TOHATSU
Outboards

SERVICE MANUAL

2 Stroke
3 & 4
Cylinder
Models

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SECTION 1
SERVICE SAFETY

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⚠⚠ WARNING

Inadequate knowledge of safe shop practices can result in severe injury or death. Review general safety procedures and specific safety information provided for each procedure prior to beginning any repairs.



INTRODUCTION

Marine manufacturers are required to comply with special regulations and standards to ensure their products are safe and reliable for the consumer. As the marine technician, it is your responsibility to keep these products safe when performing normal rigging, repair, and maintenance operations.

It is not possible to foresee all safety hazards which may occur or to include all the knowledge of an experienced technician in a single service manual. Therefore, it is assumed that those using this manual have a working knowledge of 2-cycle outboard engines and the proper technical training for servicing them.

This section discusses safe shop practices and general safety concerns relevant to the operations performed throughout this manual. Read this section carefully and follow all safety statements in this manual as they pertain to the procedures at hand. Remember, always use common sense when servicing outboard engines!

SAFETY STATEMENTS

The following safety statements are found throughout this manual and indicate information which, if ignored, could result in safety hazards or faulty service techniques:

⚠ DANGER

Indicates the presence of a hazard which, if ignored, WILL result in severe injury or death.

⚠⚠ WARNING

Indicates the presence of a hazard which, if ignored, COULD result in severe injury or death.

⚠ CAUTION

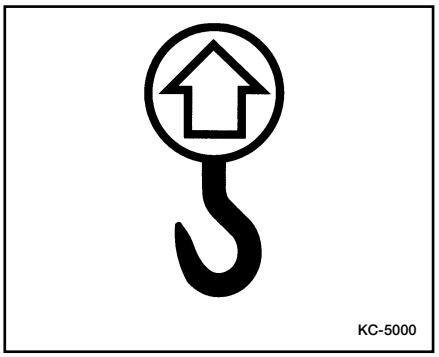
Indicates the presence of a hazard which, if ignored, COULD result in minor personal injury or damage to product, equipment, or other property.

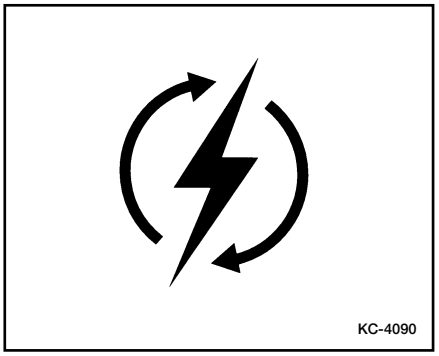
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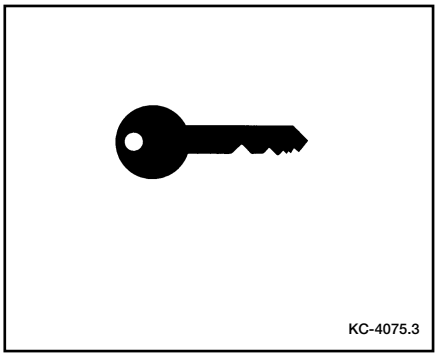
Indicates special information to facilitate the installation, operation, or maintenance of the product or further clarify information which is important but not hazard related.

SAFETY PRECAUTIONS

Handling Outboard Engines


KC-5000


KC-4090


KC-4075.3

- Never disable the neutral switch start-in-gear prevention system to accommodate installation of a foot control or other option. Always test the neutral switch and emergency stop switch before returning an engine to the customer.

- Lifting devices and hardware must be of suitable capacity for the weight of the outboard engine. Some models are equipped with a fixed hanger on the powerhead. Hanger may be used to lift the complete engine or to remove the powerhead unit. Be aware the engine may swing outward when lifted by the hanger.

- Engine stands must be in good condition, of adequate size, and mounted properly to prevent unexpected shifting or collapse.

- Engine covers are guards to prevent personal contact with the spinning flywheel and high voltage components such as spark plugs and coils. Never wear jewelry or loose clothing near a running engine. Keep hands, arms and hair away from the flywheel. Never touch electrical components when the engine is running.

- Two people working on a running engine must use extreme caution and be aware of one another. Never attempt to start an engine or operate any controls, including steering, before signaling your partner.

- To prevent accidental startup during operations which may cause the flywheel to turn, always perform the following steps:

  1. Turn the ignition key to OFF and remove the key.

  2. Disable the engine ignition system.

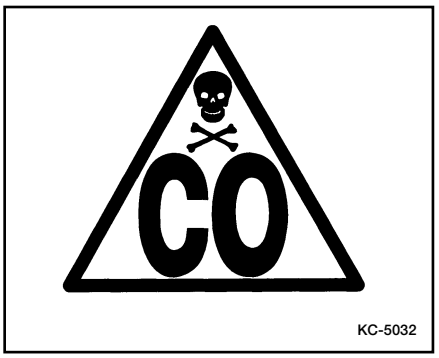
  3. Shift engine to NEUTRAL and verify propeller shaft is not in gear.

- Rotating propellers are not equipped with guards and can cause severe injury or dismemberment. Always stay clear of rotating propellers and make sure there is no possibility of engine startup before removing or installing a propeller. The propeller nut must always be tightened to torque specification prior to starting the engine.

- Avoid running the engine at high RPM. Engine speed can easily increase to excessive RPM when under a no load condition. To avoid engine damage during testing, always use the correct test propeller and keep engine speed below 2000 RPM.

- Run engines only in well ventilated areas to prevent exposure to Carbon Monoxide (CO) gas. Direct and prolonged exposure to CO will cause brain damage or death.

- Always wear eye protection, protective clothing, gloves and use other applicable safety equipment when work activities present the risk of personal injury.

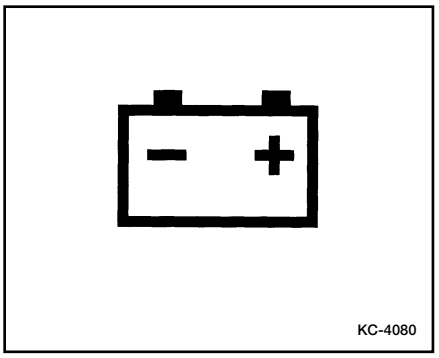


KC-5032

Lead Acid Batteries

- Never check battery charge by placing a metal object across the terminal posts; sparks may occur, resulting in serious burns.

- Avoid contact with battery acid. If battery acid is spilled on skin, thoroughly wash area with plenty of water. If battery acid gets into eyes, flush eyes with water for at least 15 minutes and get prompt medical attention.


KC-4080

- Never remove charger cables from a battery when the charger is energized; sparks and explosion are possible. To remove charger cables, follow these steps:

  1. Turn the charger to OFF.

  2. Disconnect the charger power cord from its power source.

  3. Remove the charger cables from the battery posts.


KC-5050

- Batteries emit explosive vapor through the vented caps during charging. Never charge or test batteries near sparks or flames; explosion can result. Extinguish all smoking materials and flame producing devices before charging and make sure the charging area is well ventilated.

- Make sure battery vents are not clogged or pressure may build and cause battery to explode.

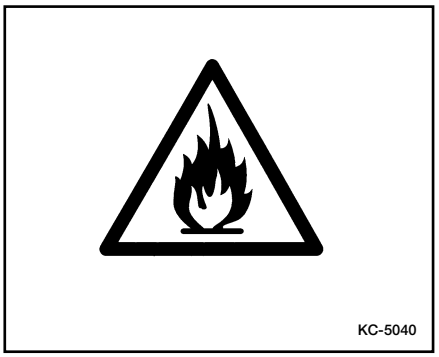
Hazardous Materials

- Gasoline vapors are highly flammable and can cause an explosion. Never smoke or allow sparks or flames nearby when handling fuel. Always store gasoline in a shaded, well ventilated area in an approved safety container.

- Ventilate gasoline fumes as soon as detected. Be aware that appliance pilot lights, such as those in furnaces and water heaters, can ignite gasoline vapors and cause explosion.

- Never use gasoline as a cleaner, and always clean up fuel spills immediately and properly dispose of rags in an approved safety container.

- Read and follow the safety labels on products used around the shop. Adhesives, lubricants, solvents, and fuel additives are usually poisonous and flammable. Store and dispose of these products properly.

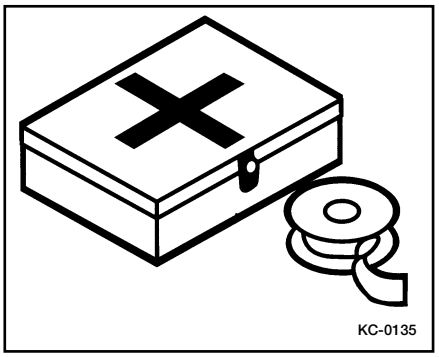

KC-5040

Shop Environment

- Make sure the shop and your work area are properly ventilated.

- Shops must be equipped with the proper tools and safety equipment such as fire extinguisher, eye flushing device, and first aid kit.

- Keep the shop clean and free of clutter. Clean up spills on the floor as soon as possible to prevent someone from slipping.


KC-0135

WORKMANSHIP STANDARDS

1. Avoid damage to the mating surfaces of crankcase and cylinder assembly. Do not use a sharp metal scraper to clean these areas.

2. Replace gaskets, o-rings, seals, split pins, lock nuts, and spring pins when removed during repair operations.

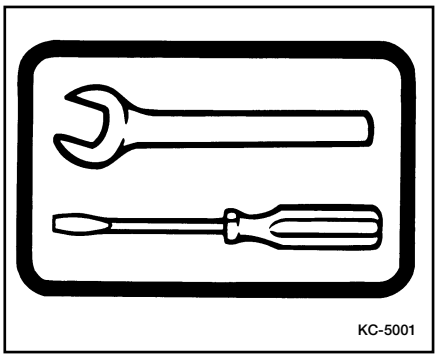
3. Use only genuine factory replacement parts and accessories.

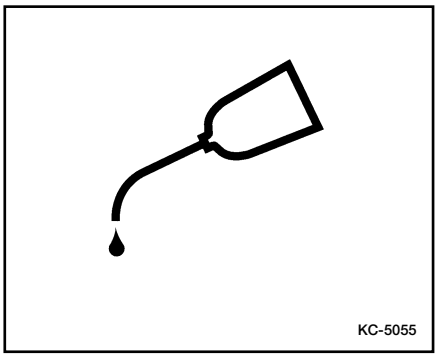
4. Use recommended special tools when specific repairs require them.

5. Calibrate measurement tools and test equipment on a regular basis.

6. Clean all metal parts with solvent before inspection and assembly operations.

7. Use penetrating solvents when necessary to remove rusted or seized hardware.


KC-5001


KC-5055

8. Keep all removed parts separated for ease of identification during assem bly.

9. Locate alignment marks on components being disassembled. If marks are not present and should be, scribe or match mark them yourself to ensure the pieces are assembled properly.

10. Follow torque sequences and specifications where they apply. First, tighten each bolt in the specified sequence. Use the same sequence to torque each bolt to final specification. Special torque specifications are listed at the beginning of each section. Standard torque specifications for common fasteners are listed in Section 2.

11. Use specified lubricant when assembling seals to prevent damage to the seal lips. Make sure seal lips are facing the correct direction.

12. Use the correct type and amount of sealing compound on metal to metal surfaces.

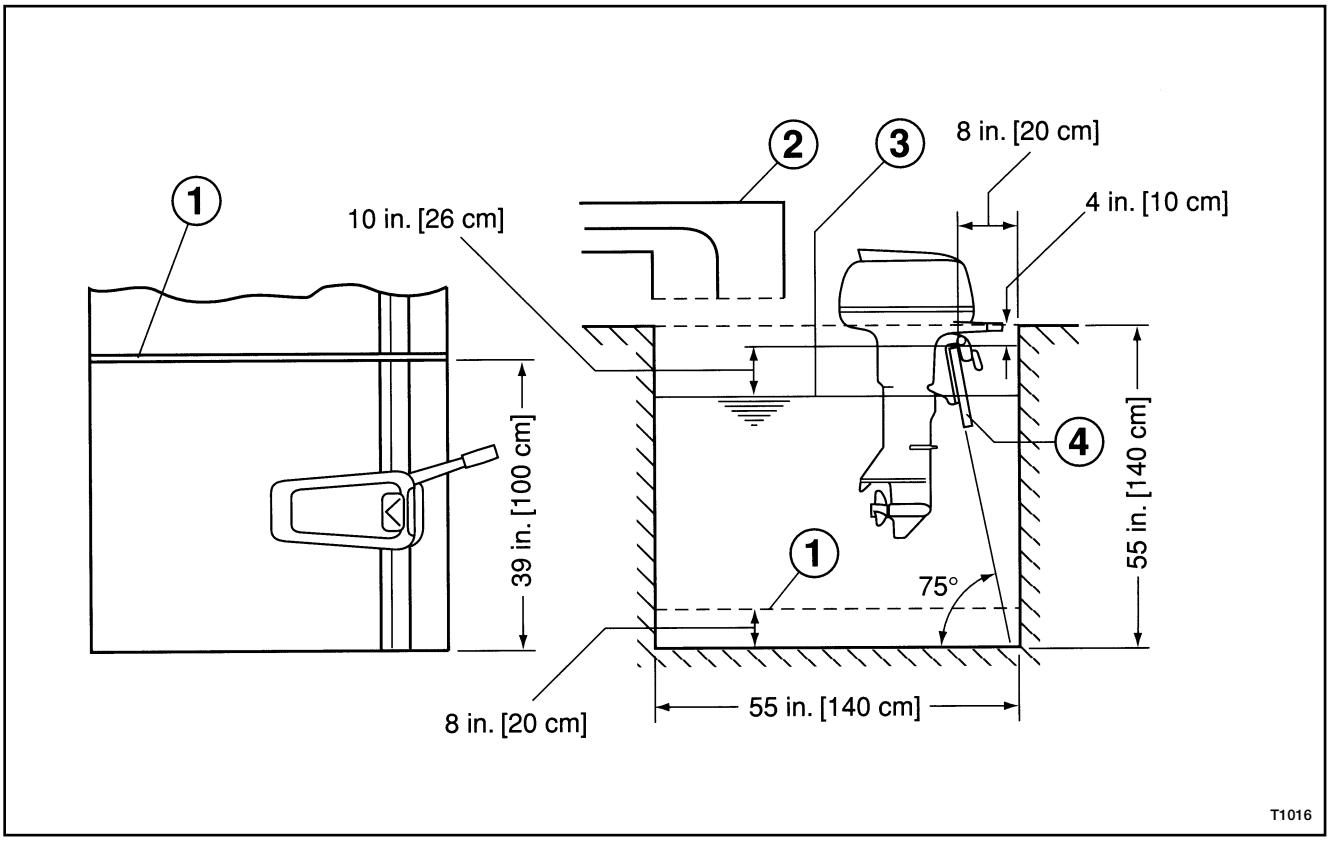
13. When using compressed air to clean or dry parts, make sure air supply is regulated not to exceed 25 psi [172 kPa / 1.76 kg/cm^2].

14. Replace missing or damaged safety labels on the engine before returning it to the customer.

TEST TANK GUIDELINES

When properly setup, test tanks provide a safe and controlled environment in which to perform outboard engine adjustment and testing procedures. Test tanks must be setup to the minimum dimensions shown. If multiple engines will be installed in the tank, secure partition plate **(1)** so that the minimum dimensions are maintained for each outboard engine installed. In addition, adhere to the following guidelines to prevent engine damage:

- Continuous usage raises the water temperature in the tank which can lead to engine seizure. Make sure water temperature in the tank does not exceed 77˚F [25˚C].
- Repeated use introduces carbon into the water which can adhere to the engine cooling system and degrade its ability to cool the engine. Always replace dirty tank water at regular intervals with clean, fresh water.
- Exhaust gases produced during engine operation can collect around the engine, causing suction into the carburetors and affecting engine performance. To prevent this condition, install forced ventilation equipment **(2)** to remove gases from the engine and work area.
- Water may splash out of the tank during testing. Maintain water level **(3)** in the tank as illustrated.
- Keep transom board **(4)** at an approximate angle of 75˚ to the tank bottom to ensure near vertical engine position.



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SECTION 2
GENERAL SERVICE INFORMATION

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SECTION 2

GENERAL PRECAUTIONS

Before performing any service work on the outboard engine, read and understand Section 1 - Service Safety.

Use only genuine factory replacement parts with equivalent characteristics such as type, material, and strength. Failure to do so may result in product malfunction and injury to the operator or passengers.

Follow the **Standard Torque Values** chart when a special torque value for a certain fastener is not listed in the **Special Torque Values** chart at the beginning of each section.

Rather than just repairing a bad part, use repair kits and overhaul kits when applicable to ensure complete and efficient repair of the complete component. Wear not readily noticed on other parts can lead to malfunction soon after the repair.

When indicated in a procedure, use manufacturer special tools. In some cases, the use of substitute tools will damage the part.

When using compressed air to clean ordry parts, make sure air supply is regulated not to exceed 25 psi [172 kPa/ 1.76 kg/cm^2].

ABBREVIATIONS AND SYMBOLS

Abbreviations

A	ampere
AC	alternating current
AH	ampere-hour
approx.	approximately
API	American Petroleum Institute
ATDC	after top dead center
BTDC	before top dead center
˚C	degree Celsius
CCA	cold cranking amp
cm	centimeter
cm^3	cubic centimeter
cm^3/min	cubic centimeter per minute
cu-in	cubic inch
DC	direct current
DVA	direct volt adapter
Kg-m	kilogram meter
˚F	degree Fahrenheit
fl oz	fluid ounce (U.S.)
fl oz/min	fluid ounce (U.S.) per minute
ft	foot
ft-lb	foot pound
ft-lbf/min	foot pound force per minute
g	gram
gal/hr	gallon (U.S.) per hour
gal	gallon (U.S.)
GL	gear lubricant
GM	General Motors Company
HP	horsepower (U.S.)
I.D.	inside diameter
in	inch
in-lb	inch pound
kg	kilogram
kg/cm^2	kilogram per square centimeter
ESG	electronic speed governor
kPa	kilopascal
kW	kilowatt
L	liter
L/hr	liter per hour
lb	pound
mL	milliliter
mm	millimeter
mV	millivolt
N	newton
N-m	newton meter
NMMA	National Marine Manufacturers Association
No.	number
O.D.	outside diameter
oz	ounce
PS	horsepower (metric)
psi	pound per square inch
qt	quart (U.S.)
RPM	revolution per minute
SAE	Society of Automotive Engineers
sec.	second
t	short ton 2000 lb
TDC	top dead center
V	volt
VAC	volt alternating current
VDC	volt direct current
W	watt

Symbols

°	angular degree
+	plus
-	minus
±	plus or minus
Ω	ohm
µ	micro
%	percent

SECTION 2

UNIT CONVERSIONS

Unit Prefixes

Prefix	Symbol	Power
mega	M	x 1,000,000
kilo	k	x 1,000
centi	c	x 0.01
milli	m	x 0.001
micro	µ	x 0.000001

Units of Length

mile	x	1.6090 = km
ft	x	0.3050 = m
in	x	2.5400 = cm
in	x	25.4000 = mm
km	x	0.6210 = mile
m	x	3.2810 = ft
cm	x	0.3940 = in
mm	x	0.0394 = in

Units of Volume

gal (U.S.)	x	3.78540 = L
qt U.S.)	x	0.94635 = L
cu-in	x	0.01639 = L
cu-in	x	16.38700 = mL
fl oz (U.S.)	x	0.02957 = L
fl oz (U.S.)	x	29.57000 = mL
cm^3	x	1.00000 = mL
cm^3	x	0.03382 = fl oz (U.S.)

Units of Mass

lb	x	0.45360 = kg
oz	x	28.35000 = g
kg	x	2.20500 = lb
g	x	0.03527 = oz

Units of Force

lbf	x	4.4480 = N
lbf	x	0.4536 = kgf
N	x	0.2248 = lbf
N	x	0.1020 = kgf
kgf	x	2.2050 = lbf
kgf	x	9.8070 = N

Units of Torque

ft-lb	x	1.3558 = N-m
ft-lb	x	0.1383 = kg-m
in-lb	x	0.1130 = N-m
in-lb	x	0.0115 = kg-m
kg-m	x	7.2330 = ft-lb
kg-m	x	86.8000 = in-lb
kg-m	x	9.8070 = N-m
N-m	x	0.7376 = ft-lb
N-m	x	8.8510 = in-lb
N-m	x	0.1020 = kg-m

Units of Pressure

psi	x	0.0689 = bar
psi	x	6.8950 = kPa
psi	x	0.0703 = kg/cm^2
bar	x	14.5030 = psi
bar	x	100.0000 = kPa
bar	x	29.5300 = in Hg (60˚F)
kPa	x	0.1450 = psi
kPa	x	0.0100 = bar
kPa	x	0.0102 = kg/cm^2
kg/cm^2	x	98.0700 = psi
kg/cm^2	x	0.9807 = bar
kg/cm^2	x	14.2200 = kPa
in Hg (60˚F)	x	0.0333 = bar
in Hg (60˚F)	x	3.3770 = kPa
in Hg (60˚F)	x	0.0344 = kg/cm^2

Units of Power

HP	x	1.01400 = PS
HP	x	745.70000 = W
HP	x	550.00000 = ft-lbf/s
PS	x	0.98630 = HP
PS	x	735.50000 = W
PS	x	542.50000 = ft-lbf/s
W	x	0.00134 = HP
W	x	0.00136 = PS
W	x	0.73760 = ft-lbf/s
kW	x	1.34100 = HP
kW	x	1.36000 = PS
kW	x	737.56000 = ft-lbf/s
ft-lbf/s	x	0.00181 = HP
ft-lbf/s	x	0.00184 = PS
ft-lbf/s	x	1.35600 = W

Units of Temperature

˚F = (1.8 · ˚C) + 32

˚C = 0.556 · (˚F - 32)

SERVICE SPECIFICATIONS

Standard Torque Values

Size	Torque			
	in-lb	ft-lb	N·m	kg-m
M4	10 - 17	0.8 - 1.4	1 - 2	0.1 - 0.2
M5	26 - 35	2.2 - 2.9	3 - 4	0.3 - 0.4
M6	44 - 52	3.6 - 4.3	5 - 6	0.5 - 0.6
M8	97 - 133	8 - 11	11 - 15	1.1 - 1.5
M10	204 - 274	17 - 22	23 - 31	2.3 - 3.1

These torque values apply only when a special torque specification is not listed in the **Special Torque Values** chart at the beginning of each section.

Manufacturer Special Tools Required

Powerhead

Flywheel Puller Assembly Kit..... 3C7-72211-0
- Plate, Flywheel Puller 3B7-72783-0, 3C7-72783-0
- Bolt, M8 x 25 mm (3 pcs) 3B7-72786-0
- Bolt, M8 x 40 mm (3 pcs) 3B7-72785-0
- Washer (3 pcs) 940191-0800
- Pressing Bolt 3B7-72784-0

Powerhead Stand 353-72247-1
Piston Pin Tool 345-7221 5-0, 353-72215-0
Piston Ring Tool 353-72249-0
Thickness Gauge Set 353-72251-0

Gearcase

Socket, Bevel Gear B Nut 345-72232-0, 3B7-72232-0
Wrench, Bevel Gear B Nut 346-72231-0, 3B7-72231-0
Bevel GearA Bearing Puller Assembly .. 3A3-72755-0 , 3B7-72755-0
Bevel GearA Bearing Set Tool .....3C8-72719-0 , 3B7-72719-0
Bevel Gear A Bearing Outer Race Fitting Tool 3B7-72739-0
Needle Roller Bearing Puller Kit 3C8-72700-0, 3B7-72700-0
Needle Bearing Press Kit 3C7-72900-1
Backlash Measurement Tool Kit (Gear A & B) 3C8-72234-0, 3B7-72234-0
Backlash Measurement Tool Kit (Gear B & C) 3B7-72255-0
Backlash Measuring Tool Clamp 3B7-72720-0
Bolt for Lower Pump Case (4 pcs).....910191-0830, 910191-0835
Dial Gauge Plate.....3B7-72729-0
Shimming Gauge.....3B7-72250-0
Thickness Gauge Set ..... (353-72251-0)
Shift Rod Joint Puller 353-72248-0
Spring Pin Tool A 345-72227-0, 369-72217-0
Spring Pin Tool B 345-72228-0, 369-72218-0
Clutch Pin Snap Tool 345-72229-0

Power Trim/Tilt

Tilt Rod Guide Wrench 3C8-72791-0
Trim Rod Guide Wrench 3B7-72792-0

General Equipment Required

Water Pressure Gauge, 0 - 15 psi [0 - 103 kPa / 0 - 1 kg/cm²]
Fuel Pressure Gauge, 0 - 15 psi [0 - 103 kPa / 0 - 1 kg/cm²]
Torque Wrench, 0 - 150 in-lb [0 - 17 N·m / 0- 1.7 kg-m]
Torque Wrench, 0 - 750 ft-lb [0 - 1000 N·m / 0 - 102 kg-m]
Dial Gauge, minimum scale 0.0001 in [0.01 mm]
Micrometer Set or Dial Caliper, minimum scale 0.0001 in [0.01 mm]
Telescoping Gauge, Inside Micrometer Set, or Dial Caliper, minimum scale 0.0001 in [0.01 mm]
Variable Load High Rate Discharge Tester, *Electronic Specialties® Model 700 or equivalent*
Analog Multimeter, *Electronic Specialties® Model M-530 or equivalent*
Digital Multimeter, *Electronic Specialties® Model KD 3200 or equivalent*
Digital Pulse Tachometer, 10 - 6000 RPM, *Electronic Specialties® Model 321 or equivalent*
Ammeter, 0 - 100A
Gearcase Pressure Tester, *Stevens® S-34 or equivalent*
Gearcase Vacuum Tester, *Stevens® V-34 or equivalent*
Engine Compression Gauge, 0 - 300 psi [0 - 2000 kPa / 0 - 20 kg/cm²]
Spark Gap Tester, *Stevens® S-13C, S-48, or equivalent*
Flexible Fuel Tubing, 1/4 in I.D. x 5 in [6 mm I.D. x 127 mm]
Flexible Fuel Tubing, 3/8 in I.D. x 5 in [9.5 mm I.D. x 127mm]
Industrial Thermometer, minimum 300˚F [150˚C]
Heat-Resistant Container, *Pyrex®*
Bearing Puller
Seal Pullers
Seal Installers
HeatGun
Hydrometer

Consumables Required

Threadlocker, *Loctite® 242*
Threadlocker, *Loctite® 243*
Gasket Dressing, *Permatex® Hylomar® Aerosol High-Temp Gasket Dressing*
Gasket Sealant, *Permatex® High Tack Gasket Sealant*
Anaerobic Gasket Maker, *Loctite® 518*
Silicone Sealant, *Permatex® Hi-Temp RTV Silicone Gasket*
Super Bond Adhesive, *Permatex® Super Glue Gel*
Cleaning Pads, *Scotch-Brite® Abrasive Pads*
Low Temperature Lithium Grease
Genuine Grease or Equivalent Friction Surface Marine Grease
Power Trim/Tilt Fluid, *Nisseki® power torque fluid or GM approved automatic transmission fluid*
Isopropyl Alcohol
Cleaning Solvent
Gasket Remover
Gear Lubricant, *Genuine gear oil or API grade GL5, SAE #80 - #90*
Engine Lubricant, *Genuine engine oil or NMMA certified TC-W3 oil*
Automotive Crankcase Oil, flashpoint above 300˚F [150˚C]
Battery Spray Protector, *Permatex® Battery Protector & Sealer*
Electrical Shrink Tubing, various diameters

ENGINE SPECIFICATIONS

Operation

Power

40	40 HP [29.4 kW]
50	50 HP [36.8 kW]
60	60 HP [44.1 kW]
70	70 HP [51.5 kW]
80	80 HP [58.8 kW]
90	90 HP [66.2 kW]
115	115 HP [84.6 kW]
120	120 HP [88.3 kW]
140	140 HP [103 kW]

Full Throttle RPM Range

40D	4500 - 5500
40D2	5000 - 5700
50D	5000 - 5700
50D2	5150 - 5850
60B, 70B	4900 - 5600
60C, 70C	5150 - 5850
80, 90	5000 - 5500
115, 120, 140	5200 - 5700

Idle RPM	IN GEAR	NEUTRAL
40, 50	750	900
60, 70	750	900
80, 90, 115, 120, 140	700	900

Fuel Consumption at Full Throttle

40	4.5 g/hr [17 L/hr]
50	5.6 g/hr [21 L/hr]
60	6.3 g/hr [24 L/hr]
70	7.4 g/hr [28 L/hr]
80, 90	9.5 g/hr [36 L/hr]
115	13.2 g/hr [50 L/hr]
120	13.2 g/hr [50 L/hr]
140	15.3 g/hr [58 L/hr]

Test Propeller

40, 50	3C8-64111-0
60B, 70B	3F3-64111-0
60C, 70C	3B7-64111-0
80, 90	3B7-64111-0
115, 120, 140	3C7-64111-0

Powerhead

Number of Cylinders

40, 50, 60, 70, 80, 90	3
115, 120, 140	4

Displacement

40, 50	42.5 cu. in [697 cm³]
60, 70	57.2 cu. in [938 cm³]
80, 90	77.3 cu. in [1267 cm³]
115, 120, 140	107.9 cu. in [1768 cm³]

Standard Bore

40, 50	2.677 in [68 mm]
60, 70	2.913 in [74 mm]
80, 90	3.386 in [86 mm]
115, 120, 140	3.465 in [88 mm]

Stroke

40, 50	2.52 in [64 mm]
60, 70, 80, 90, 115, 120, 140	2.86in [72.7mm]

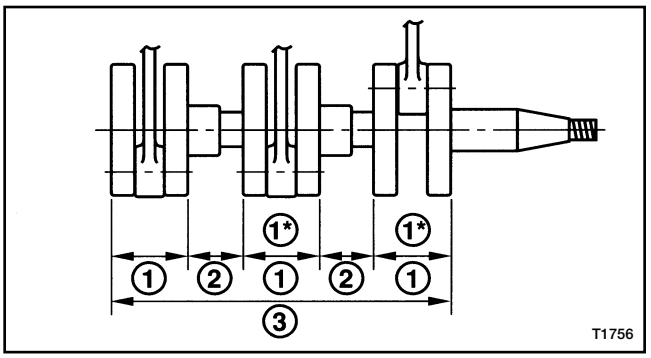
Piston Clearance

40, 50	0.0012 - 0.0028 in [0.03 - 0.07 mm]
60, 70	0.0016 - 0.0031 in [0.04 - 0.08 mm]
80, 90	0.0031 - 0.0051 in [0.08 - 0.13 mm]
115, 120, 140	0.0039 - 0.0055 in [0.10 - 0.14 mm]

Piston Ring End Gap

40, 50 Top Ring	0.009 - 0.015 in [0.22 - 0.37 mm]
40, 50 2nd Ring	0.013 - 0.019 in [0.33 - 0.48 mm]
60, 70	0.009 - 0.015 in [0.22 - 0.37 mm]
80, 90	0.010 - 0.016 in [0.25 - 0.40 mm]
115, 120, 140	0.011 - 0.019 in [0.28 - 0.49 mm]

Crankshaft Dimensions



Dimension (1)

40, 50 ..... $2.087\ ^{0}_{-0.001}$ in $[53\ ^{0}_{-0.02}$ mm$]$

60, 70 ..... $2.362\ ^{-0.008}_{-0.009}$ in $[60\ ^{-0.20}_{-0.22}$ mm$]$

80, 90 ..... $2.677\ ^{0}_{-0.001}$ in $[68\ ^{0}_{-0.02}$ mm$]$

115, 120, 140 ..... $2.677\ ^{0}_{-0.001}$ in $[68\ ^{0}_{-0.02}$ mm$]$

Dimension (1*)

80, 90 only ..... $2.598\ ^{0}_{-0.001}$ in $[66\ ^{0}_{-0.02}$ mm$]$

Dimension ②

40,50 ..... 1.457 $^{+\ 0.002}_{0}$ in [37 $^{+\ 0.05}_{0}$ mm]

60,70 ..... 1.467 $^{+\ 0.002}_{0}$ in [37.25 $^{+\ 0.05}_{0}$ mm]

80,90 ..... 1.732 $^{+\ 0.002}_{0}$ in [44 $^{+\ 0.05}_{0}$ mm]

115,120, 140 ..... 1.654 $^{+\ 0.002}_{0}$ in [42 $^{+\ 0.05}_{0}$ mm]

Dimension ③

40, 50 ..... 9.173 in [233 mm]
60, 70 ..... 10.020 in [254.5 mm]
80, 90 ..... 11.339 in [288 mm]
115, 120, 140 ..... 15.669 in [398 mm]

Gearcase

Gear Ratio
40, 50 ..... 13 : 24 (0.542)
60B, 70B ..... 13 : 23 (0.565)
60C, 70C ..... 13 : 28 (0.464)
80, 90, 115, 120, 140 ..... 13 : 26 (0.500)
Lubricant .....Genuine manufacturer gear oil or API GL5, SAE #80 - #90

Capacity
40, 50 ..... Approx. 17 U.S. fl oz [500 mL]
60B, 70B ..... Approx. 24 U.S. fl oz [700 mL]
60C, 70C ..... Approx. 30 U.S. fl oz [900 mL]
80, 90, 115,120, 140 ..... Approx. 30 U.S. fl oz [900 mL]

Clutch System .....Dog clutch type (Forward-Neutral-Reverse)

Electrical System

Ignition Type ..... Flywheel magneto capacitor discharge

Ignition Timing
40D .....ATDC 3˚ ± 1˚ - BTDC 18˚ ± 1˚
40D2 .....ATDC 3˚ ± 1˚ - BTDC 18˚ ± 1˚
50D .....ATDC 3˚ ± 1˚ - BTDC 24˚ ± 1˚
50D2 .....ATDC 3˚ ± 1˚ - BTDC 20˚ ± 1˚
60B .....ATDC 3˚ ± 1˚ - BTDC 16˚ ± 1˚
60C .....ATDC 3˚ ± 1˚ - BTDC 17.5˚ ± 1˚
70B .....ATDC 3˚ ± 1˚ - BTDC 20˚ ± 1˚
70C .....ATDC 3˚ ± 1˚ - BTDC 17.5˚ ± 1˚
80 .....ATDC 5˚ ± 1˚ - BTDC 20˚ ± 1˚
90 .....ATDC 5˚ ± 1˚ - BTDC 20˚ ± 1˚
115 ..... ATDC 10˚ - BTDC 17.5˚ ± 1˚
120 ..... ATDC 10˚ - BTDC 17.5˚ ± 1˚
140 ..... ATDC 10˚ - BTDC 20˚ ± 1˚

Spark Plug (with resistor)
40 ..... NGK BR7HS-10 or Champion RL-82C
50, 60, 70, 80, 90, 115, 120, 140 ...NGK BR8HS-10 or Champion RL-78C

Spark Plug (without resistor)
40 ..... NGK B7HS-10 or Champion L-82C
50, 60, 70, 80, 90, 115, 120, 140 ..... NGK B8HS-10 or Champion L-78C

Spark Plug Gap ..... 0.035 - 0.039 in [0.9 -1.0 mm]

Battery ..... 12 V, 500 CCA with 105 minutes [70 AH] reserve capacity

Engine Fuse ..... 20 A

Alternator
40, 50, 60, 70, 80, 90 ..... 12 V 130 W
115, 120, 140 ..... 12 V 330 W

Charging Performance (at 1500 RPM)
40, 50, 60, 70, 80, 90 ..... 3 A
115, 120, 140 ..... 12A

Charging Performance (at 5500 RPM)
40, 50, 60, 70, 80, 90 ..... 9 - 11 A
115, 120, 140 ..... 24.5 - 27.5 A

Number of Tachometer-to-Alternator Coil Impulses
40, 50, 60, 70, 80, 90 6
115, 120, 140 12

Alternator Coil Resistance
40, 50 ..... W - Y, 0.2 - 0.3 Ω
60, 70 ..... W-Y, 0.2 - 0.3 Ω
80, 90 ..... 0.2 - 0.3 Ω
115, 120, 140 ..... 0.26 - 0.40 Ω

Ignition Coil Resistance (±25%)

Primary Coil
40, 50 ..... 0.18 - 0.24 Ω
60, 70 ..... 0.18 - 0.24 Ω
80, 90 ..... 0.19 - 0.25 Ω
115, 120, 140 ..... 0.18 - 0.24 Ω

Secondary Coil
40, 50 ..... 2.7 - 3.7 kΩ
60, 70 ..... 2.7 - 3.7 kΩ
80, 90 ..... 3.6 - 4.8 kΩ
115, 120, 140 ..... 2.7 - 3.7 kΩ

CD Unit Output (Cranking)

40, 50, 60, 70, 80, 90, 115, 120, 140.....130 Min

Exciter Coil Output (Cranking)
40, 50, 60C, 70C, 80, 90, 115, 120, 140 ... 130 DVAMin
60B, 70B .... 10-15 DVA (Brown/White to White/Yellow)
100-200 DVA (White/Green to White/Yellow)

Pulser Coil Output (Cranking)
40, 50, 60, 70, 80, 90, 115, 120, 140 .....3.0 Min

note

Magneto for Model 60 / 70
Magneto style for Model 60/70 was changed and they are not interchangeable between both parts. The following Serial Numbers indicate breakpoints between older and newer magneto models.

Model	Magneto	Serial number
60B / 70B	Older	All of Engines
60C	Older and Newer	Newer : 10840 or higher
70C	Older and Newer	Newer : 13002 or higher

Remark) Magneto consists a flywheel cup, coil plate assembly, CD unit and ignition coils.

Fuel System

Required Fuel, Lubricant, and Mix Ratio
See Fuel System Requirements in Section 3

Oil Pump
Plunger type with internal worm gear, crankshaft driven

Oil Pump Output at 1500 RPM (Engine Speed)
Note: Lever opening position is 50˚ to full.
40, 50 ..... 0.049 fl oz/min [1.45 cm^3/min]
60, 70 ..... 0.085 fl oz/min [2.50 cm^3/min]
80, 90 ..... 0.123 fl oz/min [3.65 cm^3/min]
115, 120, 140 ..... 0.192 fl oz/min [5.67 cm^3/min]

Oil Pump Mix Ratio
At Trolling Speed ..... 120-100 gasoline:1 oil
At Full Throttle Speed .....50 gasoline:1 oil

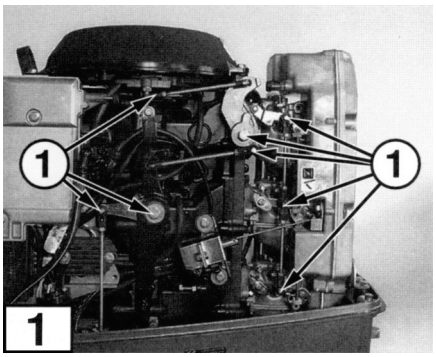
Oil Automixing Tank Capacity
40, 50 .....2.11 qt [2.0 L]
60, 70 .....2.75 qt [2.6 L]
80, 90 .....3.70 qt [3.5 L]
115, 120, 140 .....6.34 qt [6.0 L]

Carburetor
40, 50, 60, 70, 80, 90 .....3 butterfly valve type carburetors, float feed
115, 120, 140 .....4 butterfly valve type carburetors, float feed

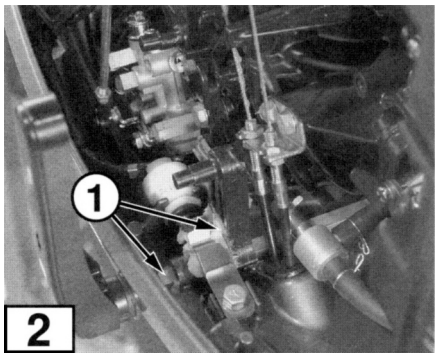
Power Trim/Tilt

Lubricant
Nisseki power torque fluid (as shipped from factory) or any GM approved automatic transmission fluid:

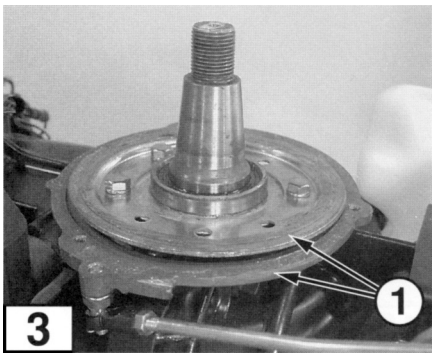
- Mobil DTE #22 or Mobil AFT 220
- Shell Dextron II orShell Tellus Oil #22 K22
- Esso Automatic Transmission Fluid



T1045



T1046



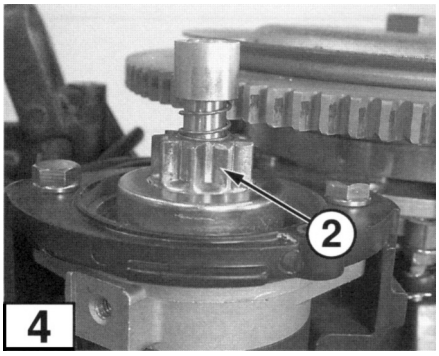
T1047

LUBRICATION CHART

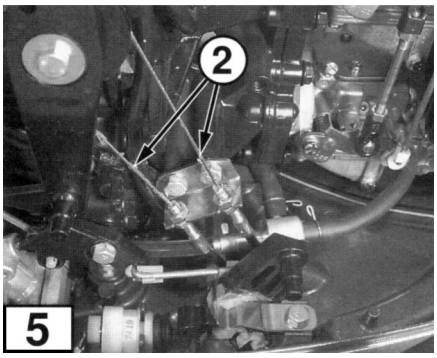
Location	Type of Lubricant	Frequency	
		Fresh Water	Salt Water
1 Advancer Arm, Throttle Cam, and Linkage Ball Joints	(1)	Every 50 hours (3 months)	Every 30 hours (1 months)
2 Shitt Lever and Shift Arm	(1)		
3 Guide Plate and Set Ring	(1)		
4 Starter Motor Pinion	(2)		
5 Throttle Cables	(2)		
6 Manual Choke Lever	(2)		
7 Carburetor Choke Valve Control Levers	(2)		
8 Throttle Shaft and Steering Handle Bushings	(2)		
9 Steering Handle Grip Portion	(2)		

(1) Low temperature lithium grease

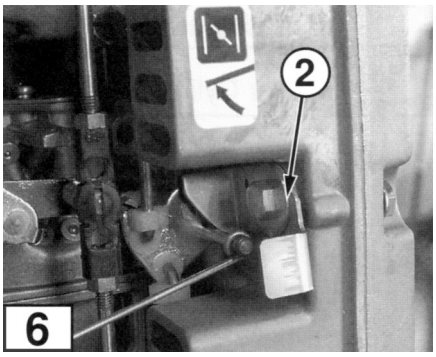
(2) Genuine grease or equivalent friction surface marine grease



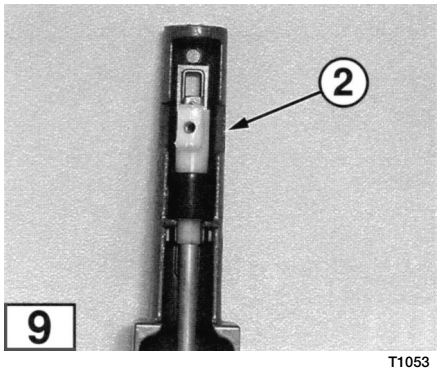
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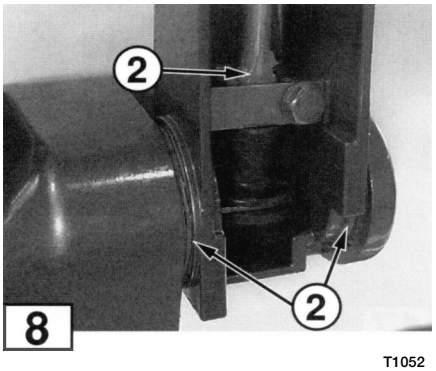
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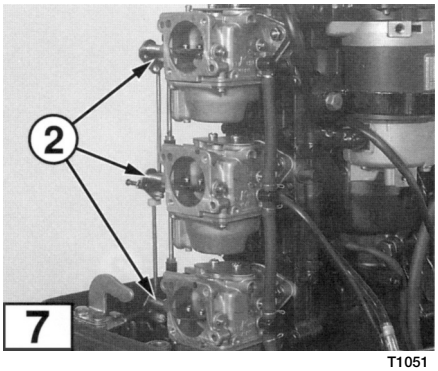
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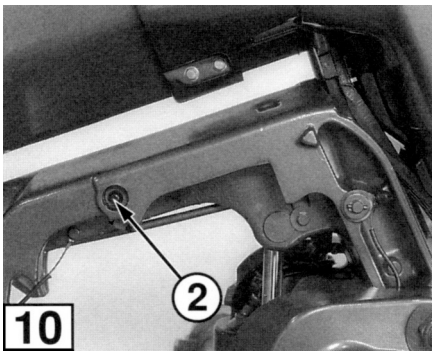
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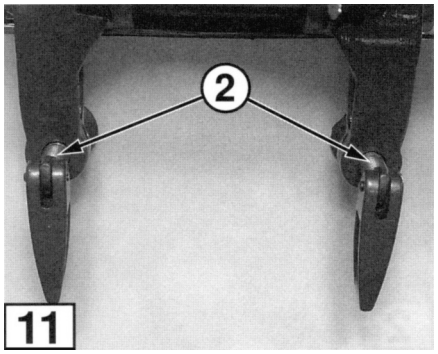
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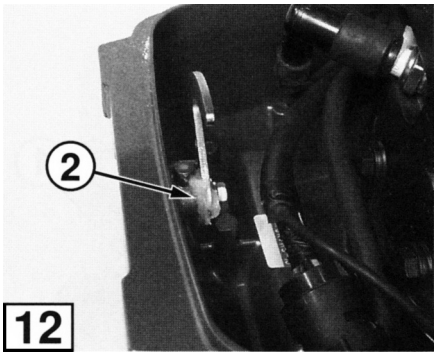
T1051



T1054



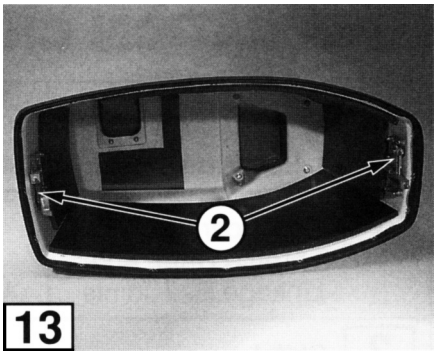
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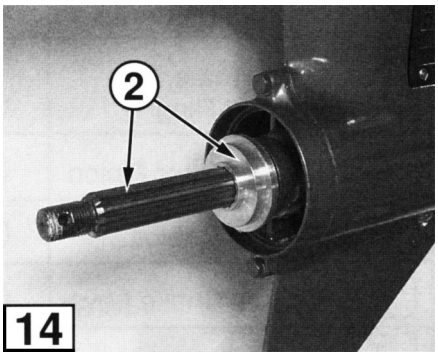
T1056

Location	Type of Lubricant	Frequency	
		Fresh Water	Salt Water
10 Swivel Bracket Grease Fitting	(2)	Every 50 hours (3 months)	Every 30 hours (1 month)
11 Clamp Screws	(2)		
12 Engine Cover Latches 13	(2)		
14 Propeller Shaft and Thrust Holder	(2)		
15 Tilt Tube Grease Fittings	(2)		
16 Tilt Stopper Lever or Tilt 17 Stopper Grease Fitting	(2)		
18 Upper Cylinder Pin	(2)		

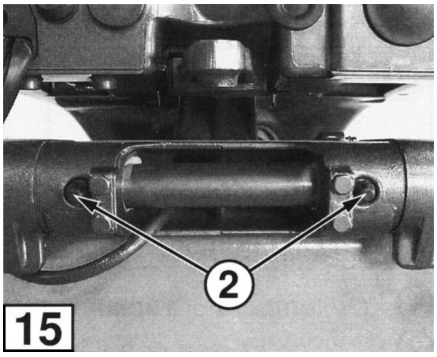
(2) Genuine grease or equivalent friction surface marine grease



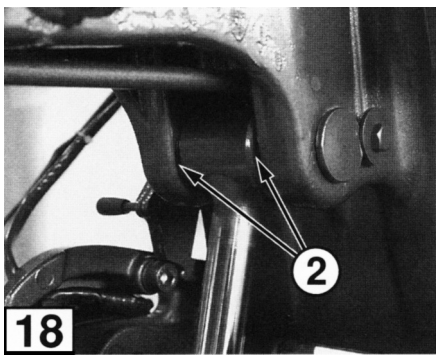
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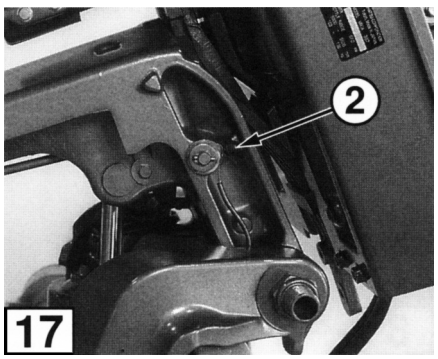
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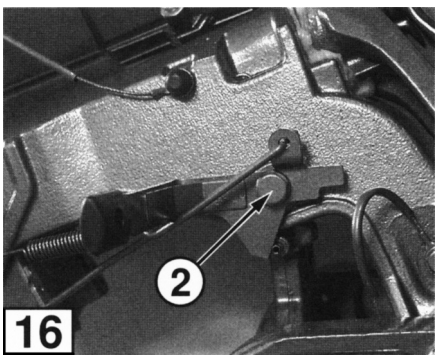
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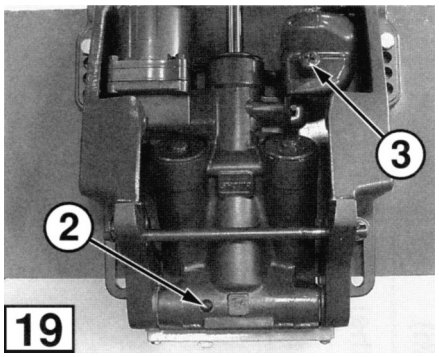
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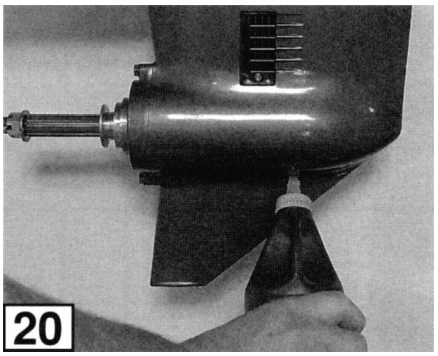
T1061



T1060



T1063



T1064

Location	Type of Lubricant	Frequency	
		Fresh Water	Salt Water
19 Lower Cylinder Pin Grease Fitting	(2)	Every 50 hours (3 months)	Every 30 hours (1 month)
19 Trim/Tilt Reservoir	(3)	Check level at time of delivery, after first 10 hours of operation, and every 100 hours (6 months). Fill reservoir as needed but do not mix different brands of oil.	
20 Gearcase	(4)	Change oil after first 10 hours of operation. Check level every 50 hours (3 months). Change every 200 hours (1 year).	

⚠ CAUTION

Do not mix different brands or types of oil. Doing so can cause oil gelling which may cause serious engine damage.

(1) Low temperature lithium grease

(2) Genuine grease or equivalent friction surface marine grease

(3) Nisseki power torque fluid (as shipped from factory) or any GM approved automatic transmission fluid:

- Mobil DTE #22 or Mobil AFT 220
- Shell Dextron II or Shell Tellus Oil #22 K22
- Esso Automatic Transmission Fluid

(4) Genuine gear oil or API GL5, SAE #80 - #90

SECTION 2

PERIODIC INSPECTIONS

NOTE

It is recommended that a complete engine overhaul be performed after 300 operating hours

Item	Inspection	Before Each Use	After First 10 Hours (2 weeks)	Every 30 Hours (1 month)	Every 50 Hours (3 month)	Every 100 Hours (6 month)	Remarks
Fastener Torque	Check the following: • Cylinder head bolts • Cylinder head cover bolts • Exhaust cover bolts • Carburetor mounting bolts or nuts • Intake manifold bolts • Crankcase bolts • Oil pump mounting bolt • Flywheel nut • Starter motor installation bolts • Driveshaft housing bolts • Gearcase bolts • Propeller shaft housing bolts • Propeller nut • Lower engine cover mounting bolts • Engine mounting bolts		●		●		Torque to specification.
Gearcase	• Check oil level and add oil as required. • Check for water or metallic matter in gear oil.		●		●		See Lubrication Chart in this section.
Spark Plugs	• Check plug gap. • Remove carbon deposits.				●		Replace plugs when electrodes are worn.
Carburetors	• Disassemble and clean. • Check float valve for wear.					●	Replace worn parts as required.
Fuel Tank, Pick-up Tube, Filters, and Fuel Pump	• Disassemble, clean, and inspect. • Check for leakage. • Check for cracks.		●		●		

Item	Inspection	Before Each Use	After First 10 Hours (2 weeks)	Every 30 Hours (1 month)	Every 50 Hours (3 month)	Every 100 Hours (6 month)	Remarks
Fuel and Recirculation Hoses	• Clean and inspect. • Check all hose clips.					●	Replace hoses every 2 years.
Engine Compression	• Check with compression gauge.				●		Obtain normal operating temperature and check at full throttle.
Warning Systems	• Check function of warning horn or pilot lamp.			●			See Operator Alert Systems in this section.
Water Pump	• Check for wear and damage.				●		Replace impeller every 200 hours (12 months).
Cooling and Exhaust Components	Remove dirt and deposits from the following: • Water pump and impeller • Water pipe • Thermostat • Exhaust cover • Exhaust pipe • Engine base • Reverse gas passage					●	
Powerhead Cleaning	Inspect and remove carbon deposits from the following: • Cylinder head • Pistons • Rings • Inner exhaust cover • Outer exhaust cover						Check every 200 hours (12 months).

Item	Inspection	Before Each Use	After First 10 Hours (2 weeks)	Every 30 Hours (1 month)	Every 50 Hours (3 month)	Every 100 Hours (6 month)	Remarks
Electrical Wiring	• Check for loose connections. • Inspect wires and insulation for damage.		●			●	
Ignition Timing and Carburetor Adjustments	• Check and adjust timing. • Adjust linkage.		●			●	See Synchronization and Linkage Adjustments in this section.
Throttle and Choke Valve Linkage	Inspect for the following: • Loose ball joints and lock nuts • Bent link rods • Loose rod snaps		●	●			
Lubrication System	Clean and inspect the following: • Oil tank • Oil hoses • Oil filter • Check components for damage and leakage		●			●	Replace automixing check valve and oil hoses every 2 years.
Sacrificial Anodes	• Inspect amount of erosion. • Test for proper installation.				●		Replace when anode has been reduced to 2/3 its original size (1/3 eroded). See Anodes - Inspection and Testing in this section.
Water Intake Screens	• Check for blockages.	●					Remove and clean as required.

Item	Inspection	Before Each Use	After First 10 Hours (2 weeks)	Every 30 Hours (1 month)	Every 50 Hours (3 month)	Every 100 Hours (6 month)	Remarks
Operational Checks	Check function and condition of the following : • Water discharge from check ports • Tiller or remote steering controls • Power trim/tilt system • Manual or remote clutch engagement • Main switch key • Emergency stop switch • Drag link and hardware	●					
Power Trim/Tilt Manual Release Valve	• Check for proper operation.					●	Open valve and move motor up and down.

SECTION 2

BREAK-IN PROCEDURE

⚠ CAUTION

Failure to follow the Break-In Procedure and special fuel mixture requirements for break-in may lead to serious engine damage and shortened engine life.

To prevent serious engine damage and ensure long engine life, new engines, used engines with new powerhead, used engines with newly rebuilt powerhead, and engines coming out of storage must be run for a period of 10 hours in accordance with the break-in procedure.

⚠ CAUTION

During break-in of engines with automixing system, a 50:1 gasoline/oil mixture is required in the fuel tank in addition to oil in the oil tank. Replenish fuel tank with pure gasoline ONLY after the first 10 hours of break-in are complete and fuel tank has been completely emptied.

⚠ CAUTION

Periodically check the level of lubricant in the oil tank has lowered, indicating automixing system is working properly and oil is being consumed by the engine.

⚠ CAUTION

Premix engines and engines with automixing system disabled, require a 25:1 gasoline/oil mixture in the fuel tank during the 10 hour break-in period. A 50:1 ratio is required after break-in.

First 10 Minutes

- Operate the engine at fast idle speed **ONLY**.
- Verify a steady stream of water from the cooling water check port and idle port on the engine, indicating the water pump is functioning properly.

Next 50 Minutes

- **DO NOT** operate the engine above 1/2 throttle (approx. 3000 RPM).
- **DO NOT** maintain a constant throttle setting. Vary engine speed every 15 minutes.

NOTE

For boats which come onto plane easily, use full throttle to quickly accelerate onto plane; then immediately reduce throttle to 1/2 and maintain this speed.

Second Hour

- Use full throttle to quickly accelerate boat onto plane; then immediately reduce throttle to 3/4 (approx. 4000 RPM) and maintain this speed.
- At intervals, run engine at full throttle for 1 - 10 minutes; then return to 3/4 throttle for a cooling period.
- Vary engine speed every 15 minutes.
- Check for water discharge from cooling water check ports.

Next Eight Hours

- Run engine at full throttle for short periods of time.
- Vary engine speed every 15 minutes.
- **DO NOT** exceed the Full Throttle RPM Range of the engine. See Engine Specifications in this section.

After Break-in

- Retorque cylinder head bolts to specification after engine has been run and cylinder head has cooled to the touch.
- Automixing Applications – Empty the fuel tank and replenish with pure gasoline. Fill the automixing tank with specified oil.
- Premix Applications – Empty the fuel tank and replenish with a 50:1 gasoline/oil mixture.

SECTION 2

TUNE-UP PROCEDURE

⚠⚠ WARNING

Deteriorated or damaged parts identified during engine tune-up must be replaced in order to maintain safe engine operation.

1. Inspect engine for leaks, missing, loose or damaged parts, or other visible defects.

2. Remove each spark plug and check for fouling, cracks in ceramic, and incorrect gap. Replace plugs if needed.

3. Check engine compression. Refer to Cylinder Compression Test in Section 4.

4. Check all wiring, connectors, and clamps for damage. Replace parts as needed.

5. Replace fuel and oil filters and inspect each carburetor. Check all fuel hoses for deterioration and replace as needed.

6. Check for proper clutch engagement and make shift cable adjustments as needed.

Model	Adjustment Part
40 /50	Shift lever stopper : Position onto Shift arm
60 / 70 F-type	Shift lever stopper : Position onto Shift lever stopper plate
60 / 70 P-type	Cable rod/joints : Length
80 / 90 F-type	Shift lever stopper : Position onto Shift lever stoppeer plate
80 / 90 P-type	Cable rod/joints : Length
115 / 120 / 140	Cable rod/joints : Length

7. Check for proper operation of the reverse lock mechanism.

8. Adjust the engine ignition timing and carburetors. See Synchronization and Linkage Adjustments, this section.

9. Remove propeller and inspect propeller shaft oil seal for leakage. Inspect propeller, thrust washer, and other propeller shaft hardware for damage. Replace as needed.

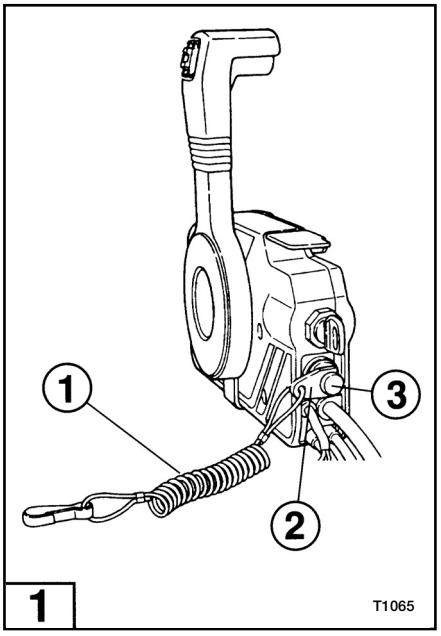
10. Drain and refill the gearcase with specified gear oil. See Engine Specifications in this section.

11. Lubricate all engine components as specified in the Lubrication Chart, this section.

12. Retorque all bolts and screws to specification.

13. Run engine in test tank with proper test propeller and check for the following:

- Abnormal engine noise.
- Improper clutch operation.
- Little or no cooling water discharge from check port and idle port.
- Fuel leaks from mating surfaces of crankcase.
- Fuel leaks from mounting surface of intake manifold.
- Cooling water leaks from mating surfaces of cylinder head.
- Cooling water leaks from engine mounting surfaces.
- Cooling water leaks from exhaust cover mounting surfaces.
- Improper idle RPM and stability.
- Defective stop switch.



EMERGENCY STOP SWITCH AND LANYARD

The emergency stop switch and lanyard should always be inspected and tested after rigging or servicing the outboard. Before each outing, the operator should perform the function test with the boat in the water and prior to leaving the launch area.

⚠⚠ WARNING

Do not attempt to repair worn or faulty stop switch and lanyard. Replace only with genuine parts. Do not substitute.

Inspection

1 1. Inspect lanyard **(1)** for cuts or fraying, lock clip **(2)** for cracks.

1 2. Inspect stop switch assembly **(3)** for signs of wear and make sure the switch has adequate spring tension to hold the lanyard lock clip in place.

Function Test

1. Attach the lanyard lock clip to the stop switch.

2. Start the engine.

3. With engine running, pull the lanyard to disengage the lock clip. Engine should stop running.

NOTE

The stop switch is designed to also operate as a pushbutton switch with the lanyard left attached.

Repeat the test but do not remove the lanyard. Press down firmly and hold the stop switch until engine stops running. If engine continues to run in either test, the stop switch or wiring are faulty and must be replaced before engine is operated, see Section 7.

OPERATOR ALERT SYSTEMS

To help protect the engine from serious powerhead damage, it is advisable to test the operator alert systems at the start of each boating season and periodically during the season.

Warning Horn Test

A warning horn is built into the prewired remote control box or is wired separately on tiller models. The horn emits a constant tone to alert the operator of critical operating conditions. Depending on engine model, these conditions may include:

- Clogged or obstructed cooling water intake
- Engine overheat
- Low oil level in oil automixing tank

⚠⚠ WARNING

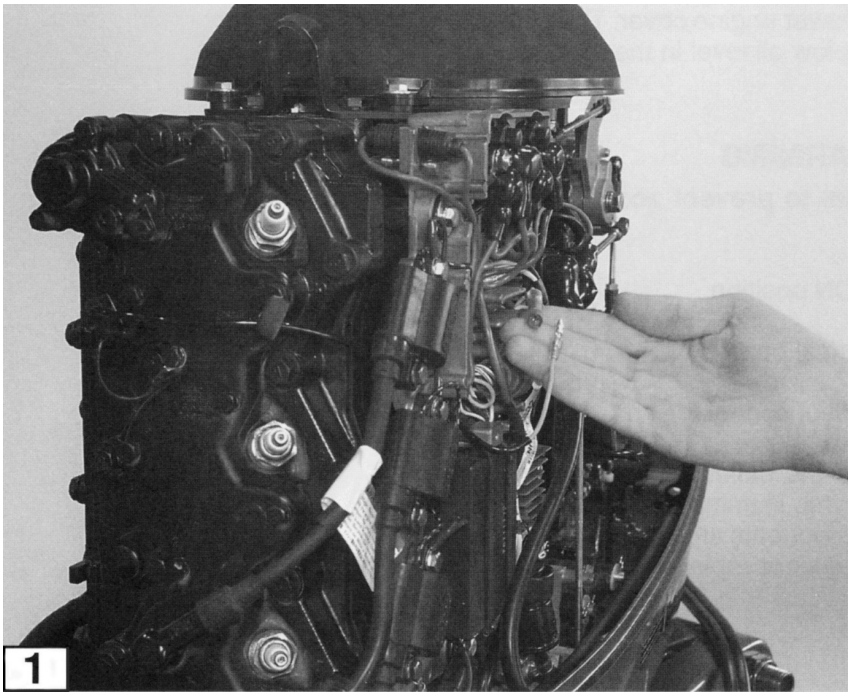
Disable the ignition system to prevent accidental engine startup.

1. Place the remote control lever (if equipped) in the FORWARD or REVERSE position.

2. Turn the main switch key to the ON position.

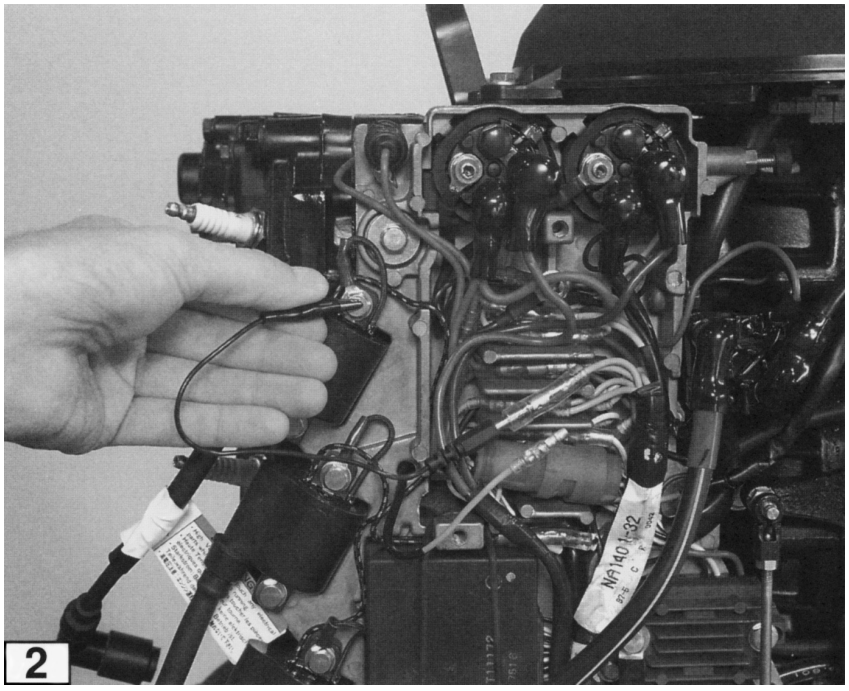
3. Remove the cover from the electrical box.

1 4. Disconnect the oil level sensor connection at the electrical box.



T1066

2 5. Connect the main switch side of the bullet connector to a clean engine ground and verify the warning horn sounds. If the horn does not sound, but other electrical components are functioning properly, the horn or wiring may be faulty. Repair or replace as needed. To test the oil level sensor, refer to Automixing System in Section 3.



T1067

Pilot Lamp Test

Models 40 and 50 EFGO, EFTO type are equipped with a pilot lamp mounted on the front surface of the lower engine cover. The pilot lamp illuminates to alert the operator of a low oil level in the oil automixing tank.

⚠⚠ WARNING

Disable the ignition system to prevent accidental engine startup.

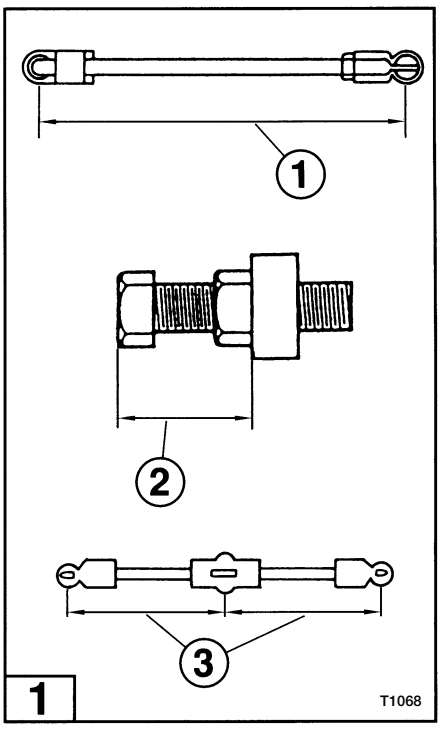
1. Turn the main switch key to the ON position.

2. Remove the cover from the electrical box.

3. Disconnect the oil level sensor bullet connector.

4. Connect the main switch side of the bullet connector to a clean engine ground and verify the pilot lamp illuminates. If the lamp does not illuminate, but other electrical components are functioning properly, the lamp or wiring may be faulty. Repair or replace as needed.

SYNCHRONIZATION AND LINKAGE ADJUSTMENTS



To ensure consistent engine idling and smooth operation throughout the full RPM range, it is important that each procedure be performed exactly as written and in the following sequence:

- 1 st - Ignition Timing Adjustment
- 2nd - Carburetor Synchronization
- 3rd - Oil Pump Aperture Adjustment

⚠⚠ WARNING

Before beginning procedures, disable the ignition system to prevent accidental engine startup.

⚠ CAUTION

The following applies to <u>all engines</u>:

1. **Should the stopper lever <u>barely contact</u> the stopper, damage to the carburetor may occur when the throttle lever is in the full throttle position. Stopper lever should firmly contact the stopper.**
2. **If stopper lever is not in firm contact with the stopper, but a small gap is present, no damage should occur.**
3. **Carburetors #2, #3 and/or #4 will have a gap between throttle stop and stopper when Carburetor #1 is properly adjusted.**
4. **After fine adjustment, stopper bolt lengths may differ from pre-adjustment settings.**

NOTE

1 *Adjustment lengths for links **(1)**, stoppers **(2)**, and carburetor link rods **(3)** are measured as shown.*

NOTE

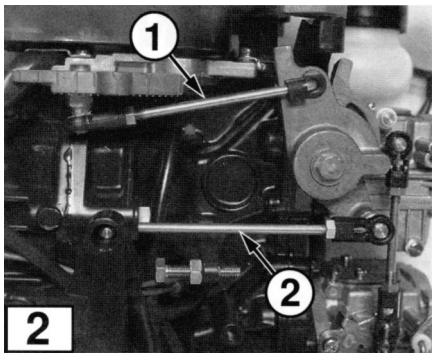
The seam at the mating surfaces of the crankcase halves is the alignment point for all ignition timing degree measurements.

Ignition Timing Adjustment

Models 40D / 50D

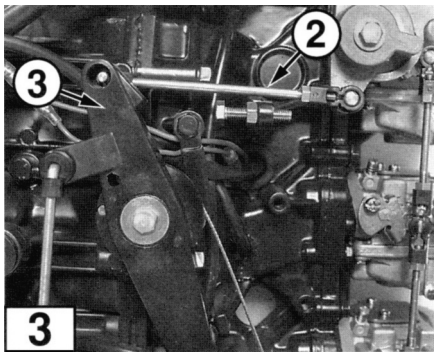
2 1. Pre-set ignition timing link **(1)** and throttle link **(2)** to specified lengths.

Model	Length (approximately)	
	Ignition Timing Link (1)	Throttle Link (2)
40D	5.04 in [129 mm]	3.86 in [99 mm]
50D	5.04 in [129 mm]	3.86 in [99 mm]



T1069

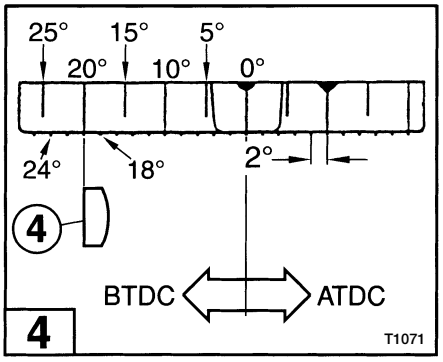
3 2. Check that the carburetor throttle is fully open when the advancer arm **(3)** is in the fully advanced position. If throttle is not fully open, make fine adjustments using throttle link **(2)**.



T1070

2 3. Adjust ignition timing link **(1)** so that the ignition timing at full throttle matches the following specifications:

Model	Ignition Timing - Full Throttle
40D	BTDC 18˚ ± 1˚
50D	BTDC 24˚ ± 1˚



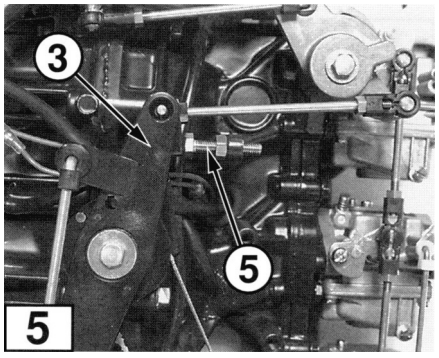
T1071

NOTE

4 *Align flat surface **(4)** of crankcase mold boss with calibration of set ring.*

5 4. After adjusting at maximum engine speed, set the advancer arm **(3)** to minimum engine speed and adjust the ignition to ATDC 3˚ ± 1˚ using the low speed side stopper **(5)**.

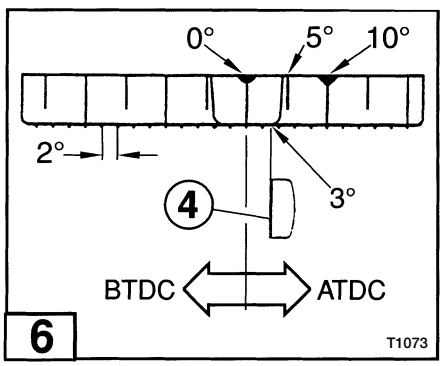
Model	Ignition Timing - Throttle Closed
40D	ATDC 3˚ ± 1˚
50D	ATDC 3˚ ± 1˚



T1072

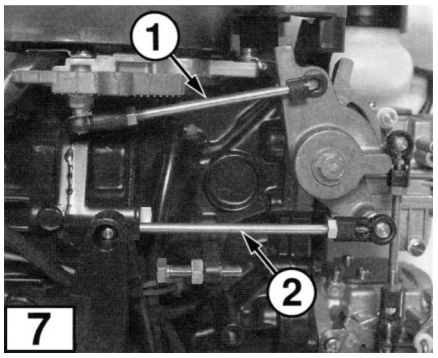
NOTE

6 *Align flat surface **(4)** of crankcase mold boss with calibration marks on set ring.*



T1073

Ignition Timing Adjustment

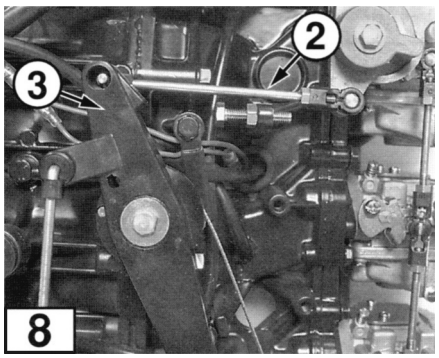


T1069

Models 40D2 / 50D2

7 1. Adjust ignition timing link **(1)** and throttle link **(2)** to specified length.

