the clutch, push rod, spring and related components and then remove them from the propeller shaft.

15. Remove the propeller shaft housing needle bearing only if replacement is necessary. Needle bearing puller kit part no. **3C7-72700-0** is required to remove the bearing.

16. Clamp the propeller shaft bearing housing into a vise with its threaded side facing upward.

17. Configure the bearing puller kit (part No. **3C7-72700-0)** as shown in the following illustrations:

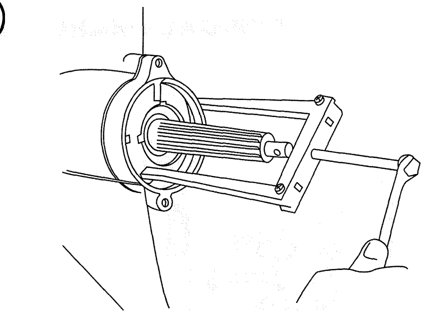
a. **40** and **50** hp models, refer to **Figure 53.**

b. **60B** and **70B** models, refer to **Figure 61.**

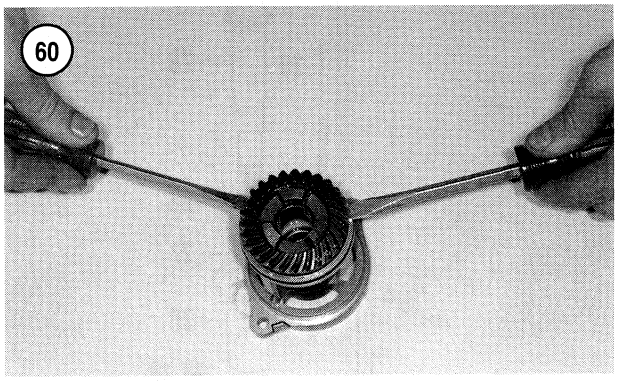
c. 60C, **70C** and **80-140** hp models, refer to **Figure 62.**

18. Insert the tool shaft into the bearing housing and through the bearing. Place the retainer. with its raised surface facing the bearing, into the correct groove in the shaft. Then, install the flange to the shaft using the washer and nut.

59

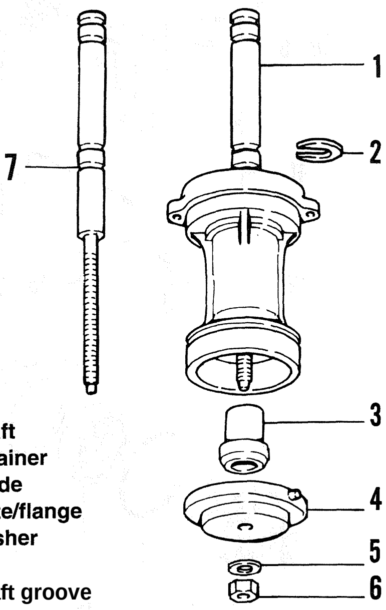


60



61

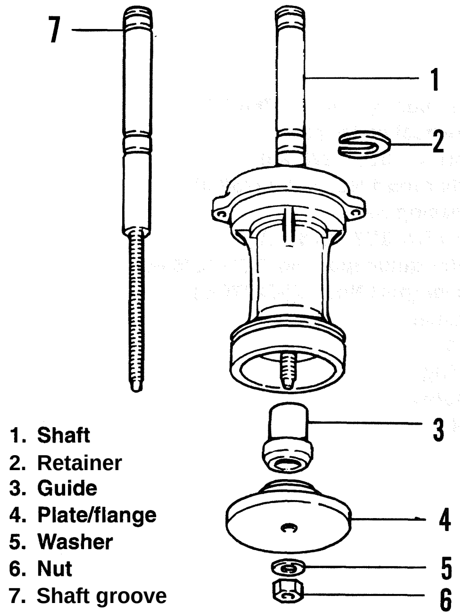
PROPELLER SHAFT NEEDLE BEARING REMOVAL (60B AND 70B MODELS)



1. Shaft
2. Retainer
3. Guide
4. Plate/flange
5. Washer
6. Nut
7. Shaft groove

62

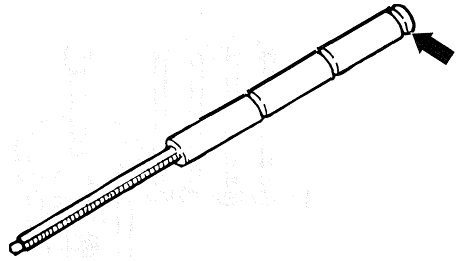
PROPELLER SHAFT NEEDLE BEARING REMOVAL (60C/70C/80-140 HP MODELS)



1. Shaft
2. Retainer
3. Guide
4. Plate/flange
5. Washer
6. Nut
7. Shaft groove

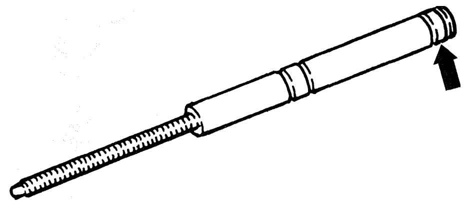
64

SHAFT (40-50 HP MODELS)



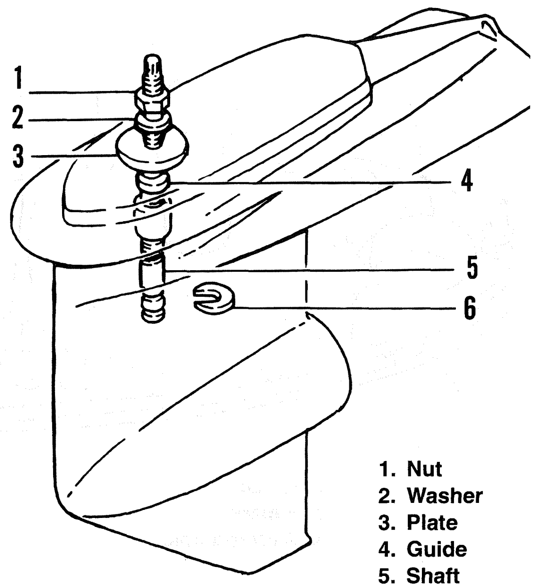
65

SHAFT (60-90 HP MODELS)



63

DRIVE SHAFT NEEDLE BEARING REMOVAL (40-90 HP MODELS)



1. Nut
2. Washer
3. Plate
4. Guide
5. Shaft
6. Retainer

19. Tighten the nut to remove the bearing.

20. Remove the drive shaft roller bearing **(Figure 54)** only if it must be replaced. Place the drive shaft in apress. Support the bearing with a suitable bearing separator and press the bearing from the shaft.

NOTE
Do not remove the drive shaft lower bearing unless replacement is required.

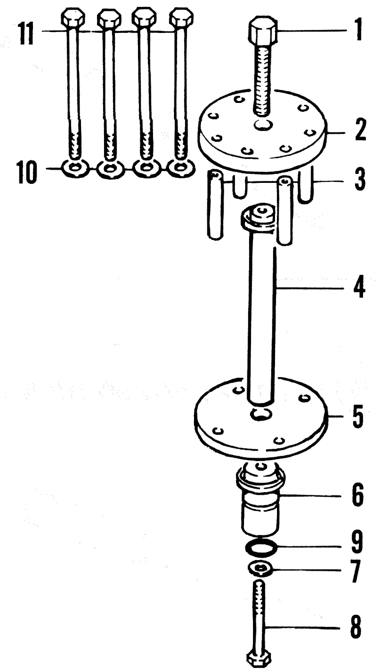
21A. *40-90* hp—Use needle bearing removal kit part No. 3C7-72700-0 to remove the bearing. See **Figure 63.**

a. Insert the shaft into the gearcase and needle bearing as shown **(Figure 63).** Insert the retainer into the lower groove **(Figure 64)** or upper groove **(Figure 65)** in the shaft.
b. Install the plate, washer and nut. Tighten the nut and pull the needle bearing from the gearcase.

21B. *115-140* hp—Use the tools specified in **Figure 66** to remove the drive shaft needle bearing.

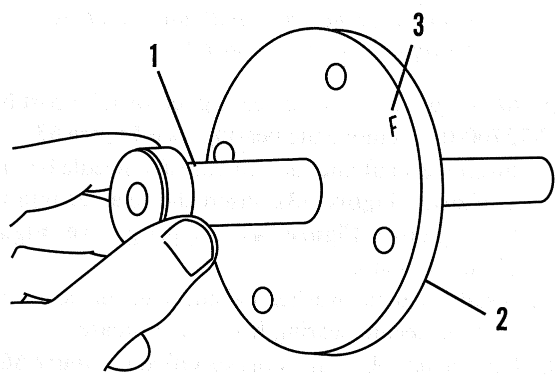
a. Insert the pressing rod through the center hole in the guide **(Figure 67).**
b. Reach into the gearcase to insert the driver (6, **Figure 66)** into the needle bearing with its shoulder side facing downward. Place the guide and press rod into the gearcase so the stamped mark **(Figure**

66 **DRIVE SHAFT NEEDLE BEARING REMOVAL (115-140 HP MODELS)**



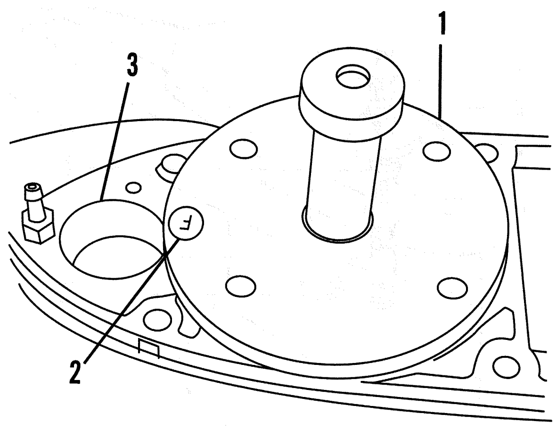
1. Bolt (part No. 3C7-72766-0)
2. Flywheel puller plate (part No. 3C7-72783-0)
3. Collar (part No. 3C7-72768-0)
4. Pressing rod (part No. 3C7-72767-0)
5. Outer guide (part No. 3C7-72765-0)
6. Driver (part No. 3C7-72770-0)
7. Washer
8. Bolt
9. O-ring
10. Washer
11. Bolt

67 **GEARCASE NEEDLE BEARING REMOVAL (115-140 HP MODELS)**



1. Pressing rod
2. Guide
3. Stamped (F) mark

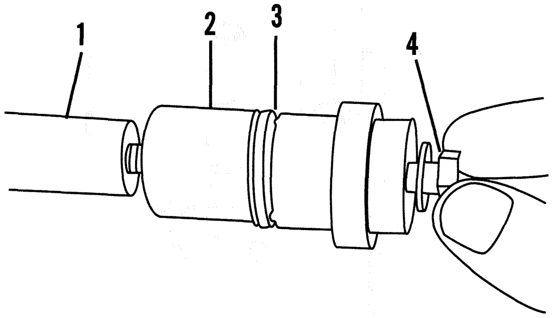
68 **GEARCASE NEEDLE BEARING REMOVAL (115-140 HP MODELS)**



1. Guide
2. F mark
3. Shift rod hole

69

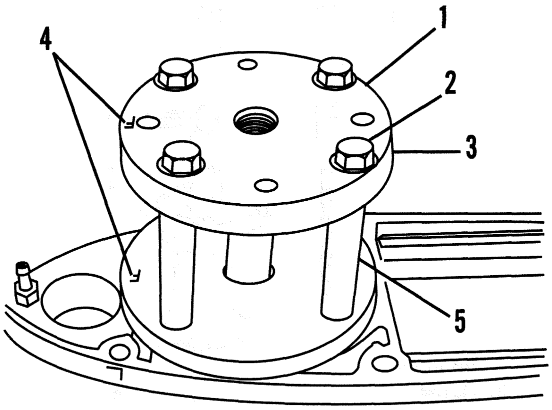
GEARCASE NEEDLE BEARING REMOVAL (115-140 HP MODELS)



1. Press rod
2. Press/driver
3. O-ring
4. Bolt

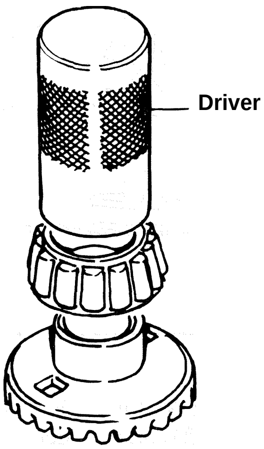
70

GEARCASE NEEDLE BEARING REMOVAL (115-140 HP MODELS)



1. Flywheel puller plate
2. Bolt
3. Washer
4. F mark
5. Collar

71



68) faces the shift rod hole. Attach the driver (2, Figure 69) to the press rod (1) using the bolt and washer (4).

c. Place the flywheel puller plate on the guide plate aligning the *F* marks. See Figure 70. Assemble the tool as shown using the collars, bolts and washers. Install the puller bolt into the puller plate. Tighten the bolt to remove the bearing.

22. Remove the forward gear bearing race using a suitable jaw-type puller and slide hammer.
23. If removal is necessary, carefully pry the forward gear bearing from the forward gear using two suitable pry tools.
24. Remove the screws and water pickup screens if necessary.
25. Inspect all components as described in this chapter.

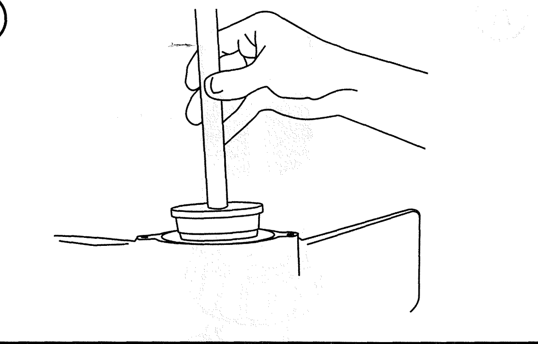
Assembly (8-140 hp Models)

Refer to Figure 41 and Figure 58 during this procedure.

CAUTION
The gearcase must be securely mounted in a suitable holding fixture during assembly.

1. Install the water pickup screens (if equipped) and install the screw(s) and nut(s) that secure the screens to the gearcase housing.
2. Lubricate the inner diameter of a new forward gear bearing with gearcase lubricant. Place the forward gear onto a wooden block with the teeth facing downward. Using a suitable driver (Figure **71**), drive the bearing onto the gear.
3. Coat the outer diameter of the forward gear bearing race with gear lubricant and place the race into the gearcase. Make sure the tapered side faces outward.

9



72

4. Drive the bearing race into the gearcase using a suitable driver **(Figure 72)** and hammer until it is fully seated.
5. Clamp the propeller shaft housing in a vise with the threaded end facing upward.
6. Install the needle bearing into the propeller shaft housing using the needle bearing tool kit part No. 3C7-72700-0.
   a. Lubricate the outer diameter of the needle bearing using gear lubricant.
   b. Install the retainer into the correct groove of the tool shaft **(Figures 73-75)** and assemble the tool onto the housing as shown. Make sure the raised surface of the retainer is facing the needle bearing and the marked side of the bearing faces the retainer.
   c. Tighten the nut (6, **Figures 73-75)** until the driver contacts the housing. Remove the tool and lubricate the bearing rollers with gear lubricant.
7. Install the drive shaft lower bearing into the gearcase using a suitable driver. Lubricate the outer diameter of the bearing using gear lubricant and position the bearing so its stamped side faces the driver during installation.
8. If removed, press new drive shaft bearing(s) onto the drive shaft **(Figure 76).**

9A. Install the drive shaft and pinion gear as follows:

For 8-40 hp models, place the forward gear into the housing. Seat the bearing against the race.
   a. Apply Loctite 242 to the threads of pinion gear nut **(Figure 77).** Slide the pinion gear onto the driveshaft **(Figure 77)** as shown from the propeller shaft side of gearcase. Hand-tighten the nut to secure the gear in place.

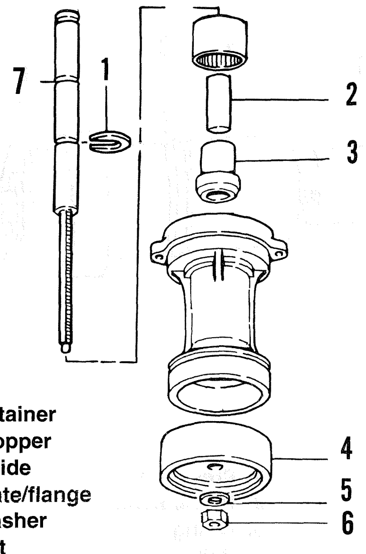
NOTE

Before applying Loctite 242, remove all grease from the pinion gear, driveshaft and threads of the driveshaft and pinion gear nut.

   b. Install a splined adapter onto the top of the driveshaft **(Figure 78)** and the special tool to the

73

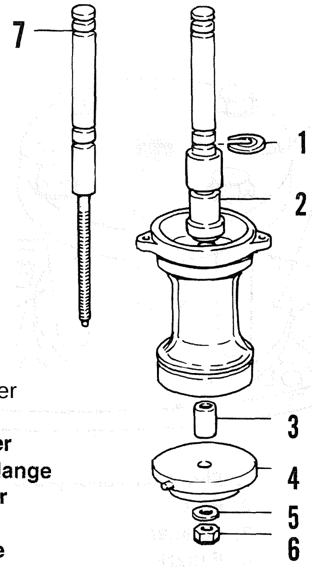
PROPELLER SHAFT HOUSING NEEDLE BEARING INSTALLATION (25-50 HP MODELS)



1. Retainer
2. Stopper
3. Guide
4. Plate/flange
5. Washer
6. Nut
7. Groove

74

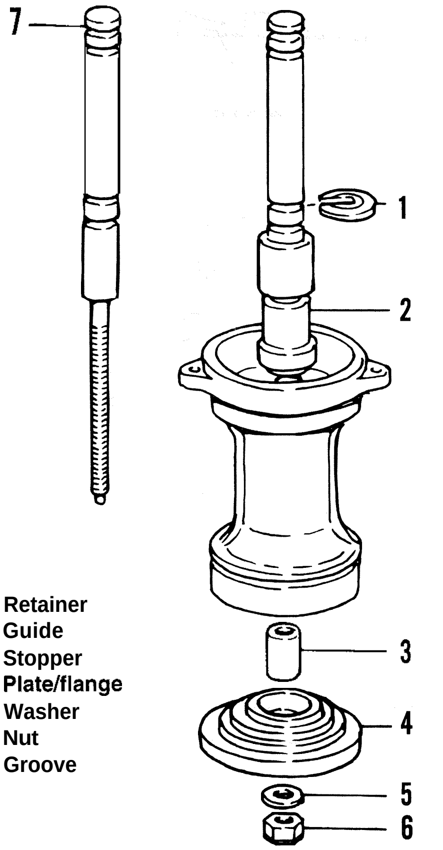
PROPELLER SHAFT HOUSING NEEDLE BEARING INSTALLATION (MODELS 60B AND 70B)



1. Retainer
2. Guide
3. Stopper
4. Plate/flange
5. Washer
6. Nut
7. Groove

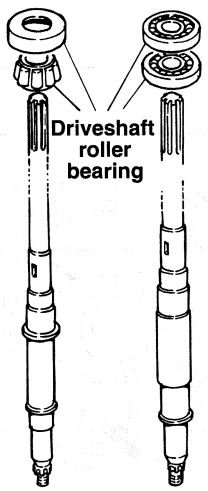
75

PROPELLER SHAFT HOUSING NEEDLE BEARING INSTALLATION (60C, 70C, AND 80-140 HP MODELS)

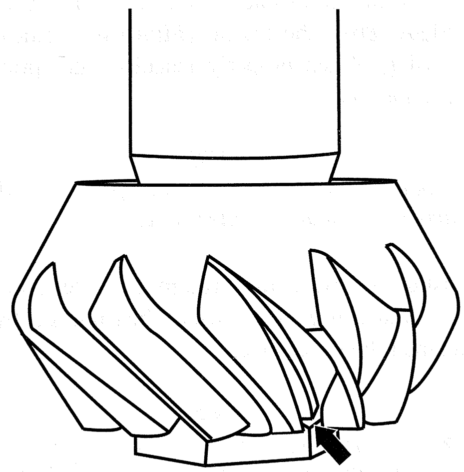


1. Retainer
2. Guide
3. Stopper
4. Plate/flange
5. Washer
6. Nut
7. Groove

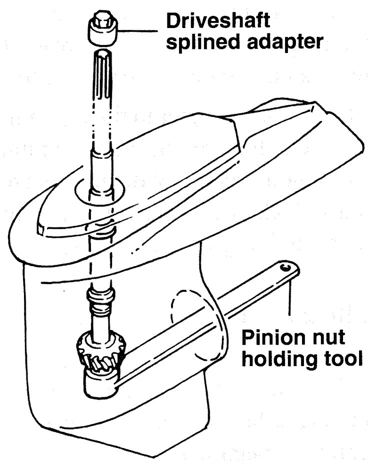
76



77



78



pinion gear nut. Hold the pinion gear nut with the wrench and turn the driveshaft clockwise to tighten the pinion gear nut to the driveshaft. Torque the pinion gear nut to the specification in **Table 1.**

9B. On 50-140 hp models, install the driveshaft spring so the flat side of spring faces the threaded end of the driveshaft. Place the spring exactly as shown so the flat side **(Figure 79)** is seated against the shoulder of the driveshaft.

CAUTION

Gearcase oil is supplied to the driveshaft tapered roller bearing by the driveshaft spring, located under the lower water pump base. If the spring is installed too high on the driveshaft, the oil supply m y be insufficient and could lead to premature driveshaft bearing failure.

a. Install the removable spring guide and seat the key (Figure 80) in the key slot (Figure 81) of the gearcase housing. When properly installed, the spring guide will not rotate.

NOTE
Models 40 and 50 hp are not equipped with driveshaft bearing outer race.

b. Install the driveshaft through the water pump housing. Make sure the driveshaft bearing is fully seated against the outer race.

NOTE
Before applying Loctite 242, remove all grease from the pinion gear, driveshaft and threads of driveshaft and pinion gear nut.

c. Apply Loctite 242 to the pinion gear nut threads. Slide the pinion gear onto the driveshaft as shown (Figure **77)** from propeller shaft side of gearcase. Hand-tighten the pinion nut to secure the gear in place.

d. Install the splined adapter to the top of the driveshaft and a wrench (Figure 78) onto the pinion gear nut. Hold the pinion gear nut with the wrench and turn the driveshaft clockwise to tighten the pinion gear nut. Torque the pinion gear nut to the specification in Table **1**.

10. On 25-140 hp models, check the pinion gear height as follows:

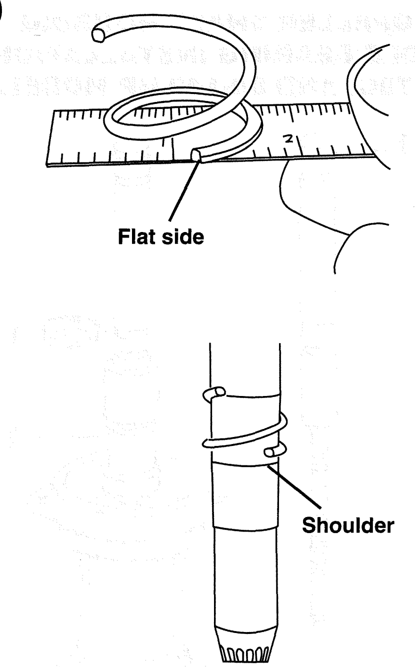
a. Install the lower water pump case (4, Figure 82) over the driveshaft (1) and seat it into position on the gearcase. Secure the lower water pump case with the four bolts.

b. Insert the shimming gauge (2, Figure 83) into the gearcase. The shimming tool must be positioned correctly in the gearcase. Make sure the tapered side (6, Figure 83) is fully seated in the forward gear bearing race with the flat side (7) and notch (4) facing upward.

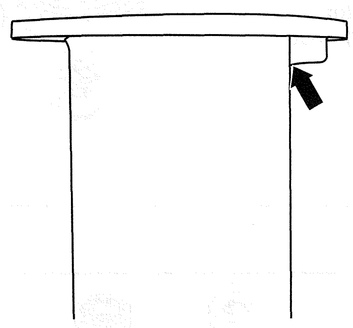
c. Eliminate all looseness between the driveshaft and gearcase by lifting up on the driveshaft and tapping down on the gearcase with a rubber mallet. With all looseness eliminated, measure the gap between the collar (5, Figure 83) and pinion gear using a feeler gauge set (3). If the gap is not within specification 0.60-0.64 mm (0.023-0.025 in.), remove the lower water pump case and install the correct size shim (Table 4) onto the roller bearing outer race.

d. Reinstall the lower water pump case before proceeding with backlash adjustment.

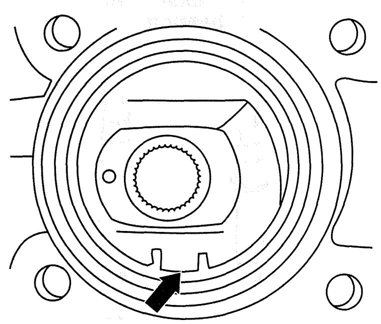
79



80

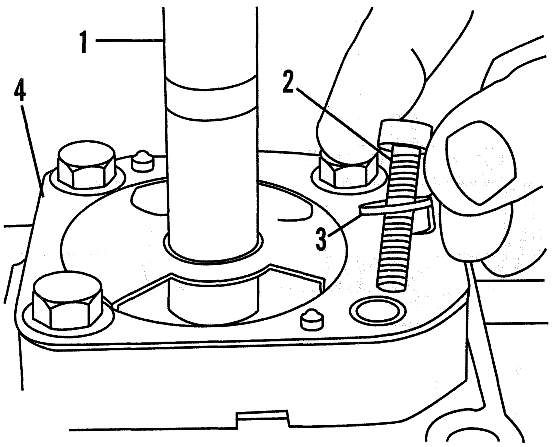


81



82

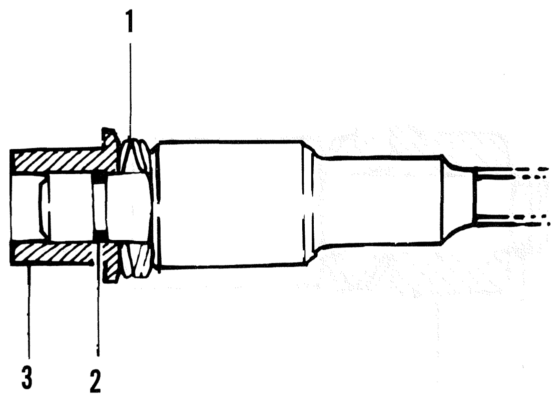
PINION GEAR HEIGHT (25-140 HP MODELS)



1. Driveshaft
2. Bolt
3. Washer
4. Lower pump case

84

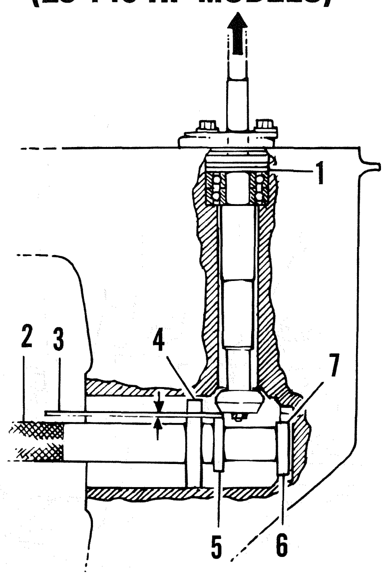
BACKLASH TOOL (25-50 HP MODELS)



1. Spring washer
2. O-ring
3. Collar

83

PINION GEAR ADJUSTMENT (25-140 HP MODELS)



1. Shims
2. Shimming tool
3. Feeler gauge
4. Notch
5. Tool collar
6. Tapered side
7. Flat side

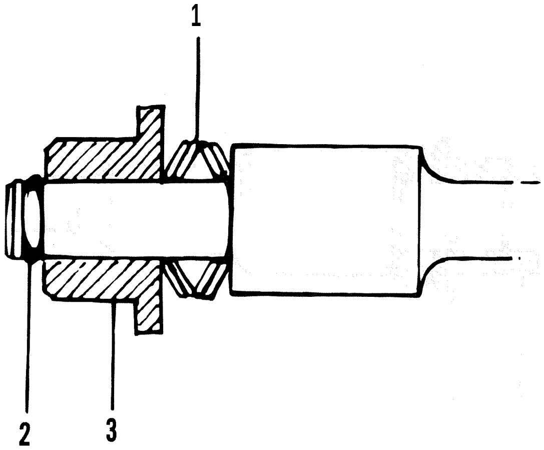
11. On 25-140 hp models, check forward gear backlash. Assemble the backlash tool in the following order using the specified number of spring washers.

NOTE
Shims are available in thicknesses of 0.05-0.60 mm in 0.05 mm increments.

a. On 25-50 hp models, install three spring washers, the O-ring and collar onto the tool shaft as shown in **Figure 84.**
b. On 60B and 70B models, install four spring washers, the set piece and O-ring onto the tool shaft as shown in **Figure 85.**
c. On 60C, 70C and 80-140 hp, install six spring washers, the set piece and O-ring onto the tool shaft as shown in **Figure 86.**
d. Install the assembled tool into the gearcase as shown in **Figure 87.** Install the plate (1, **Figure 87)** over the tool shaft and attach it to the gearcase using the correct size bolts. Tighten the shaft nuts (2, **Figure 87)** against each other so the outer nut can be used to tighten the shaft.
e. Tighten the outer nut (2, **Figure 87)** until the driveshaft begins to rotate. Then tighten the nut so the driveshaft turns an additional 112 (180°) revolution.

85

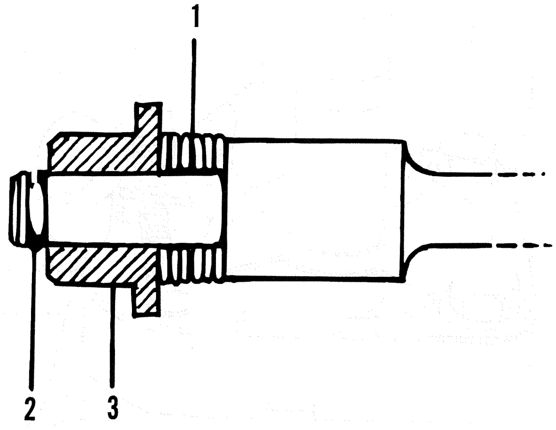
BACKLASH TOOL (60B AND 70B MODELS)



1. Conedisk spring washer
2. O-ring
3. Set piece

86

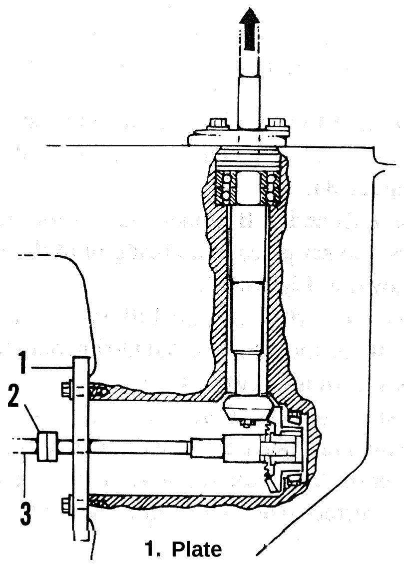
BACKLASH TOOL (60C/70C/80-140 HP MODELS)



1. Conedisk spring washer
2. O-ring
3. Set piece

87

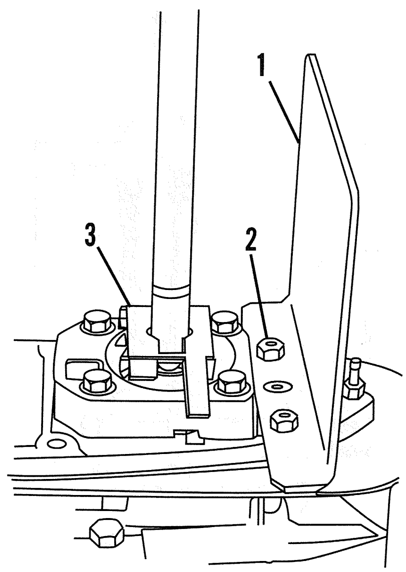
BACKLASH TOOL SET-UP (25-140 HP MODELS)



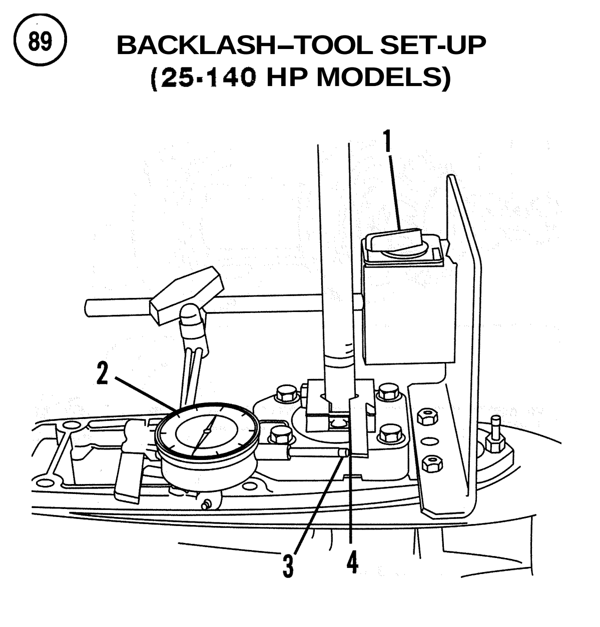
1. Plate
2. Nuts
3. Shaft

88

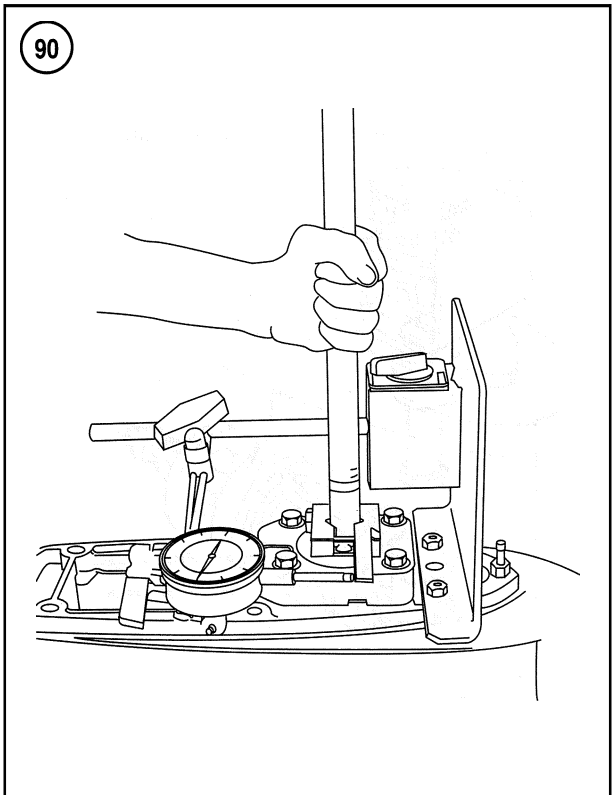
BACKLASH TOOL SET-UP (25-140 HP MODELS)

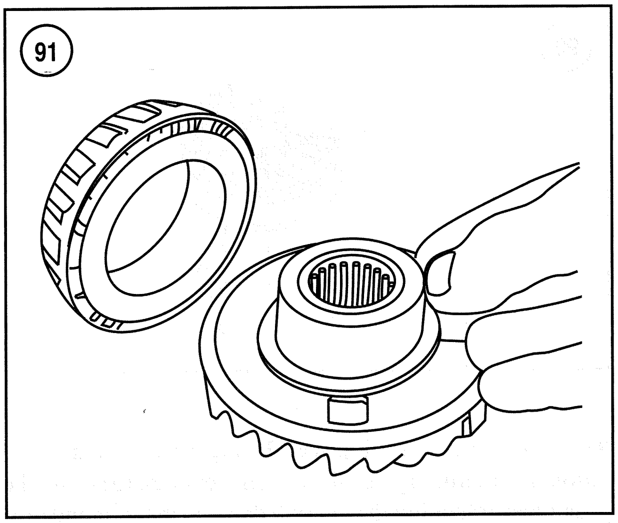


1. Dial gauge plate
2. Bolts
3. Clamp assembly



1. Magnetic base
2. Dial gauge
3. Dial gauge plunger
4. V-notch





f. Mount the clamp assembly (3, **Figure 88)** as close as possible to the lower water pump case on the driveshaft. Install a dial indicator plate (1, **Figure 88)** on the gearcase with bolts and nuts.

g. Install a magnetic base (1, **Figure 89)** and dial indicator (2) as shown. Lift up on the driveshaft and tap down on the gearcase with a rubber mallet to eliminate all looseness, then adjust the dial indicator so the plunger (3, **Figure 89)** aligns with the V-notch (4).

h. Adjust the dial indicator to zero. Lift up the driveshaft and hold it while tapping down on the gearcase with the rubber mallet to eliminate all looseness. Slightly rotate the driveshaft **(Figure 90)** in both directions and record the dial reading.

i. If the dial reading is not within the specification in **Table 3,** adjust the shim thickness between the forward gear **(Figure 91)** and the tapered roller bearing.