Model	Length	
	Ignition Timing Link (1)	Throttle Link (2)
40D2	3.98 in [101 mm]	4.53 in [115 mm]
50D2	3.86 in [98 mm]	4.53 in [115 mm]

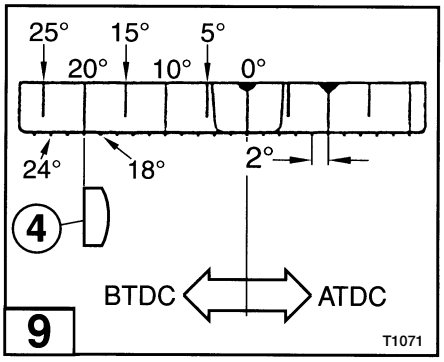


T1070

8 2. Place advancer arm **(3)** in the maximum speed position (wide open throttle) and make sure the carburetor throttle is fully open. If throttle is not fully open, make fine adjustments using throttle link **(2)**.

7 3. Adjust ignition timing link **(1)** so ignition timing at full throttle is matches the following specifications:

Model	Ignition Timing - Full Throttle
40D2	BTDC 18˚ ± 1˚
50D2	BTDC 20˚ ± 1˚



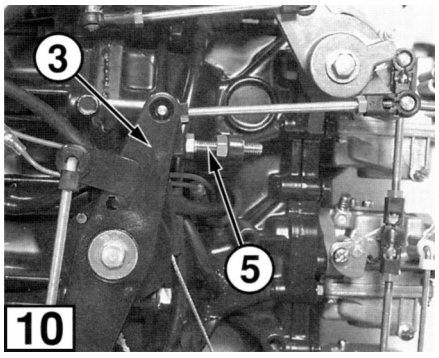
T1071

NOTE

9 *Align flat surface **(4)** of crankcase mold boss with calibration marks on set ring.*

10 4. Place advancer arm **(3)** in the minimum speed position (throttle fully closed) and adjust low speed side stopper **(5)** so ignition timing matches the following specifications:

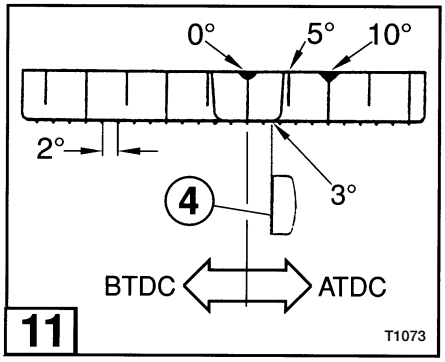
Model	Ignition Timing - Throttle Closed
40D2	ATDC 3˚ ± 1˚
50D2	ATDC 3˚ ± 1˚



T1072

NOTE

11 *Align flat surface **(4)** of crankcase mold boss with calibration marks on set ring.*



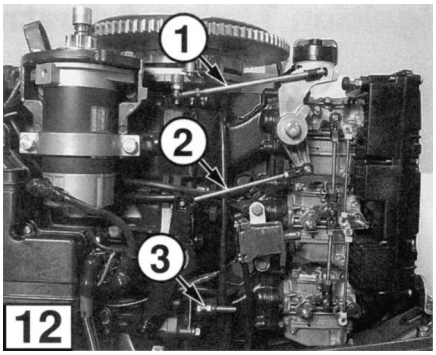
T1073

Ignition Timing Adjustment

Models 60B / 70B

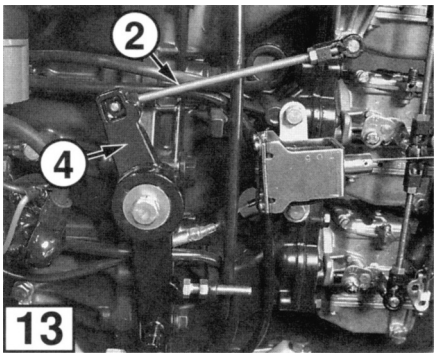
12 1. Pre-set ignition timing link **(1)**, throttle link **(2)**, and high speed side stopper **(3)** to specified length.

Model	Length (approximately)		
	Ignition Timing Link (1)	Throttle Link (2)	High Speed Stopper (3)
60B	5.24 in [133 mm]	5.00 in [127 mm]	0.28in [7 mm]
70B	5.24 in [133 mm]	5.00 in [127 mm]	0.28 in [7 mm]



T1074

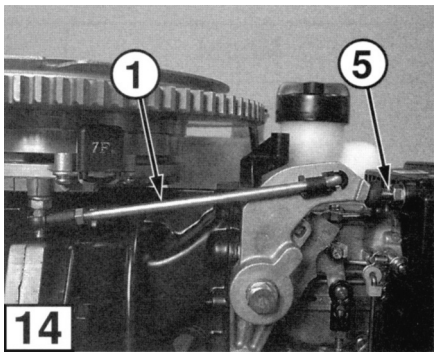
13 2. Place advancer arm **(4)** in the maximum speed position (wide open throttle) and make sure the carburetor throttle is fully open. If throttle is not fully open, make fine adjustments using throttle link **(2)**.



T1075

14 3. With the advancer arm still in the maximum speed position (wide open throttle), set the ignition timing to specification by adjusting ignition timing link **(1)**.

Model	Ignition Timing - Full Throttle
60B	BTDC 16˚ ± 1˚
70B	BTDC 20˚ ± 1˚



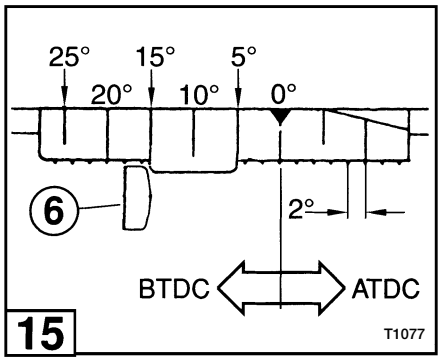
T1076

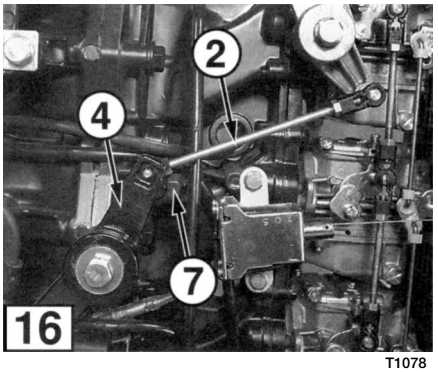
NOTE

15 *Align flat surface **(6)** of crankcase mold boss with calibration marks on set ring.*

16 4. Place advancer arm **(4)** in the minimum speed position (throttle fully closed). Adjust throttle link **(2)** so ignition timing is ATDC 3˚ ± 1˚ when the advancer arm is in contact with low speed side stopper **(7)**.

Model	Ignition Timing - Throttle Closed
60B	ATDC 3˚ ± 1˚
70B	ATDC 3˚ ± 1˚

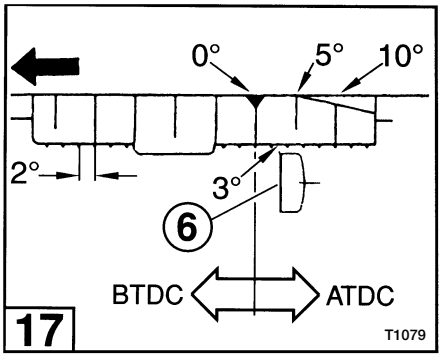




T1078

NOTE

17 *Align flat surface **(6)** of crankcase mold boss with calibration marks on set ring. Perform the adjustment with set ring pushed slightly in the direction of arrow.*



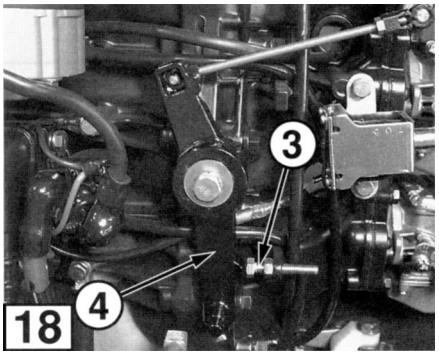
18 5. Return advancer arm **(4)** to the maximum speed position (wide open throttle) and adjust length of high speed side stopper **(3)** so it contacts the advancer arm.

Ignition Timing Adjustment

Models 60C / 70C

19 1. Adjust ignition timing link **(1)**, throttle link **(2)**, and high speed side stopper **(3)** to specification.

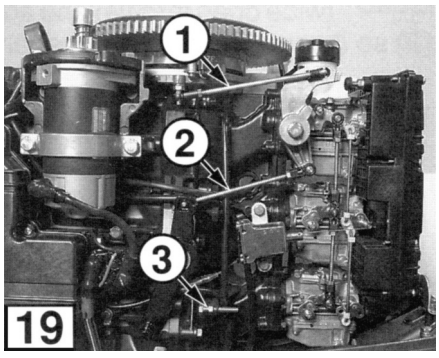
Model	Length		
	Ignition Timing Link (1)	Throttle Link (2)	High Speed stopper (3)
60C	5.75 in [146 mm]	5.04 in [128 mm]	0.87 in [22 mm]
70C	5.75 in [146 mm]	5.04 in [128 mm]	0.55 in [14 mm]



T1080

20 2. Place advancer arm **(4)** in the maximum speed position (wide open throttle) and make sure the carburetor throttle is fully open. If throttle is not fully open, make fine adjustments using throttle link **(2)**.

21 3. With the advancer arm still in the maximum speed position (wide open throttle), set the ignition timing to specification by adjusting the throttle cam stopper **(5)** on the air silencer (Models 60C and 70C).

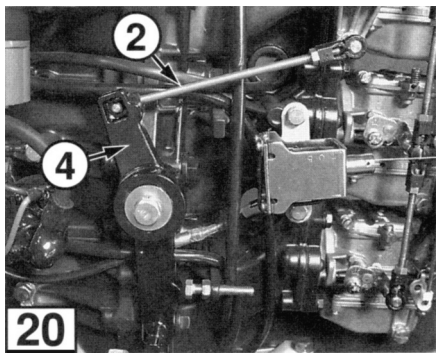


T1074

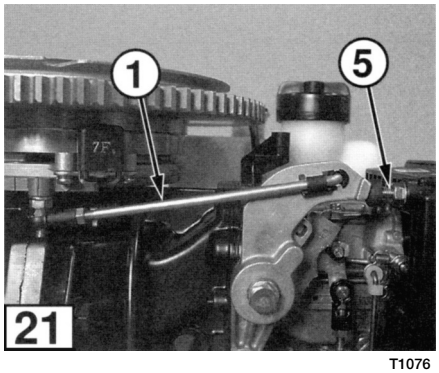
Model	Ignition Timing - Full Throttle
60C	BTDC 17.5˚ ± 1˚
70C	BTDC 17.5˚ ± 1˚

NOTE

The rubber damper must be installed on stopper when making the adjustment on 60C and 70C.



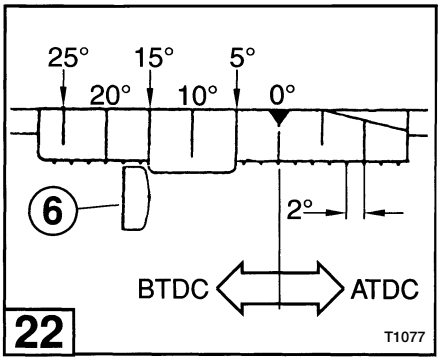
T1075



T1076

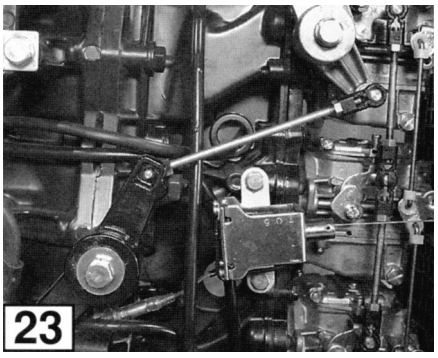
NOTE

22 *Align flat surface **(6)** of crankcase mold boss with calibration marks on set ring.*



23 4. Place advancer arm **(4)** in the minimum speed position (throttle fully closed). Adjust throttle link **(2)** so ignition timing is ATDC 3˚ ± 1˚ when the advancer arm is in contact with low speed side stoooer **(7)**.

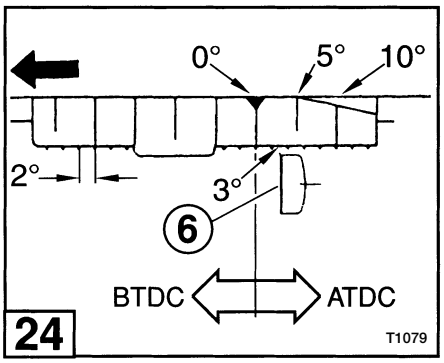
Model	Ignition Timing - Throttle Closed
60C	ATDC 3˚ ± 1˚
70C	ATDC 3˚ ± 1˚

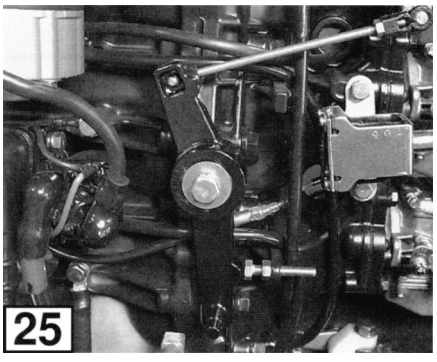


NOTE

24 *Align flat surface **(6)** of crankcase mold boss with calibration marks on set ring. Perform the adjustment with set ring pushed slightly in the direction of arrow.*

25 5. Return advancer arm **(4)** to the maximum speed position (wide open throttle) and adjust length of high speed side stopper **(3)** so it contacts the advancer arm.



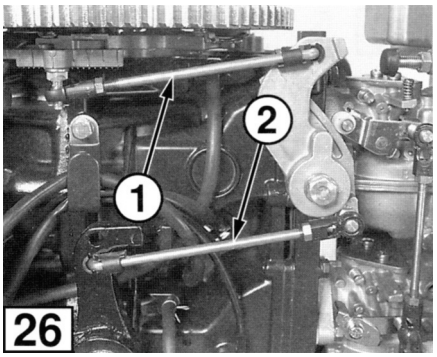


Ignition Timing Adjustment

Models 80A / 90A

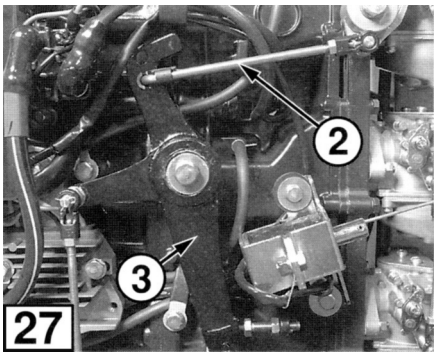
26 1. Adjust ignition timing link **(1)** and throttle link **(2)** to specification :

Model	Length	
	Ignition Timing Link (1)	Throttle Link (2)
80A	4.88 in [124 mm]	5.18 in [131.5 mm]
90A	4.88 in [124 mm]	5.18 in [131.5 mm]



T1081

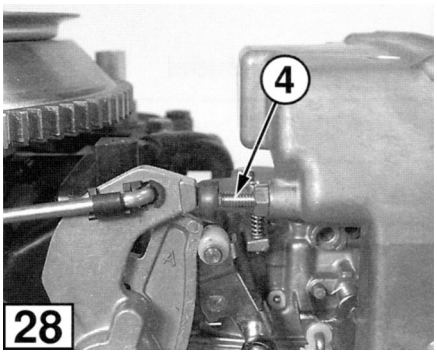
27 2. Place advancer arm **(3)** in the maximum speed position (wide open throttle) and make sure the carburetor throttle is fully open. If throttle is not fully open, make adjustments using throttle link **(2)**.



T1082

28 3. With the advancer arm at maximum speed (wide open throttle), adjust throttle cam stopper **(4)** (Pre-setting length = 20 mm) on the air silencer to obtain the specified ignition timing at full throttle:

Model	Ignition Timing - Full Throttle
80A	BTDC 20° ± 1˚
90A	BTDC 20° ± 1˚



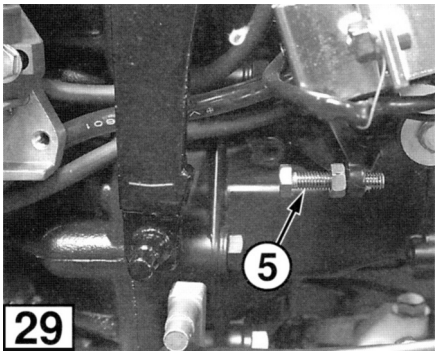
T1083

NOTE

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

29 4. Adjust high speed stopper **(5)** to specification:

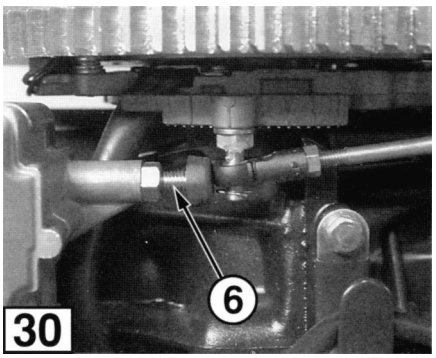
Model	Pre-setting Length
	High Speed Side Stopper (5)
80A	0.6 in (15 mm)
90A	0.6 in (15 mm)



T1084

30 5. Place the advancer arm in the minimum speed position (throttle fully closed) and adjust stopper **(6)** (Pre-setting length = 12 mm) to obtain the specified ignition timing:

Model	Ignition Timing - Throttle Closed
80A	ATDC 5° ± 1˚
90A	ATDC 5° ± 1˚

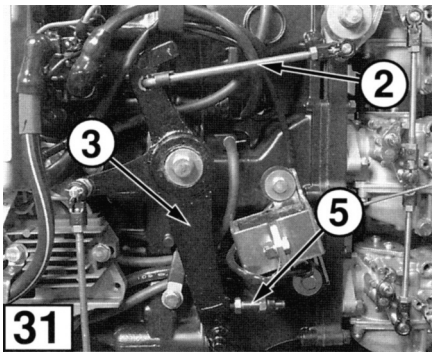


T1085

NOTE

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

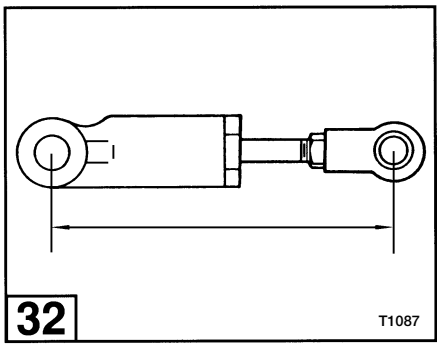
31 6. Return advancer arm **(3)** to the maximum speed position (wide open throttle) and check if comes in contact with the high speed stopper **(5)**. If advancer arm does not contact stopper, make fine adjustment using throttle link **(2)**.



T1086

32 7. Adjust shift link rod to specification.

Model	Length
	Shift Link Rod
80A	3.11 in [79 mm]
90A	3.11 in [79 mm]

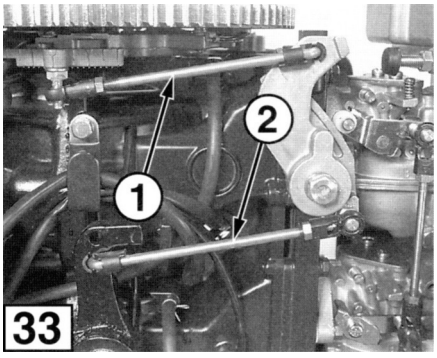


Ignition Timing Adjustment

Models 115 / 120 / 140

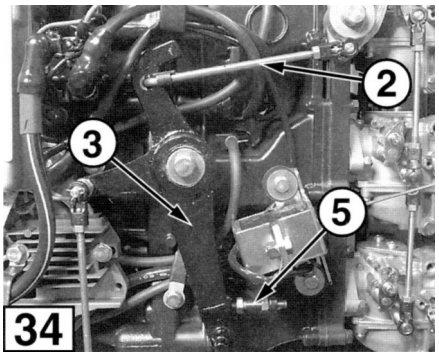
33 1. Adjust ignition timing link **(1)** and throttle link **(2)** to specification:

Model	Length	
	Ignition Timing Link (1)	Throttle Link (2)
115	5.00 in [127 mm]	6.22 in [158 mm]
120	5.00 in [127 mm]	6.22 in [158 mm]
140	5.00 in [127 mm]	6.22 in [158 mm]



T1081

34 2. Place advancer arm **(3)** in the minimum speed position (throttle fully closed). Set ignition timing to ATDC 10˚ ± 1˚ . If throttle is not fully closed, make adjustments using throttle link **(2)**.

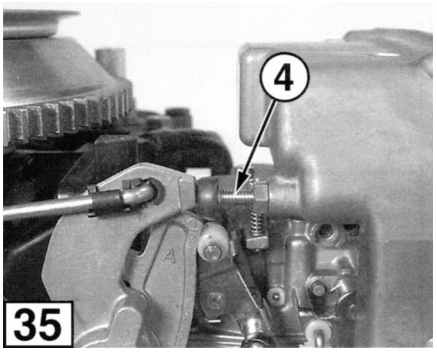


T1086

35 3. Adjust stopper bolt **(5)** length so that it contacts the advancer arm joint at maximum speed.

35 **36** 4. With the advancer arm at maximum speed (wide open throttle), adjust throttle cam stopper **(4)** on the air silencer to obtain the specified ignition timing at full throttle:

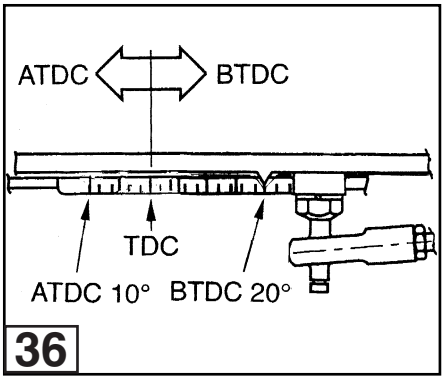
Model	Ignition Timing - Full Throttle
115	BTDC 17.5˚ ± 1˚
120	BTDC 17.5˚ ± 1˚
140	BTDC 20˚ ± 1˚



T1083

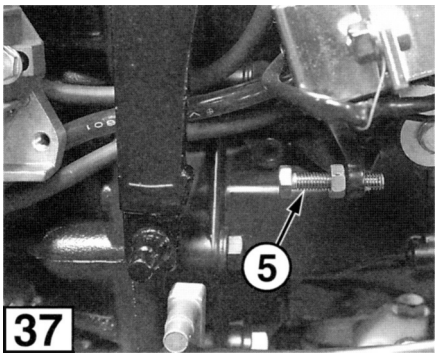
NOTE

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



37 5. Adjust high speed stopper **(5)** to specification:

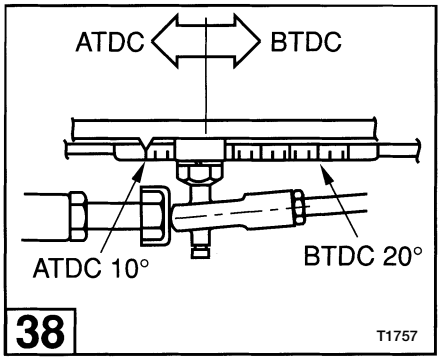
Model	Length
	High Speed Side Stopper (5)
115	0.71 in [18 mm]
120	0.71 in [18 mm]
140	0.55 in [14 mm]



T1084

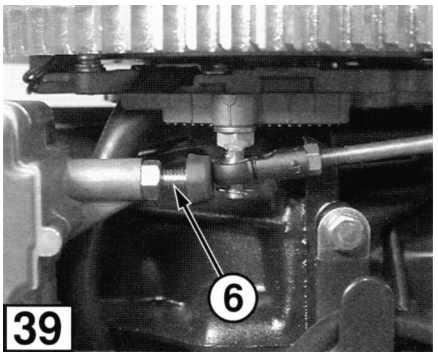
38 6. Place the advancer arm in the minimum speed position (throttle fully closed) and adjust stopper **(6)** to obtain the specified ignition timing:

Model	Ignition Timing - Throttle Closed
115	ATDC 10˚ ± 1˚
120	ATDC 10˚ ± 1˚
140	ATDC 10˚ ± 1˚



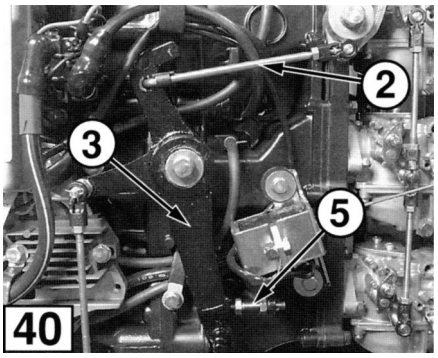
NOTE

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



T1085

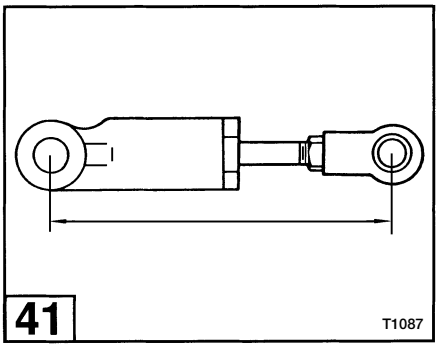
40 7. Return advancer arm **(3)** to the maximum speed position (wide open throttle) and verify that advancer arm contacts the high speed stopper **(5)**. If advancer arm does not contact stopper, make fine adjustments using throttle link **(2)**.



T1086

41 8. Adjust shift link rod to specification.

Model	Length
	Shift Link Rod
115	3.66 in [93 mm]
120	3.66 in [93 mm]
140	3.66 in [93 mm]



T1087

Carburetor Synchronization

NOTE

Engine ignition timing must be properly adjusted before synchronizing the carburetors.

1. Remove the air silencer cover.

1 2. Disconnect ignition timing link **(1)** and throttle link **(2)** so throttle lever roller **(3)** does not make contact with throttle cam **(4)**.

2 3. Adjust the length of each carburetor throttle link rod **(5)** to specification :

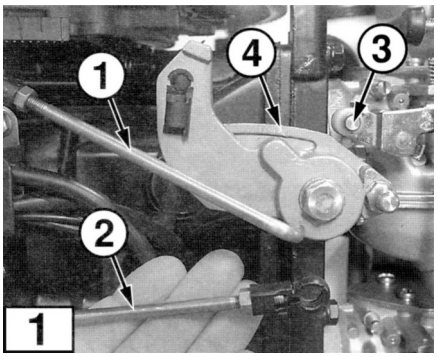
Model	Length
	Link (5)
40 / 50	3.54 in [90 mm]
60 / 70	3.81 in [97 mm]
80 / 90 / 115 / 120 / 140	4.33 in [110 mm]

1 4. Reconnect timing link **(1)**.

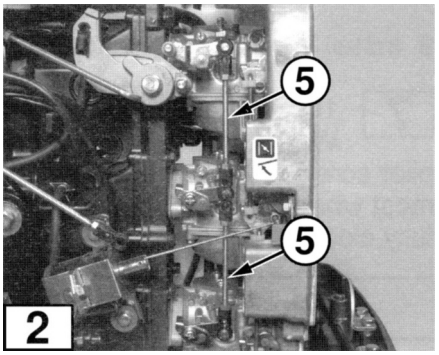
3 5. Turn **all** throttle lever screws **(6)** clockwise to loosen. The throttle butterfly valves should return to a fully closed position.

4 6. Loosen throttle stop screw **(7)** on top carburetor (middle carburetor on models 60 and 70) so it does not make contact with throttle lever **(8)**. The throttle butterfly valve should return to a fully closed position.

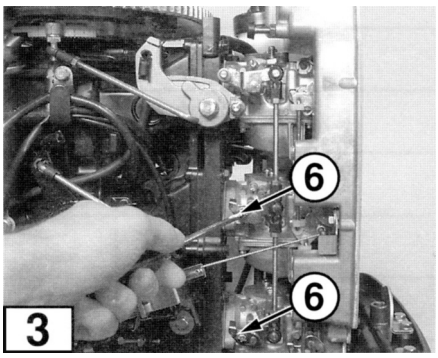
5 7. Starting with the second carburetor from the top of the engine, apply light upward pressure to linkage tab **(9)** and turn throttle lever screw **(6)** counterclockwise to tighten the throttle lever. Repeat this step for each remaining carburetor, working toward the bottom carburetor.



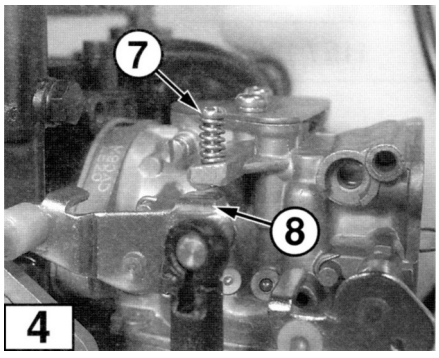
T1088



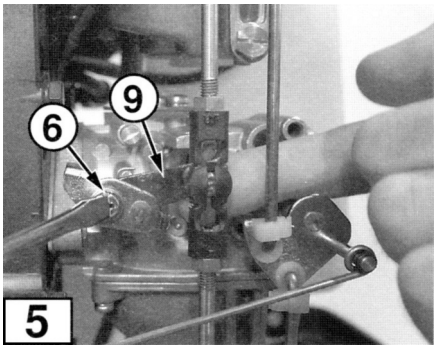
T1089



T1090



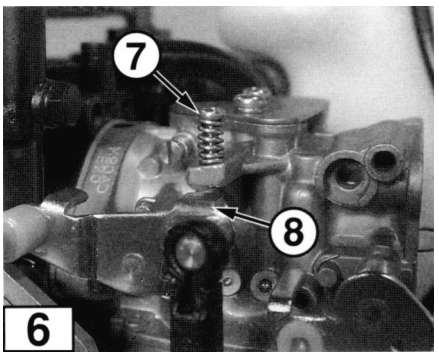
T1091



T1092

6 8. Turn throttle stop screw **(7)** until it touches throttle lever **(8)**, then tighten the screw to the specified number of turns:

Model	Throttle Stop Screw (7) Number of Turns
40 / 50	2-1/2
60 / 70	1-1/4
80 / 90 / 115 / 120 / 140	As needed so throttle valve is open 5°

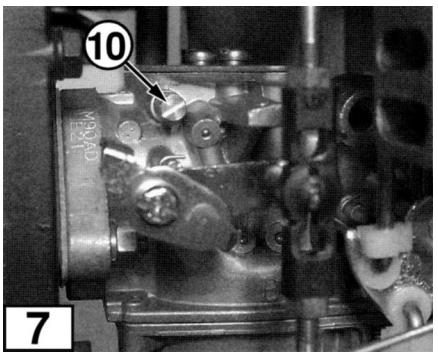


T1091

9. Install the air silencer cover.

7 10. Start and run engine up to normal operating temperature. Working from top to bottom carburetor, gradually adjust each pilot screw **(10)** to find the setting at which engine speed increases most when screw is opened to the specified number of turns from its fully closed position:

Model	Pilot Screw (10) Number of Turns
40D	1-1/4 ± 3/4
40D2	1 -5/8 ± 3/4
50 D	2-3/4 ± 3/4
50D2	2 ± 3/4
60B / 70B	1-1/2 ± 1/4
60C / 70C	1-3/8 ± 1/4
80 / 90	1-5/8 ± 1/4
115 / 120 / 140	1-5/8 ± 1/4



T1093

NOTE

For the following step, the boat and engine must be in the water under normal operating conditions with the correct propeller installed. The boat cannot be tied to a trailer or dock and must be free to move.

11. Start and run the engine up to normal operating temperature. With an accurate tachometer installed, adjust the throttle stop screw to obtain the specified RPM at neutral idle and trolling speeds:

Model	Neutral Idle RPM	Trolling RPM
40 / 50	900	750
60 / 70	900	750
80 / 90	900	700
115 / 120 / 140	900	700

Oil Pump Aperture Adjustment

NOTE

Engine ignition timing must be properly adjusted and the carburetors synchronized before adjusting the oil pump aperture.

The oil pump aperture is adjusted 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 scribe mark on the oil pump. Use the following specification table and procedure to adjust the oil pump aperture.

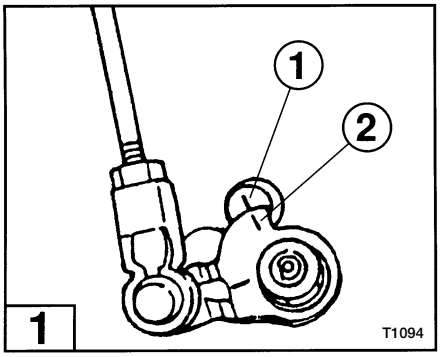
1. Set the carburetor throttle as specified.

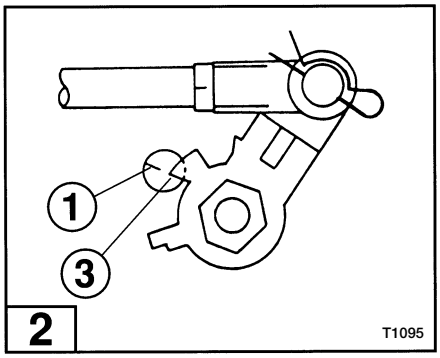
2. Check the alignment of the specified indicator mark on the control lever with the scribe mark on the oil pump. Marks must be aligned as shown in the correct figure. If not aligned, determine if link rod needs to be lengthened or shortened to bring the marks into alignment.

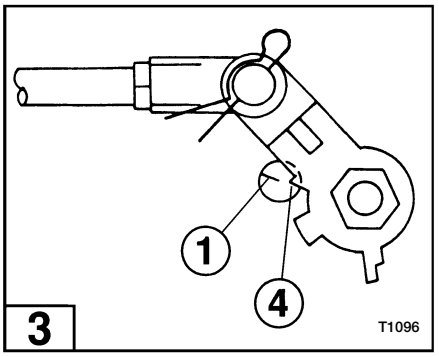
3. Remove the oil pump link rod and make length adjustment. Reinstall link rod.

4. Recheck the alignment at the specified throttle setting(s).

5. Repeat procedure until oil pump aperture is properly adjusted.

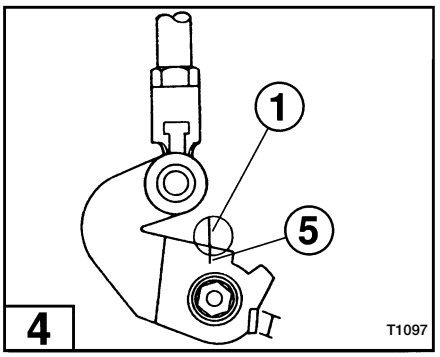


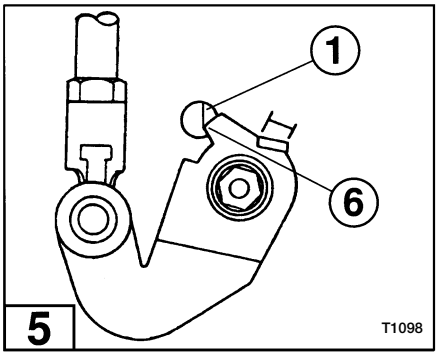




Model	Throttle Position	Aperture Setting
1 40 / 50	Fully OPEN	Marks (1) and (2) aligned.
2 60 / 70	Fully CLOSED	Marks (1) and (3) aligned.
3 70	Fully OPEN*	Marks (1) and (4) aligned.
4 90 / 115 / 120 / 140	Fully CLOSED	Marks (1) and (5) aligned.
5 90	Fully OPEN*	Marks (1) and (6) aligned.

*Verify only adjustment made in CLOSED position.



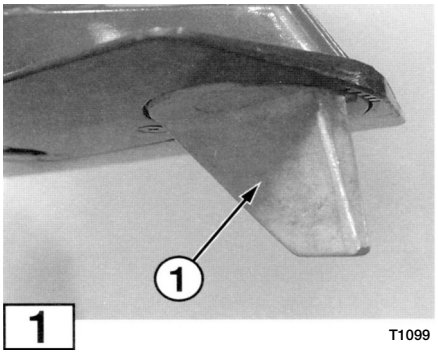


ANODES - INSPECTION AND TESTING

Engines are equipped with several sacrificial anodes to help protect metal parts from the effects of galvanic corrosion (electrolysis). Disintegration of the anodes indicates they are performing their function. An anode must be replaced when it has been reduced to 2/3 its original size (1/3 eroded). Engine corrosion will increase if eroded anodes are not replaced.

⚠ CAUTION

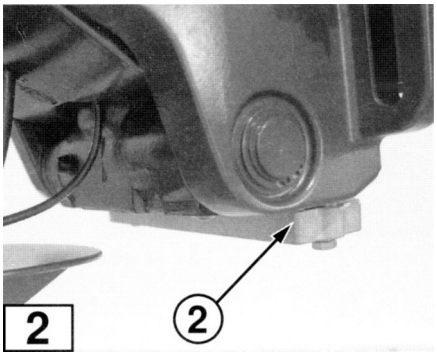
Do not paint or coat anodes or their mounting surfaces.



T1099

External Anodes

Anodes mounted externally on the engine should be inspected every 3 months, or more frequently if the engine is operated in salt or polluted water.

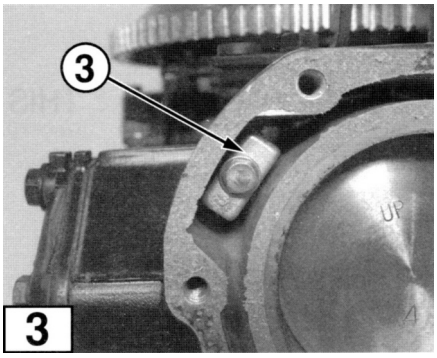


T1100

1 Inspect sacrificial trim tab **(1)** for erosion.

2 Inspect stern bracket anode **(2)** for erosion.

Crankcase Anode



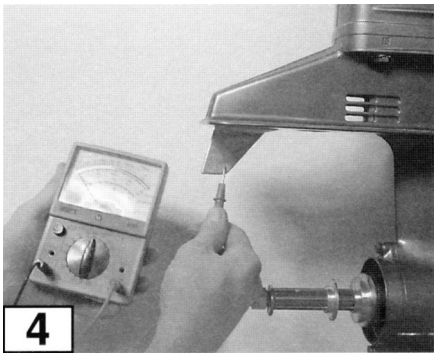
T1101

3 The powerhead is protected by an anode mounted in the crankcase under the cylinder head. Replace crankcase anode **(3)** when service work requires removal of the cylinder head or when a complete overhaul of the engine is performed.

Installation Test

Use the following procedure to test for proper installation of anodes. Make sure anode surface is clean before testing.

1. Calibrate an ohmmeter on high ohms scale.



T1102

4 2. Connect one meter lead to a ground on the powerhead and the other lead to the anode. The ohmmetershould show a low reading. If not, remove the anode and clean the surface where it was mounted. The anode and its mounting hardware should also be cleaned. Install anode and retest.

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SECTION 3
FUEL SYSTEM

TABLE OF CONTENTS

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SECTION 3

GENERAL PRECAUTIONS

⚠⚠ WARNING

Gasoline is extremely flammable and can readily explode if mishandled.

Before performing any service work on the fuel system, read and understand Section 1 - Service Safety.

Before servicing the fuel system, disable the engine ignition system to prevent accidental starting of engine.

Fuel leakage can contribute to a fire or explosion. After service work is complete and engine is fully assembled, always run the engine momentarily to pressurize the fuel system, then check for leaks.

Never run the engine with any fuel system component removed or disconnected.

Check fuel hoses and other nonmetallic components for indications of damage or deterioration. Always replace components with genuine factory replacement parts suitable for fuel systems.

Clean up fuel spills immediately and store rags in approved containers. Keep drained fuel in approved containers for proper disposal.

When using compressed air to clean or dry parts, make sure air supply is regulated not to exceed 25 psi [172 kPa / 1.76 kg/cm^2].

SERVICE SPECIFICATIONS

Special Torque Values

Description	Torque in-lb N·m kg-m				Threadlocker
	Model				
	40 / 50	60 / 70	80 / 90	115 / 120 / 140	
Carburetor Mounting Bolt	44 - 53 5 - 6 0.5 - 0.6	44 - 53 5 - 6 0.5 - 0.6	—	—	—
Intake Manifold Bolt	53 6 0.6	80 9 0.9	53 6 0.6	*	
Air Silencer Bolt	*	26 - 35 3 - 4 0.3 - 0.4	*	*	Loctite 242
Air Silencer Cover Bolt	*	8.9 1 0.1	8.9 1 0.1	26 - 44 3 - 5 0.3 - 0.5	—

*Refer to Section 2 for Standard Torque Values chart.

Carburetor Specifications

Model	Main Jet	Main Air Jet	Slow Jet	Slow Air Jet	Pilot Screw Turn-Out	Neutral Idle Speed Adjustment RPM	Trolling Speed Adjustment RPM
40D	#125	#210	#66	#130	1-14 ± 3/4	900	750
40D2	#122	#190	#66	#130	1-5/8 ± 3/4	900	750
50D	#135	#230	#74	#130	2-3/4 ± 3/4	900	750
50D2	#132 U&C #135 L	#230	#80	#150	2 ± 3/4	900	750
60B	#145	#145	#75	#75	1-1/2 ± 1/4	900	750
60C	#138 U&L #140 C	#155	#72	#75	1-3/8 ± 1/4	900	750
70B	#145	#145	#75	#75	1-1/2 ± 1/4	900	750
70C	#138 U&L #140 C	#155	#72	#75	1-3/8 ± 1/4	900	750
80	#150	#165	#75	#85	1-5/8 ± 1/4	900	700
90	#150	#165	#75	#85	1-5/8 ± 1/4	900	700
115	#162	#160	#75	#70	1-5/8 ± 1/4	900	700
120	#162	#160	#75	#70	1-5/8 ± 1/4	900	700
140	#162	#160	#75	#70	1-5/8 ± 1/4	900	700

U - Upper Carburetor C - Center Carburetor L - Lower Carburetor

SECTION 3

Manufacturer Special Tools Required

None

General Equipment Required

Fuel Pressure Gauge, 0 - 15 psi [0 - 103 kPa / 0 - 1 kg/cm²]
Torque Wrench, 0 - 150 in-lb [0 - 17 N-m / 0 - 1.7kg-m]
Digital Pulse Tachometer, 10 RPM, *Electonic Specialties®*
Model 321 or equivalent
Flexible Fuel Tubing, 1/4 in. I.D. x 5 in. [6 mm I.D. x 127 mm]
Flexible Fuel Tubing, 3/8 in. I.D. x 5 in. [9.5 mm I.D. x 127 mm]
Gearcase Pressure Tester, *Stevens® S-34 or equivalent*

Consumable Supplies Required

Thread Locker, *Loctite® 242*
Isopropyl Alcohol
Cleaning Solvent
Engine Lubricant, *Genuine Engine Oil or NMMA Certified TC-W3 Oil*
Gasket Sealant, *Permatex® High Tack Gasket Sealant*

FUEL SYSTEM REQUIREMENTS

Acceptable Fuel

Any premium gasoline with pump posted octane rating over 89 (research octane rating of 91) and with no more than 10% Ethanol by volume.

Unacceptable Fuel

Gasoline with more than 5% Methanol (even if it contains co-solvents or corrosion inhibitor) or more than 10% Ethanol, regardless of the octane rating.

Fuel Storage Life

Untreated gasoline or premixed fuel stored longer than 2 weeks should not be used for outboard engine operation. Fuel treated with a stabilizer additive at the time of storage should not be used after a period of 3 months.

Acceptable Lubricant

Any NMMA certified TC-W3 2-cycle outboard engine oil is acceptable for automixing system and fuel tank premix applications. Do not use automotive oils which can damage the engine and shorten spark plug life.

⚠ CAUTION

Do not mix different brands or types of oil. Doing so can cause oil gelling which may block the oil filter screen and cause serious powerhead damage due to lack of lubrication.

Mix Ratios

⚠ CAUTION

In addition to oil in the oil tank, a 50:1 gasoline/oil mixture is required during engine break-in. Refer to Break-In Procedure in Section 2.

Automixing
The gasoline/oil mixing ratio varies automatically between 50:1 (2% oil) and 120:1 (0.8% oil) according to throttle opening and engine speed.

Premixing
Engines not equipped with automixing system, or engines to be operated with automixing system disabled require a 50:1 gasoline/oil mixture (2% oil). New engines, reconditioned powerheads, and engines coming out of storage require a 25:1 gasoline/oil mixture (4% oil) during the first 10 hours of operation.

SECTION 3

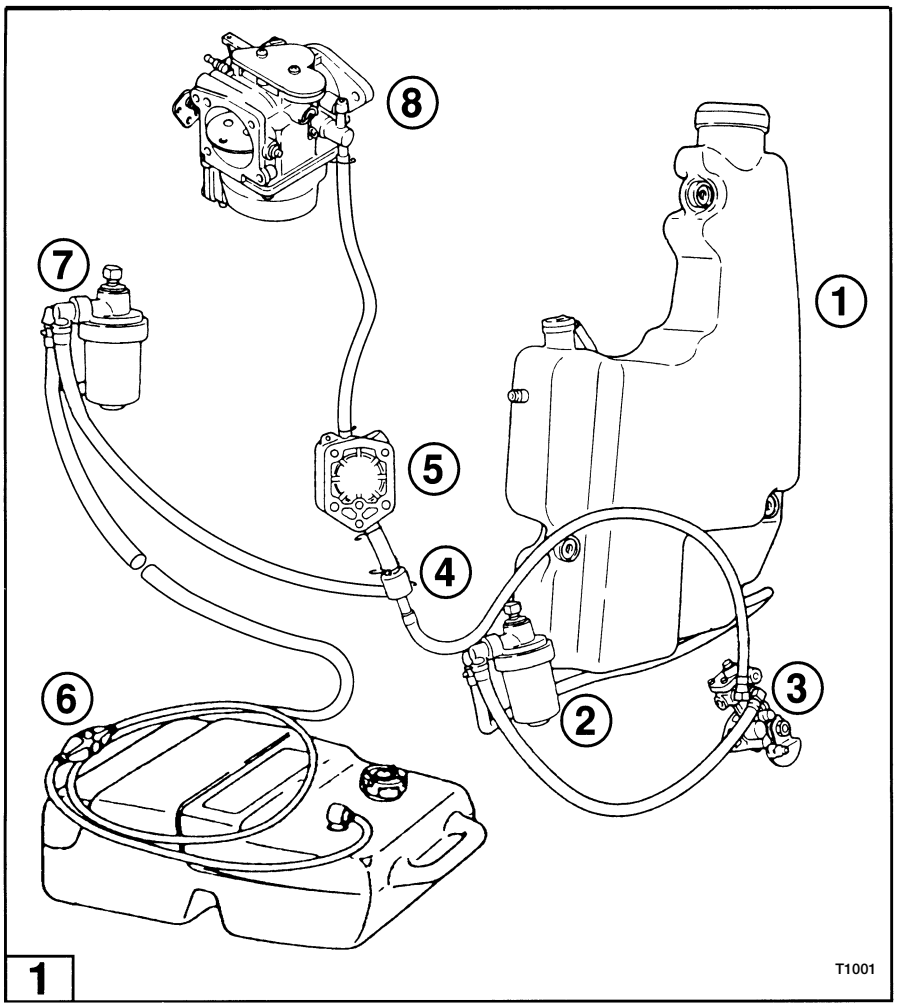
TROUBLESHOOTING

The troubleshooting chart lists common engine symptoms related to problems with the fuel system. It also indicates specific malfunctions in the fuel system which may be causing the problem so it can be isolated more effectively. Before beginning major troubleshooting operations on the fuel system, perform the following operations:

- Disconnect fuel tank hose from the engine. Connect a known good tank and hose and determine if the problem persists.
- Remove and clean the engine fuel filter assembly and replace the filter element.
- Replace filter element in the fuel tank pickup tube.
- Remove and clean the automixing check valve.

Checks \ Symptom	Hard to start or will not start	Low speed miss or will not idle smooth and slow enough	High speed miss	Poor acceleration, hesitation, coughs	Runs rough and smokes with vibration	Idles well, then slows and stops	Will not start and afterfires into exhaust housing	No acceleration, low top end RPM	Idles well but slows when accelerated	Runs at high speed only when hand primer is used	Engine stops suddenly	Runs noisy and knocks	Excessive fuel consumption
FUEL TANK AND FILTERS													
Empty fuel tank	•										•		
Low fuel in tank		•		•									
Fuel tank air vent closed	•					•				•	•		
Poor quality or old fuel	•	•	•		•								
Water in fuel system	•		•						•				
Fuel hose pinched or disconnected	•							•	•	•			
Restricted fuel pickup pipe or clogged pipe filter	•							•	•	•			
Faulty primer bulb	•												
Improper or faulty anti-siphon valve	•							•	•	•			
Clogged fuel filter	•							•	•	•			
Loose connector or vacuum leak	•								•				

Checks \ Symptom	Hard to start or will not start	Low speed miss or will not idle smooth and slow enough	High speed miss	Poor acceleration, hesitation, coughs	Runs rough and smokes with vibration	Idles well, then slows and stops	Will not start and afterfires into exhaust housing	No acceleration, low top end RPM	Idles well but slows when accelerated	Runs at high speed only when hand primer is used	Engine stops suddenly	Runs noisy and knocks	Excessive fuel consumption
OIL MIXTURE													
No oil in engine oil tank											•	•	
Mixture too rich (too much oil)		•			•								
Mixture too lean (not enough oil)		•				•		•	•			•	
CARBURETOR													
Carburetor out of adjustment	•	•		•	•			•	•	•			
Carburetor obstruction or faulty needle valve	•												
Restricted air flow to carburetor					•								
Faulty choke valve	•				•				•				
Carburetor and ignition timing not synchronized	•							•					
Carburetors not synchronized		•		•	•				•				
Float position too high					•								•
Float position too low				•					•	•			
Jet obstructed or defective				•					•	•			•
Carburetor gasket leakage				•									•
RECIRCULATION SYSTEM													
Puddle drain valve or hose blockage		•			•	•							
Recirculation hose misrouted		•		•									
FUEL PUMP													
Mounting gasket leakage						•				•			
Check valve sticking open or closed				•						•			
Ruptured diaphragm				•									•
INLET MANIFOLD													
Warped inlet manifold		•		•									
Manifold gasket leakage		•		•									
Faulty reed valve operation or broken valve		•		•				•					
Reed valve gasket leakage		•		•			•	•					



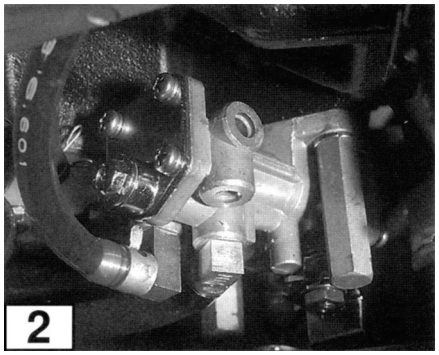
1

DESCRIPTION OF OPERATION

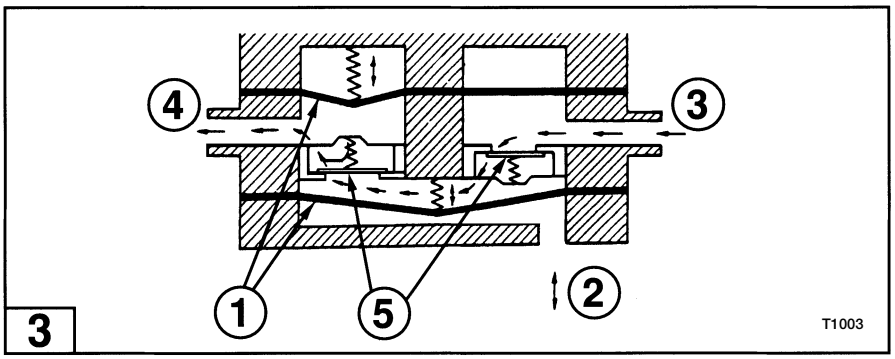
The following description of operation applies to fuel systems equipped with the oil automixing feature. Premix fuel systems operate in a similar manner but do not include a separate oil input circuit.

Fuel Flow

1 Upon engine startup, engine oil from oil tank **(1)** is drawn through oil filter **(2)** and into the oil pump. The oil output from pump **(3)** is then directed to automixing check valve **(4)**. At the same time, vacuum pressure on the suction side of fuel pump **(5)** causes raw gasoline from fuel tank **(6)** to be drawn through filter **(7)** and into the check valve. The oil mixing check valve ensures gasoline and oil are mixed before entering the fuel pump. The fuel pump output is then directed to multiple carburetors **(8)** for proper dispersal to the engine.



T1002



T1003

Oil Pump

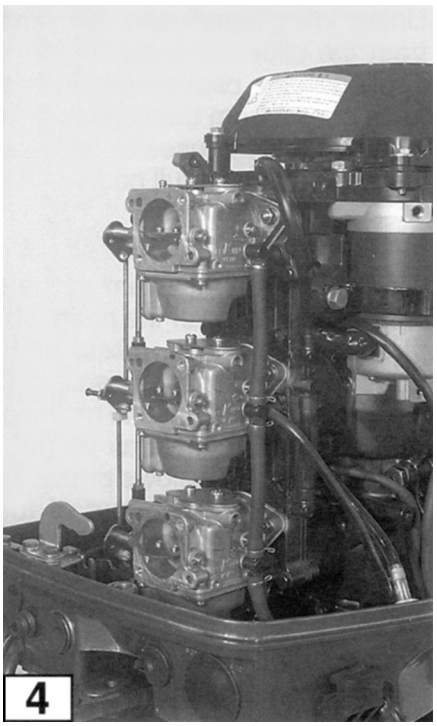
2 The oil pump is a plunger type mainly containing an internal worm gear driven by engine revolution, a spindle gear, and a cam shaft connected to engine throttle linkage.

Fuel Pump

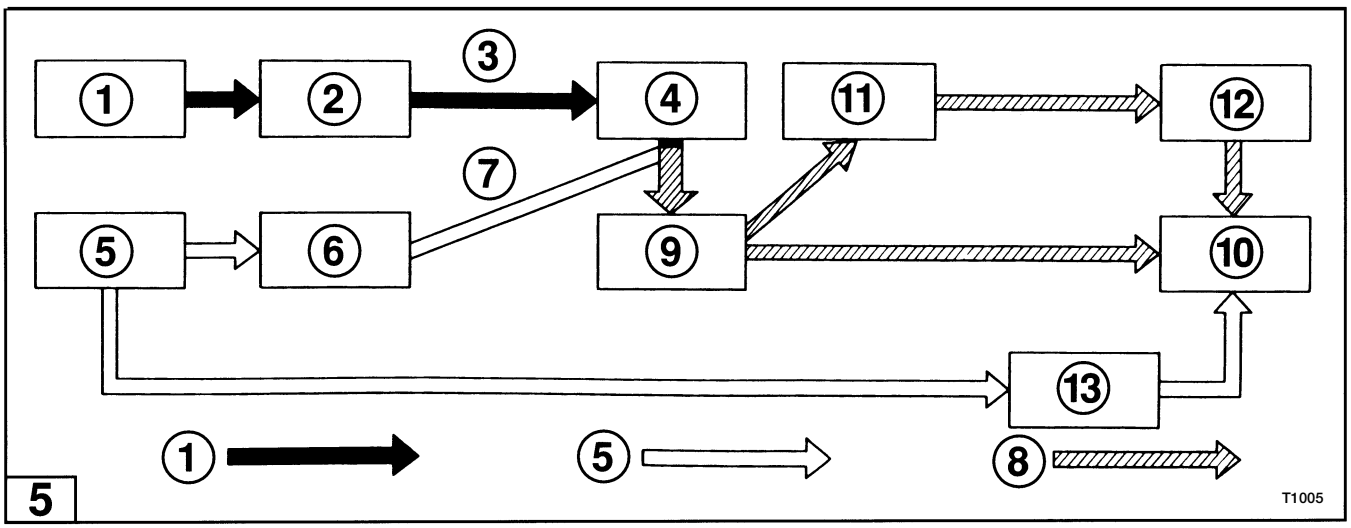
3 The fuel pump is integral with the carburetor or mounted on the side of the crankcase and contains one or more internal diaphragms **(1)**. The diaphragms fluctuate in response to changing crankcase pressures **(2)** which produces fuel input **(3)** and output **(4)** through multiple check valves **(5)** in the pump.

Carburetors

4 The carburetors use a pilot system and main system to meter and deliver an atomized fuel mixture to the engine for proper combustion under varying operating conditions.



T1004



T1005

Pilot System

5 The pilot system in the carburetor is a slow speed system consisting of the slow jet, slow air jet, pilot outlet, bypass, and pilot adjusting screw. At low throttle, mixed fuel **(1)** enters the carburetor and flows from carburetor float chamber **(2)** through passage **(3)** to slow jet **(4)**. Air **(5)** measured at slow air jet **(6)** is directed through passage **(7)** and combines with the existing fuel from the slow jet to form fuel/air mixture **(8)**. After exiting bypass **(9)**, the mixture directly enters engine **(10)** or passes pilot adjustment screw **(11)** for output to engine through pilot outlet **(12)**. Unrestricted air flow to the engine is available through venturi **(13)**.

Under idling conditions, the mixture of fuel and air is mainly output from the pilot outlet. As throttle is increased, the negative pressure applied to the pilot system increases and allows more of the mixture to be output from the bypass. When the throttle is opened further, the increase of air causes a pressure drop which allows the main system to assume almost full control of fuel delivery.

Main System

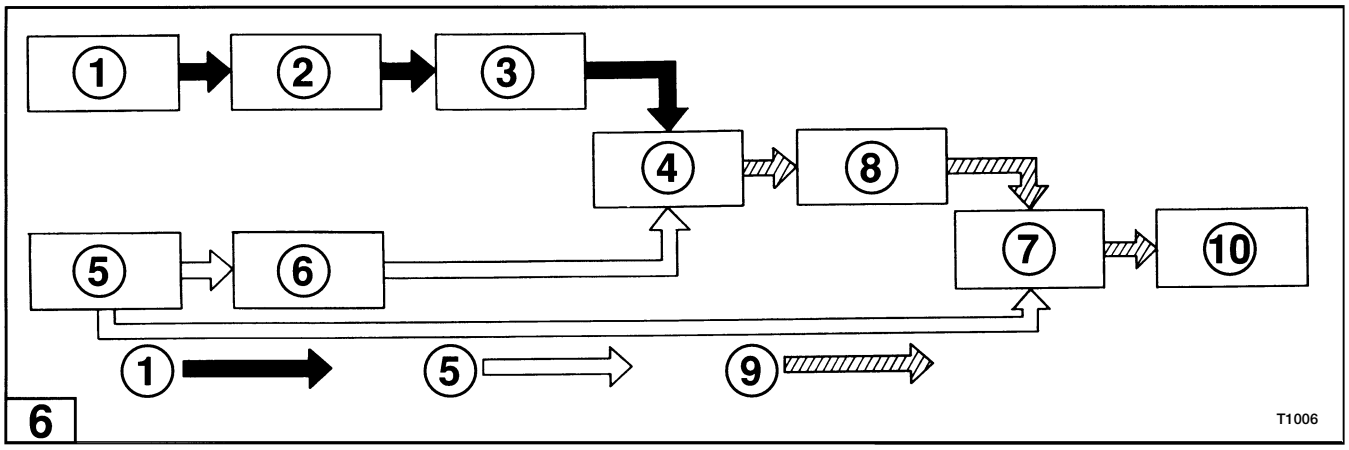
6 The main system in the carburetors is a high speed system consisting of the main jet, main nozzle, and main air jet. As the throttle valve opens, mixed fuel **(1)** enters the carburetor and flows from carburetor float chamber **(2)** to main jet **(3)**. The fuel is then measured and directed to main nozzle bleed hole **(4)** where it combines with air **(5)** from main air jet **(6)**. The increased air quantity and flow rate at venturi **(7)** allows pressure to drop at the tip of main nozzle **(8)**, causing increased output of fuel/air mixture **(9)**. The fuel mixture combines with main air at the venturi before entering engine **(10)**.

Recirculation

Recirculation hoses at the inlet manifold and crankcase assist in recirculation of unburned fuel for consumption by the engine.

Mixture Enrichment

Fuel mixture enrichment for cold engine starting is controlled by an electric choke solenoid actuated at the remote control box, or by a manual choke lever mounted on the air silencer.



6

FUEL TANK

Water or dirt in the fuel tank can cause fuel starvation and engine problems. Clean and inspect fuel tank once a year or after long time storage (more than 3 months).

Cleaning

1. Disconnect fuel line from fuel tank.

2. Empty remaining fuel from tank and properly dispose.

3. Fill tank 1/4 with fresh gasoline and install cap. Rigorously shake tank for 30 seconds to loosen dirt particles.

4. Empty gasoline from tank and properly dispose.

5. Inspect tank components before refilling.

Inspection

All worn, damaged, or missing parts must be replaced.

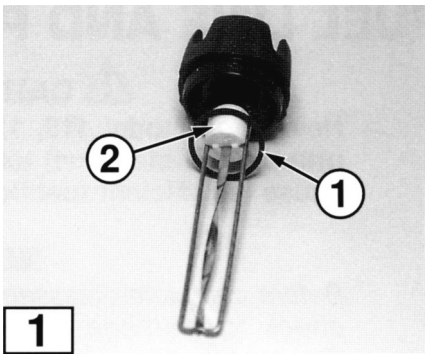
1. Inspect overall condition of tank exterior and interior. Cracked or damaged tanks must be removed from service.

1 2. Inspect the cap vent screw and inner gasket **(1)** for wear or damage. Check float **(2)** moves freely and operates the gauge needle.

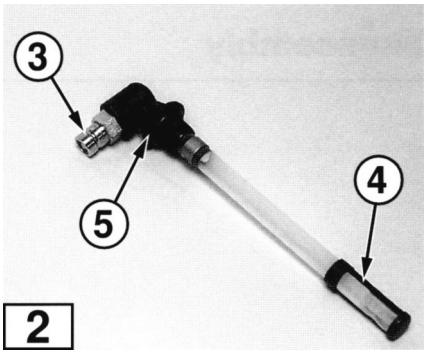
2 3. Unscrew tank pickup tube and check for cracks. Remove and inspect connector **(3)**, filter **(4)**, and o-ring **(5)**.

4. Reassemble and install all tank components.

5. See Fuel Line and Primer, this section.



T1017



T1018

SECTION 3

FUEL LINE AND PRIMER

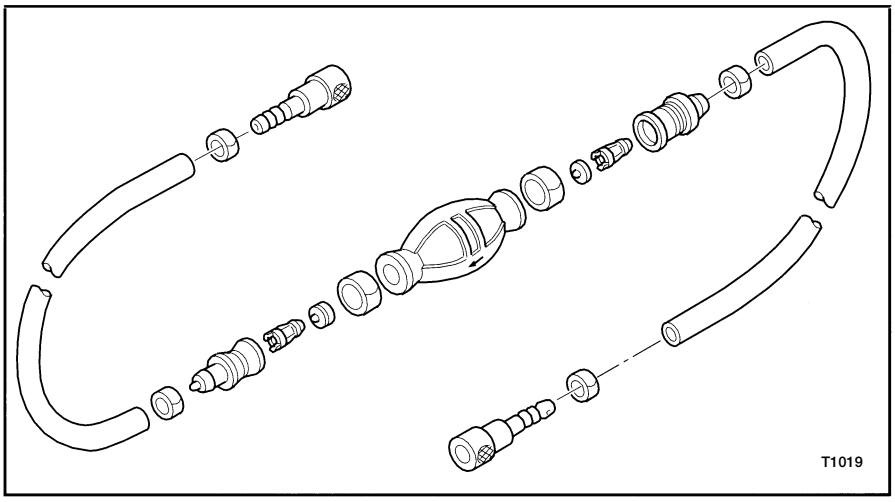
⚠ CAUTION

Model 115, 120, and 140 fuel line assembly is not same model 90, 70, 60, 50 and 40 one.

NOTE

Before complete disassembly of fuel line and primer, check for damage or blockage of fuel line quick disconnects at engine and fuel tank.

Disassembly



1. Disconnect fuel line from engine and fuel tank.

2. Carefully remove all hose clamps with flat blade screwdriver.

3. Disassemble all components.

Cleaning and Inspection

All worn, damaged, or missing parts must be replaced.

1. Clean all components with warm soapy water and rinse thoroughly with fresh water.

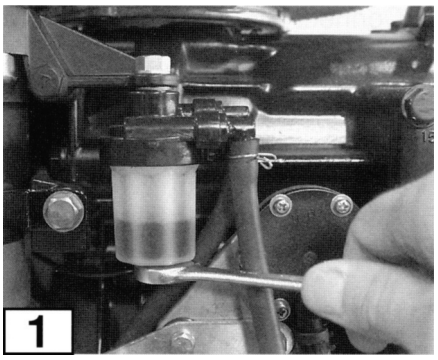
2. Dry all components with low pressure compressed air. All parts and passages must be completely dry.

3. Inspect all parts for wear or damage. Make sure check valves in quick disconnects open freely when pressed.

4. Reassemble all components.

NOTE

Install primer so arrow points in direction of fuel flow. Use pliers to compress hose clamps to proper shape.

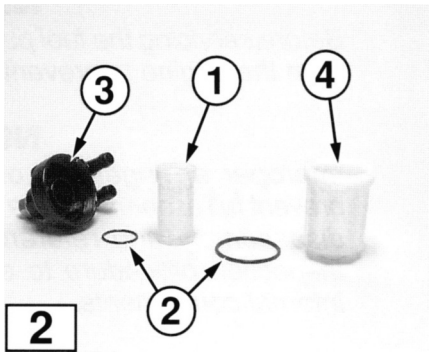


T1020

FUEL AND OIL FILTERS

The fuel and oil filter assemblies should be removed from the engine and serviced after engine break-in and after every 50 hours of operation (3 months). Replace the filter element at least once each season. Service the fuel pickup tube filter as described in Fuel Tank, this section.

1 To periodically inspect and clean the filter element without removing the filter assembly from the engine, loosen and remove the filter bowl with a wrench by turning it clockwise.



T1021

Disassembly

NOTE

Before servicing fuel filter, disconnect the fuel hose from the engine to prevent excessive fuel spillage.

1. Disconnect hoses from filter assembly.

2. Loosen nut from filter mounting bolt and remove filter assembly from engine.

3. Unscrew filter bowl and remove two o-rings and filter element.

4. Clean and inspect parts.

Cleaning and Inspection

All worn, damaged, or missing parts must be replaced.

1. Clean all parts of filter assembly with a mild aerosol solvent or isopropyl alcohol.

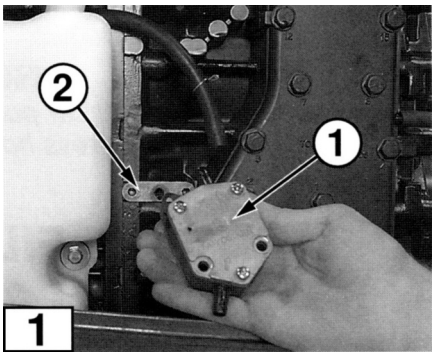
2 2. Allow filter element **(1)** to air dry. Dry all other parts with low pressure compressed air.

3 3. Inspect o-rings **(2)** for cracks and deterioration. Check body **(3)** and filter bowl **(4)** for damage. Replace filter element **(1)** if torn or still dirty.

4. Reassemble and install filter assembly.

5. Connect filter hoses.

6. After servicing oil filter, bleed automixing system. See Automixing System, this section.



T1007

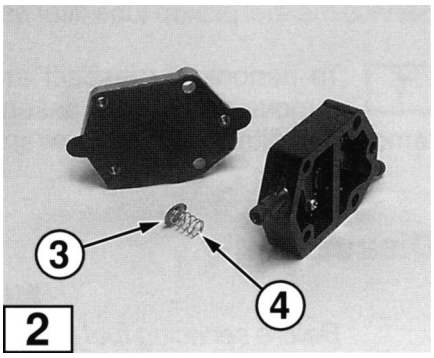
FUEL PUMP

NOTE

Before servicing the fuel pump, disconnect the fuel hose from the engine to prevent excessive fuel spillage.

NOTE

Improper arrangement of fuel pump parts may not prevent full assembly of the unit. Match mark parts before disassembly and reference the illustrations in the Inspection procedure to ensure proper orientation of internal components.



T1008

Disassembly

NOTE

Models 40 and 50 are equipped with carburetor mounted fuel pump. Disconnect fuel hoses from pump, loosen the four mounting screws and remove pump. Gently separate the pump components and continue with Cleaning and Inspection procedures.

1. Disconnect fuel hoses from fuel pump.

1 2. Loosen pump mounting screws and remove fuel pump **(1)** and gasket **(2)** from crankcase.

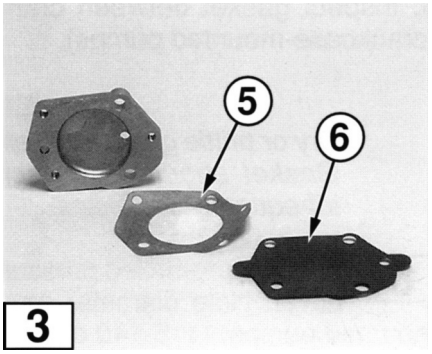
3. Remove the fuel pump cover screws and cover. Gently separate the pump components.

2

NOTE

*The fuel pump of the former production models 60, 70, 80 and 90 uses a guide plate **(3)** and a spring **(4)**. For the present production models 60, 70, 80 and 90, the material of the pump diaphragm has been changed, and the guide plate **(3)** and the spring **(4)** are not used. Those components are still used for the models 115, 120 and 140.*

4. Remove and discard all serviceable gaskets and diaphragms.



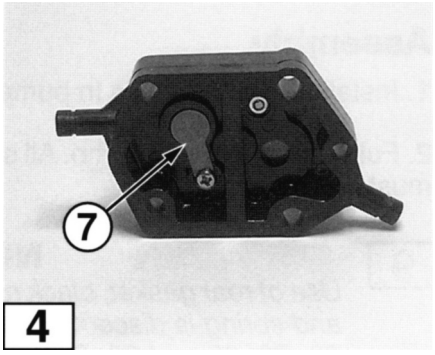
T1022

3

NOTE

*Use of gasket **(5)** with black rubber diaphram **(6)** is discontinued on past production models 60, 70, 80 and 90. Remove and discard them. Factory replacement parts include resin film diaphragm with two gaskets.*

4 5. Remove all checkvalves **(7)** from pump body.



T1009

Cleaning

1. Clean all pump components with mild solvent or isopropyl alcohol.

2. Clean pump mounting surface on carburetor with isopropyl alcohol (models 40 and 50).

3. Dry all components with low pressure compressed air. Ensure all passages are completely dry.

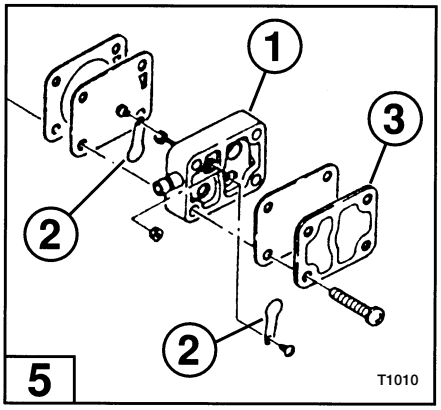
Inspection

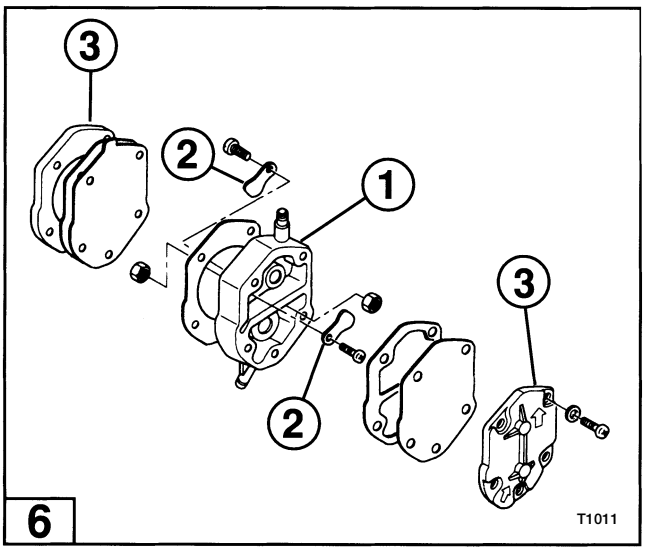
5 **6** **7** 1. Inspect pump body **(1)** for cracks.

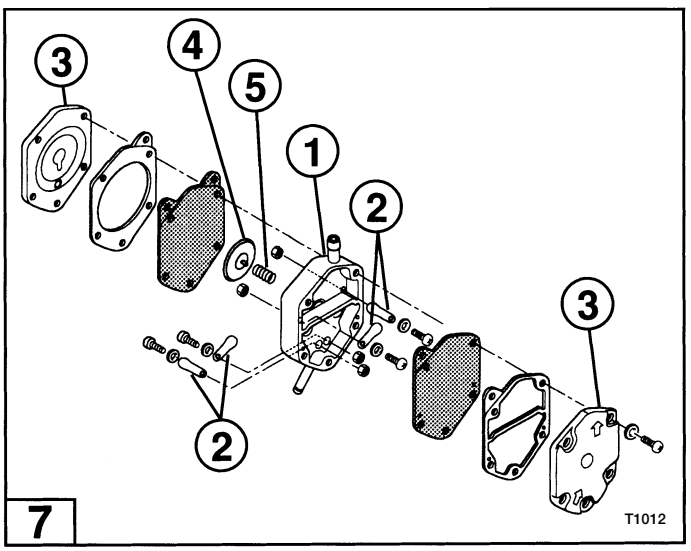
5 **6** **7** 2. Inspect check valves **(2)** for deformation.

5 **6** **7** 3. Inspect pump covers **(3)** for cracks, surface deformation, and thread damage.

7 4. Inspect guide plate **(4)** and spring **(5)** for deformation and proper tension (models 115, 120, and 140).