12. Check and correct the reverse gear backlash on 40-140 hp models:

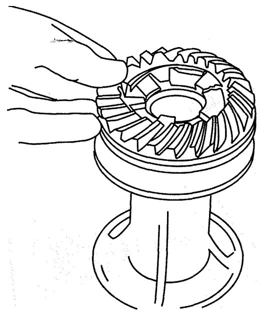
NOTE
Reverse gear backlash is not adjustable on 2.5-25 hp models.

13. Remove the forward gear from the gearcase.
14. Install the reverse gear into the propeller shaft housing **(Figure 92).**

NOTE
To accurately check reverse gear backlash, the reverse gear must be fixed in position to prevent it from turning.

15. Using a threaded rod of the correct length and washers and nuts, lightly secure the reverse gear to the propeller shaft housing to prevent it from turning. See **Figure**

92



93. Tighten the nut (1, **Figure 93)** finger-tight, then an additional 1/4 turn. Tighten the nut only enough to secure the gear. Overtightening the nut will damage the gear and propeller shaft housing.

16. Insert the propeller shaft housing and reverse gear into the gearcase while turning the drive shaft to correctly mesh the gears. See **Figure 94.**

17. Lift the drive shaft upward and tap the gearcase downward to remove all slack in the drive shaft. Attach a dial indicator to the gearcase as shown in **Figure 89.**

18. Adjust the dial indicator to zero. Lift up the driveshaft and hold it while tapping down on the gearcase with a rubber mallet to eliminate all looseness. Slightly rotate the driveshaft **(Figure 90)** in both directions and record the dial reading.

19. If the dial reading is not within the specification in **Table 3,** adjust the shim thickness between the reverse gear **(Figure 95)** and propeller shaft housing.

20. Install the forward gear so the forward gear roller bearing is filly seated into the outer race. Make sure the teeth of forward gear mesh with pinion gear teeth.

21. Replace the internal O-rings **(Figure 96)** and external O-ring on the shift shaft bushing. Coat the bushing and O-rings with gear oil. Assemble the shift rod components.

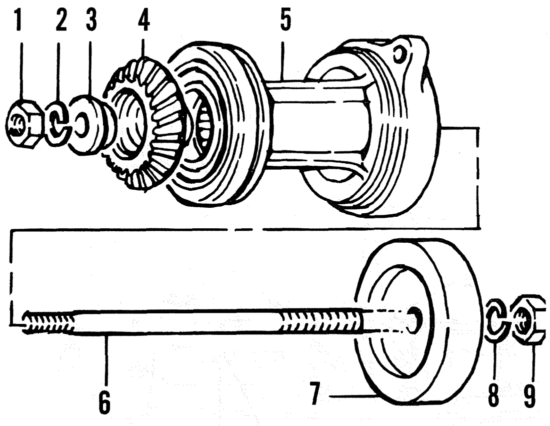
22. Apply marine grease to the exterior of the O-ring and shift rod bushing **(Figure 97).**

23. Insert the shift rod into the gearcase, and seat the bushing. Lubricate the threads of the stopper bolt **(Figure 98)** with genuine grease and install the stopper.

CAUTION
The clutch is not symmetrical. If the clutch is installed backward, the gears and clutch will be damaged.

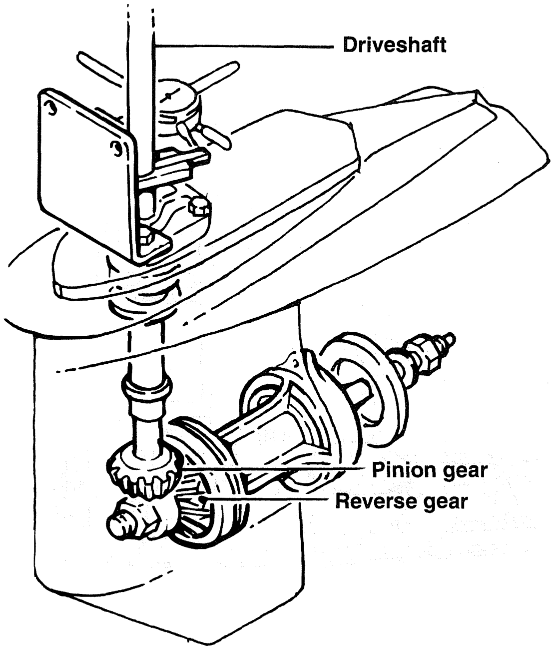
24. Align the slot in the propeller shaft with the hole in the clutch. Slide the clutch onto the propeller shaft so the wide dogs **(Figure 99)** face the propeller end of the shaft.

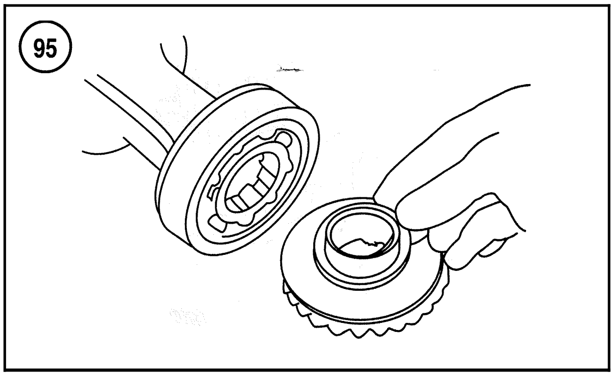
93 **REVERSEGEARBACKLASH**

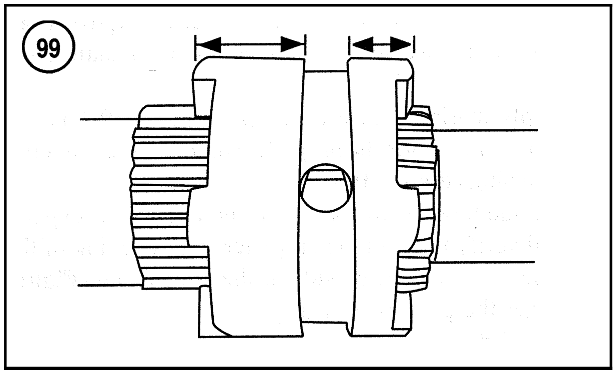


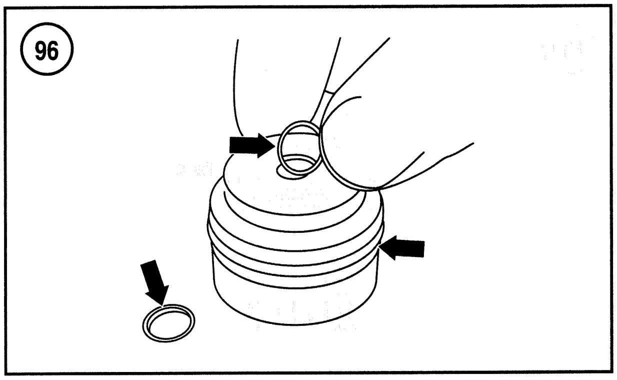
1. Nut
2. Washer
3. Collar
4. Reverse gear
5. Propeller shaft housing
6. Shaft
7. Plate
8. Washer
9. Nut

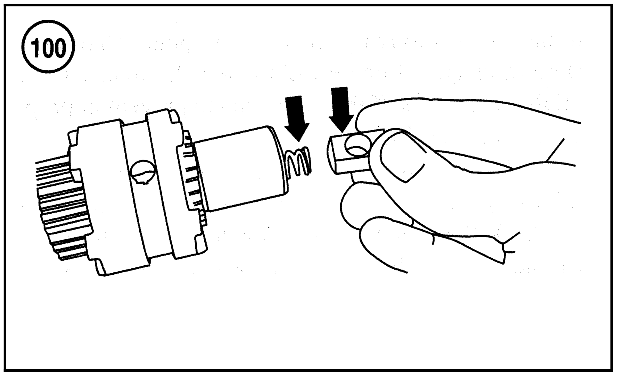
94

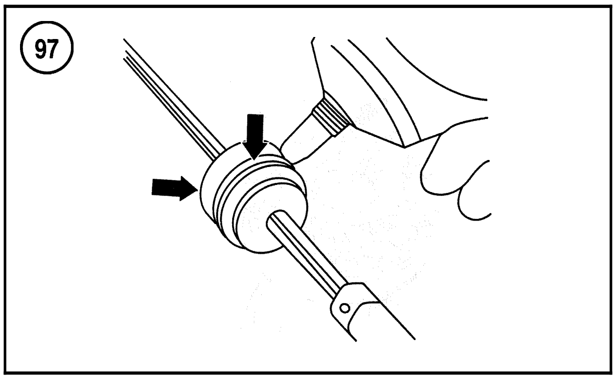


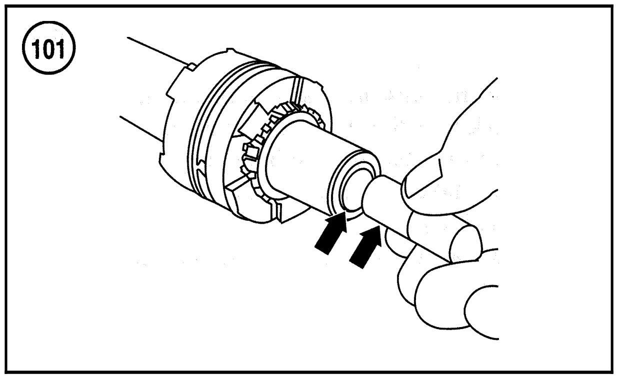


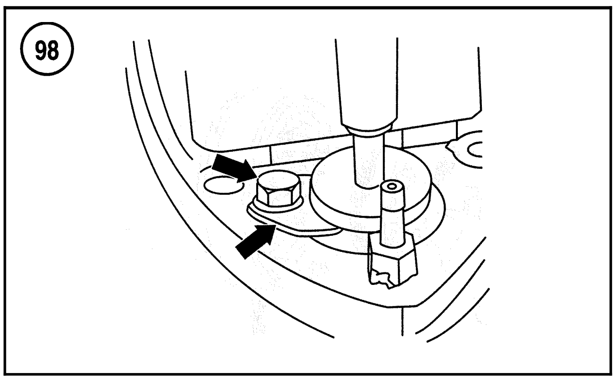












25. Insert the clutch spring **(Figure 100)** and spring holder so the hole in the spring holder aligns with the clutch hole.

26. Insert the detent ball (**Figure 101**), if equipped. Install the clutch push rod **(Figure 101)** with the tapered end toward the forward gear.

27. Compress the clutch spring by pushing in on the push rod **(Figure 102).** Apply pressure to the push rod as you align the clutch and spring holder holes and insert the clutch pin.

28. Install a new retainer spring **(Figure 103)** around the clutch pin area. Do not reuse the old retainer spring.

29. Install all shims onto the reverse gear (Figure **104**), then install the reverse gear into the propeller shaft housing.

30. Apply marine grease to the propeller shaft housing seal and O-ring. Slide the propeller shaft into the propeller shaft housing (Figure **105).**

31. Lift the lower shift shaft/shift rod to the full-up position and verify through the propeller shaft opening of the gearcase that the beveled side of the clutch cam (Figure **106)** faces the gearcase opening.

32. Install the propeller shaft housing assembly, making sure the clutch push rod aligns with the beveled side of the clutch cam. Push forward and rotate the propeller shaft (Figure **107)** as needed until the pinion gear and reverse gear engage. Thoroughly clean the propeller shaft housing bolts and apply Loctite 242 to the bolt threads. Install and tighten the bolts (Table **2)** evenly to prevent improper seating of the housing.

33. Check the shift rod in forward, neutral and reverse positions by rotating the driveshaft to test each gear function. Check the propeller shaft for looseness in the forward and reverse directions. If looseness exceeds 0.40 mm (0.016 in.), replace the reverse gear washer (Figure **108)** with one of correct thickness.

34. Install the water pump as described in this chapter.

35. Before adding gear oil, pressure test the gearcase as follows:

   a. Remove the oil level plug and install the gearcase pressure tester.
   b. Pump the pressure tester until the gauge reaches 20-39 kPa (3-6 psi). Ifpressure drops, determine the source of leakage by submerging the gearcase in water. Make necessary repairs to correct the problem and retest.

36. Fill the gearcase with the specified gear lubricant. See Chapter Four.

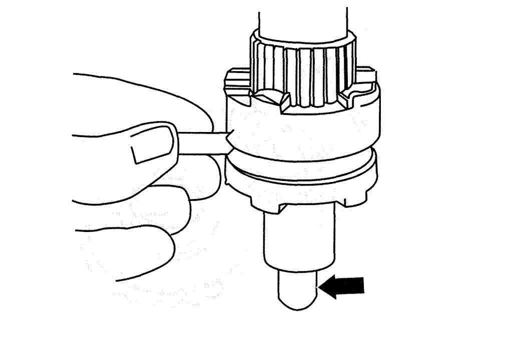
INSPECTION

Prior to inspection, thoroughly clean all components using solvent. Using compressed air, dry all components and arrange them in an orderly fashion on a clean work surface.

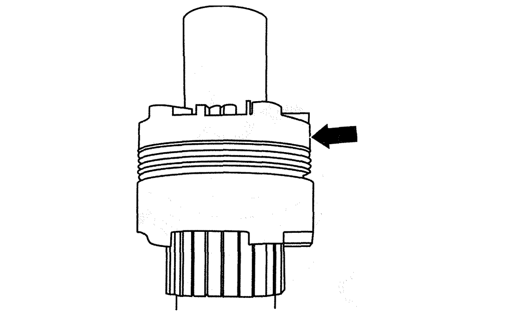
Use pressurized water to clean the gearcase. Inspect all passages and crevices for debris or contaminants. Use compressed air to thoroughly dry the gearcase.

WARNING
Never allow bearings to spin when using compressed air to dry them. The bearing may spin at high speed and fly apart, resulting in serious injury.

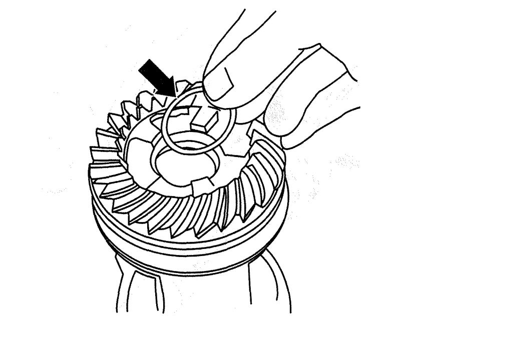
102



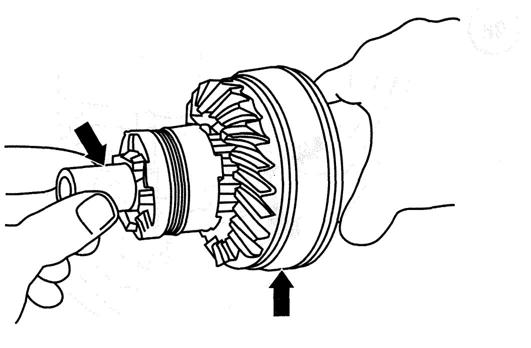
103



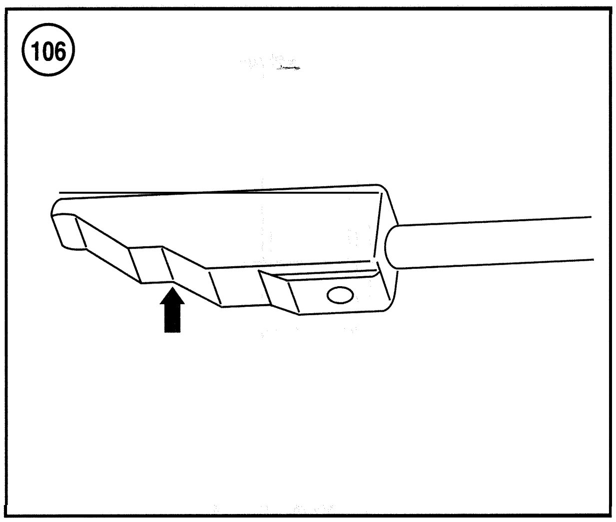
104



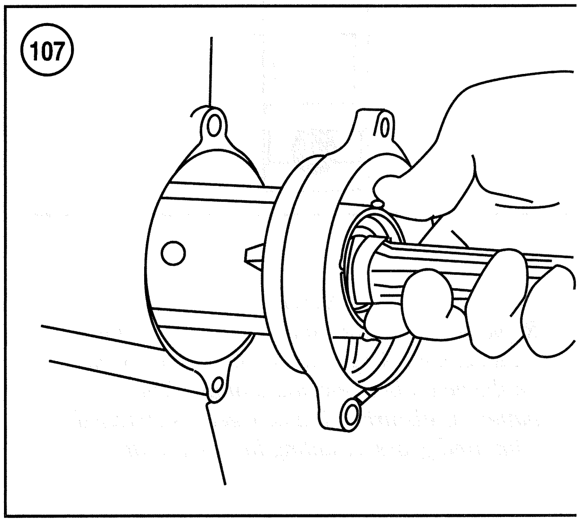
105



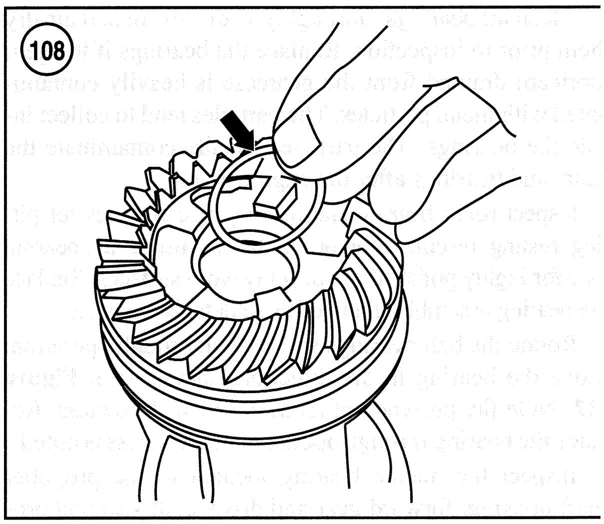
106



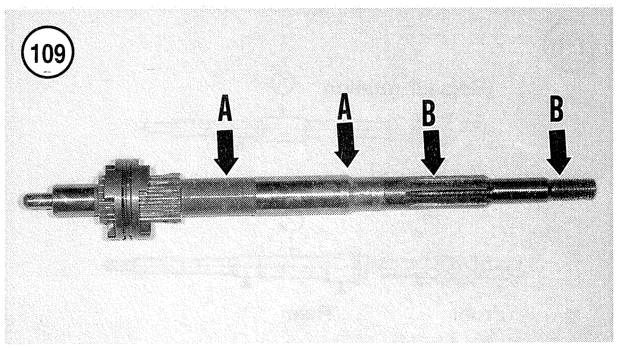
107



108



109

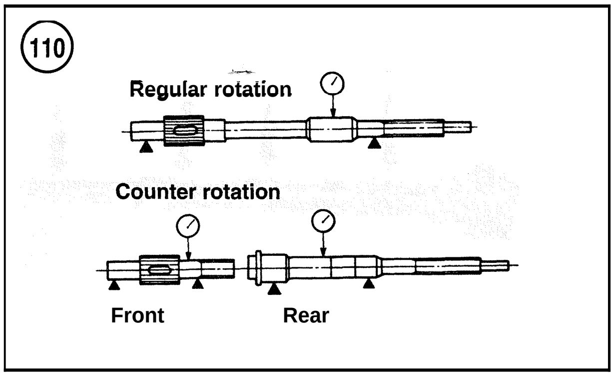


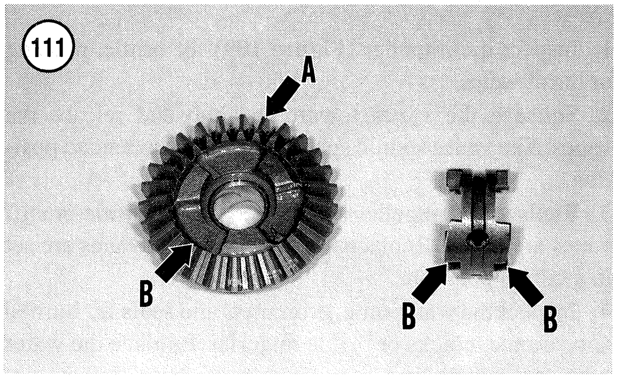
Water Pump Inspection

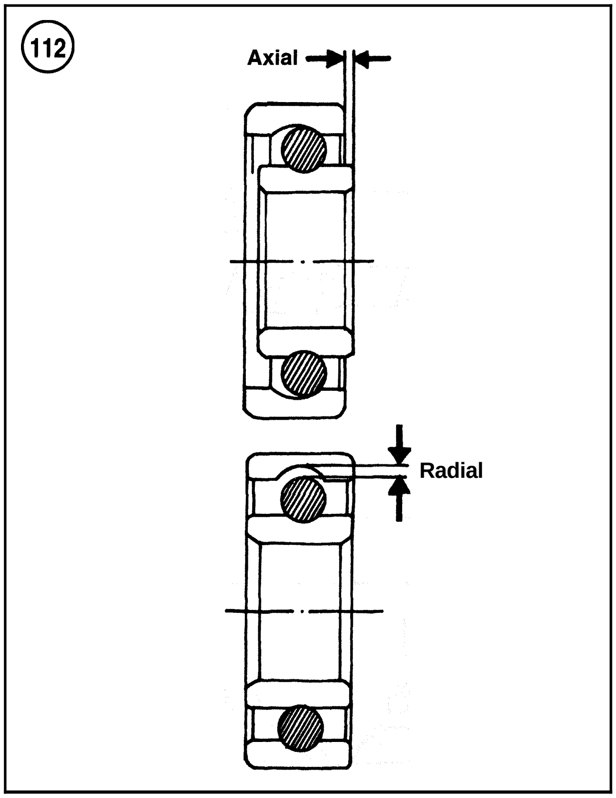
1. Inspect the impeller (**Figure 109**) for brittle, missing or burnt vanes.
2. Squeeze the vanes toward the hub and release the vanes. The vanes should spring back to the extended position.
3. Replace the impeller if damaged, burnt, brittle or stiff vanes are noted. Replace the impeller if the vanes are set in a curled position.
4. Inspect the water tube, grommets and seals for burned appearance, cracks or brittle material. Replace the water tube, grommets and seals if any of these defects are noted.
5. Inspect the cartridge plate for warpage, wear grooves, melted plastic or other damaged areas. Replace the cartridge plate if a groove is worn in the plate or any other defects are noted.
6. Inspect the water pump insert cartridge for burns, wear or damage. Replace the water pump housing if any defects are noted.
7. Inspect the water pump housing for melted plastic or other indications of overheating. Replace the cover and the seal housing if any defects are noted. Refer to *Water Pump* in this chapter for oil seal housing replacement instructions.

Propeller Shaft Inspection

1. Inspect the propeller shaft for bent, damaged, or worn areas. Replace the propeller shaft if defects are noted, as repair or straightening is not recommended.
2. Position the propeller shaft on V-blocks. Rotate the shaft and note if any deflection is present. Replace the propeller shaft if visible deflection is noted.
3. Inspect the propeller shaft (A, **Figure 110)** for corrosion, damage or excessive wear. Inspect the propeller shaft splines and threads (B, **Figure 110)** for twisted splines or damaged threads. Inspect the bearing contact







areas at the front and midpoint of the propeller shaft. Replace the propeller shaft if discolored areas, roughness, transferred bearing material or other defects are noted.

4. Inspect the propeller shaft at the seal contact areas. Replace the propeller shaft if deep grooves are worn in the surface.

5. Place V blocks at the points indicated in **Figure** 110. Use a dial indicator to measure the shaft deflection at the rear bearing support area. Securely mount the dial indicator. Observe the dial indicator movement and slowly rotate the propeller shaft. Replace the propeller shaft if the needle movement exceeds 0.15 mm (0.006 in.).

Gear and Clutch Inspection

1. Inspect the clutch and gear surfaces (B, **Figure** 111) for chips, damage, or excessive wear. Replace the clutch and gears if any of these conditions is found on either component.

2. Inspect the gear for worn, broken, or damaged teeth (A, **Figure** 111). Note the presence of pitted, rough or excessively worn (highly polished) surfaces. Replace all of the gears if any of these conditions is found.

NOTE
Replace ALL gears if any of the gears require replacement. A specific wear pattern forms on the gears in a few hours of use. The wear pattern is disturbed if a new gear is installed with used gears, resulting in rapid wear:

Bearing Inspection

1. Clean all bearings thoroughly with solvent and air-dry them prior to inspection. Replace the bearings if the gear lubricant drained from the gearcase is heavily contaminated with metal particles. The particles tend to collect inside the bearings. The particles usually contaminate the gears and bearings after the engine is run.
2. Inspect roller bearing and bearing race surfaces for pitting, rusting, discoloration or roughness. Inspect the bearing race for highly polished or unevenly worn surfaces. Replace the bearing assembly if any of these defects are noted.
3. Rotate the ball bearings and note any rough operation. Move the bearing in the directions indicated in **Figure** 112. Note the presence of *axial* or *radial* looseness. Replace the bearing if rough operation or looseness is noted.
4. Inspect the needle bearing located in the propeller shaft housing, forward gear and drive shaft seal and pro-

peller shaft housing. Replace the bearing if flattened rollers, discoloration, rusting, roughness or pitting are noted.
5. Inspect the propeller shaft and drive shaft at the bearing contact areas. Replace the drive shaft and/or propeller shaft along with the needle bearing if discoloration, pitting, transferred bearing material or roughness are noted.

Shift Rod and Cam Inspection

1. Inspect the bore in the propeller shaft for debris, damage or wear. Clean all debris from the propeller shaft bore.
2. Inspect the clutch spring for damage, corrosion or weak spring tension and replace if defects are noted.

3. Inspect the cross pin for damage, roughness or wear. Replace as required. Inspect the shift plunger and spring for damage or corrosion and replace as required.

4. Inspect the shift plunger for cracks or wear. Replace any worn or defective components.

5. Inspect the clutch shift/slider, located at the lower end of the shift shaft, for wear, chips, cracks or corrosion. Replace the clutch shift slider and push rod if the surfaces are worn or defective.

6. Inspect the shift shaft for wear, bending, or twisting. Inspect the shift bushing for cracks or wear. Replace the bushing and shift shaft if defects are noted.

Table 1 GEARCASE SPECIAL TORQUE SPECIFICATIONS

	N•m	in.-lb.	ft.-lb.
Propeller nut			
2.5-140 hp	29-39	–	22-29 ft.-lb.
Water pump base bolts			
2.5-40 hp	4.6-6.2	41-55 in.-lb.	–
Gearcase mounting bolts			
40-50 hp	19-21	–	14-16 ft.-lb.
60-140 hp M8 bolt	24-26	–	17-19 ft.-lb.
60-140 hp M10 bolt	37-41	–	27-30 ft.-lb.
Pinion gear B nut/bolt			
8-30 hp	29-34	–	22-25 ft.-lb.
40 hp	23-25	–	16-18 ft.-lb.

Table 2 GENERAL TORQUE SPECIFICATIONS*

Thread diameter	N.m	in.-lb.	ft.-lb.
5 mm bolt and nut	5	44	–
6 mm bolt and nut	10	88	–
8 mm bolt and nut	22	–	16
10 mm bolt and nut	34	–	25
12 mm bolt and nut	54	–	40
5 mm screw	4	35	–
6 mm screw	9	80	–
6 mm flange bolt with 8 mm head (small flange surface)	9	80	–
6 mm flange bolt with 8 mm head (large flange surface)	12	106	–
6 mm flange bolt with 10 mm head and nut	12	106	–
8 mm flange bolt and nut	26	–	20
10 mm flange bolt and nut	39	–	29

*This table lists general torque specifications for metric fasteners. Use this table when a specific torque specification is **not** listed for a fastener at the end of the appropriate chapter. The torque specifications listed in this table are for threads that are clean and dry.

Table 3 AVAILABLE SHIM THICKNESS

Model	Shim thickness
3.5-140 hp	0.05 mm (0.002 in.) 0.10 mm (0.004 in.) 0.15 mm (0.006 in.) 0.20 mm (0.008 in.) 0.25 mm (0.010 in.) 0.30 mm (0.012 in.) 0.35 mm (0.014 in.) 0.40 mm (0.016 in.) 0.45 mm (0.018 in.) 0.50 mm (0.020 in.) 0.55 mm (0.022 in.) 0.60 mm (0.024 in.)

Table 4 MIDSECTION TORQUE SPECIFICATIONS

Engine mounting bolt	
40-70 hp	19-21 N•m (14-15 ft.-lb.)
80-90 hp	24-26 N•m (17-19 ft.-lb.)
115-140 hp	34-41 N•m (25-30 ft.-lb.)
Bracket nut (tilt tube nut)	
5 hp	11.l-15.1 N•m (99-133 in.-lb.)
8-9.8 hp	11.7-14.7 N•m (8-11 ft.-lb.)
9.9-18 hp (Type 1)	14.7-19.6 N•m (11-14 ft.-lb.)
9.9-18 hp (Type 2)	23.5-25.5 N•m (17-19 ft.-lb.)
25-140 hp	24-26 N•m (18-19-ft.-lb.)
Upper rubber mount bolt	
9.9-18 hp	22.5-31.5 N•m (17-23 ft.-lb.)
40-50 hp	25-34 N•m (18-25 ft.-lb.)
60-90 hp	39-59 N•m (29-43 ft.-lb.)
115-140 hp	37-41 N•m (27-30 ft.-lb.)
Lower rubber mount bolt	
40-70 hp	34-44 N•m (25-33 ft.-lb.)
80-140 hp	29-34 N•m (22-25 ft.-lb.)
Gearcase mounting bolt	
25-30 hp	24-25 N•m (17-19 ft.-lb.)
40-50 hp	19-21 N•m (14-15 ft.-lb.)
60-140 hp M8	24-26 N•m (17-19 ft.-lb.)
60-140 hp M10	37-41 N•m (27-30 ft.-lb.)
Shift lever shaft bolt	
25-40 hp	4.6-6.3 N•m (41-55 in.-lb.)
60-140 hp	6-8 N•m (52-69 in.-lb.)
Handle (to steering shaft) bolt	
60-90 hp	24-26 N•m (17-19 ft.-lb.)
Exhaust pipe bolts	
8-18 hp	6.8-8.8 N•m (61-78 in.-lb.)

Chapter Ten

Manual Rewind Starter

10

REMOVAL, REPAIR AND INSTALLATION

Cleaning, inspection and lubrication of the internal components (Figure **1)** is necessary if the manual starter is not engaging properly or the starter is binding. In instances where complete repair is not required, perform the steps necessary to access the suspect component(s). Reverse the steps to assemble and install the starter.

Use only the starter rope specified for the outboard. Other types of rope will not withstand the rigorous use and will fail in a short amount of time, potentially damaging other components. Contact a marine dealership to purchase the specified starter rope.

Clean all components (except the rope) with solvent suitable for composite or plastic components. Use hot soapy water if a suitable solvent is not available. Dry all components with compressed air immediately after cleaning.

Inspect all components for wear or damage and replace them if any defects are noted. Pay particular attention to the rewind spring. Inspect the entire length of the spring for cracks or other defects. Always replace the spring if defects are noted.

Apply good quality water-resistant grease to all bushings, drive pawls, springs and pivot surfaces when installing these components. To help ensure smooth operation and prevent corrosion, apply water-resistant grease to the starter spring contact surfaces.

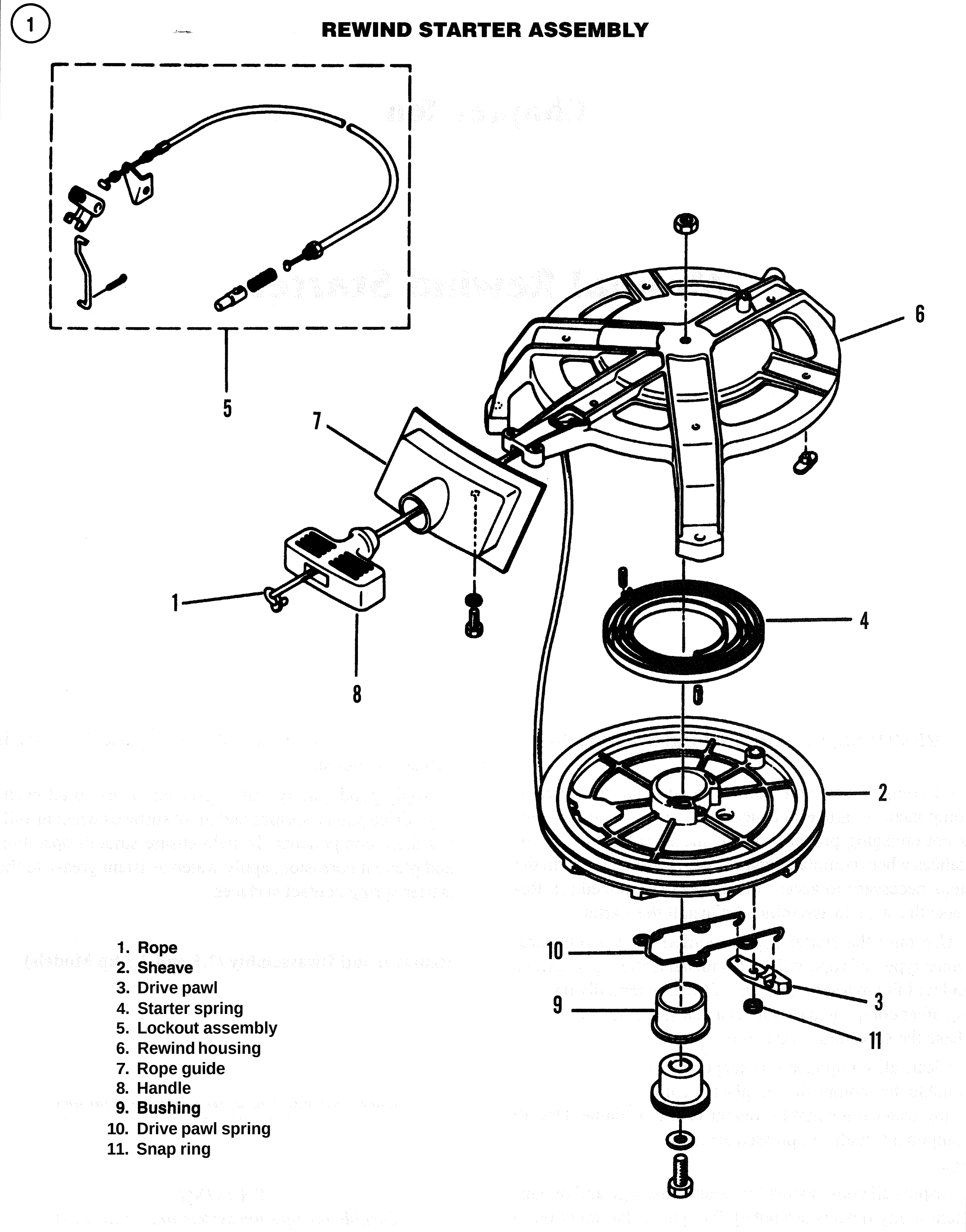
Removal and Disassembly (2.5 and 3.5 hp Models)

WARNING

A neutral start lockout device is not used. The 2.5 and 3.5A model operates in forward gear only. The propeller shaft will turn, when started. The 3.5B model is equipped with a gear shift, allowing the engine to be shifted in forward or neutral only.

WARNING

Disable the ignition system toprevent starting.



1. Rope
2. Sheave
3. Drive pawl
4. Starter spring
5. Lockout assembly
6. Rewind housing
7. Rope guide
8. Handle
9. Bushing
10. Drive pawl spring
11. Snap ring

1. Pull the starter rope out approximately 12 in. (30.5 cm). Tie a knot in the rope at the point where it exits the manual starter. The knot must be large enough to prevent the rope from pulling back into the starter.
2. Turn the reel (5, **Figure** 2) while holding the starter case (2) to release the starter spring (4).
3. Detach the E-ring (12, **Figure** 2).
4. Remove the friction plate (11, **Figure** 2), friction spring (8), ratchet (7) and ratchet return spring (10).
5. While turning the reel (5, **Figure** 2) in the rope-winding direction, slowly remove the reel.
6. Clean all components, except the rope, with a suitable solvent. Inspect all components for wear or damage. Inspect the rope for fraying or other damage. Replace any component that is in questionable condition.

Assembly and Installation (2.5 **and** 3.5 **hp Models)**

1. Wipe a light coat of water-resistant grease on the spring contact surfaces in the starter housing.
2. After attaching the outer end of the starter spring (4, **Figure** 2) to the recessed portion of the reel (5), wind it counterclockwise to set.
3. Install the reel (5, **Figure** 2) and attach the return spring (10).
4. Install the ratchet (7, **Figure** 2), friction plate (11), and E-ring (12).

CAUTION
Apply low-temperature grease to the starter guides, starter shaft, ratchet and ratchet bushing (where used) prior to installation. Do not use force when installing the ratchet E-ring.

Removal and Disassembly (5-50 **hp Models)**

1. Remove the starter locking camshaft and starter locking rod.
2. Remove the starter handle cover plate (1, **Figure** 3), cover (2), and retainer (4). Rotate the reel counterclockwise just enough to grasp a loop of the starter rope. Hold the reel securely to prevent rotation. Tie a knot in the starter rope so that the rope does not get tangled. Continue until all spring tension is relieved.
3. Remove the ratchet E-ring (22, **Figure** 3), ratchet (20), ratchet guides (18 and 27), starter shaft bolt (23), starter shaft (26) and the reel (17).

NOTE
*Note the direction in which the ratchet guides (18 and 27, **Figure 3)** are mounted. It is essential that they be installed in the same orientation during assembly.*

NOTE
After loosening the nut at the center of the starter shaft, remove the starter shaft bolt. Remove the reel with the starter rope wound on it so the internal starter spring is not displaced.

4. Clean all components (except the rope) in a suitable solvent. Inspect all components for wear or damage. Inspect the rope for fraying or damage. Replace any components that are in questionable condition.

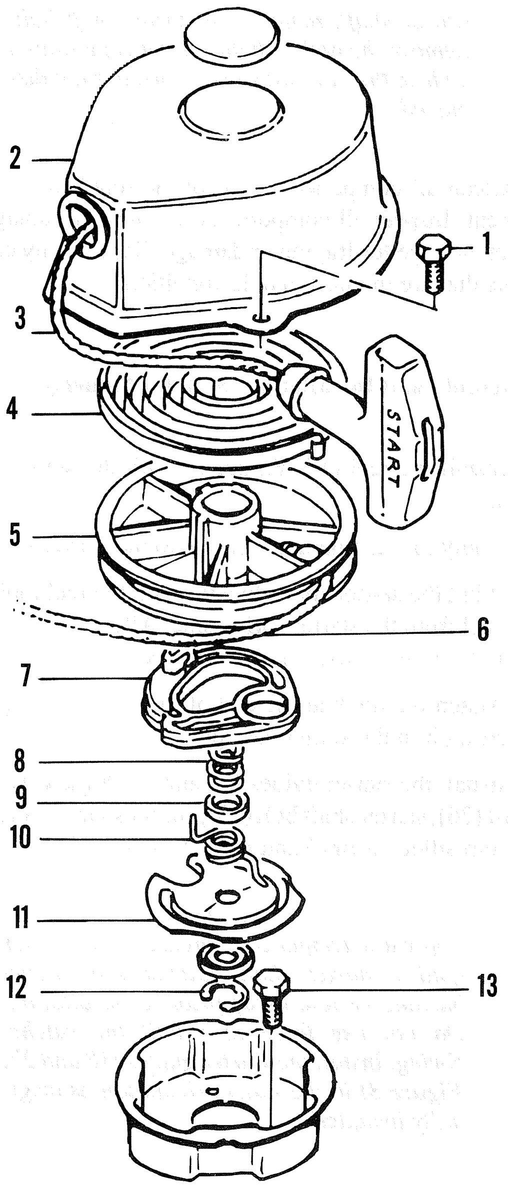
Assembly and Installation (5-50 **hp Models)**

1. Install the reel (17, **Figure** 3) with the starter spring (16).
2. Apply low-temperature grease to the starter spring.
3. Wind the starter rope clockwise on the reel looking at the reel from the starter spring side. Allow the end to protrude from the notched part of the reel.
4. Attach the hook at the end of the starter spring while inserting it in the starter case pin.
5. Install the starter guides (18 and 27, **Figure 3),** starter shaft (26), starter shaft bolt (23), starter shaft nut (12), (apply threadlocker first) and ratchet E-ring (22).

NOTE
*Apply low-temperature grease to the starter guides, starter shaft, ratchet and ratchet bushing (where used) prior to installation. Do not use force to install the ratchet E-ring. Install the starter guides (18 and 27, **Figure 3)** in the exact orientation as originally installed.*

6. Install the starter locking rod, starter locking cam shaft and starter handle.
7. With no load on the starter spring, hold the end of the rope and rotate the reel three times counterclockwise. Attach the rope to the starter handle.
8. Tie a knot in the starter rope so that the pawl of the starter lock rests in the concave part of the reel.
9. Verify that the ratchet operates when the proper load **(Table** 2) is applied to the ratchet.

2 RECOIL STARTER (2.5 AND 3.5 HP MODELS)



1. Bolt
2. Cover
3. Rope
4. Starter spring
5. Reel
6. Rope
7. Ratchet
8. Spring
9. Washer
10. Return spring
11. Friction plate
12. E-ring
13. Bolt

3 RECOIL STARTER (5-50 HP MODELS)

1. Cover plate
2. Grip cover
3. Rope
4. Bushing
5. Grip
6. Cover
7. Bolt
8. Washer
9. Bracket
10. Bushing
11. Washer
12. Nut
13. Washer
14. Roll pin
15. Flywheel cover
16. Starter spring
17. Reel
18. Ratchet guide
19. Bushing
20. Ratchet
21. Washer
22. E-ring
23. Bolt
24. Wave washer
25. Washer
26. Starter shaft
27. Ratchet guide

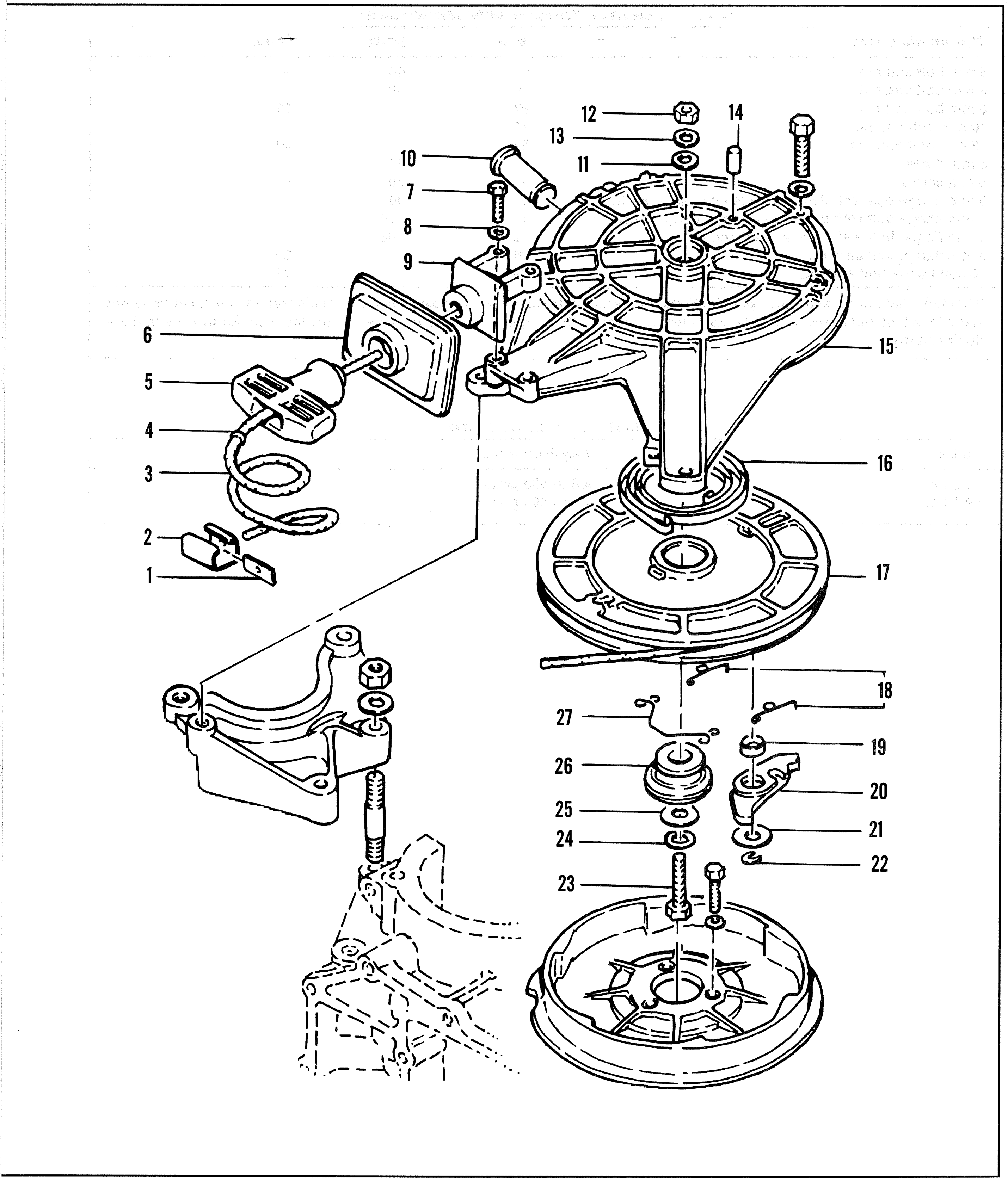

12
14
13
10
11
7
8
9
6
15
5
4
16
3
2
17
1
18
27
19
26
20
25
21
24
22
23

Table 1 GENERAL TORQUE SPECIFICATIONS*

Thread diameter	N.m	in.-lb.	ft.-lb.
5 mm bolt and nut	5	44	–
6 mm bolt and nut	10	88	–
8 mm bolt and nut	22	–	16
10 mm bolt and nut	34	–	25
12 mm bolt and nut	54	–	40
5 mm screw	4	35	–
6 mm screw	9	80	–
6 mm flange bolt with 8 mm head (small flange surface)	9	80	–
6 mm flange bolt with 8 mm head (large flange surface)	12	106	–
6 mm flange bolt with 10 mm head and nut	12	106	–
8 mm flange bolt and nut	26	–	20
10 mm flange bolt and nut	39	–	29

*This table lists general torque specifications for metric fasteners. Use this table when a specific torque specification is not listed for a fastener at the end of the appropriate chapter. The torque specifications listed in this table are for threads that are clean and dry.

Table 2 RATCHET LOAD

Model	Requirements
5-9.8 hp	600 to 800 grams
9.9-40 hp	300 to 500 grams

Chapter Eleven

Power Trim and Tilt Repair

Power trim and tilt is a factory-installed option on all electric start 40 and 50 hp models and is standard on all 60-140 hp models.

Disassembling and reassembling the hydraulic system requires special tools and a fair amount of practical experience in hydraulic system repair. Have the hydraulic system repaired at a marine repair facility if you do not have access to the required tools or are unfamiliar with the repair operations.

Power Trim and Tilt System Removal and Installation

There are three different styles of power trim/tilt systems used. One style is used on 40 and 50 hp models only (Figure 1). Two styles are used on 60-140 hp models. The old style (Figure 2) and new style (Figure 3) are used on 60-140 hp models. Refer to these figures for identification and orientation of parts.

WARNING
Always wear skin and eye protection when servicing the power trim and tilt unit.

WARNING
Never open the manual relief valve fully when the engine is in the fully up position. The oil pressure in the system is at its highest in this position.

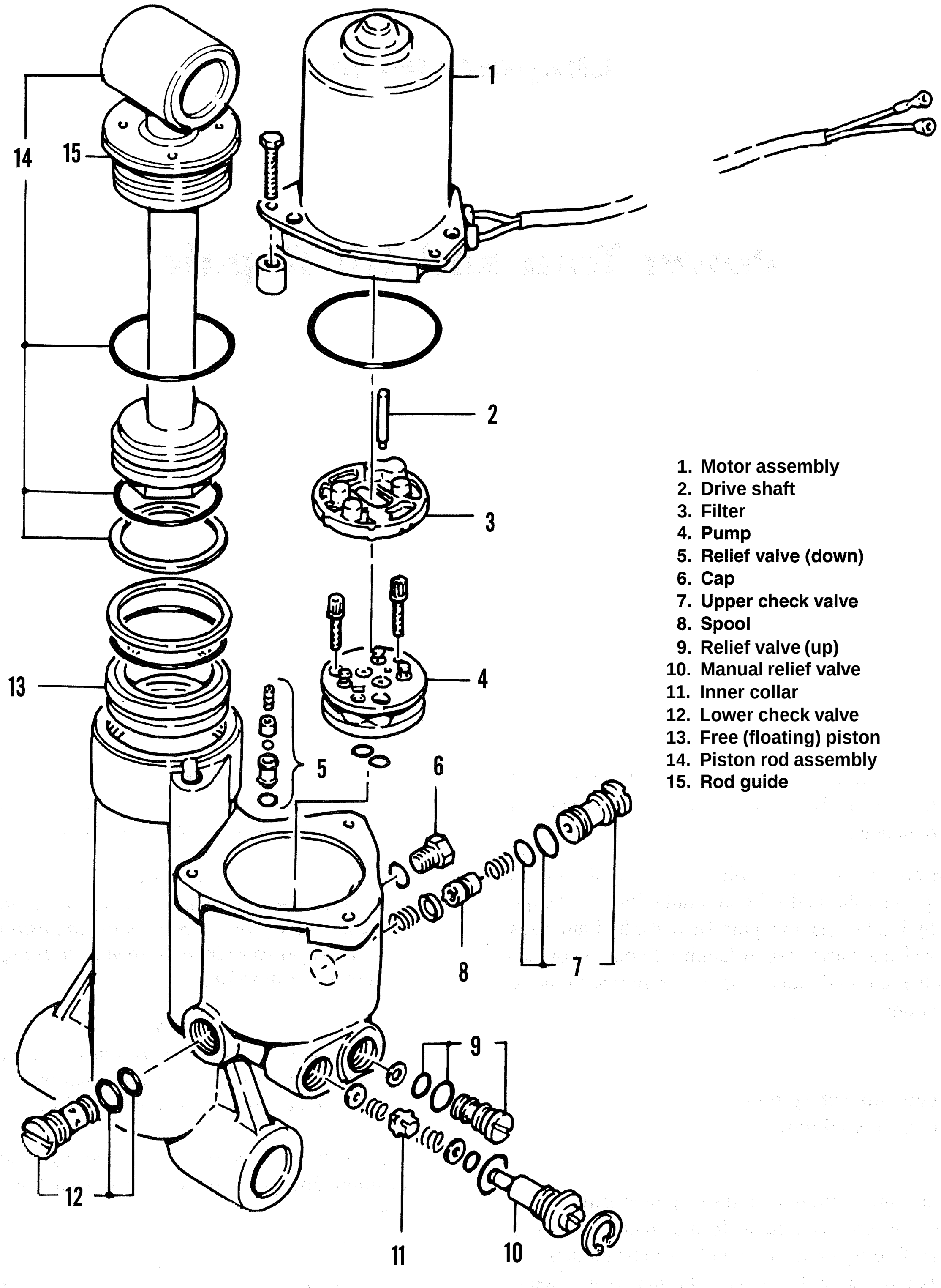
NOTE
Although the illustrations reflect the new style trim system, the removal and installation procedures are the same for all models.

1. Operate the trim motor and raise the engine to the fully up position. Engage the tilt rod lock to secure the engine in position.

NOTE
If the trim motor is not operative, open the manual relief valve 3-4 turns and raise the engine by hand.

1

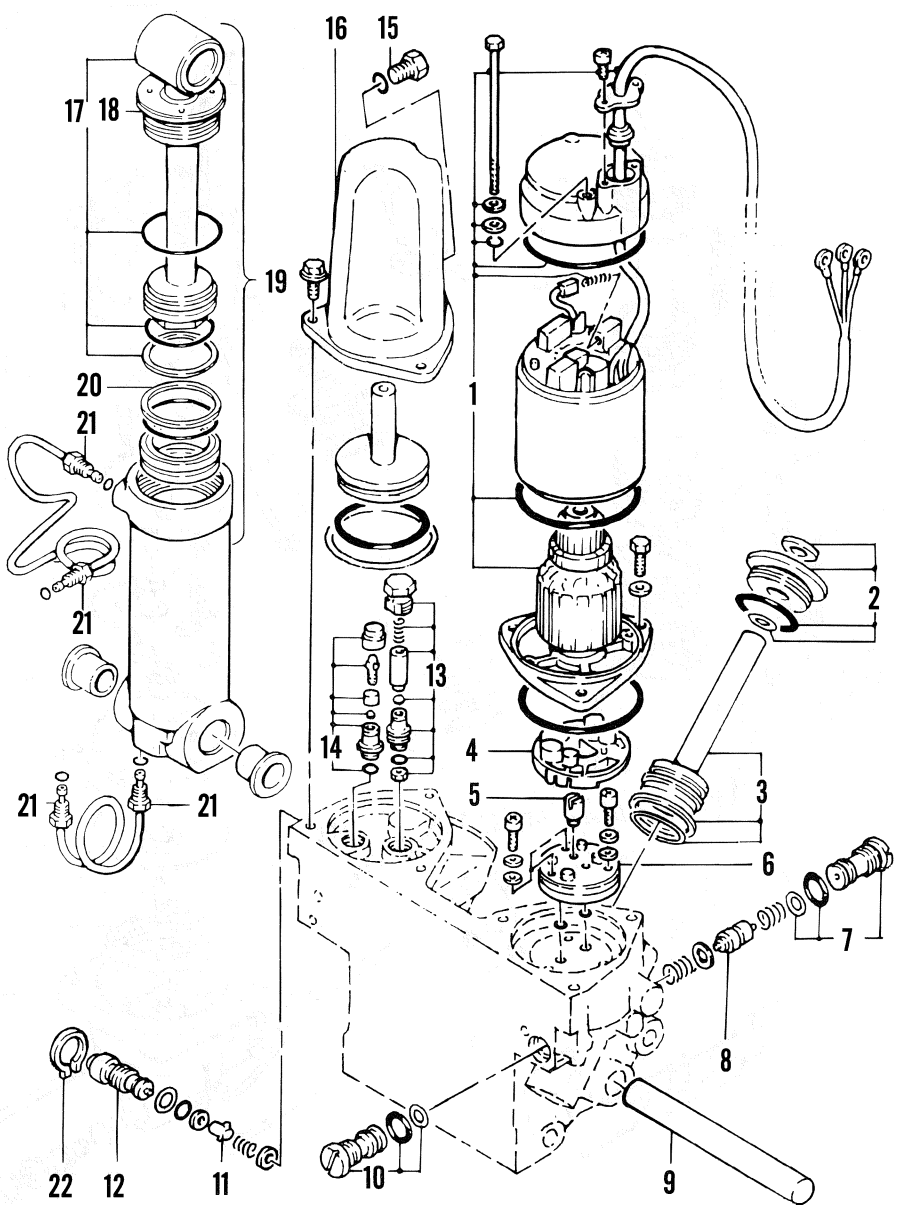
POWER TRIM/TILT UNIT (40 AND 50 HP MODELS)



1. Motor assembly
2. Drive shaft
3. Filter
4. Pump
5. Relief valve (down)
6. Cap
7. Upper check valve
8. Spool
9. Relief valve (up)
10. Manual relief valve
11. Inner collar
12. Lower check valve
13. Free (floating) piston
14. Piston rod assembly
15. Rod guide

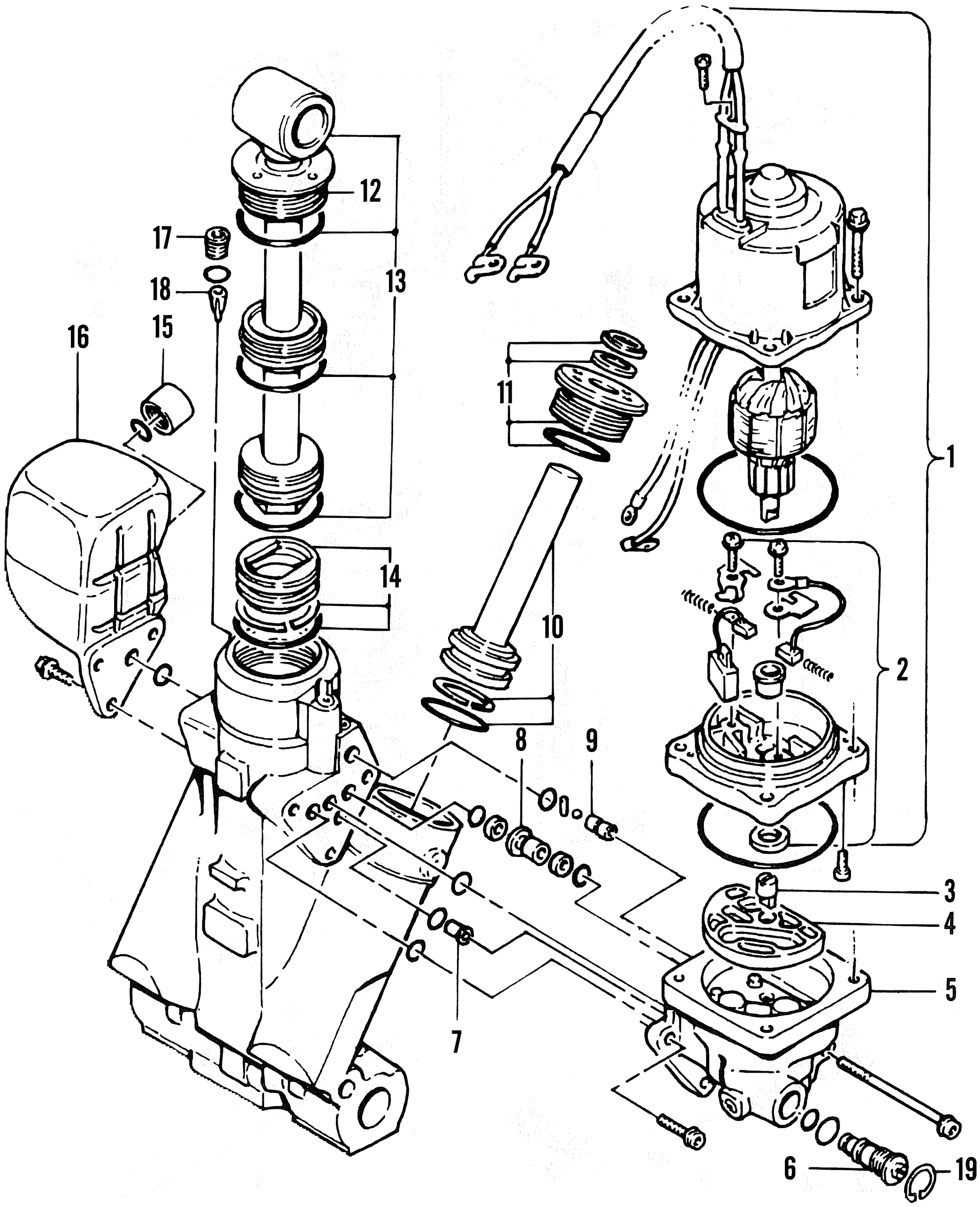
(2)

POWER TRIM/TILT UNIT (60-140 HP MODELS-OLD STYLE)

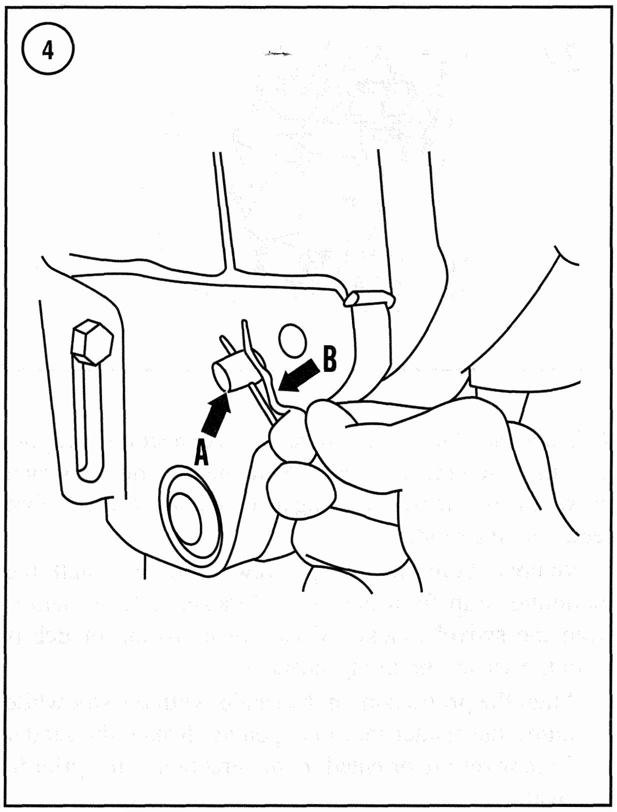


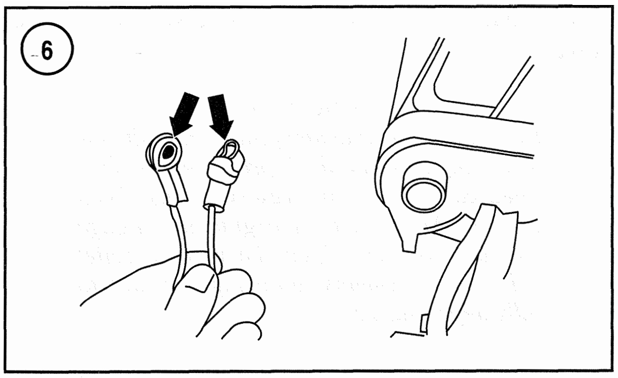
1. Motor assembly
2. Trim rod guide assembly
3. Trim rod assembly
4. Filter
5. Pump coupling
6. Pump
7. Upper check valve
8. Spool
9. Shaft
10. Lower check valve
11. Inner collar
12. Manual relief valve
13. Relief valve up
14. Pilot relief valve down
15. Cap
16. Reservoir (Fluid)
17. Tilt rod assembly
18. Tilt rod guide
19. Tilt cylinder assembly
20. Free (Floating) piston
21. Tilt tubing
22. Snap ring

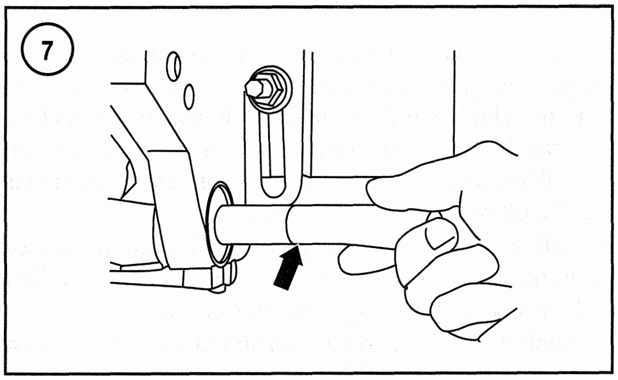
3 **POWER TRIM/TILT UNIT (60-140 HP MODELS-NEW STYLE)**

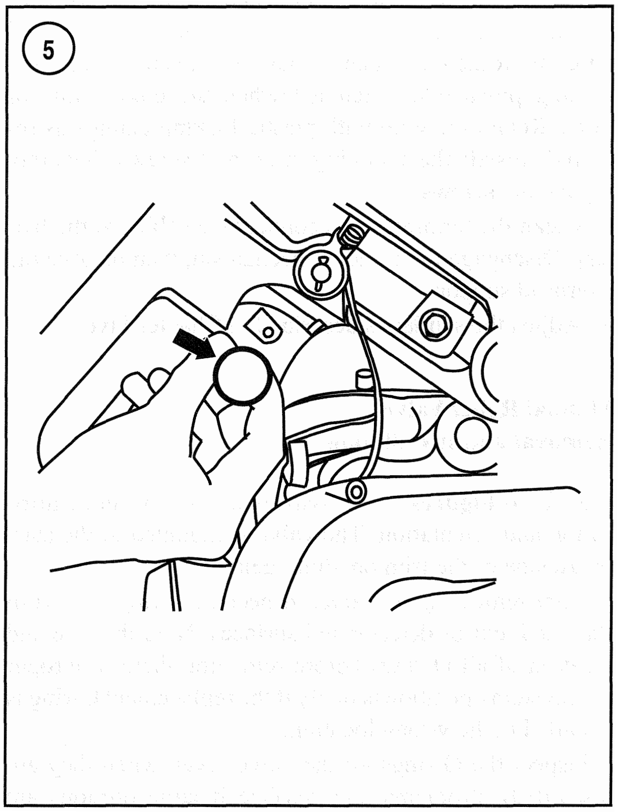


1. Motor assembly
2. Bracket assembly
3. Pump coupling
4. Filter
5. Pump
6. Manual relief valve
7. Orifice
8. Valve seat
9. Orifice
10. Trim rod assembly
11. Trim guide assembly
12. Tilt rod guide
13. Tilt rod assembly
14. Free (floating) piston
15. Cap
16. Reservoir (fluid)
17. Plug
18. Filter
19. Snap ring









2. Pull the thrust rod keeper pin (B, Figure 4) and remove the thrust rod (A) (if so equipped) from the clamp brackets.

3. Remove the upper cylinder pin (Figure 5) that secures the tilt cylinder in the swivel bracket.

4. With the engine held securely in position with a tilt rod lock, operate the motor and retract the trim rods fully and disconnect the battery cables from the battery.

5. Disconnect the up (blue) and down (green) leads **(Figure *6)*** from the solenoids in the electrical box and remove the leads from the lower motor cowling and clamp bracket.

NOTE
On old style units, the motor cable contains an additional ground lead that must be disconnected. Mark all leads before disconnecting them to prevent improper wire connections duriizg testing and installation.

6. Remove the trim assembly mounting bolts (old style) and lower the cylinder pin (Figure ***7)*** from between the clamp brackets.

7. Lift and remove the unit from between the clamp brackets (Figure **8).**

11

8. Installation is done in the reverse order of removal.

WARNING
Do not disassemble any power trim/tilt system component until all pressure has been released and the oil reservoir has been drained. Fully raise the engine and engage the tilt rod lock. Open the manual relief valve in increments, allowing the unit to fully depressurize.

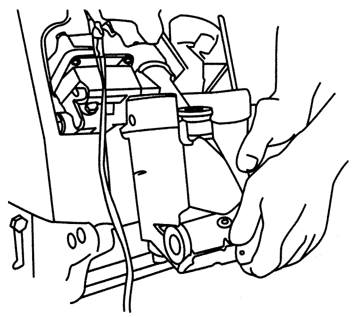
Tilt and Trim Cylinders Disassembly and Assembly

1. Using a suitable spanner wrench, remove the cap from the trim/tilt cylinder (40 and 50 hp) or the caps from the trim/tilt cylinders (60-140 hp). On 40 and 50 hp models, pull the trim/tilt rod assembly from the cylinder. On 60-140 hp models, pull the trim rod from the trim cylinder and the tilt rod from the tilt cylinder.
2. Before assembling, apply oil to all internal components, the inner surface of the tilt cylinder and/or manifold and especially the O-rings and backup rings.
3. Apply Loctite 242 to the trim and tilt rod, then tighten to the specification in **Table 1.**
4. Before installing the tilt and trim piston rod assembly, fill the bottom of the manifold with the specified oil. Insert the rod into the adjuster and push down by hand until it is level with the oil surface. Fill the remaining portion of the cylinder with oil. Install the rod caps and tighten them securely.
5. On the old style unit, thread the oil tube nuts by hand (21, **Figure 2)** several times before tightening with a wrench to prevent leakage caused by cross threading.

Trim Position Sender Removal and Installation

A trim position sender is installed on some 115-140 hp models.
1. Place the engine in the full tilt position. Engage the tilt lock mechanism and support the engine with an overhead hoist. Disconnect both battery cables.
2. Locate the trim position sender on the upper inside starboard clamp bracket. Make a sketch of the sender wire routing and connections prior to removal to ensure a proper installation.
3. Trace the sender wires to the harness connection within the engine cover and disconnect them. Route the wires out of the motor cover to remove the wire and sender. Remove all clamps prior to removal.

8



4. Trace the black sender wire to its connection at engine ground. Disconnect the wire. Note the direction in which the wires are oriented (leading up or leading down) before removing the sender.
5. Remove both mounting screws and then pull the mounting strap from the swivel bracket. Lift the sensor from the swivel bracket. Clean all corrosion or debris from the sensor mounting surfaces.
6. Align the protrusion on the sender with the slot while installing the sender into the opening. Rotate the sender until the wires are oriented in the direction noted prior to removal.
7. Route the wires to their connection points. Slide the sleeve over the terminal and/or coat the terminals with liquid neoprene after connecting the terminals. Ensure all wires are routed in a manner that prevents them from becoming pinched or stretched when the engine tilts or turns. Retain the wire with plastic locking clamps as required. Install the retaining strap and screws. Securely tighten the screws.
8. Clean the terminals and connect the cables to the battery. Disengage the tilt lock mechanism, then remove the overhead support.
9. Adjust the sender as described in Chapter Five.

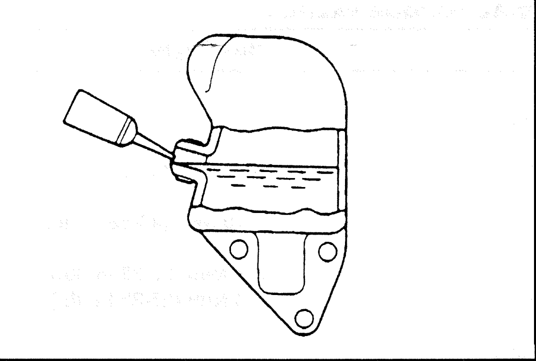
Manual Relief Valve Removal and Installation

Refer to **Figures 1-3** to assist with component identification and orientation. The valve is mounted to the starboard side of the trim on all models.

After removing the valve, inspect all O-rings for worn flattened, cut or deteriorated surfaces. Note the size and location of all O-rings before removing them. Improper trim system operation is likely if the replacement O-ring is installed in the wrong location.

Inspect the O-rings on the valve (even when they are discarded). Problems may surface if large portions are

9



missing or torn away from the O-rings. They usually migrate to a pressure relief valve or other component within the trim system. Remove and install the manual relief valve as follows:

1. Position the engine in the full up tilt position. Engage the tilt lock lever, then support the engine with an overhead hoist or suitable blocks.
2. Locate the manual relief valve and place a suitable container under the trim system to capture any spilled fluid.
3. Using needlenose pliers, pull the snap ring from the valve. Rotate the valve counterclockwise until you can pull it from the housing.
4. Use a suitable light along with a pick, small screwdriver and/or tweezers to remove any remnants of the valve or O-ring from the opening. Avoid damaging any of the machined surfaces in the opening.
5. Lubricate the manual relief valve with Dextron II automatic transmission fluid, then carefully slide the new O-rings (when removed) onto the valve. Lubricate the O-rings with Dextron II automatic transmission fluid or its equivalent. Install the valve into the opening. Do not tighten the valve at this time.
6. Rotate the valve clockwise until a slight resistance is felt. Rotate the valve 1/4 turn in the closed direction then 1/8 turn in the open direction. Repeat this process until the manual relief valve is fully seated.
7. Using needlenose pliers, install the snap ring into its groove in the valve. Refer to *Filling and Bleeding* in this chapter and correct the fluid level and purge air from the system.

FLUID FILLING

Refer to Figures **1-3.** Use Dextron II automatic transmission fluid in both styles of trim systems. Fill the system as follows:

1. Open the manual relief valve and position the engine in the full up position. Engage the tilt lock lever, then support the engine with wooden blocks or an overhead cable. Close the manual relief valve.
2. Clean the area around the fluid fill plug. Remove the plug, then inspect the O-ring on the plug. Replace the O-ring if it is damaged.
3. Fill the unit to the lower edge of the fill cap opening (Figure **9).** Install the fill cap to the reservoir, then tighten it securely. Remove the supports and disengage the tilt lock lever.
4. Cycle the trim to the full up and to the full down position. Repeat this step several times to bleed the air from the system. Stop operating the pump immediately if there is pump ventilation. Ventilation causes a change in the tone of the system as the unit operates. Repeat Steps 1-4 if ventilation is detected. Continue until the unit operates to the full up position without ventilation.
5. Allow the unit to sit in the full up position for several minutes, then check the fluid level. Add fluid if required. Securely tighten the fluid fill plug.