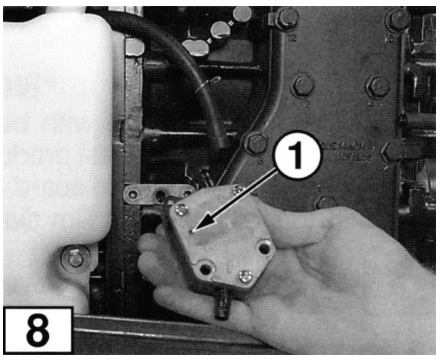






5. Inspect gasket between crankcase and fuel pump for dryness (crankcase-mounted pumps).

8 6. Verify pre-drilled pressure intake hole **(1)** exists in rear pump cover. Hole diameter must be 0.079 in [2 mm] (crankcase-mounted pumps) (115-140 only).



T1979

Assembly

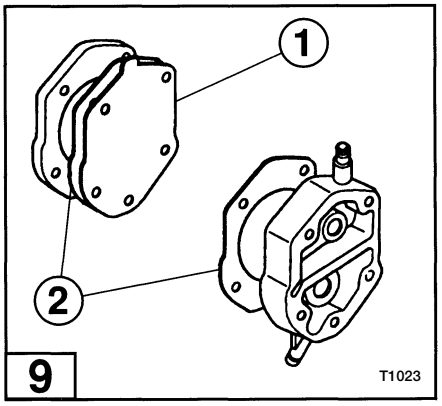
1. Install all check valves in pump body.

2. Fully assemble fuel pump. All serviceable gaskets and diaphragms must be replaced

9

NOTE

*Use of rear gasket, black rubber diaphram, guide plate, and spring is discontinued on past production models 60, 70, 80 and 90. Factory replacement parts include resin film diaphram **(1)** with gaskets **(2)**.*



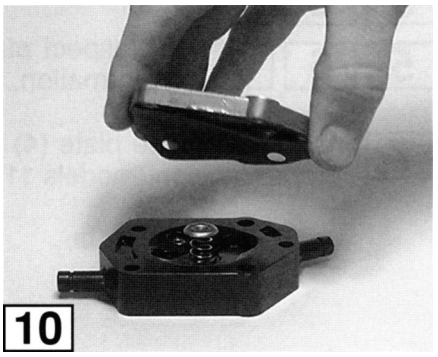
10

NOTE

On past production models 60, 70, 80, and 90 and all models 115, 120, and 140, first install internal guide plate and spring assemblies in pump body.

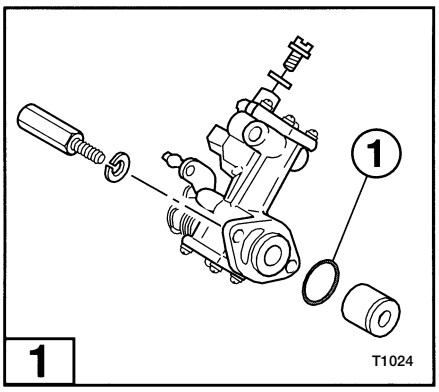
3. Install fuel pump. Use Loctite 242 on mounting screw threads.

4. Connect fuel hoses to fuel pump.



T1014

AUTOMIXING SYSTEM



Routine inspection of the oil automixing system should be performed once a season.

Inspection

1. Inspect entire automixing circuit for leaks. Check all hose connections, clamps must be tight.

1 Check for leakage from pump and between surface of pump and crankcase. If leakage exists, remove pump and inspect o-ring **(1)** for damage or deterioration. Apply acceptable 2cycle engine oil to replacement o-ring and test oil pump output, this section. If further damage is suspect, disassemble pump and check for internal gear damage. Replace pump as required.

2. Inspect oil hoses for kinks and damage.

3. Inspect overall condition of oil tank and cap air vent.

4. Service the oil filter. See Fuel and Oil Filters, this section.

5. Check oil pump link rod is secure and lubricate the ball joint with low temperature lithium grease.

6. Test low oil warning systems, pilot warning lamp, and warning horn. See Operator Alert Systems in Section 2.

7. Test the oil tank level sensor and oil automixing check valve, this section.

Function Test - Oil Pump Output

Perform this test with the engine in a test tank or on the boat. Ensure all air has been purged from oil system.

⚠ CAUTION

Oil pump output to engine will be cutoff during testing. Perform test with a 50:1 gasoline/oil mixture in the fuel tank.

1. Prepare a 50:1 gasoline/oil mixture in fuel tank. Connect tank to engine.

2. Check oil tank is at least 1/2 full.

3. Disconnect the oil pump link rod from the oil pump control lever.

4. Using a short piece of wire, secure the oil pump control lever in the WIDE OPEN position.

NOTE

See Oil Pump Aperture Adjustment in Section 2 for correct position of oil pump control lever at full throttle.

5. Install tachometer.

2 6. Disconnect the oil pump OUTPUT hose from the automixing check valve and route hose into a clean graduated container.

7. Start and run engine in NEUTRAL at 1500 RPM for 10 minutes. Starttiming when oil begins to drip from oil OUTPUT hose. Stop engine after 10 minutes and measure oil quantity in container. Repair or replace oil pump if following oil output is not obtained:

Model	Oil Output fl oz / 10 min [mL / 10 min]
40 / 50	0.4 - 0.5 [13 - 16]
60 / 70	0.8 - 0.9 [23 - 28]
80 / 90	1.1 - 1.4 [33 - 40]
115 / 120 / 140	1.7 - 2.1 [51 - 62]

Function Test - Oil Level Sensor

1. Disconnect the oil level sensor leads at the electrical box and remove sensor from tank.

2. Reconnect the sensor leads.

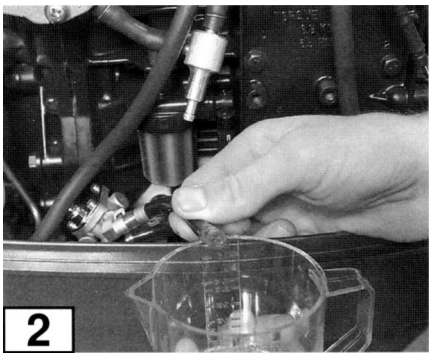
3. Place the remote control lever in the FORWARD or REVERSE position.

4. Turn the main switch key to the ON position and check the following:

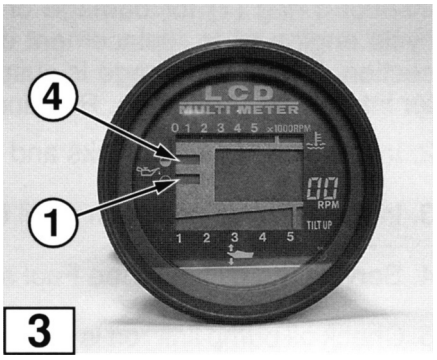
Models 115 / 120 / 140:

3 **4** • Lower oil level indicator **(1)** flashes, warning horn sounds and ESG limits RPM to 3000 ± 200 RPM when float **(2)** makes contact with sensor switch **(3)**.

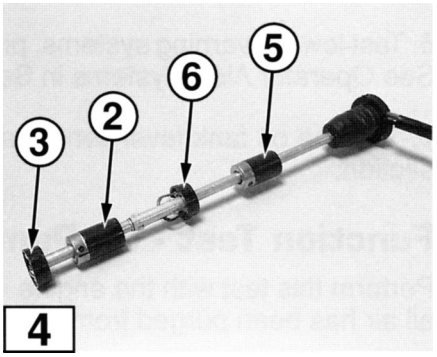
3 **4** • Upper oil level indicator **(4)** illuminates when float **(5)** makes contact with sensor switch **(6)**.



T1025



T1026



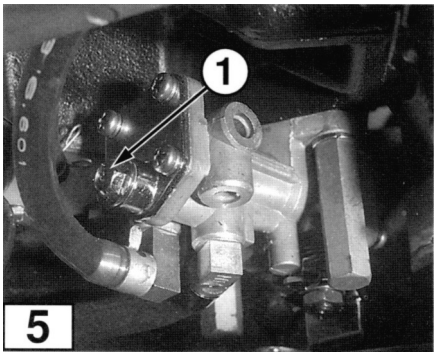
T1027

Models 60 / 70 / 80 / 90:
- Oil level indicator on tachometer illuminates and warning horn sounds when float makes contact with sensor switch.

Models 40 / 50 with remote control:
- Oil level indicator on tachometer illuminates and warning horn sounds when float makes contact with sensor switch.

Models 40 / 50 with tiller control:
- Pilot lamp on lower motor cover illuminates when float makes contact with sensor switch.

5. Re-install oil level sensor. Apply a silicone-based sealant to the sensor cap.



T1028

Function Test - Automixing Check Valve

1. Disconnect the oil INPUT hose and fuel OUTPUT hose from the automixing check valve.

2. Connect a gear case pressure tester to the oil INPUT fitting on automixing check valve.

3. Slowly pump up pressure and watch gauge. Gauge reading should drop off at 5 psi [34 kPa/0.34 kg/cm²], indicating the valve has opened. If pressure drops at lower or higher reading, replace the valve.

Bleeding the Automixing System

Always bleed the air from the oil automixing system in the following situations:
- When the engine is new from the factory.
- After engine runs out of oil.
- After checking the oil filter element.
- After disconnecting any oil hose between the oil tank and pump.

1. Fill the oil tank.

2. Momentarily run engine to ensure the oil system is pressurized. Stop engine.

5 3. Loosen air bleed screw **(1)** on oil pump.

4. Visually check no air remains in the transparent oil hoses from tank to filter and from filter to pump, then tighten the bleed screw.

5. Start and idle engine in NEUTRAL until no air remains in the transparent oil hose between pump and automixing check valve.

NOTE

To purge the air more quickly, remove oil pump link rod and idle engine with pump control lever in WIDE OPEN position.

SECTION 3

CARBURETOR

Removal

1. Remove the air silencer and oil tank.

2. Remove the carburetor throttle and choke linkage.

3. Disconnect the choke solenoid plunger hook or choke knob link rod as required.

4. Remove all fuel hoses from carburetor fuel fittings.

⚠ CAUTION

Do not pull fuel hoses off fuel fittings — push them off. If hose cannot be pushed off, carefully cut the hose along its side and peel it off to avoid damaging the fitting.

5. Remove carburetors and discard the carburetor base gaskets.

Disassembly

NOTE

Bottom carburetor on models 40 and 50 is equipped with integral fuel pump. To ensure proper cleaning of the carburetor, remove and service the fuel pump at this time. Refer to Fuel Pump, this section.

1. Remove drain screw from float chamber and allow to drain.

2. Fully disassemble the carburetor as illustrated in the Inspection procedure.

⚠ CAUTION

Use the following precautions during carburetor disassembly:

- **Use correct size screwdrivers to avoid damaging the carburetor jets.**
- **Throttle stop screw spring has higher tension than pilot screw spring. DO NOT interchange the springs.**

Cleaning

⚠ CAUTION

Never clean carburetor by submerging or soaking in a hot tank or carburetor dip cleaner. Do not expose plastic parts to any carburetor cleaner.

1. Clean all metal components using a mild aerosol solvent or isopropyl alcohol. Use a soft bristle brush to remove gummy deposits. Clean plastic parts with warm soapy water.

2. Dry all components with low pressure compressed air. When drying passages, direct the flow of air opposite the direction of fuel flow.

3. Inspect the carburetors, this section.

Inspection

All worn, damaged, or missing parts must be replaced.

1 2 3 Internal Components

1. Inspect the following float valve components:
- Check tip of float valve **(1)** for grooves, nicks, or distortion.
- Check float valve pin **(2)** and float clip **(3)** for damage or deformation.
- Check float **(4)** for damage and signs of fuel saturation.

2. Inspect pilot adjust screw **(5)** for thread damage. Check tip for grooves, nicks, or distortion.

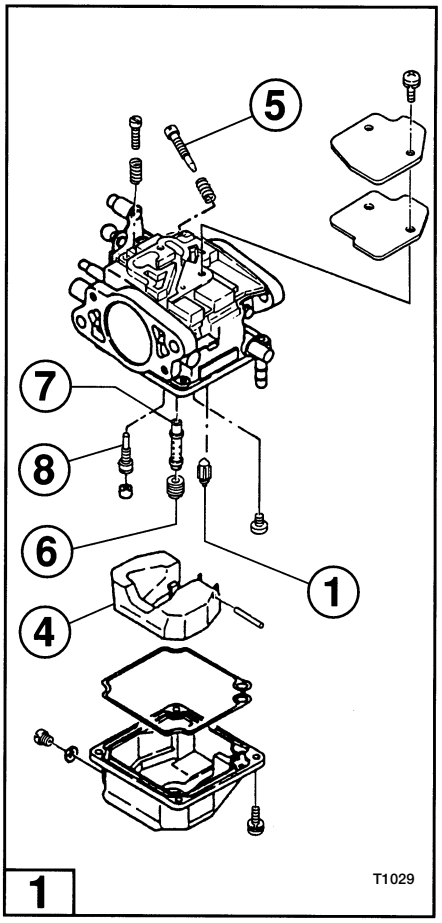
3. Check tension of throttle stop screw and pilot adjust screw springs. DO NOT interchange the springs.

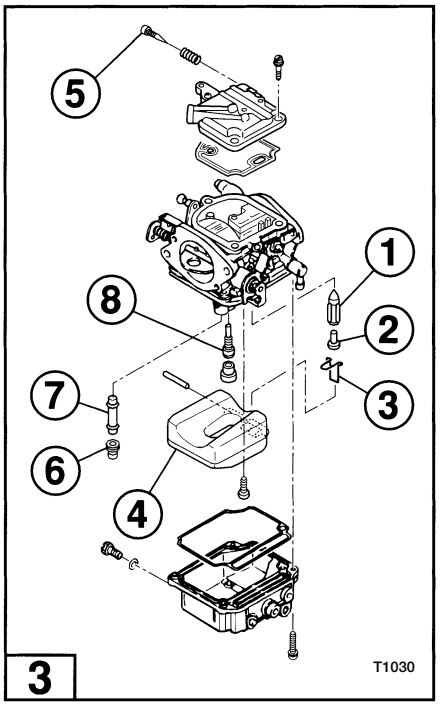
4. Inspect main jet **(6)** for thread damage and blockage. Check all passages in main nozzle **(7)** are free of blockage.

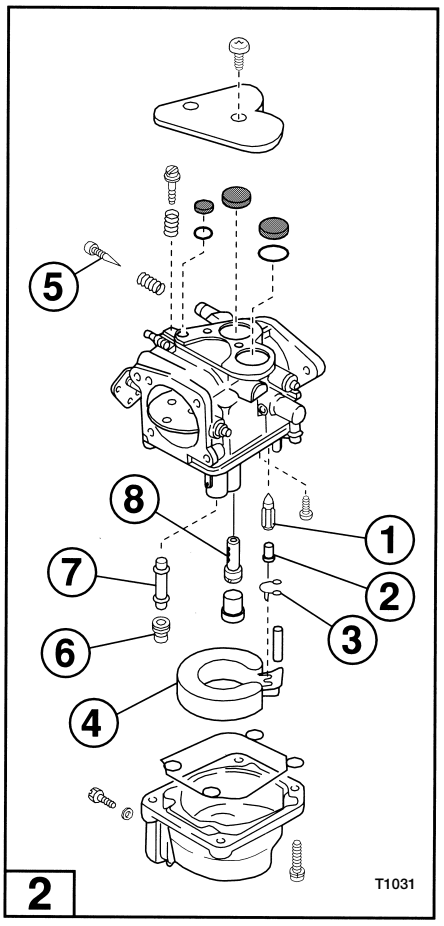
5. Inspect slow jet **(8)** for thread damage and blockage.

Carburetor Body

6. Check all passages and drillings with a syringe filled with isopropyl alcohol.





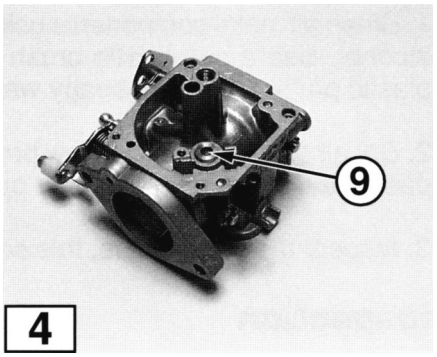


4 7. Inspect float valve seat **(9)** for nicks, scratches, or distortion. DO NOT remove the seat. If valve seat is defective, carburetor must be replaced.

8. Inspect all gasket surfaces for damage.

9. Check throttle shaft and choke shaft for excessive play. Inspect the butterfly valves for damage.

10. Visually inspect the fuel fitting, carburetor cover, float chamber, drain screw, and all other screws and washers for damage.



T1032

Assembly

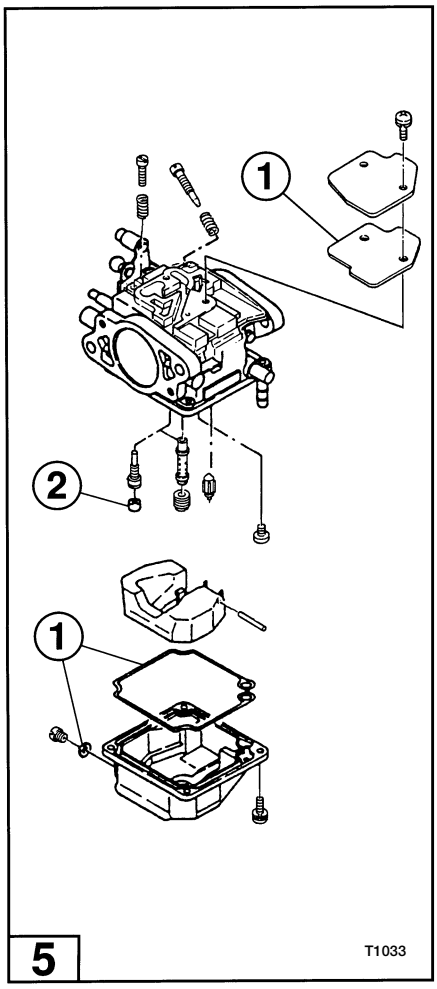
NOTE

Before proceeding, be sure all components are completely clean and dry and all replacement parts match the originals.

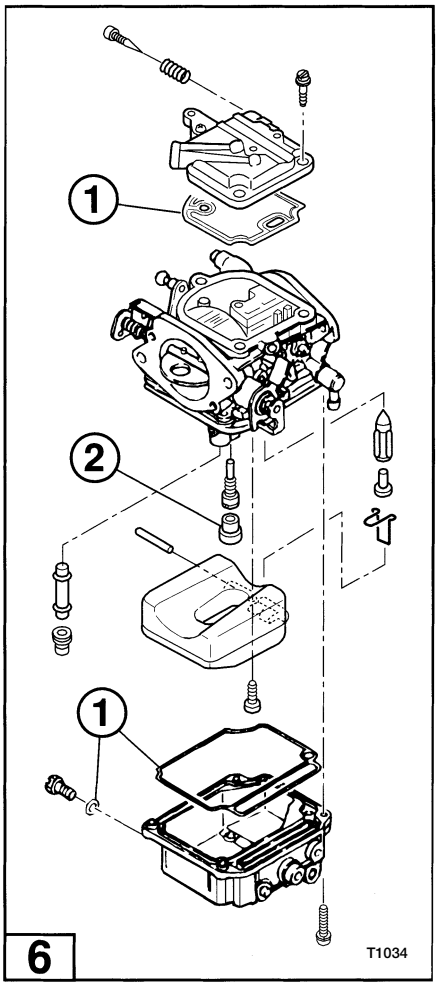
NOTE

Fully assemble bottom carburetor on models 40 and 50 before installing the fuel pump.

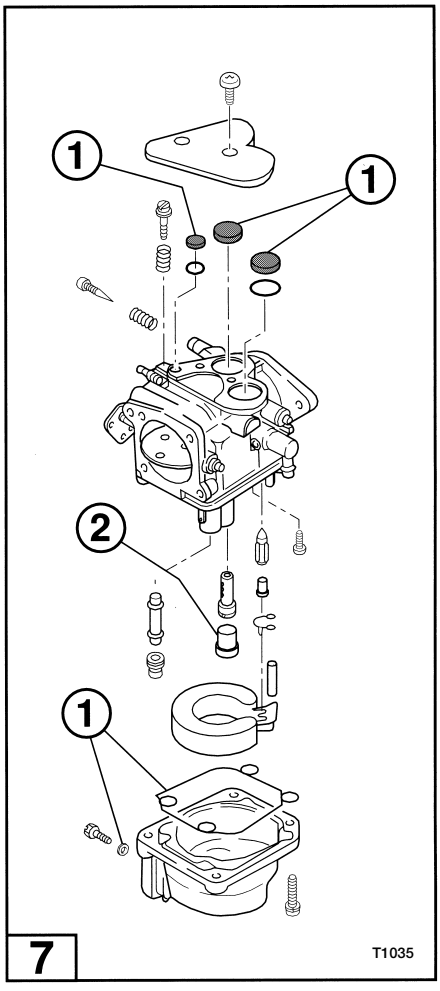
5 6 7 1. During assembly, replace all serviceable gaskets **(1)** and plugs **(2)** as illustrated.



T1033



T1034



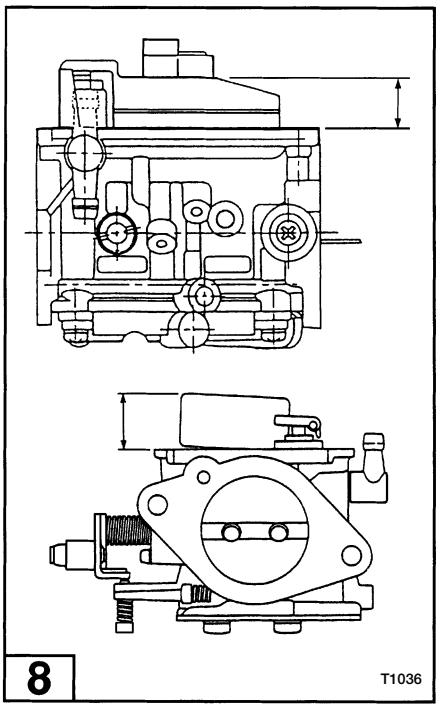
T1035

2. Invert carburetor and install following components. Tighten jets securely but do not use threadlocker:

- Main nozzle and main jet.
- Slow jet and plug.
- Float valve assembly.

8 3. Check the float height with the carburetor inverted on a flat surface. Measure the distance between the top of the float and the float chamber surface at the opposite side of the needle valve.

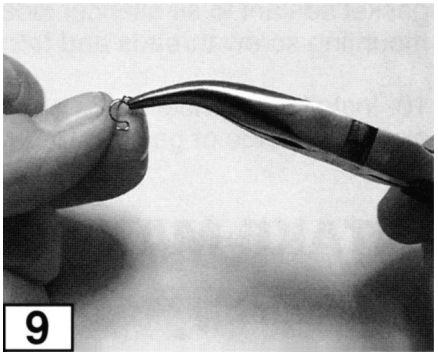
MODEL	FLOAT HEIGHT
40D / 40D2	0.591 in (15.0 mm)
500 / 50D2	0.591 in (15.0 mm)
60B / 60C	0.551 in (14 mm)
70B / 70C	0.551 in (14 mm)
80A	0.768 in (19.5 mm)
90A	0.768 in (19.5 mm)
115A2	0.768 in (19.5 mm)
120A2	0.768 in (19.5 mm)
140A2	0.768 in (19.5 mm)



9

NOTE

If float height is not correct, remove the float valve assembly and make minor adjustments by slightly bending the tabs on the float hinge clip. Models 40 and 50 cannot be adjusted.



4. Install new gasket on float chamber.

5. Install float chamber, and tighten screws in a criss-cross pattern.

6. Install drain screw and new o-ring gasket.

7. Place carburetor in upright position and install gasket plates (if equipped), new gasket(s), and carburetor cover.

8. Install pilot and throttle stop screws and springs. DO NOT interchange springs.

Installation

1. Clean the carburetor mounting surfaces on the intake manifold with isopropyl alcohol.

2. Install new carburetor base gaskets dry.

3. Mount carburetors to intake manifold and torque to specification.

4. Install all fuel hoses and clamps.

5. Install the oil tank.

6. Install the throttle and choke linkage and reconnect the choke solenoid or choke knob.

7. Run the engine momentarily to pressurize the fuel system and check for leaks.

8. Adjust the ignition timing and synchronize the carburetors. Refer to Synchronization and Linkage Adjustments in Section 2.

9. Mount air silencer to carburetors. If gaskets are required, apply gasket sealant to air silencer side of new gaskets. Use Loctite 242 on mounting screw threads and torque to specification.

10. Install air silencer cover and new gasket. Apply gasket sealant to air silencer side of gasket. Torque cover bolts to specification.

INTAKE MANIFOLD

Disassembly

1. Remove the carburetors. See Carburetor, this section.

2. Disconnect the linkage at the throttle cam.

3. Remove the crankcase recirculation hose from the manifold (models 80, 90, 115, 120, and 140).

4. Remove recoil starter or flywheel cover as applicable.

5. Remove the manifold bolts and manifold.

⚠ CAUTION

Reed valve assemblies are not bolted to the manifold on models 80, 90, 115, 120, and 140. Valves assemblies could fall off and be damaged if they stick to the manifold when removing it.

6. Remove the reed valve assemblies from the manifold or lift them from the crankcase as applicable. DO NOT disassemble the reed valve assemblies.

7. Inspect the manifold and reed valve assemblies, this section.

Inspection

1. Inspect the reed valve assemblies:

1 All gasket surfaces must be flat, within ± 0.003 in [0.08 mm].

2 Inspect reeds **(1)** for cracks or chips. Reeds must be seated flat without any preload.

Inspect valve seat surfaces **(2)** for rise, wear, or damage.

Check tightness of reed valve stoppers. If loose, tighten screws usingLoctite 242.

3 Lift height of each reed valve stopper must be within specification.

Model	Lift Height Limit in [mm]
40	0.25 - 0.26 [6.5 - 6.7]
50	0.36 - 0.37 [9.3 - 9.5]
60 / 70 / 80 / 90	0.39 - 0.40 [10.0 - 10.2]
115 / 120 / 140	0.36 - 0.37 [9.3 - 9.5]

Inspect entire valve assembly for corrosion.

If any part of the reed valve assembly is worn, damaged, or corroded, entire valve assembly must be replaced.

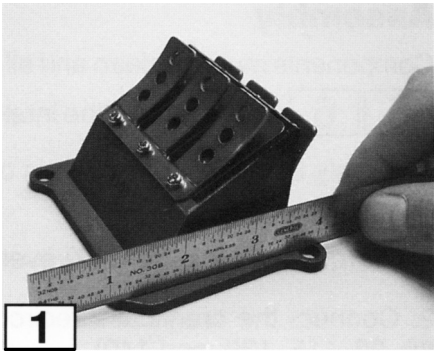
⚠ CAUTION

Used reeds must never be turned over and reused. Reed could break when returned to service, causing serious powerhead damage.

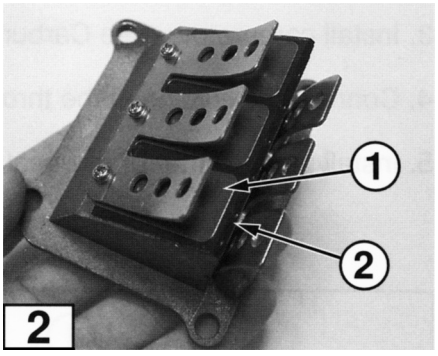
4 2. Inspect the intake manifold. All gasket surfaces must be smooth and free of nicks. Check manifold surface for flatness in all directions. Mounting surface must be flat, within ± 0.004 in [0.10 mm].

NOTE

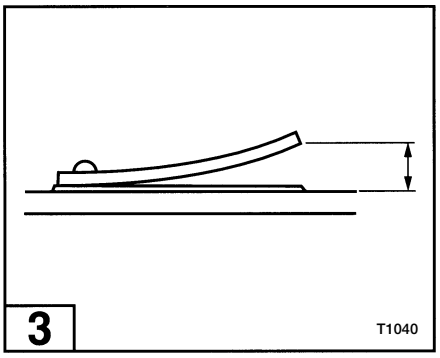
All intake manifold components must be perfectly clean before assembly. Use isopropyl alcohol. DO NOT use a carburetor cleaner or hot soaking tank.



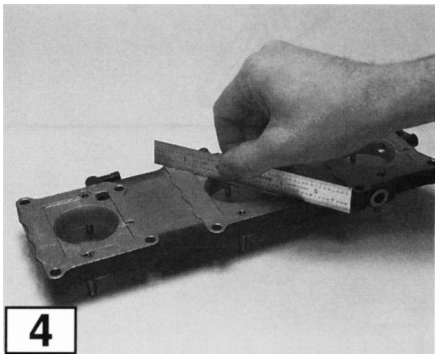
T1038



T1039



T1040



T1041

Assembly

Components must be clean and all serviceable gaskets must be replaced.

5 6 1. Assemble the intake manifold components as illustrated:

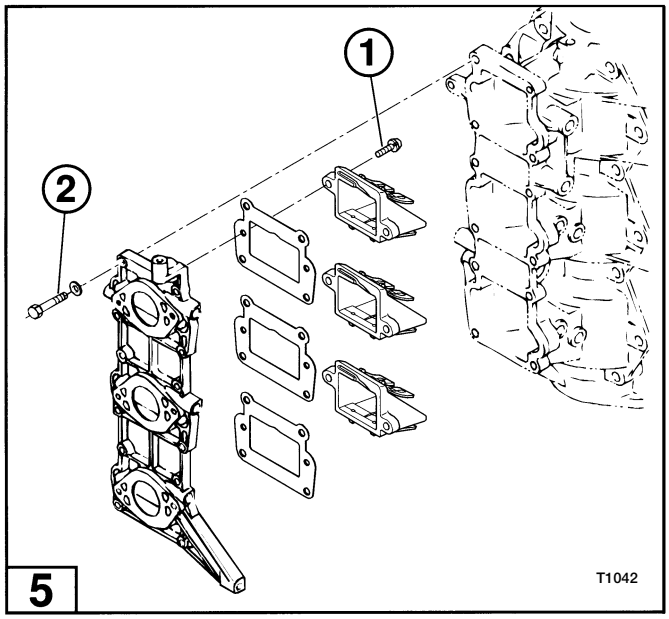
- Apply Loctite 242 to threads of reed valve assembly screws **(1)**.
- Install all gaskets dry.
- Torque manifold bolts **(2)** evenly to specification.

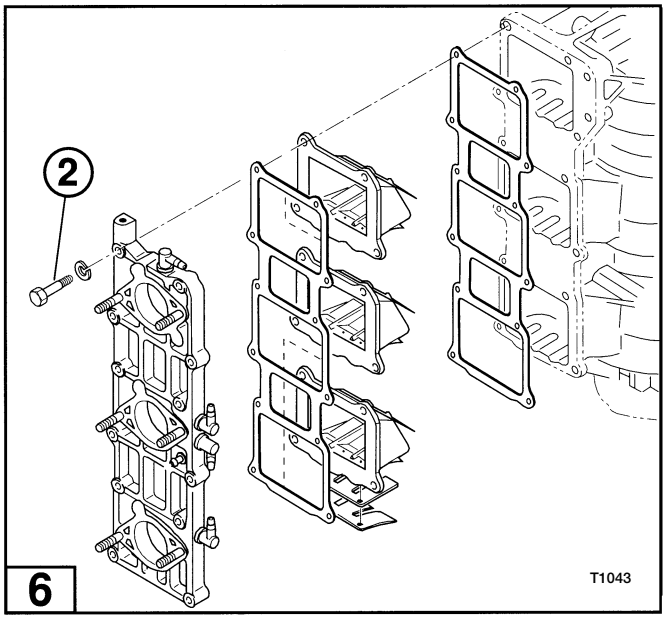
2. Connect the crankcase recirculation hose to the manifold (models 80, 90, 115, 120, and 140).

3. Install carburetors. See Carburetor, this section.

4. Connect the linkage at the throttle cam.

5. Install recoil starter or flywheel cover as applicable.





SECTION 4
POWERHEAD

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Thermostat 4-14
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SECTION 4

GENERAL PRECAUTIONS

Before performing any service work on the powerhead, read and understand the Service Safety section at the beginning of this manual.

Use the manufacturer special tools as indicated during servicing of the powerhead.

Use caution when performing tests with the engine cover removed. Do not wear loose clothing or jewelry. Keep hair, hands, and clothing away from the flywheel.

Check entire fuel system for leaks after servicing the powerhead to prevent fire or explosion.

Make sure all ignition and electrical leads are properly routed and clamped in their original positions.

Disable the ignition system and disconnect the battery when servicing the powerhead.

Replace locking fasteners when their locking feature becomes weak. Use only factory replacement parts.

Always inspect and test the start-in-gear prevention system before returning engine to customer.

SERVICE SPECIFICATIONS

Special Torque Values

Description	Torque in-lb (ft-lb) N·m kg-m				Threadlocker
	Model				
	40 / 50	60 / 70	80 / 90	115 / 120 / 140	
Thermostat Cap	44 - 53 5 - 6 0.5 - 0.6	44 - 53 5 - 6 0.5 - 0.6	44 - 53 5 - 6 0.5 - 0.6	44 - 53 5 - 6 0.5 - 0.6	—
Electrical Box Cover Bolt	—	4 - 9 0.45 - 1.0 0.05 - 0.1	4 - 9 0.45 - 1.0 0.05 - 0.1	26 - 44 3 - 5 0.3 - 0.5	—
Spark Plug	(18 - 22) 25 - 29 2.5 - 2.9	(18 - 22) 25 - 29 2.5 - 2.9	(18 - 22) 25 - 29 2.5 - 2.9	(18 - 22) 25 - 29 2.5 - 2.9	—
Engine Mounting Bolt	(14 - 15) 19 - 21 1.9 - 2.1	(14 - 15) 19 - 21 1.9 - 2.1	(17 - 19) 24 - 26 2.4 - 2.6	(25 - 30) 34 - 41 3.4 - 4.1	—
Exhaust Cover Bolt	71 - 88 8 - 10 0.8 - 1.0	71 - 88 8 - 10 0.8 - 1.0	115 - 133 13 - 15 1.3 - 1.5	115 - 133 13 - 15 1.3 - 1.5	—
Flywheel Nut	(65 - 80) 88 - 108 8.8 - 10.8	(101 - 116) 137 - 157 13.7 - 15.7	(101 - 116) 137 - 157 13.7 - 15.7	(181 - 195) 245 - 265 24.5 - 26.5	—
Cylinder Head Bolt	M6: (3 - 5) 5 - 6 0.5 - 0.6 M8: (22 - 25) 29 - 34 2.9 - 3.4	(22 - 25) 29 - 34 2.9 - 3.4	(22 - 25) 29 - 34 2.9 - 3.4	(22 - 25) 29 - 34 2.9 - 3.4	—
Cylinder Head Cover Bolt	—	44 - 53 5 - 6 0.5 - 0.6	44 - 53 5 - 6 0.5 - 0.6	44 - 53 5 - 6 0.5 - 0.6	—
Crankcase Bolt	(17 - 19) 24 - 26 2.4 - 2.6	M8: (17 - 19) 24 - 26 2.4 - 2.6 M10: (27 - 30) 37 - 41 3.7 - 4.1	M8: (17 - 19) 24 - 26 2.4 - 2.6 M10: (27 - 30) 37 - 41 3.7 - 4.1	M8: (17 - 19) 24 - 26 2.4 - 2.6 M10: (27 - 30) 37 - 41 3.7 - 4.1	—
Carburetor Mounting Bolt	44 - 53 5 - 6 0.5 - 0.6	44 - 53 5 - 6 0.5 - 0.6	—	—	—
Intake Manifold Bolt	44 - 53 5 - 6 0.5 - 0.6	68 - 88 8 - 10 0.8 - 1.0	44 - 53 5 - 6 0.5 - 0.6	44 - 53 5 - 6 0.5 - 0.6	—

Description	Torque in-lb N·m kg-m				Threadlocker
	Model				
	40 / 50	60 / 70	80 / 90	115 / 120 / 140	
Air Silencer Bolt	44 - 53 5 - 6 0.5 - 0.6	27 - 35 3 - 4 0.3 - 0.4	44 - 53 5 - 6 0.5 - 0.6	44 - 53 5 - 6 0.5 - 0.6	Loctite 242
Air Silencer Cover Bolt	—	4 - 9 0.45 - 1.0 0.05 - 0.1	4 - 9 0.45 - 1.0 0.05 - 0.1	27 - 35 3 - 4 0.3 - 0.4	

*Refer to Section 2 for Standard Torque Values chart.

Powerhead Specifications

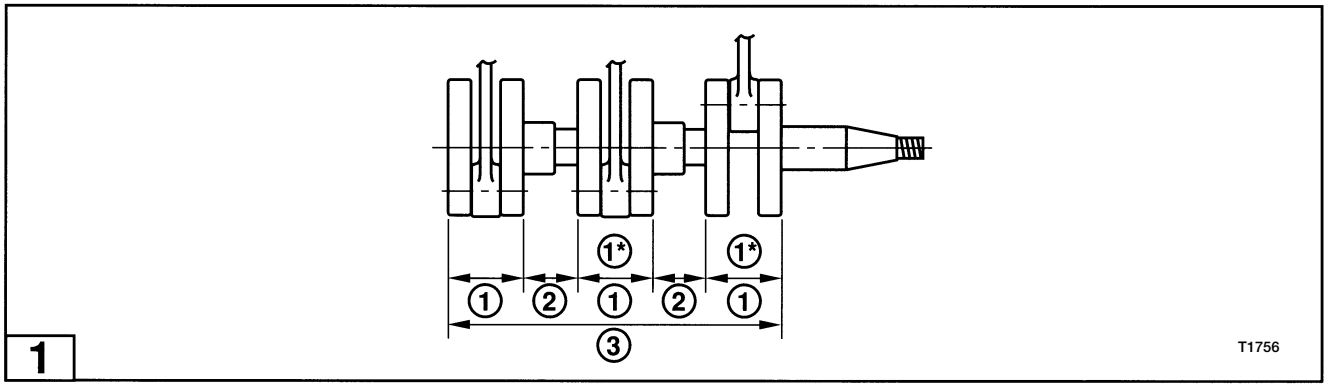
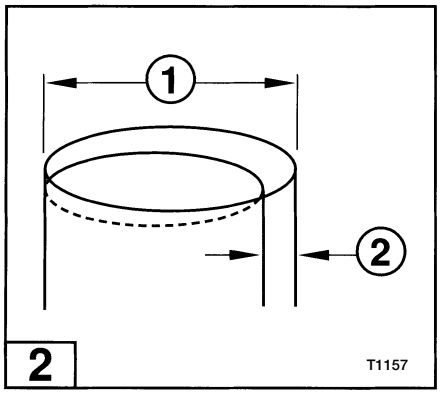
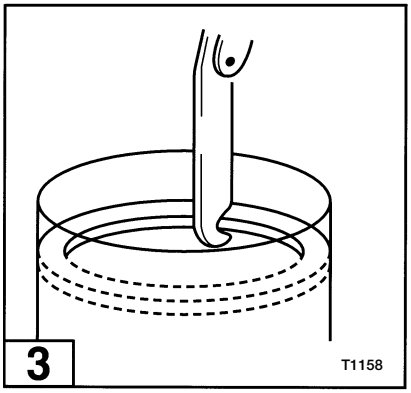


Figure	Description		Unit	40 / 50	60 / 70	80 / 90	115 / 120 / 140
	Compression		psi kPa kg/cm²	101.5 699.8 7.14	120.8 833.0 8.50	116.6 804.0 8.20	127.9 882.0 9.00
	Thermostat Opening Temperature		°F °C	140 60	140 60	140 60	140 60
1	Crankshaft	①	in mm	$2.087^{\ 0}_{-\ 0.001}$ in $[53^{\ 0}_{-\ 0.02}$ mm]	$2.362^{-\ 0.008}_{-\ 0.009}$ in $[60^{-\ 0.20}_{-\ 0.22}$ mm]	$2.677^{\ 0}_{-\ 0.001}$ in $[68^{\ 0}_{-\ 0.02}$ mm]	$2.677^{\ 0}_{-\ 0.001}$ in $[68^{\ 0}_{-\ 0.02}$ mm]
		1*		—	—	$2.598^{\ 0}_{-\ 0.001}$ in $[66^{\ 0}_{-\ 0.02}$ mm]	—
		②		$1.457^{+\ 0.002}_{-\ 0}$ in $[37^{+\ 0.05}_{-\ 0}$ mm]	$1.467^{+\ 0.002}_{-\ 0}$ in $[37.25^{+\ 0.05}_{-\ 0}$ mm]	$1.732^{+\ 0.002}_{-\ 0}$ in $[44^{+\ 0.05}_{-\ 0}$ mm]	$1.654^{+\ 0.002}_{-\ 0}$ in $[42^{+\ 0.05}_{-\ 0}$ mm]
		③		9.173 in 233.0 mm	10.020 in 254.5 mm	11.339 in 288.0 mm	15.669 in 398.0 mm





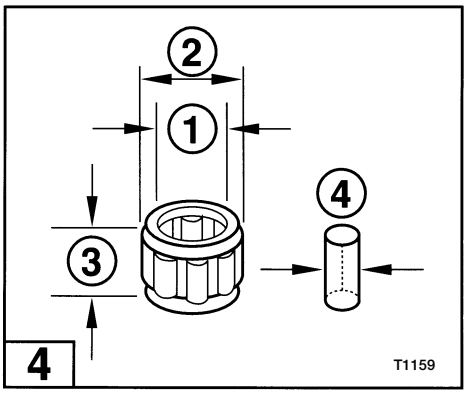


Figure	Description		Unit	40 / 50	60 / 70	80 / 90	115 / 120 /140
2	Cylinder Bore (Standard)	①	in mm	2.677 68.0	2.913 74.0	3.386 86.0	3.465 88.0
	Piston Clearance	②		0.0012 - 0.0028 0.03 - 0.07	0.0016 - 0.0031 0.04 - 0.08	0.0031 - 0.0051 0.08 - 0.13	0.0039 - 0.0055 0.10 - 0.14
3	Piston Ring End Gap		in mm	Top Ring 0.008 - 0.015 0.22 - 0.37 2nd Ring: 0.013 - 0.018 0.33 - 0.48	0.009 - 0.015 0.22 - 0.37	0.010 - 0.016 0.25 - 0.40	0.011 - 0.019 0.28 - 0.49
4	Connecting Rod Bearing (Small End)	①	in mm	0.669 17.0	0.787 20.0	0.787 20.0	0.787 20.0
		②		0.827 21.0	0.984 25.0	0.984 25.0	0.984 25.0
		③		1.063 27.0	0.945 24.0	1.102 28.0	1.102 28.0
		④		0.079 2.0	0.098 2.5	0.098 2.5	0.098 2.5
4	Connecting Rod Bearing (Big End)	①	in mm	0.984 25.0	1.063 27.0	1.181 30.0	1.260 32.0
		②		1.260 32.0	1.417 36.0	1.535 39.0	1.614 41.0
		③		0.778 19.8	0.709 18.0	0.858 21.8	0.866 22.0
		④		0.138 3.5	0.177 4.5	0.177 4.5	0.177 4.5

SECTION 4

Manufacturer Special Tools Required

Flywheel Puller Assembly, 3B7-72214-0, 3C7-72211-0
Plate, Flywheel Puller, 3B7-72781 -2, 3C7-72783-0
Bolt, M8 x 25 mm, 3B7-72786-0
Bolt, M8 x 40 mm, 3B7-72785-0
Washer, 940191-0800
Pressing Bolt, 3B7-72784-0
Powerhead Stand, 353-72247-0, 353-7247-1
Shackle, 353-01512-0
Piston Pin Tool, 345-72215-0, 353-72215-0
Piston Ring Tool, 353-72249-0
Thickness Gauge Set, 353-72251-0

General Equipment Required

Compression Gauge, 0 - 199 psi [0 - 1372 kPa / 0 - 14 kg/cm²]
Water Pressure Gauge, 0 - 15 psi [0 - 103 kPa / 0 - 1 kg/cm²]
Torque Wrench, 0- 150 in-lb [0 - 17 N-m / 0- 1.7 kg-m]
Torque Wrench, 0 - 750 ft-lb [0 - 1000 N-m / 0 - 100 kg-m]
Micrometer Set or Venier Caliper, graduation 0.0001 in [0.01 mm], range 0 - 1 in [0 - 30 mm]
Telescoping Gauge, Inside Micrometer Set, or Venier Caliper, minimum scale 0.0001 in [0.01 mm]
Dial Indicator, graduation 0.0001 in [0.01 mm], range 0 - 1 in [0 - 30 mm]
Analog Multimeter, *Electronic Specialties® Model M-530 or equivalent*
Digital Pulse Tachometer, 10 - 6000 RPM, *Electronic Specialties® Model 321 or equivalent*
Industrial Thermometer, minimum 300˚F [150˚C]
Heat-Resistant Container, *Pyrex®*
Bearing Puller
SealPullers
SealInstaller
Surface Plate, 20 x 20 in [500 x 500 mm], 0.0001 in [0.01 mm] accuracy

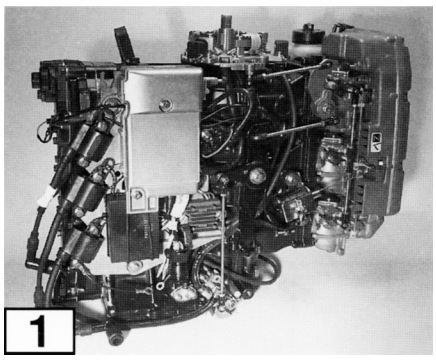
Consumables Required

Threadlocker, *Loctite® 242*
Threadlocker, *Loctite® 243*
Gasket Dressing, *Permatex® Hy/omar® Aerosol High-Temp Gasket Dressing*
Gasket Sealant, *Permatex® High Tack Gasket Sealant*
Anaerobic Gasket Maker, *Loctite® 518*
Dielectric Lubricant, *Permatex® Dielectric Tune-Up Grease*
Cleaning Pads, *Scotch-Brite® Abrasive Pads*
Isopropyl Alcohol
Cleaning Solvent
Gasket Remover
Heat-Sensitive Markers, 125˚F [52˚C] and 163˚F [73˚C], *Markal® Thermomelt Stik*
Low Temperature Lithium Grease
Bearing Cup Grease
Engine Lubricant, *Genuine engine oil or NMMA certified TC-W3 oil*
Automotive Crankcase Oil, flashpoint above 300˚F [150˚C]

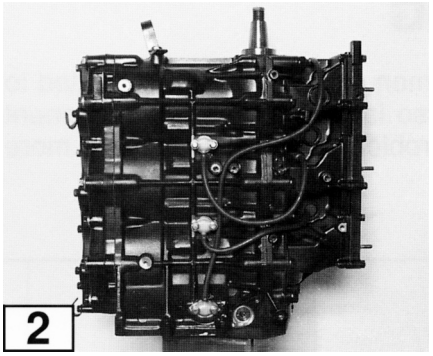
TROUBLESHOOTING

The troubleshooting chart lists common engine symptoms related to problems with the powerhead. It also indicates specific component failures which may be causing the problem so it can be isolated more effectively.

Checks \ Symptom	Hard to start or will not start	Low cylinder compression	Runs rough or erratically	Idles poorly	No acceleration, low top end RPM	RPM decreases	Engine overheats	Runs noisy or has excessive vibration
Poor crankcase seal	•							
Ignition timing or throttle linkage out of adjustment, see Section 2			•		•			
Water entering lower crankcase				•		•		
Defective thermostat	•				•		•	
Fouled, defective or incorrect spark plug; wrong gap setting	•		•	•		•	•	
Worn or defective cylinder, piston, rings or warped head	•	•			•			•
Blown cylinder head or engine base gasket	•	•	•	•	•	•		•
Worn connecting rod or crankshaft bearings, internal wear limits out of specification	•		•					•
Defective ignition components, see Section 7	•		•		•			
Carbon accumulation in combustion chamber	•				•	•		



T1160



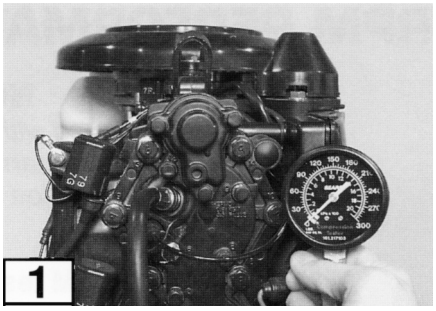
T1161

DESCRIPTION OF OPERATION

1 2 The power head of this outboard motor is a two-stroke engine (or two-stroke cycle engine). The engine completes its one cycle operation including gas mixture suction, compression, explosion and exhaust while the crankshaft rotates once i. e. the piston moves upward and then downward (two strokes).

As the piston starts to move toward top dead center (TDC), the interior of the crank case is made vacuum pressure causing the reed valve to open and the gas mixture to be taken into the crankcase. As the piston comes near the TDC, the spark plug produces the sparks to ignite the compressed gas mixture for combustion. As the fuel mixture is exploded, the piston moves toward bottom dead center (BDC) and open the exhaust port and then scavenging port. The scavenging is an action that sends the fresh gas mixture in the crankcase to the cylinder.

CYLINDER COMPRESSION TEST



T1162

1. Operate engine up to normal operating temperature.

2. Stop engine.

3. Disconnect the magneto leads to disable the ignition system.

⚠⚠ WARNING

Ignition system must be disabled to prevent accidental engine startup during compression test.

1 4. Remove all spark plugs and install thread-type compression tester in spark plug hole.

5. Place throttle in fully open position and crank engine with starter through at least four compression strokes. Take reading for each cylinder and verify specified pressure is obtained:

Model	Cylinder Compression* psi [kPa / kg/cm²]
40 / 50	117 [800 / 8.2] ± 13 %
60 / 70	121 [830 / 8.5] ± 13 %
80 / 90	117 [810 / 8.2] ± 13 %
115 / 120 / 140	128 [880 / 9.0] ± 13 %

* Compression variation among cylinders should not exceed 15 psi [103 kPa / 1.05 kg/cm²].

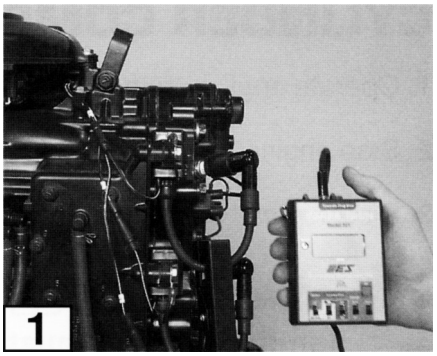
If variation of cylinder compression exceeds 15 psi [103 kPa / 1.05 kg/cm²], check for the following:

- Scored cylinder walls.
- Piston damage.
- Head gasket damage.
- Stuck or broken piston rings.

If cylinder compression is low, engine is difficult to start and runs poorly, check for the following:

- Scored cylinder walls.
- Piston damage.
- Stuck or worn piston rings.

RPM PERFORMANCE TEST



T1170

NOTE

Engines are equipped with RPM limiting function. If full throttle RPM values cannot be obtained, see RPM Limitation Test in Section 7.

⚠ CAUTION

Do not perform RPM test if engine shows signs of overheating.

Perform this test with correct test propeller installed and with the engine in a test tank.

1. Operate engine up to normal operating temperature.

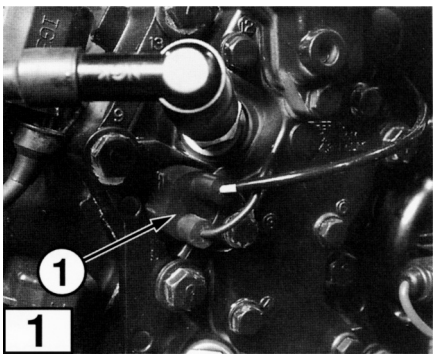
1 2. Stop engine and install tachometer.

3. Start and run engine at NEUTRAL idle and verify specified RPM is obtained. If test tank conditions permit, run engine in forward gear at trolling and full throttle speeds and check for correct RPM:

Model	NEUTRAL Idle RPM	Trolling Speed RPM	Full Throttle Speed RPM
40D	900	750	4500 - 5500
500	900	750	5000 - 5700
40D2	900	750	5000 - 5700
50D2	900	750	5150 - 5850
60B	900	750	4900 - 5600
70B	900	750	4900 - 5600
60C	900	750	5150 - 5850
70C	900	750	5150 - 5850
80A	900	700	5000 - 5500
90A	900	700	5000 - 5500
115A2	900	700	5200 - 5700
120A2	900	700	5000 - 5500
140A2	900	700	5200 - 5700

4. If test results vary, refer to Troubleshooting in this section.

OVERHEAT SENSOR



T1164

1 Overheat sensor **(1)** is a heat sensitive switch installed in the cylinder head to monitor engine temperature The sensor is connected in series with the warning horn. If the sensor detects temperature in excess of a predetermined limit, contacts close and cause the warning horn to emit a continuous tone when the key switch is ON and the remote control lever is in the FORWARD or REVERSE position. Depending on model, the engine RPM limitation function will also activate.

NOTE

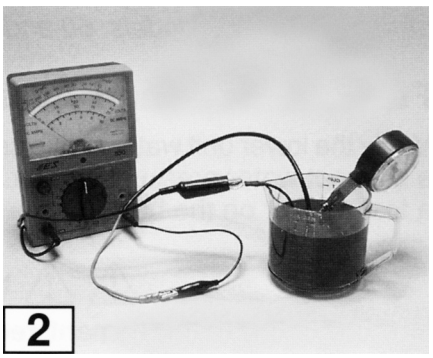
The overheat sensor is not standard equipment on model 40 prior to 1994 but is available as an option.

Function Test

1. Disconnect the overheat sensor bullet connector at the electrical box and the ground wire.

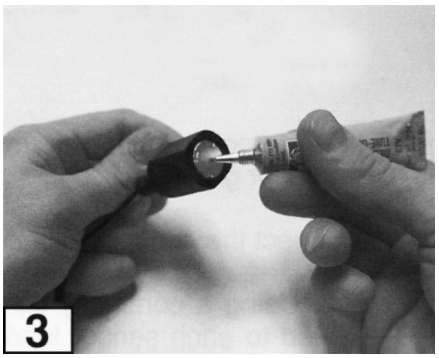
2. Remove the overheat sensor from the cylinder head.

3. Using a continuity light or calibrated ohmmeter, connect one tester lead to each sensor lead.



T1165

2 4. Place sensor and thermometer in a heat-resistant container filled with automotive crankcase oil. Slowly heat the oil using an external heat source.



T1248

⚠⚠ WARNING

Avoid fire or explosion:

- **Use a heat-resistant container such as Pyrex® glassware.**
- **Use oil with a flashpoint above 300˚F [150˚C].**
- **DO NOT use open flame as a heat source.**

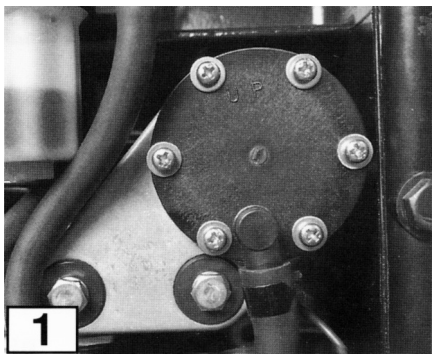
5. Verify the sensor switch reacts to the changing temperature as follows:

Model	Switch Closed (Continuity Present) ˚F [˚C]	Switch Open (No Continuity) ˚F [˚C]
40 / 50	212 [100]	185 [85]
60 / 70	257 [125]	230 [110]
80 / 90	176 [80]	156 [69]
115 / 120 / 140	212 [100]	185 [85]

NOTE

3 *Apply light coat of dielectric lubricant to sensor before installation.*

WATER PRESSURE SENSOR



T1171

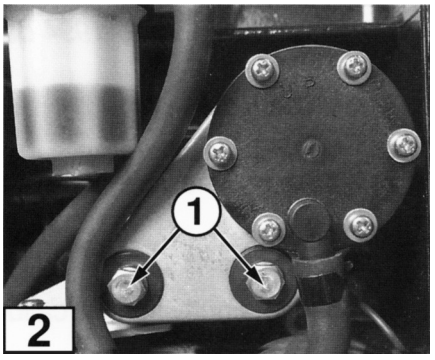
1 The water pressure sensor is a pressure-sensitive switch installed on the powerhead to monitor the forced water cooling system. The sensor is connected in series with the warning horn. If the sensor detects low water pressure at a predetermined RPM, contacts close and cause the warning horn to emit a continuous tone. The engine RPM limitation function is also activated.

NOTE

The water pressure sensor is standard equipment on models 80, 90, 115, 120, and 140. It is available as an option for models 60 and 70.

Function Test and Adjustment

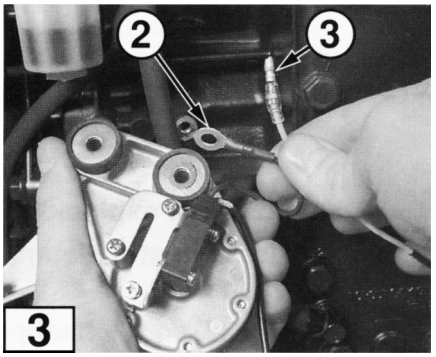
Verify the lower unit water intake screens are not clogged before testing a suspect water pressure sensor. Perform this test with the engine in a test tank or on the boat.



T1172

⚠⚠ WARNING

Test and adjustment requires running the engine in close proximity to the technician. To avoid serious injury, keep wires, test equipment, tools, and body parts away from powerhead linkage and flywheel.



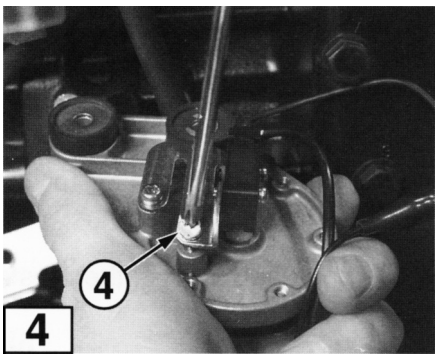
T1173

2 1. Remove sensor mounting screws **(1)** and disconnect the sensor ground wire.

2. Disconnect the sensor bullet connector at the electrical box.

3 3. Using a continuity light or ohmmeter, connect one tester lead to each sensor lead **(2)** and **(3)**. Tester should indicate continuity (switch closed).

4 If tester indicates no continuity (switch open), loosen adjustment screw **(4)** just enough so the switch button does not make contact with the diaphragm pressure button. If still no continuity, replace the sensor assembly.



T1174

5 4. Disconnect the INPUT hose from the sensor fitting. Using a T-fitting (obtain locally), install a water pressure gauge between the sensor and the hose.

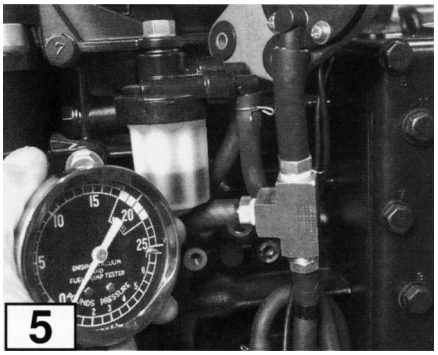
⚠⚠ WARNING

Make sure all hose connections are tight and all test leads and equipment are clear of powerhead linkage and flywheel.

5. Start and idle engine in NEUTRAL.

6. Slowly increase engine speed. Take pressure reading when tester indicates no continuity (switch open). Switch should open at 4.3 psi [29.4 kPa / 0.30 kg/cm²]. If switch opens at lower over higher pressure, continue as follows:

- Fully loosen the adjustment screw.
- Set and maintain throttle position so water pressure is at 4.3 psi [29.4 kPa / 0.30 kg/cm²].
- Gradually tighten adjustment screw until tester indicates no continuity (switch open).



T1175

THERMOSTAT

Removal

1 1. Remove thermostat cap screws. Gently tap thermostat cap with rubber mallet to loosen and remove cap and gasket. Discard gasket.

2. Remove and inspect thermostat.

NOTE

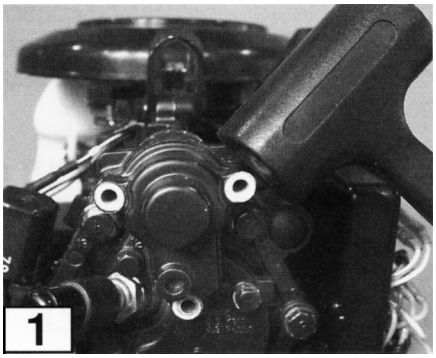
Earlier 90, 115, 120 and 140 engines had a flat metal bypass valve with a spring and retainer. This has been eliminated from newer 90, 115, 120 and 140 engines.

3. Perform thermostat Function Test if thermostat is suspect.

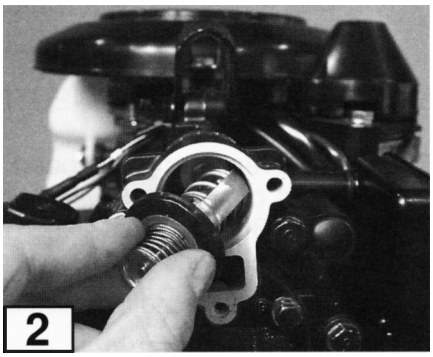
Installation

2 1. Install thermostat in cylinder head.

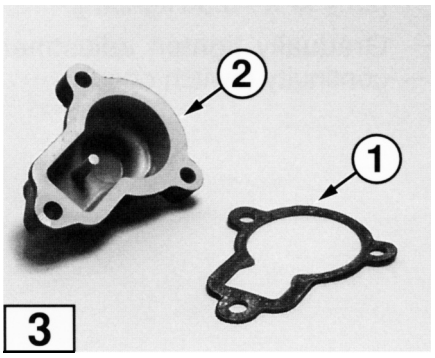
3 2.Install thermostat cap **(2)** and gasket **(1)** and torque to specification.



T1166

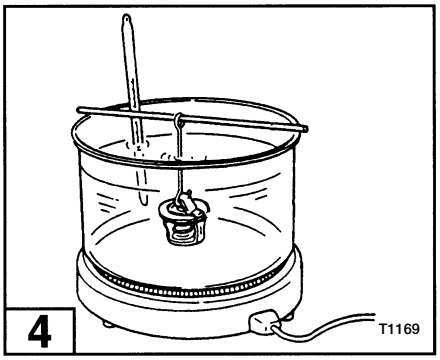


T1167



T1168

Function Test



4 1. Suspend thermostat and thermometer in a heat-resistant container filled with water.

2. Slowly heat and stir the water. Verify the thermostat opens at 140˚F [60˚C]. If it does not open at specified temperature, replace thermostat.

⚠⚠ WARNING

Use a heat-resistant container such as Pyrex® glassware. DO NOT allow thermostat or thermometer to rest against the glass. Items could overheat and rupture.

3. Remove thermostat and observe its closing action as it cools. If closing action is not slow and smooth, replace thermostat.

RECOIL STARTER

⚠⚠ WARNING

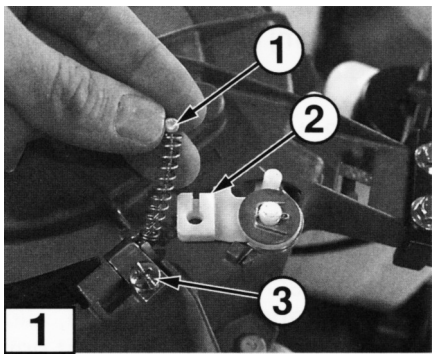
F-type of 40/50 engines have neutral start mechanism (start-in-gear protection) attached to the recoil starter. This feature disables the engine from starting wheel in gear (forward or reverse). During reassembly of the engine following repair, ensure that you DO NOT DISABLE THE START-IN-GEAR PROTECTION.

⚠⚠ WARNING

Ignition system must be disabled to prevent accidental engine startup during servicing of the recoil starter.

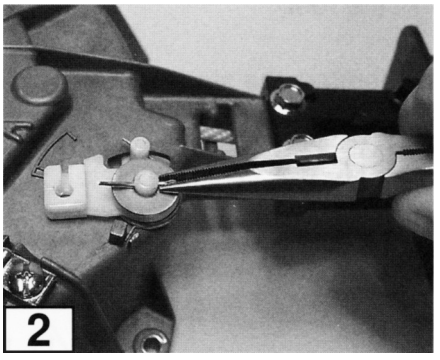
Removal

1. Place engine in NEUTRAL to relieve tension from neutral start cable.

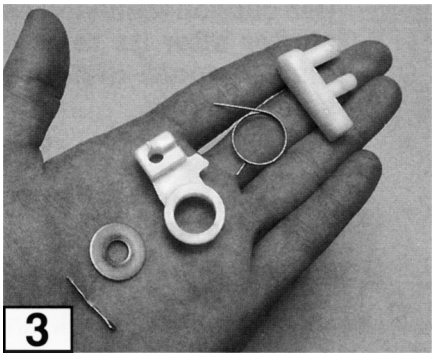


1 2. Disconnect cable **(1)** from stopper arm **(2)**. Loosen cable clamp **(3)** and remove cable from recoil starter.

3. Remove recoil starter mounting bolts and lift starter off powerhead.



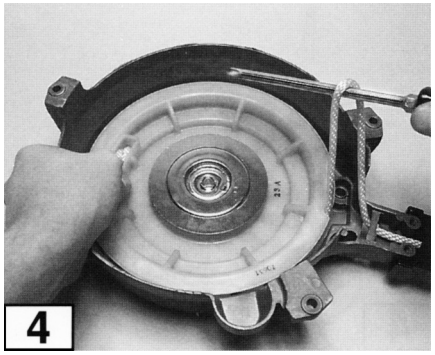
Disassembly



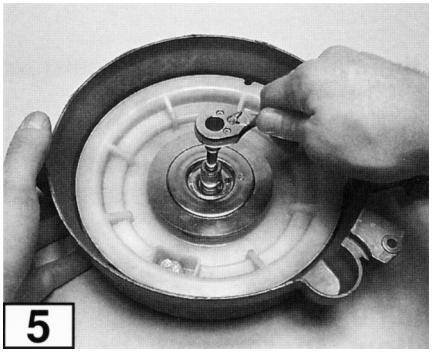
⚠⚠ WARNING

Recoil starter rewind spring is under high tension. Wear safety glasses at all times during disassembly.

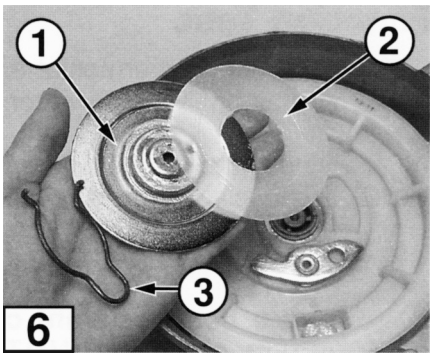
2 3 1. Remove pin from stopper arm and disassemble the neutral lockout components: pin, washer, stopper arm, stopper spring, and reel stopper.



T1179



T1180



T1181

2. Place recoil starter top side down on bench. Pull out approximately 24 in [60 cm] of starter rope and hold the reel tightly to prevent it from rewinding.

4 3. Hold reel tightly at all times so it does not suddenly rewind while completing the following steps:

- Allow reel to slowly rewind just enough so the notch in the reel aligns with the rope guide in the starter housing.
- Use a screw driver to position the rope in the reel notch. With the rope caught in the notch, allow reel to slowly rotate clockwise to slacken the rope. Repeat until no starter spring tension is felt on thereel.

4. Remove the starter rope handle.

5 **6** 5. Remove the friction plate bolt and lift off friction plate **(1)**, slide plate **(2)**, and friction spring **(3)**.

7 6. Carefully remove the snap ring. DO NOT remove the washer below the snap ring.

⚠⚠ WARNING

Use caution removing snap ring and handling recoil starter after its removal. Sudden impact to the starter could dislodge rewind spring causing serious injury.

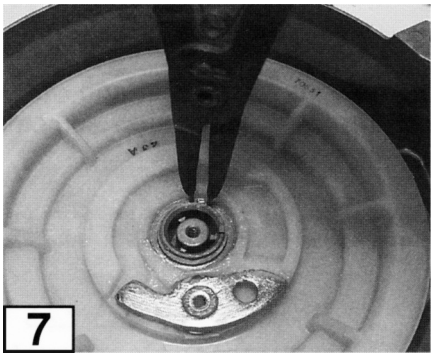
⚠⚠ WARNING

DO NOT attempt to remove washer from reel assembly at this time.

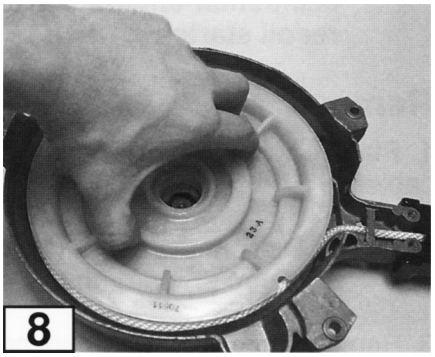
8 **9** 7. Remove the reel from the starter housing by slowly rotating it back and forth while lifting upward. Once removed, take out reel washer **(4)**, ratchet **(5)**, and return spring **(6)**.

⚠⚠ WARNING

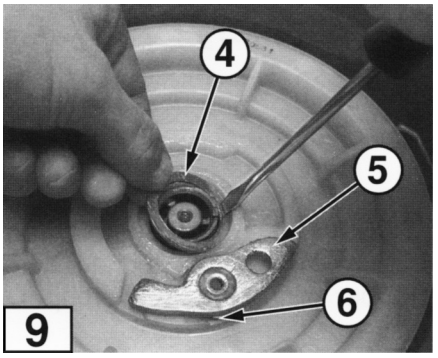
DO NOT pull hard or quickly on the reel. Keep face away from the spring at all times.



T1182

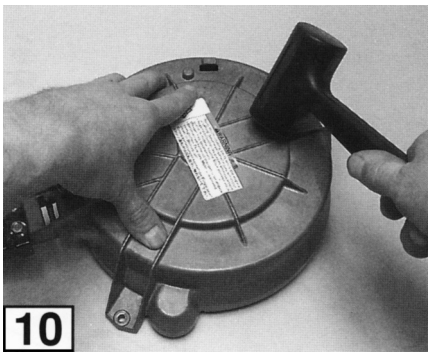


T1183



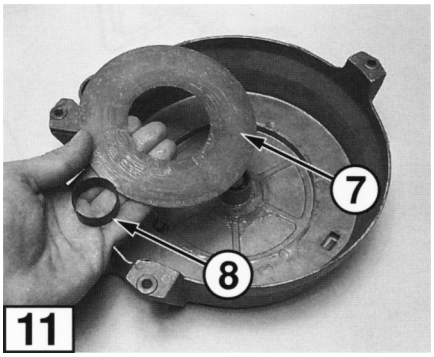
T1184

10 8. Carefully turn over recoil starter on bench so spring is facing down. Firmly hold starter housing against bench and lightly tap housing with rubber mallet to dislodge the starter spring. Remove the spring.



T1185

11 9. Turn recoil starter over and remove sliding plate **(7)** and bushing **(8)**.



T1186

Cleaning and Inspection

All worn, damaged, or missing parts must be replaced.

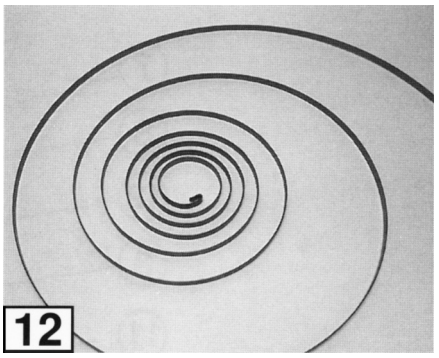
1. Clean metal parts with solvent and dry with low pressure compressed air. Clean plastic parts with isopropyl alcohol.

2. Inspect following components as follows:

12 Starter rewind spring for cracked or broken end loops.

- Ratchet and reel stopper springs for deformation or poor tension.
- Sliding plates, stopper components, and busing for cracks or signs of wear.
- Reel assembly for wear.
- Starter housing for sharp or rough edges which could fray starter rope.

13 Starter rope for frays and rope handle for damage.



T1187

Assembly

⚠⚠ WARNING

Recoil starter rewind spring is under high tension.
Wear safety glasses at all times during assembly.

1. Apply low temperature lithium grease to the following:

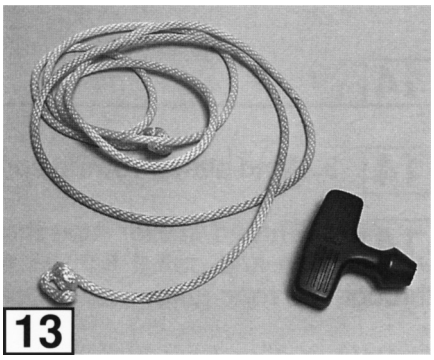
14 Inner and outer surfaces of bushing **(1)**.

14 Both sides of sliding plates **(2)** and **(3)**.

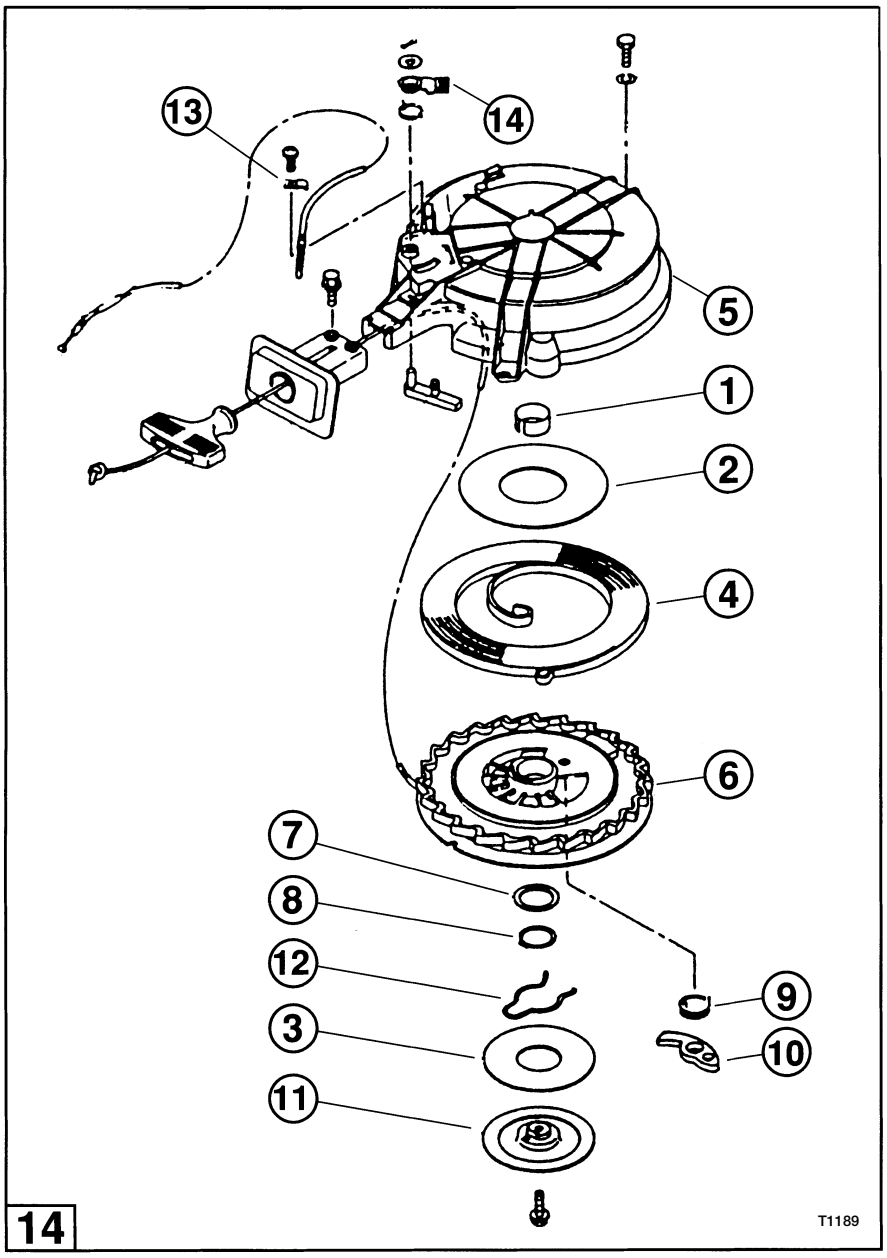
14 Rewind spring **(4)**.

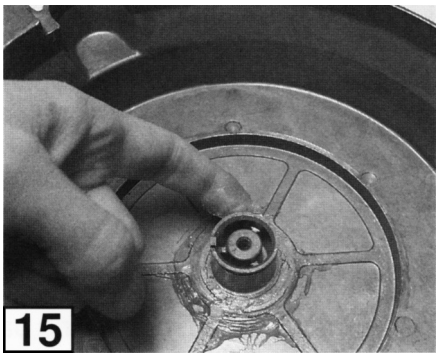
15 Bushing shaft in starter housing.

14 2. Install bushing **(1)** and sliding plate **(2)** in starter housing **(5)**.

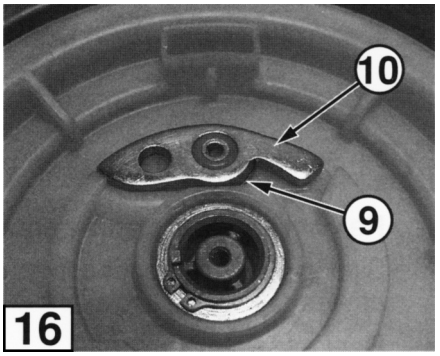


T1188





T1190



T1191

14 3. Wind starter rewind spring **(4)** into starter housing.

14 4. Thread starter rope through rope hole in reel **(6)**. Knot the rope and pull it tight in the reel. Route the remaining rope through the rope guide and attach the handle.

5. Hold reel so knot is facing up. Wind the starter rope clockwise 1-1/2 times around the reel and hook it into the reel notch.

14 6. Position reel in starter housing so rope notch is aligned with the rope guide. Install washer **(7)** and snap ring **(8)**.

14 **16** 7. Install return spring **(9)** and ratchet **(10)** on the reel.

8. Place sliding plate **(3)** on friction plate **(11)** and install friction spring **(12)**. Position the assembly on the reel so key hole in friction plate is properly aligned. Install mounting bolt.

9. With the rope hooked in the reel notch and aligned with the rope guide, rotate the reel counterclockwise 5 times to tighten the rewind spring. Remove the rope from the notch and allow the reel to slowly wind the remaining starter rope onto the reel.

10. Install the neutral lockout mechanism in the starter housing: pin, washer, stopper arm, stopper spring, and reel stopper.

11. Check operation of the recoil starter before installation.

Installation

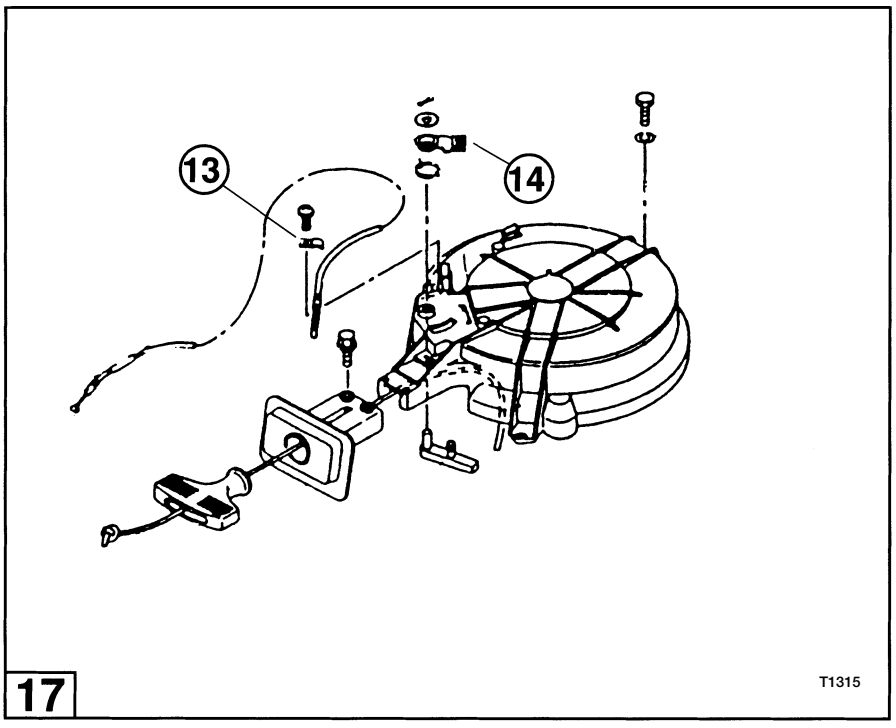
1. Position recoil starter on powerhead and install mounting bolts.

17 2. Make sure engine is in NEUTRAL. Thread the neutral start cable through cable clamp **(13)** on the starter housing. Tighten the cable clamp and connect the cable to stopper arm **(14)**. Press the remaining cable into the cable clamps on the starter housing.

3. Test the operation of the neutral start mechanism.

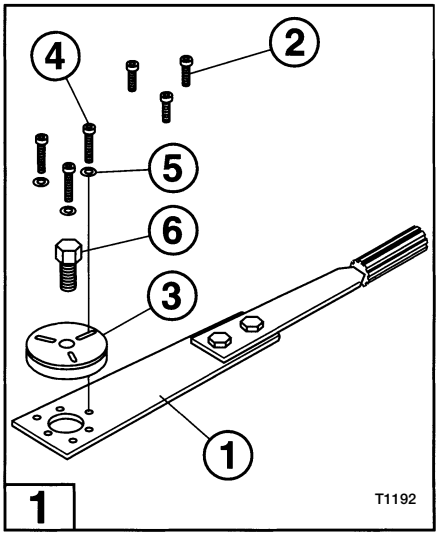
⚠⚠ WARNING

Start-in-gear protection mechanism must be installed. NEVER return engine to customer with mechanism disconnected or not functioning properly.



17

FLYWHEEL



NOTE

Flywheel magnets must be of a particular strength in order to run the ignition system. Weak magnets can cause low ignition voltage which may affect engine performance. Flywheels seldom go bad and would only be replaced as a last resort in solving an ignition problem.

⚠ CAUTION

1 **Flywheel is under high torque and requires the use of special tools for removal and installation. Failure to use the specified tools can result in injury or damage to the flywheel or coil plate electrical components.**

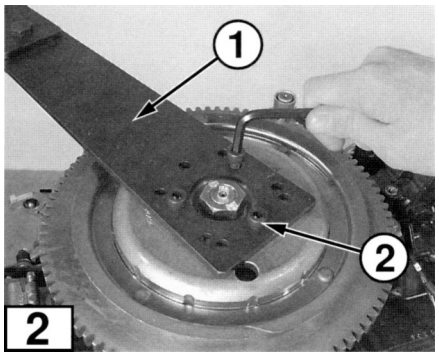
⚠ CAUTION

The force needed to loosen and tighten the flywheel nut requires flywheel be removed and installed with engine mounted and secured on an engine stand.

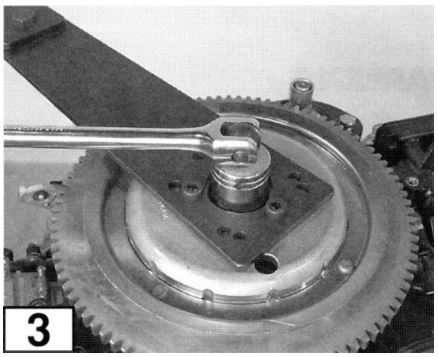
NOTE

Reference the following specification table for flywheel Removal and Installation special tool requirements.

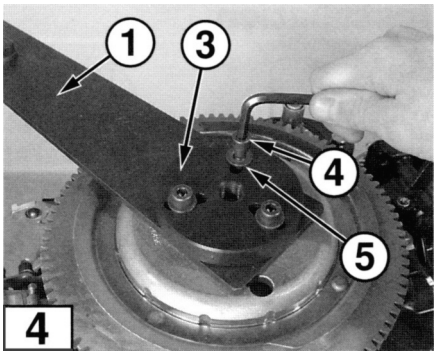
Tool	Part Number	Applicability	Engine Serial Number
		Model	
Flywheel Puller (1) - (6)	3C7-72211-1	40 / 50 / 60 / 70 / 80 / 90 / 115 / 120 / 140	All
Bolt (2), M8 x 25 mm	3B7-72786-0	40 / 50 / 60 / 70 / 80 / 90 / 115 / 120 / 140	All
Flywheel Puller Plate (3)	3B7-72783-0	40 / 50 / 60 / 70 / 80 / 90	All
Flywheel Puller Plate (3)	3C7-72783-0	115 / 120 / 140	All
Bolt (4), M8 x 40 mm	3B7-72785-0	40 / 50 / 60 / 70 / 80 / 90 / 115 / 120 / 140	All
Washer (5)	940194-0800	40 / 50 / 60 / 70 / 80 / 90 / 115 / 120 / 140	All
Pressing Bolt (6)	3B7-72784-0	40 / 50 / 60 / 70 / 80 / 90 / 115 / 120 / 140	All



T1193



T1194



T1195

Removal

⚠⚠ WARNING

Ignition system must be disabled to prevent accidental engine startup during removal of the flywheel.

1. Remove recoil starter and starter pulley or remove the flywheel cover as required.

2. Determine the direction of rotation for removing flywheel nut by running your thumbnail along the threads of the crankshaft.

⚠ CAUTION

Past production models may have reverse thread.

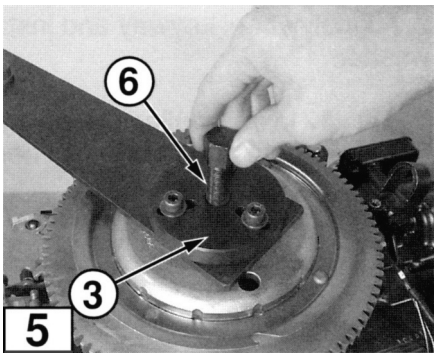
2 3. Install puller **(1)** on flywheel using bolts **(2)**.

3 4. Hold puller by its handle and remove flywheel nut with a socket wrench. Make sure to turn nut in the correct direction.

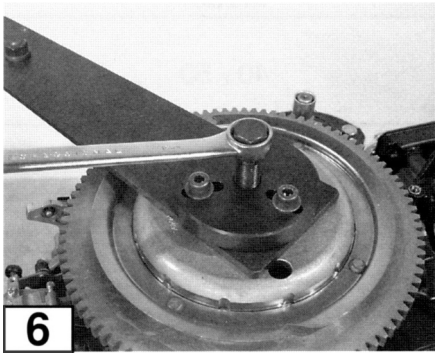
4 5. Install puller **(1)** and plate **(3)** on flywheel using bolts **(4)** and washers **(5)**.

5 6. Install pressing bolt **(6)** in plate **(3)**.

6 7. Hold puller by its handle and tighten pressing bolt until flywheel releases.



T1196



T1197

Inspection

1. Inspect flywheel for cracks, chips, and worn taper.

2. Inspect crankshaft for thread damage and worn taper.

3. Inspect flywheel key and keyway for damage.

Installation

⚠⚠ WARNING

Ignition system must be disabled to prevent accidental engine startup during installation of the flywheel.

1. Remove all grease from crankshaft threads and tapered portion of flywheel with solvent.

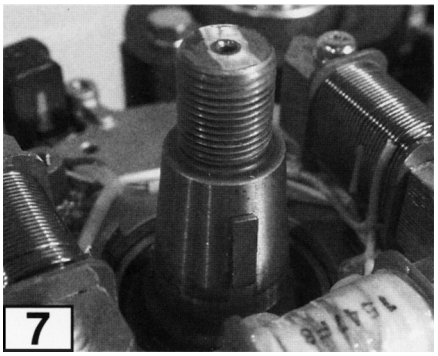
7 2. Check flywheel key is inserted in crankshaft.

3. Align flywheel keyway and install on crankshaft. Install the flywheel washer.

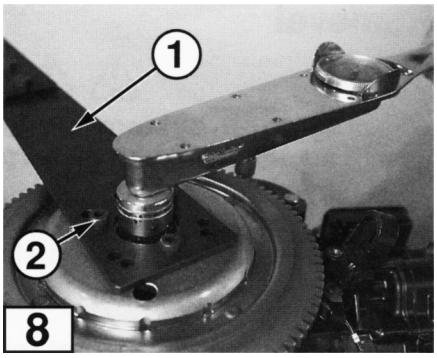
8 4. Install puller **(1)** on flywheel using bolts **(2)**. Hold puller handle and torque flywheel nut to specification.

5.Install recoil starter or flywheel cover as required.

Model	Flywheel Nut Torque ft-lb N·m kg-m
40 / 50	65.1 - 79.5 88.2 - 107.8 9.0 - 11.0
60 / 70 / 80 / 90	101.2 - 115.7 137.2 - 156.8 14.0 - 16.0
115 / 120 / 140	181.0 - 195.0 245.0 - 264.6 25.0 - 27.0



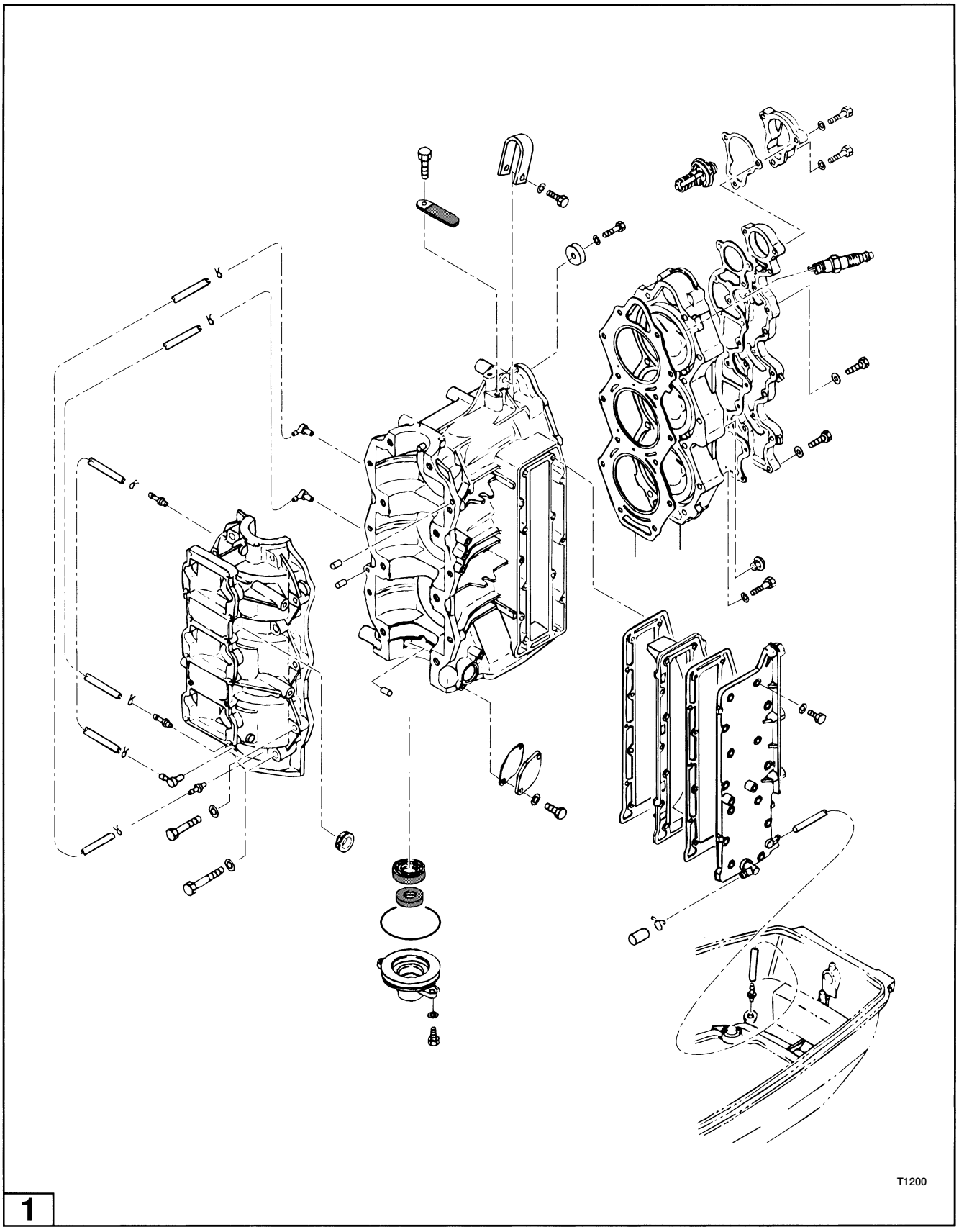
T1198



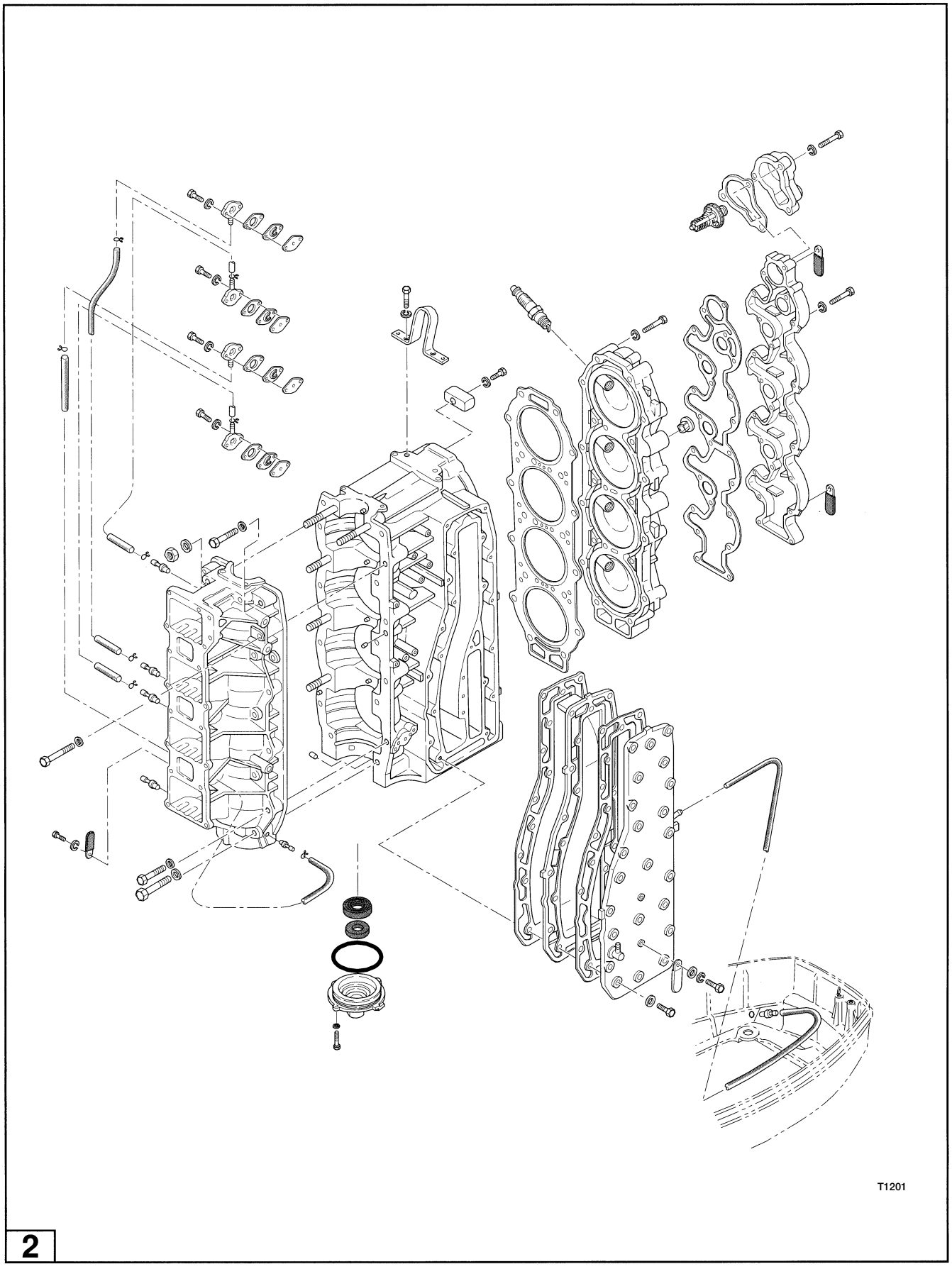
T1199

POWERHEAD

Typical 3-Cylinder



Typical 4-Cylinder



Removal

⚠⚠ WARNING

Ignition system must be disabled to prevent accidental engine startup during removal of the powerhead.

NOTE

If service work requires flywheel to be removed, remove flywheel before lifting powerhead from the rest of the engine. See Flywheel, this section.

NOTE

Mark the mounting location of all clamps so they can be returned to their original positions during assembly of the powerhead.

1. Disconnect the battery and fuel tank.

2. Disable the ignition system and disconnect the battery terminals on the powerhead.

3. Disconnect all electrical connections as applicable:
- Ground connections between lower engine cover and cylinder block.
- Power trim and tilt connections.
- Remote control or main key switch wire harness.
- Neutral switch.

4. Disconnect fuel INPUT hose from fuel filter.

5. Disconnect pilot water hose from exhaust cover.

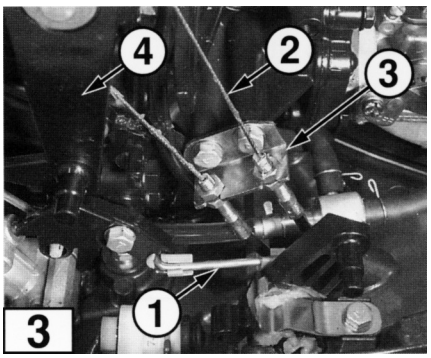
6. Complete the following operations.

3 Tiller models:
- Disconnect shift arm L-link **(1)**.
- Remove throttle cable **(2)** from throttle cable bracket **(3)**.
- Remove advancer arm **(4)** and throttle cable.
- Disconnect choke knob link rod.

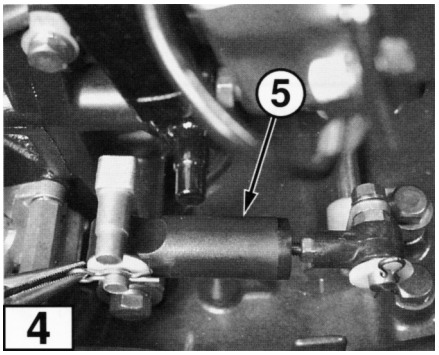
4 Remote control models:
- Disconnect shift cable from shift arm.
- Remove shift assist case **(5)**.
- Disconnect throttle cable from advancer arm.

5 7. Remove the splash pan.

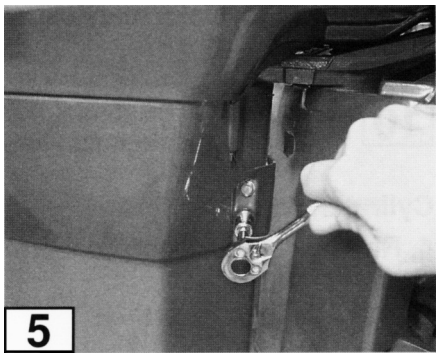
6 8. Remove the engine mounting bolts.



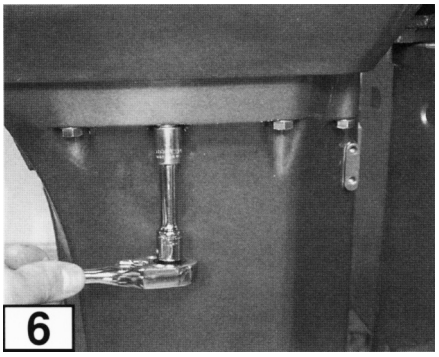
T1202



T1203



T1204



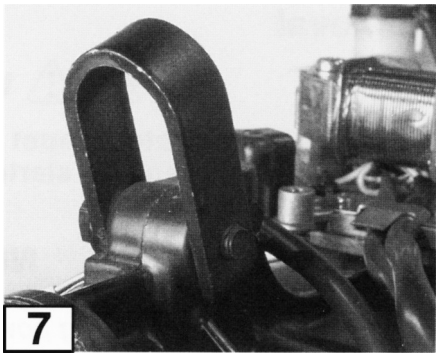
T1205

7 9. Using an adequate hoist, lift and remove the powerhead by its lifting eye.

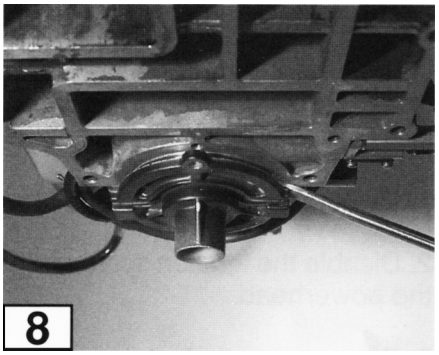
8 10. Remove lower crankcase head bolts. Insert screwdriver in pinch groove and remove lower crankcase head.

9 11. Install specified powerhead stand in vice. Bolt powerhead base surface to powerhead stand.

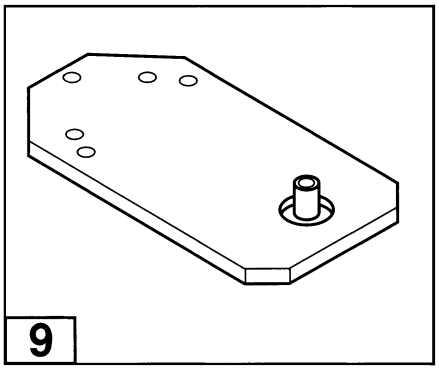
Powerhead Stand Part Number	Applicability
	Model
—	40 / 50
353-72247-1	60 / 70 / 80 / 90 / 115 / 120 / 140



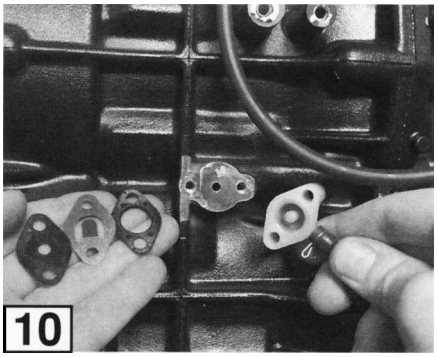
T1206



T1207



T1208



T1209

Disassembly

Preliminary

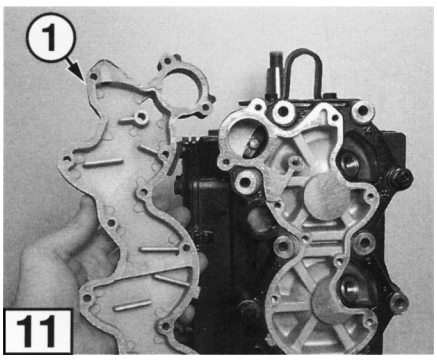
1. Remove all carburetion, ignition, and electrical components from the powerhead.

2. Remove the intake manifold and reed valves. See Intake Manifold in Section 3.

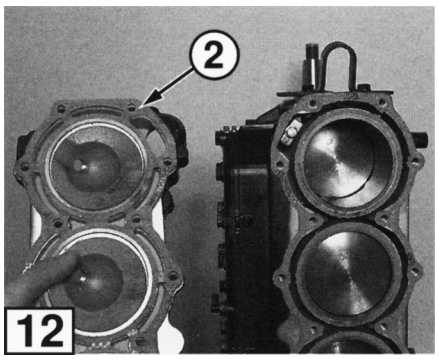
10 3. Remove the check valves (models 80, 90, 115, 120, and 140) and recirculation lines.

Cylinder Head

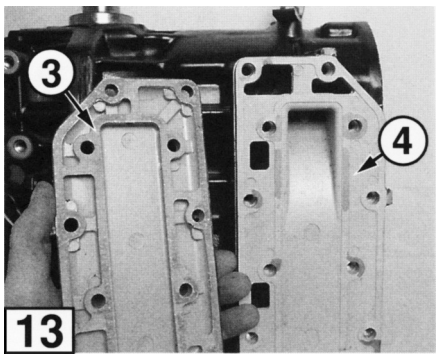
4. Remove and inspect the thermostat. See Thermostat, this section.



T1210



T1211



T1212

11 **12** 5. Remove the cylinder head cover bolts and cylinder head bolts. Separate and remove cylinder head cover **(1)** and cylinder head **(2)**.

NOTE

Remove the smallest size bolts first. Remove the bolts in order from highest embossed number to lowest. If the bolts are not numbered, start with those farthest from the center of the cylinder head and work inward.

6. Using a pointed scribe, identify the heads of the cylinders for correct positioning during assembly operations.

Exhaust Cover

13 7. Remove the exhaust cover bolts. Insert screwdriver into pinch grooves to separate and remove outer **(3)** and inner **(4)** exhaust covers.

NOTE

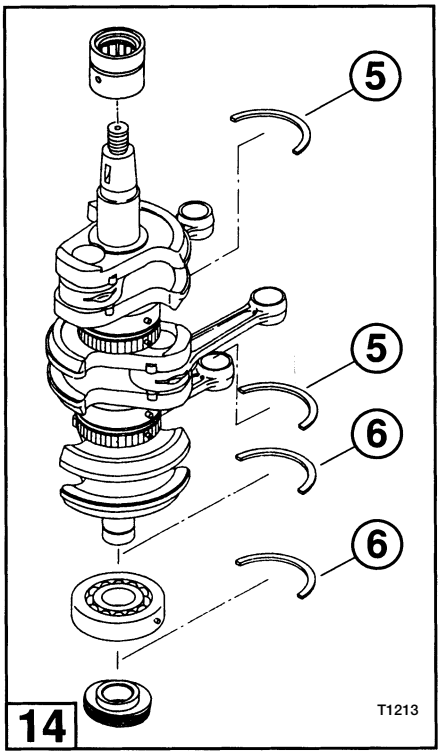
Remove the bolts in order from highest embossed number to lowest.

Crankcase and Crankshaft

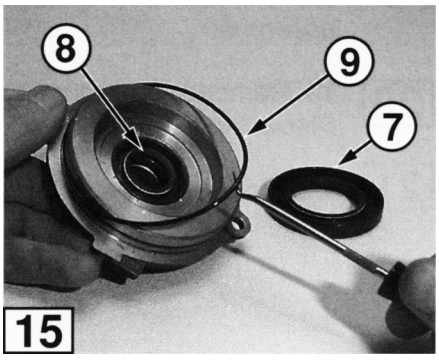
NOTE

14 *Crankshaft on models 40 and 50 is equipped with bearing thrust plates **(5)** and crankshaft thrust plates **(6)**. Mark these parts so they can be returned to their original positions during assembly.*

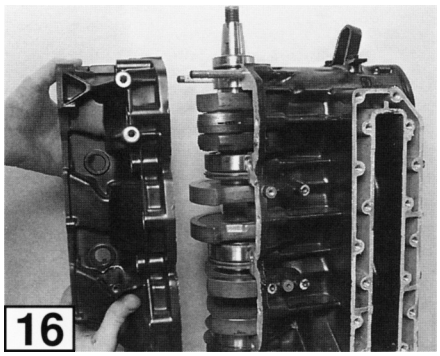
15 8. Remove and discard oil seals **(7)** and **(8)** and o-ring **(9)** from lower crankcase head. Use a seal puller to prevent damage to the head.



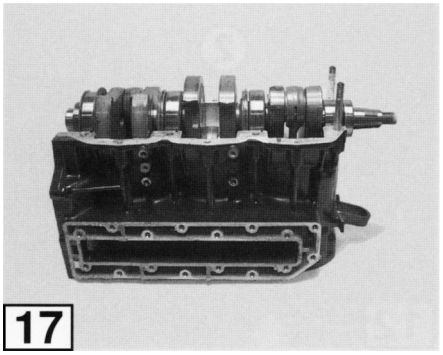
T1213



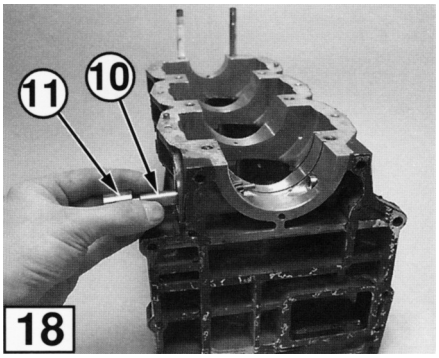
T1214



T1215



T1216



T1217

16 9. Remove the crankcase bolts and separate the crankcase from the cylinder block.

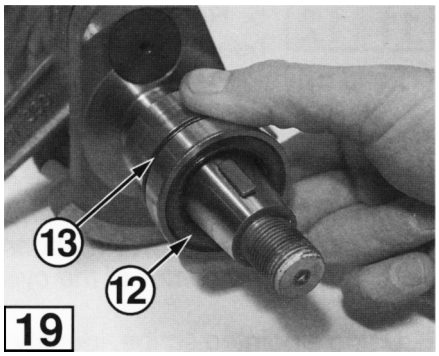
NOTE

Remove the smallest size bolts first. Start with the bolts farthest from the center of the crankcase and work inward.

17 10. Lift the crankshaft and pistons from the cylinder block and place on bench for disassembly.

18 11. Remove oil pump driven gear **(10)** and bushing **(11)** from the cylinder block.

19 12. Slide the upper main bearing off the crankshaft. Remove and discard bearing oil seal **(12)** and o-ring **(13)**.

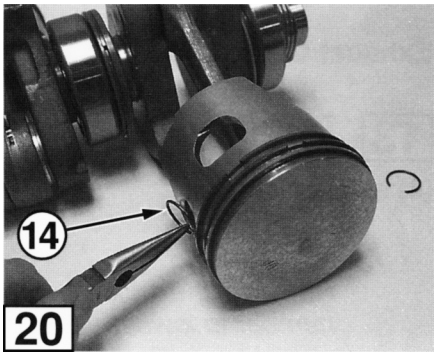


T1218

Pistons

NOTE

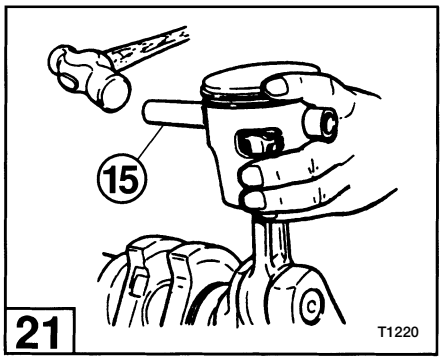
Pistons, rings, and connecting rod bearings are wear parts which seat with operation of the engine. Make sure these parts are marked and kept together so they can be returned to their original positions during assembly.



T1219

20 13. Remove piston pin clip **(14)** from both sides of each piston. Discard the clips.

21 14. Tap out the piston pins using specified piston pin tool **(15)**:



T1220

Piston Pin Tool Part Number	Applicability Model
345-72215-0	40 / 50
353-72215-0	60 / 70 / 80 / 90 / 115 / 120 / 140

22 15. Remove the piston, bearing washers **(16)** (models 80, 90, 115, 120 and 140), and bearing **(17)** from the connecting rod.

23 16. Remove each piston ring using the piston ring tool (Part No. 353-72249-0).

NOTE

Identify each ring so it can be returned to its original piston and ring groove.

Cleaning

1. Remove all carbon accumulation from exhaust port areas and cylinder head combustion chambers.

24 2. Use gasket remover and Scotch-Brite Abrasive Pads to remove all traces of gasket and sealer from the cylinder block, crankcase, cylinder head, intake manifold, exhaust covers, and air silencer.

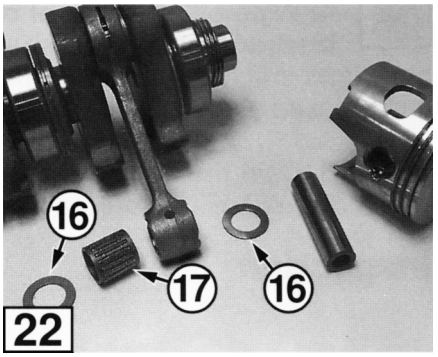
⚠ CAUTION

DO NOT use a metal scraper on gasket surfaces or the mating surfaces of the crankcase.

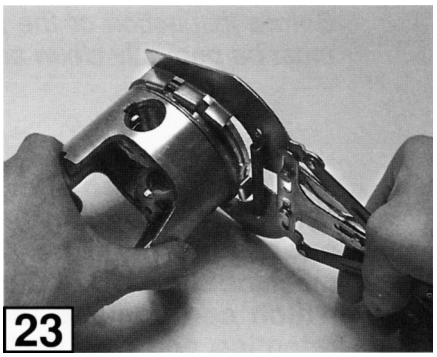
25 3. Remove all carbon deposits from the tops and ring grooves of the pistons.

NOTE

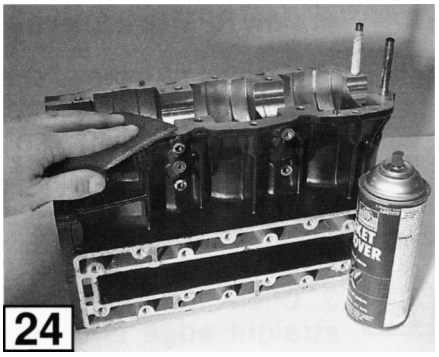
A ring groove cleaning tool can be made by breaking an old ring and grinding an angle on its end. Do not damage the grooves when cleaning.



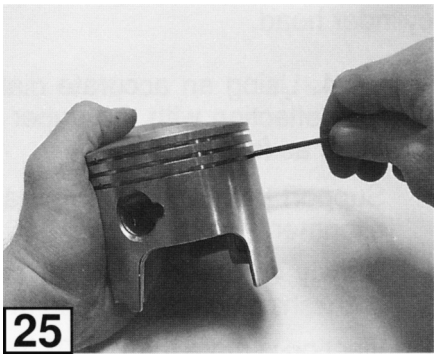
T1221



T1222

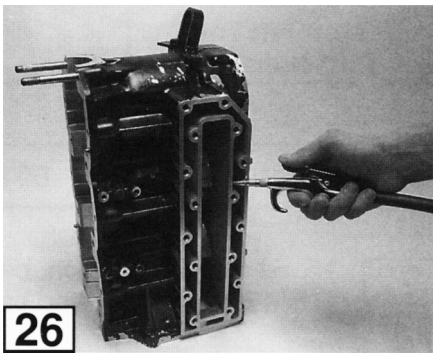


T1223



T1224

26 4. Wipe off all traces of oil and thoroughly wash the cylinder block and crankcase with warm, soapy water. Air dry the cylinder block and crankcase. Dry all holes and passages with low pressure compressed air.



T1225

27 5. Coat the cylinder walls with genuine engine oil or certified TC-W3 oil to protect them from corrosion.



T1226

Inspection

NOTE

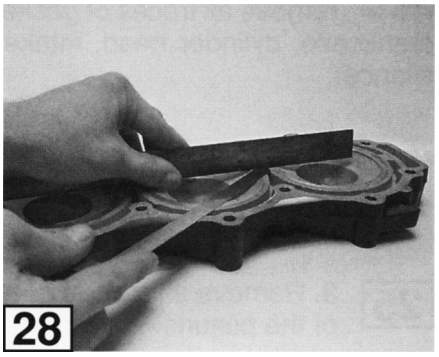
Before inspection of the powerhead, all components must be perfectly clean and free of contaminants.

⚠ CAUTION

If it is determined after complete inspection that cylinder resurfacing or boring is necessary, all operations must be performed at a qualified machine shop. Light scuffing or burn does not require boring for removal. Use water-resistant sand paper of around #320 to remove the damages, and then use #400 and #600 to finish.

1. Visually inspect all internal components. Inspect for unusual wear patterns, heat-related discoloration of bearings, broken parts, and scuffing or damage to aluminum parts.

2. Inspect the intake manifold and reed valves. See Intake Manifold in Section 3.

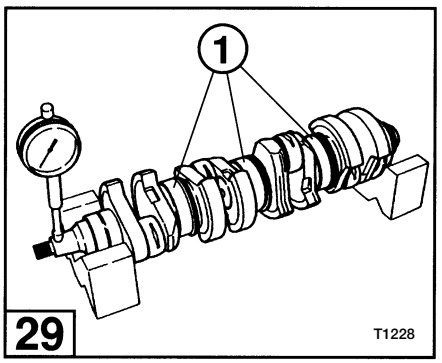


T1227

28 3. Check the cylinder head for warpage using a machinist straight edge and the thickness gauge set (Part No. 353-72251-0). If warpage exceeds 0.004 in [0.10 mm], replace the cylinder head.

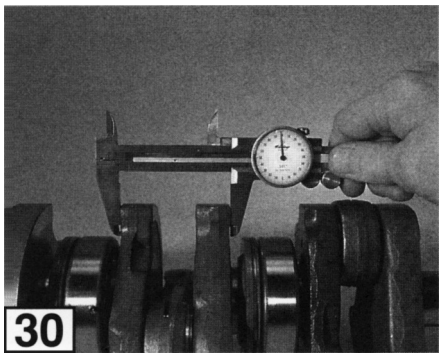
29 4. Using an accurate dial indicator, measure the crankshaft deflection with the upper and lower main bearings installed. Measure as follows:

- Support both ends of the crankshaft in precision V-blocks or an alignment jig.
- Slowly rotate crankshaft and record measurement at each crankshaft bearing **(1)** and at both ends of the crankshaft.

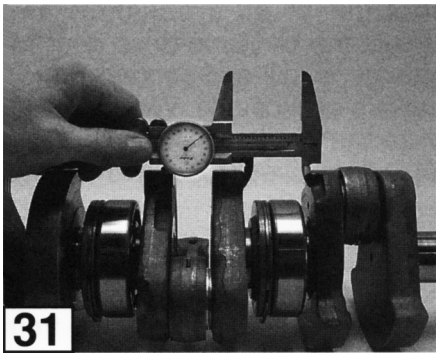


T1228

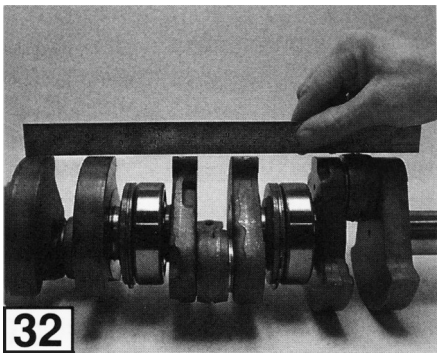
If deflection is more than 0.002 in [0.05 mm] on either end, replace the crankshaft.



T1229



T1230



T1231

5. Measure and record the following crankshaft dimensions and check for signs of wear:

30 • Dimension 1 : Distance between the outside edges of each pair of crankshaft webs. Measure at both ends of the webs.

31 • Dimension 2 : Distance between each pair of crankshaft webs.

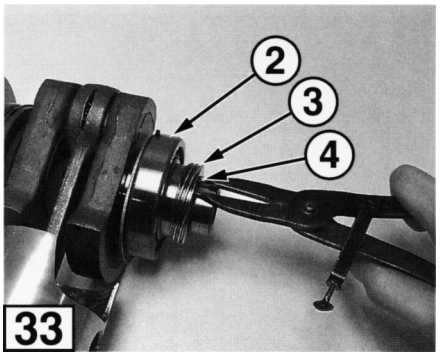
32 • Dimension 3 : Distance between the outside edges of the first and last crankshaft webs.

If any dimension is not within specification, replace the crankshaft assembly.

Figure	Description		Unit	40 / 50	60 / 70	80 / 90	115 / 120 / 140
1	Crankshaft	①	in mm	2.087 $^{0}_{-0.001}$ in [53 $^{0}_{-0.02}$ mm]	2.362 $^{-0.008}_{-0.009}$ in [60 $^{-0.20}_{-0.22}$ mm]	2.677 $^{0}_{-0.001}$ in [68 $^{0}_{-0.02}$ mm]	2.677 $^{0}_{-0.001}$ in [68 $^{0}_{-0.02}$ mm]
		①*		—	—	2.598 $^{0}_{-0.001}$ in [66 $^{0}_{-0.02}$ mm]	—
		②		1.457 $^{+0.002}_{-0}$ in [37 $^{+0.05}_{-0}$ mm]	1.467 $^{+0.002}_{-0}$ in [37.25 $^{+0.05}_{-0}$ mm]	1.732 $^{+0.002}_{-0}$ in [44 $^{+0.05}_{-0}$ mm]	1.654 $^{+0.002}_{-0}$ in [42 $^{+0.05}_{-0}$ mm]
		③		9.173 in 233.0 mm	10.020 in 254.5 mm	11.339 in 288.0 mm	15.669 in 398.0 mm

33 6. Check for smooth operation of all crankshaft and connecting rod bearings. Inspect the oil pump drive gear for damage. Upper and lower main bearings, small end connecting rod bearings, and the oil pump drive gear are serviceable. Wear of other parts requires replacement of the crankshaft assembly. If lower main bearing **(2)** or oil pump drive gear **(3)** is defective, proceed to remove the components as follows:

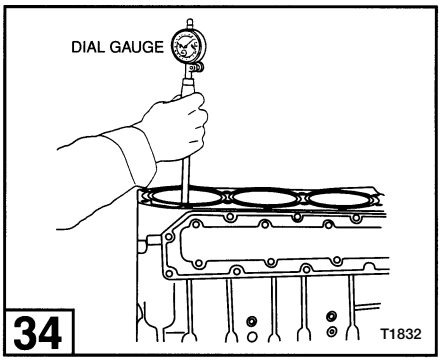
- Remove snap ring **(4)**.
- Install a universal bearing puller with bearing retainer plate and remove lower main bearing **(2)** and oil pump drive gear **(3)** from the crankshaft.
- See powerhead Assembly procedure for installation.



T1232

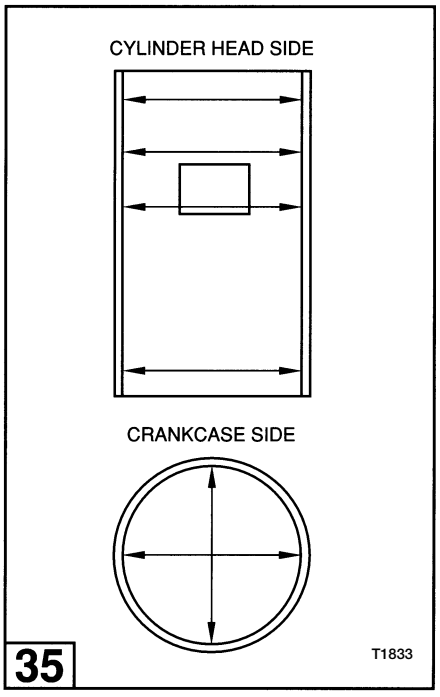
34 **35** 7. Measure and record the diameter of each cylinder bore and the outside diameter of its respective piston. Subtract the values to calculate the piston clearances. If any bore diameter or piston clearance exceeds the specified limit, the cylinder must be professionally bored oversize for use with an oversize piston.

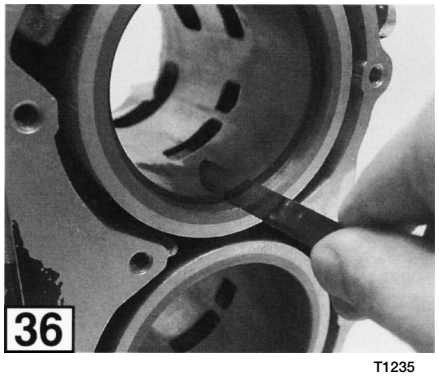
Model	Standard Bore Diameter in [mm]	Piston Clearance in [mm]
40 / 50	2.677 [68.0]	0.0012 - 0.0028 [0.03 - 0.07]
60 / 70	2.913 [74.0]	0.0016 - 0.0031 [0.04 - 0.08]
80 / 90	3.386 [86.0]	0.0031 - 0.0051 [0.08 - 0.13]
115 / 120 / 140	3.465 [88.0]	0.0039 - 0.0055 [0.10 - 0.14]



36 8. Complete the following inspection for new or used piston ring sets. Inspect each ring separately:

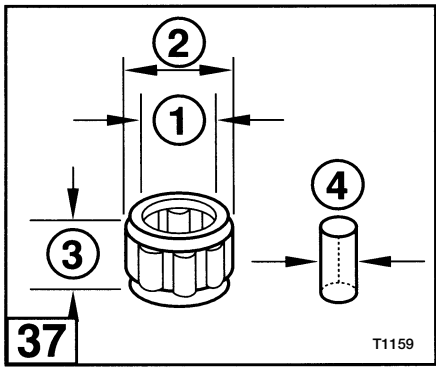
- Place ring in its respective cylinder bore.
- Use a piston to square the ring in the bore.
- Use the thickness gauge set (Part No. 353-72251-0) to measure the ring end gap.





T1235

The ring end gap must be within specification:



Model	Ring End Gap in [mm]	
	STD Value	Repair Limit
40 / 50	Top Ring: 0.009 - 0.015 [0.22 - 0.37] 2nd Ring 0.013 - 0.019 [0.33 - 0.48]	0.032 [0.8] 0.032 [0.8]
60 / 70	0.009 - 0.015 [0.22 - 0.37]	0.032 [0.8]
80 / 90	0.010 - 0.016 [0.25 - 0.40]	0.032 [0.8]
115 / 120 / 140	0.011 - 0.019 [0.28 - 0.49]	0.032 [0.8]

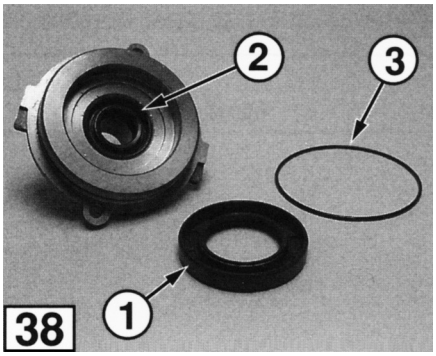
37 9. Measure the specified dimensions of the small end connecting rod bearings. If measurements are not as specified, the bearing is excessively worn and must be replaced.

Model	Small End Connecting Rod Bearing Dimensions in [mm]			
	Inside Diameter (1)	Outside Diameter (2)	Height (3)	Needle Roller Diameter (4)
40 / 50	0.669 [17.0]	0.827 [21.0]	1.063 [27.0]	0.079 [2.0]
60 / 70	0.787 [20.0]	0.984 [25.0]	0.945 [24.0]	0.098 [2.5]
80 / 90	0.787 [20.0]	0.984 [25.0]	1.102 [28.0]	0.098 [2.5]
115 / 120 / 140	0.787 [20.0]	0.984 [25.0]	1.102 [28.0]	0.098 [2.5]

If crankshaft was fully disassembled for further inspection, measure the big end connecting rod bearings in the same manner. Wear or damage to large end connecting rod bearings requires replacement of the crankshaft assembly.

Model	Big End Connecting Rod Bearing Dimensions in [mm]			
	Inside Diameter (1)	Outside Diameter (2)	Height (3)	Needle Roller Diameter (4)
40 / 50	0.984 [25.0]	1.260 [32.0]	0.779 [19.8]	0.138 [3.5]
60 / 70	1.063 [27.0]	1.417 [36.0]	0.709 [18.0]	0.177 [4.5]
80 / 90	1.181 [30.0]	1.535 [39.0]	0.858 [21.8]	0.177 [4.5]
115 / 120 / 140	1.260 [32.0]	1.614 [41.0]	0.866 [22.0]	0.177 [4.5]

10. Inspect recirculation line nipples for damage or obstruction.



T1236

Assembly

NOTE

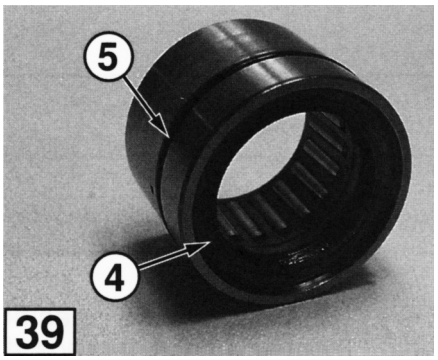
Before assembly of the powerhead, all components must be perfectly clean and lightly coated with genuine engine oil or a NMMA certified TC-W3 oil. All serviceable gaskets and seals must be replaced.

⚠ CAUTION

Proceed slowly when assembling powerhead. DO NOT make forced assemblies unless a pressing operation is indicated.

Preliminary

38 39 1. Before installation, lightly coat the outside surfaces of new bearing seals and o-rings with genuine engine oil or TC-W3 oil. Apply bearing cup grease to the seal lips. Press fit the seals into place using an appropriate size seal installer to avoid damaging the seal or component.



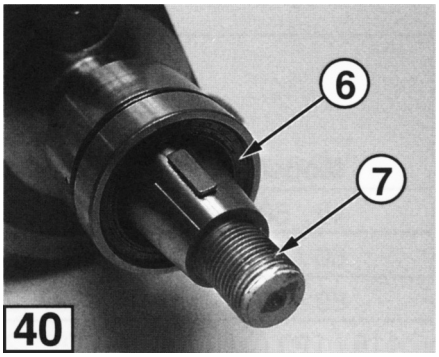
T1237

- Install new oil seals **(1)** and **(2)** in lower crankcase head. Install new o-ring **(3)**.
- Install new oil seal **(4)** in upper main bearing and new o-ring **(5)**.

2. Coat the rotating surfaces of the crankshaft and connecting rod bearings, bearing washers, and bearing thrust plates (models 40 and 50) with genuine engine oil or TC-W3 oil.

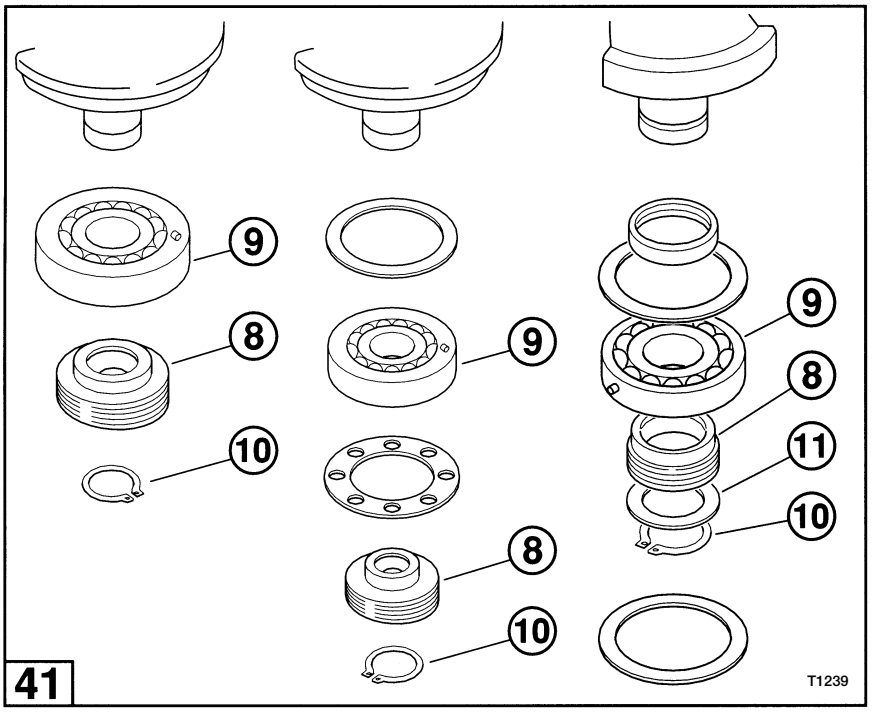
Crankshaft

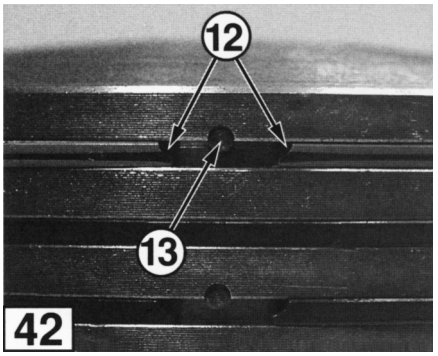
40 3. Slide upper main bearing onto crankshaft so bearing seal **(6)** faces threaded end **(7)**.



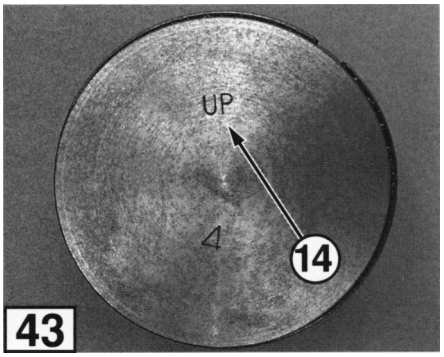
T1238

41 4. If oil pump drive gear **(8)** and lower main bearing **(9)** were removed, coat lower end of crankshaft with genuine engine oil or TC-W3 oil and install the lower crankshaft components in order, press fitting the gear and bearing onto the crankshaft. Make sure snap ring **(10)** is properly seated.





T1240



T1242

NOTE

41 *On models 80, 90, 115, 120, 140, measure the end gap between oil pump drive gear **(8)** and snap ring **(10)** with all lower crankshaft components properly seated. If end gap exceeds 0.004 in [0.09 mm], install correct size shim **(11)**.*

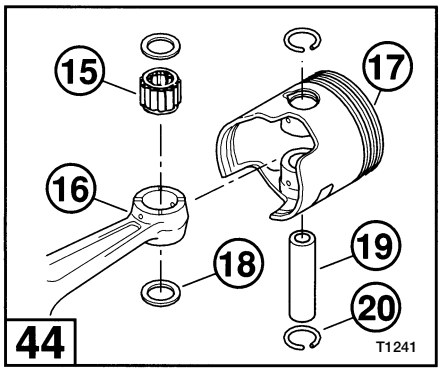
Pistons

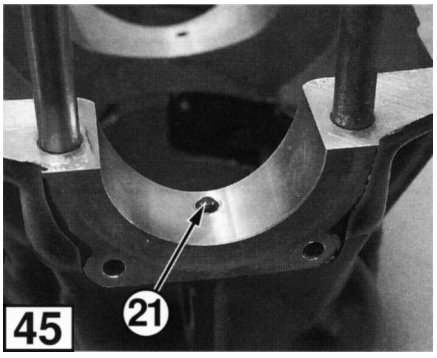
42 5. Install each piston ring in its original groove on its original piston using the piston ring tool (Part No. 353-72249-0). Each ring must be installed so end notches **(12)** fit the contour of piston knock **(13)** when the ring is compressed.

6. Install each piston on its respective connecting rod as follows:

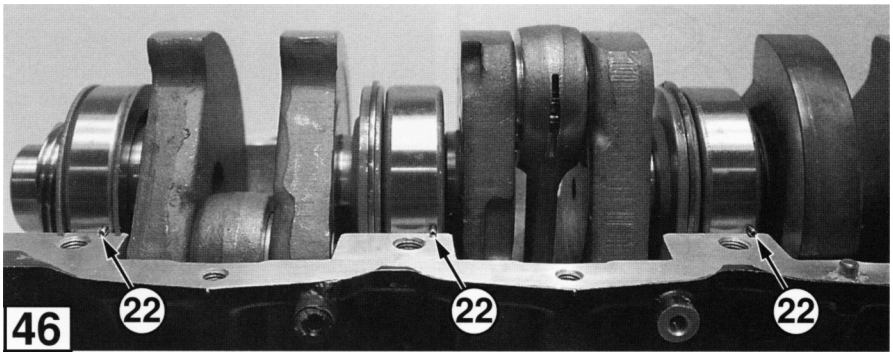
NOTE

43 *Each piston must be installed so [UP] mark **(14)** points to the flywheel end. Use the same piston pin tool as was specified for disassembly.*





T1243



T1244

44 Insert bearing **(15)** into bearing collar of connecting rod **(16)**.

44 Correctly position piston **(17)** onto the connecting rod.

44 Insert bearing washer **(18)** on each side of the connecting rod (models 80, 90, 115, 120 and 140).

44 Align components so piston pin hole is not obstructed and install piston pin **(19)** using piston pin tool.

44 Install new piston pin clips **(20)**. Do not reuse old clips.

Cylinder Block and Crankcase

7. Install the oil pump driven gear and bushing in the cylinder block.

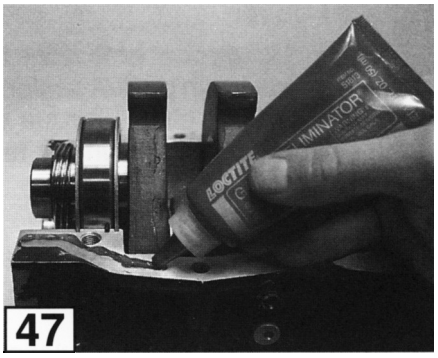
8. Coatthe pistons, rings, cylinder walls, and oil pump drive gear and driven gear with genuine engine oil or TC-W3 oil. Install the bearing washers or thrust plates (models 40 and 50) and lower crankshaft assembly into cylinder block, guiding each piston into its respective cylinder. Ensure the following:

45 Dowel pin **(21)** in cylinder block is inserted in the hole in the upper main bearing.

46 All main bearing nocks **(22)** are seated against the crankcase mating flange of the cylinder block for proper alignment with the crankcase.

- Oil pump drive gear on crankshaft is meshed with the oil pump driven gear.
- Bearing washers or thrust plates (models 40 and 50) are seated properly in the cylinder block.

47 9. Degrease the crankcase flange and mating surface of the cylinder block. Apply anaerobic gasket maker to the cylinder block flange. The application must cover the flange evenly and not be excessive.



T1245

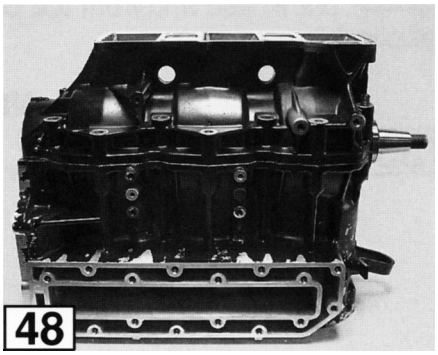
48 10. Install crankcase on cylinder block. Ensure the following:

- All dowel pins in cylinder block are properly aligned in the crankcase.
- All main bearing nocks are seated in the crankcase notches.

11. Install crankcase mounting bolts and torque to specification:

NOTE

Install and torque the largest size bolts first. Start with the bolts closest to the center of the crankcase and work outward.



T1246

Cylinder Head

49 12. Lightly coat both sides of new cylinder head gasket and cylinder head cover gasket with high temperature gasket dressing. Install the gaskets.

13. Install the cylinder head, cylinder head cover, and overheat sensor (if equipped). Torque the bolts to specification.

50

NOTE

Apply light coat of dielectric lubricant to sensor before installation.



T1247

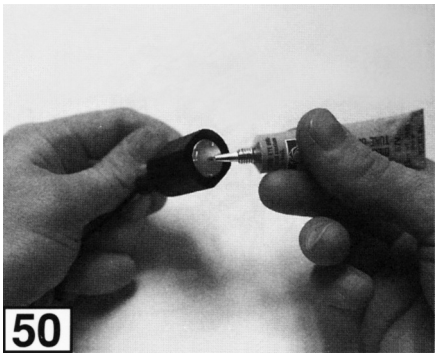
NOTE

On models 40 and 50, torque the cylinder head M6 bolts first, starting with those nearest the center of the cylinder head and working outward. Torque the M8 bolts in order from lowest embossed number to highest.

NOTE

On models 60, 70, 80, 90, 115, 120, and 100, torque all bolts in order from lowest embossed number to highest.

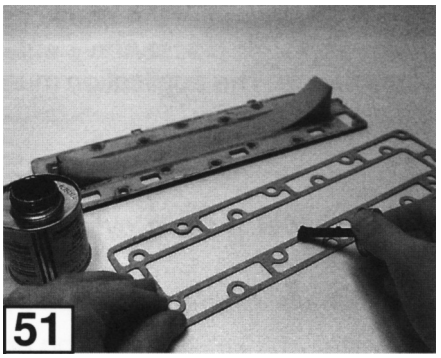
14. Install thermostat and torque thermostat cap bolts to specification. See Thermostat, this section.



T1248

Exhaust Cover

51 15. Lightly coat both sides of new inner and outer exhaust cover gaskets with gasket sealant. Install gaskets and mount exhaust covers to cylinder block. Torque exhaust cover bolts to specification from lowest embossed number to highest.



T1249

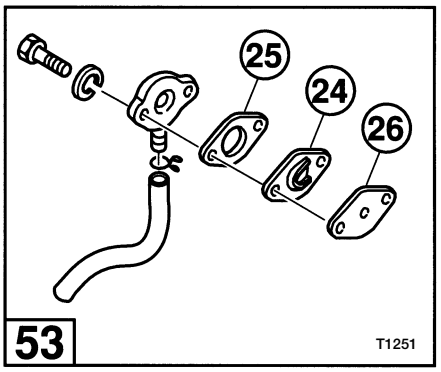
Final Assembly

16. Install the reed valves and intake manifold. See Intake Manifold in Section 3.

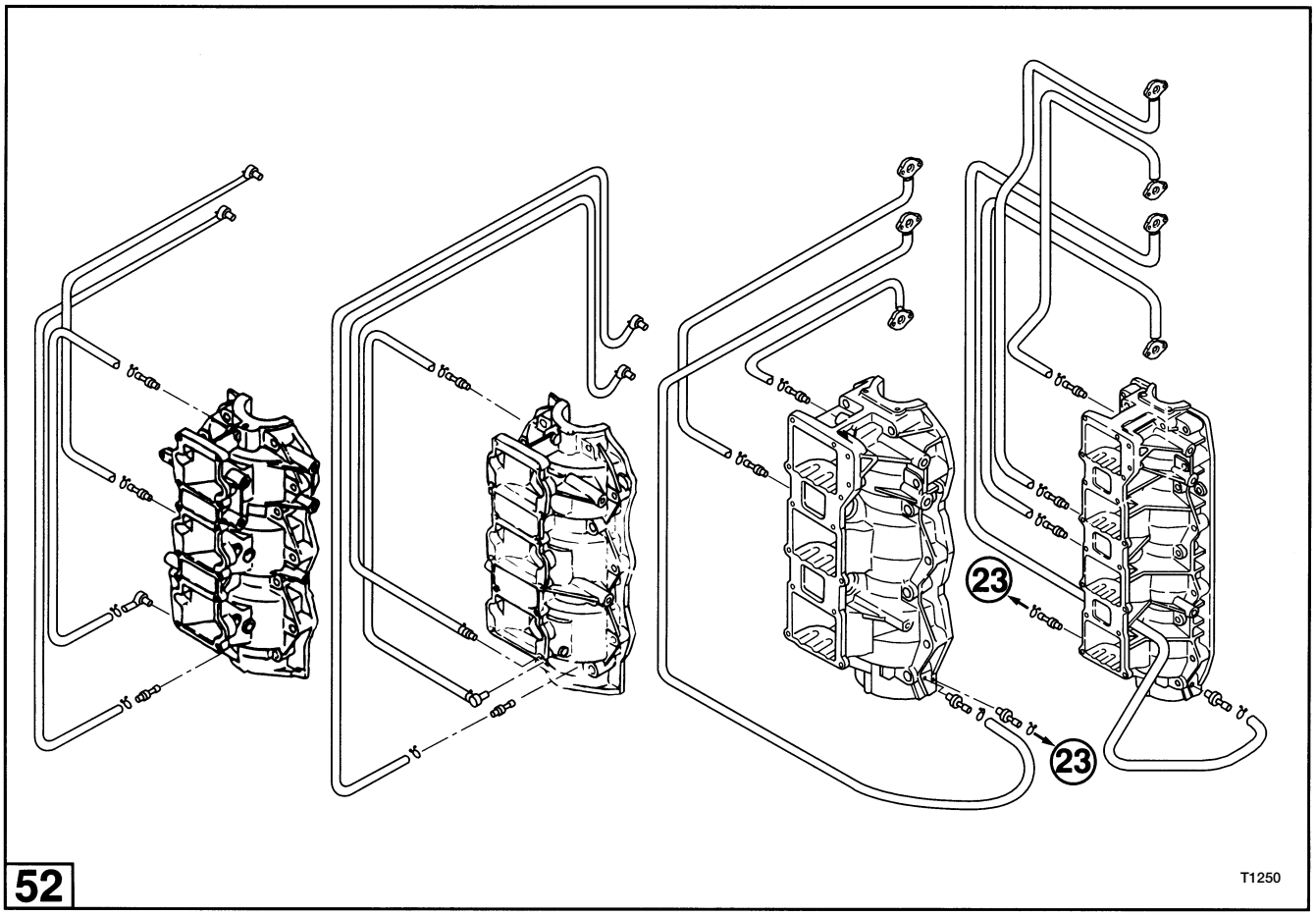
52 17. Install new recirculation lines from the cylinder block to the crankcase and from the crankcase to intake manifold **(23)** as applicable.

NOTE

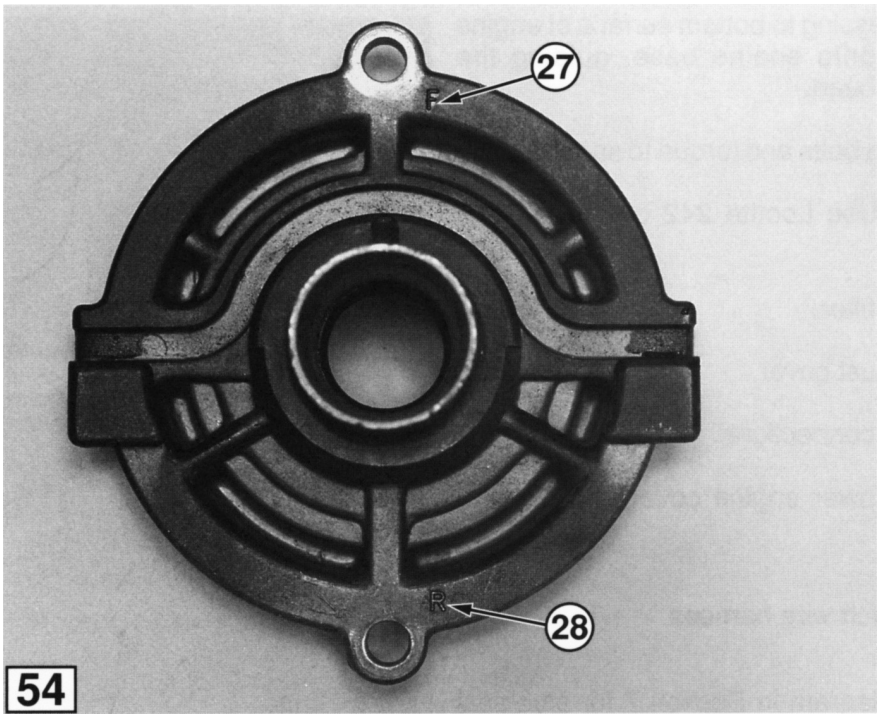
53 *Install check valve **(24)** so flap is bent toward the cylinder block. Install new gaskets **(25)** and **(26)** dry.*



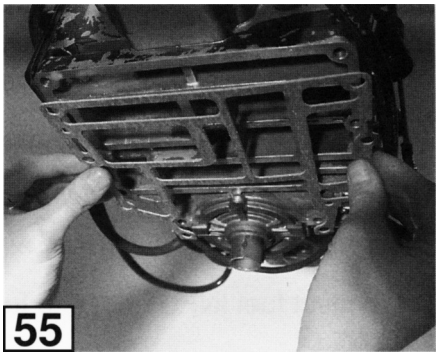
T1251



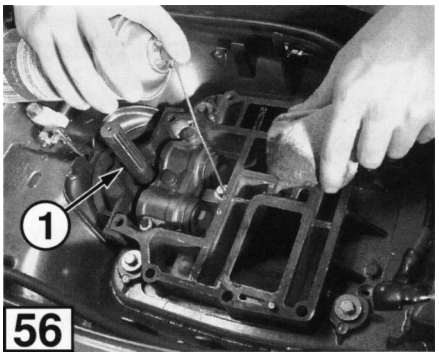
T1250



T1252



T1253



T1254

18. Install all carburetion, ignition, and electrical components on the powerhead using the following guidelines. Assemble as much as possible before mounting powerhead to engine midsection.

- Follow all relevant procedures and wiring diagrams in other sections of this manual.
- Torque fasteners to specification. Use Loctite 243 on the pulsar coil assembly screws.
- Lubricate powerhead components as specified. See Lubrication Chart in Section 2.
- Route and clamp all wires and hoses away from moving engine parts.
- Do not install flywheel until powerhead has been bolted to engine base.

19. Using an adequate hoist, lift powerhead by its lifting eye.

54 20. Install lower crankcase head so F mark **(27)** faces carburetors and R mark **(28)** faces cylinders.

55 21. Apply high temperature gasket dressing to engine base gasket and install gasket on powerhead.

Installation

56 1. Degrease the engine base surface and coat driveshaft splines **(1)** with genuine engine oil or TC-W3 oil.

2. Apply high temperature gasket dressing to bottom surface of engine base gasket. Lower powerhead onto engine base, guiding the driveshaft into the lower crankcase head.

57 3. Install the engine mounting bolts and torque to specification.

58 4. Install the splash pan. Use Loctite 242 on splash pan mounting bolts.

5. Connect fuel INPUT hose to fuel filter.

6. Connect pilot water hose to exhaust cover.

7. Complete the following electrical connections:

- Ground connections between lower engine cover and cylinder block.
- Power trim and tilt connections.
- Remote control or main key switch wire harness.
- Neutral safety switch.