AIR BLEEDING

A spongy feeling or an inability to hold trim under load is a common symptom if air is present in the system. Minor amounts of air in the system purge into the reservoir during normal operation. If major components have been removed, a significant amount of air can enter the system. Most air is purged during the fluid filling process. Bleeding the air takes considerably longer if the pump ventilates.

Allow the engine to sit for 30 minutes or longer if air remains in the system after filling the fluid. Place the engine in the full tilt position using the manual relief valve. Correct the fluid level, then cycle the trim to the full up and down positions. Again check and correct the fluid level after a 30-minute break.

1. Ensure the oil reservoir cap is tight.
2. Open the manual relief valve several turns.
3. Lift the engine manually to the full up position. Engage the tilt rod stopper to lock the engine in position.
4. Confirm the oil level is sufficient. Add oil if needed.
5. Close the manual relief valve fully and keep the engine in the full up position for a minimum of 5 minutes.
6. Disengage the tilt rod stopper, and operate the motor and lower the engine to the full down position. Maintain this position for a minimum of 5 minutes.
7. Run the motor and raise the engine to the full up position. Engage the tilt rod stopper and check the oil level. Add oil if needed. Maintain this position for a minimum of 5 minutes.
8. Repeat Steps 6 and 7 for a minimum of five cycles.

11

Table 1 POWER TRIM/TILT SPECIAL TORQUE VALUES

Description	Old style	New style
PT/T mounting bolt		
60-140 hp	23-31 N•m (17-22 ft.-lb.)	–
Mounting bolt oil reservoir		
60-140 hp	5-7 N•m (44-62 in.-lb.)	4-6 N•m (35-53 in.-lb.)
Oil reservoir cap		
40-140 hp	3-5 N•m (27-44 in.-lb.)	5-10 N•m (44-89 in.-lb.)
Manual valve		
40-50 hp	–	3-4 N•m (27-35 in.-lb.)
60-140 hp	2-3 N•m (18-27 in.-lb.)	3-4 N•m (27-35 in.-lb.)
Nut, oil tube		
60-140 hp	11-13 N•m (97-115 in.-lb.)	
Motor assembly mounting bolt		
40-140 hp	5-7 N•m (44-62 in.-lb.)	–
60-140 hp	–	3-4 N•m (27-35 in.-lb.)
Motor throughbolt		
60-140 hp	3-4 N•m (27-35 in.-lb.)	–
Mounting bolt oil pump		
40-140 hp	5-6 N•m (44-53 in.-lb.)	–
60-140 hp	–	7-10 N•m (62-89 in.-lb.)
Upper relief valve		
40-140 hp	12-14 N•m (106-124 in.-lb.)	–
Down relief valve		
60-140 hp	12-14 N•m (106-124 in.-lb.)	–
Down pilot relief valve		
60-140 hp	12-14 N•m (106-124 in.-lb.)	–
Check valve		
40-140 hp	9-10 N•m (80-89 in.-lb.)	–
Trim rod guide		
60-140 hp	69-89 N•m (51-65 ft.-lb.)	75-81 N•m (55-60 ft.-lb.)
Tilt rod guide		
40-50 hp	78-118 N•m (58-87 ft.-lb.)	–
60-140 hp	78-118 N•m (58-87 ft.-lb.)	108-147 N•m (80-108 ft.-lb.)
Tilt rod nut		
60-140 hp	78-118 N•m (58-87 ft.-lb.)	78-118 N•m (58-87 ft.-lb.)

Table 2 POWER TRIM/TILT SPECIFICATIONS

40-50 hp pump manifold assembly	
Pump type	Geared oil pump
Up relief valve opening pressure	13729-16671 kPa (1991-2417 psi)
Down relief valve opening pressure	1961-3334 kPa (284-483 psi)
Down pilot relief valve opening pressure	–
Floating piston relief valve opening pressure	–
Upper chamber valve (valve seat A) open pressure	235 kPa (34 psi)
Lower chamber valve (valve seat B) open pressure	118 kPa (17 psi)
Oil type	Manufacture recommended or GM ATF
Oil capacity	550 cm (18.6 fl oz)
Motor	
Rated time	60 seconds
Rated voltage	12 VDC
Output	0.4 kW
Direction of rotation	Forward/reverse
Type circuit breaker	Internal, bi-metallic, current-sensitive
Circuit breaker activation	–
Circuit breaker reset	–
Commutator standard, outside diameter	–

(continued)

Table 2 POWER TRIM/TILT SPECIFICATIONS (continued)

Motor (continued) —	
Commutators wear limit outside diameter	–
Brushes wear limit length	–
Field coil standard resistance	–
Trim cylinder	
Piston diameter	–
Piston rod diameter	–
Piston stroke	–
Tilt cylinder	
Piston diameter	54 mm (2.13 in.)
Piston rod diameter	16 mm (0.63 in.)
Pistons stroke	141 mm (5.55 in.)
Shock absorber valve opening pressure	3432-5393 kPa (497-782 psi)
PT/T Switches	
Control box (P type)	3A single-pole double-throw rocker switch
Lower motor cover (P type)	3A single-pole double-throw rocker switch
Panel (F type)	20A single-pole double-throw rocker switch
Solenoid switches	
Rated voltage	12 VDC
Rated time	–
Excitation current	–
Excitation coil standard resistance	–
60-140 hp pump manifold assembly	
Pump type	Geared oil pump
Up relief valve opening pressure	
Old style PT/T	11767-13728 kPa (1706-1991 psi)
New style PT/T	8825-11768 kPa (1280-1706 psi)
Down relief valve opening pressure	
Old style PT/T	–
New style PT/T	3922-7354 kPa (568-1066 psi)
Down pilot relief valve opening pressure	
Old style PT/T	3922-6864 kPa (569-995 psi)
Floating piston relief valve opening pressure	
Old style PT/T	245-343 kPa (36-50 psi)
Upper chamber valve (valve seat A) open pressure	
Old style PT/T	235 kPa (34 psi)
Lower chamber valve (valve seat B) open pressure	
Old style PT/T	118 kPa (17 psi)
Oil type	Manufacture recommended or GM ATF
Oil capacity	
Old style PT/T	730 cm (24.7 fl oz)
New style PT/T	682 cm (23.0 fl oz)
Motor	
Rated time	60 seconds
Rated voltage	12 VDC
Output	
Old style PT/T	0.3 kW
New style PT/T	0.4 kW
Direction of rotation	Forwardlreverse
Type circuit breaker	Internal, bi-metallic, current-sensitive
Circuit breaker activation	
Old style PT/T	40-120 seconds at 52 A
New style PT/T	20 seconds minimum at 80 A
Circuit breaker reset	
Old style PT/T	Within 35 seconds
Commutator standard, outside diameter	
Old style PT/T	28.0 mm (1.10 in.)
New style PT/T	22.1 mm (0.87 in.)
Commutators wear limit outside diameter	
Old style PT/T	27.0 mm (1.06 in.)
New style PT/T	21.0 mm (0.82 in.)

(continued)

Table 2 POWER TRIM/TILT SPECIFICATIONS (continued)

Brush standard length	
Old style PTK	11.5 mm (0.45 in.)
New style PT/T	10.0 mm (0.39 in.)
Brushes wear limit length	
Old style PTK	7.5 mm (0.29 in.)
New style PTK	5.0 mm (0.20 in.)
Field coil standard resistance	
Old style PTK	0.05 ohms (pink-blue)
Trim cylinder	
Piston diameter	
Old style PTK	38.0 mm (1.50 in.)
New style PTK	38.0 mm (1.50 in.)
Piston rod diameter	
Old style PTK	16.0 mm (0.63 in.)
New style PTK	17.8 mm (0.70 in.)
Piston stroke	
Old style PTK	69.0 mm (2.72 in.)
New style PTK	96.9 mm (3.81 in.)
Tilt cylinder	
Piston diameter	
Old style PTK	45.0 mm (1.77 in.)
New style PTK	45.0 mm (1.77 in.)
Piston rod diameter	
Old style PTK	19.0 mm (0.75 in.)
New style PTR	19.0 mm (0.75 in.)
Pistons stroke	
Old style PTK	131.0 mm (6.16 in.)
New style PTK	131.0 mm (6.16 in.)
Shock absorber valve opening pressure	
Old style PT/T	12258-15200 kPa (1778-2204 psi)
New style PTK	14710-18632 kPa (2133-2702 psi)
PTK Switches	
Control box (P type)	3A single-pole double-throw rocker switch
Lower motor cover (P type)	3A single-pole double-throw rocker switch
Panel (F type)	20A single-pole double-throw rocker switch
Solenoid switches	
Rated voltage	12 VDC
Rated time	Old style 30 seconds at 100 A
New style 60 seconds at 80 A	
Excitation current	Old style 3 A maximum
New style 4 A maximum	
Excitation coil standard resistance	Old style PT/T 5.20 ohms

Table 3 GENERAL TORQUE SPECIFICATIONS*

Thread diameter	N.m	in.-lb.	ft.-lb.
5 mm bolt and nut	5	44	
6 mm bolt and nut	10	88	
8 mm bolt and nut	22		16
10 mm bolt and nut	34		25
12 mm bolt and nut	54	–	40
5 mm screw	4	35	–
6 mm screw	9	80	
6 mm flange bolt with 8 mm head (small flange surface)	9	80	
6 mm flange bolt with 8 mm head (large flange surface)	12	106	

(continued)

Table 3 GENERAL TORQUE SPECIFICATIONS* (continued)

Thread diameter	N.m	in.-lb.	ft.-lb.
6 mm flange bolt with 10 mm head and nut	12	106	–
8 mm flange bolt and nut	26	–	20
10 mm flange bolt and nut	39	–	29

'This table lists general torque specifications for metric fasteners. Use this table when a specific torque specification is not listed for a fastener at the end of the appropriate chapter. The torque specifications listed in this table are for threads that are clean and dry.

A

Adjustment
- carburetor 94
  - pilot screw 125
  - synchronization 102-104. 125
  - throttle stop screw turns 125
- choke valve 102
- engine RPM at idle and trolling 125
- float height 146
- fuel system 101-106
- idle RPM, engine 101.102. 125
- ignition timing 106-115, 124
- linkage. throttle 115-123
- neutral start mechanism 122
- oil pump 104-106
- pilot screw 101.125. 147-148
- propeller. test 123
- pump. oil 104-106
- RPM, engine at idle and trolling 125
- sender. trim position 122-123
- start mechanism. neutral 122
- test propeller recommendations 123
- throttle linkage 115-123
- timing 106-115, 124
- trim position sender 122-123
- trim tab 117-122
- trolling. engine RPM 125
- valve, choke 102

Alternator specifications 180

Anode
- gearcase. inspection 88-89
- sacrificial 86

B

Basic hand tools 21-26

Battery 149-153
- charge coil removal and installation 163-164
- charging 152-153
- inspection 91, 150.15 1
- requirements 179
- storage 152
- testing 151-152

Bearing inspection 254-255

Bleeding. air 269

Bore. cylinder 210

Break-in, engine 208

Bulb. primer 132-133

C

Cam and shift rod inspection 255

Capacities. gearcase lubricant 99

Carbon deposits. removing 85-86

Carburetor 137-146
- adjustment 94
- inspection 128-129
- pilot screw 125
- specifications 147
- synchronization 102-104. 125
- throttle stop screw 125

CDI unit removal and installation 168-169

Charge coil. removal and installation 163-164

Charging system 163-164

Choke valve adjustment 102

Clamp and hose inspection 86-87

Clutch and gear inspection 254

Coil. removal and installation
- battery charge 163-164
- exciter 165-166
- ignition 168
- pulser 166-168

Compression
- cylinder 209
- test 92

Connecting rod
- inspection 206
- specifications 211

Connectors. fuel hose 131.132

Corrosion prevention 97-98

Cranking voltage test 152

Crankshaft
- dimensions 210
- inspection 206-208

Cylinder block
- disassembly and assembly 195-202
- inspection 202-205

Cylinder
- bore 210
- compression 209
- head inspection 205
- head removal and installation 190-192
- tilt and trim. disassembly and assembly 268

E

Electrical system
- alternator specifications 180
- battery 149-153
  - charge coil removal and installation 163-164
  - charging 152-153
  - inspection 150-151
  - requirements 179
  - storage 152

testing 151-152
charge coil removal and installation 163-164
charging system 163-164
coil. battery charge. removal and installation. . 163-164
cranking voltage test 152
electric starting system 154
electric trolling motors. wiring for 12- and 24-volt . 153
ignition system specifications 172-179
inspection. battery 150-151
jump starting 153
lanyard switchremoval and installation 170
motor
starter. inspection 161-162
trolling. wiring for 12- and 24-volt electric 153
neutral start switch removal and installation . . 162-163
oil level sensor removal and installation 171
overheatsensorremovalandinstallation 171
rectifier or rectifierlregulator
removal and installation 164
specifications 180
relay. starter. removal and installation. 154
requirements. battery 179
sensor
oil level. removal and installation 171
overheat. removal and installation 171
water pressure. removal and installation 171
specifications
alternator 180
battery requirements 179
ignition system 172-179
rectifier/regulator 180
torque 172
start switch. neutral. removal and installation . 162-163
starter motor inspection 161-162
starter relay removal and installation 154
torque specifications 172
trolling motors. wiring 153
warning system 171
water pressure sensor removal and installation . . . 171
wiring for electric trolling motors 153
Engine
break-in 208
oil requirements 85
operation 2
RPM at idle and trolling 125
recommissioning 97
Exciter coil removal and installation 165-166
Exhaust cover removal and installation 192-195

F

Fasteners 2-8
Filter. fuel
replacement 132
inspection 84-85
Float height 148
adjustment 146
Fluid
filling 269
trim system. level 90-91
Flywheel 181-186
Fuel system 101-106
adjustment
float height 146
pilot screw 147-148
bulb. primer 132-133
carburetor 137-146
inspection 128-129
specifications 147
cleaning 127-128
connectors. fuel hose 131-132
filter. fuel replacement 132
float height 148
hose. fuel. connectors 131-132
inspection. carburetor 128-129
intake manifold and reed valve assembly . . . 144-146
integral fuel tank 131
jets, fuel 129
manifold. intake and reed valve assembly . . . 144-146
pilot screw adjustment 147-148
portable fuel tank 130-131
primer bulb 132-133
pumps, fuel 133-137
reed valve
assembly and intake manifold 144-146
liftheight 148
screw. pilot. adjustment 147-148
specifications
carburetor 147
fuel system torque 146-147
tank. fuel 129-132
portable 130-131
integral 131
torque specifications 146-147

G

Galvanic corrosion 11-13
Gasket sealant 10-11
Gear and clutch inspection 254
Gearcase 228-252
anode inspection 88-89
bearing inspection 254-255
cam and shift rod inspection 255

clutch and gear inspection . . . 254
gear and clutch inspection . . . 254
lubricant . . . 87-88
capacities . . . 99
changing . . . 88
operation . . . 213-214
propeller
removal and installation . . . 214-216
shaft inspection . . . 253-254
shear pin type . . . 215-216
thrust hub type . . . 216
removal and installation . . . 216-222
shift rod and cam inspection . . . 255
shim thickness, available . . . 256
specifications
available shim thickness . . . 256
gearcase special torque . . . 255
torque . . . 255
thrust hub type . . . 216
torque specifications . . . 255
water pump . . . 222-228
assembly . . . 224-228
disassembly . . . 222-224
inspection . . . 253
General information
engine operation . . . 2
fasteners . . . 2-8
galvanic corrosion . . . 11-13
gasket sealant . . . 10-11
lubricants . . . 8-10
propellers . . . 14-20
protection from galvanic corrosion . . . 13-14
torque specifications . . . 2

H

Hose
and clamp inspection . . . 86-87
fuel, connectors . . . 131-132

I

Idle speed . . . 101-102, 125
Ignition coil removal and installation . . . 168
Ignition switch removal and installation . . . 154
Ignition system specifications . . . 172-179
Ignition system . . . 165-170
CDI unit removal and installation . . . 168-169
coil, removal and installation
exciter . . . 165-166
ignition . . . 168
pulser . . . 166-168
ignition switch, removal and installation . . . 154
pulser coil removal and installation . . . 166-168
stator removal and installation . . . 166
torque specifications . . . 172
timing . . . 94-95, 106-115
adjustment . . . 124
Initial inspection . . . 80-82
Intake manifold and reed valve assembly . . . 144-146
Integral fuel tank . . . 131

J

Jets, fuel . . . 129
Jump starting . . . 153

L

Lanyard switch
removal and installation (tiller handle models) . . . 170
Linkage, throttle, adjustment . . . 115-123
Lubricants . . . 8-10
Lubrication
capacities, gearcase lubricant . . . 99
changing, gearcase lubricant . . . 88
engine oil requirements . . . 85
fluid, trim system, level . . . 90-91
gearcase lubricant capacities . . . 99
lubrication system description . . . 85
oil, engine, requirements . . . 85
recommended lubricants and sealants . . . 100
swivel and tilt tube . . . 89
tilt tube and swivel lubrication . . . 89
trim system fluid level . . . 90-91

M

Maintenance
after each use . . . 82-83
anodes
gearcase, inspection . . . 88-89
sacrificial . . . 86
battery inspection . . . 91
carbon deposits, removing . . . 85-86
clamp and hose inspection . . . 86-87
corrosion prevention . . . 97-98
fuel
filter inspection . . . 84-85
requirements . . . 84
hose and clamp inspection . . . 86-87
inspection
battery . . . 91
clamp . . . 86-87
fuel filter . . . 84-85

gearcase anode 88-89
hose 86-87
steering system 90
thermostat 87
water pump 89
wiring 91
propeller shaft .89
recommissioning the engine 97
sacrificial anodes 86
schedule, maintenance 83, 98-99
sealants. recommended 100
shaft. propeller 89
shift linkage and throttle 91
starter motor 91
storage 97-98
submersion .96-97
throttle and shift linkage 91
water test 95
Manifold. intake and reed valve assembly 144-146

Mechanics' techniques 31-32
Midsection
inspection 252-255
torque specifications 256

N

Neutral start
mechanism adjustment 122
switch removal and installation 162-163

O

Oil
engine. requirements 85
level sensor removal and installation 171
pump adjustment 104-106
Overheat sensor removal and installation 171

P

Pilot screw
adjustment 101.147.148
turns 125
Piston
clearance 205
inspection 205
ring end gap 206
Portable fuel tank 130-131
Power head .186-202
bore. cylinder .210
break-in, engine 208
clearance. piston 205
compression. cylinder 209
connecting rod inspection 206
connecting rod specifications 211
cover. exhaust. removal and installation 192-195
crankshaft
dimensions 210
inspection 206-208
cylinder
block
disassembly and assembly 195-202
inspection 202-205
bore 210
compression 209
head inspection 205
head removal and installation 190-192
dimensions. crankshaft 210
end gap. piston ring 206
engine break-in 208
exhaust cover removal and installation 192-195
flywheel 181-186
installation 188-189
piston
clearance 205
inspection 205
ring end gap 206
removal 186-188
specifications
connecting rod 211
general torque 211-212
power head torque 209
thermostat
installation 190
removal 189-190
torque specifications 209
general 211-212
power head 209
Power trim and tilt system
air bleeding 269
cylinders. tilt and trim. disassembly and assembly . 268
fluid filling 269
manual relief valve removal and installation . . 268-269
removal and installation 263-268
sender. trim position. removal and installation . . . 268
specifications 270-272
general torque 272-273
power trim/tilt special torque values 270
power trim/tilt 270-272
special torque values 270
tilt and trim cylinders disassembly and assembly . . 268
torque specifications 270.272.273
trim position sender removal and installation 268
Primer bulb .132-133

12

Propeller 14-20
removal and installation 214-216
shaft 89
inspection 253-254
shear pin type 215-216
test, recommendations 123
thrust hub type 216
Protection from galvanic corrosion 13-14
Pulser coil removal andinstallation 166-168
Pump
fuel 133-137
oil, adjustment 104-106
water 222-228
assembly 224-228
disassembly 222-224
inspection 89, 253

R

Ratchet load 262
Recommissioning the engine 97
Rectifier or rectifierregulator
removal and installation 164
specifications 180
Reed valve
assembly and intake manifold 144-146
lift height 148
Regulator specifications 180
Regulator/rectifier, removal and installation 164
Relay. starter. removal and installation 154
Relief valve. manual 268-269
Removing carbon deposits 85-86

S

Sacrificial anodes 86
Schedule. maintenance 98-99
Scheduled maintenance 83
Screw
pilot
adjustment 101.147.148
turns 125
throttle stop
turns 125
Sealants. recommended 100
Sender. trim position 122-123
removal and installation 268
Sensor
oil level. removal and installation 171
overheat. removal and installation 171
water pressure. removal andinstallation 171
Shear pin type 215-216
Shift linkage and throttle 91
Shift rod and cam inspection 255
Shim thickness. available 256
Spark plug
application 100
replacement 92-94
Specifications
alternator 180
available shim thickness 256
battery requirements 179
carburetor 147
pilot screw turns 125
synchronization 125
throttle stop screw turns 125
connecting rod 211
engine RPM at idle and trolling 125
fuel system torque 146-147
gearcase special torque 255
general torque 211-212, 272-273
ignition
system 172-179
timing adjustment 124
midsection torque 256
power head torque 209
power trim/tilt 270-272
ratchet load 262
rectifier/regulator 180
test propeller 123
tilt/trim, power 270
timing 124. 172
torque 255. 262
trim/tilt, power. special torque values 270
Start mechanism. neutral. adjustment 122
Start switch. neutral. removal and installation . . 162-163
Starter. manual 257-262
Starter motor 154-163
inspection 161-162
maintenance 91
Starter relay removal and installation 154
Starting system. electric 154
Stator removal and installation 166
Steering system inspection 90
Stop screw. carburetor throttle. turns 125
Storage 97-98
Submersion 96-97
Switch removal and installation
ignition 154
lanyard 170
neutral start 162-163
Swivel and tilt tube lubrication 89
Synchronization
adjustment

pilot screw 101
throttle linkage 115-123
carburetor 102.104. 125
pilot screw turns 125
synchronization 102-104. 125
throttle stop screw turns 125
fuel system 101-106
idle speed 101-102
linkage. throttle. adjustment 115-123
pilot screw adjustment 101

T

Tank. fuel 129-132
portable 130-131
integral 131
Test
battery 151-152
compression 92
cranking voltage 152
equipment 26-28
propeller recommendations 123
water 95
Thermostat
inspection 87
installation 190
removal 189-190
Throttle
and shift linkage 91
linkage adjustment 115-123
stop screw turns 125
Thrust hub type 216
Tiller handle models
lanyard switch removal and installation 170
Tilt
and power trim system
removal and installation 263-268
and trim cylinders disassembly and assembly 268
tube and swivel lubrication 89
Timing
ignition 94-95, 106-115, 124
adjustment 124
specifications 124
Tools and techniques
basic hand tools 21-26
mechanics' techniques 31-32
special tips 30-31
test equipment 26-28
Torque specifications 2, 172, 255, 262, 272-273
fuel system 146-147
gearcase 255
general 211-212
power head 209
power tridtilt 270
midsection 256
trim/tilt, power 270
Trim
and tilt cylinders. disassembly and assembly 268
position sender 122-123
removal and installation 268
system fluid level 90-91
tab adjustment 117-122
Trolling motors. wiring for 12- and 24-volt electric . 153
Trolling. engine RPM 125
Troubleshooting and testing
alternator charging coil test 52
amperage 36
blown cylinder head gasket 69
carburetor malfunction 38-39
CDI unit 42-43
peak voltage test 43-44
charging coil. alternator. test 52
charging system 50-54
output 50-51
checking diodes 36
coil
alternator charging test 52
ignition 40
ignition exciter 42
pulser 40-41
compression test 39. 69
continuity test 63
cooling system 69-72
description 69-70
inspection 70
cylinder
head gasket. blown 69
water entering 68-69
determining a fuel or ignition fault 37
detonation 68
electrical testing 63-67
engine
model identification 78-79
noises 67-69
seizure 68
speed limiting system 54-57
temperature verification 70-71
fuel
fault. determining 37
pump and fuel tank 38
system inspection 37-38
fuse
and wire harness 54
testing 54

12

gearcase. 72-75
  vibration or noise 74
harness. wire test 54
horn. warning. test 44
ignition
  coil 40
  exciter coil 42
  fault. determining 37
  switch test 47-48
  system
    testing 39-44
    troubleshooting 76
knocking noises 67
lamp. warning. test 44
lockdown hook. and tilt pin 57
low-speed limit (115-140 hp) 57
lubricant
  metal contamination in 74
lubrication system failure 67-68
malfunction. carburetor 38-39
manual start system 50
metal contamination in the lubricant 74
multimeter 33-34
neutral switch test 49-50
noise
  engine 67-69
  knocking 67
  or vibration in gearcase 74
  ticking 67
  whirring 67
oil level sensor test 44
operating requirements 37
overheat sensor test 71.72. 79
over-speed limitation 79
peak voltage 34
  CDI unit 43-44
power trim and tilt 58-63
preignition 68
pressure test 74
pulser coil 40-41
pump. fuel 38
rectifier/regulator test 52-54
resistance 35-36
sensor. overheat. test 79
shifting difficulty 75
solenoid. starter test 48
spark plug cap 40
specifications
  engine model identification 78-79
  general torque 78
  overheat sensor test 79
  over-speed limitation 79
speed
  limit system test 57
  low-speed limit (115-140 hp) 57
  one-half maximum limit test 55-57
start button test (tiller models) 48
start system, manual 50
starter
  cranking voltage test 47
  solenoid test 48
starting
  difficulty 37-39
  system 45-50
    troubleshooting 75-76
stop circuit test 39-40
tank, fuel 38
temperature. engine. verification 70-71
thermostat testing 71
tiller models. start button test 48
tilt pin and lockdown hook 57
trim system 57-63
  indicator
    input voltage 65-66
    output voltage 66
  sender output voltage 67
  switch test 63-65
  power. and tilt 58-63
vibration. or noise in gearcase 74
voltage
  drop 35
  measuring 34
  peak 34
  starter cranking test 47
  trim indicator input 65-66
  trim sender output 67
warning
  horn test 44
  lamp test 44
  system 44-45
water entering the cylinder 68-69
whirring noises 67
wire harness test 54
wire harness. and fuses 54
Tune-up 92-96
  carburetor adjustment 94
  compression test 92
  ignition timing 94-95
  spark plug
    application 100
    replacement 92-94

V

Valve
- choke. adjustment 102
- manual relief. removal and installation 268-269
- reedassembly andintakemanifold 144-146
- reed lift height 148

Voltage. cranking. test 152

W

Warning system 171

Water pressure sensor removal and installation 171

Water pump 222-228
- assembly 224-228
- disassembly 222-224
- inspection 253
- inspection 89

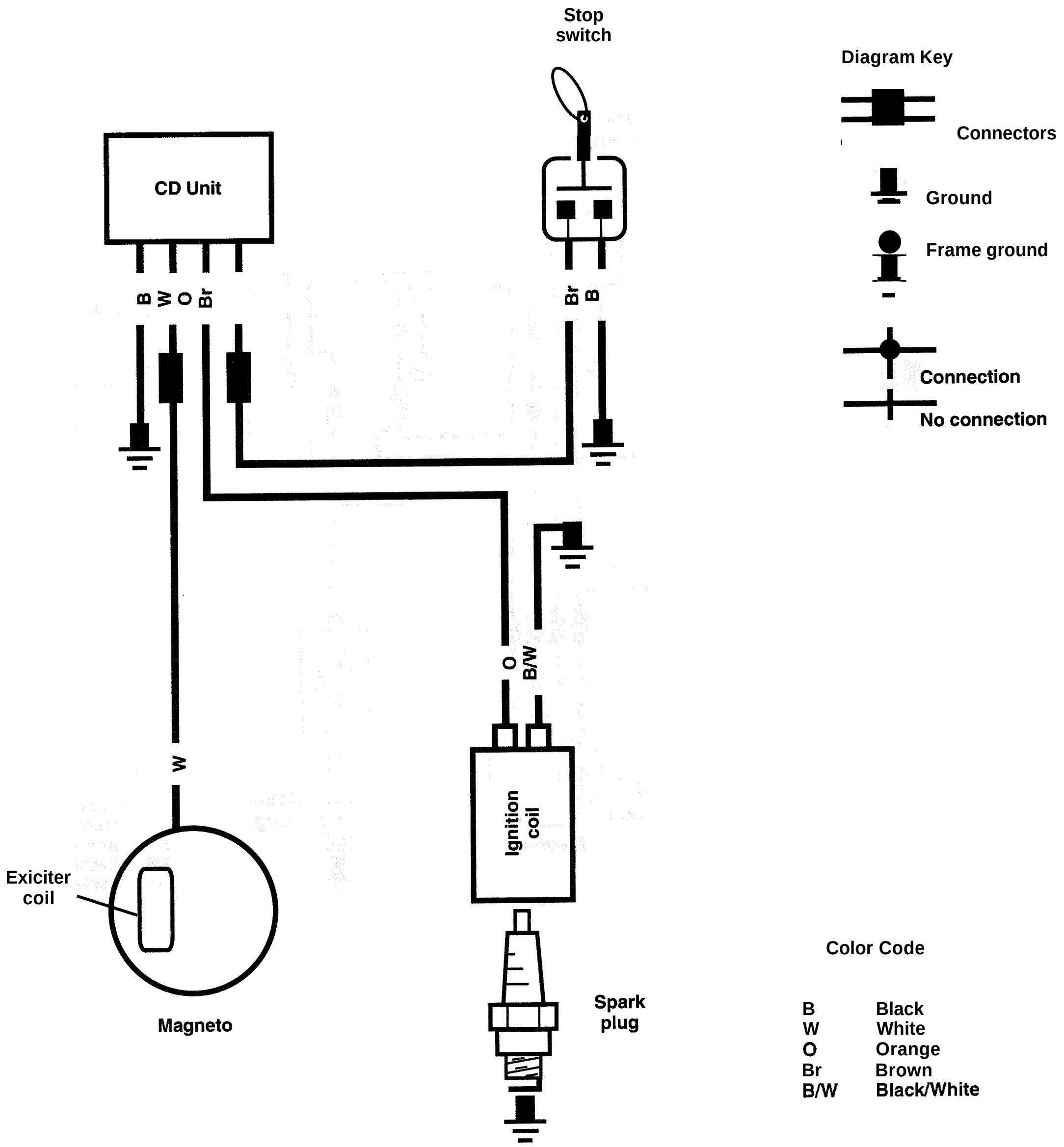
Watertest 95

Wiring diagrams 282

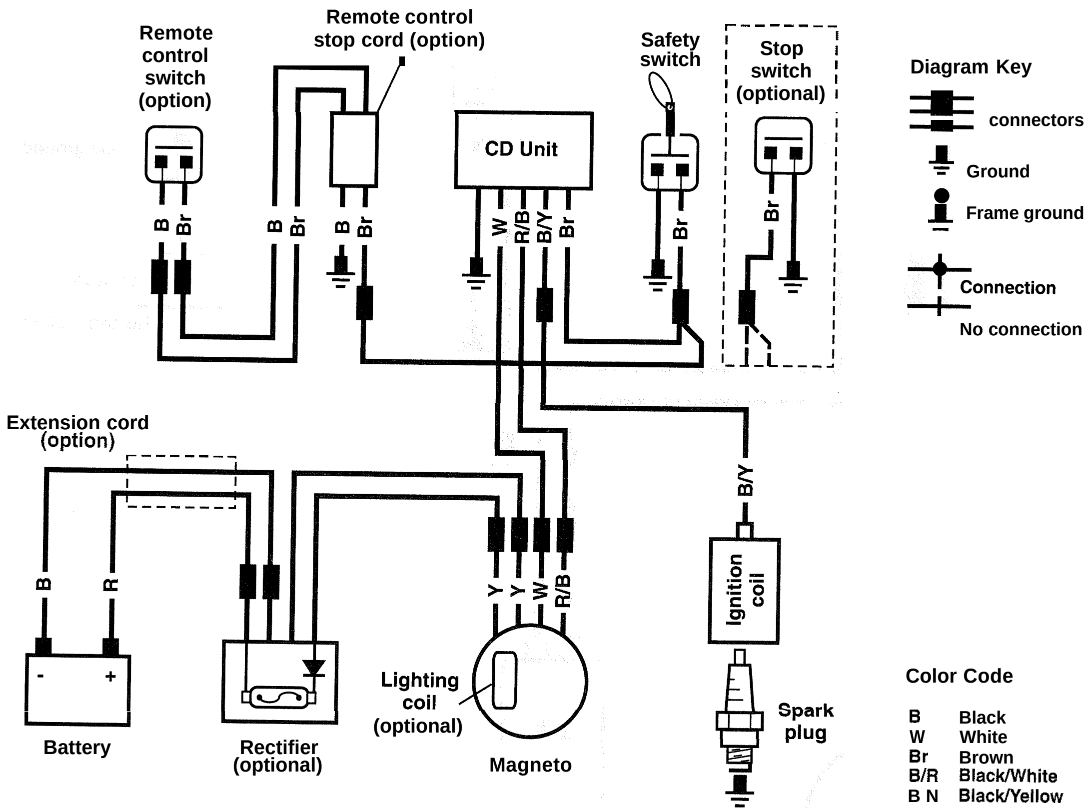
Wiring for electric trolling motors 153

Wiring inspection 91

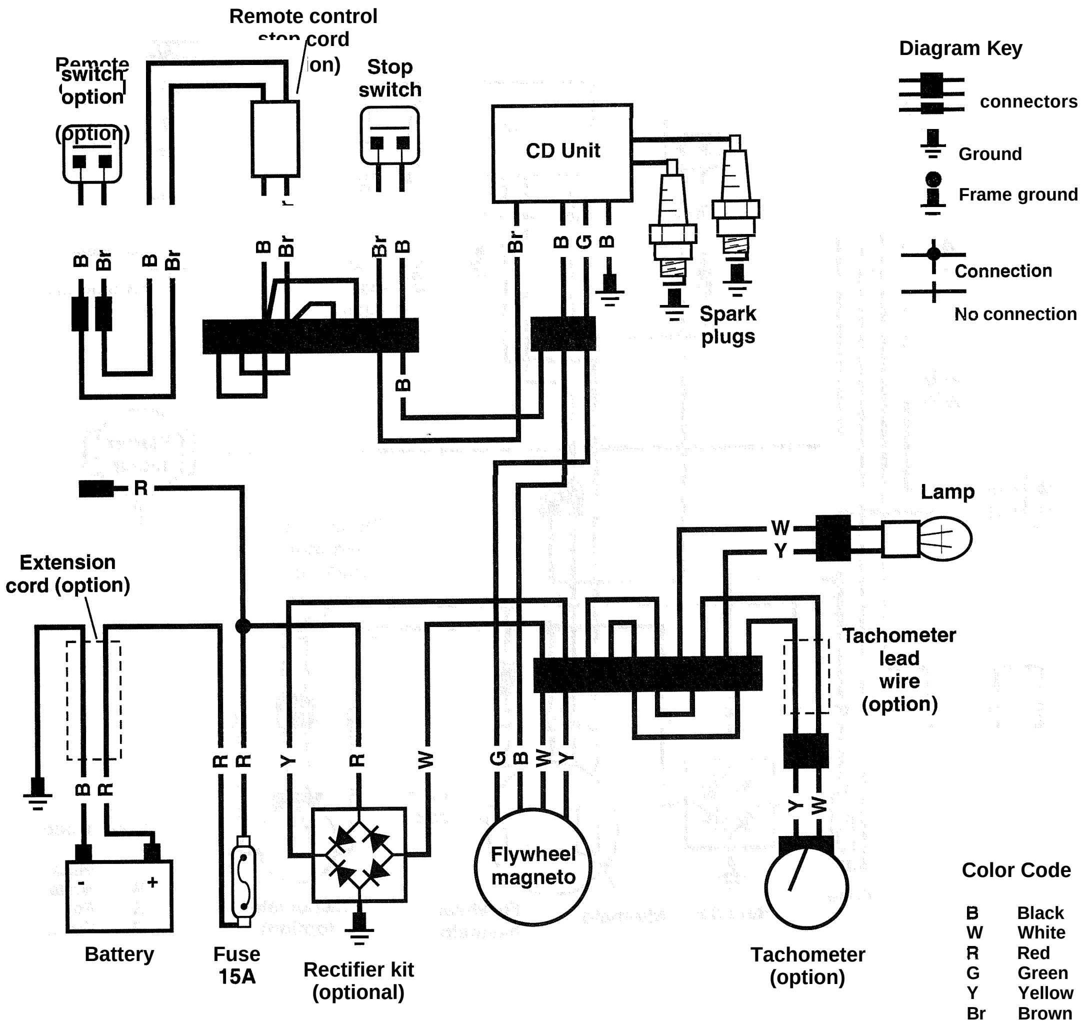
2.5/3.5 MODELS


Stop
switch
Diagram Key
Connectors
Ground
Frame ground
Connection
No connection
CD Unit
B W O Br
Br B
O B/W
W
Ignition
coil
Exiciter
coil
Magneto
Spark
plug
Color Code
B Black
W White
O Orange
Br Brown
B/W Black/White