Reference the appropriate wiring diagram in Section 7 for electrical box connections. Leave ignition system disabled.

59 **60** 8.Complete the following operations.

Tiller models:

- Connect shift arm L-link **(2)**.
- Secure throttle cable **(3)** to throttle cable bracket **(4)**.
- Install advancer arm **(5)**.
- Connect choke knob link rod.

Remote control models:

- Connect shift cable to shift arm.
- Install shift assist case so beveled edge **(6)** faces upward.
- Connect throttle cable to advancer arm.

9. Install flywheel and recoil starter (if equipped). See Flywheel and Recoil Starter, this section.

10. Perform all carburetor and ignition timing adjustments. See Synchronization and Linkage Adjustments in Section 2.

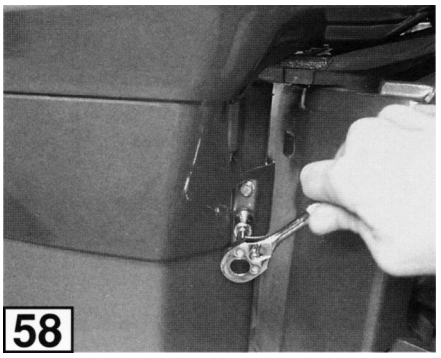
11. Purge all air from the oil automixing system. See Automixing System in Section 3.

12. Perform all tune-up operations. See Tune-Up Procedure in Section 2.

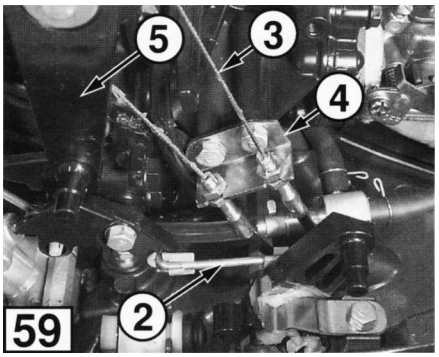
13. Test and inspect all safety features of the engine.



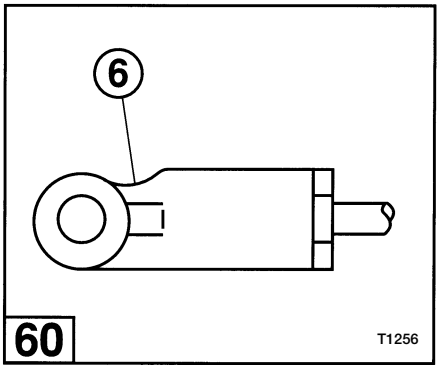
T1205



T1204



T1255



T1256

SECTION 5
MIDSECTION

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Service Specifications 5-3

Tiller Steering Handle 5-5

Lower Engine Cover 5-9

Driveshaft Housing 5-10

Stern and Swivel Brackets 5-16

SECTION 5

GENERAL PRECAUTIONS

Before performing any service work on the midsection, read and understand the Service Safety section at the beginning of this manual.

Replace locking fasteners when their locking feature becomes weak. Use only factory replacement parts.

When using compressed air to clean ordry parts, make sure air supply is regulated not to exceed 25 psi [172 kPa / 1.76 kg/cm^2].

Always inspect and test the start-in-gear prevention system before returning engine to customer.

Most service work on the midsection requires preliminary steps to remove major components. Follow all applicable procedures in other sections when indicated.

Use threadlockers and follow torque specifications as indicated to ensure shock-absorbing components remain secure after returning the engine to service.

SERVICE SPECIFICATIONS

Special Torque Values

Description	Torque in-lb (ft-lb) N·m kg-m				Thread locker
	Model				
	40 / 50	60 / 70	80 / 90	115 / 120 / 140	
Engine Mounting Bolt	(14 - 15) 19 - 21 1.9 - 2.1	(14 - 15) 19 - 21 1.9 - 2.1	(17 - 19) 24 - 26 2.4 - 2.6	(25 - 30) 34 - 41 3.4 - 4.1	—
Bracket Bolt Nut (Tilt Tube Nut)	(17 - 19) 24 - 26 2.4 - 2.6	(17 - 19) 24 - 26 2.4 - 2.6	(17 - 19) 24 - 26 2.4 - 2.6	(17 - 19) 24 - 26 2.4 - 2.6	—
Rubber Mount Bolt - Upper	(18 - 25) 25 - 34 2.5 - 3.4	(29 - 43) 39 - 59 3.9 - 5.9	(29 - 43) 39 - 59 3.9 - 5.9	(27 - 30) 37 - 41 3.7 - 4.1	Loctite 242
Rubber Mount Bolt - Lower	(25 - 33) 34 - 44 3.4 - 4.4	(25 - 33) 34 - 44 3.4 - 4.4	(22 - 25) 29 - 34 2.9 - 3.4	(22 - 25) 29 - 34 2.9 - 3.4	Loctite 243
Gearcase Mounting Bolt	(14 - 15) 19 - 21 1.9 - 2.1	M8: (17 - 19) 24 - 26 2.4 - 2.6 M10: (27 - 30) 37 - 41 3.7 - 4.1	M8: (17 - 19) 24 - 26 2.4 - 2.6 M10: (27 - 30) 37 - 41 3.7 - 4.1	M8: (17 - 19) 24 - 26 2.4 - 2.6 M10: (27 - 30) 37 - 41 3.7 - 4.1	Loctite 242
Shift Lever Shaft Holder Bolt	—	52 - 69 6 - 8 0.6 - 0.8	52 - 69 6 - 8 0.6 - 0.8	52 - 69 6 - 8 0.6 - 0.8	
Handle B (to Steering Shaft) Bolt	—	(17 - 19) 24 - 26 2.4 - 2.6	(17 - 19) 24 - 26 2.4 - 2.6	—	

Refer to Section 2 for Standard Torque Values chart.

Manufacturer Special Tools Required

Shackle, 353-01512-0 (for powerhead removal only, if necessary)

General Equipment Required

Torque Wrench, 0 - 150 in-lb [0 - 17 N·m / 0 - 1.7kg-m]
Torque Wrench, 0 - 750 ft-lb [0 - 1000 N·m / 0 - 100 kg-m]
Dial Gauge, minimum scale 0.0001 in [0.01 mm]

SECTION 5

Consumable Supplies Required

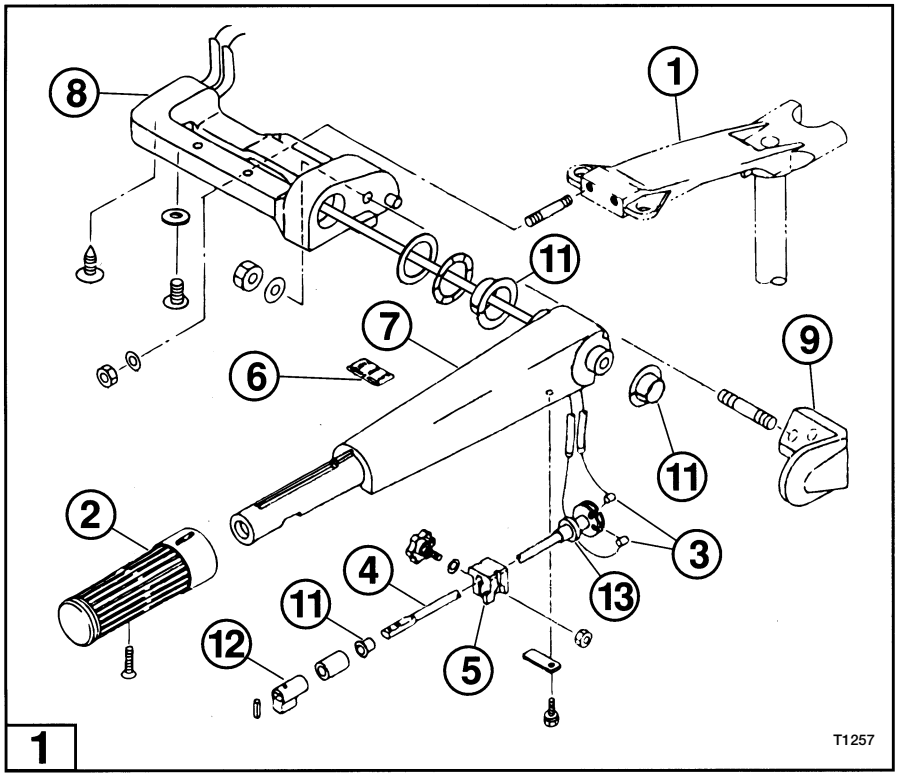
Threadlocker, *Loctite® 242*
Threadlocker, *Loctite® 243*
Gasket Dressing, *Permate® Hylomai® Aerosol High-Temp Gasket Dressing*
Silicone Sealant, *Permatex® Hi-Temp RTV Silicone Gasket*
Super Bond Adhesive, *Permatex® Super Glue Gel*
Cleaning Pads, *Scotch-Brite® Abrasive Pads*
Isopropyl Alcohol
Cleaning Solvent
Gasket Remover
Genuine Grease or Equivalent Friction Surface Marine Grease

TILLER STEERING HANDLE

NOTE

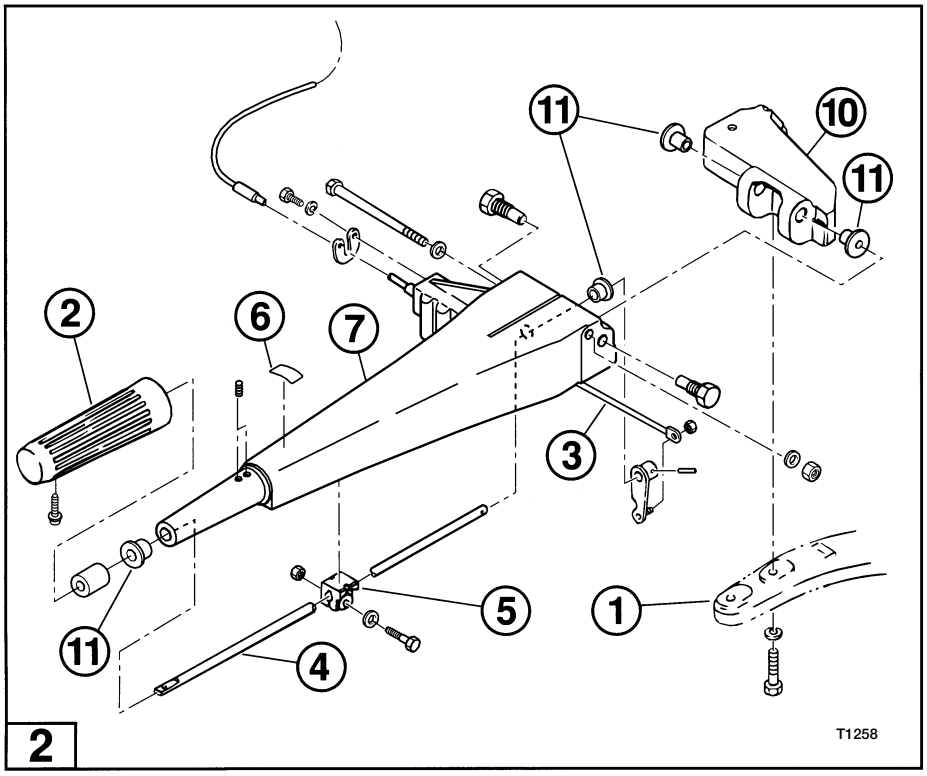
Reference the following illustrations for all procedures.

Models 40 and 50



1

Models 60 / 70 / 80 / 90



2

Removal

1. Disconnect throttle cables from advancer arm and remove cables from lower engine cover.

1 2 2. Remove the tiller steering assembly from steering shaft **(1)** and place on bench for disassembly.

Disassembly

1 2 1. Remove grip **(2)**.

1 2 2. Disconnect throttle cables **(3)** from throttle shaft **(4)**. Remove the throttle shaft.

1 2 3. Fully disassemble all remaining components as illustrated.

Cleaning and Inspection

All worn, damaged, or missing parts must be replaced.

1. Wipe off all excess grease from components. Thoroughly clean individual parts with mild solvent or isopropyl alcohol.

2. Dry all parts with low pressure compressed air.

1 2 3. Inspect all plastic and rubber bushings and spacers, grip **(2)**, and friction piece **(5)** for cracks or deformation caused by wear.

4. Check all fasteners for thread damage, all washers for deformation.

1 2 5. Replace throttle label **(6)** if damaged or missing.

1 2 6. Verify the following components and their friction surfaces are not cracked, bent, or worn:

- Steering handle **(7)**.
- Steering bracket **(8)** and holder **(9)** or handle B **(10)**.

1 2 7. Inspect throttle cables **(3)** for kinks, wear, cracks in the protective covering, and excessive stretch.

Assembly

1 2

NOTE

*Apply genuine grease or equivalent friction surface marine grease to bushings **(11)**, spacer **(12)**, throttle shaft roller **(13)**, and the grip portion of steering handle **(7)** before assembly. DO NOT lubricate friction piece **(5)**.*

1. Apply spray lubricant to the throttle cables. Work the cables back and forth to ensure full coverage under the protective covering.

1 2 2. Assemble all components onto throttle shaft **(4)** and connect throttle cables **(3)** to throttle shaft as required. Route opposite end of throttle cables through steering handle **(7)**.

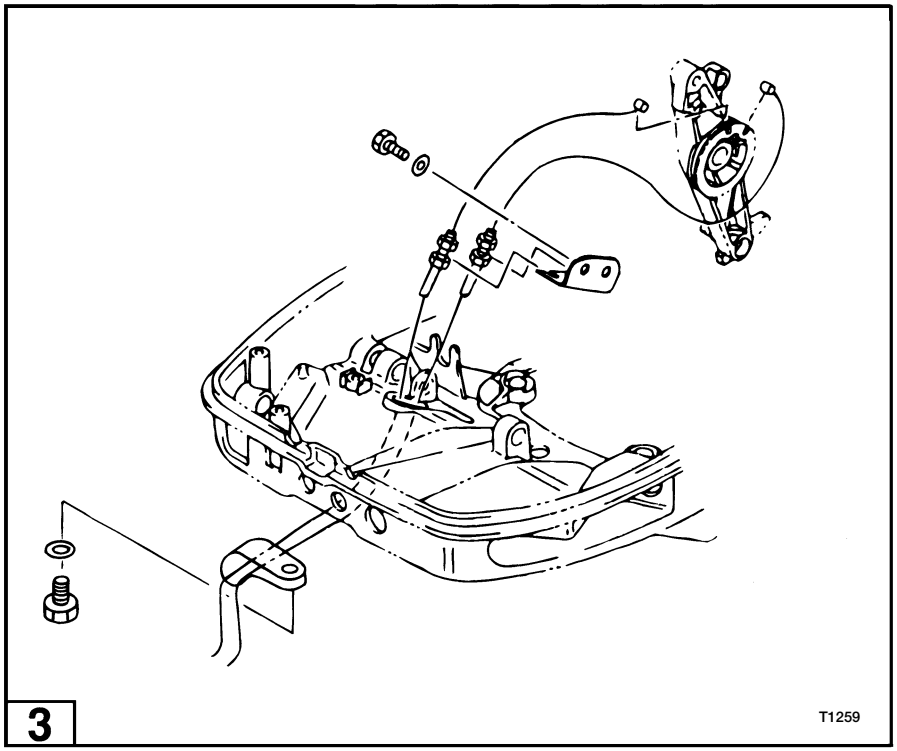
3. Install throttle shaft in steering handle.

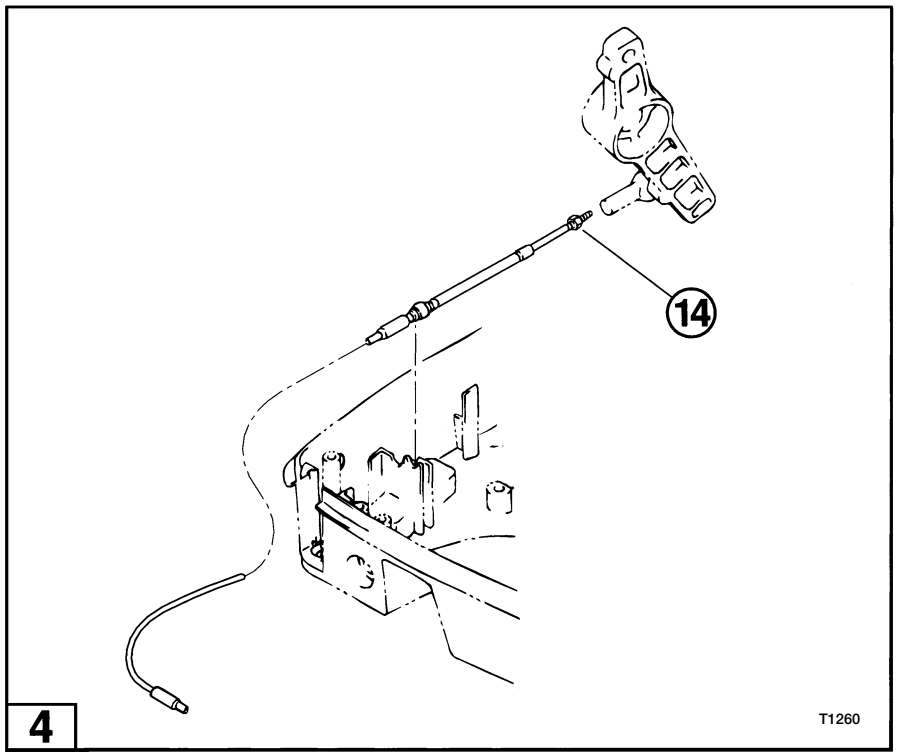
1 2 4. Install grip **(2)**.

1 2 5. Fully assemble all remaining components as illustrated.

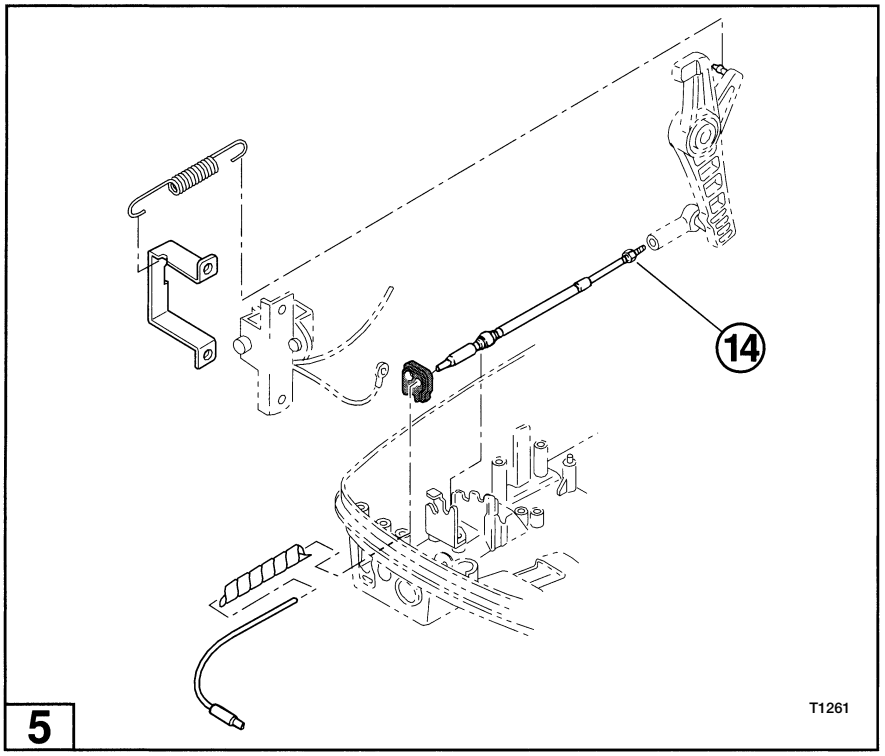
Installation

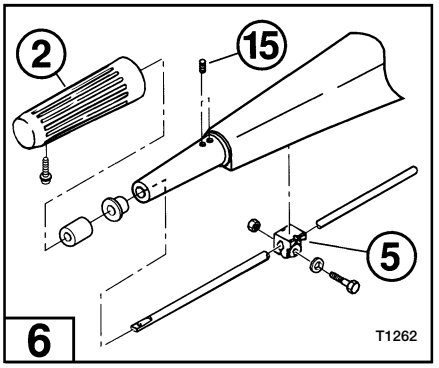
1 2 1. Install the tiller steering assembly onto steering shaft **(1)**. Torque handle B bolt to specification (models 60, 70, 80, and 90).

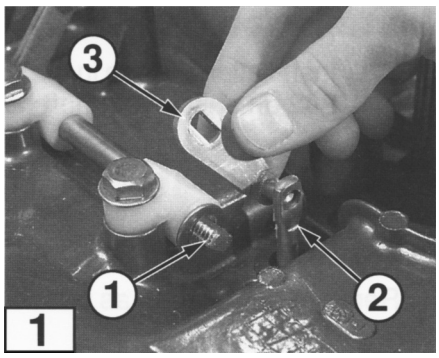




3 4 5 2. Route throttle cables through lower engine cover, clamp in place, and connect cables to advancer arm.



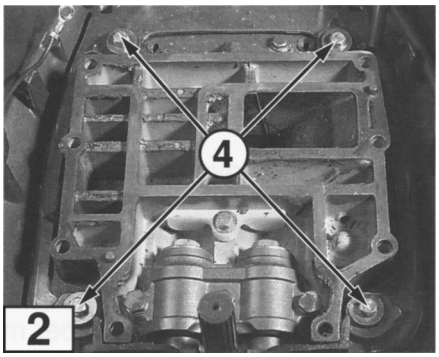




T1263

4 5 6 3. Adjust the throttle cable length at adjusting nut **(14)** so grip **(2)** contacts stop screw **(15)** when the grip is in the fully open position (models 60, 70, 80 and 90). Return grip to fully closed position and confirm sufficient freeplay between grip and stop screw.

6 4. Adjust throttle friction piece **(5)** by tightening or loosening the bolt to obtain proper grip turning resistance.



T1264

LOWER ENGINE COVER

Removal

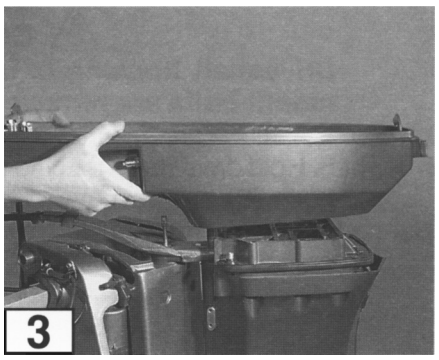
1. Remove powerhead as described in Section 4.

2. Remove control cables and electrical leads as required from lower engine cover.

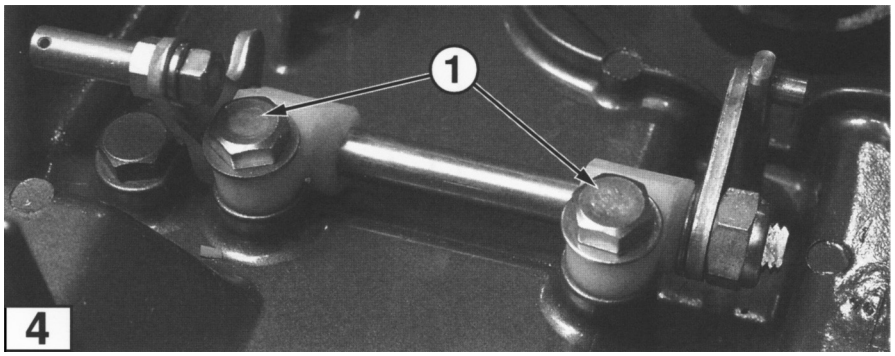
1 3. Remove nut or clip from shift lever shaft **(1)**. Disconnect shift rod **(2)** from shift rod lever **(3)**.

2 4. Remove lower engine cover bolts **(4)**.

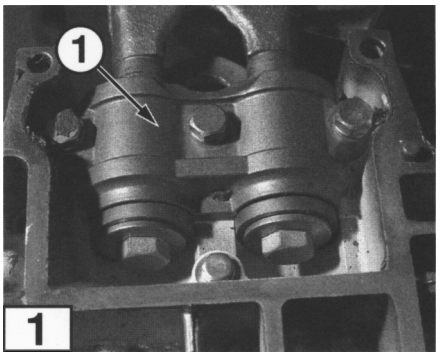
3 5. Lift cover off engine base.



T1265



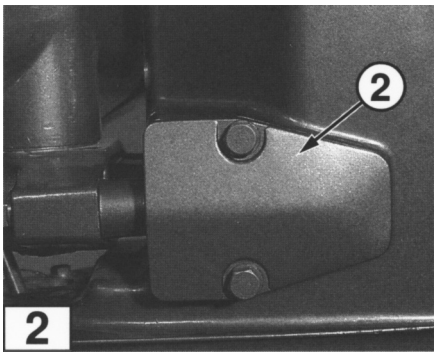
T1336



T1266

Installation

4 Installation is done in the reverse order of Removal. Use Loctite 242 on shift lever shaft holder bolts **(1)** if removed.



T1267

DRIVESHAFT HOUSING

Removal

1. Remove powerhead as described in Section 4.

2. Remove tiller steering handle if equipped, this section.

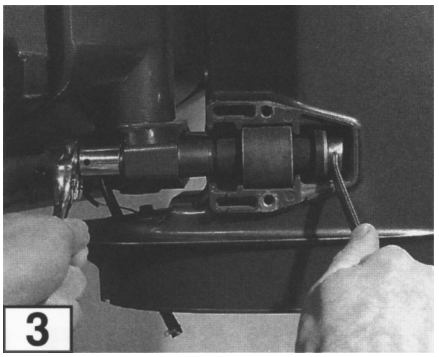
3. Remove lower engine cover, this section.

4. Remove gearcase as described in Section 6.

1 5. Remove upper rubber mount cap **(1)**.

2 6. Remove lower rubber mount cap **(2)**.

3 7. With driveshaft housing tilted fully down, remove the nut from each lower rubber mount bolt. Do not remove the bolts.

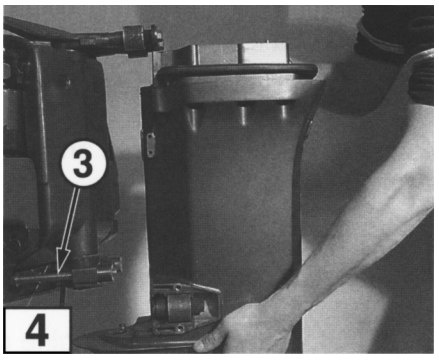


T1268

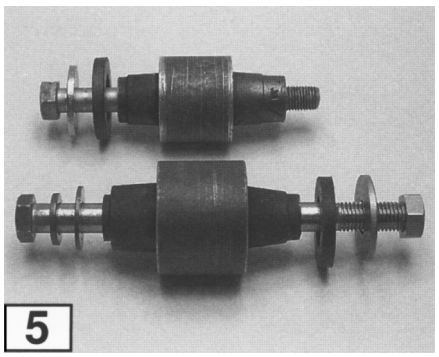
⚠ CAUTION

Driveshaft housing is free to fall if lower rubber mount bolts are removed.

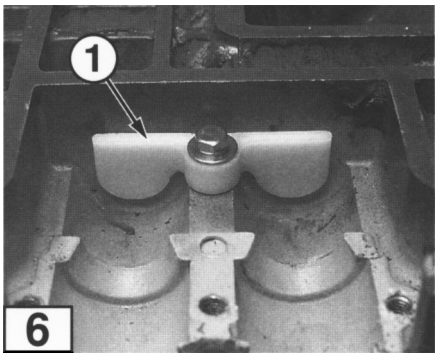
4 8. Hold driveshaft housing securely. Pull out lower rubber mount bolts **(3)** and remove driveshaft housing. Place housing on bench for disassembly.



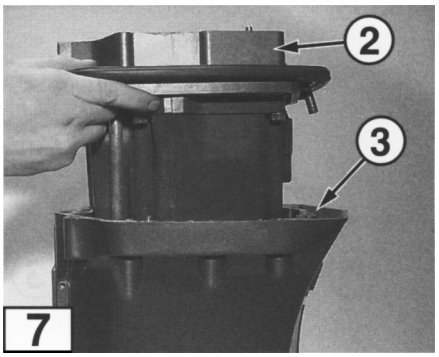
T1269



T1270



T1271



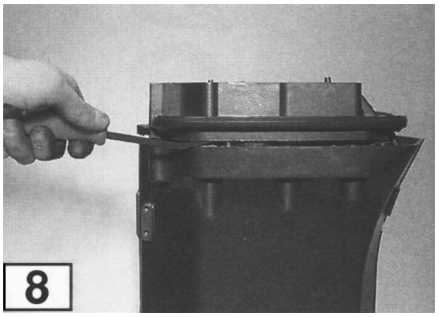
T1272

Disassembly

5 1. Remove and disassemble the upper and lower rubber mounts.

6 2. Remove upper rubber mount damper **(1)** if equipped, from engine base.

7 3. Remove bolts securing engine base **(2)** to driveshaft housing **(3)**. Use rubber mallet to break seal between base and housing. Lift base section from driveshaft housing.



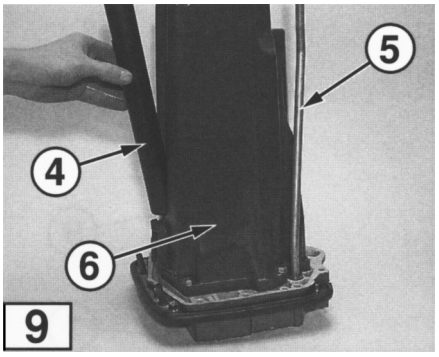
T1273

8

⚠ CAUTION

Engine base and driveshaft housing are aligned with dowel pins and may be difficult to separate. Avoid damage to the mating surfaces and gently pry sections apart if necessary.

9 4. Remove reverse gas passage **(4)** and water pipe **(5)**. Remove mounting bolts and lift exhaust housing **(6)** off engine base.

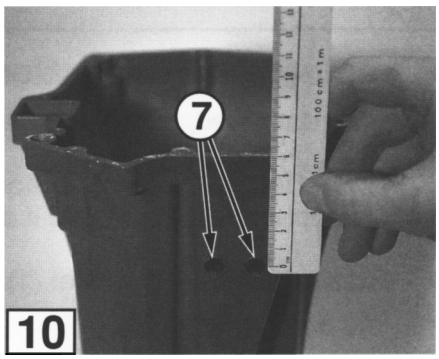


T1274

10

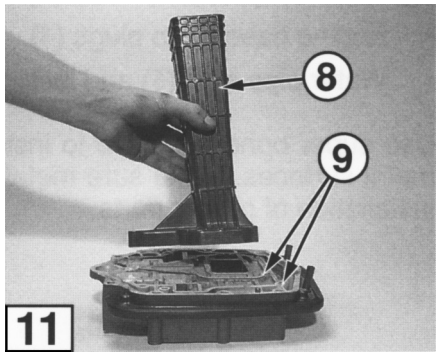
NOTE

*On model 90, verify two pre-drilled holes **(7)** exist in the exhaust housing on side opposite the reverse gas passage. If not, drill two #10 (10 mm) holes at the location shown. Measure the drill holes at center, 60 mm from top of exhaust housing and 20 mm apart.*

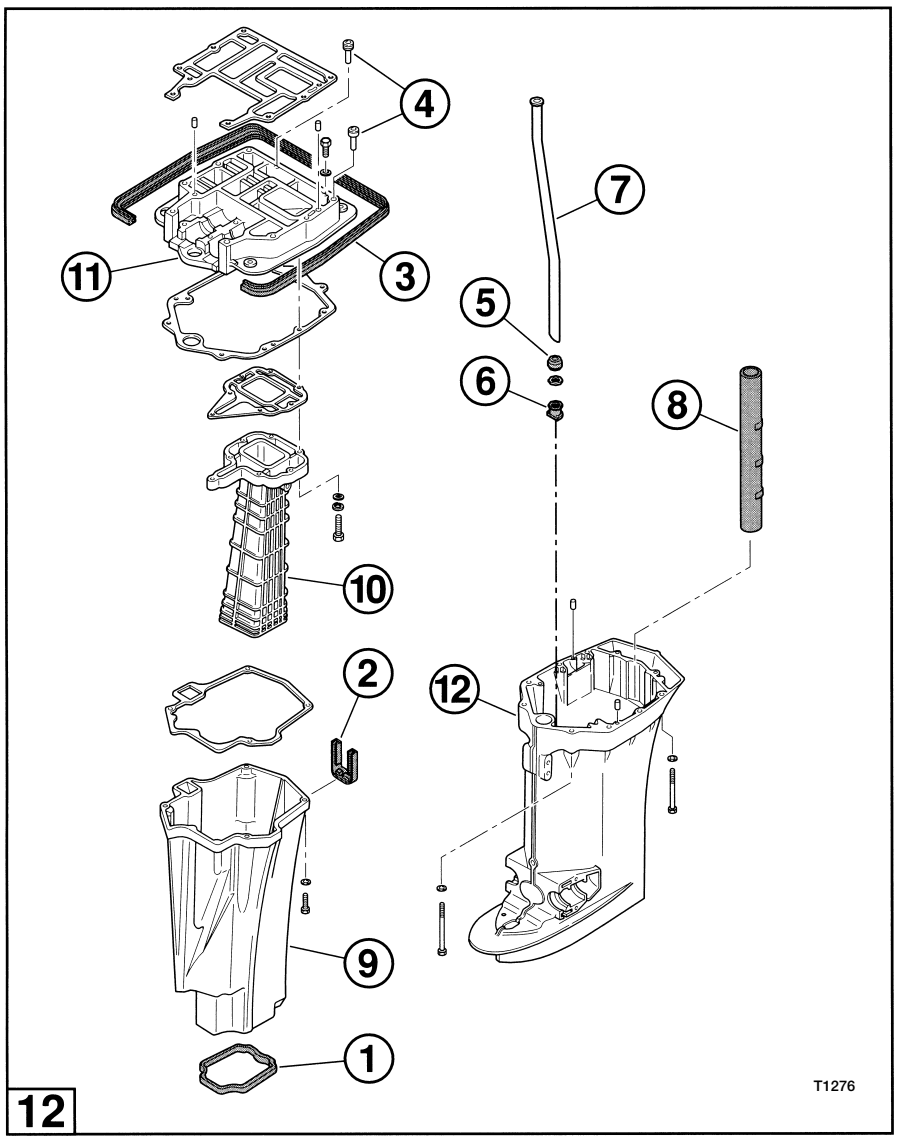


T1314

11 5. Remove exhaust pipe **(8)** and discard gaskets **(9)**.



T1275



Cleaning and Inspection

All worn, damaged, or missing parts must be replaced.

12 1. Before cleaning, examine the following rubber parts as applicable and remove if damaged, dry, or brittle:

- Exhaust housing grommet **(1)**.
- Idle port grommet **(2)**.
- Lower engine coverseal **(3)**.
- Engine base drain plugs **(4)**.
- Water pipe seal **(5)** and locking rubber **(6)**.

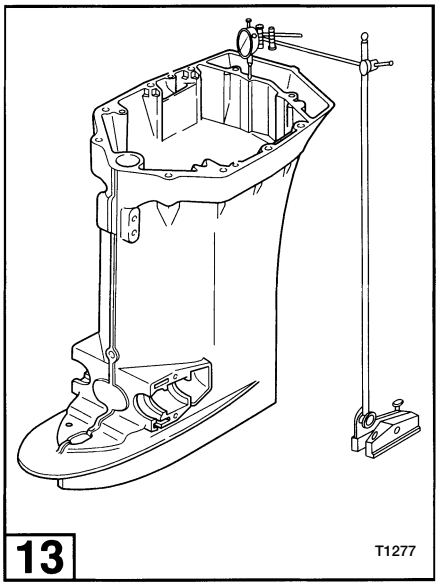
Use super bond adhesive to install new rubber parts as needed on metal surfaces. Make sure metal surfaces are clean and dry before installation of rubber parts.

2. Thoroughly clean all parts including fasteners with solvent and dry with low pressure compressed air. Verify all carbon deposits, gasket adhesives, and threadlocker residue have been removed.

12 3. Inspect water pipe **(7)** for kinks or obstruction, reverse gas passage **(8)** for signs of deterioration. Replace as needed.

12 4. Inspect exhaust housing **(9)**, exhaust pipe **(10)**, engine base **(11)**, and driveshaft housing **(12)** for cracks, chips, dents or other damage.

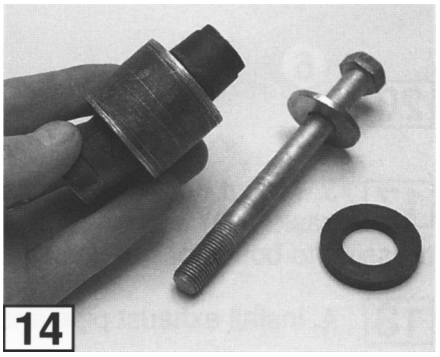
13 5. Check driveshaft housing for distortion. Place housing on a surface plate and use a dial gauge to measure the run-out on the top edge of the housing. The run-out measurement should not exceed 0.009 in [0.228 mm]. If dial gauge and surface plate are not accessible, seek the services of a qualified machine shop.



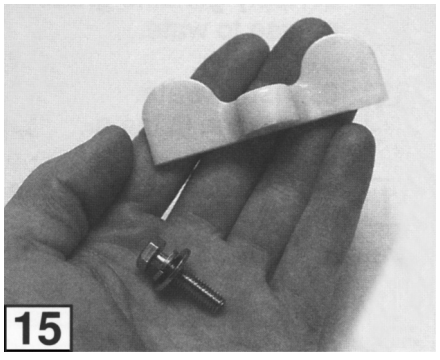
⚠ CAUTION

DO NOT attempt to straighten a distorted driveshaft housing. It must be replaced. A distorted driveshaft housing can cause excessive wear of upper driveshaft splines and will damage the crankshaft splines.

14 6. Examine the upper and lower rubber mount components for damage or signs of deterioration. Replace as needed.



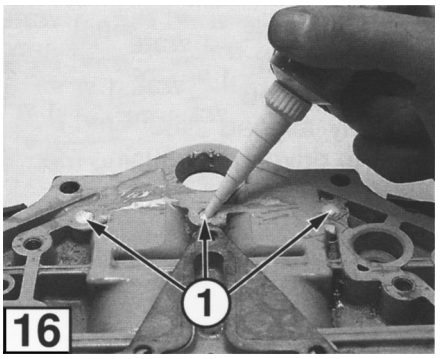
15 7. Inspect the upper rubber mount damper if equipped, for cracks or chips.

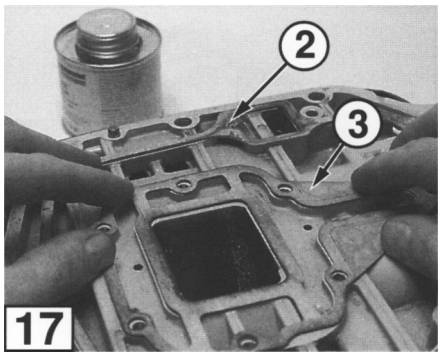


Assembly

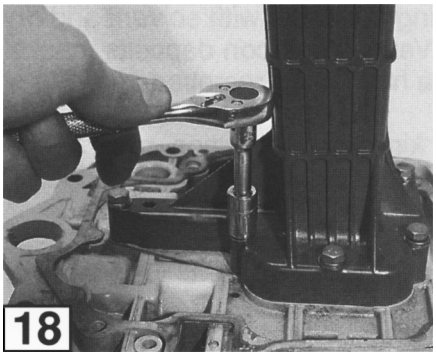
1. Verify all new rubber replacement parts have been installed on components as needed.

16 2. Position engine base with powerhead side facing down. Seal the bottom portion of upper mount cap bolt holes **(1)** with silicone sealant and allow to dry.

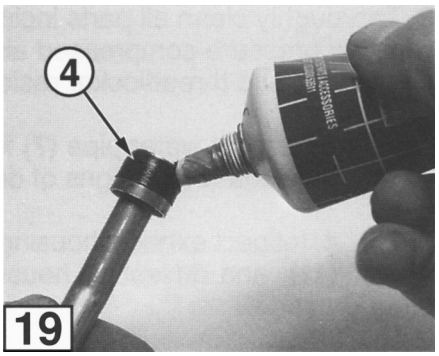




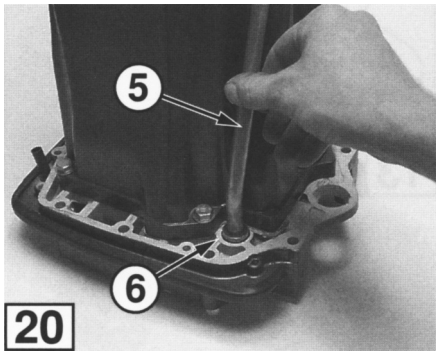
T1281



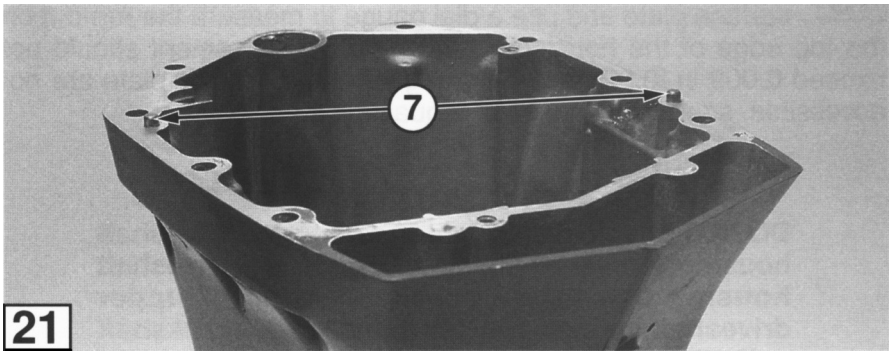
T1282



T1283



T1284



T1285

17 3. Mount new exhaust housing gasket **(2)** and exhaust pipe gasket **(3)** on engine base. Apply high temperature gasket dressing to both sides of gaskets.

18 4. Install exhaust pipe and exhaust housing.

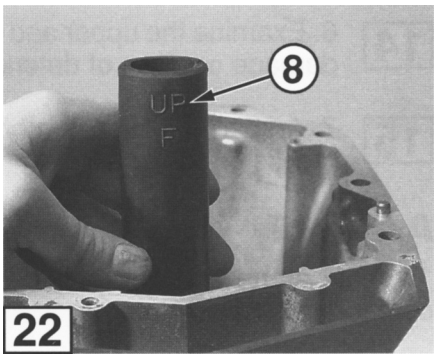
19 5. Apply genuine grease or equivalent friction surface marine grease to water pipe seal **(4)**.

20 6. Install water pipe **(5)** in engine base **(6)** and align for installation in the driveshaft housing.

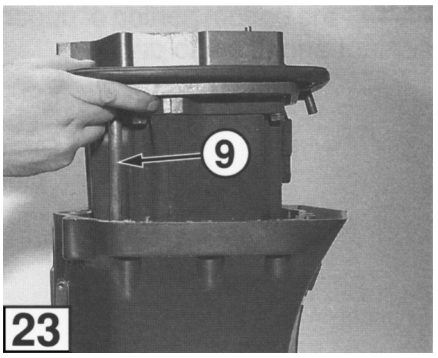
21 7. Verify dowel pins **(7)** are installed in driveshaft housing. Apply high temperature gasket dressing to both sides of new driveshaft housing gasket and install gasket on housing.

22 8. Install reverse gas passage in driveshaft housing so UP mark **(8)** is positioned at powerhead side of housing.

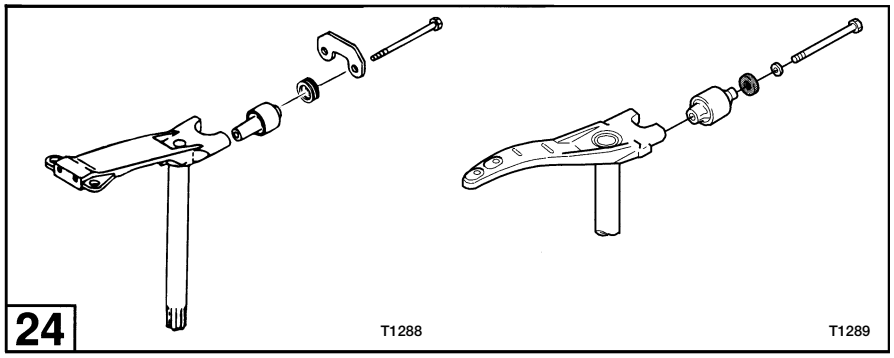
23 9. Verify the water pipe locking rubber is installed in driveshaft housing. Align water pipe **(9)** and lower base section into driveshaft housing. Ensure the driveshaft housing dowel pins are properly aligned and seated in the engine base. Install the engine base to driveshaft housing mounting bolts.

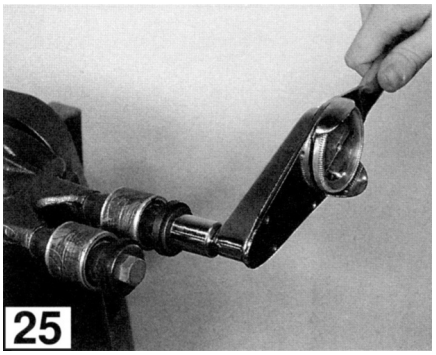


T1286

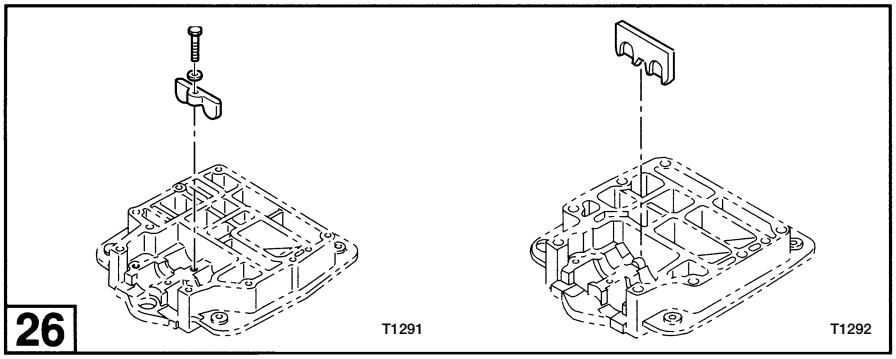


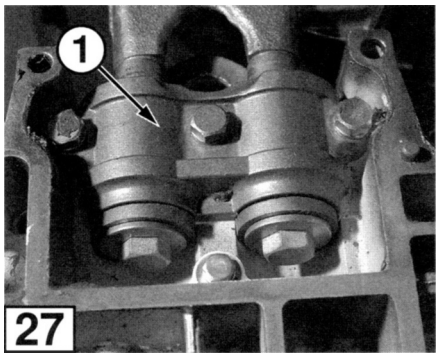
T1287





T1290





T1266

Installation

24 1. Assemble the upper rubber mount components.

25 2. Apply Loctite 242 to bolt threads and install upper rubber mounts on steering shaft. Torque to specification.

26 3. Install the upper rubber mount damper if equipped, in engine base.

27 4. Position driveshaft housing so upper rubber mounts are properly seated in engine base. Install upper mount cap **(1)**.

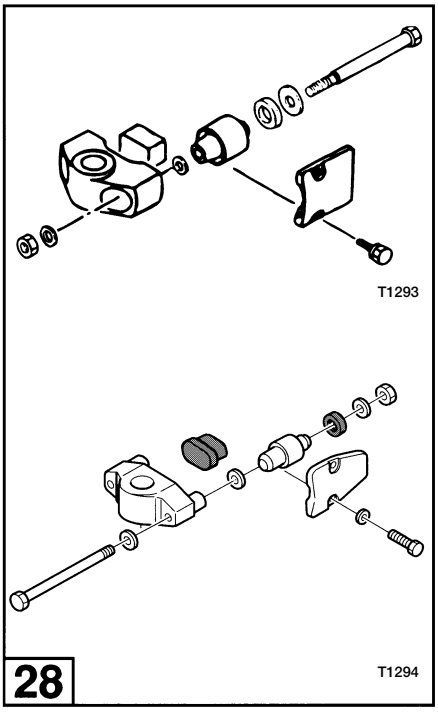
28 5. Install lower rubber mount components. Apply Loctite 243 to bolt threads and torque to specification.

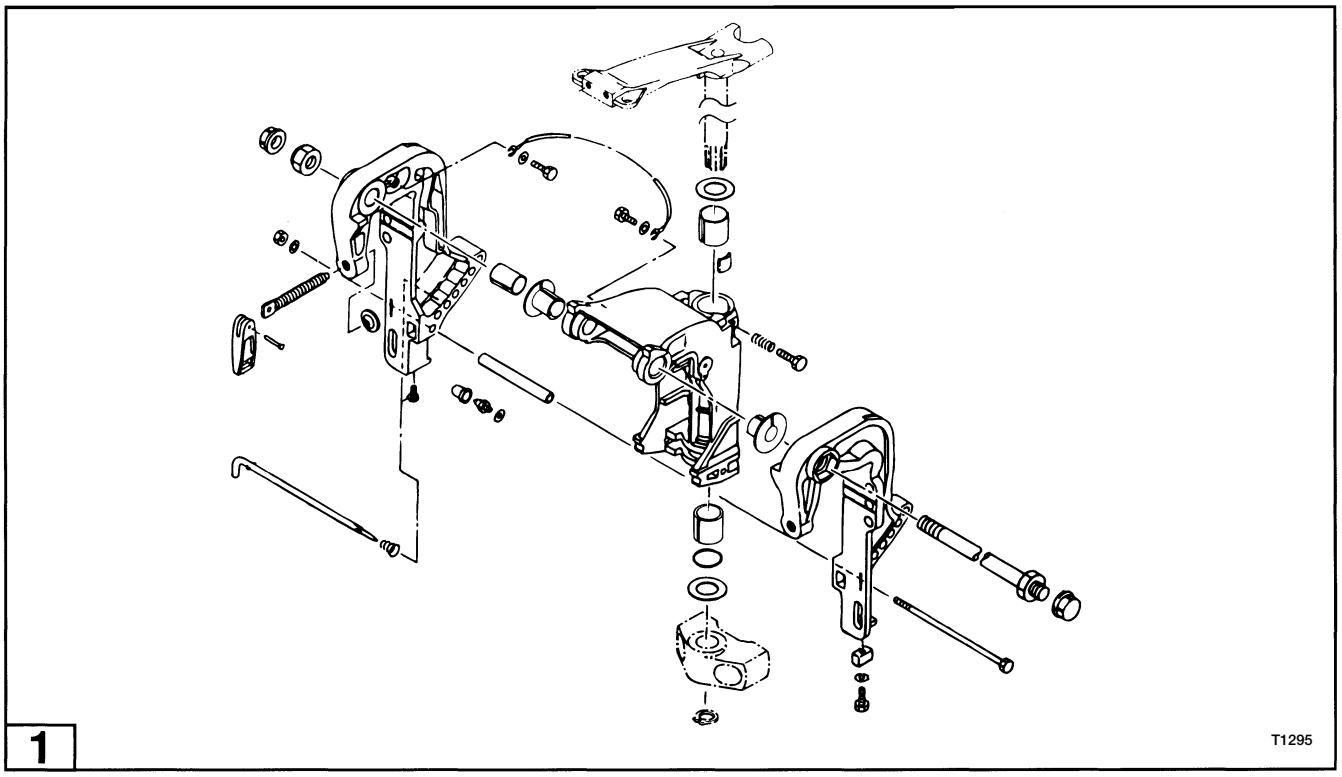
6. Install gearcase as described in Section 6.

7. Install lower engine cover, this section.

8. Install tiller steering handle if equipped, this section.

9. Install powerhead as described in Section 4.





STERN AND SWIVEL BRACKETS

NOTE

The following procedures cover full disassembly of the stern and swivel bracket components with the engine mounted on an engine stand. To service only the stern brackets, suspend engine with adequate hoist and remove and install stern brackets as illustrated. To service only the power trim/tilt unit, see Section 8.

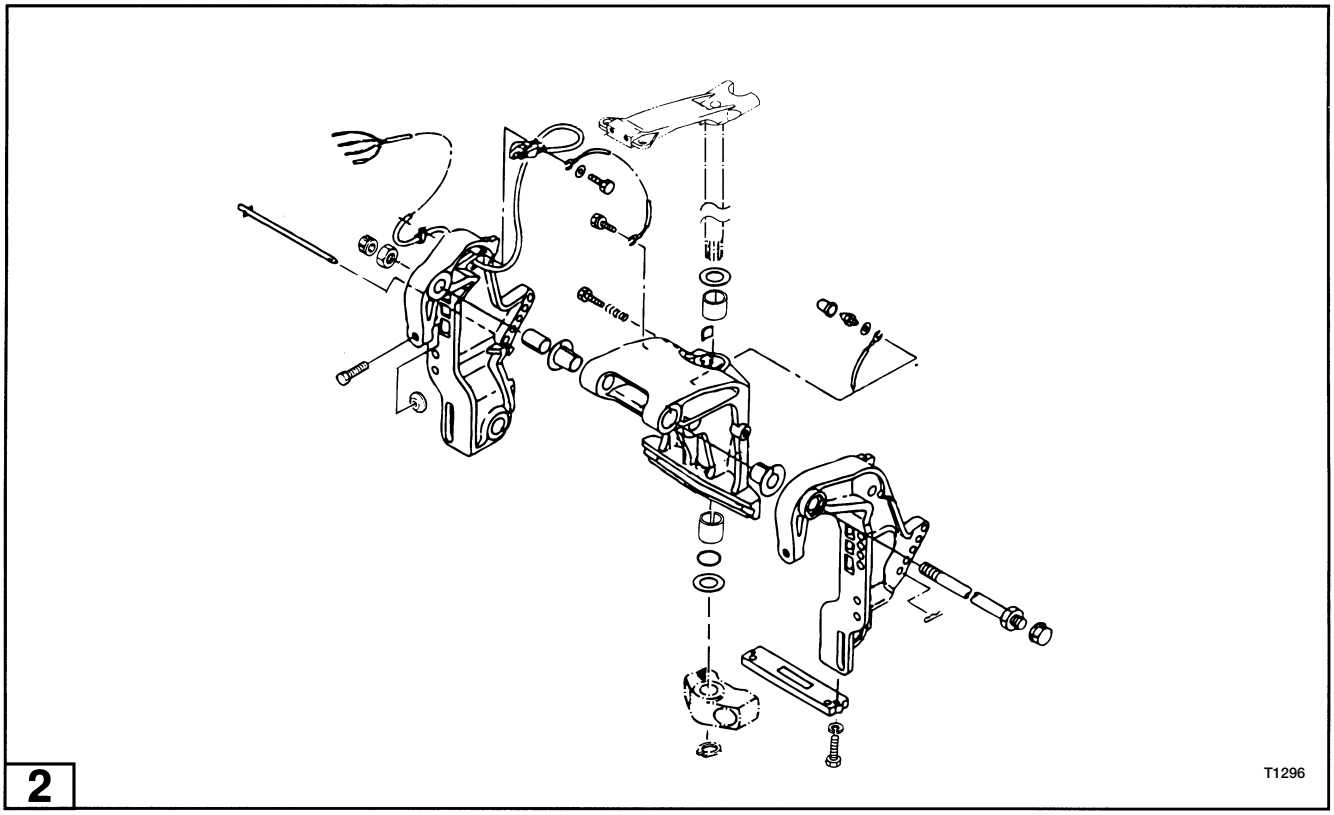
1 **Models 40 and 50 (for Manual Tilt)**

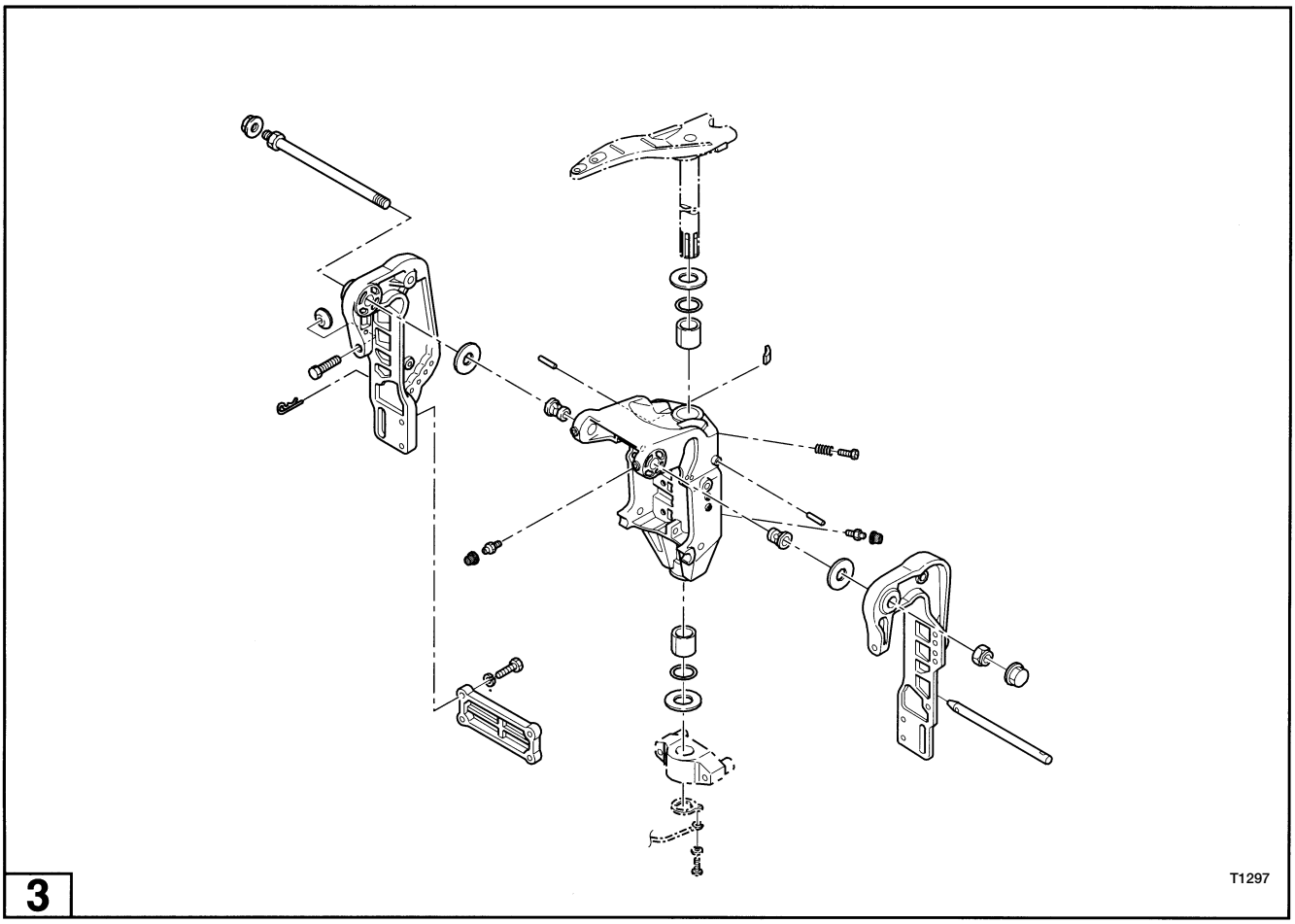
2 **Models 40 and 50 (for Gas Assist Tilt and PT/T)**

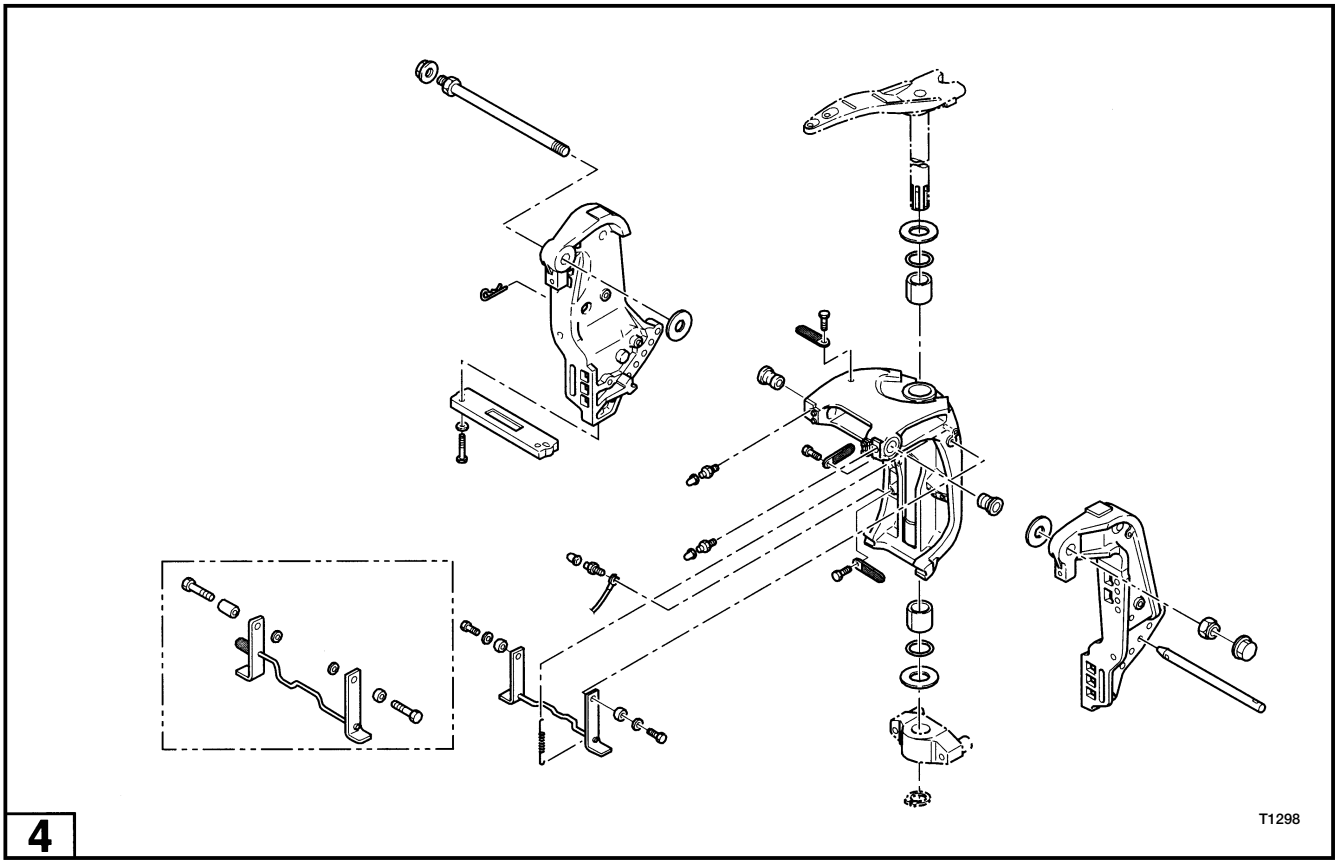
3 **Models 60 and 70 (for Manual Tilt)**

4 **Models 60 / 70 / 80 / 90 (for Gas Assist Tilt and Old PT/T)**
Models 115 / 120 / 140 (for Old PTT)

5 **Models 60 / 70 / 80 / 90 / 115 / 120 / 140 (for New PT/T)**


2
T1296


3
T1297



4

Removal

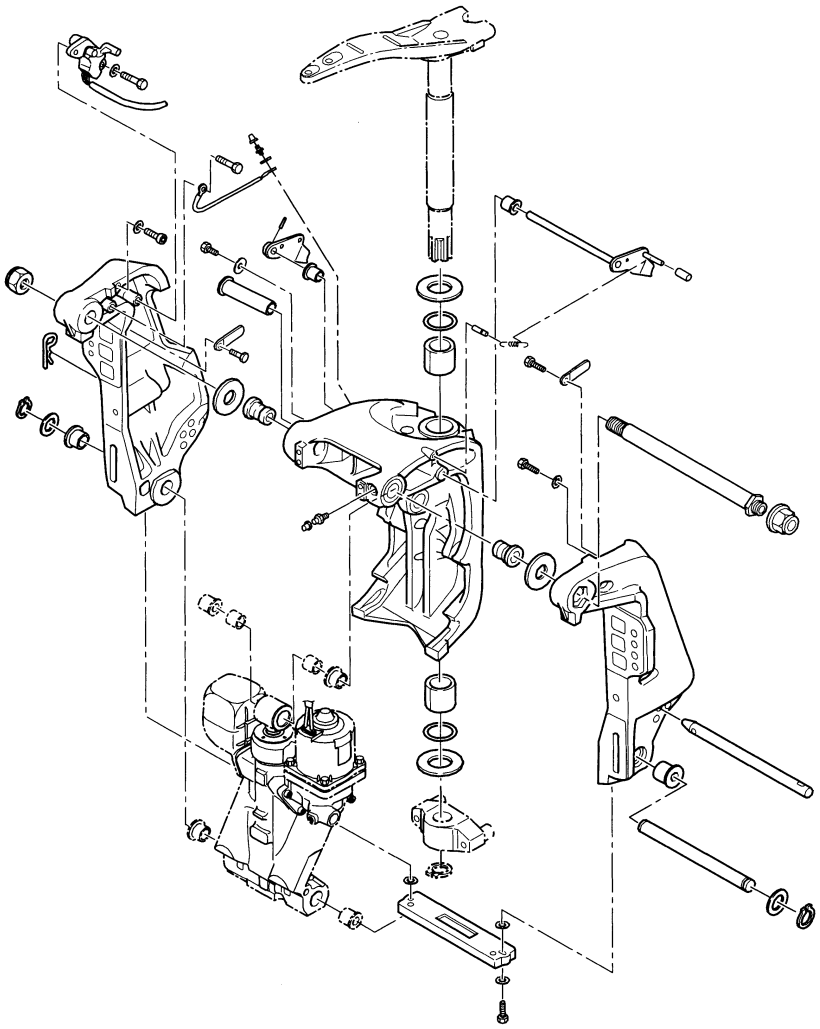
1. Remove powerhead as described in Section 4.

2. Remove tiller steering handle if equipped, this section.

3. Remove lower engine cover, this section.

4. Remove gearcase as described in Section 6.

5. Remove driveshaft housing, this section.



5

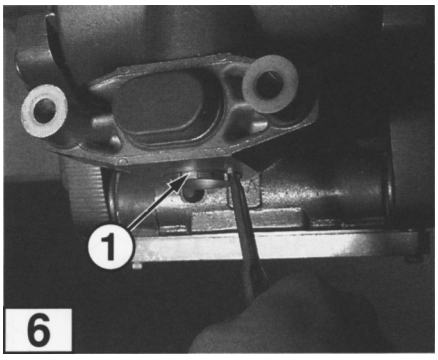
T1299

Disassembly

NOTE

Disconnect all bracket ground wires before disassembly.

6 1. Remove snap ring **(1)** from steering shaft. Discard the snap ring.



T1300

7 2. Pull lower mount bracket **(2)** off steering shaft.

8 3. Lift steering shaft from swivel bracket.

9 4. Remove the bracket bolt nut.

10 5. Remove the bracket bolt, upper cylinder pin **(3)** if equipped, and lift swivel bracket **(4)** from stern brackets.

6. Remove the gas assist cylinder or power trim/tilt unit if equipped. Refer to Section 8 for power trim/tilt removal.

7. Remove the stern brackets from engine stand.

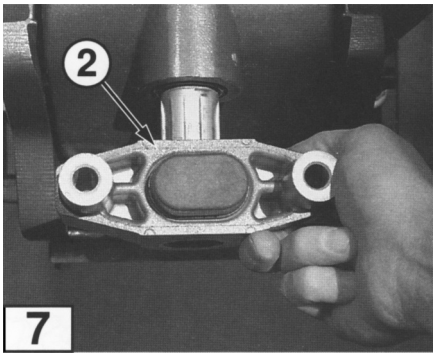
8. If required, fully disassemble and inspect the manual tilt or gas assist tilt components as illustrated. Refer to Section 8 for servicing power trim/tilt.

11 **Models 40 and 50 - Manual Tilt**

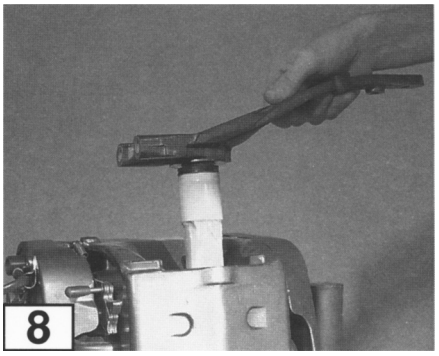
12 **Models 40 and 50 - Gas Assist Tilt**

13 **Models 60 and 70 - Manual Tilt**

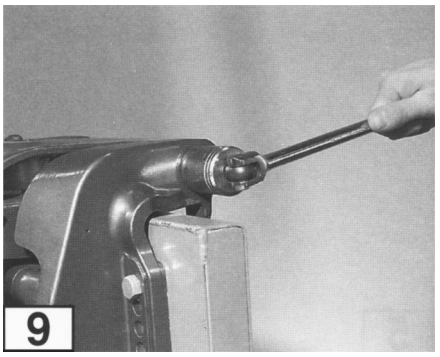
14 **Models 60 / 70 / 80 / 90 - Gas Assist Tilt**



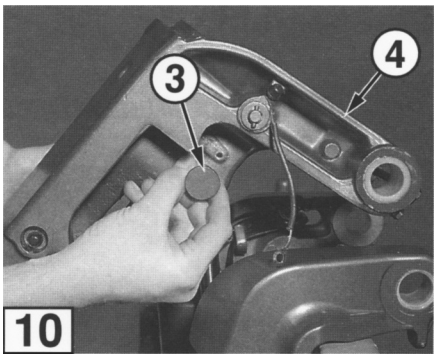
T1301



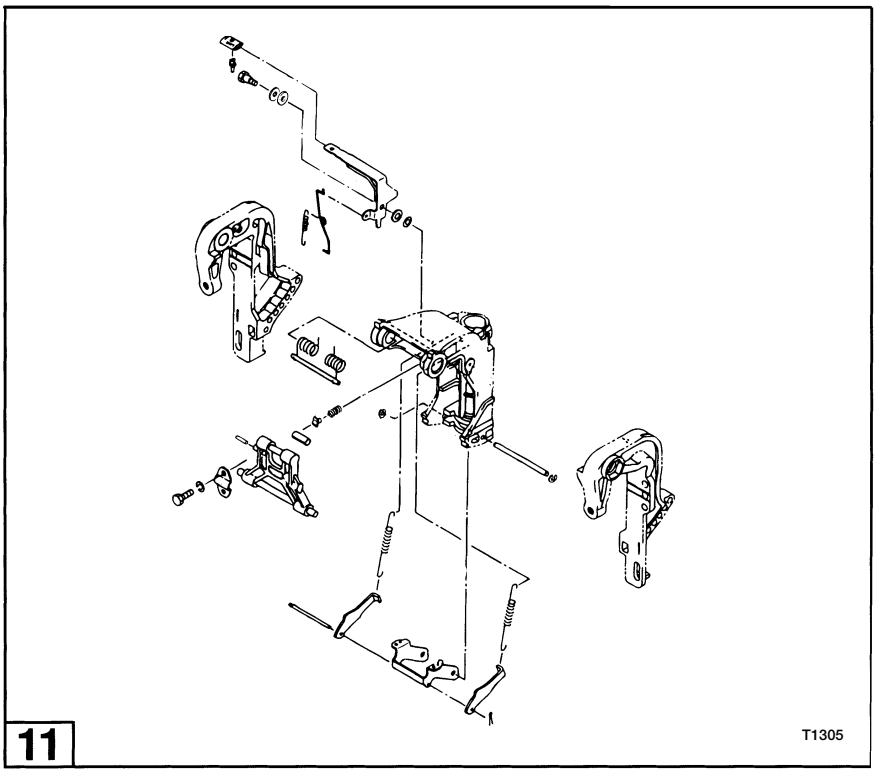
T1302



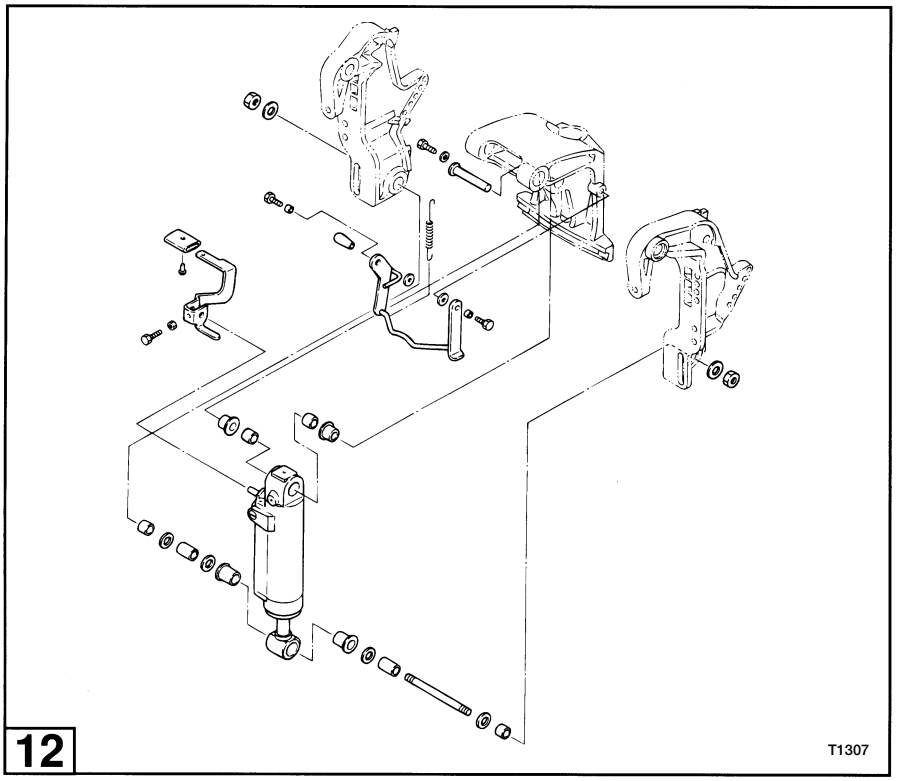
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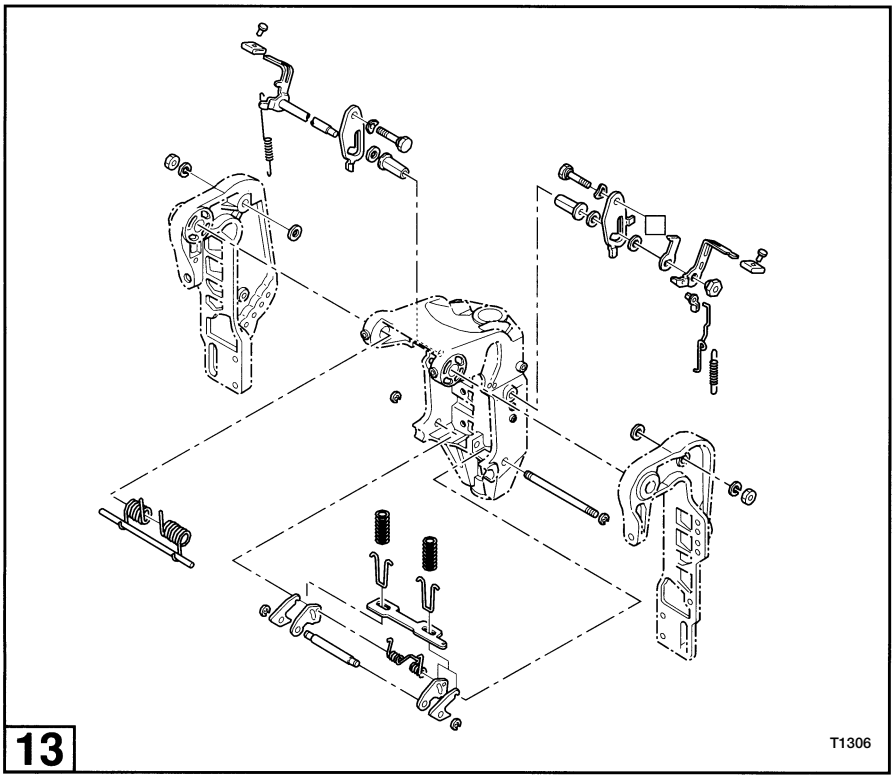


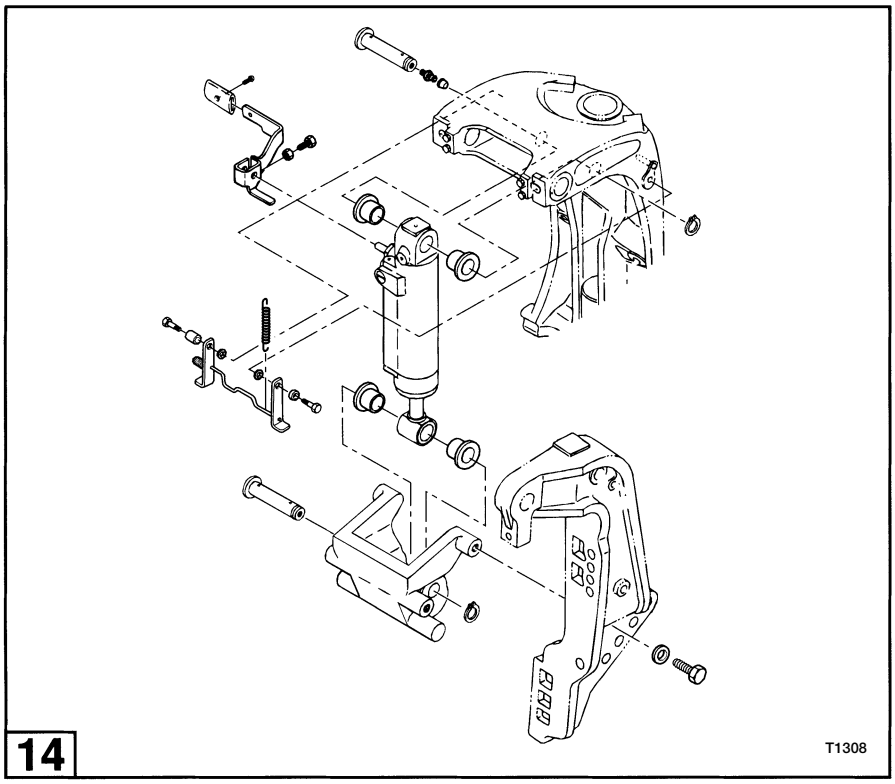
T1304



T1305


12
T1307


13
T1306



Assembly

NOTE

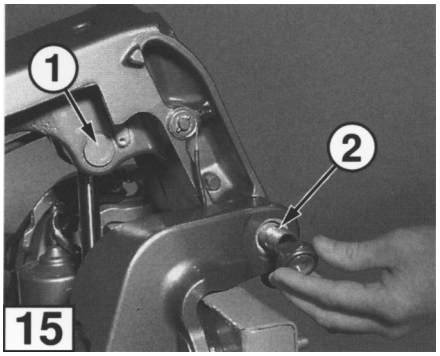
Before proceeding, make sure all components have been thoroughly cleaned with solvent and allowed to dry. Inspect all parts, especially bushings, thrust washers, and upper and lower engine mounts for damage and deterioration. Replace all seals and o-rings.

NOTE

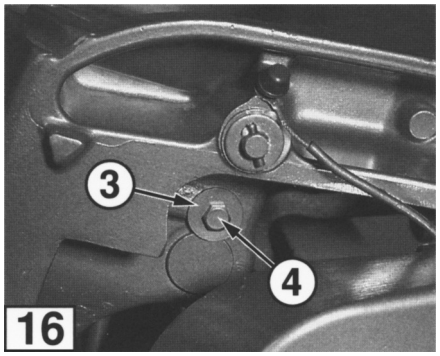
Improper arrangement of bushings and thrust washers may not prevent full assembly of the bracket components. Reference the preceding illustrations to ensure correct orientation of all parts.

NOTE

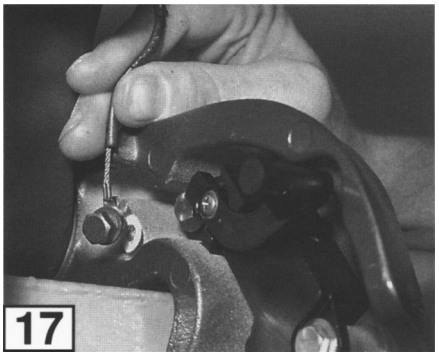
During assembly, apply genuine grease or equivalent friction surface marine grease to all friction parts and surfaces.



T1309



T1310



T1311

1. Mount the stern brackets on engine stand.

2. Fully assemble and install the manual tilt or gas assist tilt components as illustrated in the Disassembly procedure or install the power trim/tilt unit at this time as described in Section 8.

15 3. Place swivel bracket between stern brackets. Install upper cylinder pin **(1)** if equipped, and bracket bolt **(2)**. Torque bracket bolt nut to specification.

16

NOTE

*Upper cylinder pin must be locked in place by washer **(3)** and bolt **(4)** or new snap ring as applicable.*

17 4. Connect bracket ground leads as required.

5. Install steering shaft.

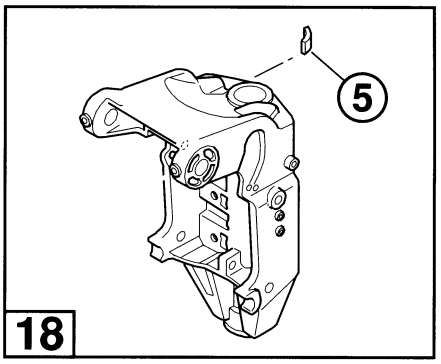
18

NOTE

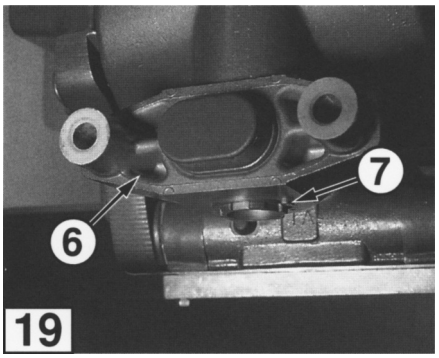
*Note the installation of friction plate **(5)** on manual tilt models.*

19 6. Slide lower mount bracket **(6)** onto steering shaft and install new snap ring **(7)**. DO NOT use old snap ring.

7. Fill all grease fittings. See Lubrication Chart in Section 2.



T1312



T1313

Installation

Installation is done in the reverse order of Removal.

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SECTION 6
GEARCASE

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Gearcase 6-9

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SECTION 6

GENERAL PRECAUTIONS

Before performing any service work on the gearcase, read and understand the Service Safety section at the beginning of this manual.

Full servicing of the gearcase requires manufacturer special tools. Follow all special tool requirements as specified. Substituting special tools with those not provided by the manufacturer may result in severe personal injury, equipment or engine damage, or faulty service work.

Perform bearing removal and installation operations exactly as specified to avoid damage to the bearing or housing during pressing operations.

Replace locking fasteners when their locking feature becomes weak. Use only factory replacement parts.

When using compressed air to clean or dry parts, make sure air supply is regulated not to exceed 25 psi [172 kPa / 1.76 kg/cm^2].

SERVICE SPECIFICATIONS

Special Torque Values

Description	Torque in-lb (ft-lb) N·m kg-m				Thread locker
	Model				
	40 / 50	60 / 70	80 / 90	115 / 120 / 140	
Propeller Nut	(22 - 29) 29 - 39 2.9 - 3.9	(22 - 29) 29 - 39 2.9 - 3.9	(22 - 29) 29 - 39 2.9 - 3.9	(22 - 29) 29 - 39 2.9 - 3.9	
Gearcase Mounting Bolt	(14 - 15) 19 - 21 1.9 - 2.1	M8: (17 - 19) 24 - 26 2.4 - 2.6 M10: (27 - 30) 37 - 41 3.7 - 4.1	M8: (17 - 19) 24 - 26 2.4 - 2.6 M10: (27 - 30) 37 - 41 3.7 - 4.1	M8: (17 - 19) 24 - 26 2.4 - 2.6 M10: (27 - 30) 37 - 41 3.7 - 4.1	Loctite 242

Refer to Section 2 for Standard Torque Values chart.

Manufacturer Special Tools Required

Socket, Bevel Gear B Nut, 345-72232-0, 3B7-72232-0

Wrench, Bevel Gear B Nut, 346-72231-0, 353-72231-0, 3B7-72231-0

Bevel Gear A Bearing Puller Assembly, 3A3-72755-0 , 387-72755-0

Bevel Gear A Bearing Set Tool, 3C8-72719-0, 3B7-72719-0

Shift Rod Joint Puller, 353-72248-0

Spring Pin Tool A, 345-72227-0, 369-72217-0

Spring Pin Tool B, 345-72228-0, 369-72218-0

Bevel Gear A Bearing Outer Race Fitting Tool, 3B7-72731-0

Needle Roller Bearing Puller Kit, 3C8-72700-0, 3B7-72700-0

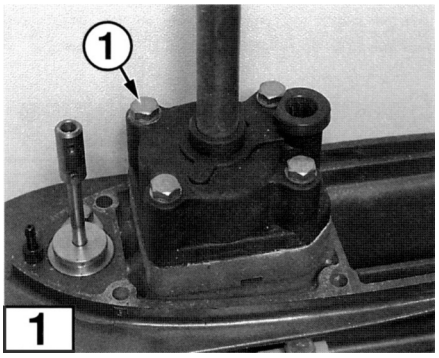
Backlash Measurement Tool Kit, 3C8-72234-0, 3B7-72234-0, 3B7-72255-0

Clutch Pin Snap Tool, 345-72229-0

Needle Bearing Press Kit, 3C7-72900-0

General Equipment Required

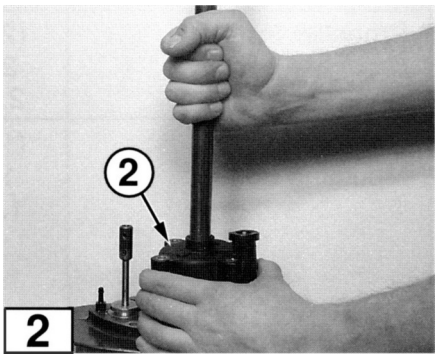
Torque Wrench, 0 - 150 in-lb [0 - 17 N·m/0 - 1.7 kg-m]
Torque Wrench, 0 -750 ft-lb [0 - 1000 N·m/0 - 100 kg-m]
Dial Gauge, minimum scale 0.0001 in [0.01 mm]
Gearcase Pressure Tester, *Stevens® S-34 or equivalent*
Gearcase Vacuum Tester, *Stevens® V-34 or equivalent*
Seal Pullers
Seal Installers
Heat Gun



T1337

Consumables Required

Threadlocker, *Loctite® 242*
Gasket Sealant, *Permatex® High Tack Gasket Sealant*
Anaerobic Gasket Maker, *Loctite® 518*
Silicone Spray Lubricant, *Permatex® Silicone Spray Lubricant*
Genuine Grease or Equivalent Friction Surface Marine Grease
Isopropyl Alcohol
Cleaning Solvent
Engine Lubricant, *Genuine engine oil or NMMA certified TC-W3 oil*
Gear Lubricant, *Genuine gear oil or API grade GL5, SAE #80 - #90*
Cleaning Pads, *Scotch-Brite® Abrasive Pads*
Gasket Remover



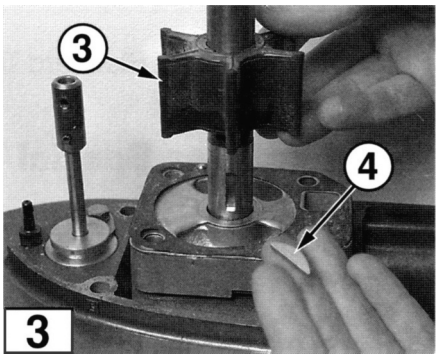
T1338

WATER PUMP

If the gearcase has been in use for any length of time, the water pump should be serviced with a water pump repair kit. Use the following procedures to install the repair kit.

Removal

1. Remove the gearcase. See Gearcase, this section.



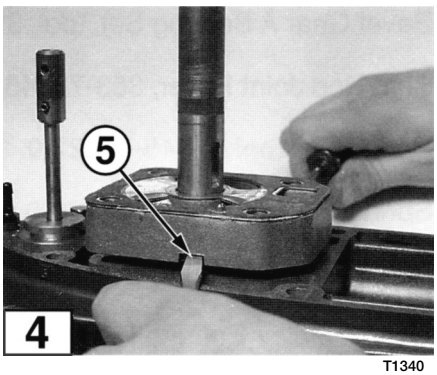
T1339

1 2. Remove water pump mounting bolts **(1)**.

2 3. Hold upper pump case **(2)** securely and rotate driveshaft clockwise to free impeller from upper pump case.

⚠ CAUTION

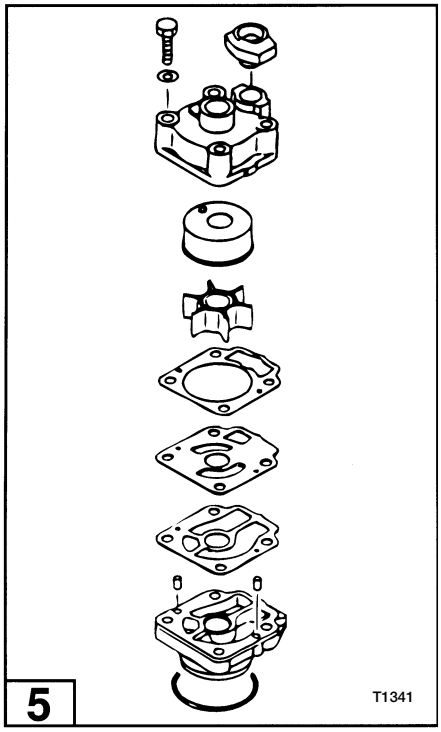
Do not rotate driveshaft counterclockwise. Doing so will bend impeller fins in wrong direction and may weaken or damage the impeller.

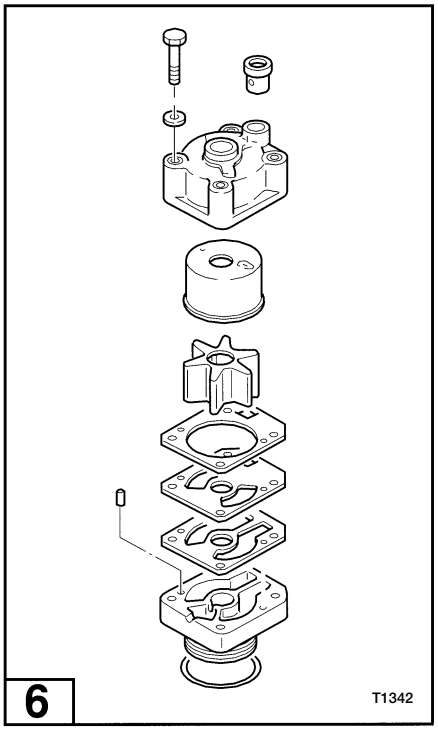


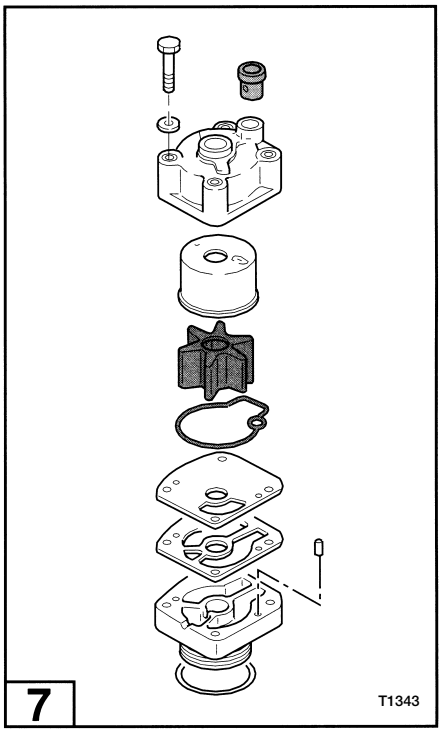
T1340

3 4. Slide upper pump case off driveshaft and remove pump impeller **(3)** and impeller key **(4)**.

4 5. Insert a screwdriver in each lower pump case notch **(5)** and gently pry upward to remove. Slide lower pump case off driveshaft.







Disassembly and Assembly

5 6 7 1. Disassemble the water pump components as illustrated and verify the kit parts match the originals before discarding old parts.

NOTE

Lower pump case dowel pins are difficult to remove and should only be pulled out if replacement is necessary.

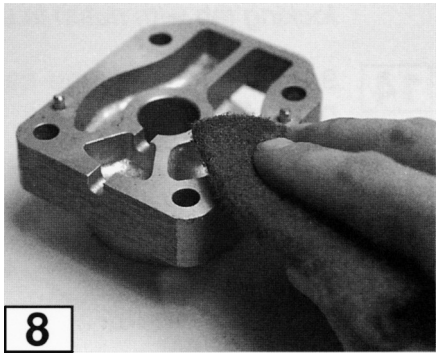
8 2. Remove all gasket residue from lower pump case with abrasive cleaning pads and gasket remover. Do not scrape the gasket surface with metal scraper. Thoroughly clean all components with isopropyl alcohol and dry with low pressure compressed air.

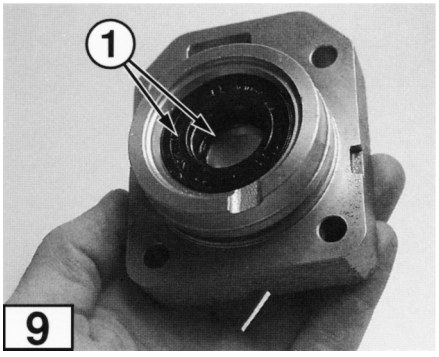
3. Inspect the upper and lower pump cases for signs of cracks. Replace as needed.

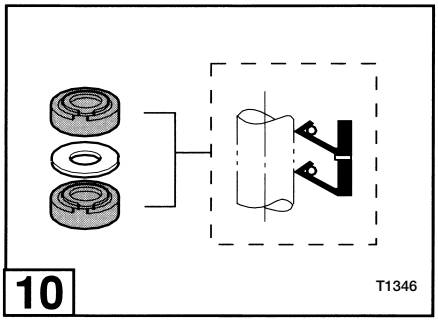
9 4. Examine lower pump case oil seals **(1)** for signs of damage and deterioration.

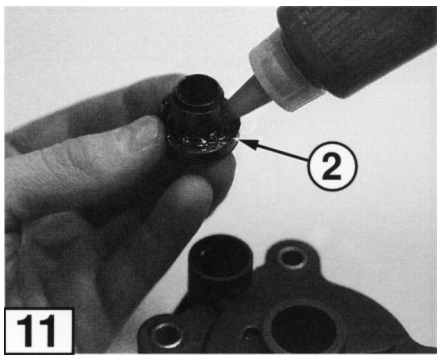
10 **NOTE**

If necessary to replace seals, use appropriate size seal puller and installer to avoid damaging new seals and seating surfaces in lower pump case. Apply silicone spray lubricant to seals and install so lips face direction indicated.

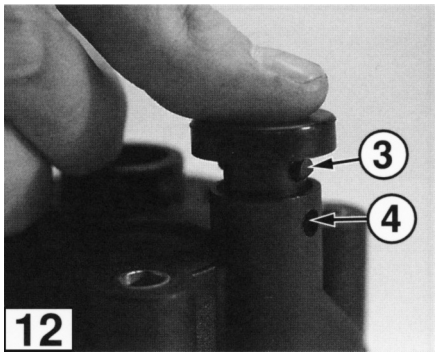




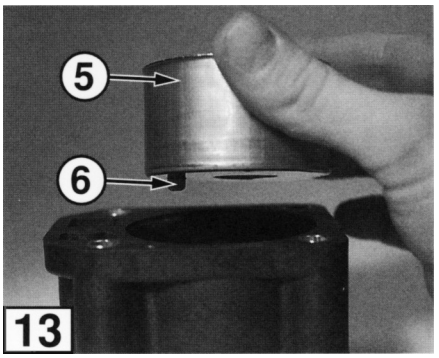




T1347



T1348



T1349

11 5. Apply anaerobic gasket maker to seating surface of water pipe lower seal **(2)**.

12 6. Install seal in upper pump case so locking tabs **(3)** align with holes **(4)**.

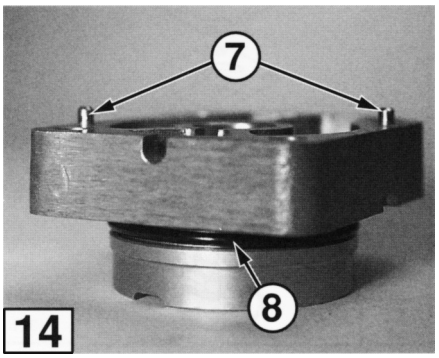
13 7. Slide pump case liner **(5)** partially into upper pump case housing so locking tab **(6)** is aligned with notch in housing.

NOTE

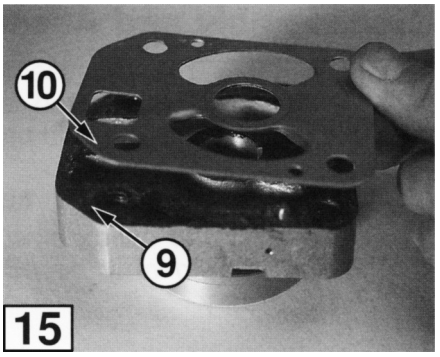
Pump case liner must be flush with flanged surface of upper pump case. If not, remove liner and re-align locking tab with notch in upper pump case housing.

14 9. Install lower pump case dowel pins **(7)** if removed. And install new O-ring **(8)**.

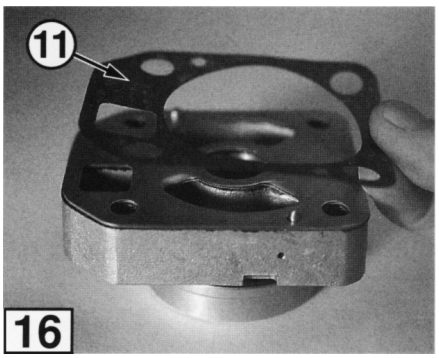
15 10. Apply gasket sealant to both sides of guide plate gasket **(9)**. Mount gasket and guide plate **(10)** on lower pump case.



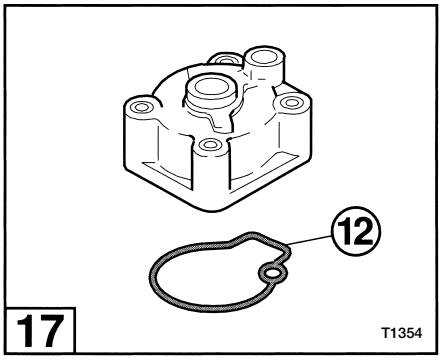
T1351



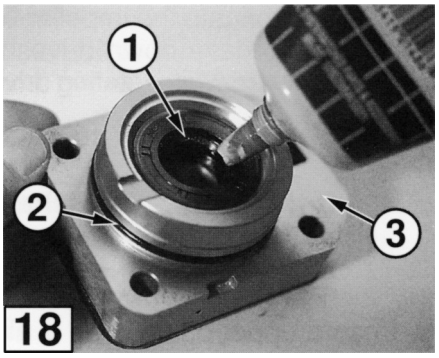
T1352



T1353



T1354



T1355

16 11. Apply gasket sealant to guide plate side of upper pump case gasket **(11)**. Mount gasket on guide plate.

17

NOTE

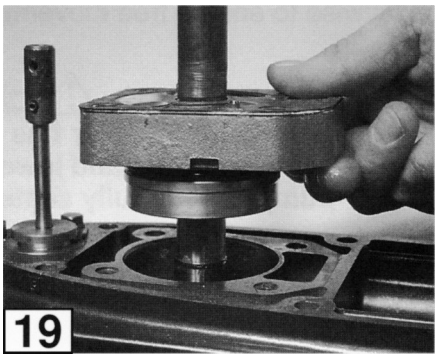
*Models 115, 120, and 140 are equipped with special shaped pump case o-ring seal **(12)** instead of gasket. Apply a thin bead of anaerobic gasket maker in the upper pump case seal groove and install o-ring seal in groove.*

Installation

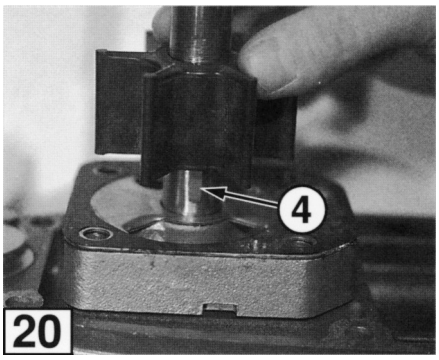
18 1. Apply a light coating of genuine grease or equivalent friction surface marine grease to the oil seal lips **(1)**, and o-ring **(2)**. Apply an aerobic gasket maker to flanged surface **(3)** to provide adequate seal between lower pump case and gearcase.

19 2. Slide lower pump case down driveshaft and seat into position on gearcase.

20 3. Insert impeller key **(4)** in driveshaft and align impeller slot with key. Hold the impeller key in place and push impeller down until seated in position.

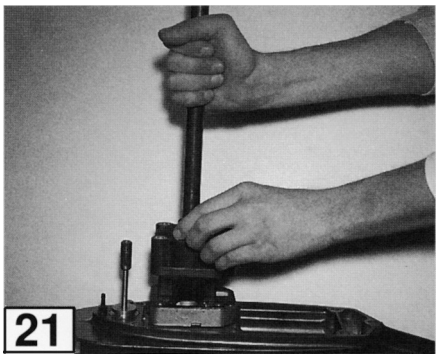


T1356



T1357

21 5. Lubricate the impeller fins with soapy water and slide upper pump case down driveshaft. Hold pump case securely and push downward while rotating driveshaft clockwise to seat the impeller.



T1355

⚠ CAUTION

Do not rotate driveshaft counterclockwise. Doing so will bend impeller fins in wrong direction and may weaken or damage the impeller.

6. Ensure upper pump case is aligned and fully seated on the dowel pins. Hold the upper pump case in position and rotate driveshaft clockwise to ensure free movement.

⚠ CAUTION

Make sure impeller fins are not caught or pinched between upper and lower pump cases when upper pump case is fully seated.

22 7. Apply genuine grease or equivalent friction surface marine grease to neck portion of water pump mounting bolts. Install the bolts.

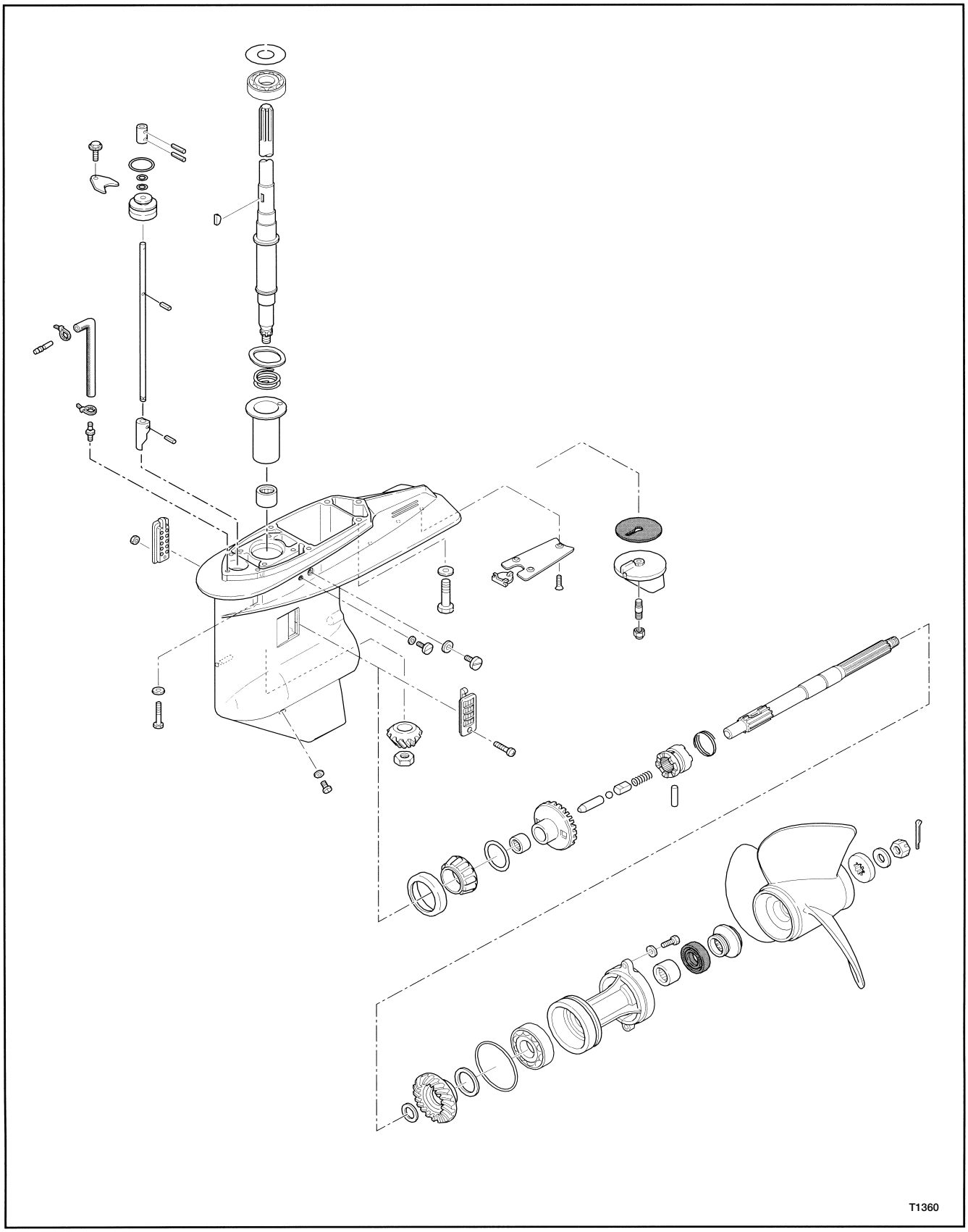


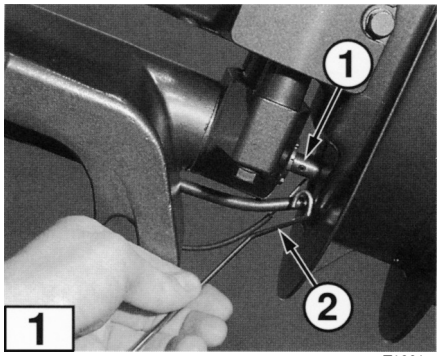
T1356

8. Install the gearcase. See Gearcase, this section.

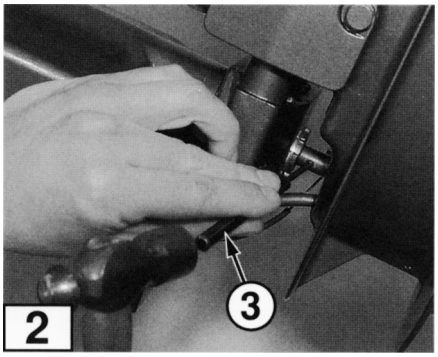
GEARCASE

Typical Gearcase

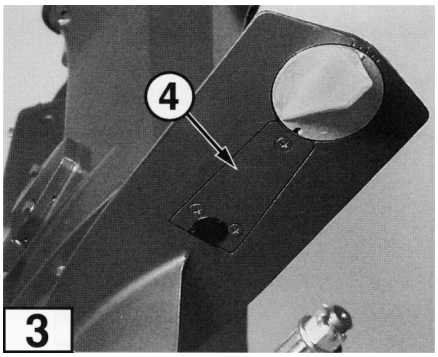




T1361



T1362



T1363

Removal

⚠⚠ WARNING

Ignition system must be disabled to prevent accidental engine start-up during removal of the gearcase.

1 1. Place engine in FORWARD gear so shift rod joint **(1)** is accessible. If necessary, use shift rod joint puller **(2)** (Part No. 353-72248-0) to hook and pull up the shift rod joint.

2 2. Use correct size spring pin tool A **(3)** to remove upper spring pin from shift rod joint. Discard the spring pin.

Description	Part Number	Application
Spring Pin Tool A	345-72227-0	3 mm spring pins
Spring Pin Tool A	369-72217-0	3.5 mm spring pins

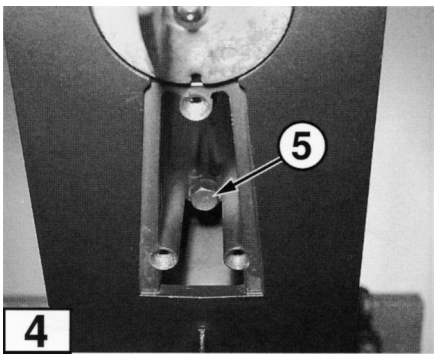
3. Complete the following for models 60, 70, 80, 90, 115, 120, and 140:

3 Remove gearcase plate **(4)** or sub water strainer from underside of cavitation plate.

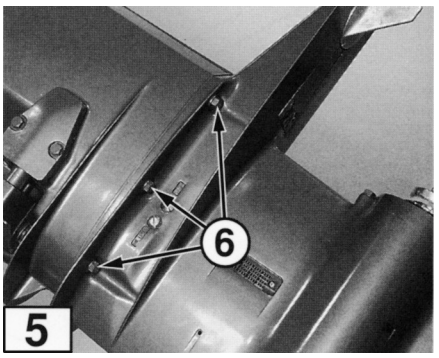
4 Remove internal coupling bolt **(5)**.

5 4. Remove gearcase mounting bolts **(6)** from both sides of gearcase.

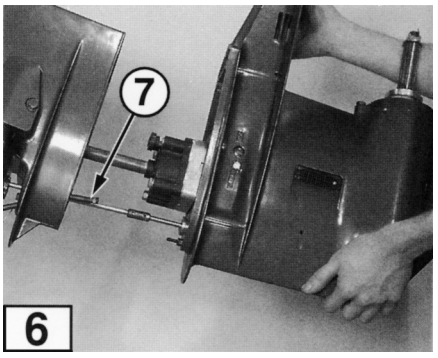
6 5. Separate gearcase from driveshaft housing and disconnect speedometer pickup tube **(7)** if equipped.



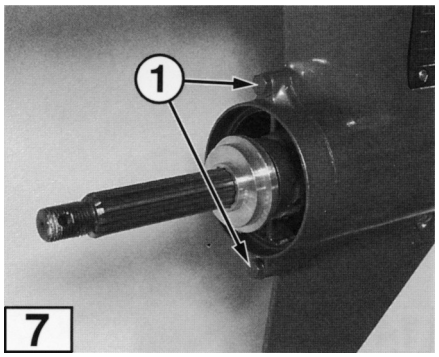
T1364



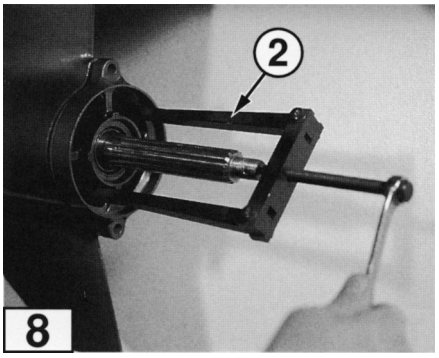
T1365



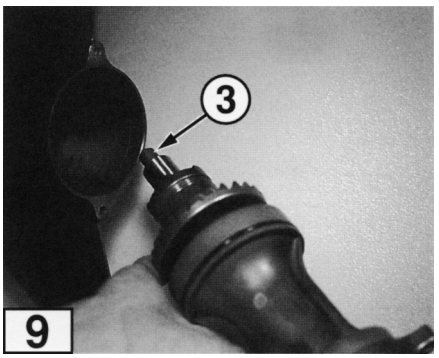
T1366



T1367



T1368



T1369

Disassembly

⚠ CAUTION

Gearcase must be secured in a suitable holding fixture during disassembly.

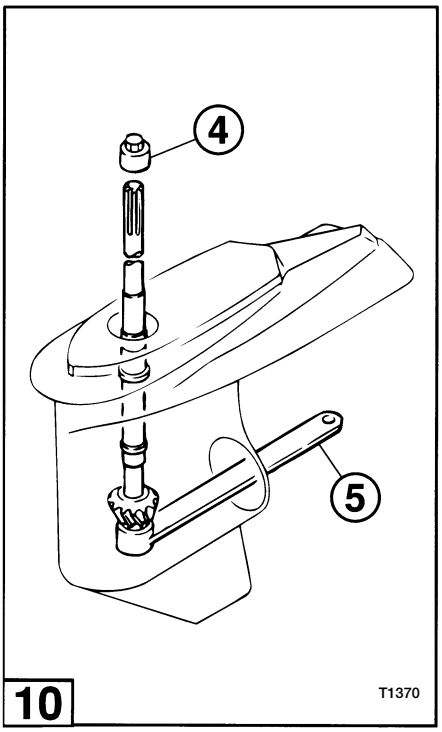
1. Drain all gearcase oil into a container and inspect the oil for metal chips.

NOTE

Small metal fragments may indicate normal wear of gears, bearings, and shafts. Large metal chips usually indicate extensive internal damage. Record your observations for future reference when inspecting internal components.

2. Remove the water pump and install a water pump repair kit if gearcase has been in service for any length of time. See Water Pump, this section.

3. Remove propeller mounting hardware and propeller.



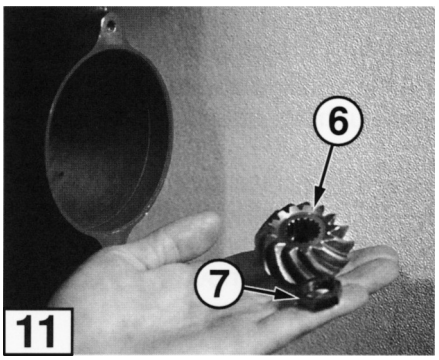
T1370

7 4. Remove propeller shaft housing bolts **(1)**.

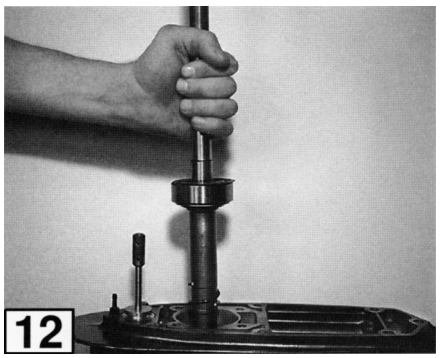
8 5. Install propeller shaft housing puller **(2)** (Part No. 353-72252-0). Tighten the pressing bolt until propeller housing separates from gearcase.

9 6. Remove propeller shaft and housing from gearcase. Make sure clutch push rod **(3)** is also removed. Set the assembly aside.

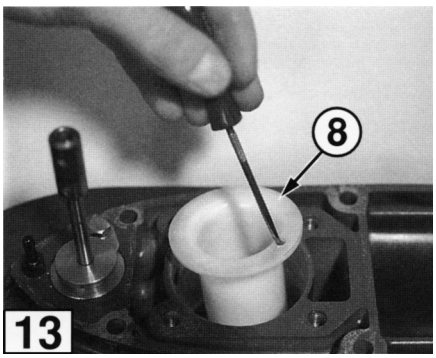
10 11 7. Thoroughly degrease the driveshaft splines and the bevel gear B nut. Install specified socket **(4)** and wrench **(5)**. Hold bevel gear B nut with wrench and turn driveshaft counterclockwise to loosen the nut. Remove bevel gear B **(6)** and nut **(7)** from gearcase.



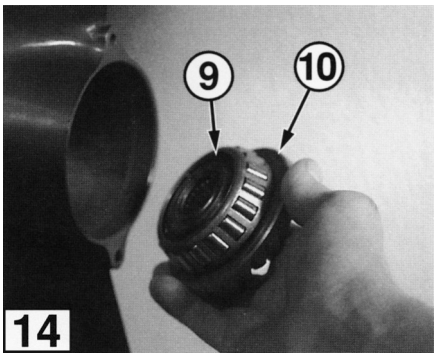
T1371



T1372

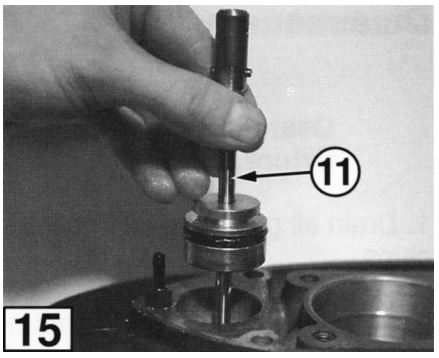


T1373

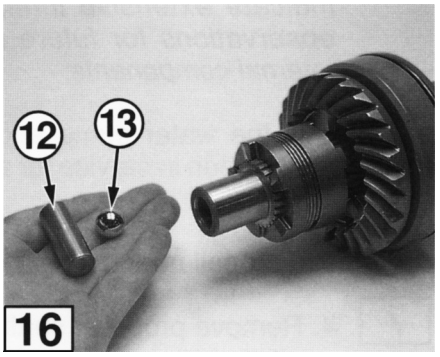


T1374

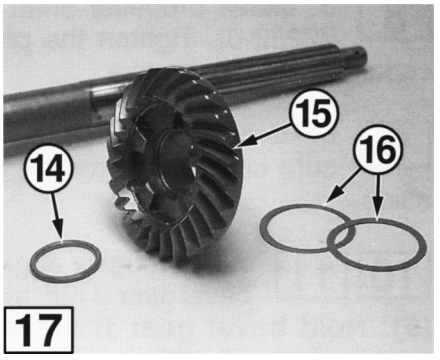
Tool	Part Number	Model
Socket, Bevel Gear B Nut	345-72232-0	40 / 50 / 60B / 70B
Socket, Bevel Gear B Nut	3B7-72232-0	60C / 70C / 80 / 90 115 / 120 / 140
Wrench, Bevel Gear B Nut	346-72231-0	40 / 50
Wrench, Bevel Gear B Nut	353-72231-0	60B / 70B
Wrench, Bevel Gear B Nut	3B7-72231-0	60C / 70C / 80 / 90 115 / 120 / 140



T1375



T1376



T1377

12 8. Lift the driveshaft from the gearcase and set it aside.

13 9. Using a piece of wire or other hooking device, remove driveshaft spring guide **(8)**.

NOTE

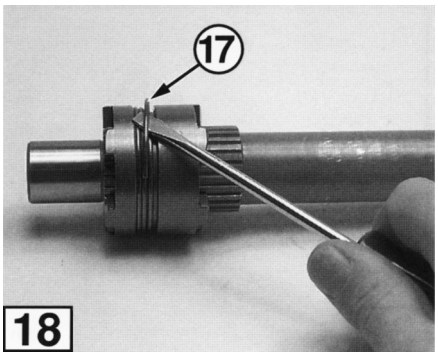
Models 40 and 50 are not equipped with removable driveshaft spring guide.

14 10. Reach inside gearcase and remove roller bearing **(9)** and bevel gear A **(10)**.

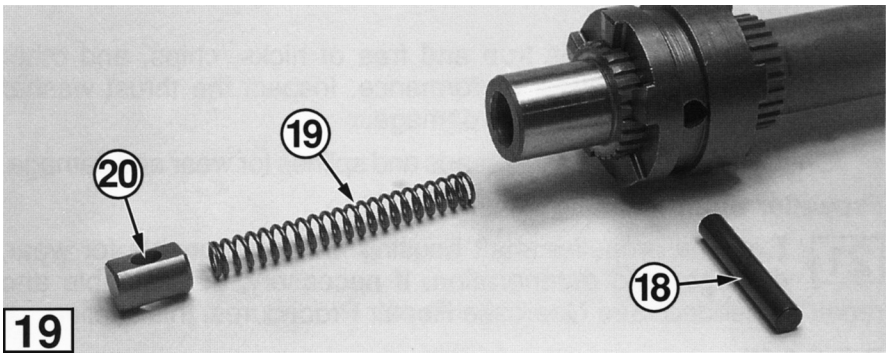
15 11. Remove the stopper and lift cam rod **(11)** from gearcase. Fully disassemble the cam rod components, including the cam rod bushing internal and external o-rings.

16 12. Remove clutch push rod **(12)** and detent ball **(13)** from propeller shaft. Pull propeller shaft out of housing.

17 13. Remove washer **(14)**, bevel gear **(15)**, and all shims **(16)** from propeller shaft.



T1378

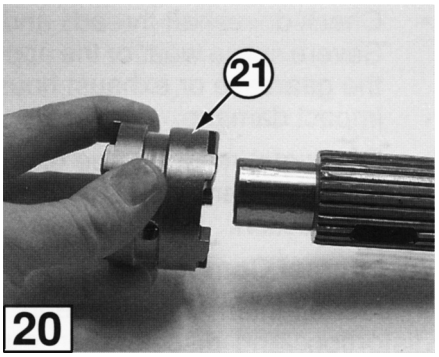


T1379

18 14. Insert screwdriver under one end of clutch pin snap spring **(17)**. Remove spring from groove by unwrapping it from clutch. Discard the spring.

⚠ CAUTION

DO NOT reuse clutch pin snap spring (17), it must be replaced. Reusing clutch pin snap spring may cause severe damage to gears and other components.



T1380

19 15. Place propeller shaft open end against bench surface and push out clutch pin **(18)**. Remove clutch spring **(19)** and spring holder **(20)**.

⚠⚠ WARNING

Wear safety glasses and DO NOT hold open end of propeller shaft towards face or body when removing clutch pin. Clutch spring and spring holder come out with great force.

20 16. Pull clutch **(21)** off propeller shaft.

Cleaning and Inspection

NOTE

All worn, damaged, and missing parts must be replaced.

1. Discard the clutch pin snap spring and all seals and o-rings that have been removed.

2. Clean all gearcase components with solvent and dry with low pressure compressed air. After cleaning, apply specified gear oil to all internal components to prevent rusting.

3. Perform the following inspections:

Gearcase Housing

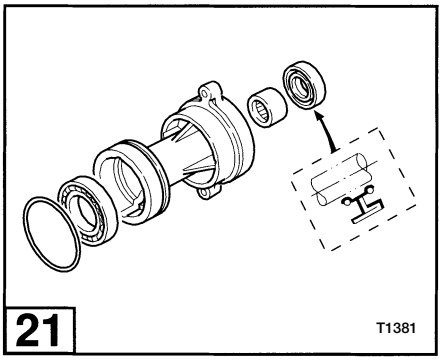
- Inspect internal and external surfaces of housing for cracks and other damage. All threaded holes must be undamaged and free of corrosion and sealing agents.
- Check the sacrificial trim tab for damage and erosion. See Anodes - Inspection and Testing in Section 2.
- Inspect the water intake screens for damage and blockage. If screens cannot be fully cleaned, replace them.

Propeller and Shaft

- Verify the propeller is true and free of nicks, chips, and other damage that will affect performance. Inspect the thrust washer and mounting hardware for damage.
- Check the propeller shaft threads and splines for wear and damage.

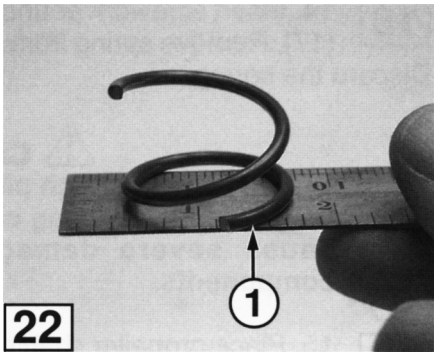
Propeller Shaft Housing

21 Examine propeller shaft housing and components for wear, damage, and deterioration. And repair as needed. See Gearcase Repair Procedures, this section.



Driveshaft

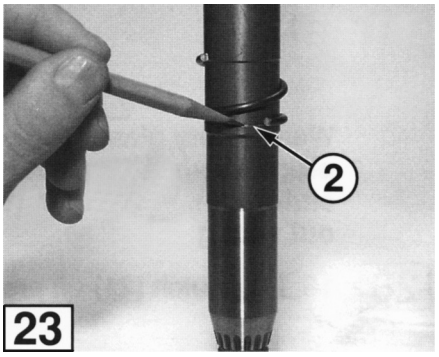
- Check driveshaft threads and splines forwear, chips, and cracks. Severe spline wear or the appearance of spline “twisting” indicates the gearcase has been distorted, possibly by impact damage.
- Bearing(s) must be free of damage, corrosion, and discoloration. Replace bearing(s) as required. See Gearcase Repair Procedures, this section.



All Internal Components

Inspect all internal components for signs of wear, chipping, pitting, distortion, and discoloration due to improper lubrication. Special attention to the following:

- Check the bevel gear A tapered roller bearing outer race. If damaged or corroded, replace both the race and the bearing. See Gearcase Repair Procedures in this section.
- Inspect clutch and gear teeth and the clutch cam for chips and signs of metal transfer. Replace parts as needed.



Assembly

⚠ CAUTION

Gearcase must be secured in a suitable holding fixture during assembly.

1. Install new gearcase needle bearing, bevel gear A roller bearing and outer race, and driveshaft bearing(s) if any of these parts were removed. See Gearcase Repair Procedures, this section.

2. Secure gearcase in holding fixture with water pump side facing upward.

22 23 3. Slide the driveshaft spring onto the driveshaft so flat side **(1)** faces threaded end of driveshaft. Position the spring exactly as shown so flat side **(1)** is seated against shoulder **(2)**.

⚠ CAUTION

The driveshaft spring provides oil lubrication to the tapered roller bearing(s) under the lower water pump case. If spring is installed too high, oil supply may be insufficient.

24 25 4. Install the removable spring guide if equipped so key **(3)** is seated in keyway **(4)** of gearcase housing. Spring guide will not rotate in gearcase when properly installed.

5. Install the driveshaft through the drive shaft housing. Make sure driveshaft bearing outer race is fully seated against the bearing.

NOTE

Models 40 and 50 are not equipped with bearing outer race.

26 6. Apply Loctite 242 to bevel gear B nut **(5)**. Slide bevel gear B **(6)** onto driveshaft **(7)** as shown from propeller shaft side of gearcase. Hand tighten nut **(5)** to secure the gear in place.

27 7. Install specified socket **(8)** and wrench **(9)**. Hold bevel gear B nut with wrench and turn driveshaft clockwise to tighten the nut. Torque bevel gear B nut to specification.

Tool	Part Number	Model
Socket, Bevel Gear B Nut	345-72232-0	40 / 50 / 60B / 70B
Socket, Bevel Gear B Nut	3B7-72232-0	60C / 70C / 80 / 90 / 115 / 120 / 140
Wrench, Bevel Gear B Nut	346-72231-0	40 / 50
Wrench, Bevel Gear B Nut	353-72231-0	60B / 70B
Wrench, Bevel Gear B Nut	3B7-72231-0	60C / 70C / 80 / 90 / 115 / 120 / 140

8. Perform all adjustment steps before proceeding. See Adjustments, this section.

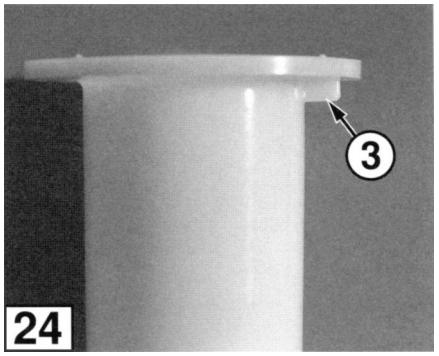
⚠ CAUTION

Failure to perform the adjustment steps may result in poor engine performance, premature wear of parts, or severe damage to gearcase components.

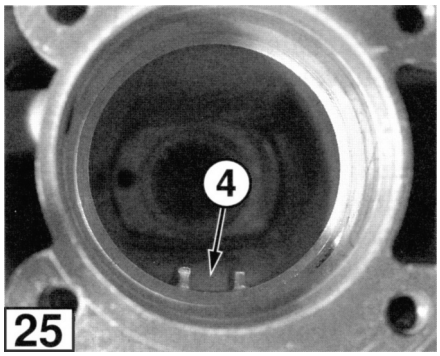
9. Install the water pump. See Water Pump, this section.

NOTE

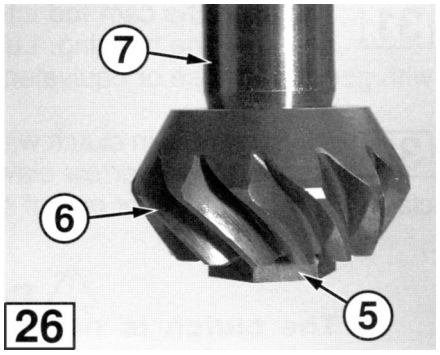
Make sure all necessary adjustment shims are installed on driveshaft bearing before installing lower pump case.



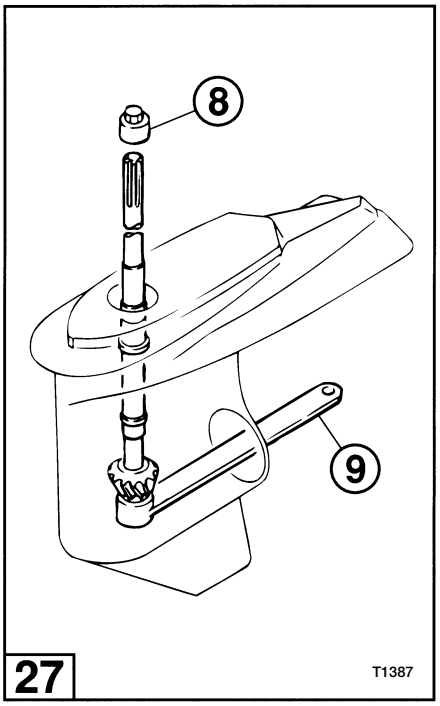
T1384



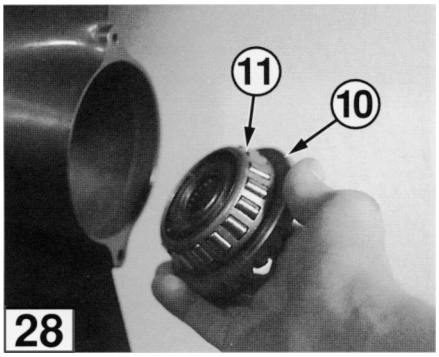
T1385



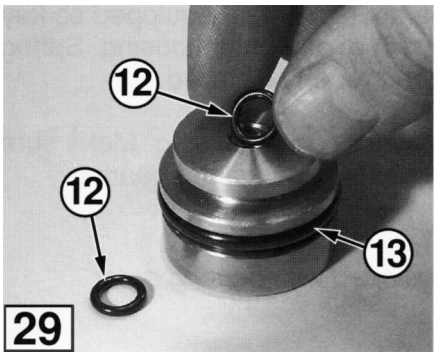
T1386



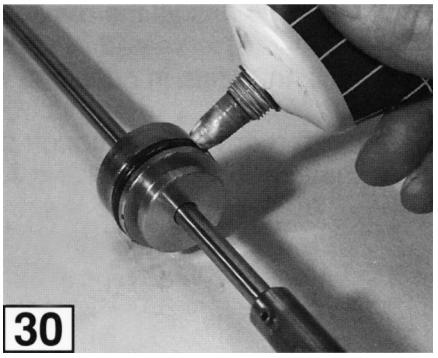
T1387



T1388



T1389



T1390

28 10. Install bevel gear A **(10)** so tapered roller bearing **(11)** is seated in outer race and the gear teeth are properly meshed with bevel gear B.

29 11. Replace cam rod bushing internal o-rings **(12)** and external o-ring **(13)**. Coat the internal o-rings and inner surface of bushing with specified gear oil. Then fully assemble the cam rod components.

30 12. Apply genuine grease or equivalent friction surface marine grease to the exterior of the cam rod bushing and o-ring.

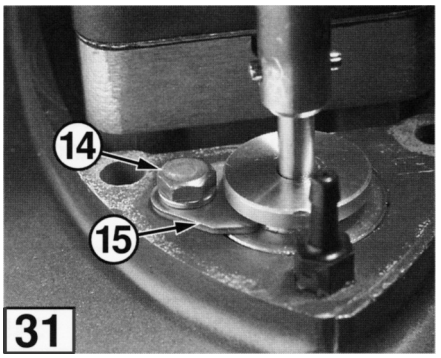
31 13. Insert the cam rod into the cam rod port on the gearcase and seat the bushing. Lubricate threads of stopper bolt **(14)** with genuine grease or equivalent and install stopper **(15)**.

32 14. Align hole in clutch with slot in propeller shaft. Slide clutch onto shaft so narrow claw **(16)** faces bevel gear A and wide claw **(17)** faces propeller end of shaft.

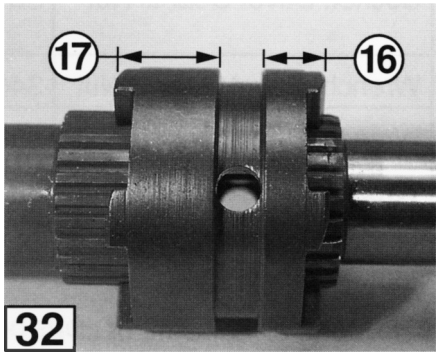
⚠ CAUTION

The clutch is not symmetrical. If installed backwards, clutch and gears will be damaged.

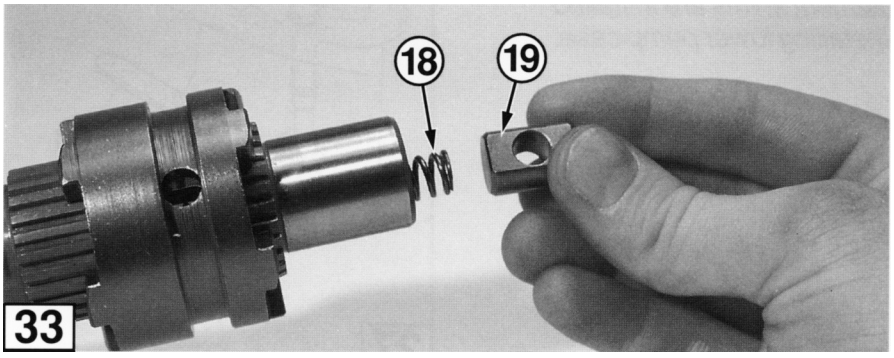
33 15. Insert clutch spring **(18)** and install spring holder **(19)** so hole in spring holder is aligned with clutch hole.



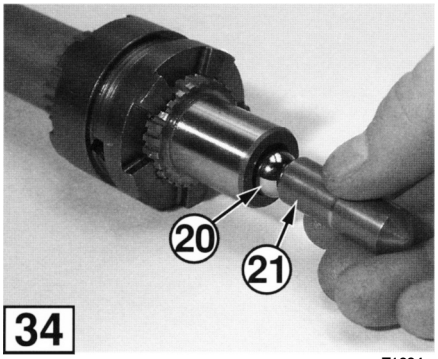
T1391



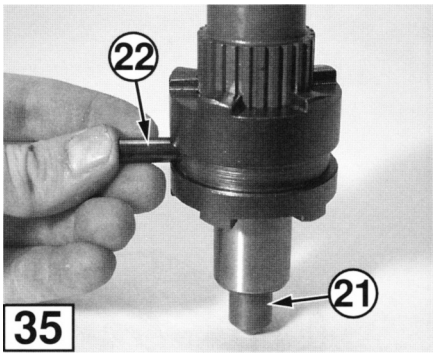
T1392



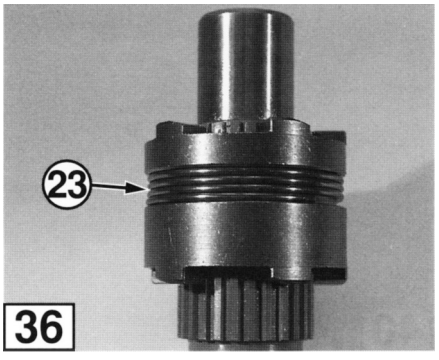
T1393



T1394



T1395



T1396

34 16. Insert detent ball **(20)**. Install clutch push rod **(21)** so tapered end faces bevel gear A.

35 17. Compress the clutch spring by applying pressure to push rod **(21)**. Align the holes of the clutch and spring holder and insert clutch pin **(22)**.

⚠ CAUTION

Wear safety glasses and DO NOT hold spring end of propeller shaft towards face or body when compressing the clutch spring.

36 18. Install new clutch pin snap spring **(23)**. Do not reuse old snap spring.

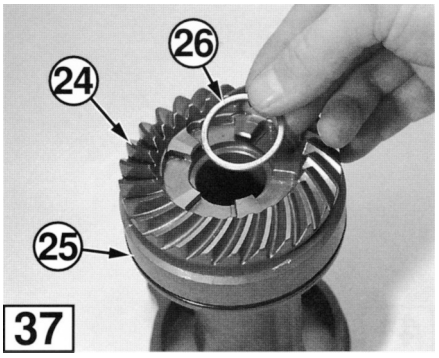
⚠ CAUTION

DO NOT reuse clutch pin snap spring (23), it must be replaced. Reusing clutch pin snap spring may cause severe damage to gears and other components.

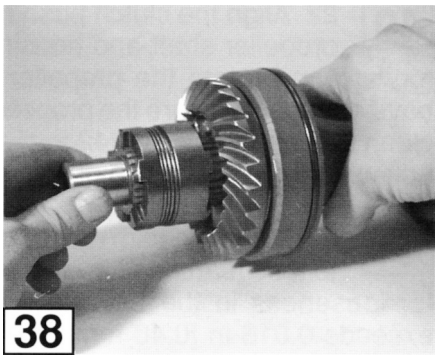
37 19. Make sure all necessary adjustment shims are installed on bevel gear C **(24)** and install gear onto propeller shaft housing **(25)**. Install washer **(26)** onto bevel gear.

38 20. Apply genuine grease or equivalent to the propeller shaft housing o-ring and oil seal. Slide the propeller shaft into the propeller shaft housing.

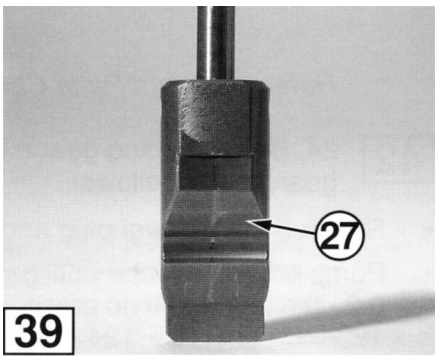
39 21. Lift the cam rod to the fully UP position and verify through the gearcase opening that clutch cam beveled side **(27)** faces gearcase opening.



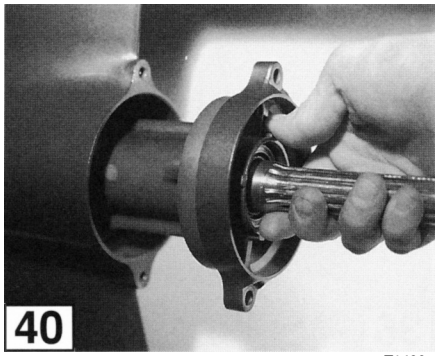
T1397



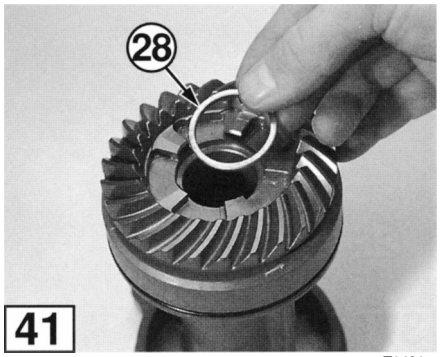
T1398



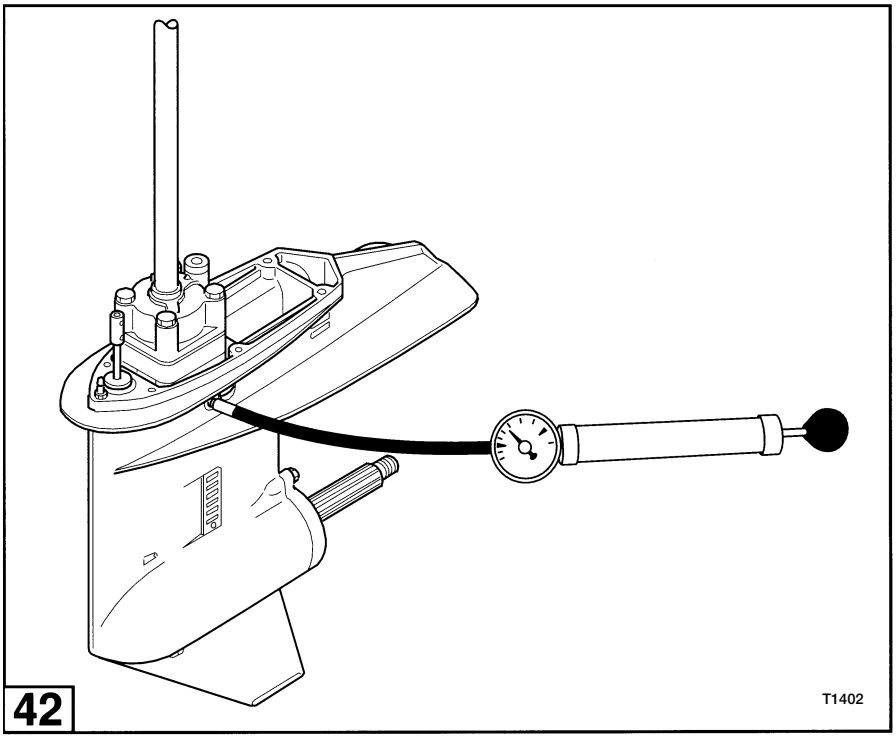
T1399



T1400



T1401



T1402

40 22. Align the clutch push rod with the clutch cam and slide the propeller shaft and housing into the gearcase opening. Push forward and rotate the propeller shaft as needed until bevel gears have engaged. Ensure the propeller shaft housing bolts are completely clean and apply Loctite 242 to the bolt threads. Install and torque the bolts evenly to prevent improper seating of the housing.

41 23. Move the cam rod to each position and rotate the driveshaft to test gearcase function in all gears. Check the propeller shaft for looseness in the forward and reverse directions. If looseness exceeds 0.016 in [0.40 mm], replace bevel gear C washer **(28)** with one of correct thickness.

NOTE

Refer to current Parts Catalog for washer availability.

42 24. Before adding gear oil, pressure test and vacuum test the gearcase as follows:

- Remove the oil level plug and install gearcase pressure tester.
- Pump pressure tester until gauge indicates 3 - 6 psi [21 - 42 kPa / 0.2 - 0.4 kg/cm²]. If pressure loss occurs, determine source of leakage by submerging gearcase in water. Make necessary repairs to correct the problem and retest.
- Remove the pressure tester and install gearcase vacuum tester.

- Pump vacuum tester until gauge indicates 3 - 5 in [76 - 127 mm] of mercury. If loss of vacuum occurs, apply oil around suspected seal. If leak stops or oil is drawn in, the seal is defective and must be replaced. Make necessary repairs to correct the problem and retest.

25. Fill gearcase with specified gear lubricant. See Engine Specifications in Section 2 for gearcase capacities.

26. Apply genuine grease or equivalent to the propeller shaft and propeller mounting hardware. Install the propeller and propeller mounting hardware. Torque propeller nut to specification.

⚠ CAUTION

Make sure propeller thrust holder is installed and seated against the propeller shaft oil seal before installing propeller. If installed improperly, propeller may be pushed into gearcase housing during tightening.

Adjustments

⚠ CAUTION

DO NOT attempt gearcase adjustments without proper manufacturer special tools and adequate knowledge of gearcase setup.

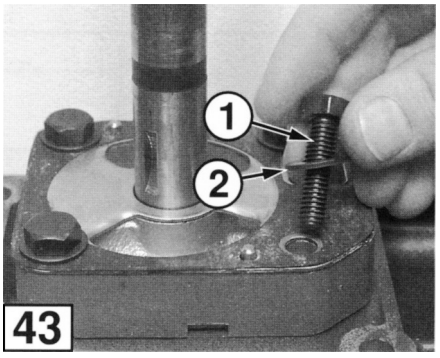
NOTE

Specific assembly steps must be completed in order to perform the gearcase adjustments. If these steps have not been performed, refer to Assembly, this section.

NOTE

Unless otherwise indicated, all gearcase adjustment specifications are based on measurements obtained with manufacturer special tools.

43 1. Slide lower pump case onto driveshaft and seat into position on gearcase. Secure lower pump case with bolts **(1)** and flat washers **(2)**.



T1403

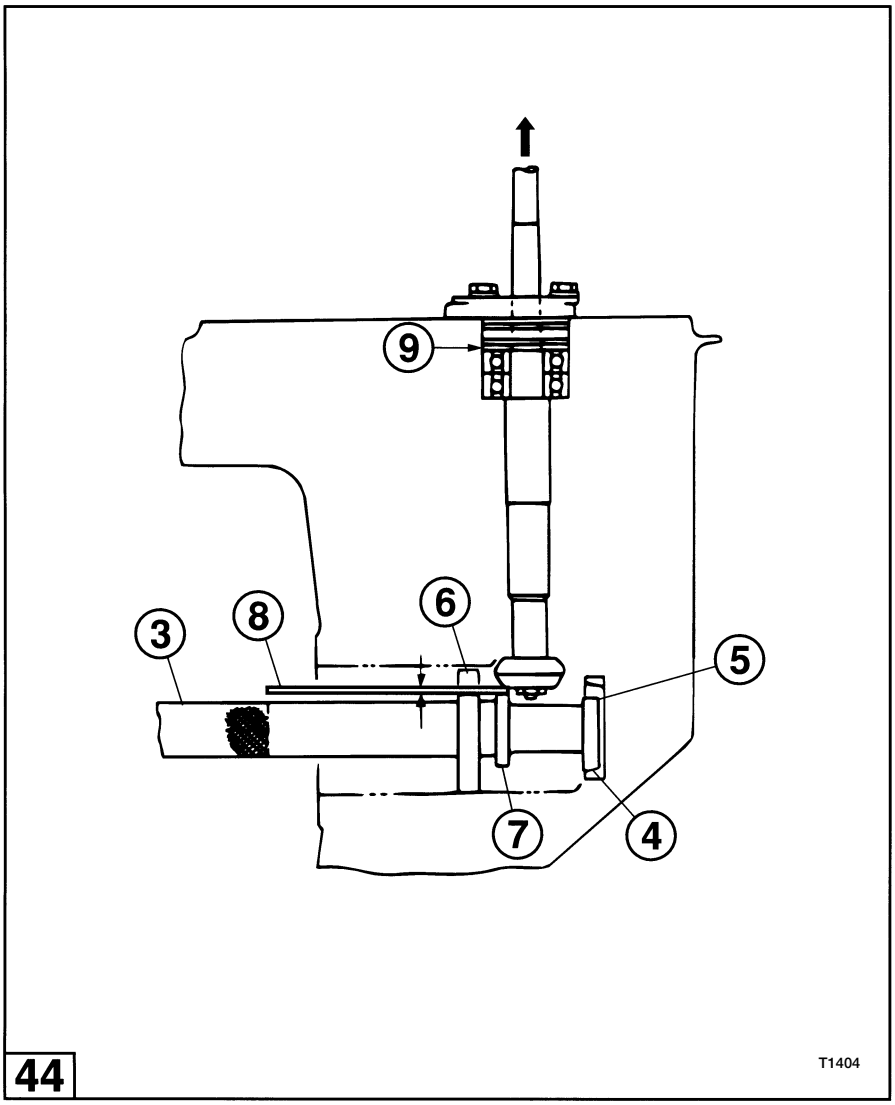
Bevel Gear B Adjustment

44 2. Insert specified shimming gauge **(3)** into gearcase.

Tool	Part Number	Model
Shimming Gauge	3C8-72250-0	40 / 50 / 60B / 70B
Shimming Gauge	3B7-72250-0	60C / 70C / 80 / 90 / 115 / 120 / 140

NOTE

*Correct positioning of the shimming gauge in the gearcase is critical. Make sure tapered side **(4)** is fully seated in bevel gear A bearing outer race with flat side **(5)** and notch **(6)** facing upward.*



44

44 3. Eliminate all looseness between driveshaft and gearcase using one of the following methods:

- Lift driveshaft upward and tap down on gearcase with rubber mallet.
- Slide a compression spring (obtain locally) over driveshaft and seat onto lower pump case. Install backlash measuring tool clamp assembly (Part No. 3B7-72720-0) on driveshaft. Compress the spring and tighten the clamp to maintain the spring compression and provide constant upward pressure against driveshaft.

With all looseness eliminated, measure the gap between collar **(7)** and bevel gear B using thickness gauge set **(8)** (Part No. 353-72251-0). If gap measurement is not within 0.023 - 0.025 in [0.60 - 0.64 mm], remove the lower pump case and install correct size shim onto roller bearing outer race at location **(9)**.

NOTE

Refer to current Parts Catalog for shim availability.

4. If shimming was necessary re-install the lower pump case before proceeding with Backlash Adjustment - Bevel Gears A and B.