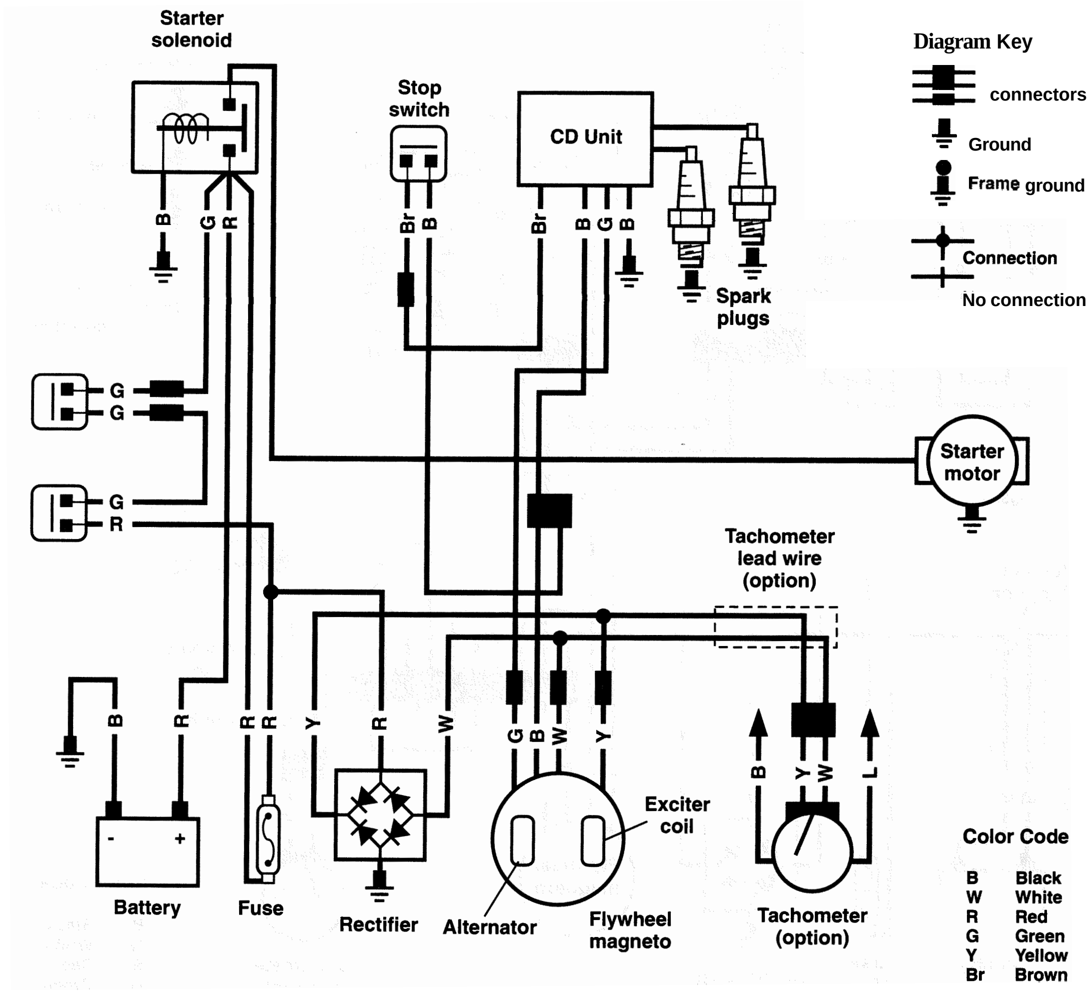
5B/BS MODELS


Remote control switch (option)
Remote control stop cord (option)
CD Unit
Safety switch
Stop switch (optional)
Diagram Key
connectors
Ground
Frame ground
Connection
No connection
B
Br
W
R/B
B/Y
Extension cord (option)
R
Y
Battery
Rectifier (optional)
Lighting coil (optional)
Magneto
Ignition coil
Spark plug
Color Code
B Black
W White
Br Brown
B/R Black/White
B N Black/Yellow

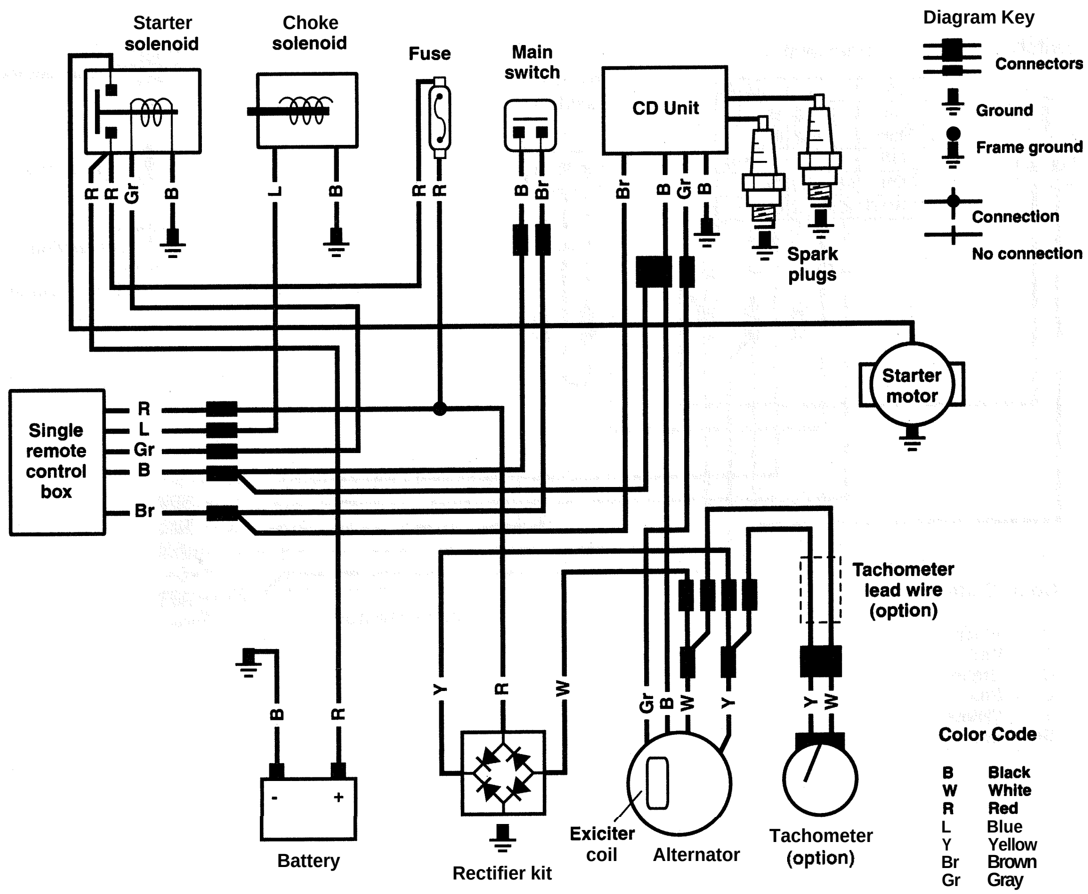
8B/9.8 MODELS


Remote control
stop cord
(option)
Remote switch (option)
Stop switch
CD Unit
Spark plugs
Diagram Key
connectors
Ground
Frame ground
Connection
No connection
Lamp
Extension cord (option)
Tachometer lead wire (option)
Battery
Fuse 15A
Rectifier kit (optional)
Flywheel magneto
Tachometer (option)
Color Code
B Black
W White
R Red
G Green
Y Yellow
Br Brown

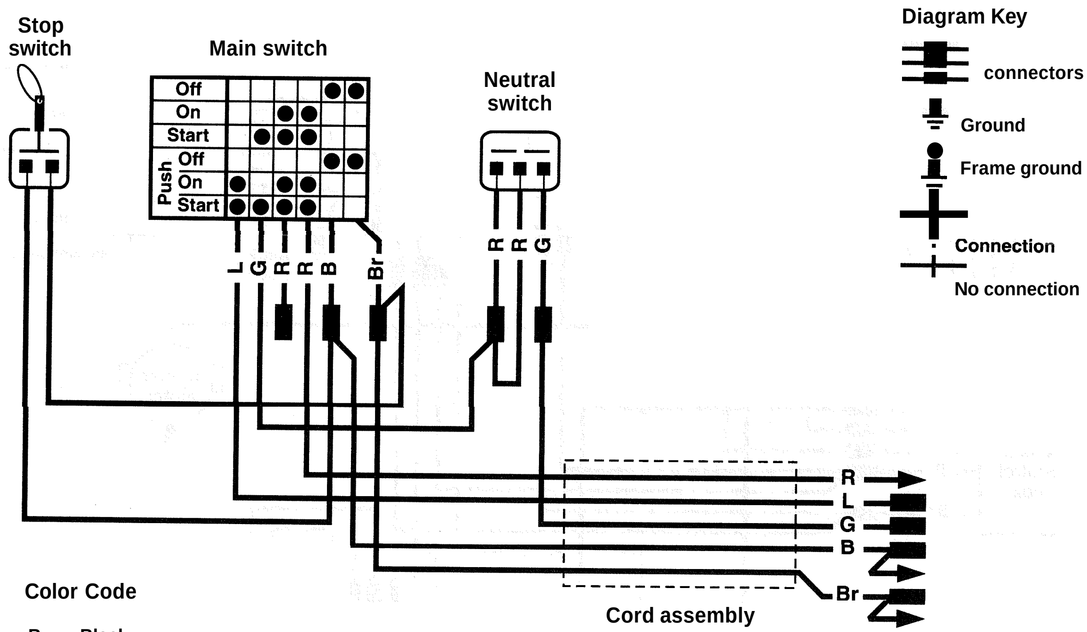
8/9.8 (EF TYPE) MODELS



819.8 (EP TYPE) MODELS



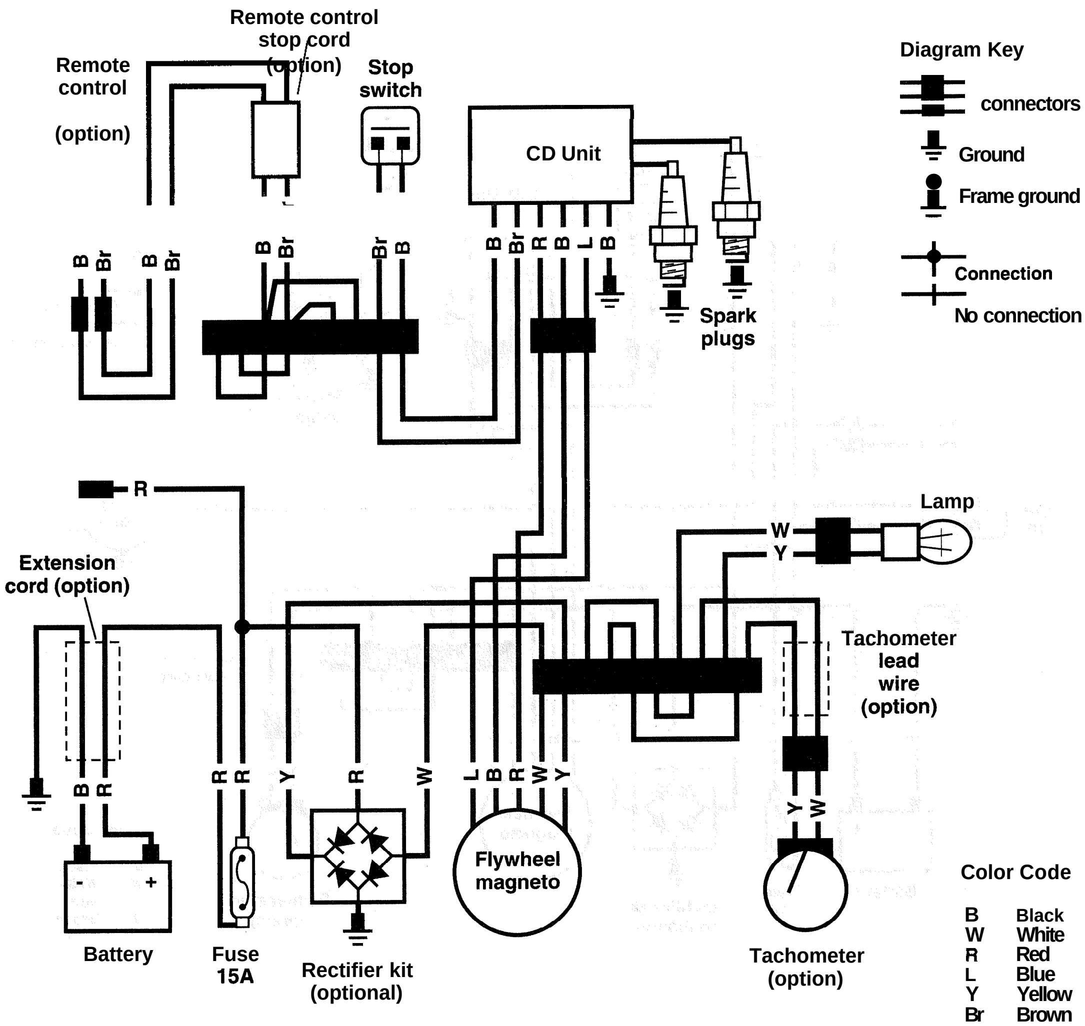
8/9.8 MODELS W/SINGLE REMOTE CONTROL BOX



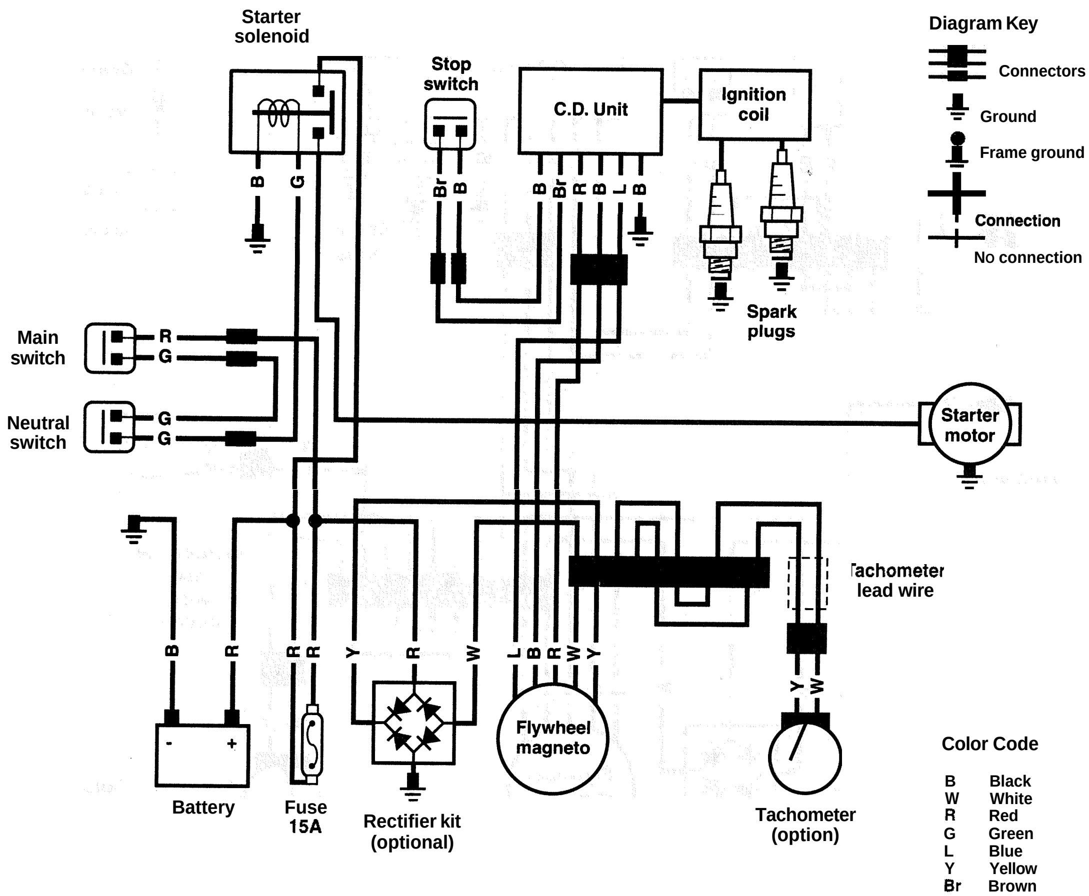
Color Code

B	Black
R	Red
G	Green
L	Blue
Y	Yellow
Br	Brown

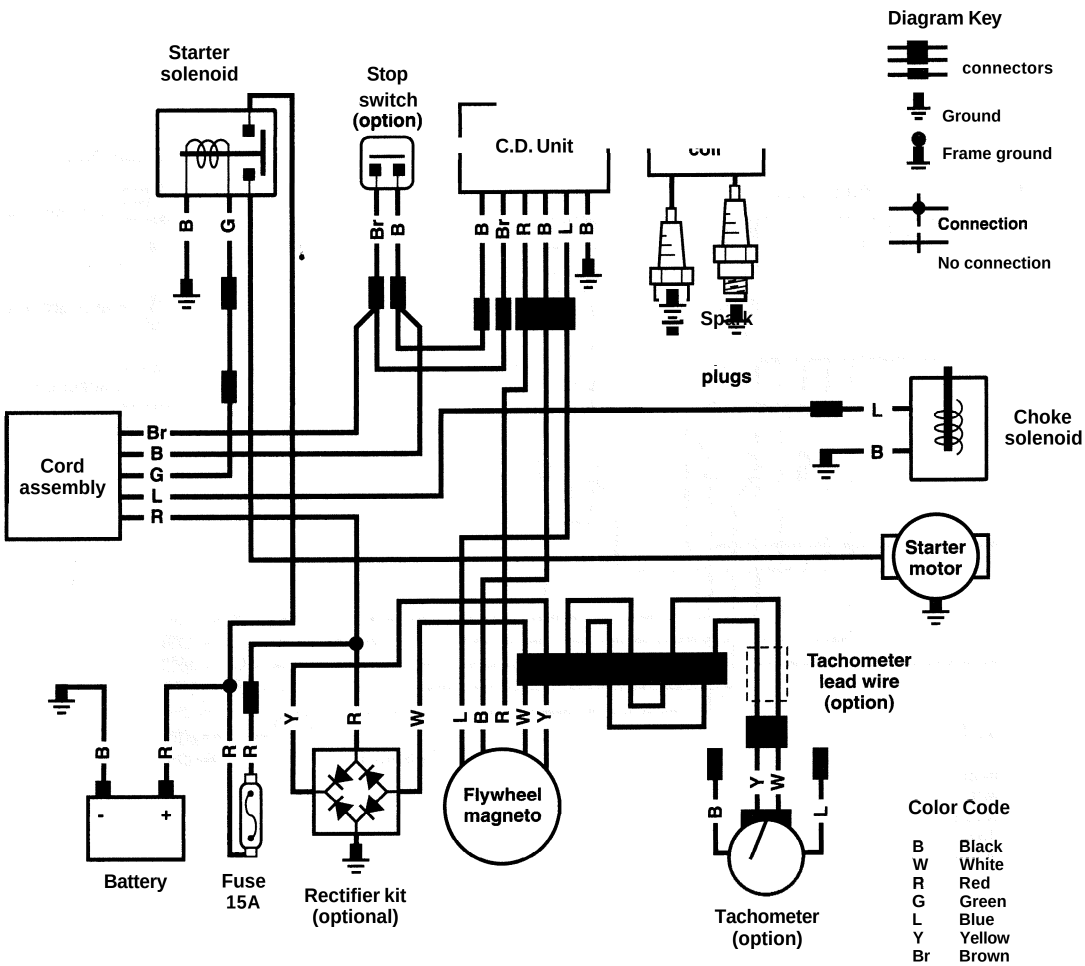
9.9D/15D/18E MODELS



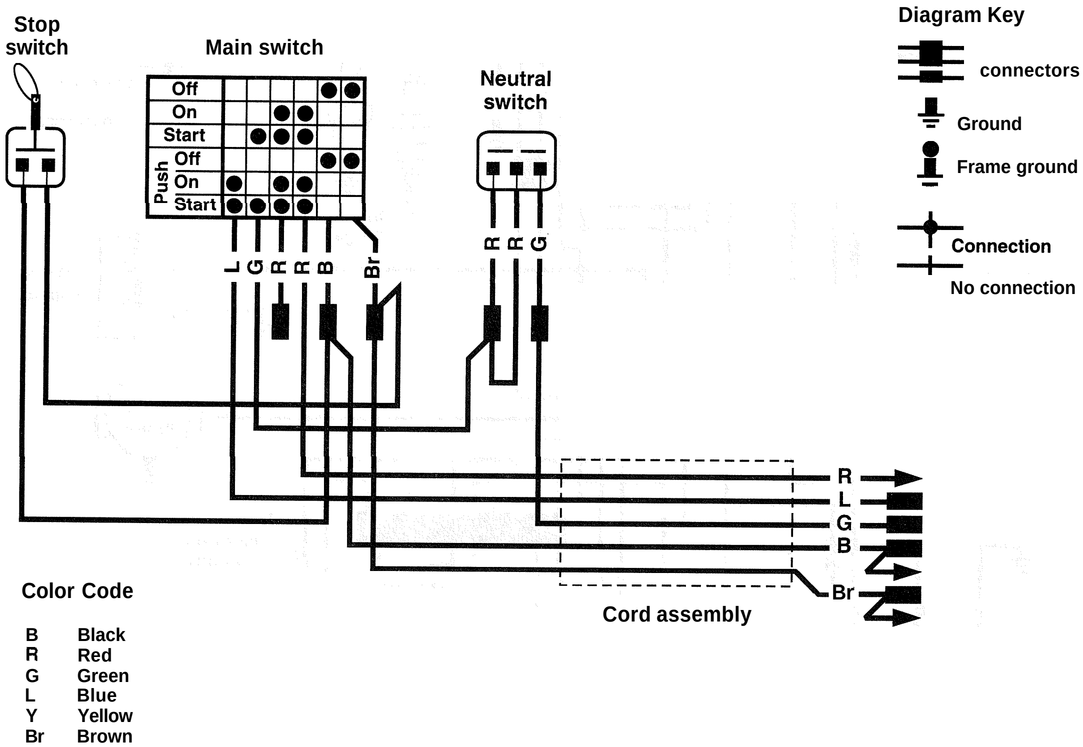
9.9D/15D/18E (EF TYPE) MODELS



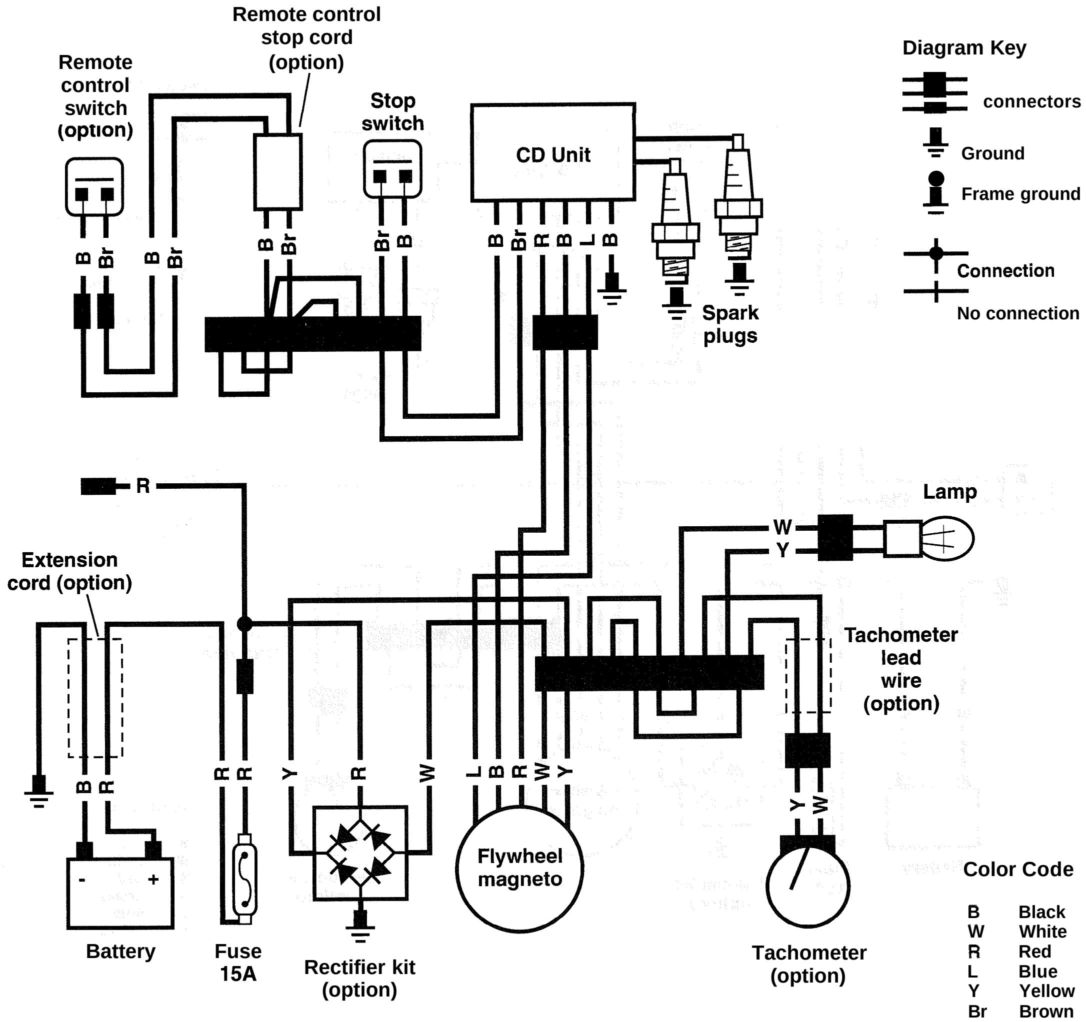
– 9.9D/15D/18E (EP TYPE) MODELS



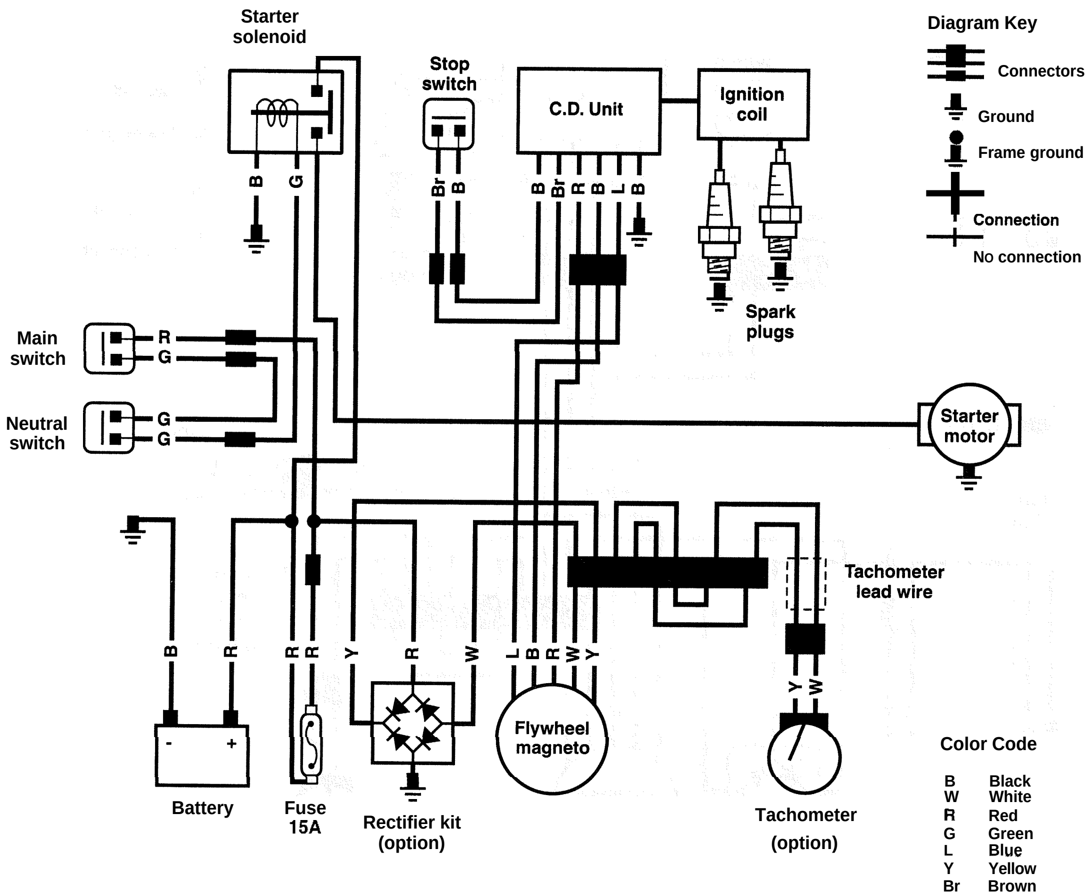
9.9115118 MODELS W/SINGLE REMOTE CONTROL BOX