Backlash Adjustment - Bevel Gears A and B

NOTE

Obtain backlash measuring tool kit. Reference the following specification table for Backlash Adjustment special tool requirements:

Tool	Part Number	Model
Backlash Measuring Tool Kit for Gears “A” & “B”	3C8-72234-0	40 / 50
Backlash Measuring Tool Kit for Gears “A” & “B”	3B7-72234-0	60 / 70 / 80 / 90 / 115 / 120 / 140
Collar, Backlash Measuring Tool	353-72245-1	40 / 50
Set Piece A, Backlash Measuring Tool	3A3-72245-0	60B / 70B
Set Piece A, Backlash Measuring Tool	3B7-72245-0	60C / 70C / 80 / 90 / 115 / 120 / 140
O-ring, 2-9	332-60002-0	40 / 50 / 60B / 60C / 70B / 70C /80 / 90 / 115 / 120 / 140
Conedisk Spring Washer	3B7-72734-0	40 / 50 / 60B / 60C / 70B / 70C / 80 / 90 / 115 / 120 / 140
Shaft, Backlash Measuring Tool	345-72723-0	40 / 50
Shaft, Backlash Measuring Tool	3B7-72723-0	60B / 60C / 70B / 70C / 80 / 90 / 115 / 120 / 140
Plate (order separately or obtain from Bevel Gear A Bearing Puller Assembly Part No. 345-72224-1)	3A3-72724-0	40 / 50
Plate, Backlash Measuring Tool	3B7-72724-0	60B / 60C / 70B / 70C / 80 / 90 / 115 / 120 / 140
Nut, Shaft	930191-1000	40 / 50
Nut, Shaft, 12Pl.5	3B7-72735-0	60B / 60C / 70B / 70C / 80 / 90 / 115 / 120 / 140
Clamp Assembly, Backlash Measuring Tool	3B7-72720-0	40 / 50 / 60B / 60C / 70B / 70C / 80 / 90 / 115 / 120 / 140
Dial Gauge Plate	3B7-72729-0	40 / 50 / 60B / 60C / 70B / 70C / 80 / 90/ 115 / 120 / 140
Bolt, Lower Pump Case	910191-0830	40 / 50
Bolt, Lower Pump Case	910191-0835	60B / 60C / 70B / 70C / 80 / 90 / 115 / 120 / 140

5. With the tapered roller bearing installed, position bevel gear A in gearcase so bearing is fully seated in outer bearing race. Rotate the driveshaft to ensure gears are properly meshed.

6. Assemble the following backlash tool components. Note the correct quantity and orientation of conedisk spring washers:

45 Models 40 and 50 - Assemble three conedisk spring washers **(10)**, o-ring **(11)**, and collar **(12)**.

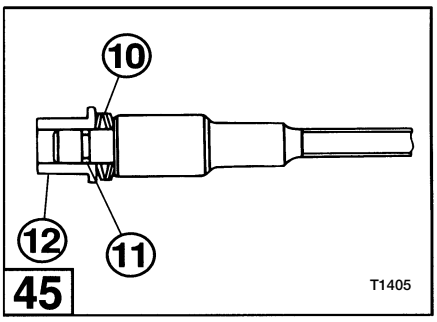
46 Models 60B and 70B - Assemble four conedisk spring washers **(13)**, set piece A **(14)**, and o-ring **(15)**.

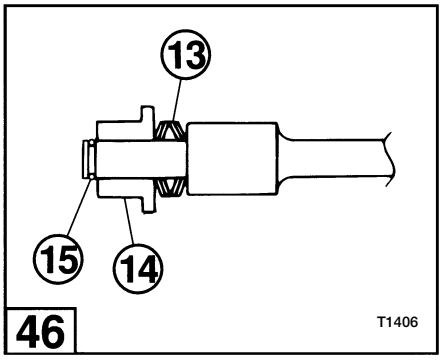
47 Models 60C / 70C / 80 / 90 / 115 / 120 / 140 - Assemble six conedisk spring washers **(16)**, set piece A **(17)**, and o-ring **(18)**.

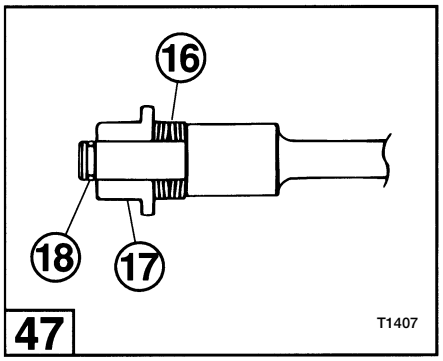
48 7. Insert shaft **(19)** into gearcase and seat collar/guide end in bevel gear A. Install plate **(20)** using appropriate size bolts. Put nuts **(21)** onto shaft. Screw in the shaft **(19)** and fix the bevel gear “A” to the tapered bearing.

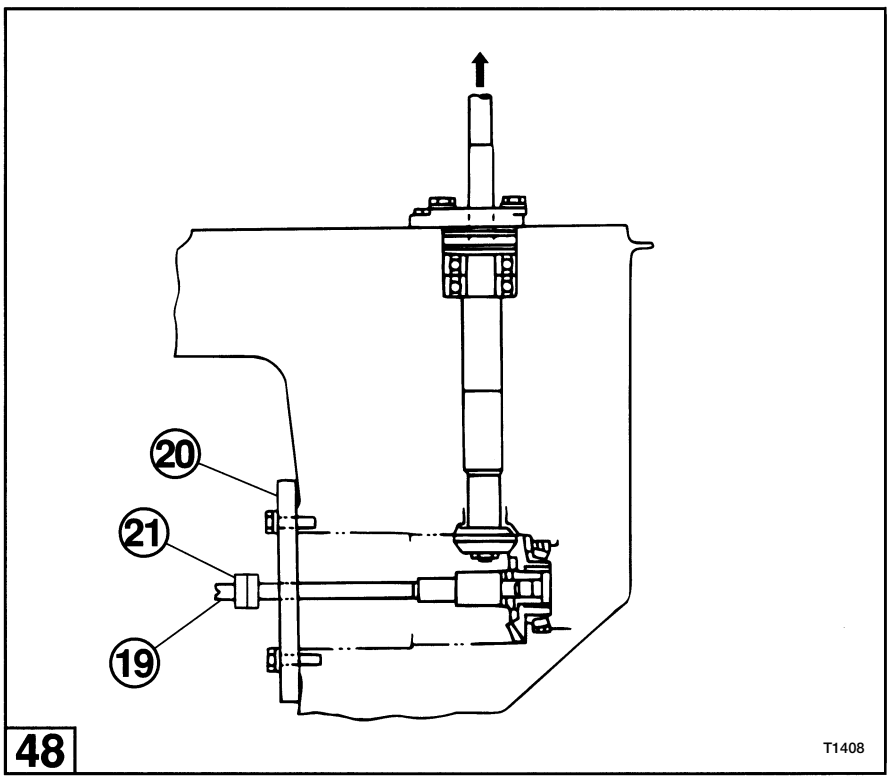
8. Look nuts.

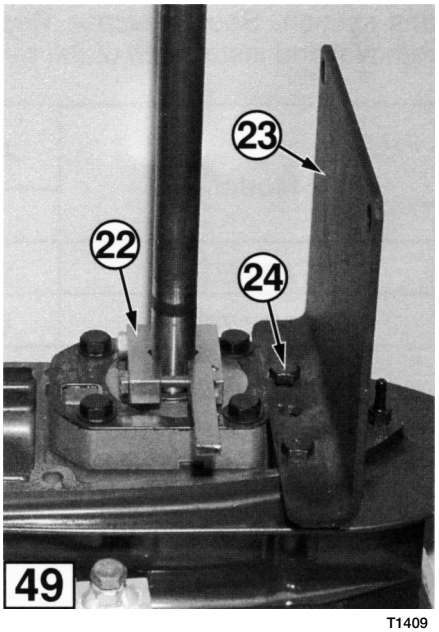
49 9. Mount clamp assembly **(22)** on driveshaft as close as possible to lower pump case. Install dial gauge plate **(23)** on gearcase with bolts **(24)** and nuts.

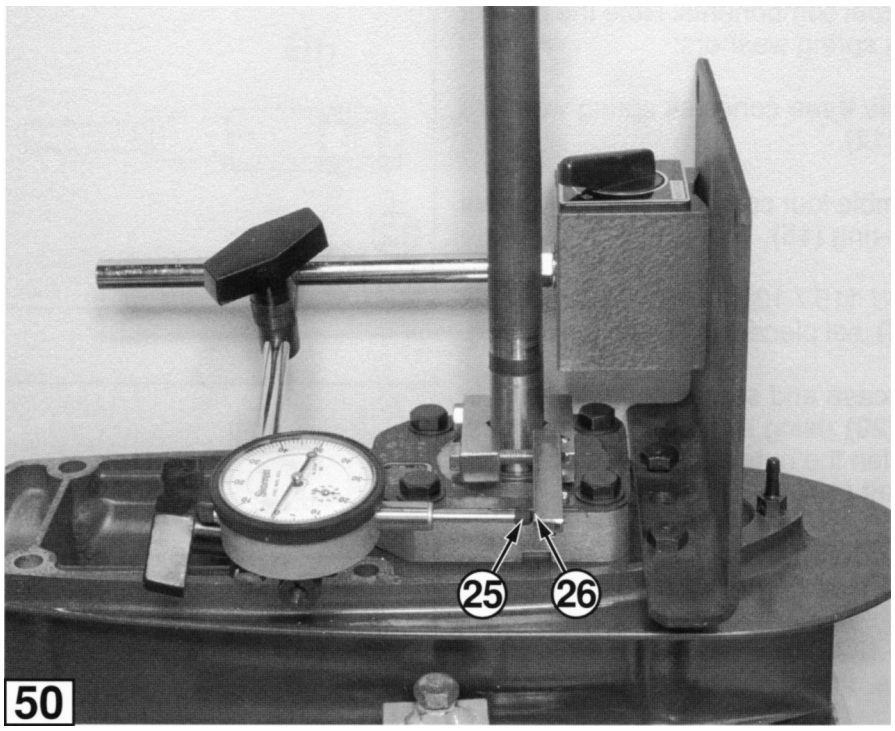




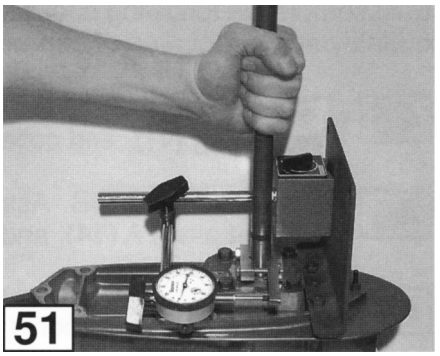




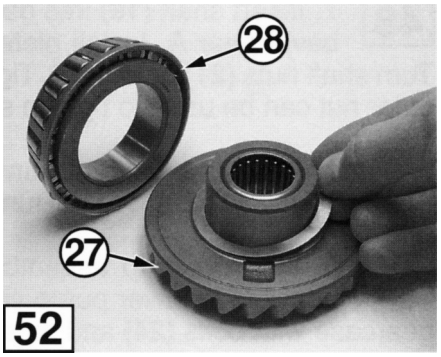




T1410



T1411



T1412

50 10. Mount a magnetic base and dial gauge (obtain locally) as shown. Lift driveshaft upward and tap down on gearcase with rubber mallet to eliminate all looseness and proceed to adjust the setup so dial gauge **(25)** is aligned with V-notch **(26)**.

51 11. Set dial gauge to zero. Lift driveshaft upward and tap down on gearcase with rubber mallet to eliminate looseness. Rotate driveshaft in both directions and record the dial gauge reading.

52 If the dial gauge reading is not within the specified range, adjust, shim thickness between bevel gear A **(27)** and tapered roller bearing **(28)** in accordance with the Backlash - Shim Adjustment Table, this section. See Gearcase Repair Procedures in this section for removal and installation of the bevel gear A roller bearing.

Model	Acceptable Dial Gauge Reading	
	in	mm
40 / 50	0.0122 - 0.0244	0.31 - 0.62
60B / 70B	0.0094 - 0.0319	0.29 - 0.58
60C / 70C	0.0106 - 0.0213	0.27 - 0.54
80 / 90 / 115 / 120 / 140	0.0094 - 0.0189	0.24 - 0.48

12. Proceed with Backlash Adjustment - Bevel Gears B and C.

Backlash Adjustment - Bevel Gears B and C

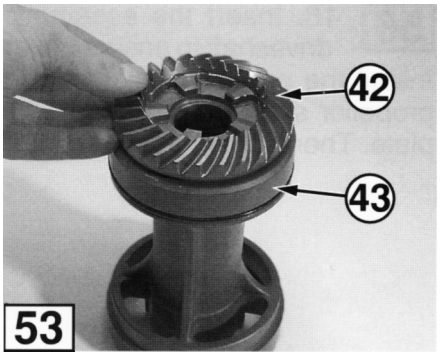
NOTE

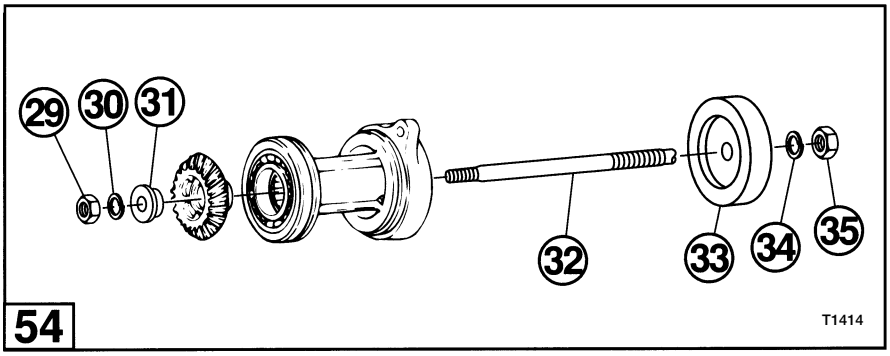
Obtain backlash measuring tool kit. Reference the following specification table for Backlash Adjustment special tool requirements:

Tool	Part Number	Model
Backlash Measuring Tool Kit	3A3-72255-0	60B / 70B
Nut (29)	930191-0800	60B / 70B
Washer (30)	940191-0800	60B / 70B
Set Piece B, Backlash Measuring Tool (31)	3A3-72727-0	60B / 70B
Shaft B, Backlash Measuring Tool (32)	3A3-72726-0	60B / 70B
Plate B, Backlash Measuring Tool (33)	353-72725-0	60B / 70B
Washer (34)	940191-1000	60B / 70B
Nut (35)	930191-1000	60B / 70B
Backlash Measuring Tool Kit	3B7-72255-0	60C / 70C / 80 / 90 / 115 / 120 / 140
Retainer (36)	3B7-72903-0 (353-72703-0)	60C / 70C / 80 / 90 / 115 / 120 / 140
Set Piece B, Backlash Measuring Tool (37)	3B7-72727-0	60C / 70C / 80 / 90 / 115 / 120 / 140
Shaft (38)	3B7-72726-0 (3B7-72702-0)	60C / 70C / 80 / 90 / 115 / 120 / 140
Plate (38)	3B7-72725-0 (3B7-72701 -0)	60C / 70C / 80 / 90 / 115 / 120 / 140
Washer, 13-21-2.5 (40)	346-72707-0	60C / 70C / 80 / 90 / 115 / 120 / 140
Nut, 12P1.5 (41)	3B7-72735-0	60C / 70C / 80 / 90 / 115 / 120 / 140

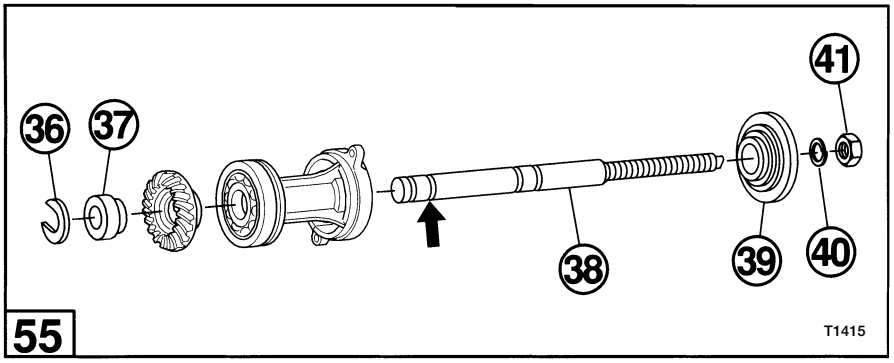
13. Remove bevel gear A from gearcase.

53 14. Install bevel gear C **(42)** onto propeller shaft housing **(43)**.

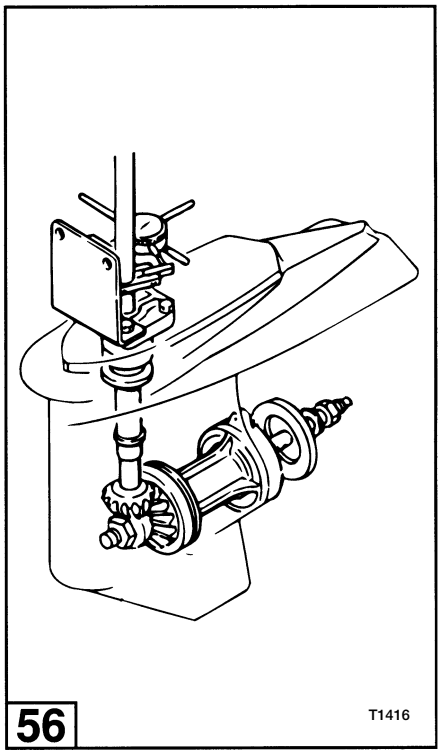




54



55



56

15. Assemble special tools as follows:

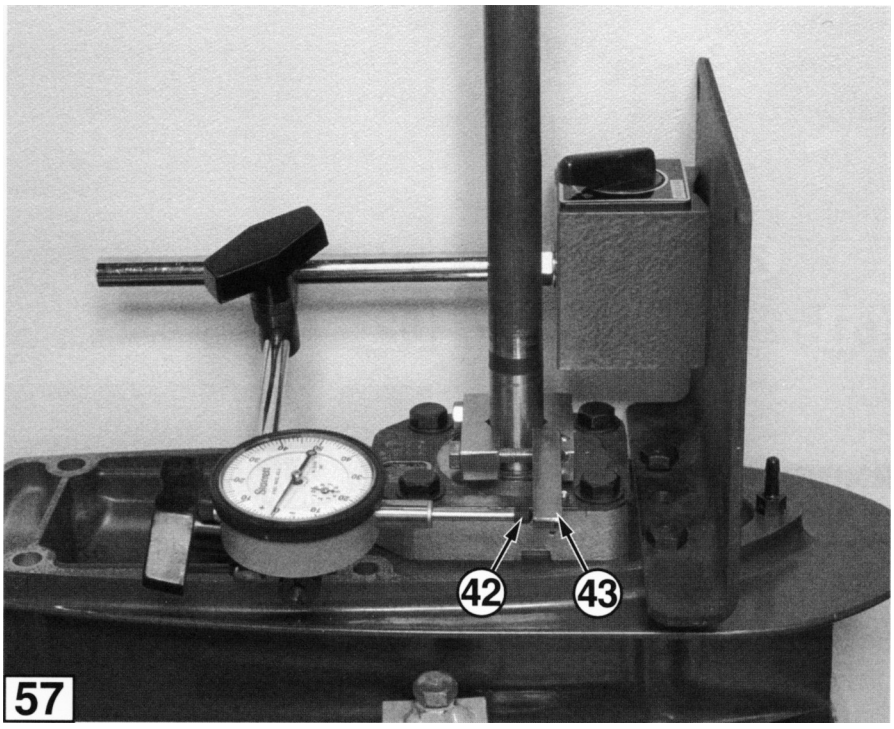
54 Models 60B / 70B:

- Slide shaft **(32)** through propeller shaft housing so shorter length of thread is at gear end of housing.
- Attach set piece B **(31)** and secure with nut **(29)** and washer **(30)**. Tighten the nut to secure bevel gear C to propeller shaft housing.
- Slide plate B **(33)** onto shaft and attach washer **(34)** and nut **(35)**.

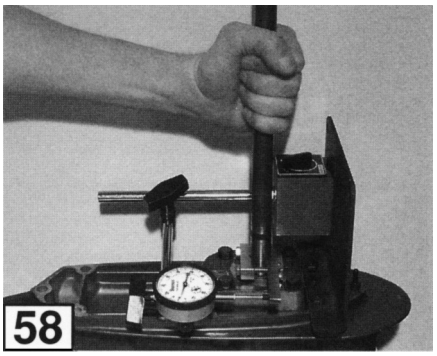
55 Models 60C / 70C / 80 / 90 / 115 / 120 / 140:

- Slide shaft **(38)** through propeller shaft housing and bevel gear C as shown.
- Install set piece B **(37)** and attach retainer **(36)** to shaft groove shown.
- Slide plate **(39)** onto shaft and attach washer **(40)** and nut **(41)**.

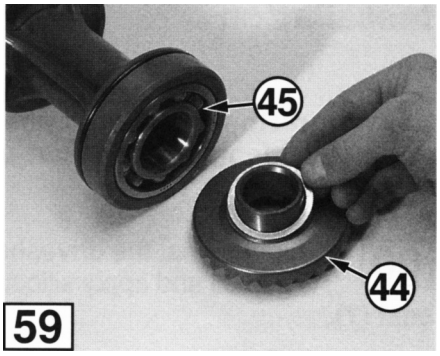
56 16. Insert the assembly into the gearcase and rotate the driveshaft to ensure bevel gears B and C are properly meshed. Install the propeller shaft housing bolts. Seat the plate against the propeller shaft housing and finger tighten the shaft nut against the plate. Then tighten the nut an addition 1/4-turn.



T1418



T1411



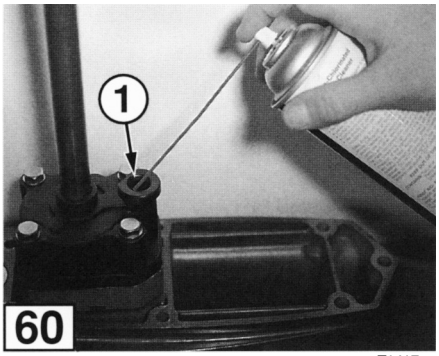
T1419

57 17. Lift driveshaft upward and tap down on gearcase with rubber mallet to eliminate all looseness and proceed to adjust the dial gauge **(42)** is aligned with V-notch **(43)**.

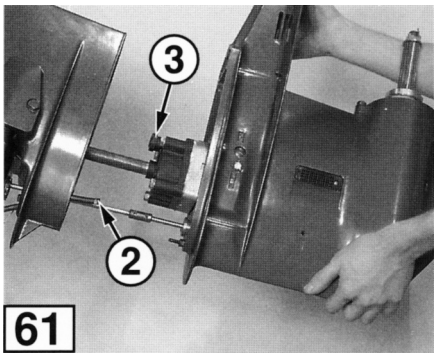
58 18. Set dial gauge to zero. Lift driveshaft upward and tap down on gearcase with rubber mallet to eliminate looseness. Rotate driveshaft in both directions and record the dial gauge reading.

59 If the dial gauge reading is not within the specified range, adjust shim thickness between bevel gear C **(44)** and propeller shaft housing bearing **(45)** in accordance with the Backlash - Shim Adjustment Table, this section.

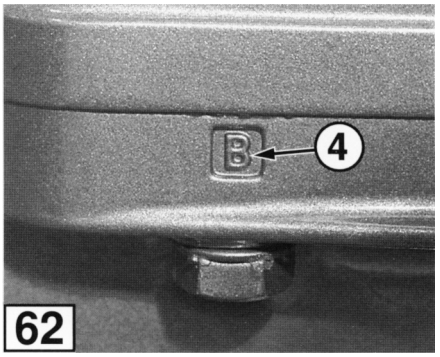
Model	Acceptable Dial Gauge Reading	
	in	mm
40 / 50	0.0122 - 0.0244	0.31 - 0.62
60B / 70B	0.0094 - 0.0319	0.29 - 0.58
60C / 70C	0.0106 - 0.0213	0.27 - 0.54
80 / 90 / 115 / 120 / 140	0.0094 - 0.0189	0.24 - 0.48



T1417



T1420



T1421

Installation

⚠⚠ WARNING

Ignition system must be disabled to prevent accidental engine start-up during installation of the gearcase.

60 1. Lightly coat the driveshaft splines with genuine engine oil or TC-W3 oil and apply silicone spray lubricant to water pipe lower seal **(1)**.

61 2. Slide driveshaft into lower crankcase head. Connect speedometer pickup tube **(2)** if equipped and align water pipe with lower seal **(3)** before seating gearcase on driveshaft housing.

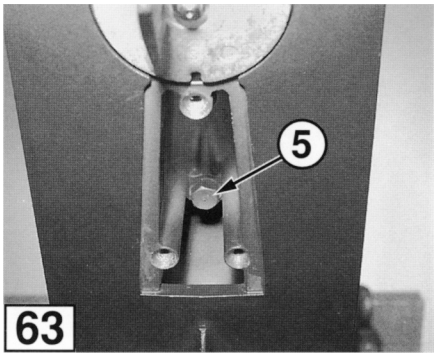
62 3. Apply Loctite 242 to threaded portion of gearcase mounting bolts. Install bolts at two locations marked B **(4)** for initial positioning of the gearcase. Install the remaining gearcase mounting bolts and torque all bolts specification.

63 4. Install internal coupling bolt **(5)**.

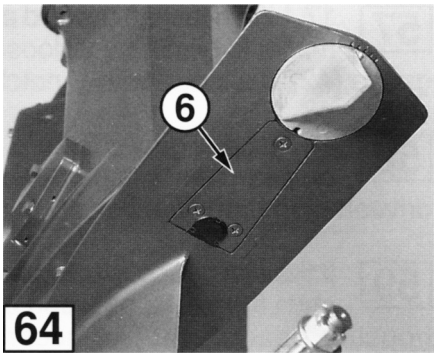
64 5. Install gearcase plate **(6)** or subwater strainer if equipped using Loctite 242 on the screw threads.

65 6. Use correct size spring pin tool B **(7)** to install new upper spring pin in shift rod joint. DO NOT reuse the old spring pin.

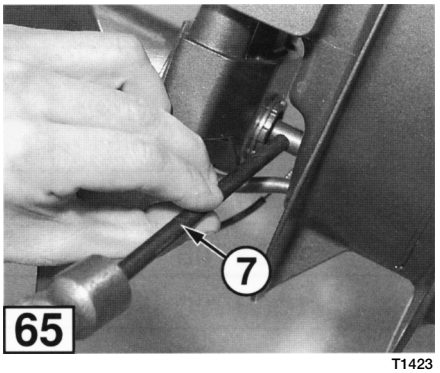
Description	Part Number	Application
Spring Pin Tool B	345-72228-0	3 mm spring pins
Spring Pin Tool B	369-72218-0	3.5 mm spring pins



T1364



T1422



T1423

BACKLASH - SHIM ADJUSTMENT TABLE

NOTE

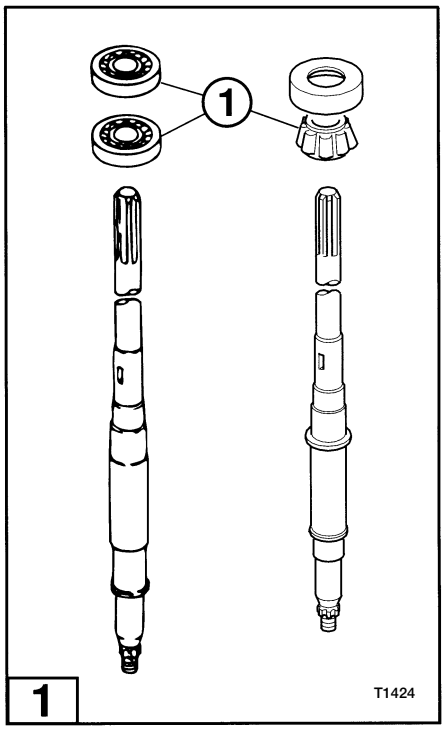
Refer to current Parts Catalog for shim availability.

1. Determine Dial Gauge Reading range in table that has a low end value closest to the obtained dial gauge reading.
2. Find corresponding Shim Thickness value in table.
3. Install or remove shims to increase or decrease shim thickness by the value specified.
4. Re-check the backlash measurement.

Dial Gauge Reading								Shim Thickness + Increase shim thickness - Decrease shim thickness	
40 / 50		60B / 70B		60C / 70C		80 / 90 / 115 / 120 / 140			
in	mm	in	mm	in	mm	in	mm	in	mm
0.0000 - 0.0063	0.00 - 0.16	0.0000 - 0.0071	0.00 - 0.18	0.0000 - 0.0055	0.00 - 0.14	0.0000 - 0.0043	0.00 - 0.11	-0.0039	-0.10
0.0067 - 0.0118	0.17 - 0.30	0.0075 - 0.0110	0.19 - 0.28	0.0059 - 0.0102	0.15 - 0.26	0.0047 - 0.0091	0.12 - 0.23	-0.0020	-0.05
0.0122 - 0.0244	0.31 - 0.62	0.0114 - 0.0228	0.29 - 0.58	0.0106 - 0.0213	0.27 - 0.54	0.0094 - 0.0189	0.24 - 0.48	0.0000	0.00
0.0248 - 0.0291	0.63 - 0.74	0.0232 - 0.0264	0.59 - 0.67	0.0217 - 0.0260	0.55 - 0.66	0.0193 - 0.0232	0.49 - 0.59	+0.0020	+0.05
0.0295 - 0.0370	0.75 - 0.94	0.0268 - 0.0327	0.68 - 0.83	0.0264 - 0.0331	0.67 - 0.84	0.0236 - 0.0291	0.60 - 0.74	+0.0039	+0.10
0.0374 - 0.0445	0.95 - 1.13	0.0331 - 0.0390	0.84 - 0.99	0.0335 - 0.0398	0.85 - 1.01	0.0295 - 0.0350	0.75 - 0.89	+0.0059	+0.15
0.0449 - 0.0524	1.14 - 1.33	0.0394 - 0.0453	1.00 - 1.15	0.0402 - 0.0469	1.02 - 1.19	0.0354 - 0.0409	0.90 - 1.04	+0.0079	+0.20
0.0528 - 0.0598	1.34 - 1.52	0.0457 - 0.0516	1.16 - 1.31	0.0472 - 0.0539	1.20 - 1.37	0.0413 - 0.0472	1.05 - 1.20	+0.0098	+0.25
0.0602 - 0.0677	1.53 - 1.72	0.0520 - 0.0579	1.32 - 1.47	0.0543 - 0.0606	1.38 - 1.54	0.0476 - 0.0531	1.21 - 1.35	+0.0118	+0.30
0.0681 - 0.0756	1.73 - 1.92	0.0583 - 0.0642	1.48 - 1.63	0.0610 - 0.0677	1.55 - 1.72	0.0535 - 0.0591	1.36 - 1.50	+0.0138	+0.35
0.0760 - 0.0831	1.93 - 2.11	0.0646 - 0.0705	1.64 - 1.79	0.0681 - 0.0748	1.73 - 1.90	0.0594 - 0.0650	1.51 - 1.65	+0.0157	+0.40
0.0835 - 0.0909	2.12 - 2.31	0.0709 - 0.0768	1.80 - 1.95	0.0752 - 0.0815	1.91 - 2.07	0.0654 - 0.0713	1.66 - 1.81	+0.0177	+0.45
0.0913 - 0.0988	2.32 - 2.51	0.0772 - 0.0831	1.96 - 2.11	0.0819 - 0.0886	2.08 - 2.25	0.0717 - 0.0772	1.82 - 1.96	+0.0197	+0.50
—	—	—	—	—	—	0.0776 - 0.0831	1.97 - 2.11	+0.0217	+0.55
—	—	—	—	—	—	0.0835 - 0.0890	2.12 - 2.26	+0.0236	+0.60

= Acceptable range

GEARCASE REPAIR PROCEDURES



⚠ CAUTION

DO NOT attempt gearcase repairs without proper manufacturer special tools.

Use this section when service work requires disassembly or replacement of the following gearcase components:

- Driveshaft roller bearings.
- Gearcase needle bearing.
- Propeller shaft housing needle bearing.
- Bevel gear A bearing outer race.
- Bevel gear A roller bearing.

Driveshaft Roller Bearings

1

⚠ CAUTION

If it is determined after complete inspection that replacement of driveshaft roller bearings (1) is necessary, all pressing operations during removal and installation must be performed at a qualified machine shop equipped with minimum 4 ton press. Your local machine shop may be able to assist you.

NOTE

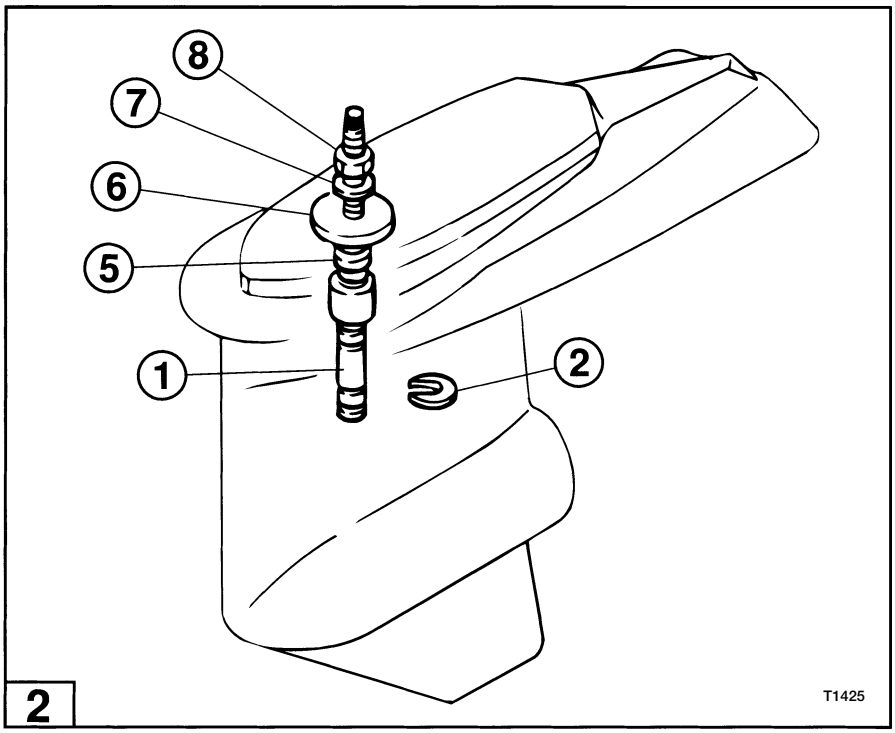
On models equipped with tapered roller bearing, bearing must be installed on driveshaft so tapered end faces powerhead.

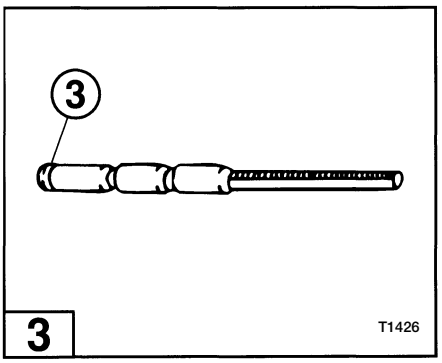
Gearcase Needle Bearing - Models 40 / 50 / 60 / 70 / 80 / 90

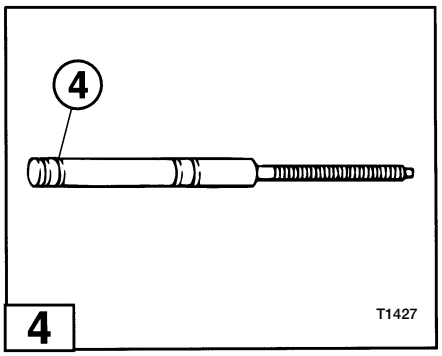
NOTE

Obtain needle roller bearing puller kit. Reference the following specification table for gearcase needle bearing Removal and Installation special tool requirements:

Tool	Part Number	Model
Needle Bearing Puller Kit	3C8-72700-0	40 / 50
Needle Bearing Puller Kit	3B7-72700-0	60C / 70C / 80 / 90 /115 / 120 / 140
Shaft, Needle Bearing Puller	346-72702-0	40 / 50
Shaft, Needle Bearing Puller	3B7-72702-0	60B / 60C / 70B / 70C / 80 / 90
Retainer A, Needle Bearing Puller	345-72703-0	40 / 50
Retainer, Needle Bearing Puller	353-72703-0	60B / 60C / 70B / 70C / 80 / 90
Guide A, Needle Bearing Puller	345-72705-0	40 / 50
Guide, Needle Bearing Puller	353-72705-0	60B / 70B
Guide A, Needle Bearing Puller	3B7-72705-0	60C / 70C / 80 / 90
Flange A, Needle Bearing Puller	3C8-72701-0	40 / 50
Plate, Needle Bearing Puller	353-72701-0	60B / 70B
Plate, Needle Bearing Puller	3B7-72701-0	60C / 70C / 80 / 90
Washer, 13-21-2.5	346-72707-0	40 / 50 / 60B / 60C / 70B / 70C / 80 / 90
Nut, 12P1.25	346-72706-0	40 / 50
Nut, 12P1.5	3B7-72735-0	60B / 60C / 70B / 70C / 80 / 90
Stopper A, Needle Bearing Puller	3C8-72704-0	40 / 50
Stopper, Needle Bearing Puller	353-72704-0	60B / 60C / 70B / 70C / 80 / 90







Removal

2 1. Insert shaft **(1)** through needle bearing from water pump side of gearcase.

2 2. Attach retainer **(2)** from propeller shaft side of gearcase to specified shaft groove. Make sure retainer is fully seated in groove with raised surface facing bearing:

3 Models 40 and 50 - groove **(3)**.

4 Models 60B / 60C / 70B / 70C / 80 / 90 - groove **(4)**.

2 3. Slide guide **(5)** onto shaft from water pump side of gearcase. Make sure guide is seated in bearing.

4. Install plate/flange **(6)**, washer **(7)**, and nut **(8)** onto shaft.

5. Hold end of threaded shaft with wrench and tighten nut **(8)** until bearing releases from housing.

Installation

6 1. Insert shaft **(1)** through needle bearing housing in gearcase.

2. Coat the new needle bearing with gear oil. Slide bearing onto shaft from propeller shaft side of gearcase so bearing stamped surface **(2)** faces propeller shaft side.

⚠ CAUTION

Stamped surface of needle bearing must face propeller shaft side of gearcase or bearing could be damaged during installation.

3. Attach retainer **(3)** from propeller shaft side of gearcase to specified shaft groove. Make sure retainer is fully seated in groove with raised surface facing bearing:

7 Models 40 and 50 - groove **(4)**.

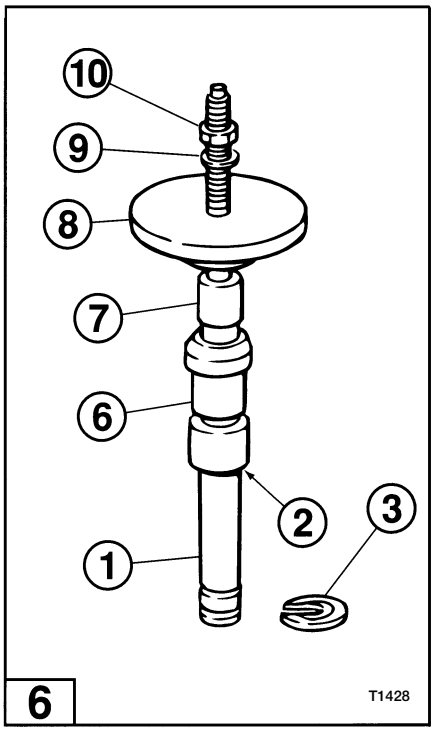
8 Models 60B / 60C / 70B / 70C / 80 /90 - groove **(5)**.

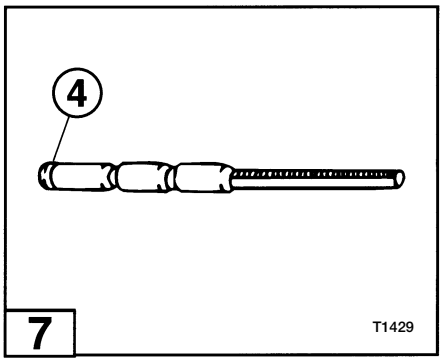
6 4. Slide guide **(6)** onto shaft from water pump side of gearcase. Make sure guide is seated in bearing.

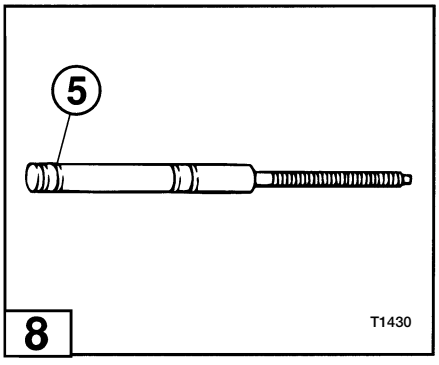
5. Install stopper **(7)**, plate/flange **(8)**, washer **(9)**, and nut **(10)** onto shaft from water pump side of gearcase.

6. Hold end of threaded shaft with wrench and tighten nut **(10)** until stopper **(7)** contacts plate/flange **(8)**.

7. Remove tools and verify needle bearing is fully seated in housing.







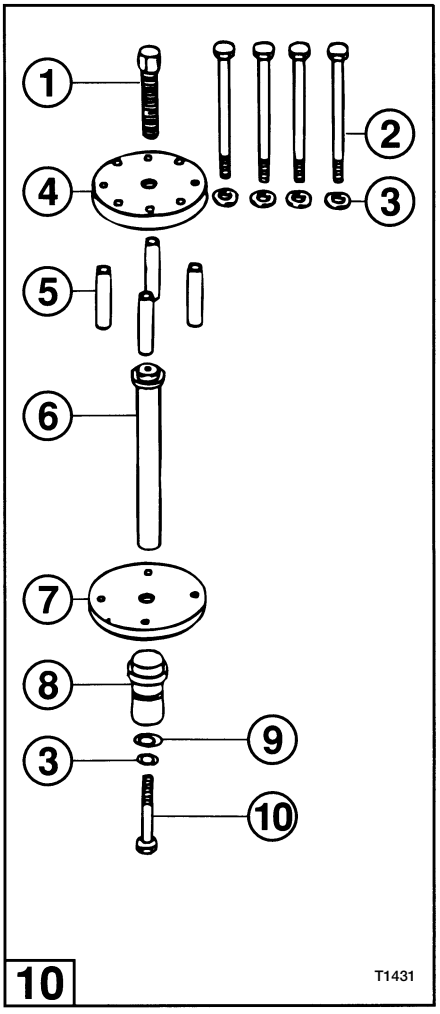
Gearcase Needle Bearing - Models 115 / 120 / 140

10

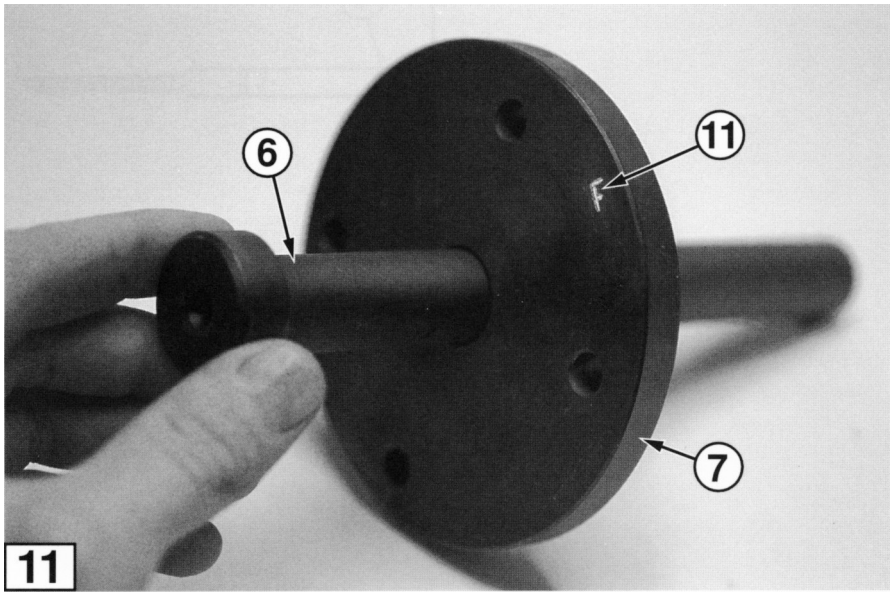
NOTE

Reference the following specification table for gearcase needle bearing Removal and Installation special tool requirements :

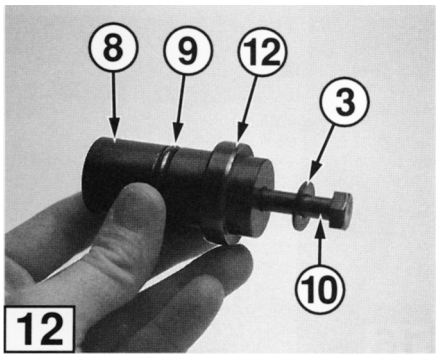
Tool		Part Number	Model
Needle Bearng Press Kit		3C7-72900-1	115 / 120 / 140
Pressing Bolt, Needle Bearing	(1)	3C7-72766-0	115 / 120 / 140
Bolt, 8-110	(2)	3C7-72773-0	115 / 120 / 140
Washer	(3)	940191-0800	115 / 120 / 140
Flywheel Puller Plate	(4)	3C7-72901-0	115 / 120 / 140
Pressing Collar, Needle Roller Bearing	(5)	3C7-72768-0	115 / 120 / 140
Pressing Rod, Needle Roller Bearing	(6)	3C7-72767-0	115 / 120 / 140
Bearing Outer Pressing Guide	(7)	3C7-72765-0	115 / 120 / 140
Press B, Needle Roller Bearing	(8)	3C7-72770-0	115 / 120 / 140
O-ring, 4.25-19.5	(9)	3B2-62415-0	115 / 120 / 140
Bolt, 8-80	(10)	910194-0880	115 / 120 / 140



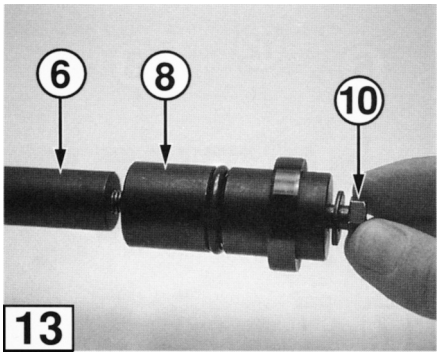
Removal



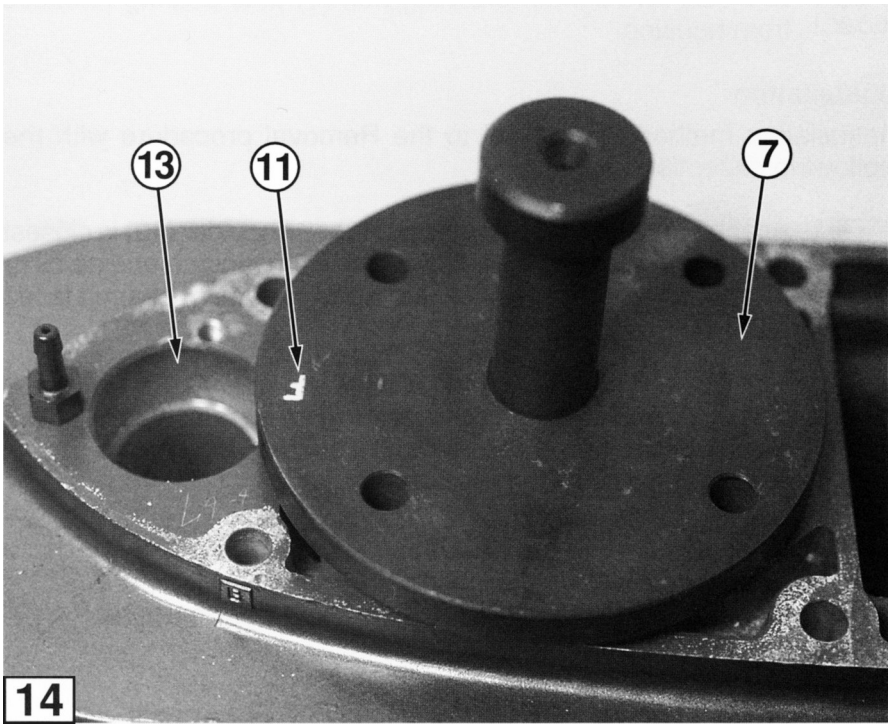
11 1. Place pressing rod **(6)** through hole in bearing outer pressing guide **(7)**. Note side stamped with F mark **(11)**. T1432



T1433



T1434



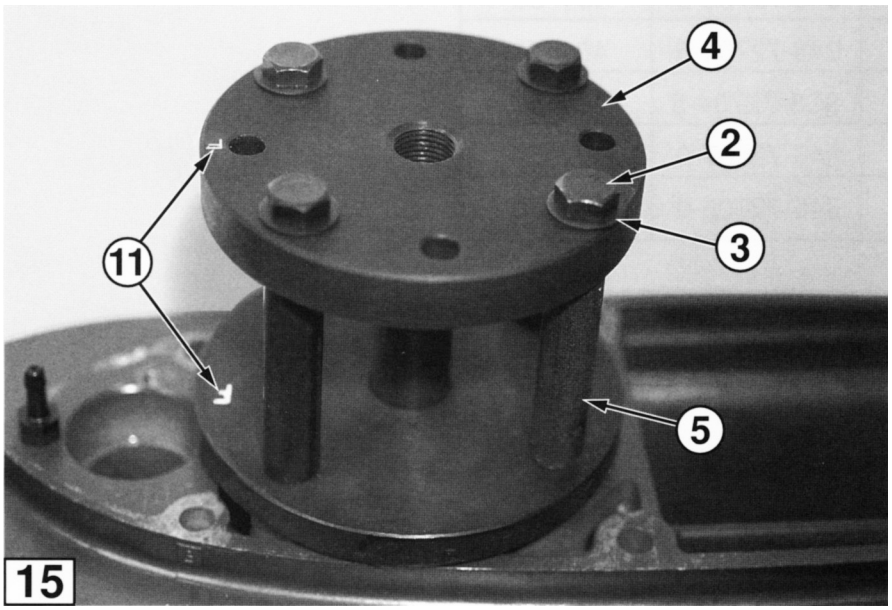
T1435

12 2. Install o-ring **(9)** on press B **(8)**. Place washer **(3)** on bolt **(10)** and insert bolt through hole closest to shoulder **(12)**.

13 3. Attach press B **(8)** to pressing rod **(6)** by tightening bolt **(10)** into threaded portion of rod.

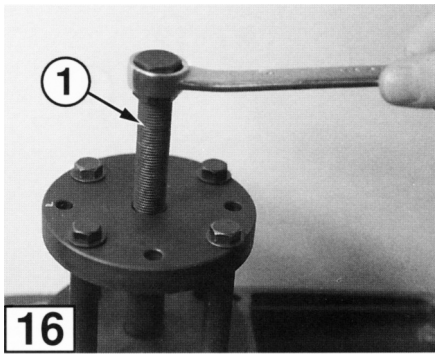
14 4. Install bearing outer pressing guide **(7)** on gearcase so F mark **(11)** faces cam rod port **(13)**. Holes in guide **(7)** should align with water pump bolt holes in gearcase.

15 5. Assemble bolts **(2)**, washers **(3)**, flywheel puller plate **(4)**, and pressing collars **(5)**. F-marks **(11)** must be aligned.



T1436

16 6. Install and tighten pressing bolt **(1)** until bearing releases from housing.



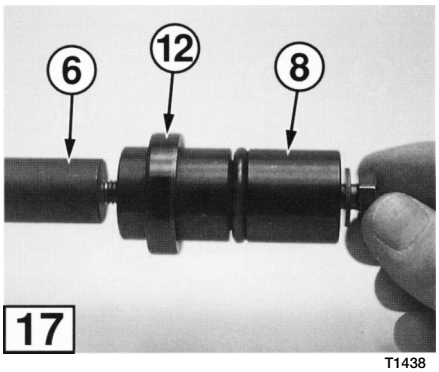
T1437

Installation
Installation method is identical to the Removal procedure with the following exception:

17 Attach press B **(8)** to pressing rod **(6)** so shoulder **(12)** is closest to the rod. Coat new needle bearing with gear oil and slide onto press B so stamped surface of bearing faces shoulder **(12)**.

⚠ CAUTION

Stamped surface of needle bearing must face water pump side of gearcase or bearing could be damaged during installation.



T1438

18

NOTE

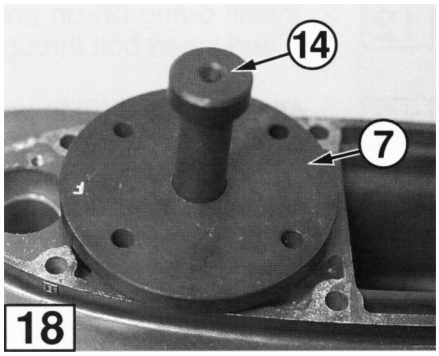
*The needle bearing is fully seated in housing when stopper **(14)** on pressing rod contacts bearing outer pressing guide **(7)**.*

Propeller Shaft Housing Needle Bearing - Models 40 and 50

19 20

NOTE

Obtain needle roller bearing puller kit. Reference the following specification table for propeller shaft housing needle bearing Removal and Installation special tool requirements :



T1439

Tool	Part Number	Model
Shaft, Needle Bearing Puller (1)	346-72702-0	40 / 50
Retainer A, Needle Bearing Puller (2)	345-72703-0	40 / 50
Guide B, Needle Bearing Puller (4)	345-72705-5	40 / 50
Flange B, Needle Bearing Puller (5)	346-72701 -5	40 / 50
Washer, 13-21-2.5 (6)	346-72707-0	40 / 50
Nut, 12P1.25 (7)	346-72706-0	40 / 50
Stopper B, Needle Bearing Puller (8)	3C8-72704-5	40 / 50

19 Removal

1. Remove oil seal from propeller shaft housing.

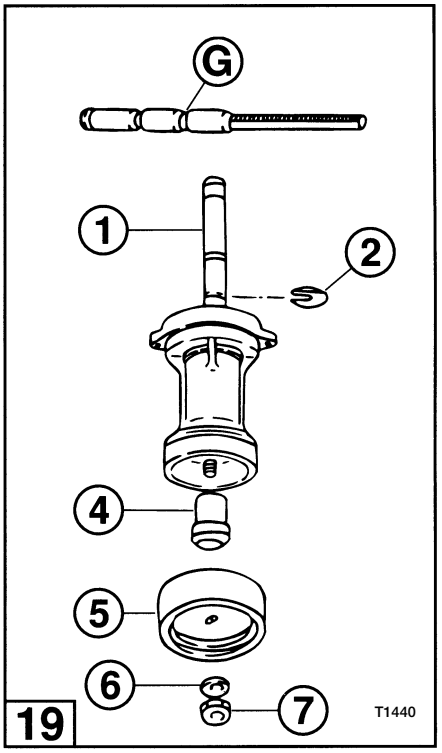
2. Remove roller bearing from propeller shaft housing by heating the housing with a heat gun.

3. Place shaft **(1)** through needle bearing.

4. Attach retainer A **(2)** to shaft groove **(G)** with raised surface of retainer facing bearing.

5. Slide guide B **(4)** and flange B **(5)** onto shaft and secure with washer **(6)** and nut **(7)**.

6. Tighten nut **(7)** until needle bearing releases from housing.



20 Installation

1. Attach retainer A **(2)** to shaft groove **(G)** with raised surface of retainer facing bearing.

2. Coat new needle bearing with gear oil. Slide bearing onto shaft so bearing stamped surface faces retainer A **(2)**.

⚠ CAUTION

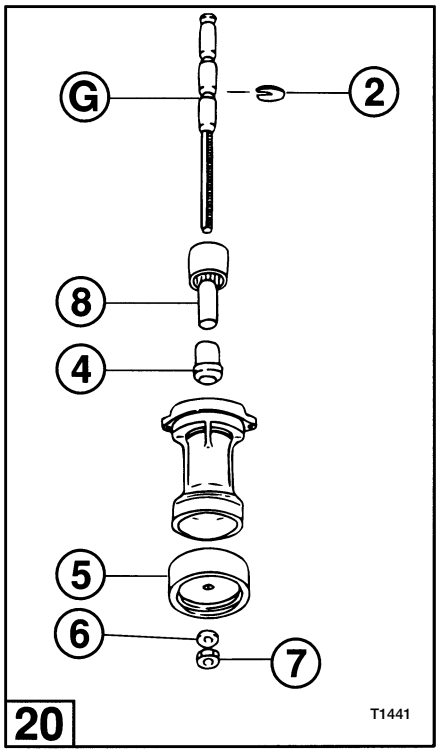
Stamped surface of needle bearing must face retainer or bearing could be damaged during installation.

3. Slide stopper B **(8)** and guide B **(4)** onto shaft and insert shaft in propeller shaft housing.

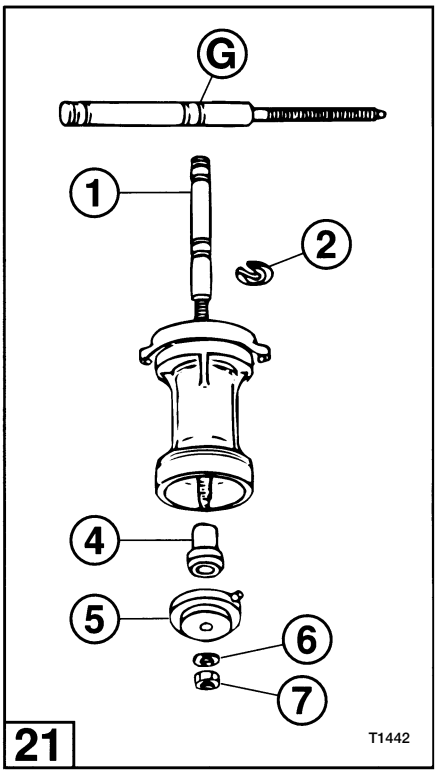
4. Slide flange B **(5)** onto shaft and secure with washer **(6)** and nut **(7)**.

5. Tighten nut **(7)** until stopper B **(8)** contacts flange B **(5)**.

6. Remove tools and verify needle bearing is fully seated in housing.



Propeller Shaft Housing Needle Bearing - Models 60B and 70B



21 22

NOTE

Obtain needle roller bearing puller kit. Reference the following specification table for propeller shaft housing needle bearing Removal and Installation special tool requirements :

Tool		Part Number	Model
Shaft, Needle Bearing Puller	1	3B7-72702-0	60B / 70B
Retainer, Needle Bearing Puller	2	353-72703-0	60B / 70B
Guide, Needle Bearing Puller	4	353-72705-0	60B / 70B
Plate, Needle Bearing Puller	5	353-72701 -0	60B / 70B
Washer, 13-21-2.5	6	346-72707-0	60B / 70B
Nut, 12P1.5	7	3B7-72735-0	60B / 70B
Stopper, Needle Bearing Puller	8	353-72704-0	60B / 70B

21 Removal

1. Remove oil seal from propeller shaft housing.

2. Remove roller bearing from propeller shaft housing by heating the housing with a heat gun.

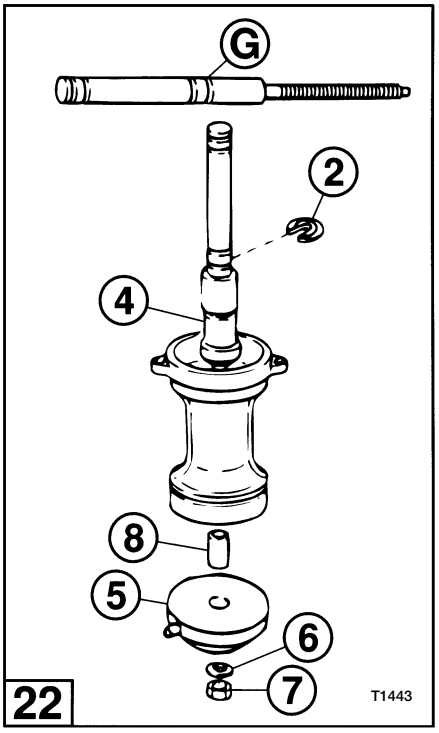
3. Place shaft **(1)** through needle bearing.

4. Attach retainer **(2)** to shaft groove **(G)** with raised surface of retainer facing bearing.

5. Slide guide **(4)** and plate **(5)** onto shaft and secure with washer **(6)** and nut **(7)**.

6. Tighten nut **(7)** until needle bearing releases from housing.

Installation



22 1. Attach retainer **(2)** to shaft groove **(G)** with raised surface of retainer facing bearing.

2. Coat new needle bearing with gear oil. Slide bearing onto shaft so bearing stamped surface faces retainer **(2)**.

⚠ CAUTION

Stamped surface of needle bearing must face retainer or bearing could be damaged during installation.

3. Slide guide B **(4)** onto shaft and insert shaft in propeller shaft housing.

4. Slide stopper **(8)** and plate **(5)** onto shaft and secure with washer **(6)** and nut **(7)**.

5. Tighten nut **(7)** until stopper **(8)** contacts plate **(5)**.

6. Remove tools and verify needle bearing is fully seated in housing.

Propeller Shaft Housing Needle Bearing - Models 60C / 70C / 80 / 90 / 115 / 120 / 140

23 24

NOTE

Obtain needle roller bearing puller kit. Reference the following specification table for propeller shaft housing needle bearing Removal and Installation special tool requirements :

Tool	Part Number	Model
Shaft, Needle Bearing Puller (1)	3B7-72702-0	60C / 70C / 80 / 90 / 115 / 120 / 140
Retainer, Needle Bearing Puller (2)	3B7-72709-0	60C / 70C / 80 / 90 / 115 / 120 / 140
Guide B, Needle Bearing Puller (4)	3B7-72710-0	60C / 70C / 80 / 90 / 115 / 120 / 140
Plate, Needle Bearing Puller (5)	3B7-72701-0	60C / 70C / 80 / 90 / 115 / 120 / 140
Washer, 13-21-2.5 (6)	346-72707-0	60C / 70C / 80 / 90 / 115 / 120 / 140
Nut, 12P1.5 (7)	3B7-72735-0	60C / 70C / 80 / 90 / 115 / 120 / 140
Stopper, Needle Bearing Puller (9)	353-72704-0	60C / 70C / 80 / 90 / 115 / 120 / 140

23 Removal

1. Remove oil seal from propeller shaft housing.

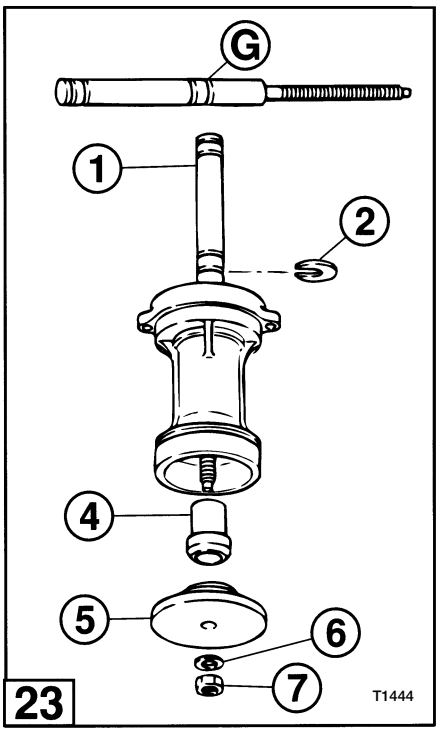
2. Remove roller bearing from propeller shaft housing by heating the housing with a heat gun.

3. Place shaft **(1)** through needle bearing.

4. Attach retainer **(2)** to shaft groove **(G)** with raised surface of retainer facing bearing.

5. Slide guide B **(4)** and plate **(5)** onto shaft and secure with washer **(6)** and nut **(7)**.

6. Tighten nut **(7)** until needle bearing releases from housing.



24 Installation

1. Attach retainer **(2)** to shaft groove **(G)** with raised surface of retainer facing bearing.

2. Coat new needle bearing with gear oil. Slide bearing onto shaft so bearing stamped surface faces retainer **(2)**.

⚠ CAUTION

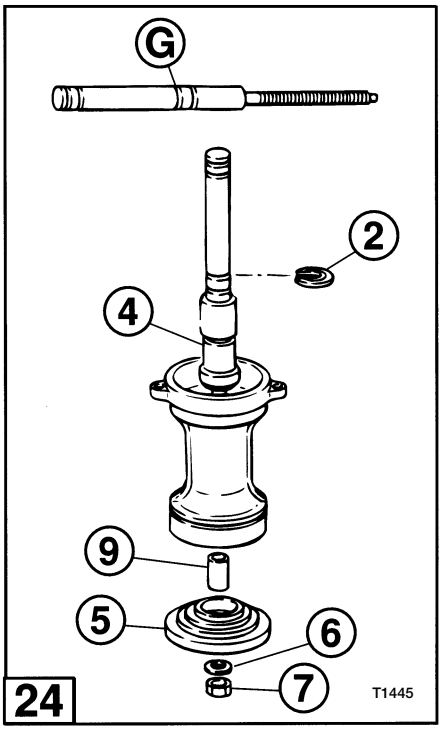
Stamped surface of needle bearing must face retainer or bearing could be damaged during installation.

3. Slide guide B **(4)** onto shaft and insert shaft in propeller shaft housing.

4. Slide stopper **(9)** and plate **(5)** onto shaft and secure with washer **(6)** and nut **(7)**.

5. Tighten nut **(7)** until stopper **(9)** contacts plate **(5)**.

6. Remove tools and verify needle bearing is fully seated in housing.



Bevel Gear A Bearing Outer Race

NOTE

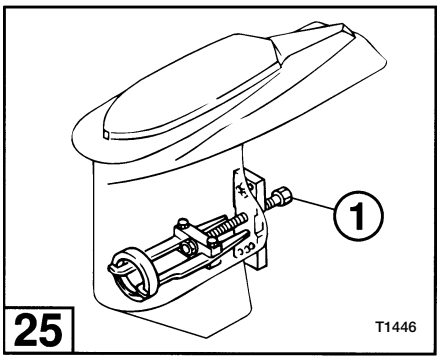
Reference the following specification table for bevel gear A bearing outer race Removal and Installation special tool requirements:

Tool	Part Number	Model
Bevel Gear A Bearing Puller Assembly	3A3-72755-0 (345-72224-1)	40 / 50
Bevel Gear A Bearing Puller Assembly	3B7-72755-0 (3B7-72224-0)	60B / 60C / 70B / 70C / 80 / 90 / 115 / 120 / 140
Bearing Outer Press Kit	3B7-72739-0	40 / 50 / 60 / 70 / 80 / 90 / 115 / 120 / 140
Guide, Bearing Outer Pressing	346-72733-0	40 / 50
Guide, Bearing Outer Pressing	3B7-72733-0	60B / 60C / 70B / 70C / 80 / 90 / 115 / 120 / 140
Rod, Bearing Outer Pressing	3B7-72731-0	40 / 50 / 60B / 60C / 70B / 70C / 80 / 90 / 115 / 120 / 140
Plate, Bearing Outer Pressing	353-72732-0	40 / 50 / 60B / 70B
Plate, Bearing Outer Pressing	3B7-72732-0	60C / 70C / 80 / 90 / 115 / 120 / 140
Spring Washer	941392-1000	40 / 50 / 60B / 60C / 70B / 70C / 80 / 90 / 115 / 120 / 140
Nut	931191-1000	40 / 50 / 60B / 60C / 70B / 70C / 80 / 90 / 115 / 120 / 140

Removal

1. Install bevel gear A bearing puller assembly.

25 2. Tighten bolt **(1)** until bearing race releases from housing.



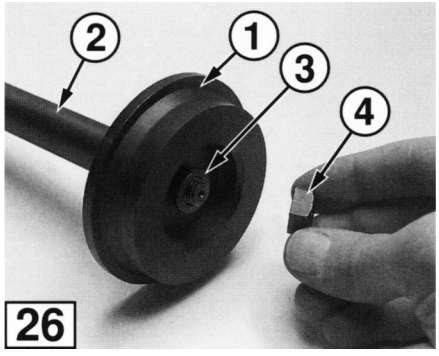
Installation

1. Secure gearcase horizontally in padded vice or other fixture so propeller shaft opening faces upward.

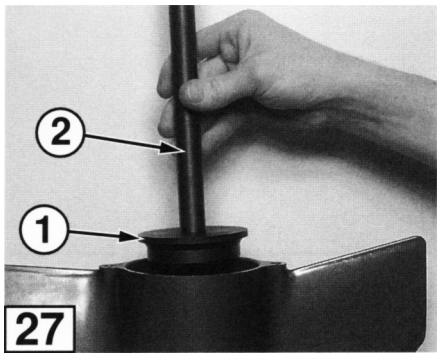
2. Verify bearing race seating surface in gearcase is clean and smooth.

3. Apply specified gear oil to exterior of bearing race. Position race in gearcase so stamped surface faces closed end of gearcase.

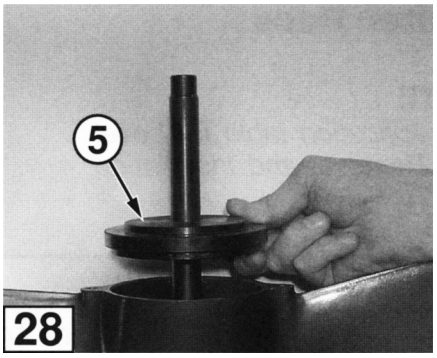
26 4. Attach plate **(1)** to threaded end of rod **(2)** using spring washer **(3)** and nut **(4)**. Tighten nut with wrench.



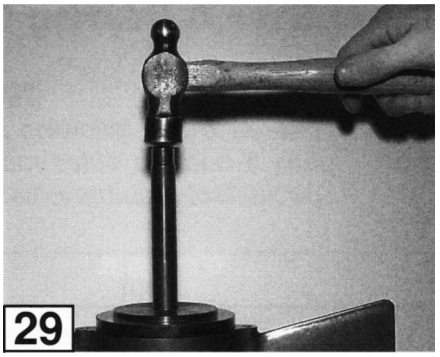
T1447



T1448



T1449

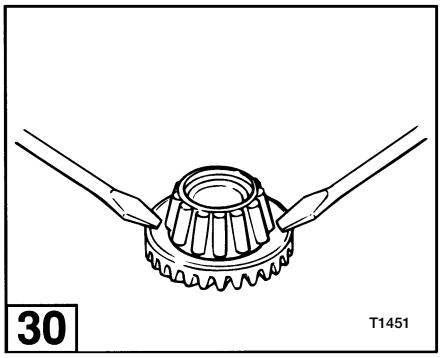


T1450

27 5. Insert rod **(2)** into gearcase so plate **(1)** is seated within the bearing race.

28 6. Slide guide **(5)** onto rod and seat into position on gearcase. Raised surface of guide must fit tightly within the circumference of the gearcase opening.

29 7. Fully seat bearing race in gearcase by hammering the rod end.



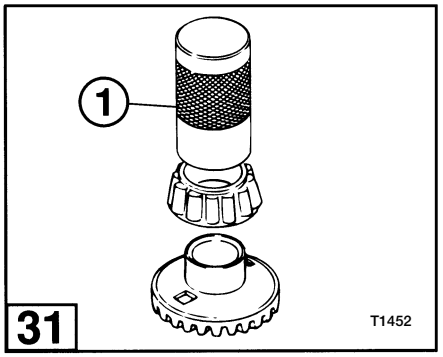
T1451

Bevel Gear A Roller Bearing

Removal and Installation

30 1. Insert screwdrivers in notches of bevel gear A and gently pry gear and bearing apart.

31 2. Use specified set tool **(1)** to press fit bearing onto bevel gear.



T1452

Tool	Part Number	Model
Set Tool, Bevel Gear A Bearing	3C8-72719-0	40 / 50 / 60B / 70B
Set Tool, Bevel Gear A Bearing	3B7-72224-0	60C / 70C / 80 / 90 / 115 / 120 / 140

SECTION 7
ELECTRICAL SYSTEM

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Starting System 7-74
Charging System 7-106

SECTION 7

GENERAL PRECAUTIONS

Before performing any service work on the electrical system, read and understand the Service Safety section at the beginning of this manual.

Use the manufacturer and special tools as indicated during servicing of the electrical system.

Avoid electrical shock:

- Do not handle spark gap tester leads during performance testing.
- Do not touch ignition coils, exciter coil, pulser coils, or alternator coils while the engine is cranking or running.

Use the spark gap tester to prevent the engine from starting when performing static ignition performance tests.

Use caution when performing tests with the engine cover removed. Do not wear loose clothing or jewelry. Keep hair, hands, and clothing away from the flywheel and other moving parts.

After repairs are complete, make sure all ignition and electrical leads are properly routed and clamped in their original positions.

Replace locking fasteners when their locking feature becomes weak. Use only factory replacement parts.

Always inspect and test the start-in-gear prevention system before returning engine to customer.

note

Magneto for Model 60 / 70

Magneto style for Model 60/70 was changed and they are not interchangeable between both parts. The following Serial Numbers indicate breakpoints between older and newer magneto models.

Model	Magneto	Serial number
60B /70B	Older	All of Engines
60C	Older and Newer	Newer : 10840 or higher
70C	Older and Newer	Newer : 13002 or higher

Remark) Magneto consists a flywheel cup, coil plate assembly, CD unit and ignition coils.

SERVICE SPECIFICATIONS

Special Torque Values

Description	Torque in-lb (ft-lb) N·m kg-m				Threadlocker
	Model				
	40 and 50	60 and 70	80 and 90	115 / 120 / 140	
Electrical Box Cover Bolt	—	4 - 9 0.5 - 1.0 0.05 - 0.1	4 - 9 0.5 - 1.0 0.05 - 0.1	26 - 43 3 - 5 0.3 - 0.5	—
Spark Plug	(18 - 22) 25 - 29 2.5 - 2.9	(18 - 22) 25 - 29 2.5 - 2.9	(18 - 22) 25 - 29 2.5 - 2.9	(18 - 22) 25 - 29 2.5 - 2.9	—
Flywheel Nut	(65 - 80) 88 - 108 9 - 11	(101 - 116) 137 - 157 14 - 16	(101 - 116) 137 - 157 14 - 16	(181 - 195) 245 - 265 25 - 27	—

* Refer to Section 2 for Standard Torque Values chart.