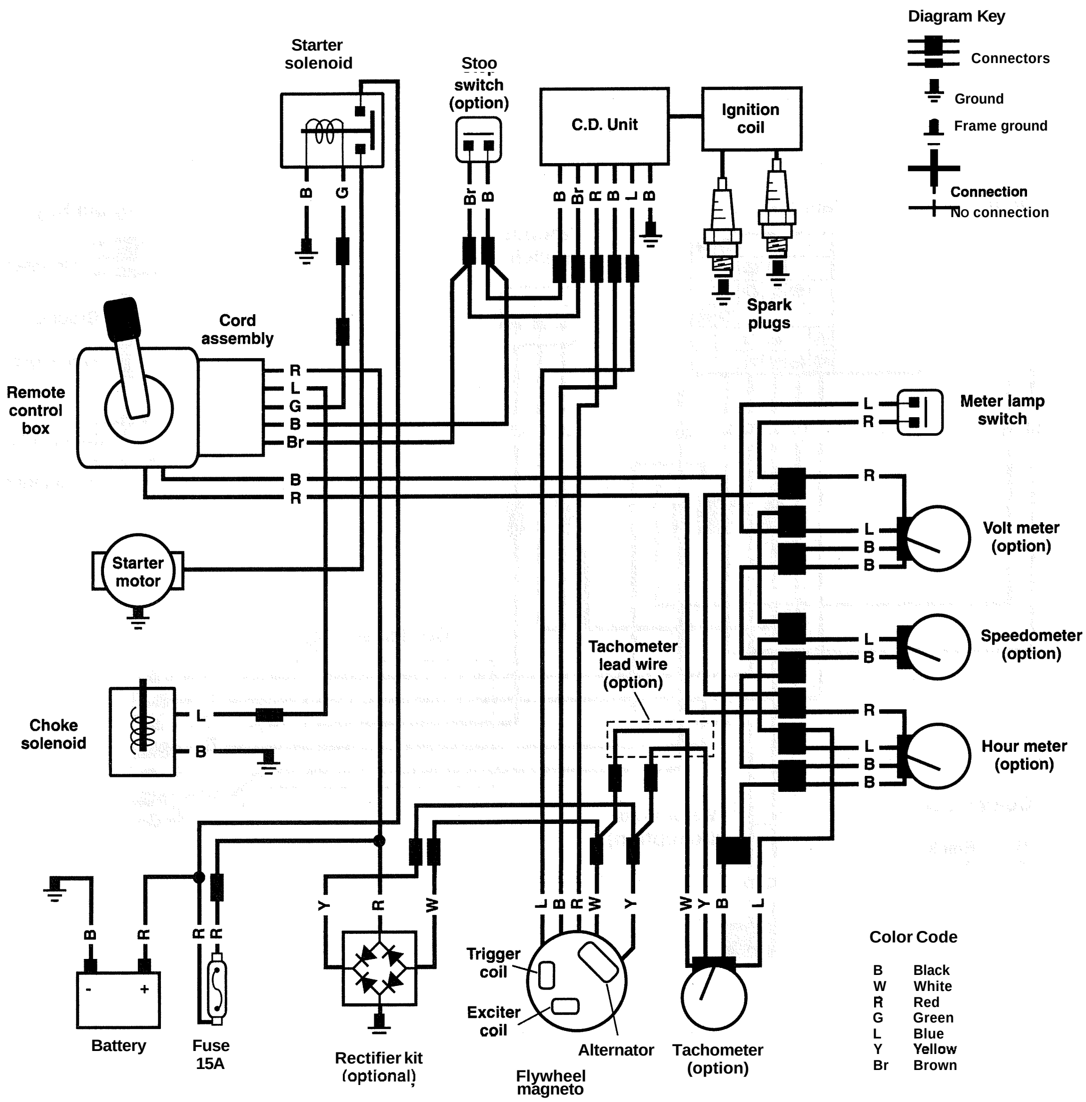
25C/30A/40C MODELS



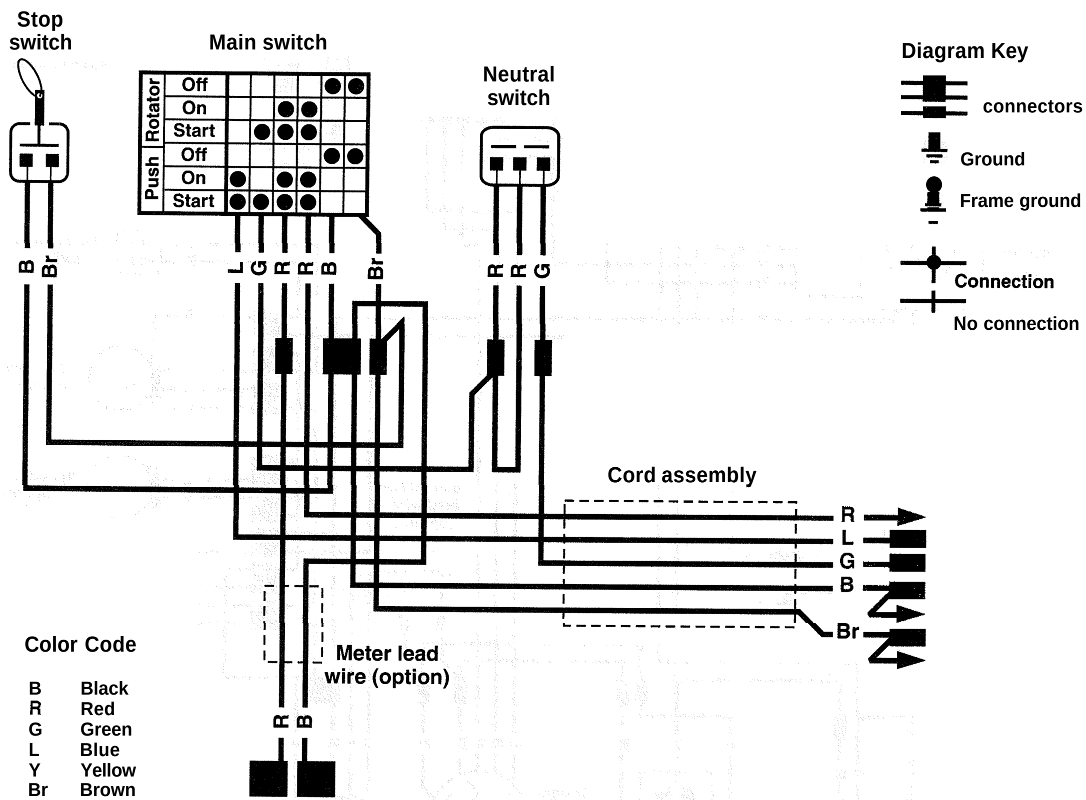
25130140 (EF TYPE) MODELS



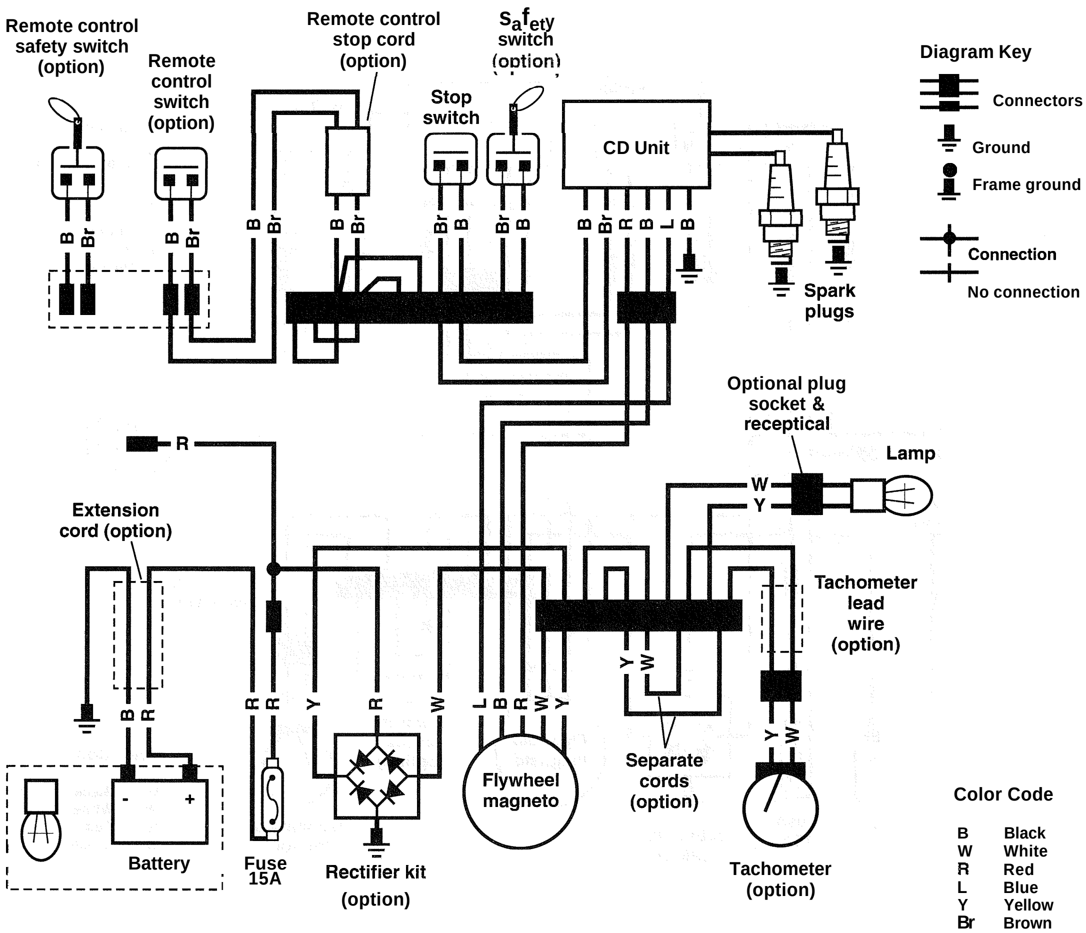
25130140 (EP TYPE) MODELS



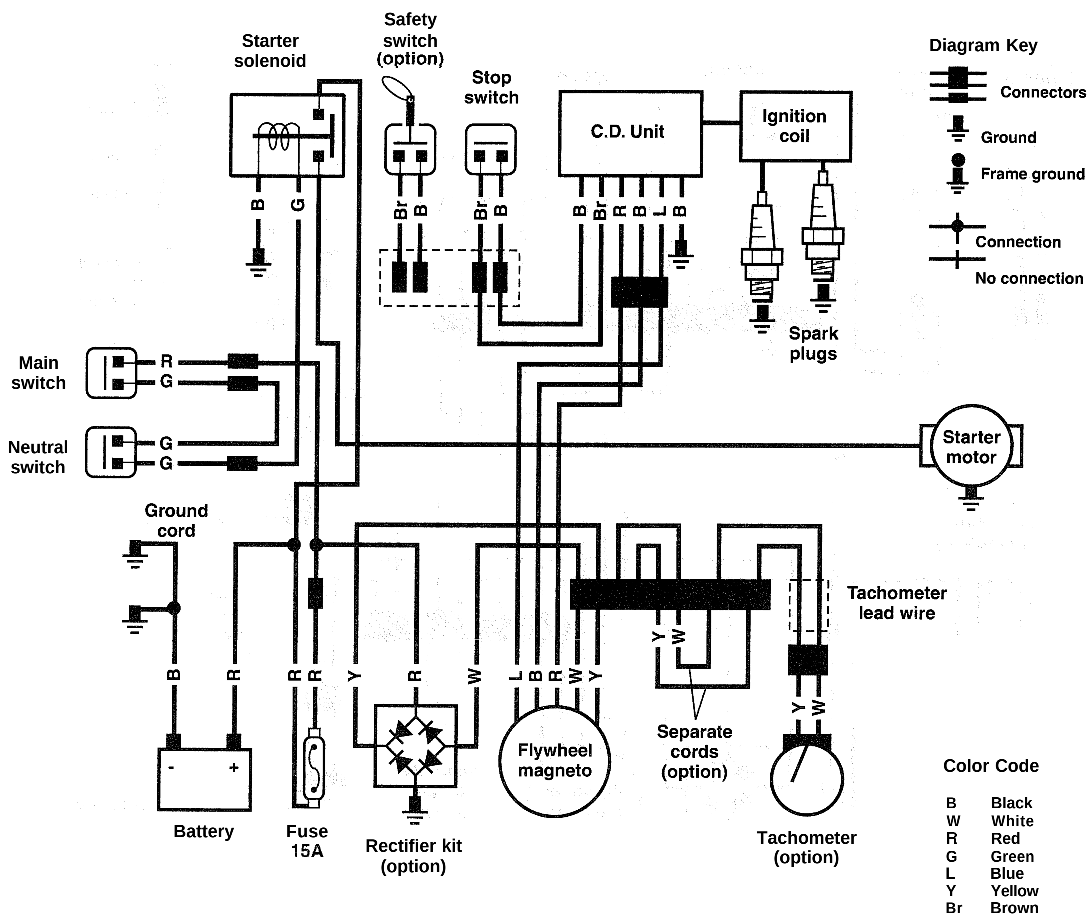
25/30/40 MODELS (SINGLE REMOTE CONTROL BOX)



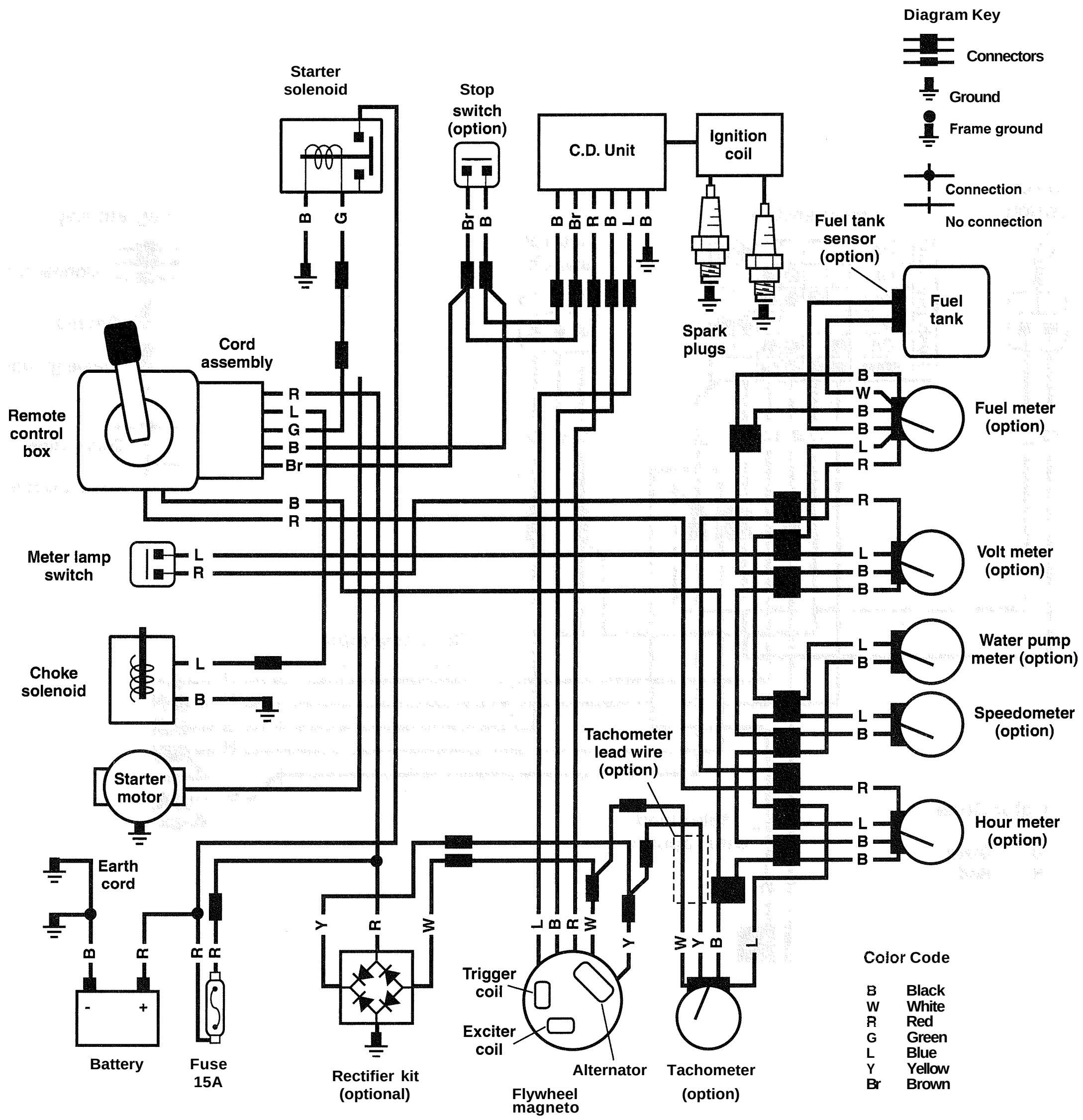
40C MODELS


Remote control
safety switch
(option)
Remote
control
switch
(option)
Remote control
stop cord
(option)
Stop
switch
Safety
switch
(option)
CD Unit
Spark
plugs
Diagram Key
Connectors
Ground
Frame ground
Connection
No connection
Optional plug
socket &
receptical
Lamp
Extension
cord (option)
Tachometer
lead
wire
(option)
Separate
cords
(option)
Battery
Fuse
15A
Rectifier kit
(option)
Flywheel
magneto
Tachometer
(option)
Color Code
B Black
W White
R Red
L Blue
Y Yellow
Br Brown

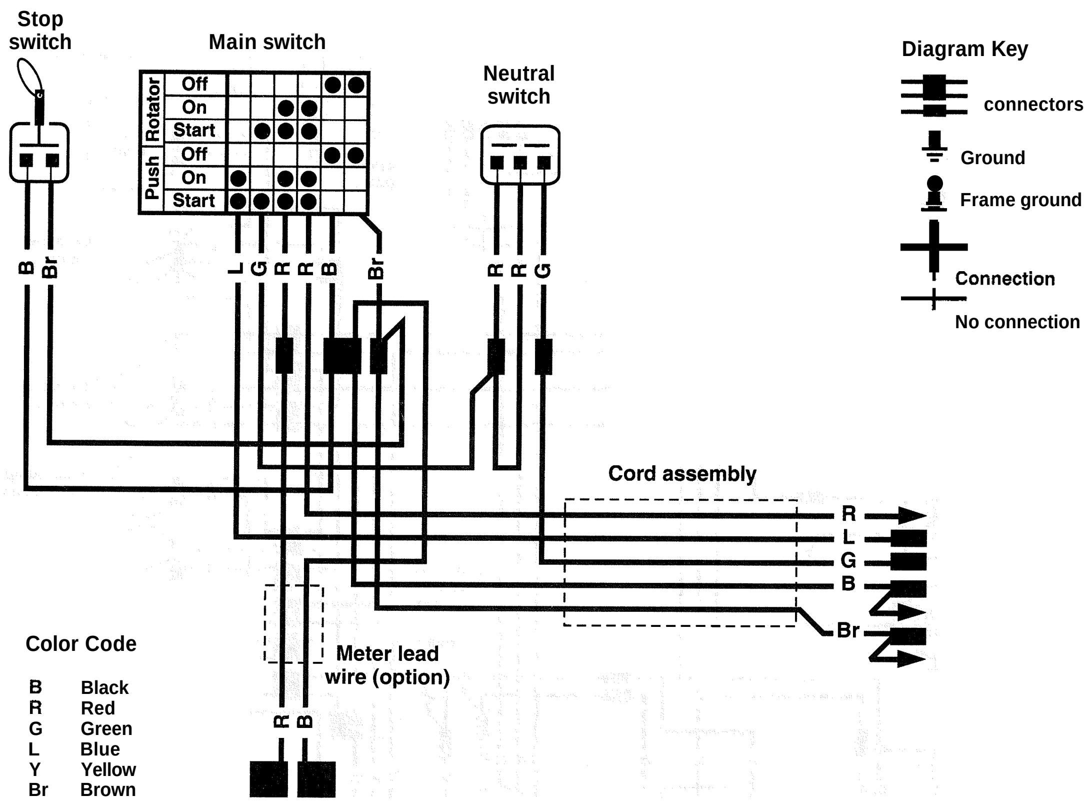
40C (EF TYPE) MODELS



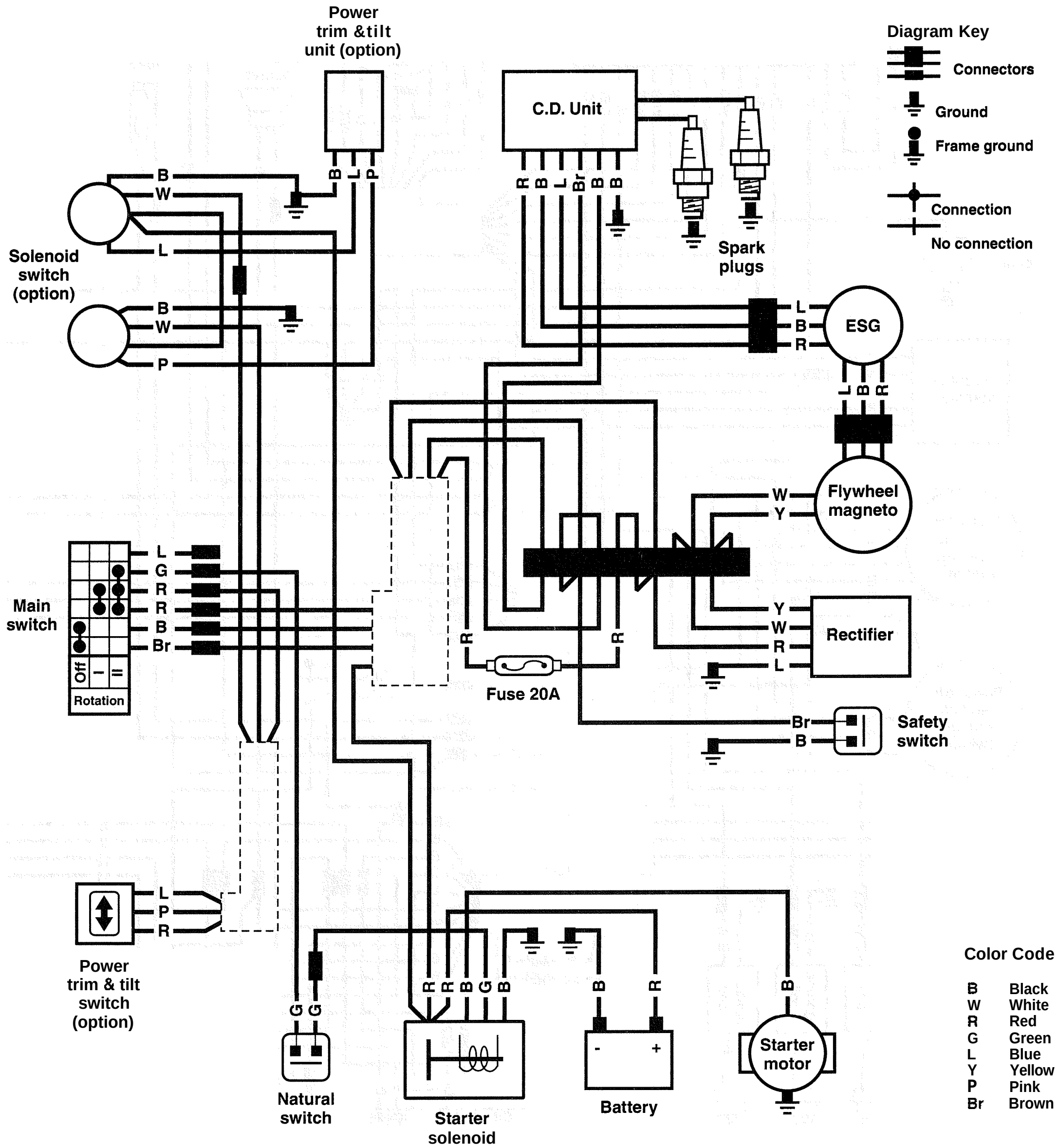
40C (EP TYPE) MODELS



40C MODEL (SINGLE REMOTE CONTROL BOX)

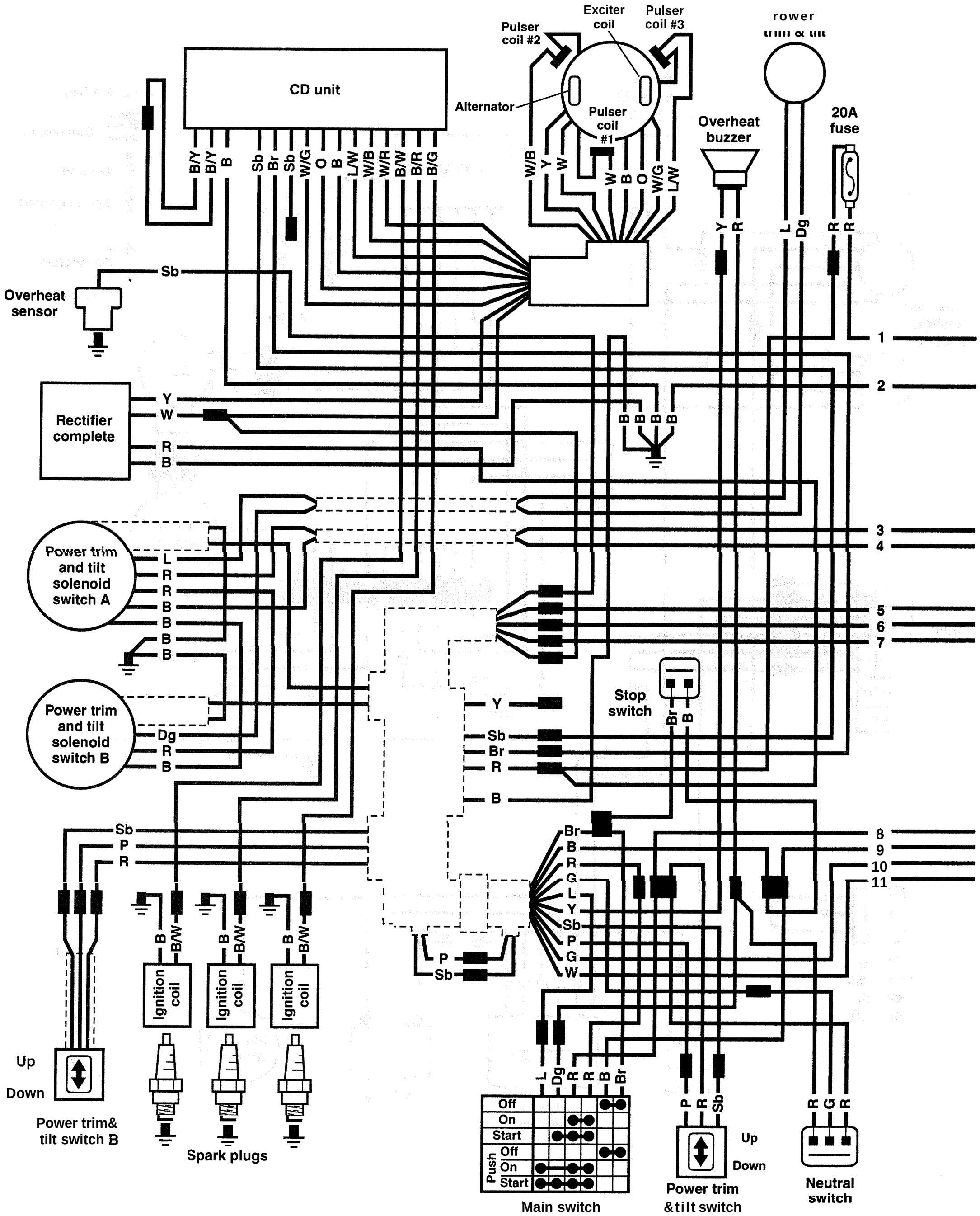


50C/60A/70A2 MODELS



13

40/50 (EPO AND EPTO TYPE) MODELS



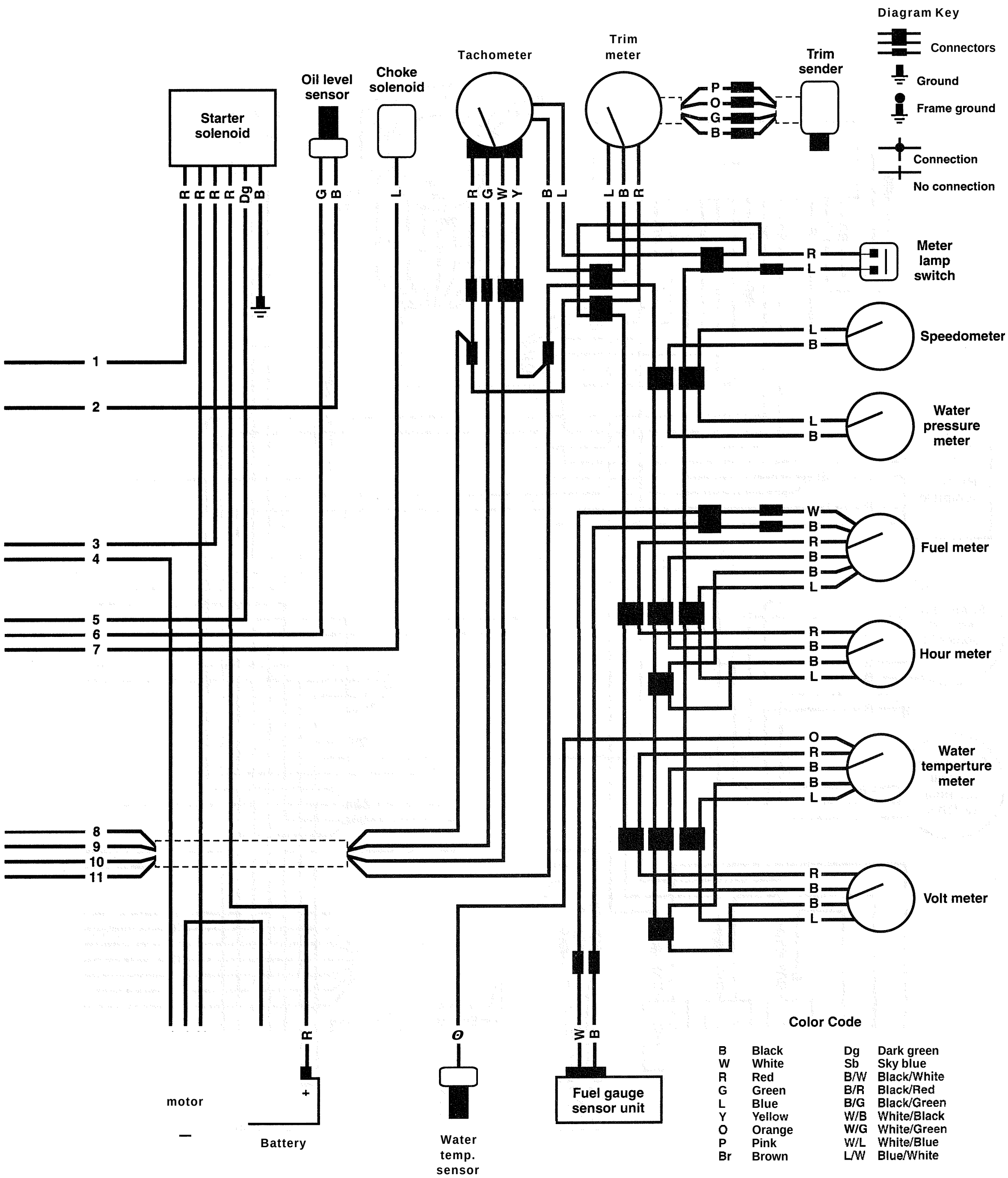
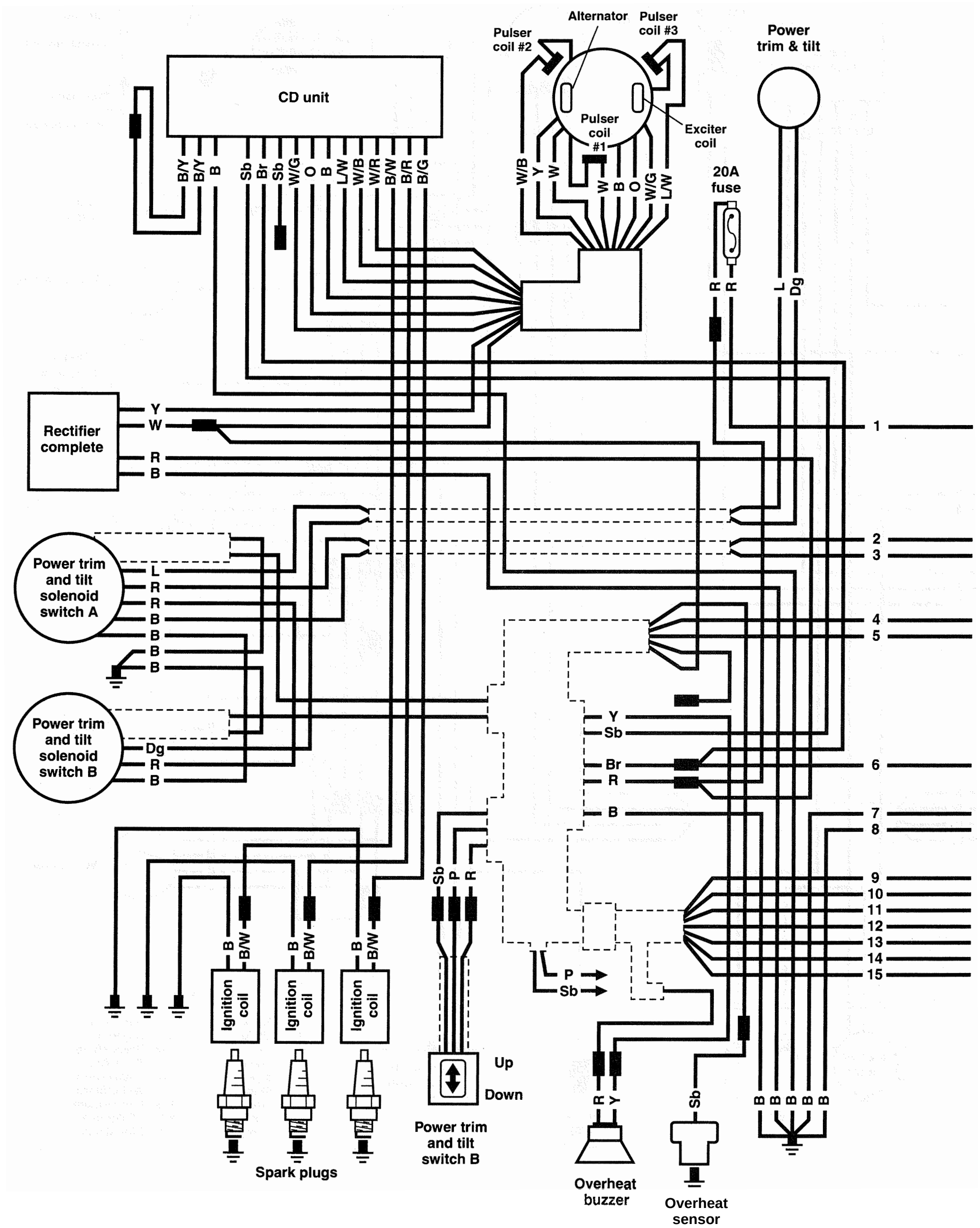
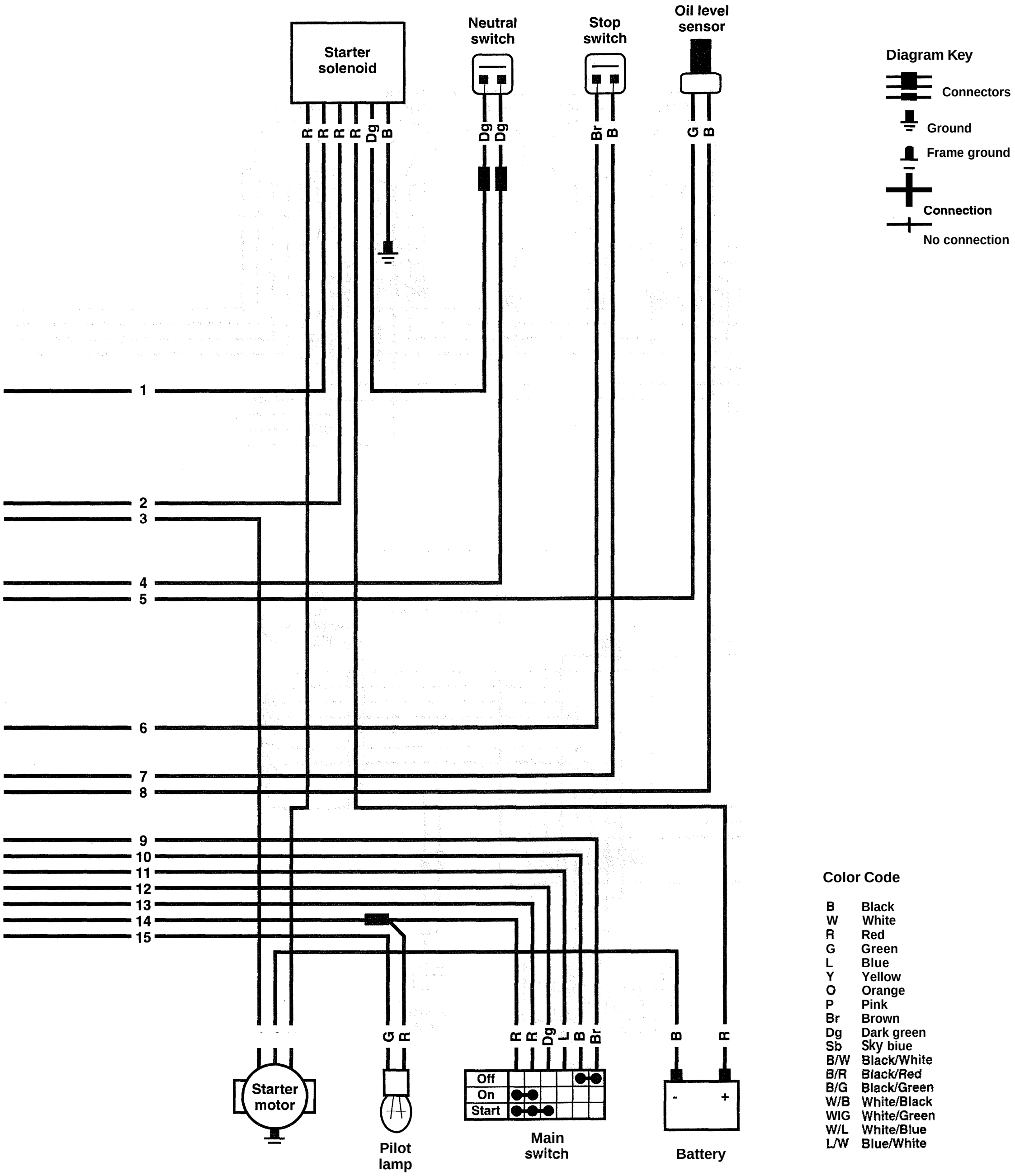


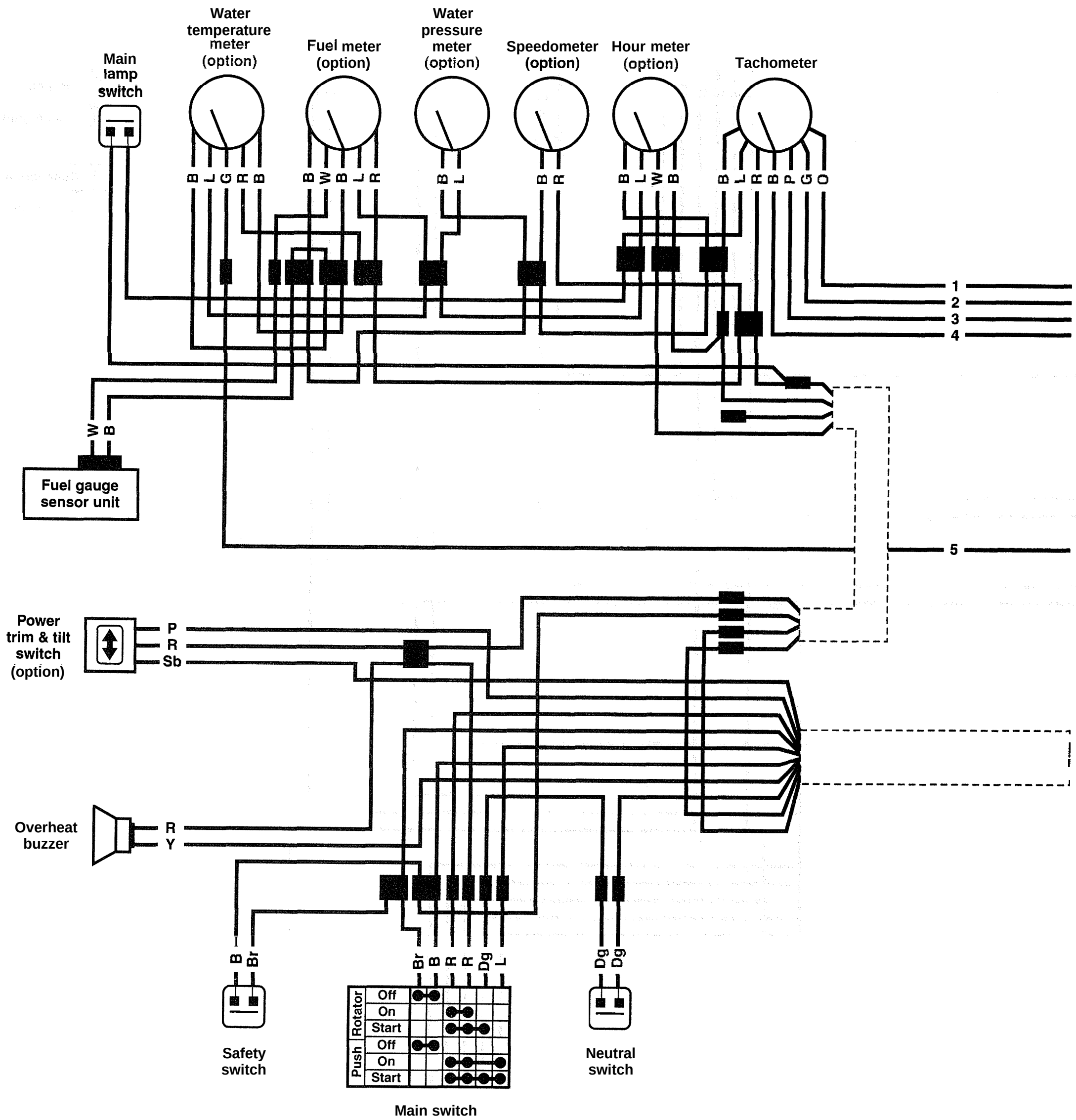
Diagram Key
Connectors
Ground
Frame ground
Connection
No connection
Starter solenoid
Oil level sensor
Choke solenoid
Tachometer
Trim meter
Trim sender
Meter lamp switch
Speedometer
Water pressure meter
Fuel meter
Hour meter
Water temperture meter
Volt meter
1
2
3
4
5
6
7
8
9
10
11
motor
Battery
Water temp. sensor
Fuel gauge sensor unit
Color Code
B Black
W White
R Red
G Green
L Blue
Y Yellow
O Orange
P Pink
Br Brown
Dg Dark green
Sb Sky blue
B/W Black/White
B/R Black/Red
B/G Black/Green
W/B White/Black
W/G White/Green
W/L White/Blue
L/W Blue/White

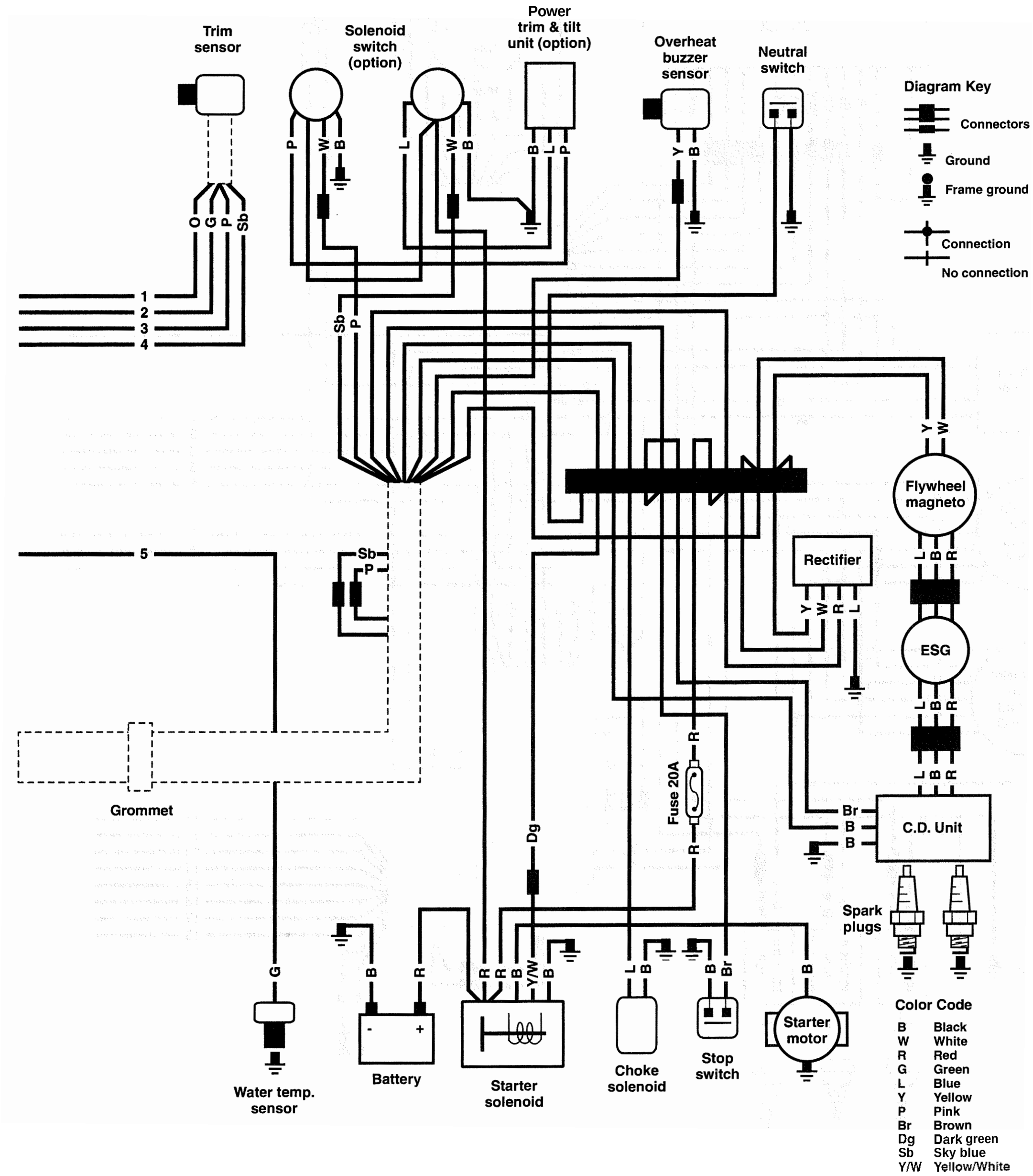
40/50 (F, EF, EFO, EFTO TYPE) MODELS




Starter solenoid
R R R R Dg B
Neutral switch
Dg Dg
Stop switch
Br B
Oil level sensor
G B
Diagram Key
Connectors
Ground
Frame ground
Connection
No connection
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
G R
R R Dg L B Br
B R
Starter motor
Pilot lamp
Off
On
Start
Main switch
-
+
Battery
Color Code
B Black
W White
R Red
G Green
L Blue
Y Yellow
O Orange
P Pink
Br Brown
Dg Dark green
Sb Sky blue
B/W Black/White
B/R Black/Red
B/G Black/Green
W/B White/Black
W/G White/Green
W/L White/Blue
L/W Blue/White

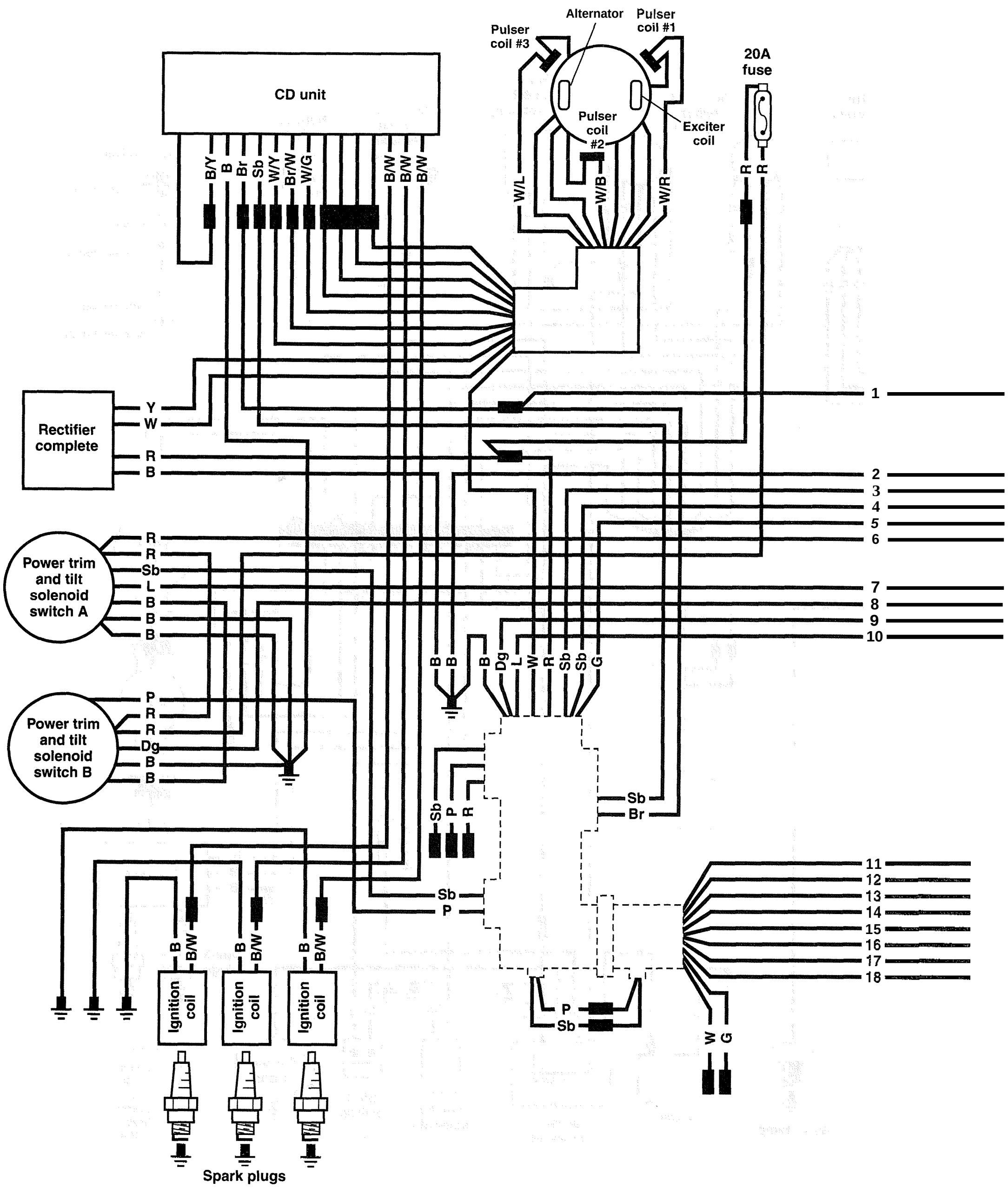
50C/60A/70A2 MODELS

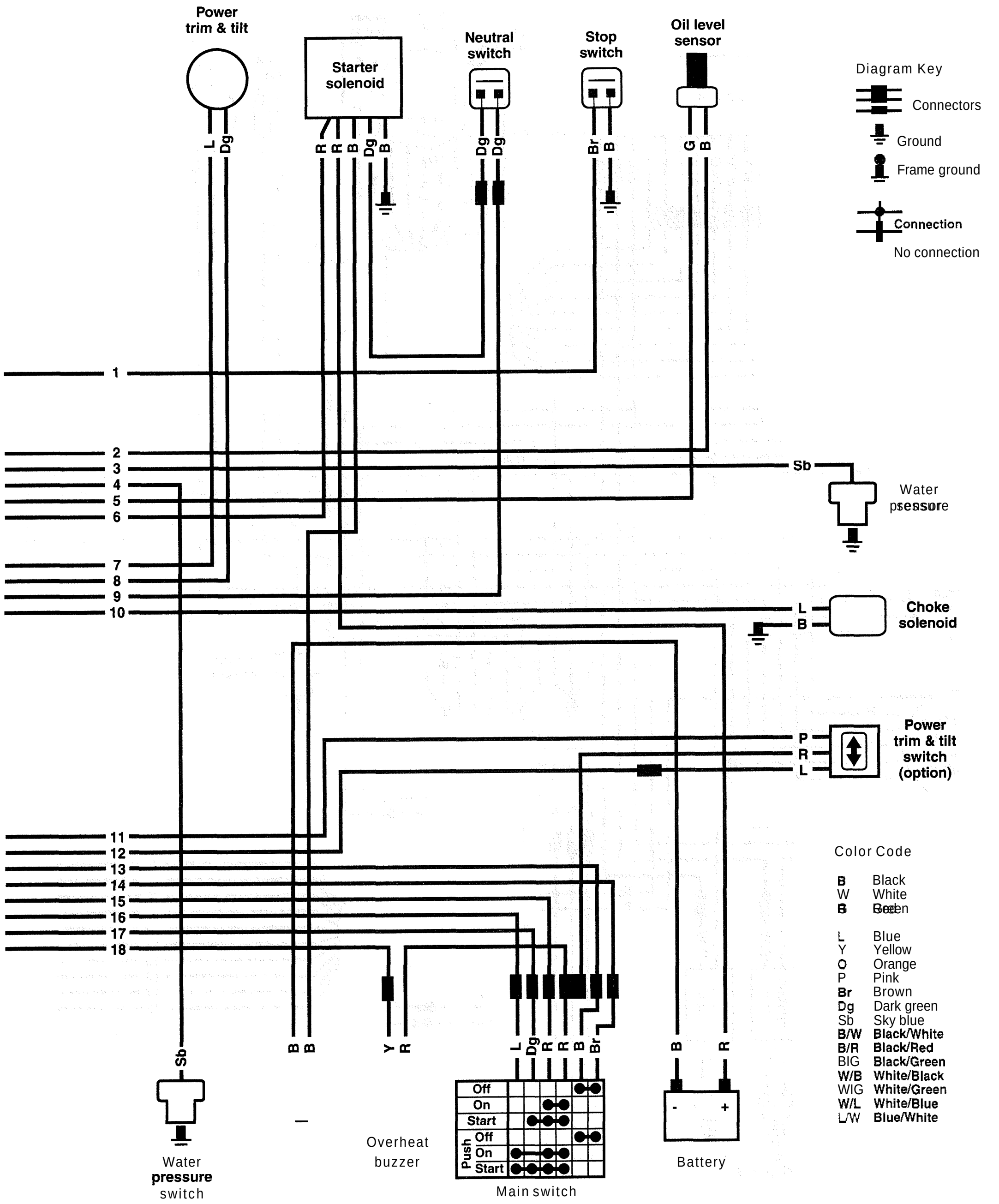



Trim sensor
Solenoid switch (option)
Power trim & tilt unit (option)
Overheat buzzer sensor
Neutral switch
Diagram Key
Connectors
Ground
Frame ground
Connection
No connection
Flywheel magneto
Rectifier
ESG
Grommet
Fuse 20A
C.D. Unit
Spark plugs
Water temp. sensor
Battery
Starter solenoid
Choke solenoid
Stop switch
Starter motor
Color Code
B Black
W White
R Red
G Green
L Blue
Y Yellow
P Pink
Br Brown
Dg Dark green
Sb Sky blue
Y/W Yellow/White

13

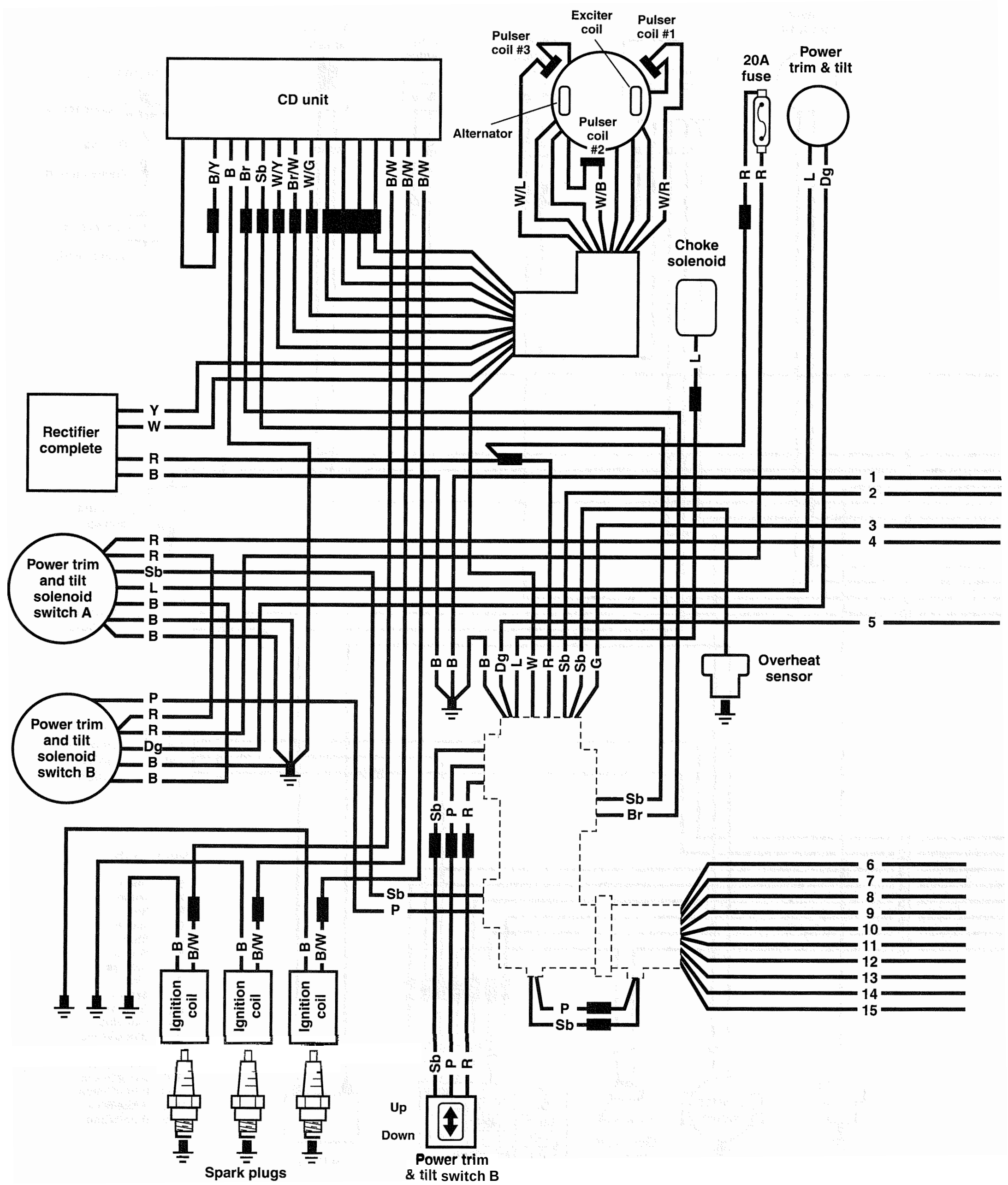
60/70/90/120/140 (EFO, EFTO) MODELS




Power trim & tilt
Starter solenoid
Neutral switch
Stop switch
Oil level sensor
Diagram Key
Connectors
Ground
Frame ground
Connection
No connection
Water pressure sensor
Choke solenoid
Power trim & tilt switch (option)
Color Code
B Black
W White
G Green
R Red
L Blue
Y Yellow
O Orange
P Pink
Br Brown
Dg Dark green
Sb Sky blue
B/W Black/White
B/R Black/Red
B/G Black/Green
W/B White/Black
W/G White/Green
W/L White/Blue
L/W Blue/White
Off
On
Start
Push
Water pressure switch
Overheat buzzer
Main switch
Battery

13

60/70/90/120/140/ (EPO, EPTO) MODELS



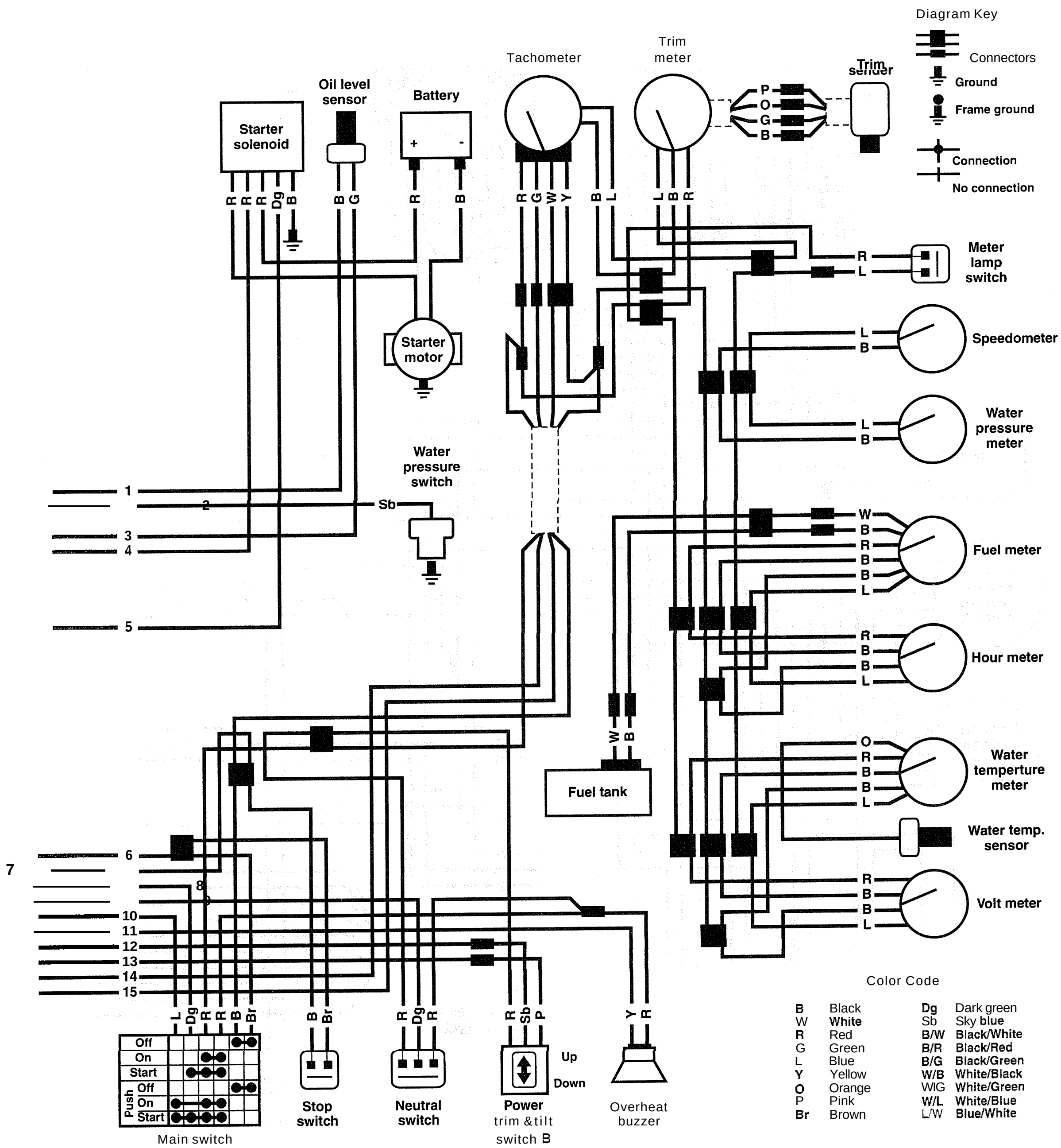
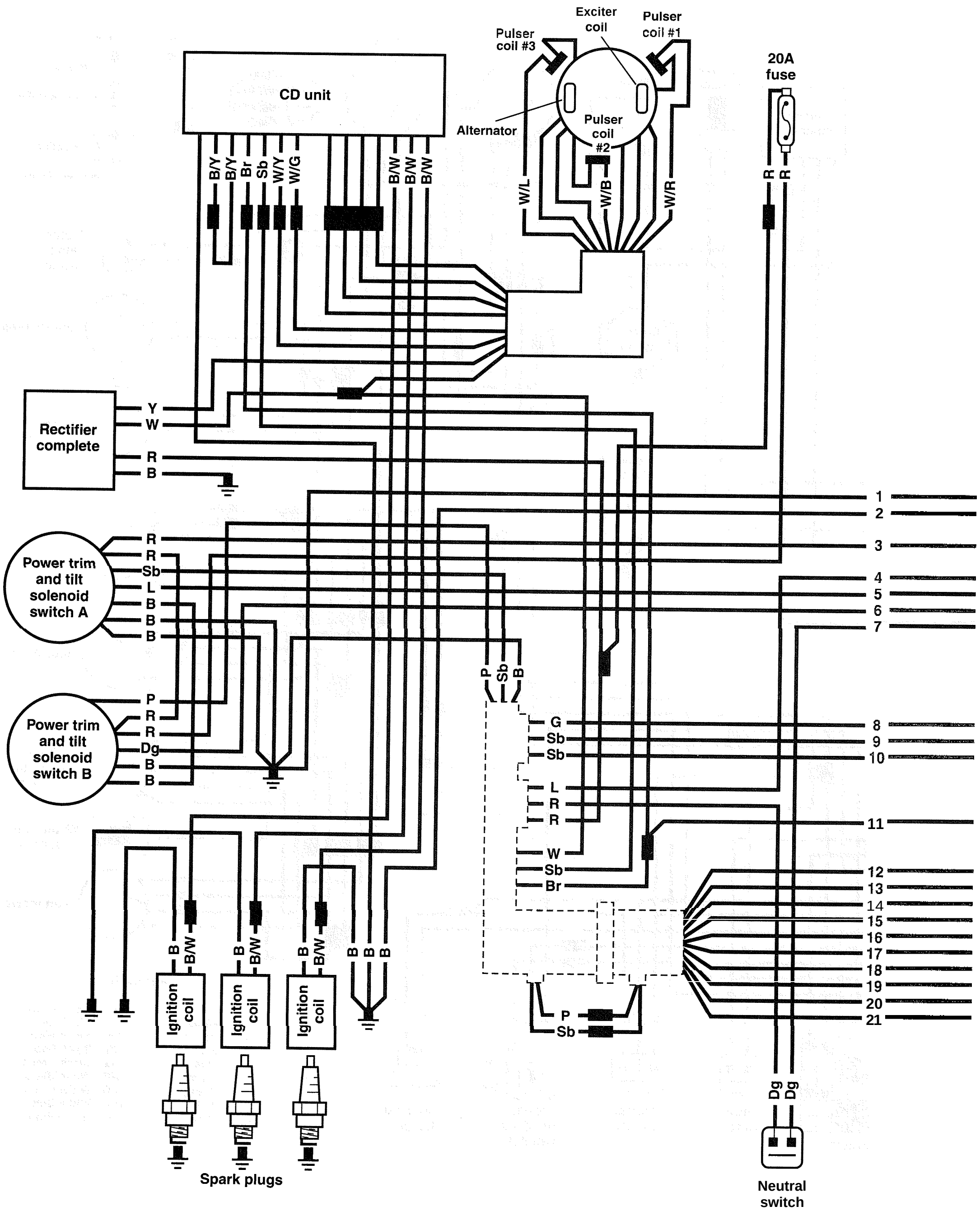


Diagram Key
Connectors
Ground
Frame ground
Connection
No connection
Tachometer
Trim meter
Trim sender
Oil level sensor
Battery
Starter solenoid
Starter motor
Water pressure switch
Meter lamp switch
Speedometer
Water pressure meter
Fuel meter
Hour meter
Fuel tank
Water temperture meter
Water temp. sensor
Volt meter
Off
On
Start
Push
Main switch
Stop switch
Neutral switch
Up
Down
Power trim &tilt switch B
Overheat buzzer
Color Code
B Black
W White
R Red
G Green
L Blue
Y Yellow
O Orange
P Pink
Br Brown
Dg Dark green
Sb Sky blue
B/W Black/White
B/R Black/Red
B/G Black/Green
W/B White/Black
W/G White/Green
W/L White/Blue
L/W Blue/White

60/70/90/120/140 (EF, (T) O) MODELS



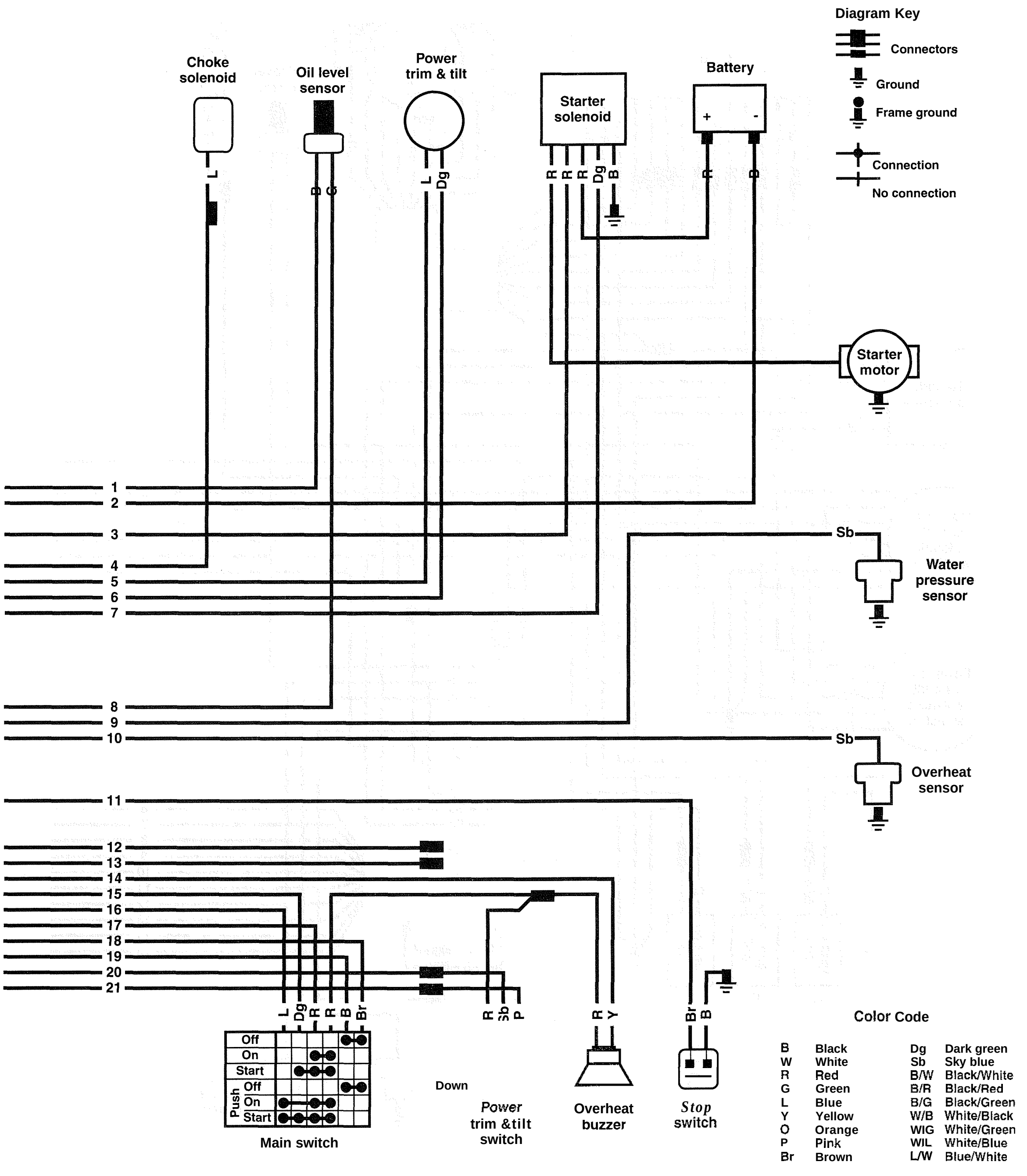
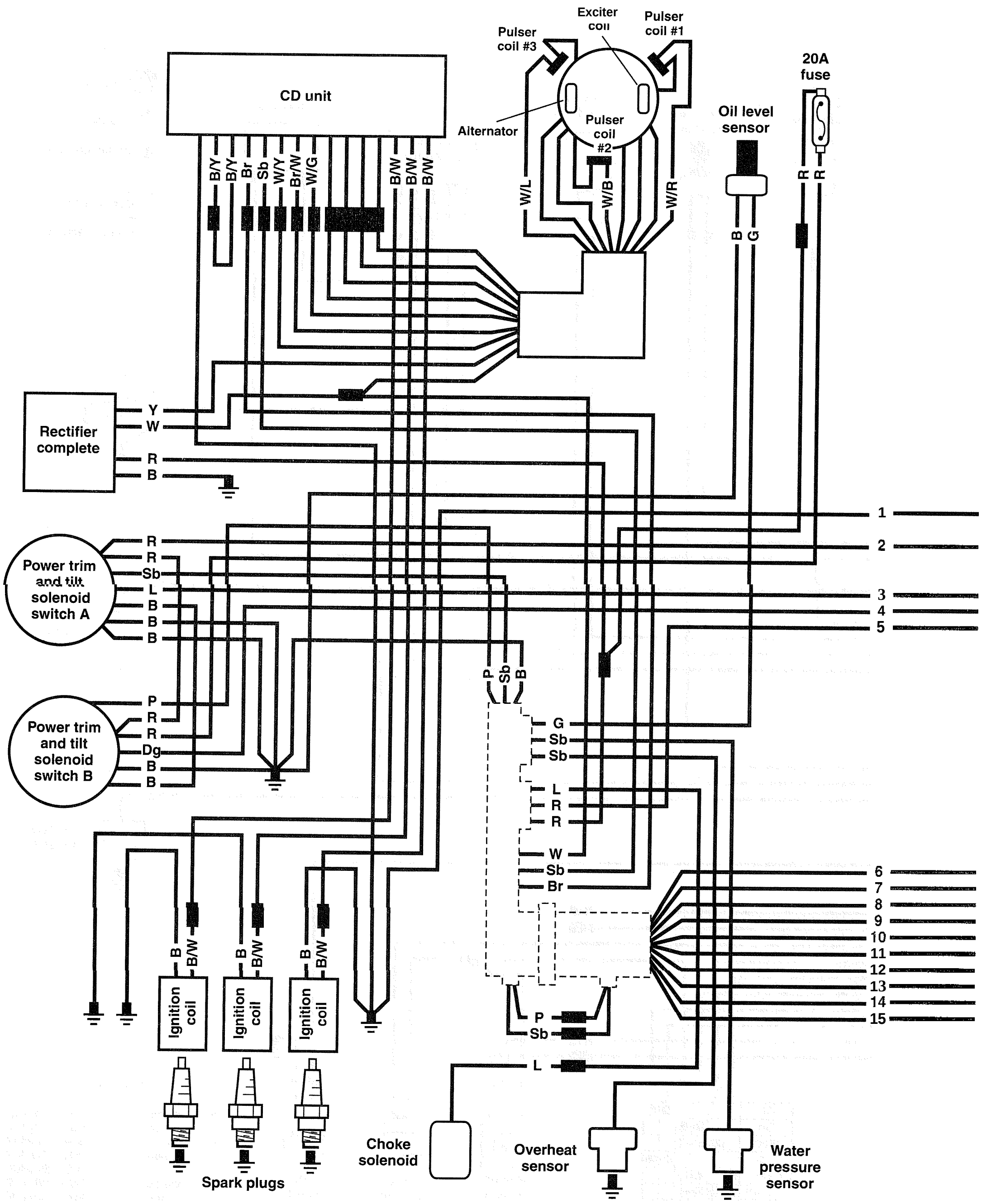


Diagram Key
Connectors
Ground
Frame ground
Connection
No connection
Choke solenoid
Oil level sensor
Power trim & tilt
Starter solenoid
Battery
Starter motor
Water pressure sensor
Overheat sensor
Off
On
Start
Push
Main switch
Down
Power trim &tilt switch
Overheat buzzer
Stop switch
Color Code
B Black
W White
R Red
G Green
L Blue
Y Yellow
O Orange
P Pink
Br Brown
Dg Dark green
Sb Sky blue
B/W Black/White
B/R Black/Red
B/G Black/Green
W/B White/Black
WIG White/Green
WIL White/Blue
L/W Blue/White

13

60/70/90/120/140 (EPTO) MODELS



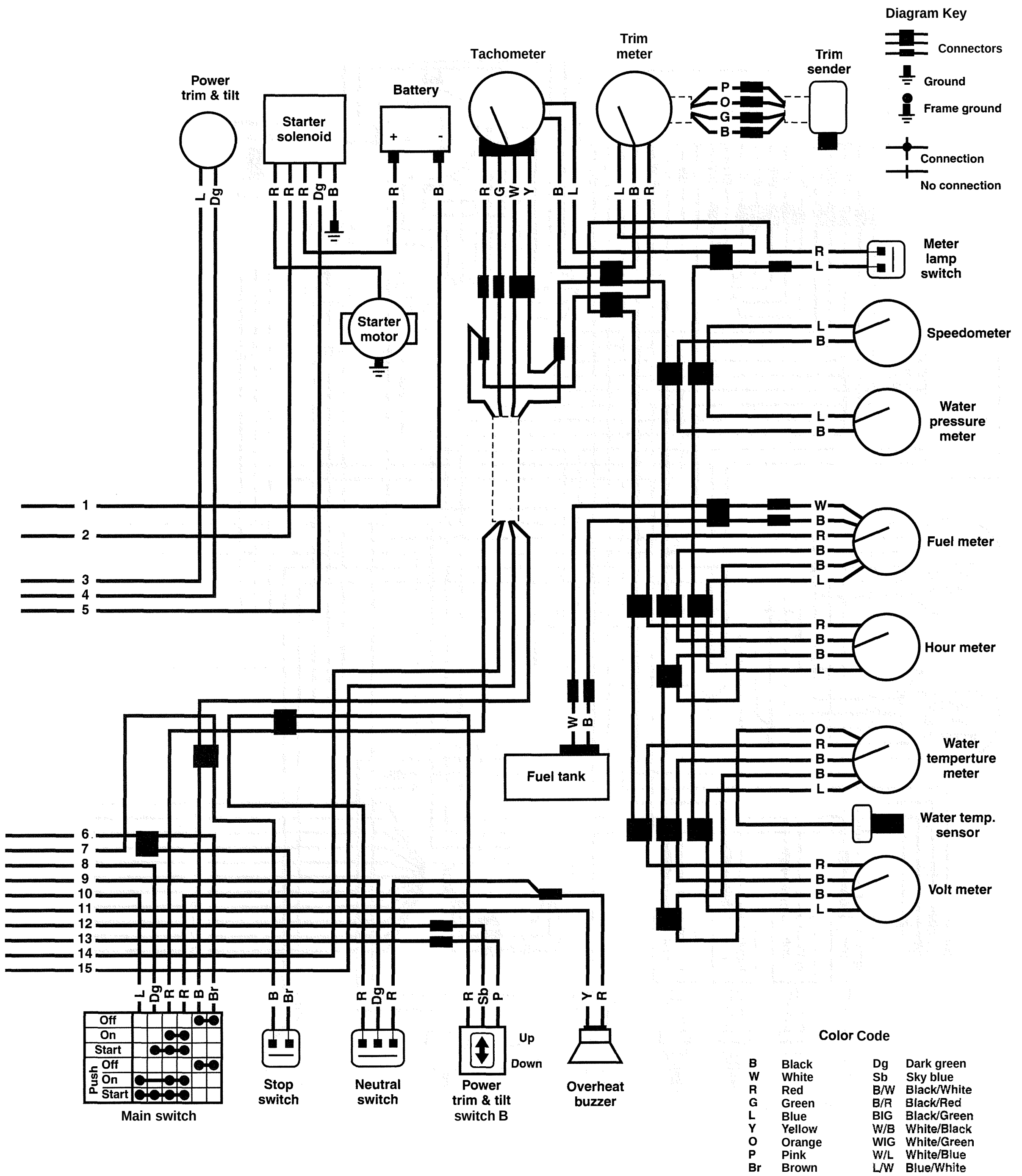
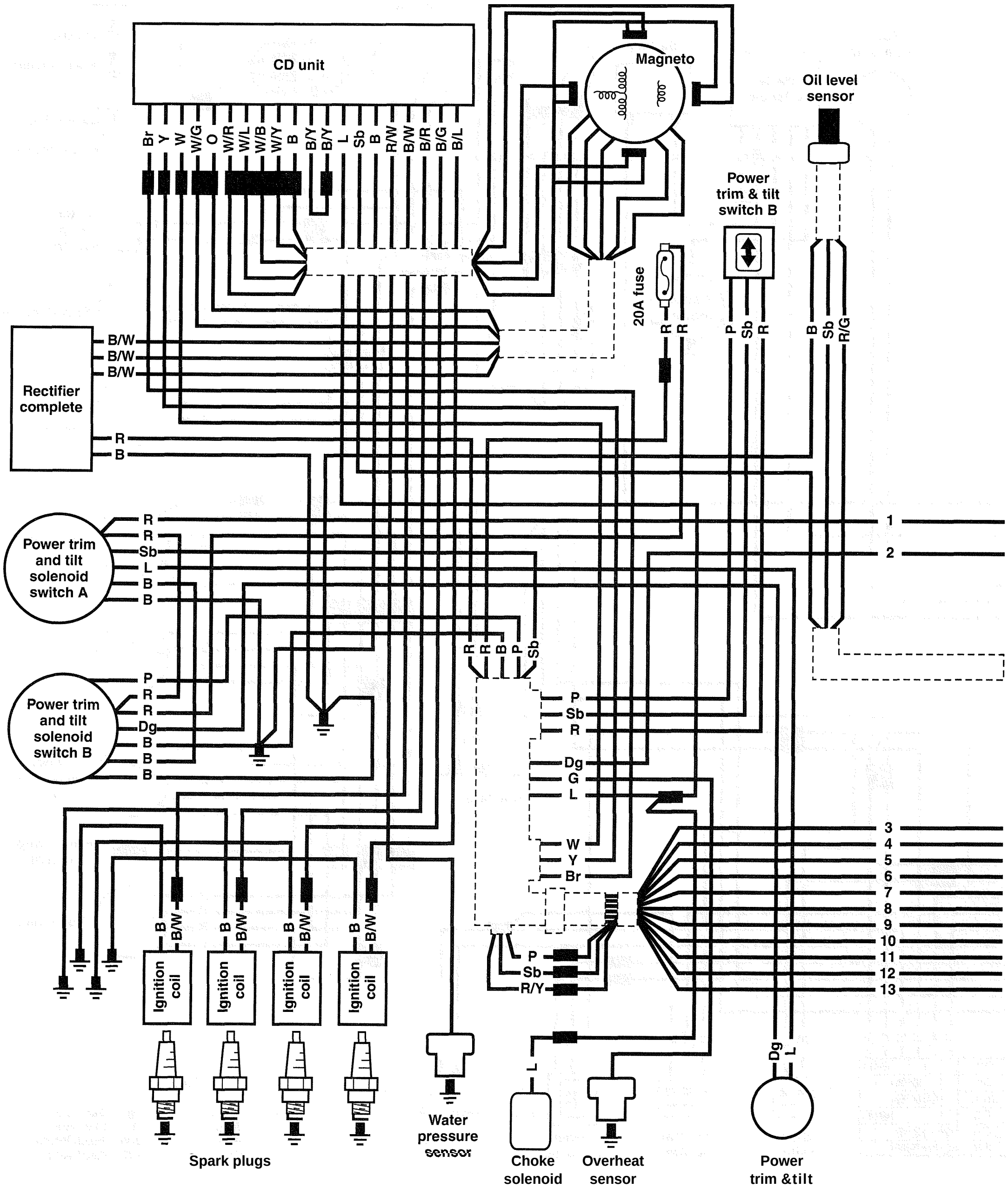
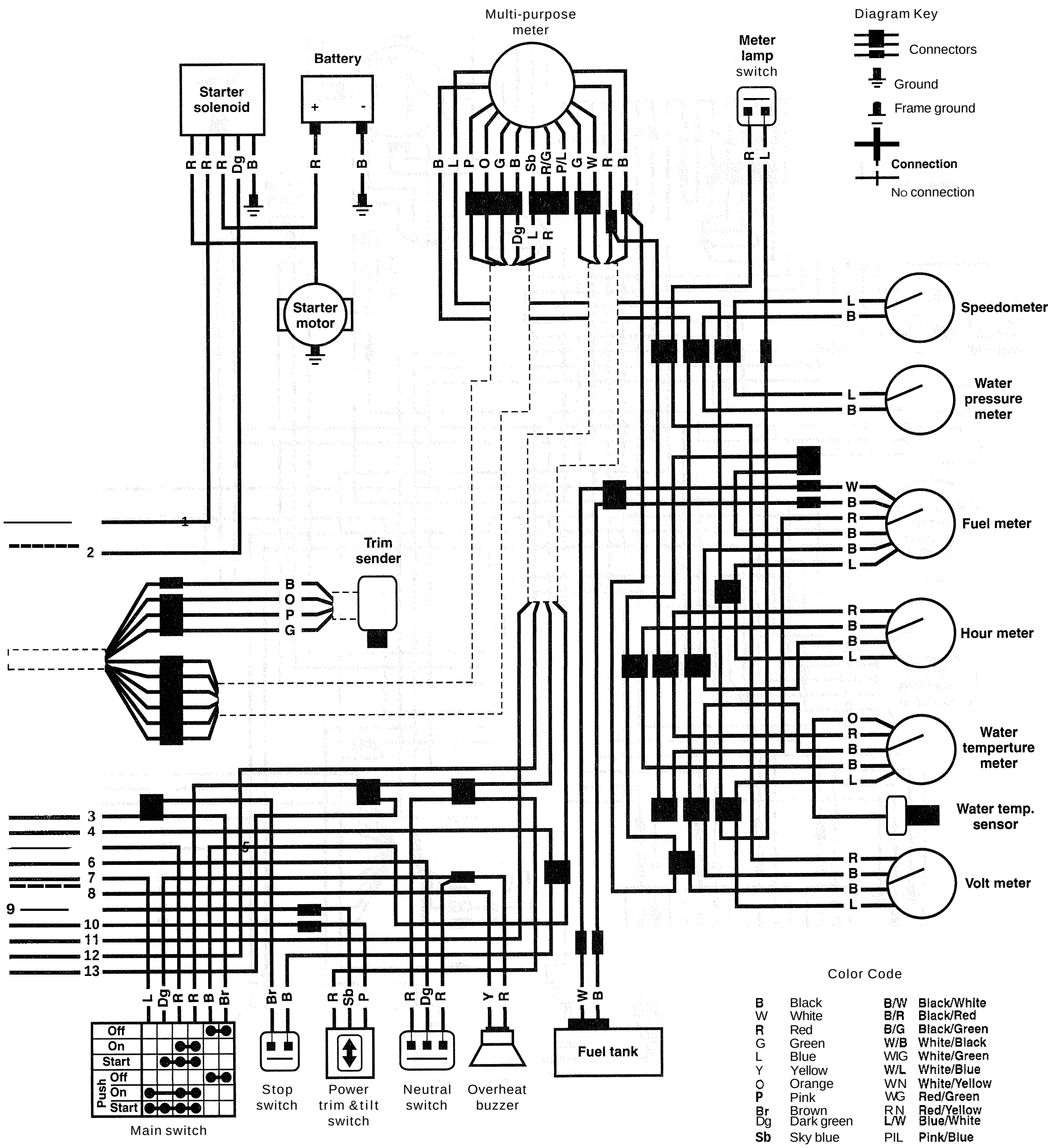


Diagram Key
Connectors
Ground
Frame ground
Connection
No connection
Power trim & tilt
Starter solenoid
Battery
Tachometer
Trim meter
Trim sender
Starter motor
Meter lamp switch
Speedometer
Water pressure meter
Fuel meter
Hour meter
Fuel tank
Water temperture meter
Water temp. sensor
Volt meter
Off
On
Start
Push
Main switch
Stop switch
Neutral switch
Up
Down
Power trim & tilt switch B
Overheat buzzer
Color Code
B Black
W White
R Red
G Green
L Blue
Y Yellow
O Orange
P Pink
Br Brown
Dg Dark green
Sb Sky blue
B/W Black/White
B/R Black/Red
B/G Black/Green
W/B White/Black
W/G White/Green
W/L White/Blue
L/W Blue/White

13

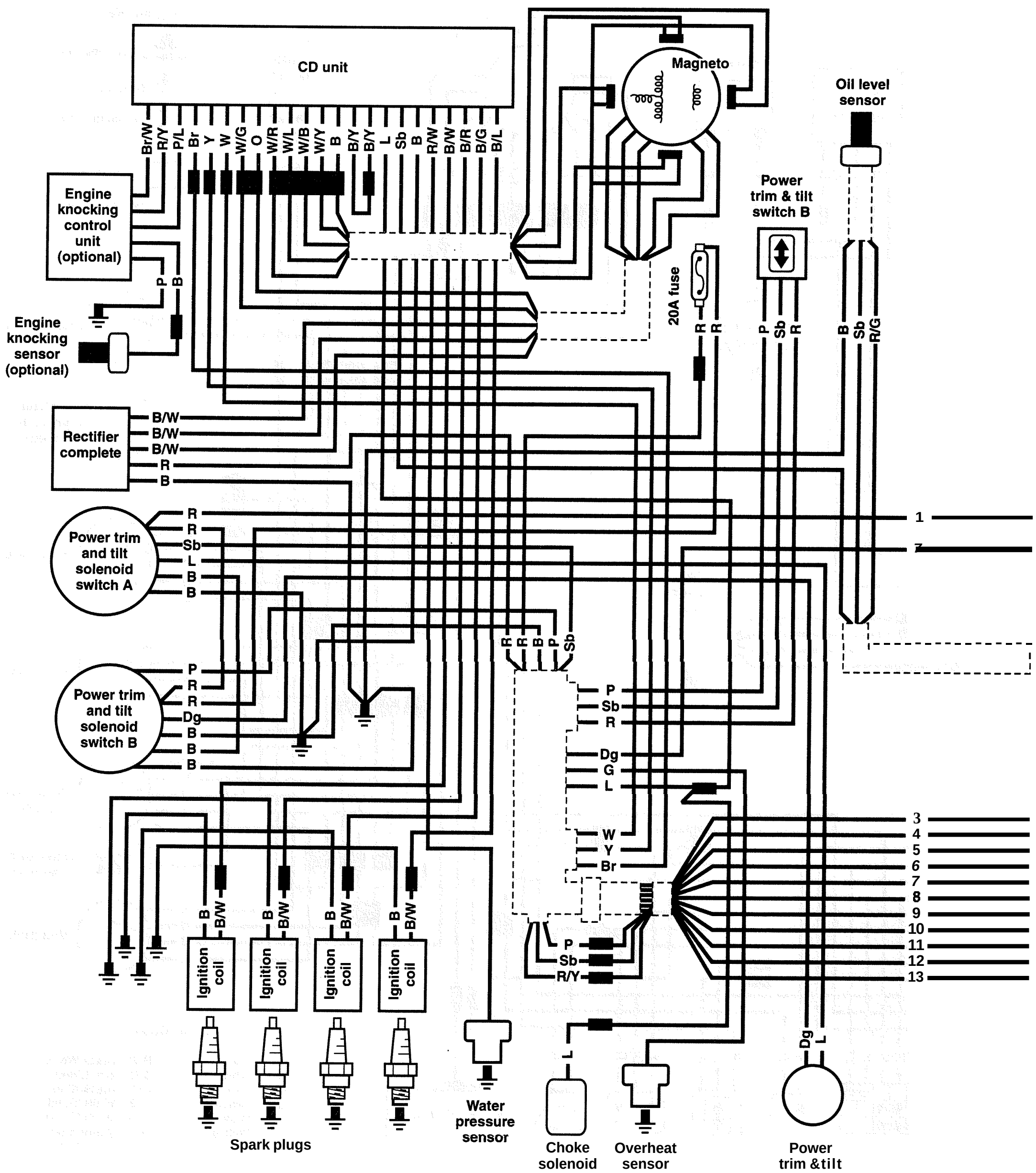
60/70/90/120/140 (120A2, 140A2, EPTQ) MODELS

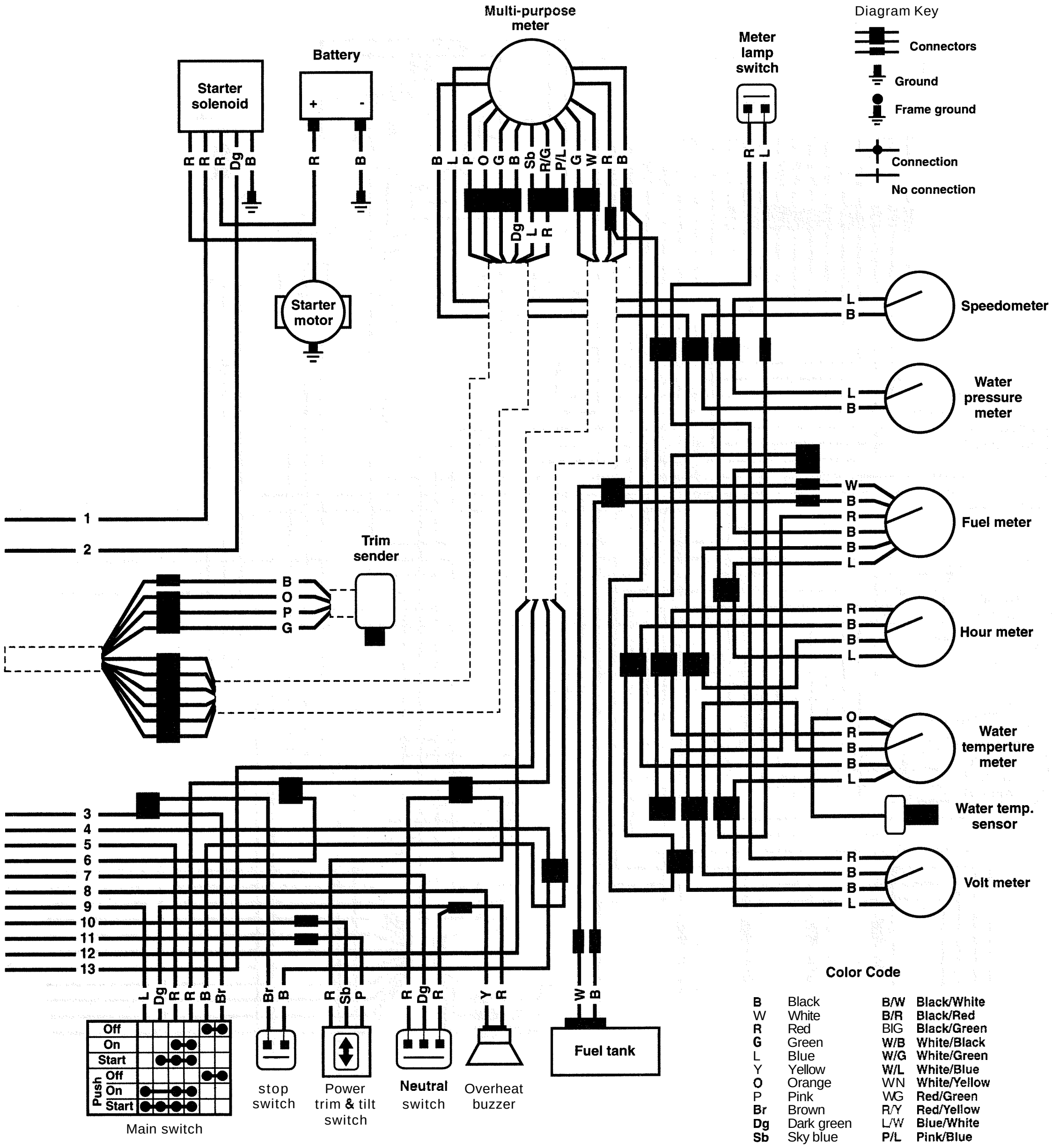



Multi-purpose meter
Meter lamp switch
Diagram Key
Connectors
Ground
Frame ground
Connection
No connection
Starter solenoid
Battery
Starter motor
Trim sender
Speedometer
Water pressure meter
Fuel meter
Hour meter
Water temperture meter
Water temp. sensor
Volt meter
Main switch
Off
On
Start
Push
Stop switch
Power trim &tilt switch
Neutral switch
Overheat buzzer
Fuel tank
Color Code
B Black
W White
R Red
G Green
L Blue
Y Yellow
O Orange
P Pink
Br Brown
Dg Dark green
Sb Sky blue
B/W Black/White
B/R Black/Red
B/G Black/Green
W/B White/Black
WIG White/Green
W/L White/Blue
WN White/Yellow
WG Red/Green
RN Red/Yellow
L/W Blue/White
PIL Pink/Blue

13

115 MODELS (PRIOR TO SERIAL NO. 003-11050-3)



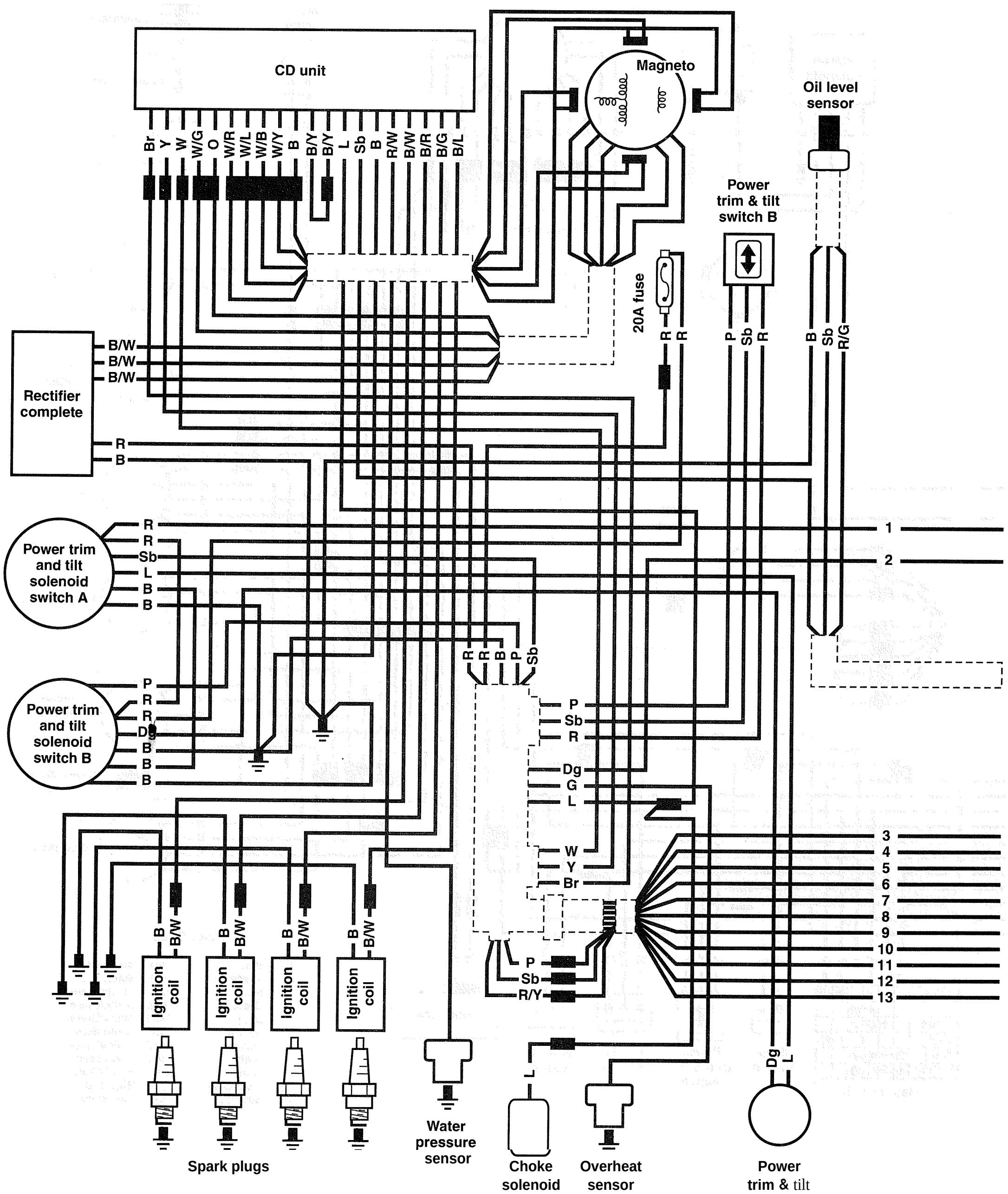


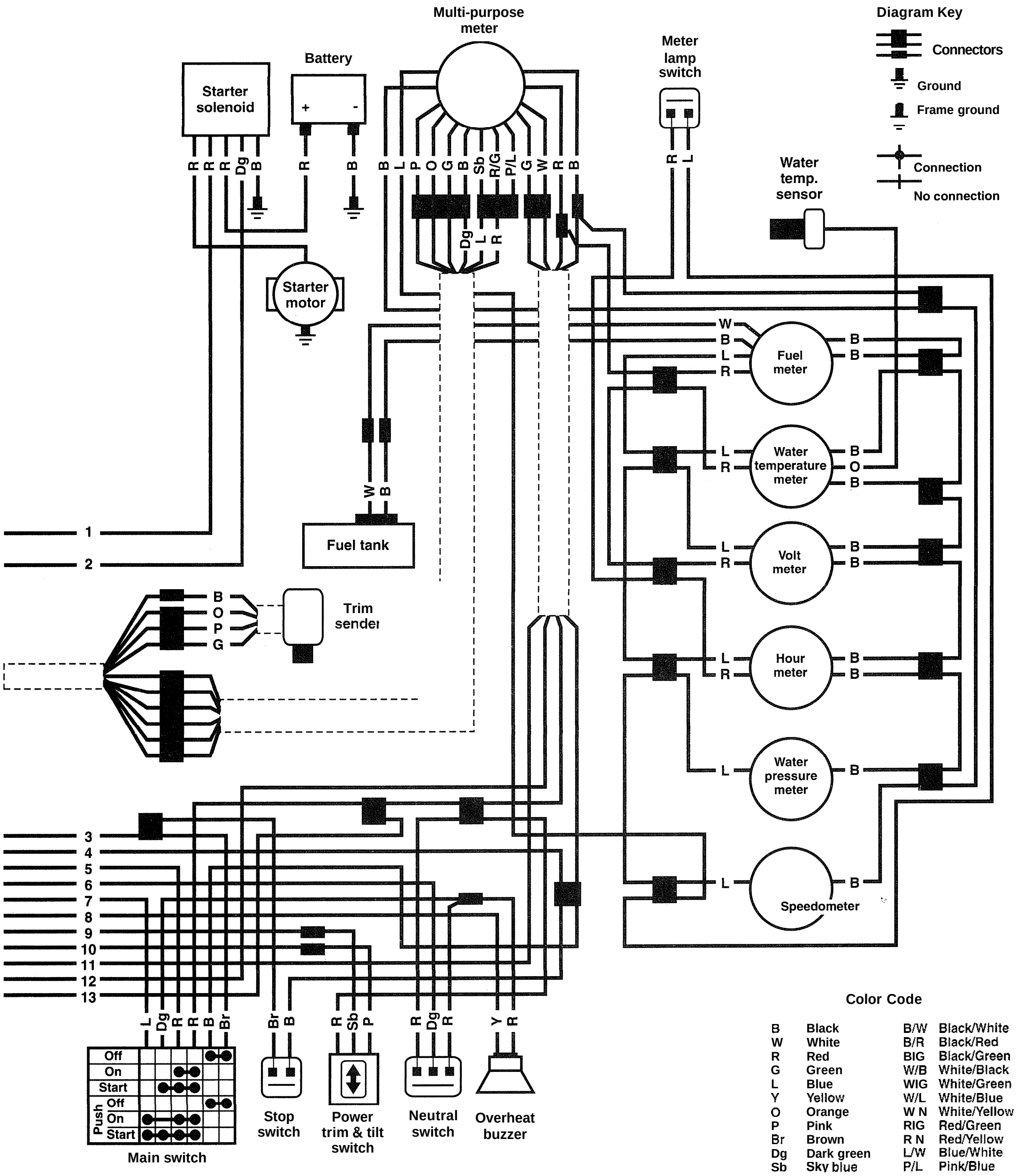
Color Code

B	Black	B/W	Black/White
W	White	B/R	Black/Red
R	Red	B/G	Black/Green
G	Green	W/B	White/Black
L	Blue	W/G	White/Green
Y	Yellow	W/L	White/Blue
O	Orange	W/Y	White/Yellow
P	Pink	R/G	Red/Green
Br	Brown	R/Y	Red/Yellow
Dg	Dark green	L/W	Blue/White
Sb	Sky blue	P/L	Pink/Blue

13

115 MODELS (No. 003-11050-3 - ON)




Multi-purpose meter
Diagram Key
Connectors
Ground
Frame ground
Connection
No connection
Starter solenoid
Battery
Meter lamp switch
Water temp. sensor
Starter motor
Fuel meter
Water temperature meter
Volt meter
Hour meter
Water pressure meter
Speedometer
Fuel tank
Trim sender
Off
On
Start
Push
Main switch
Stop switch
Power trim & tilt switch
Neutral switch
Overheat buzzer
Color Code
B Black
W White
R Red
G Green
L Blue
Y Yellow
O Orange
P Pink
Br Brown
Dg Dark green
Sb Sky blue
B/W Black/White
B/R Black/Red
BIG Black/Green
W/B White/Black
WIG White/Green
W/L White/Blue
W N White/Yellow
RIG Red/Green
R N Red/Yellow
L/W Blue/White
P/L Pink/Blue

CDI UNIT PEAK OUTPUT **VOLTAGE**

Model	(+) Test lead connection	(-) Test lead connection	Specification (peak volt)
2.5 and 3.5 hp	Orange ignition coil lead'	Black ignition coil lead	100²
5-40 hp (one and two-cylinder)	Black/yellow ignition coil lead'	Black ignition coil lead	100²
40-140 hp (three-cylinder)	Black/white ignition coil lead'	Black ignition coil lead	130²

1. The ignition coil lead(s) must be connected to the CDI unit lead(s) for this test Insert the test lead probe between the bullet connector sleeves to contact the metal terminal.
2. Minimum peak output voltage at cranking speed with the ignition coil leads connected to the CDI unit leads.

Chapter Three and Chapter Seven Supplement

REVISED IGNITION SYSTEM TEST SPECIFICATIONS

This supplement provides updated ignition system test specifications and test lead connection points in response to revisions of the manufacturer's specifications after the publication of this manual. Test the ignition system components as described on pages 40-44 of Chapter Three. Use the test specifications and test lead connection points listed in this supplement in place of the information in Tables 2-24 of Chapter Seven.

Perform all resistance testing with the component at normal room temperature of 20" C (68° F). The resistance reading will increase at higher temperatures and decrease at lower temperatures. To ensure accurate test results, disconnect all other electrical component leads from the components prior to resistance testing.

Perform all peak output voltage testing at *cranking speed.* Do not test the output voltage while running the engine as specified in pages 40-44 of Chapter Three. The output voltage specifications list the minimum peak voltage at normal cranking speed (250-350 rpm) only. Testing at running speed is unnecessary as cranking speed testing will identify faults that occur at running speeds. Excessively slow cranking speed will likely result in low output voltage readings and unnecessary parts replacement.

Manual start models**—**While testing, have an assistant pull briskly on the rewind starter rope to ensure the flywheel rotates with sufficient speed.

Electric start models—Make sure the battery is fully charged and the electric starter is rotating the flywheel with sufficient speed before testing the ignition system.

CAUTION

Prior to testing CDI unit output voltage, disconnect and ground the spark plug lead(s) to prevent accidental starting.

EXCITER **COIL** RESISTANCE

Model	(+) Test lead connection	(-) Test lead connection	Specification (ohms)
2.5 and 3.5 hp	White exciter coil lead	Engine ground	210-525*
5 hp	White exciter coil lead	Black/red exciter coil lead	70-175'
8 and 9.8 hp	Green exciter coil lead	Black/red exciter coil lead	168-420*
9.9D, 15D, 18E	Red exciter coil lead	Black exciter coil lead	126-315*
9.9D2, 15D2, 18E2	Red exciter coil lead	Black exciter coil lead	98-244*
25C2 and 30A3	Red exciter coil lead	Black exciter coil lead	150-375*
25C3 and 30A4	Red exciter coil lead	Black exciter coil lead	98-244*
40 hp (two-cylinder)	Red exciter coil lead	Black exciter coil lead	150-375'
40 and 50 hp (three-cylinder)	White/green exciter coil lead	Orange exciter coil lead	398-900*
60B and 70B	Whitelgreen exciter coil lead	Brown/white exciter coil lead	162-405*
	White/yellow exciter coil lead	Brown/white exciter coil lead	12-30*
60C and 70C	White/green exciter coil lead	Whitelyellow exciter coil lead	165-412*
80 and 90 hp	White/green exciter coil lead	White/yellow exciter coil lead	131-295*
115-140 hp	Whitelgreen exciter coil lead	Orange exciter coil lead	191-431*

'Measure the resistance with the component at normal room temperature of 20" C (68" F).

EXCITER COIL PEAK OUTPUT VOLTAGE

Model	(+) Test lead connection	(–) Test lead connection	Specification (peak volt)
2.5 and 3.5 hp	White exciter coil lead	Coil mounting plate[1]	100[2]
5 hp	White exciter coil lead	Coil mounting plate[1]	100[2]
8 and 9.8 hp	Green exciter coil lead	Coil mounting plate[1]	100[2]
9.9D, 15D, 18E	Red exciter coil lead	Coil mounting plate[1]	100[2]
9.9D2, 15D2, 18E2	Red exciter coil lead	Coil mounting plate[1]	100[2]
25C2 and 30A3	Red exciter coil lead	Coil mounting plate[1]	100[2]
25C3 and 30A4	Red exciter coil lead	Coil mounting plate[1]	100[2]
40 hp (two-cylinder)	Red exciter coil lead	Coil mounting plate[1]	100[2]
40 and 50 hp (three-cylinder)	White/green exciter coil lead	Orange exciter coil lead	130[2]
60B and 70B	White/green exciter coil lead	White/yellow exciter coil lead	100-200[3]
	Brown/white exciter coil lead	White/yellow exciter coil lead	10-15[3]
60C and 70C	White/green exciter coil lead	White/yellow exciter coil lead	130[2]
80 and 90 hp	White/green exciter coil lead	White/yellow exciter coil lead	130[2]
115-140 hp	White/green exciter coil lead	Orange exciter coil lead	130[2]

1. Touch the test lead probe to a clean unpainted surface on the exciter coil mounting plate (below the flywheel).
2. Minimum peak output voltage at cranking speed with the exciter coil leads *disconnected* from the CDI unit. Replace the coil if the peak voltage is below the minimum specification.
3. Peak output voltage at cranking speed with the exciter coil leads *disconnected* from the CDI unit. Replace the coil if the peak voltage is below the minimum specification. A voltage reading above the specification is acceptable.

PULSER COIL RESISTANCE

Model	(+) Test lead connection	(–) Test lead connection	Specification (ohms)
2.5 and 3.5 hp			
5 hp	Red/white pulser coil lead	Black pulser coil lead	60-146[2]
8 and 9.8 hp[1]			
9.9D, 15D, 18E	Blue pulser coil lead	Black pulser coil lead	23-58[2]
9.9D2, 15D2, 18E2[1]			
25C2 and 30A3	Blue pulser coil lead	Black pulser coil lead	23-58[2]
25C3 and 30A4[1]			
40 hp (two-cylinder)	Blue pulser coil lead	Black pulser coil lead	23-58[2]
40 and 50 hp (three-cylinder)	White/red pulser coil lead	Black pulser coil lead	120-275[2]
	White/black pulser coil lead	Black pulser coil lead	120-275[2]
	Blue/white pulser coil lead	Black pulser coil lead	120-275[2]
60-90 hp	White/red pulser coil lead	Black pulser coil lead	120-275[2]
	White/black pulser coil lead	Black pulser coil lead	120-275[2]
	White/blue pulser coil lead	Black pulser coil lead	120-275[2]
115-140 hp	White/red pulser coil lead	Black pulser coil lead	140-316[2]
	White/black pulser coil lead	Black pulser coil lead	140-316[2]
	White/blue pulser coil lead	Black pulser coil lead	140-316[2]
	White/yellow pulser coil lead	Black pulser coil lead	140-316[2]

1. This model is not equipped with a pulser coil. The exciter coil performs the pulser coil function.
2. Measure the resistance with the component at normal room temperature of 20° C (68° F).

PULSER COIL PEAK OUTPUT VOLTAGE

Model	(+) Test lead connection	(–) Test lead connection	Specification (peak volt)
2.5 and 3.5 hp[1]			
5 hp	Red/white pulser coil lead	Coil mounting plate[2]	3[3]
8 and 9.8 hp[1]			
9.9D, 15D, 18E	Blue pulser coil lead	Coil mounting plate[2]	3[3]
9.9D2, 15D2, 18E2[1]			
25C2 and 30A3	Blue pulser coil lead	Coil mounting plate[2]	3[3]
25C3 and 30A4[1]			
40 hp (two-cylinder)	Blue pulser coil lead	Coil mounting plate[2]	3[3]
40 and 50 hp (three-cylinder)	White/red pulser coil lead	Coil mounting plate[2]	3[3]
	White/black pulser coil lead	Coil mounting plate[2]	3[3]
	Blue/white pulser coil lead	Coil mounting plate[2]	3[3]
60-90 hp	White/red pulser coil lead	Coil mounting plate[2]	3[3]
	White/black pulser coil lead	Coil mounting plate[2]	3[3]
	White/blue pulser coil lead	Coil mounting plate[2]	3[3]
115-140 hp	White/red pulser coil lead	Coil mounting plate[2]	3[3]
	White/black pulser coil lead	Coil mounting plate[2]	3[3]
	White/blue pulser coil lead	Coil mounting plate[2]	3[3]
	White/yellow pulser coil lead	Coil mounting plate[2]	3[3]

1. These models are not equipped with a pulser coil. The exciter coil performs the pulser coil function.
2. Touch the test lead probe to a clean unpainted surface on the pulser coil mounting plate.
3. Minimum peak output voltage at cranking speed with the pulser coil leads *disconnected* from the CDI unit.

IGNITION COIL RESISTANCE

Model	(+) Test lead connection	(–) Test lead connection	Specification (ohms)
2.5 and 3.5 hp			
Primary resistance	Orange coil lead	Black coil lead	0.14-0.30[1]
Secondary resistance	Spark plug lead[2]	Black coil lead	2025-4625[1]
5 hp			
Primary resistance	Black/yellow coil lead	Black coil lead	0.20-0.47[1]
Secondary resistance	Spark plug lead[2]	Black coil lead	3075-7625[1]
8 and 9.8 hp			
Primary resistance	Black/yellow coil lead	Black coil lead	continuity[3]
Secondary resistance	Spark plug lead[2]	Black coil lead	1575-3875[1]
9.9-40 hp (two-cylinder)			
Primary resistance	Black/yellow coil lead	Black coil lead	0.15-0.37[1]
Secondary resistance	Spark plug lead[2]	Black coil lead	3075-7625[1]
40 and 50 hp (three-cylinder)			
Primary resistance	Black/white coil lead	Black coil lead	0.12-0.30[1]
Secondary resistance	Spark plug lead[2]	Black coil lead	2025-4625[1]
60 and 70 hp			
Primary resistance	Black/white coil lead	Black coil lead	0.12-0.30[1]
Secondary resistance	Spark plug lead[2]	Black coil lead	2475-6250[1]
80 and 90 hp			
Primary resistance	Black/white coil lead	Black coil lead	0.14-0.31[1]
Secondary resistance	Spark plug lead[2]	Black coil lead	2700-6000[1]
115-140 hp			
Primary resistance	Black/white coil lead	Black coil lead	0.14-0.30[1]
Secondary resistance	Spark plug lead[2]	Black coil lead	2025-4625[1]

1. Measure the resistance with the component at normal room temperature of 20° C (68° F).
2. Remove the connector cap from the spark plug lead before testing the secondary resistance. Touch the test lead to the wire element within the spark plug lead.
3. Primary resistance specifications are not provided for these models. Replace the coil if a *no continuity* reading is noted.