Manufacturer Special Tools Required

None

SECTION 7

General Equipment Required

Analog Multimeter, *Electronic Specialties® Model M-530 or equivalent*
Digital Multimeter, *Electronic Specialties® Model KD 3200 or equivalent*
Spark Gap Tester, *Stevens® S-13C, S-48, or equivalent*
Digital Pulse Tachometer, 10 - 6000 RPM, *Electronic Specialties® Model 321 or equivalent*
Variable Load High Rate Discharge Tester, *Electronic Specialties® Model 700 or equivalent*
Hydrometer
Heat Gun
Torque Wrench, 0 -150 in-lb [0 -17 N-m / 0 - 1.7 kg-m]

Consumables Required

Dielectric Lubricant, *Permate® Dielectric Tune-Up Grease*
Battery Spray Protector, *Permatex® Battery Protector and Sealer*
Low Temperature Lithium Grease
Genuine Grease or Equivalent Friction Surface Marine Grease
Threadlocker, *Loctite® 243*
Isopropyl Alcohol
Cleaning Solvent
Thermomelt Stik, 125˚F [52˚C] and 163˚F [73˚C]
Electrical Shrink Fit Tubing, various diameters

Electrical System

NOTE

Refer to Outboard Motors Service Data publication for all wiring diagrams when performing electrical testing.

Ignition Type
Flywheel magneto capacitor discharge

Ignition Timing
degree

40D: ATDC 3˚ ± 1˚ - BTDC 18˚ ± 1˚

50D: ATDC 3˚ ± 1˚ - BTDC 24˚ ± 1˚

$40D_2$: ATDC 3˚ ± 1˚ - BTDC 18˚ ± 1˚

$50D_2$: ATDC 3˚ ± 1˚ - BTDC 20˚ ± 1˚

60B: ATDC 3˚ ± 1˚ - BTDC 16˚ ± 1˚

70B: ATDC 3˚ ± 1˚ - BTDC 20˚ ± 1˚

60C: ATDC 3˚ ± 1˚ - BTDC 17.5˚ ± 1˚

70C: ATDC 3˚ ± 1˚ - BTDC 17.5˚ ± 1˚

80: ATDC 5˚ ± 1˚ - BTDC 20˚ ± 1˚

90: ATDC 5˚ ± 1˚ - BTDC 20˚ ± 1˚

115: ATDC 10˚ - BTDC 17.5˚ ± 1˚

120: ATDC 10˚ - BTDC 17.5˚ ± 1˚

140: ATDC 10˚ - BTDC 20˚ ± 1˚

Spark Plug (with resistor)
40: NGK BR7HS-10 or Champion RL-82C
50, 60, 70, 80, 90, 115, 120, 140: NGK BR8HS-10 or Champion RL-78C

Spark Plug (without resistor)
40: NGK B7HS-10 or Champion L-82C
50, 60, 70, 80, 90, 115, 120, 140: NGK B8HS-10 or Champion L-78C

Spark Plug Gap
in [mm]
0.035 - 0.039 [0.9 - 1.0]

Battery
12 V, 500 CCA with 105 minutes [70 AH] reserve capacity

Engine Fuse
20 A

Alternator
40, 50, 60, 70, 80, 90: 12 V 130 W
115, 120, 140: 12 V 330 W

Charging Performance

At 1500 RPM	**40, 50, 60, 70, 80, 90 :** 3 A
	115, 120, 140 : 12 A
At 5500 RPM	**40, 50, 60, 70, 80, 90 :** 9 - 11 A
	115, 120, 140 : 24.5 - 27.5 A

Number of Tachometer-to-Alternator Coil Impulses
40, 50, 60, 70, 80, 90 : 6
115, 120, 140 : 12

Alternator Coil Resistance
40, 50: W - Y, 0.2 - 0.3 Ω
60, 70: W - Y, 0.2 - 0.3 Ω
80, 90: 0.2 - 0.3 Ω
115, 120, 140: 0.26 - 0.40 Ω

Ignition Coil Resistance
Primary Coil
40, 50: 0.18 - 0.24 Ω
60, 70: 0.18 - 0.24 Ω
80, 90: 0.19 - 0.25 Ω
115, 120, 140: 0.18 - 0.24 Ω

Secondary Coil
40, 50: 2.7 - 3.7 kΩ
60, 70: 2.7 - 3.7 kΩ
80, 90: 3.6 - 4.8 kΩ
115, 120, 140: 2.7 - 3.7 kΩ

CD Unit Output (Cranking)
40, 50, 60, 70, 80, 90, 115, 120, 140:
198 - 220 DVA

Exciter Coil Output (Cranking)
40, 50, 60C, 70C, 80, 90, 115, 120, 140:
135 - 150 DVA
60B, 70B:
8.1 - 9.9 DVA (WHITE/GREEN to BROWN/WHITE)
34.2 - 41.8 DVA (WHITE/GREEN to WHITE/YELLOW)
35.1 - 42.9 DVA (BROWN/WHITE to WHITE/YELLOW)

Pulser Coil Output (Cranking)
40, 50, 60, 70, 80, 90, 115, 120, 140:
4.75 - 5.0 DVA (minimum 3.0 DVA)

ELECTRICAL SERVICING STANDARDS

Electrical Connectors

When you replace electrical components or perform diagnostic tests, you must disconnect electrical connectors in many instances.

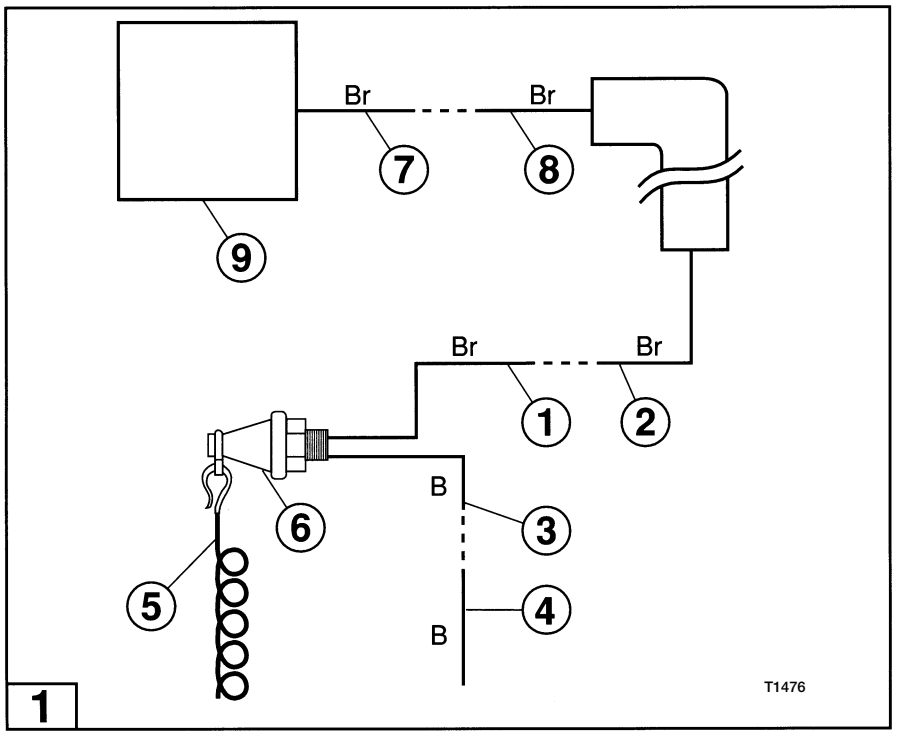
The following discussion will help you recognize connectors in electrical drawings and show you how to disconnect and connect them.

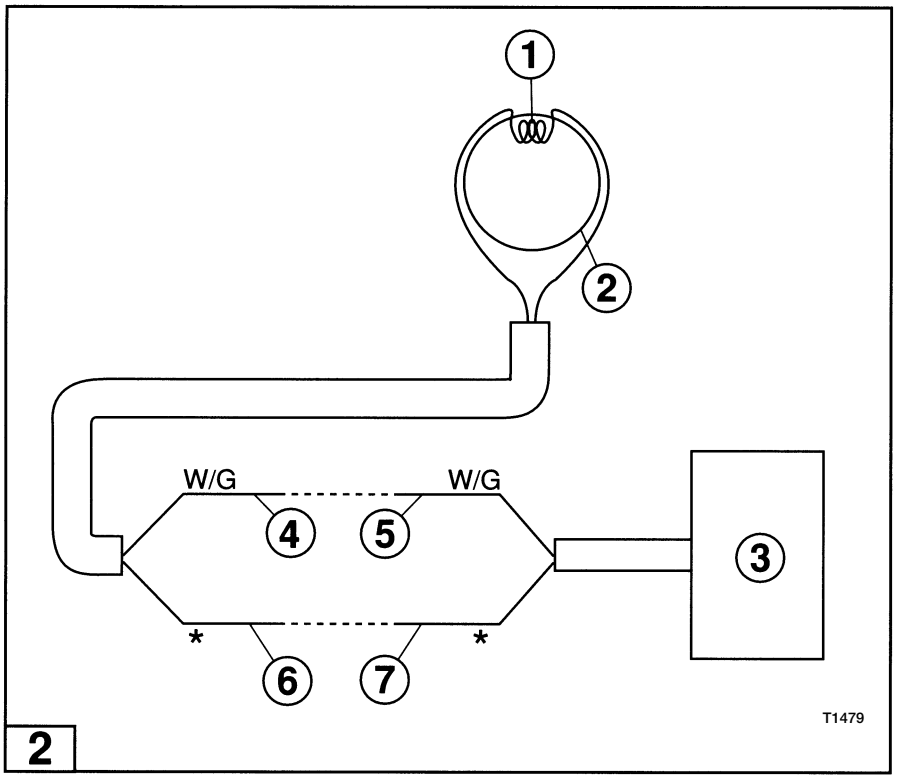
Electrical Connector Drawings

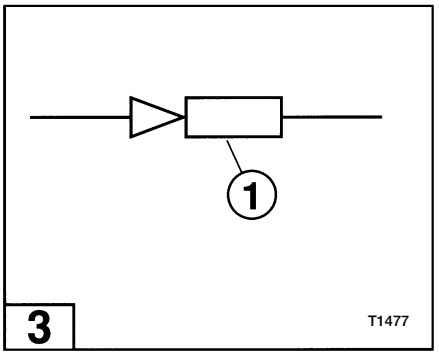
In most of the electrical drawings in this section, the physical shape of electrical connectors has been eliminated to clarify testing procedures.

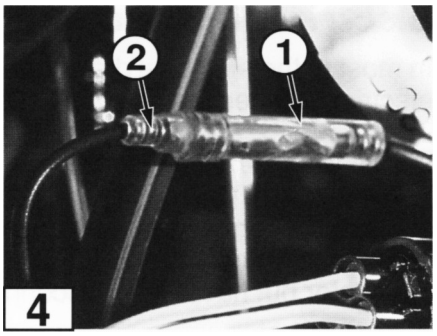
1 Atypical electrical drawing illustrates several connectors. Items **(1), (2), (3), (4), (7)** and **(8)** are terminals that are located inside of electrical connectors. The dashed line between two terminals [e.g., between terminal **(7)** and **(8)**] means that they are a part of the same connector but have been disconnected for testing.

Note that Terminal **(7)** is directly connected to the CD Unit **(9)** (no connectors between the terminal and CD Unit). When you disconnect an electrical connector to test a component, it is very important that you disconnect the FIRST CONNECTOR.
Terminals **(1)**, **(3)** and **(7)** are examples of how the first connector is illustrated.









2 Special cases are the connectors used to test components located on the coil plate assembly. For testing purposes, the first connector is located at the far end of the cable (away from the coil plate assembly) and usually found inside of the electrical box.

Bullet Connectors

NOTE

3 *Bullet connectors **(1)** are shown like this in electrical drawings.*

Disconnecting Bullet Connectors

1. Carefully examine the connector to determine which end is removable and which end is fixed. Typically the insulation surrounding the removable end is tapered so it fits inside of the insulation for the fixed end.

4 2. Grasp the fixed end **(1)** of the connector and carefully pull the removable end **(2)** straight out without twisting or bending it.

NOTE

Never twist or bend bullet connectors or damage to the connectors will occur. Always PULL these connectors apart.

Connecting Bullet Connectors

Grasp the fixed end **(1)** of the connector and carefully push the removable end **(2)** into it without twisting or bending the connector.

Rectangular and Triangular Multi-Conductor Connectors

NOTE

5 *Multiple-conductor connectors may be shown like this **(1)** or this **(2)** in electrical drawings.*

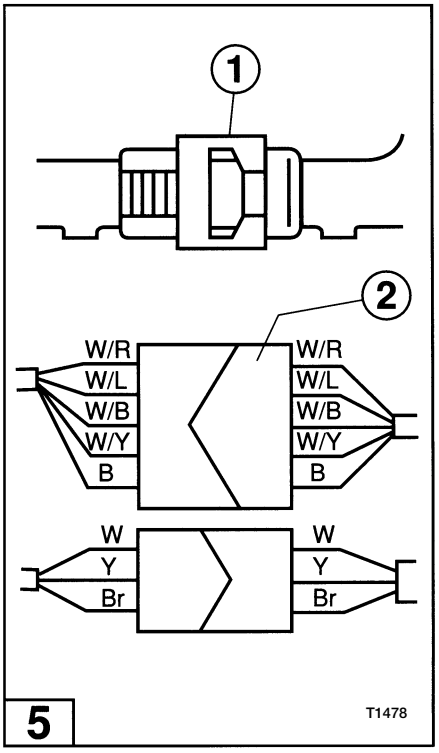
These types of connectors are held closed with a plastic tab. The tab is constructed with a “spring” action so it stays locked. Two types of locks are typically used:

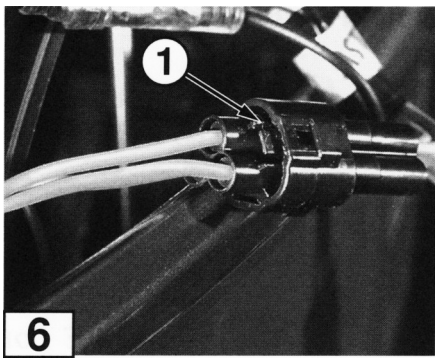
6 PRESS tab **(1)** and pull connector apart.

7 LIFT UP on tab **(1)** and pull connector apart.

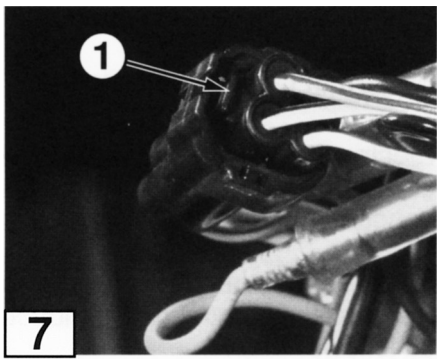
NOTE

Always PRESS or LIFT UP the tab of these connectors while you pull them apart. Do not pry or twist the connector or use force or damage will occur.





T1466

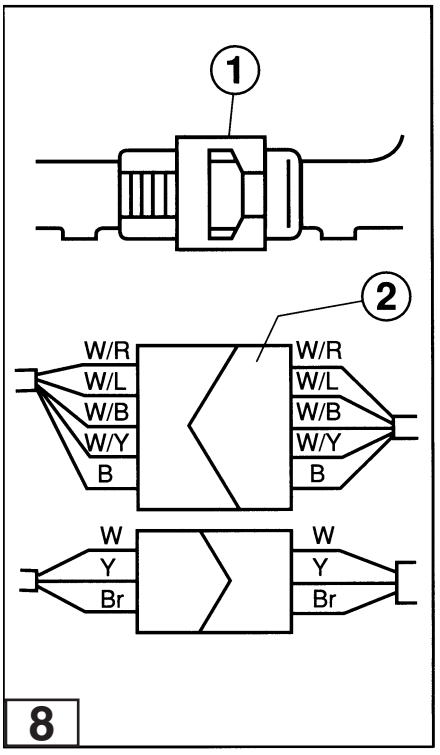


T1467

Round Multi-Conductor Cable Connectors

NOTE

8 *Multiple-conductor connectors may be shown like this **(1)** or this **(2)** in electrical drawings.*



9 These types of connectors are held closed with a lock ring. SQUEEZE both ridged locks **(1)** and at the same time carefully pull the connector apart without twisting or bending it.

NOTE

Always SQUEEZE both ridged locks on these connectors while you pull them apart. Do not pry or twist the connector or use force or damage will occur.

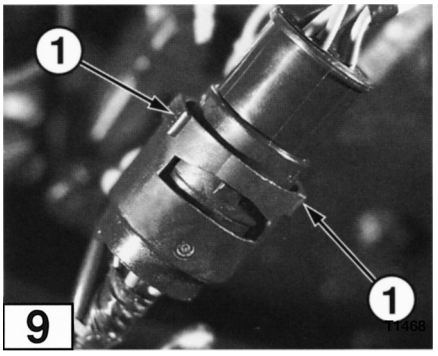
Electrical Cable Color Codes

Electrical cables have color coded conductors so you can locate the correct conductor during troubleshooting and repair procedures. All conductor colors are in capital letters in this manual. T1479

Some conductors have a background color and a different color stripe that runs the length of the conductor. These conductors are designated as follows:

A/B
Where A = Background Color
B = Stripe Color

Example:
BLACK/WHITE
This conductor has a BLACK background with a WHITE stripe.



Electrical Drawings

All electrical drawings shown in this manual have been simplified to clarify the circuit that is being tested. They represent typical configurations and may not look exactly like the electrical wiring for your engine. Complete electrical schematics are provided in the Outboard Motors Service Data publication.

TROUBLESHOOTING

The troubleshooting chart lists common engine symptoms related to problems with the electrical system. It also indicates specific malfunctions in the electrical system which may be causing a problem so it can be isolated more effectively. Before beginning major troubleshooting on the electrical system, perform the following operations:

- Check battery fluid level and specific gravity. Charge or replace as required. See Battery Care and Maintenance, this section.
- Check the following electrical connections and make sure they are secure and free of corrosion:
    - Battery cables
    - Starter solenoid wiring
    - Starter motor wiring (including ground connection)
    - Spark plug leads
    - Ignition circuit wiring
    - Stop circuit wiring
    - Charge circuit wiring
- Make sure shift lever or remote control lever operates freely.
- Attach lanyard to emergency stop switch, see Section 2.

Ignition System

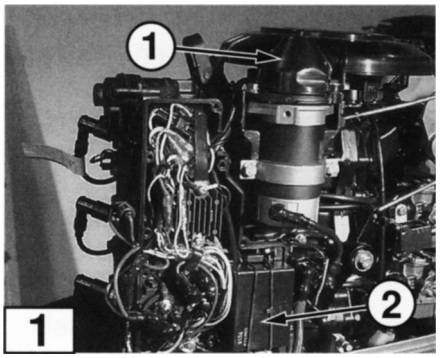
SYMPTOM / CHECKS	Cranks but will not start	Will not start and pops or backfires	Starts but stops immediately	Low or high speed miss	Poor acceleration, low top end RPM	Engine will not shut off
Faulty stop circuit - see Test 2 - Stop Circuit Test, this section						●
Faulty ignition system - see Ignition System Performance Testing, this section		●		●	●	●
Faulty spark plug(s) - See Section 2	●		●	●	●	
Overheating, low water pressure, or faulty RPM limitation circuit - see RPM Limitation Test, this section			●	●		
Incorrect ignition timing or carburetor synchronization - See Section 2		●	●	●	●	

Starting System

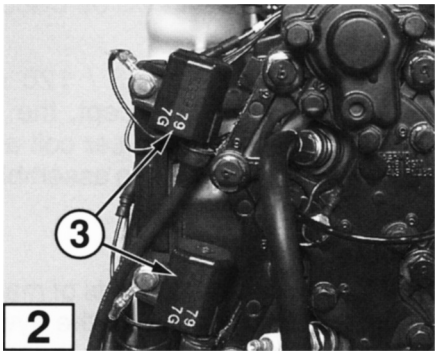
SYMPTOM / CHECKS	Will not crank
Blown fuse	●
Faulty main key switch	●
Not in Neutral, defective Neutral switch	●
Faulty battery, starter solenoid cable or starter motor cable	●
Faulty starter solenoid	●
Faulty starter motor: - Faulty brushes - Damaged pinion assembly	●

Charging System

SYMPTOM / CHECKS	Battery does not maintain charge or overcharges
Blown fuse	●
Shorted or faulty alternator coil	●
Faulty recitier/regulator	●
Faulty charge circuit wiring	●



T1453

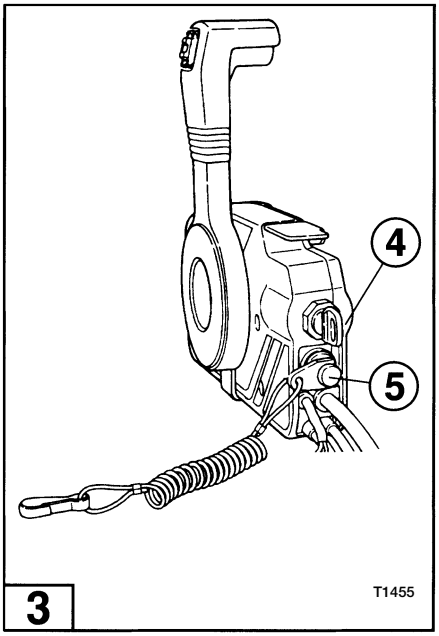


T1454

DESCRIPTION OF OPERATION

Ignition System

1 2 3 The ignition system consists of the magneto **(1)**, Capacitive Discharge (CD) unit **(2)**, ignition coils **(3)**, main key switch **(4)** and emergency stop switch **(5)**. The purpose of this system is to provide an electric spark inside each cylinder at the precise moment needed by the combustion chamber.



T1455

Magneto
For models 40 / 50 / 60 / 70 / 80 / 90 :

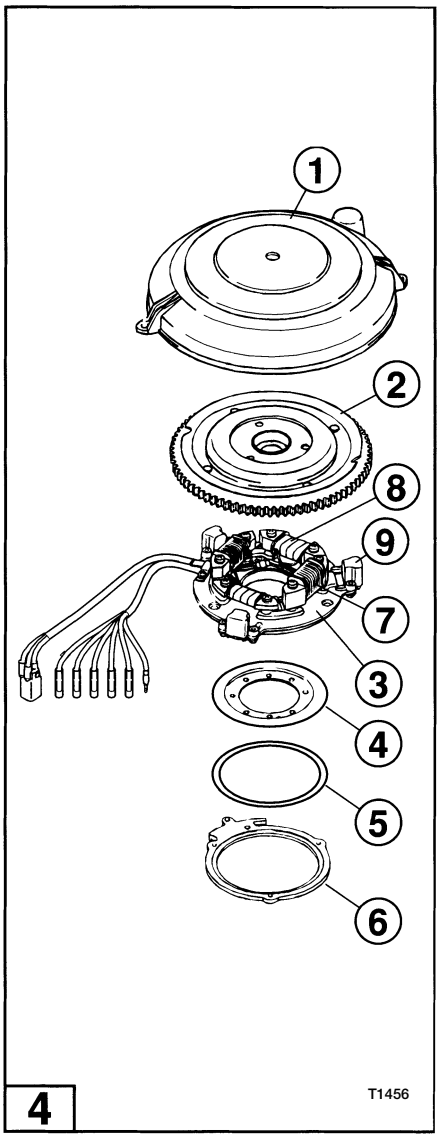
4 The magneto consists of a cover **(1)**, flywheel **(2)**, and coil plate assembly **(3)**, guide plate **(4)**, shim **(5)**, and set ring **(6)**. Mounted radially inside the flywheel are a series of high-performance ferrite magnets. The boss, located in the center of the flywheel, is keyed to maintain proper alignment with the crankshaft. The flywheel is plated to help prevent corrosion.

The coil plate assembly consists of an alternator coil set **(7)**, exciter coil set **(8)**, and pulser coil set **(9)**. The alternator coil set provides charging voltage and will be discussed further in the charging system description.

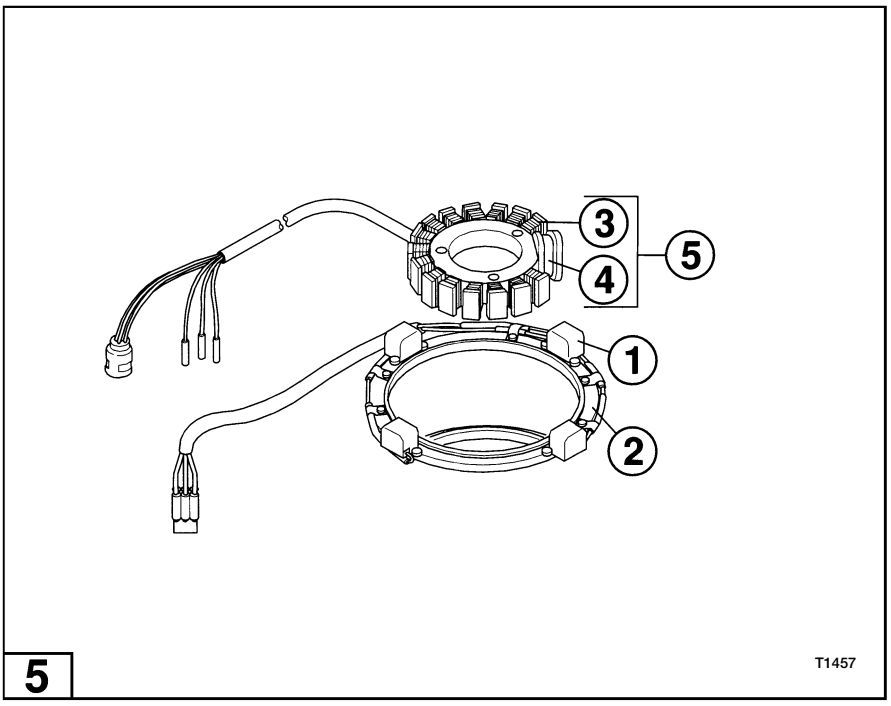
5 For models 115 / 120 / 140: The magneto has similar components except, the pulser coils **(1)** are on a separate assembly called the pulser coil assembly **(2)**. The alternator **(3)** and exciter coils **(4)** are on an assembly called the alternator assembly **(5)**.

Exciter Coil Set
The exciter coil set consists of many windings of wire wrapped around a metal lamination. Once the flywheel exceeds a minimum cranking RPM, the lines of force from the ferrite magnets cut through the exciter coil windings to produce about 150 DVA (peak voltage) at cranking speed. The output from the exciter coil set is used to power the CD Unit.

60B and 70B engines have two exciter coils; one activates at speeds up to 1700 RPM and both coils are activated at speeds over 1700 RPM.



4



5

Pulser Coil Set
Each pulser coil in the coil consists of a permanent magnet with many windings of wire wrapped around it. The flywheel has a metallic cam, called an interrupter, molded on it. When the interrupter passes in close proximity to the pulser coil, the lines of force produced by the permanent magnet collapse momentarily. At cranking speed this produces a 4.75 to 5.0 DVA signal in the coil.

The output voltage from each pulser coil is used to control a small electronic switch (SCR) located inside of the CD Unit. When the CD Unit receives an output from a pulser coil, it directs an output, approximately 220 DVA, to the appropriate ignition coil primary.

- 3 cylinder models - Three pulser coils are provided, one per cylinder.
- 4 cylinder models - Four pulser coils are provided, one per cylinder.

CDUnit
The CD Unit has three major functions:

- The CD Unit receives its operating voltage from the exciter coil(s) and converts it into pulsating direct current for storage.
- The CD Unit stores this pulsating direct current in a capacitor.
- The CD Unit uses a series of electronic switches (SCRs), activated by pulser coil output, to select the correct ignition coil primary winding for firing. The CD Unit has one SCR for each ignition coil it controls.

Depending upon the engine model, the CD Unit will limit the engine speed to about half its maximum RPM when the overheat sensor, water pressure sensor, or oil level sensor signals an abnormal condition. A safety feature provided by the CD Unit on all engine models, is over-speed limitation. The 115, 120 and 140 model engines have a third type of speed limitation. The CD Unit will limit the top engine speed to about 1500 RPM if the RED/YELLOW lead from the CD Unit to the remote control box is not properly connected. Refer to the RPM Limitation Test section for more detail on RPM limitation functions.

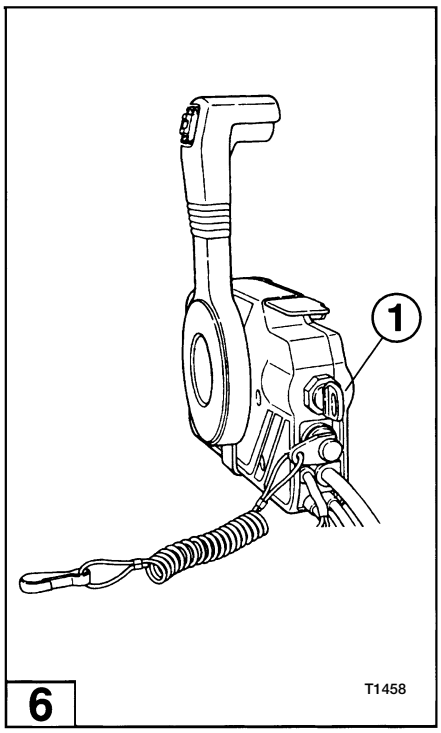
The engines of the models 115, 120 and 140 are provided with a starting-automatic-advance mechanism that is described below.

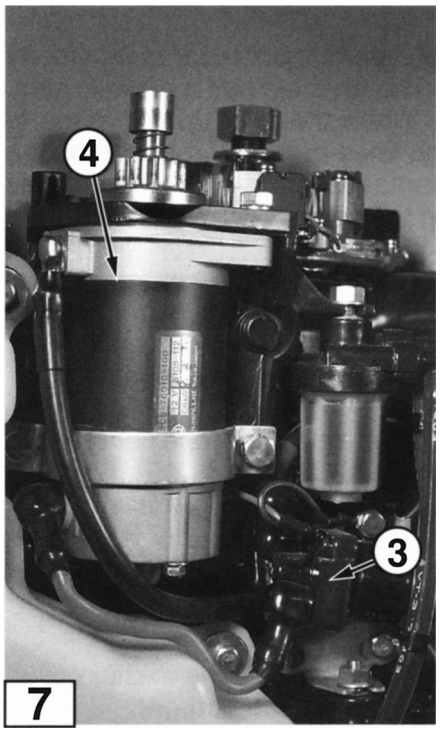
Choke solenoid	Angle of advance	Period of connection
when inactive	6 degrees	1 to 4 seconds
when active	6 degrees	When the choke solenoid is active, and 30 seconds after it stops its operation

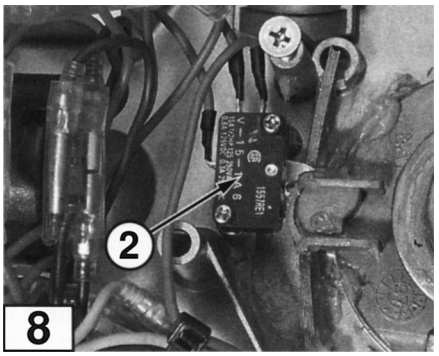
IgnitionCoil
Each ignition coil consists of two windings of wire wrapped around a compacted ferrite material. The coil has a primary and secondary terminal connection and a ground plate.

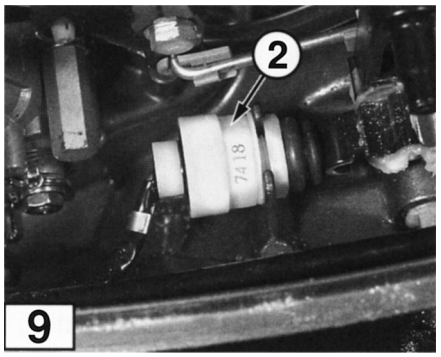
Through mutual induction, the ignition coil transforms the output from the CD Unit to as much as 40,000 volts to fire the spark plug.

- 3 cylinder models - Three ignition coils are provided, one per cylinder.









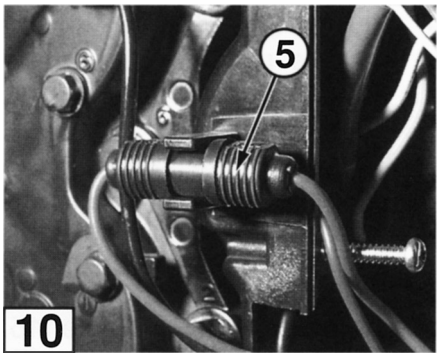
- 4 cylinder models - Four ignition coils are provided, one per cylinder.

Main Key Switch and Emergency Stop Switch

The main key switch and emergency stop switch are connected to the CD Unit through an engine wiring harness. When the main key switch is in the OFF position, or the lanyard is removed from the emergency start switch, an input to the CD Unit is grounded. This deactivates the CD Unit and the engine shuts down.

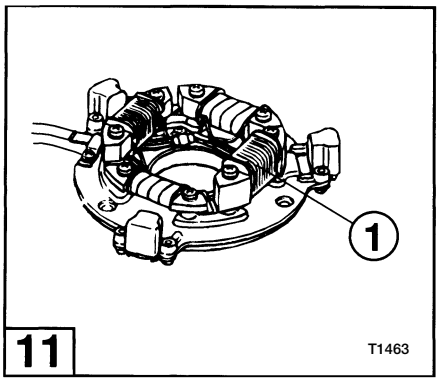
Starting System

6 7 8 9 10 The starting system consists of the battery, main key switch **(1)**, neutral start switch **(2)**, starter solenoid **(3)**, starter motor **(4)** and 20 A engine fuse **(5)**. When the main key switch is in the START position, and the start contacts of the neutral start switch are closed, power is sent to the starter solenoid, energizing it. When the starter solenoid is energized, a connection between the positive terminal of the battery and the starter motor is provided. The connection between the starter motor and ground completes the circuit. The fuse opens if the coil circuit of the starter solenoid shorts or overloads.



Charging System

11 12 The charging system consists of the alternator coil set **(1)**, rectifier/regulator **(2)**, 20 A engine fuse, and the battery. When the flywheel is turning approximately 1500 RPM or higher, the alternator coil set provides alternating current (AC) voltage to the rectifier/regulator. The rectifier/regulator transforms the AC voltage into direct current (DC) voltage. Regulator output is about 15 volts DC with a current rating of 9 - 11 A [models 40 / 50 / 60 / 70 / 80 / 90] or 24.5 - 27.5 A [models 115 / 120 / 140] at 5,500 RPM. The fuse protects the charging circuit from shorts or an overload.



BATTERY CARE AND MAINTENANCE

⚠⚠ WARNING

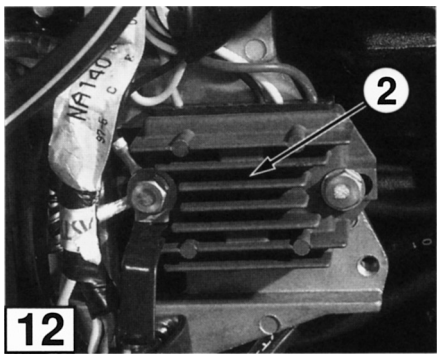
Batteries produce an explosive mixture of oxygen and hydrogen! Keep any sparks or open flame away from battery while charging or performing terminal voltage test. When you charge the battery, remove the filler caps (if any) from each cell. Always remove the negative cable first, then the positive one.

⚠ CAUTION

Battery electrolyte is an acidic solution and is poisonous. It is strong enough to burn skin, eat holes in clothing, and cause blindness if splashed into the eyes. Work in a well-ventilated area, wear eye protection and protective gloves.

If electrolyte is spilled, flush exposed skin with plenty of clean water. Flush eyes for 10 to 15 minutes. Get medical help immediately.

If electrolyte is ingested, do not induce vomiting, drink large amounts of milk of magnesia, beaten eggs, or vegetable oil. Get medical help immediately.



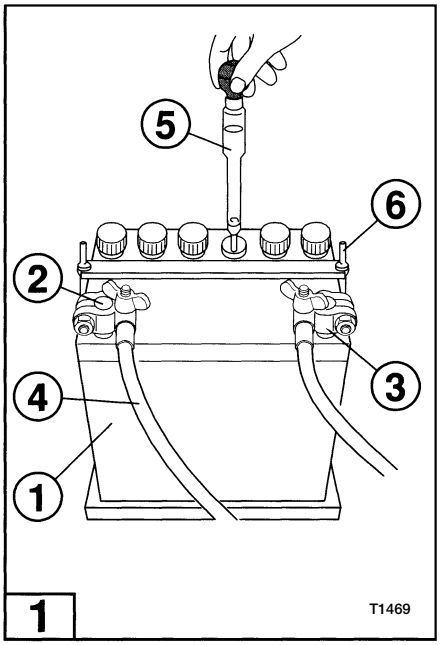
Inspection and Cleaning

Inspection

The first step in determining the condition of a battery should be a visual inspection. Check:

1 • Battery case **(1)** for cracks or other damage.

- Terminals **(2)** for corrosion; make sure they have not come loose from battery.
- Cable connectors **(3)** for corrosion; tighten to manufacturer's specifications for good electrical contact.
- Cables **(4)** for cracked or frayed insulation.
- Electrolyte level (if not a sealed maintenance free type); add fluid (distilled water) according to manufacturer's instructions; check for visible contamination; check specific gravity **(5)**.
- Battery mounting **(6)** for corrosion; tighten to manufacturer's specifications.



Cleaning
Follow this procedure to clean the battery:

1. Disconnect cables and remove battery.

2. Prepare a solution of one part baking soda to four parts of water. Clean battery, terminals, cable connectors, battery mounting, and battery box.

NOTE

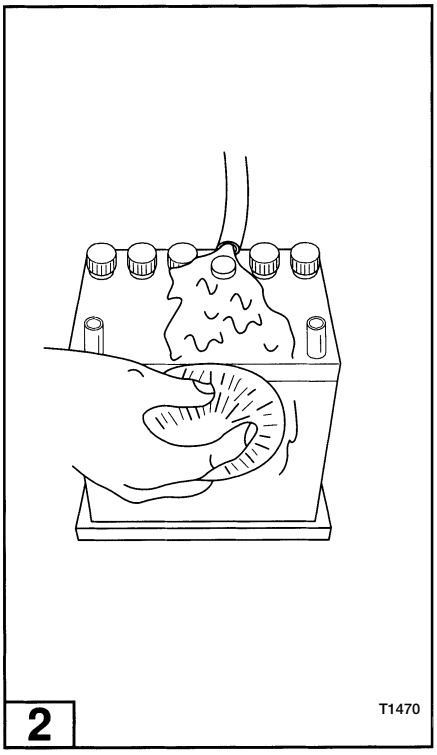
Keep cleaning solution out of battery cells.

3. Flush with clear water. Let dry.

4. Install battery according to manufacturer's specifications.

5. Apply battery spray protector to battery terminals and cable connectors to prevent corrosion.

6. Attach cables and tighten to manufacturer's specifications.



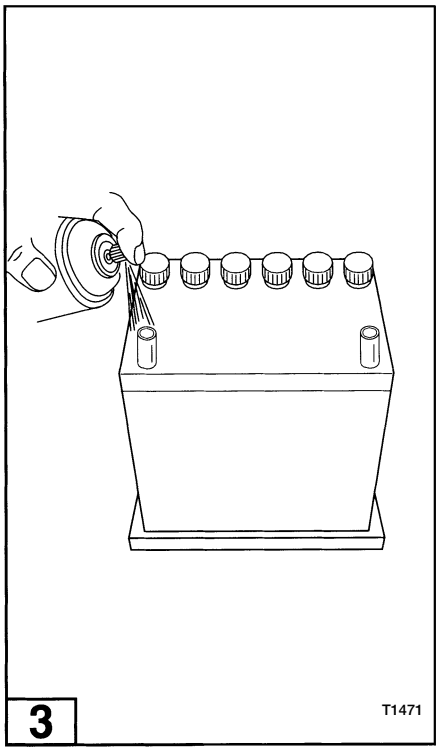
Testing

Specific Gravity Test
If the battery is not a sealed maintenance free type, follow this procedure to check the specific gravity:

1. Make sure electrolyte in each cell is up to level specified by manufacturer.

NOTE

If more fluid is added, only fill to lower fill line since the fluid level will rise during charging process. Charge battery per the instructions provided in the Charging Capacity Test in this section,



4 2. Insert the hydrometer tube into the battery cell and use the bulb to withdraw fluid until the float is free.

3. View the hydrometer with your eye at the same level as the fluid.

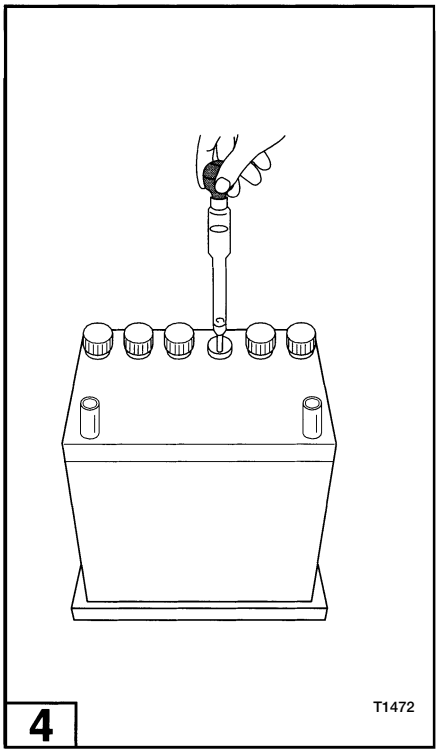
4. Note the temperature of the battery fluid or ambient air.

5. For a fully charged battery, specific gravity should be 1.260 at 68˚F [20˚C] and uniform [variation 0.030 or less between any two cells]. Correct for actual temperature as follows:

Corrected specific gravity = MSP + (temperature - 20) x 0.0007

Where: MSP = measured specific gravity
temperature = measured temperature in ˚C

6. If the corrected specific gravity is below 1.260, or the specific gravity between any two cells is greater than 0.030, perform the Charging Capacity Test which is described next.



4

Charging Capacity Test

⚠⚠ WARNING

Batteries produce an explosive mixture of oxygen and hydrogen! Keep any sparks or open flame away from battery while charging or performing terminal voltage test. When you charge the battery, remove the filler caps (if any) from each cell.

⚠⚠ WARNING

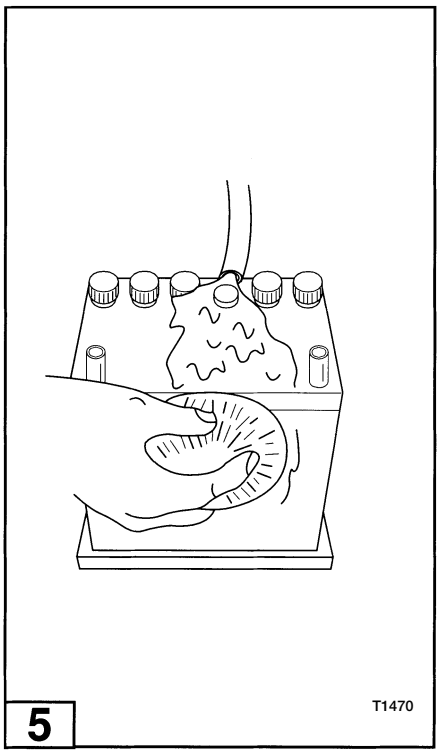
To avoid the potential for an explosion with fuel vapor, always remove the battery from boat when you are charging it.

⚠⚠ WARNING

Always remove the negative cable first, then the positive one.

This test determines whether a battery can take a full charge (if the battery is not a sealed maintenance free type).

5 1. Clean the battery and make sure electrolyte is at lower fill line.



5

6 2. Test the specific gravity of the battery. See the Specific Gravity Test previously discussed in this section.

7 3. Find the Battery Charge Percent using the Specific Gravity/ Battery Charge Relationship Chart.

4. Calculate the amount of discharge in ampere hours using this formula:

Amount of Discharge (AH) = Rated Ampere Hours x Battery Charge Percent x 0.01

Where: RatedAmpere Hours = Manufacturer's rating for battery being tested.

Battery Charge Percent = Equals value obtained from chart.

5. Calculate the charging current using this formula:

Charging Current (A) = 0.3 x Rated Ampere Hours

Where: Rated Ampere Hours = Manufacturer's rating for battery being tested.

6. Calculate the number of hours to charge the battery using this formula:

$$\text{Charging (hours)} = \frac{\text{Amount of Discharge (AH)}}{\text{Charging Current (A)}} \times 1.5$$

7. Remove the caps from each cell and begin charging at the charging current previously determined.

⚠ CAUTION

Reduce charging current, and lengthen the charging time proportionately, if the temperature of the electrolyte rises above 115˚F [45˚C] or gassing becomes excessive. Heat will shorten the life of the battery.

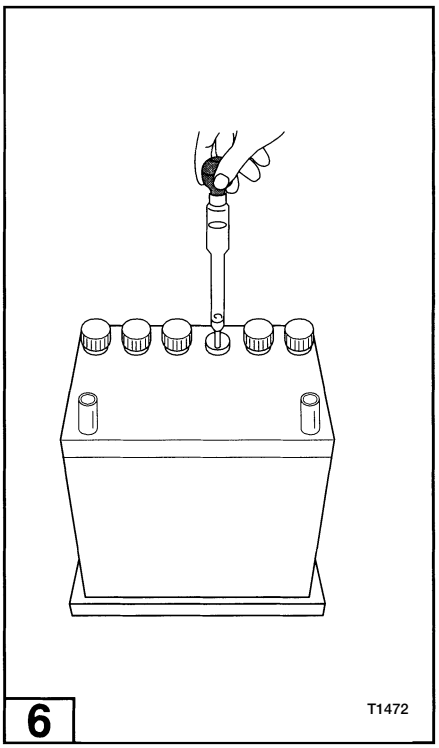
NOTE

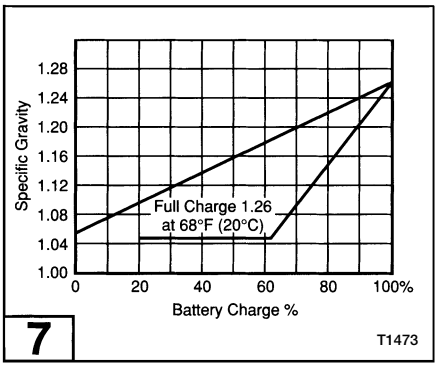
Set the battery charger to the charging current value previously determined or the nearest lower charging current value.

8. Monitor the battery voltage while it is charging. If the voltage suddenly jumps to over 13 volts just after the start of charging, the plates are probably sulfated and the battery should be replaced.

A good battery will rise to 12 volts immediately and then gradually go up to 12.5 to 13 volts in about 30 to 60 minutes after charging is started.

9. If one cell produces little or no gas bubbles during charging, it is probably shorted and the battery should be replaced.





10. As soon as the charging process has completed, measure the battery voltage and specific gravity. The voltage should be 15 to 16 volts and the specific gravity should be 1.260 (corrected for temperature). If either of these conditions are not met, replace the battery.

Terminal Voltage Test

⚠⚠ WARNING

Batteries produce an explosive mixture of oxygen and hydrogen! Keep any sparks or open flame away from battery while charging or performing terminal voltage test. When you charge the battery, remove the filler caps (if any) from each cell.

⚠⚠ WARNING

To avoid the potential for an explosion with fuel vapor, always remove the battery from boat when you are charging it.

⚠⚠ WARNING

Always remove the negative cable first, then the positive one.

Check electrolyte level and specific gravity before running the terminal voltage test.

1. Connect the Variable Load High Rate Discharge Tester to battery terminals.

2. Discharge at 210 amperes (3 x ampere hour rating of battery) for 15 seconds.

3. Measure voltage at battery terminals. If 9.6 volts, or higher, battery has a good output capacity. If lower than 9.6 volts, replace the battery.

Charging

See the Charging Capacity Test procedure in this section for the correct battery charging procedure.

IGNITION SYSTEM

⚠ CAUTION

All cranking output tests must be performed with spark plugs installed and torqued in the cylinder head. If necessary to remove the spark plugs, be sure to keep the spark gap tester away from open spark plug holes.

⚠ CAUTION

Avoid electrical shock:

- **Do not handle spark gap tester leads during performance testing.**
- **Do not touch ignition coils, exciter coil, pulser coils, or alternator coils while the engine is cranking or running.**

⚠ CAUTION

Use proper precautions when performing tests with the engine cover removed. Do not wear loose clothing or jewelry. Keep hair, hands, and clothing away from the flywheel and other moving parts.

⚠ CAUTION

When repairs are complete, make sure all ignition and electrical leads are properly routed and clamped in their original positions and the start-ingear prevention system must be tested before returning engine to customer.

Ignition System Performance Testing

Ignition Performance Testing is divided into two sections. The first section consists of a flow chart. This chart presents the correct sequence of performing ignition system performance tests to effectively and efficiently check for problems in starting and running the engine. Follow the steps in the order listed until the problem is resolved and the ignition system meets specifications while the engine is running.

The chart references specific performance tests that must be completed to resolve each problem. These tests are described in detail in the section which follows the flow chart.

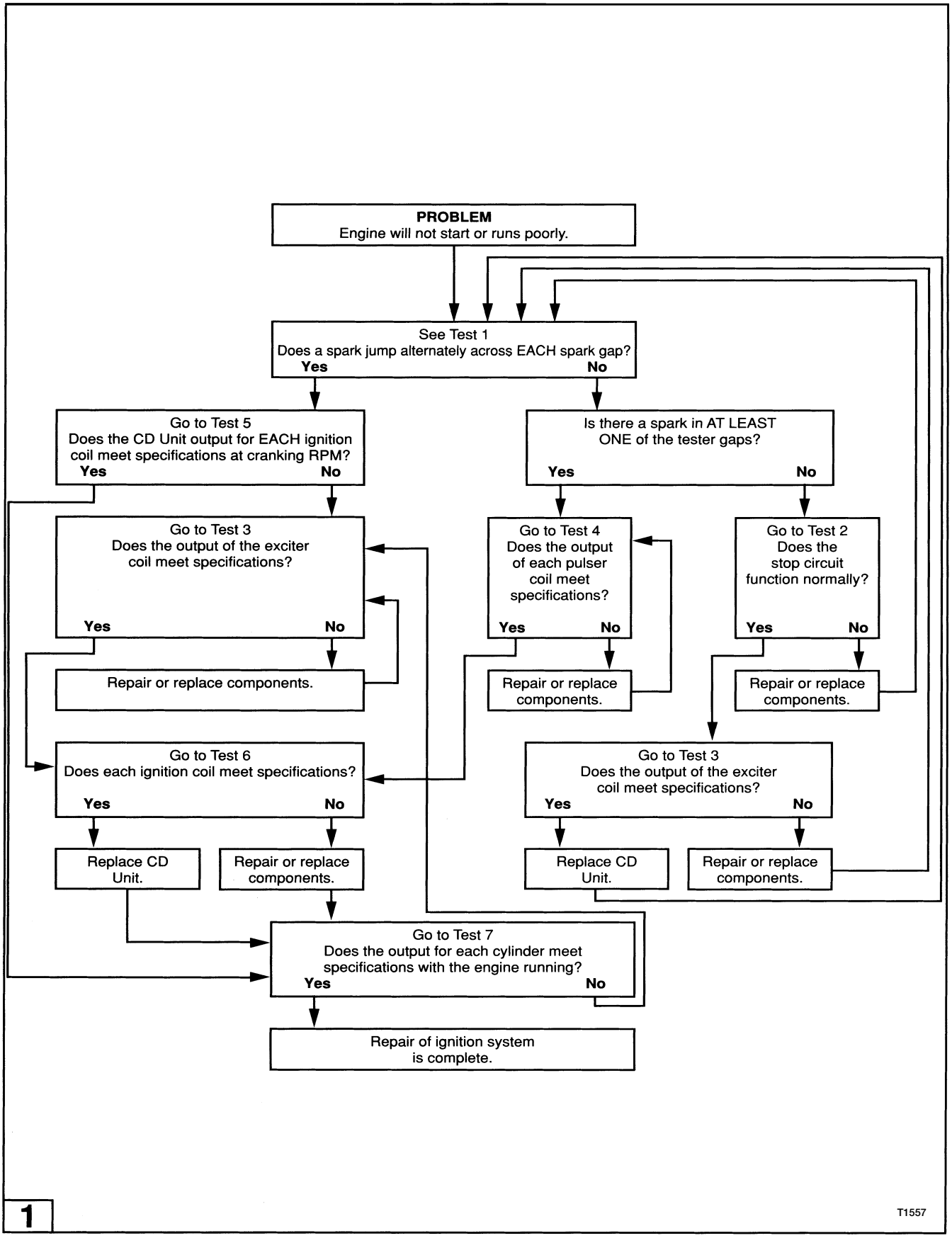
The performance tests, identified as Test 1 through Test 7, contain specific instructions for testing and servicing various ignition system components. Use this section to perform the tests correctly in accordance with the factory recommendations.

NOTE

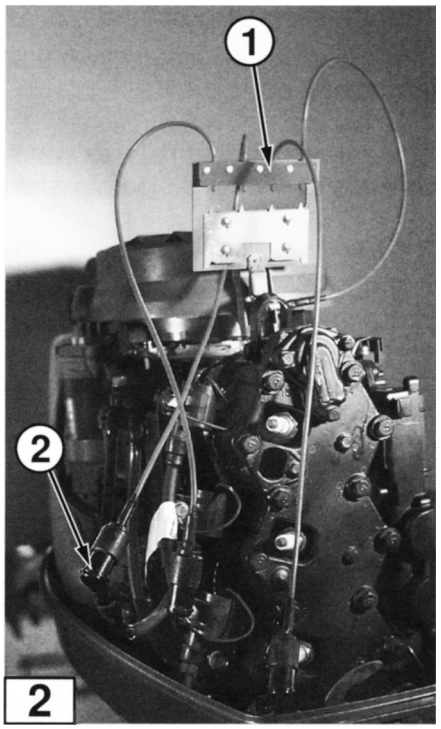
After you complete each performance test refer back to the flow chart for the next step. You must follow the flow chart until the ignition system meets specifications while the engine is running. The only way to be sure that you have uncovered and repaired all ignition system problems is to follow these procedures in a systematic fashion.

If you only have problems in stopping the engine, proceed directly to Test 2 - Stop Circuit Test.

1 Ignition System Performance Testing Flow Chart



Test 1 - Spark Test



NOTE

Make sure all electrical terminals are connected during this test except those that are noted in the test procedure.

Check for continuity between chassis ground and the ground connection for the magneto plate, CD Unit, and ignition coils before conducting the following procedure.

1. Remove all spark plug caps.

2

2. Adjust spark gap tester **(1)** to 7/16 in [11 mm].

3. Connect each spark plug cap **(2)** to spark gap tester **(1)**.

4. Secure spark gap tester to a clean ground on engine block.

⚠⚠ WARNING

To avoid possible shock hazard, do not handle ignition coils or spark gap tester during cranking tests.

NOTE

To prevent possible arcing of high voltage, route tester leads at least 2 in [51 mm] from any metal surface.

Ground unused test leads to a clean engine ground.

5. Attach lanyard to emergency stop switch.

6. Crank engine.

A spark should jump across the gap for each cylinder and alternate from one gap to another.

7. Reconnect all wires disconnected during test.

8. Return to Ignition System Performance Testing Flow Chart.

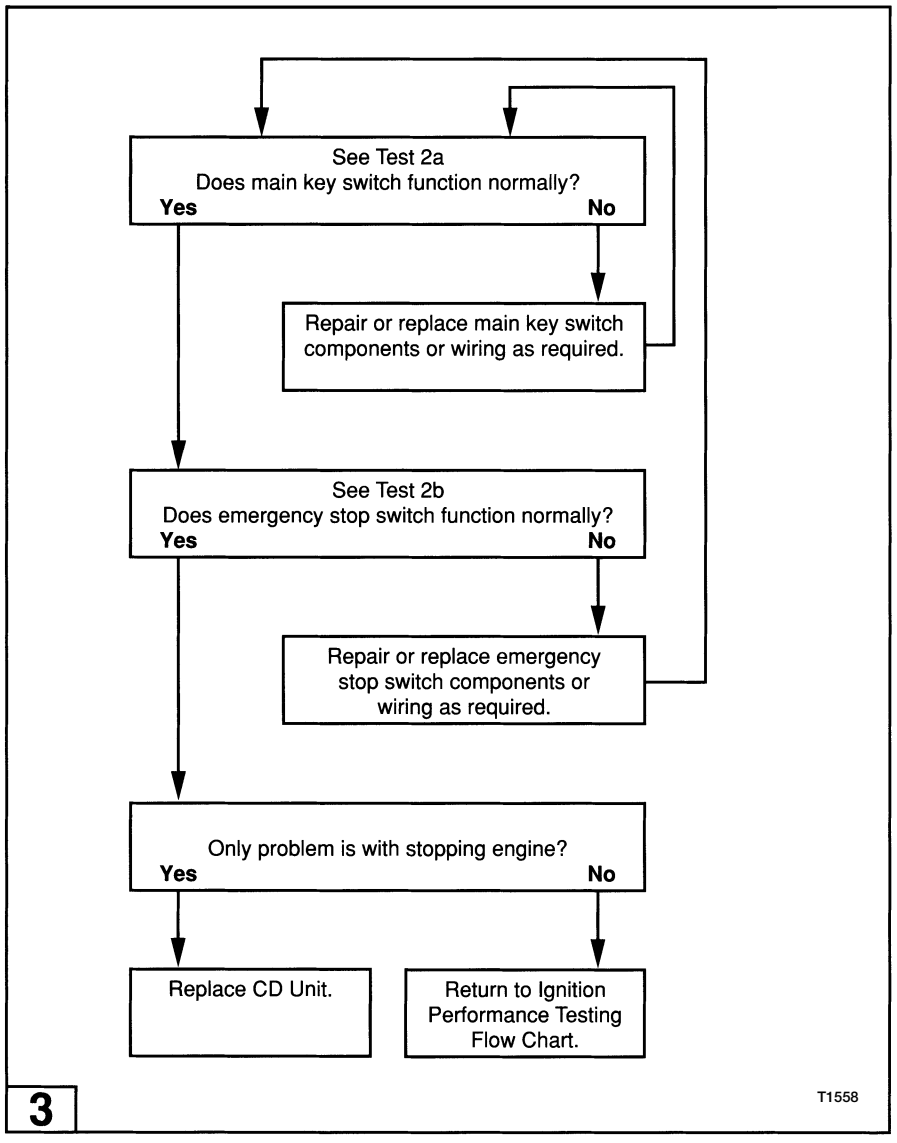
Test 2 - Stop Circuit Test

Stop circuit malfunction can cause the engine not to start or prevent it from stopping.

Several component failures can cause the stop circuit to malfunction. Use this flow chart to isolate and repair all component failures.

NOTE

3 *After you complete each stop circuit test, refer back to the flow chart for the next step.*



Test 2a - Stop Circuit Main Key Switch Test
This test is used to determine whether the main key switch and connecting wiring are functioning normally.

NOTE

Make sure all electrical terminals are connected during this test except those that are noted in the test procedure.

Check for continuity between chassis ground and the ground connection for the magneto plate, CD Unit, and ignition coils before conducting the following procedure.

All continuity tests must be conducted with negative lead from battery disconnected or you may damage the meter.

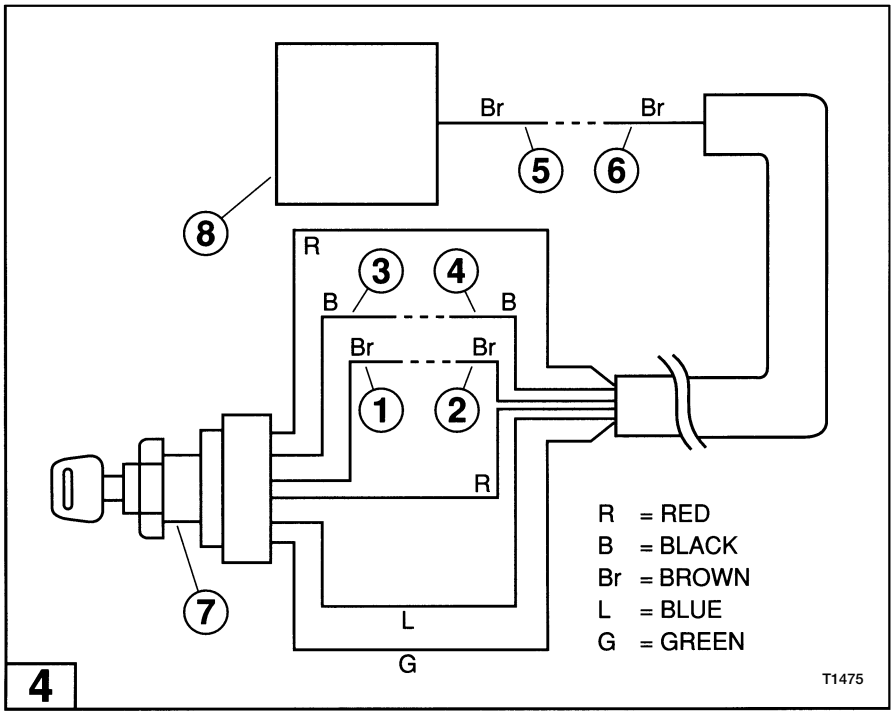
1. Remove negative lead from battery.

4 2. Disconnect main key switch terminals **(1)**, **(2)**, **(3)** and **(4)**.

4 3. Set analog multimeter to check continuity. Connect one meter lead to terminal **(1)** and the other to terminal **(3)**.

4 4. Turn main key switch **(7)** to OFF position, meter must show continuity. If not, replace main key switch.

5. Turn main key switch to ON position, meter must not show continuity. If it does, replace it.



5 6. Disconnect CD Unit **(8)** terminals **(5)** and **(6)**.

5 7. Connect one meter lead to terminal **(6)** and the other to terminal **(2)** and check continuity. If the meter does not show continuity, replace the cable.

5 8. Connect one meter lead to terminal **(6)** and the other to a clean engine ground. If the meter shows continuity, replace the cable.

9. Reconnect all wires and return to Test 2 - Stop Circuit Test flow chart.

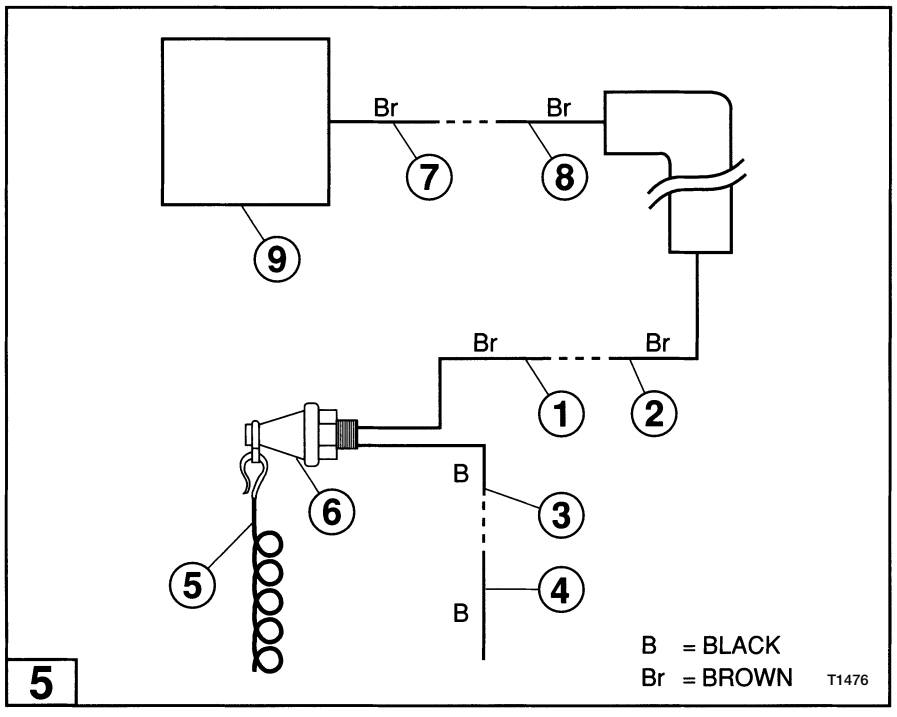
Test 2b - Stop Circuit Emergency Stop Switch Test
This test is used to determine whether the emergency stop switch and connecting wiring are functioning normally.

NOTE

Make sure all electrical terminals are connected during this test except those that are noted in the test procedure.

Check for continuity between chassis ground and the ground connection for the magneto plate, CD Unit, and ignition coils before conducting the following procedure.

All continuity tests must be conducted with negative lead from battery disconnected or you may damage the meter.



1. Remove negative lead from battery.

6 2. Disconnect emergency stop switch terminals **(1)**, **(2)**, **(3)** and **(4)**.

6 3. Set analog multimeter to check continuity. Connect one meter lead to terminal **(1)** and the other to terminal **(3)**.

6 4. Attach lanyard **(5)** to emergency stop switch **(6)**, meter must not show continuity. If it does, replace emergency stop switch.

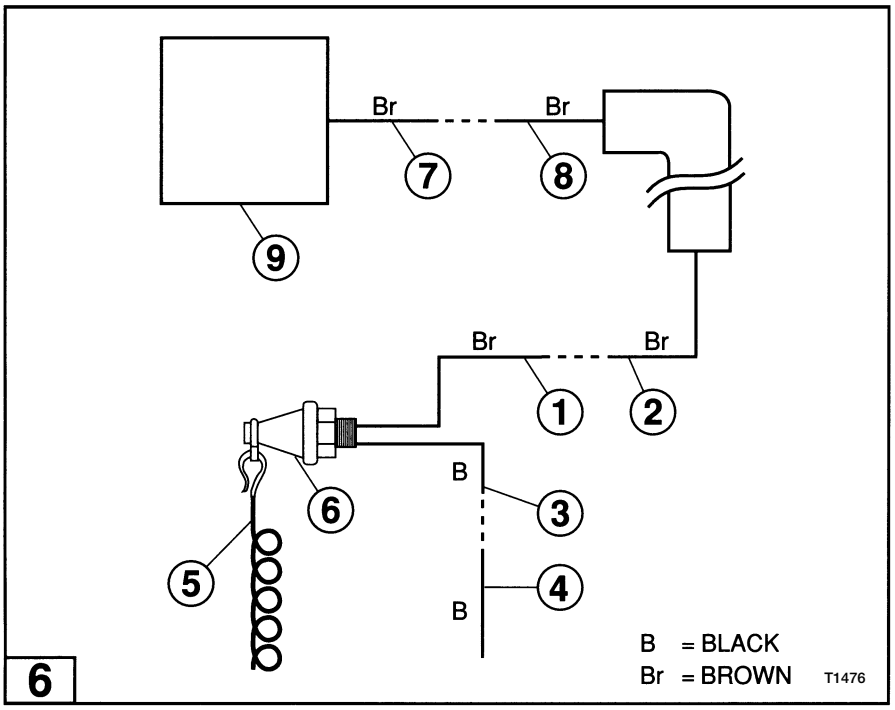
6 5. Remove lanyard **(5)** from emergency stop switch **(6)**, meter must show continuity. If not, replace emergency stop switch.

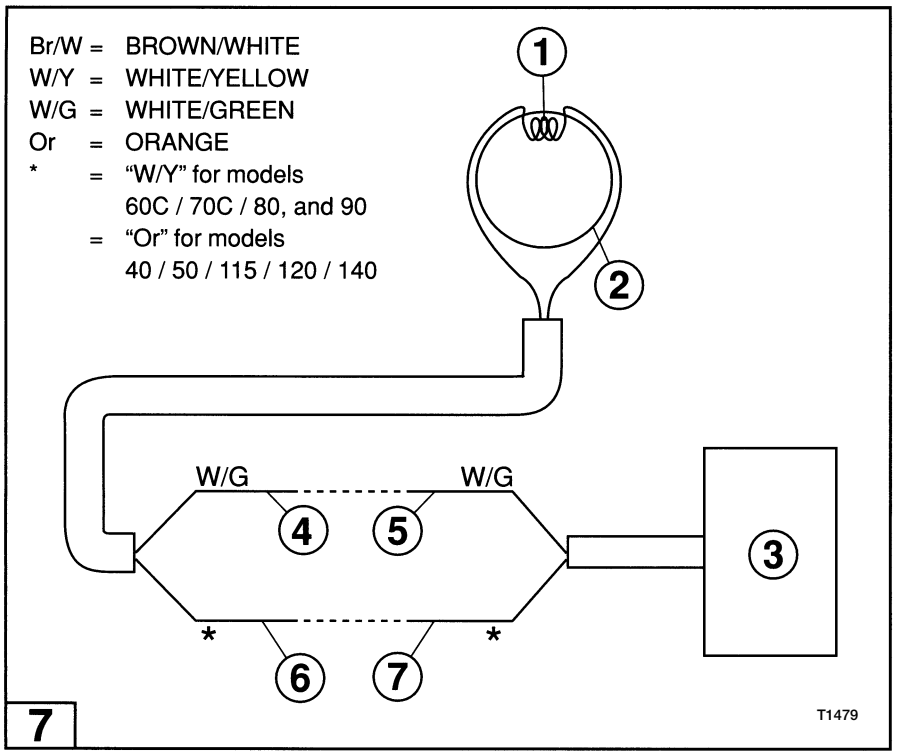
6 6. Disconnect CD Unit **(9)** terminals **(7)** and **(8)**.

6 7. Connect one meter lead to terminal **(8)** and the other to terminal **(2)** and check continuity. If the meter does not show continuity, replace the cable.

6 8. Connect one meter lead to terminal **(8)** and the other to a clean engine ground. If the meter shows continuity, replace the cable.

9. Reconnect all wires and return to Test 2 - Stop Circuit Test flow chart.





Test 3 - Exciter Coil Test

NOTE

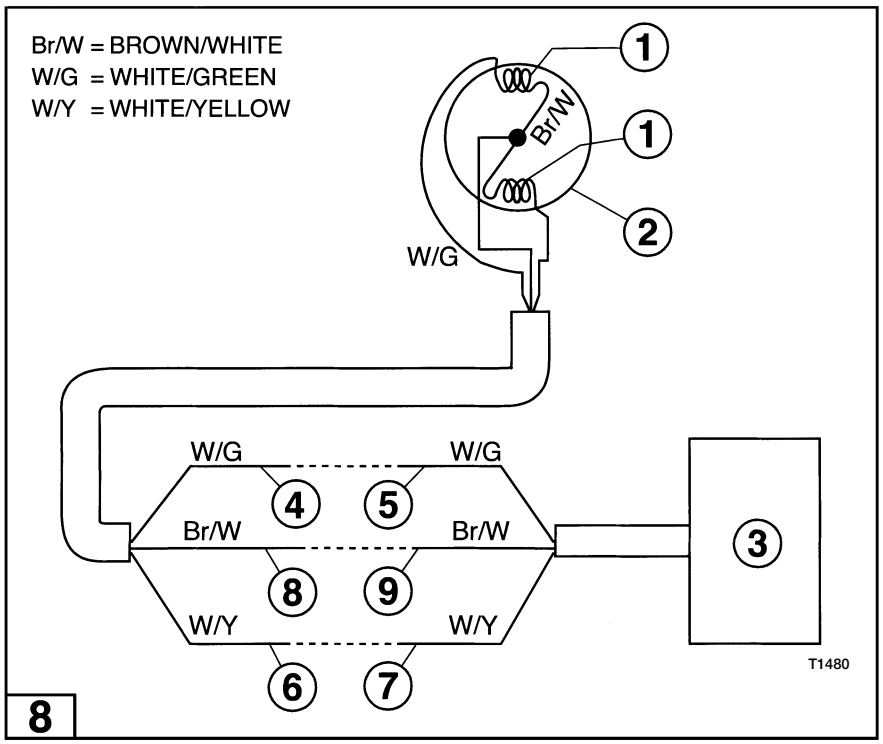
Make sure all electrical terminals are connected during this test except those that are noted in the test procedure.

Check for continuity between chassis ground and the ground connection for the magneto plate, CD Unit, and ignition coils before conducting the following procedure.

Reference the following electrical drawings for the exciter coil test. The pulser and alternator coils have been removed from both illustrations for clarity.

7 - Figure 1 - models 40 / 50 / 60C / 70C 80 / 90 / 115 / 120 / 140.

8 - Figure 2 - models 60B / 70B.



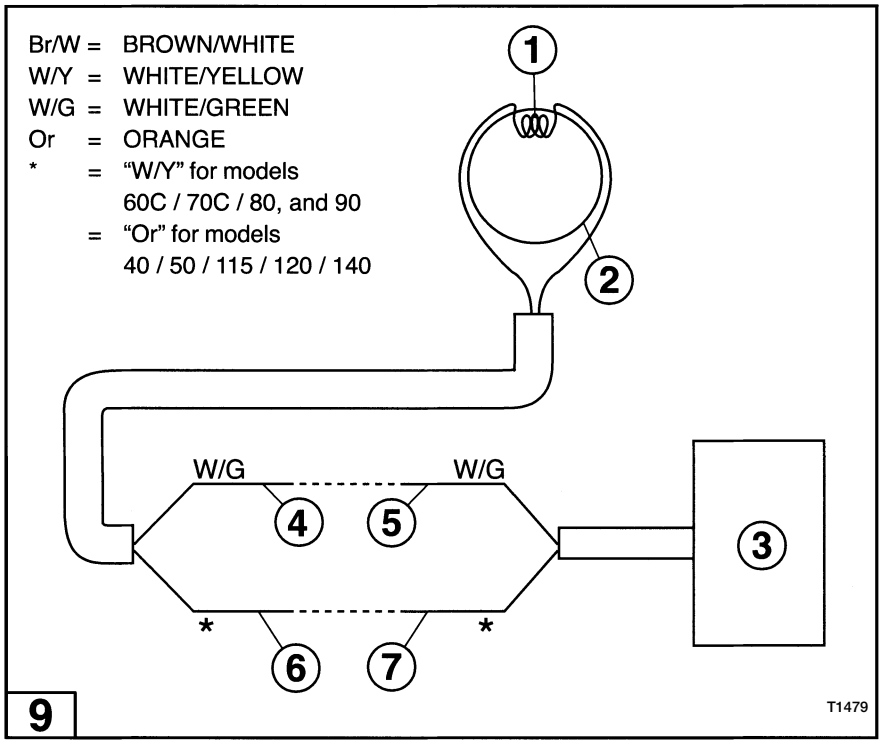
7 8 The exciter coil test is used to determine the output voltage, in DVA, from the exciter coil **(1)**, located on the coil plate assembly **(2)** [models 40 / 50 / 60 / 70 / 80 / 90] or the alternator assembly **(2)** [models 115 / 120 / 140] to the CD Unit **(3)** while you are cranking the engine.

1. Disconnect the following terminals:

Engine Models	Disconnect Terminals
40 / 50 / 60C / 70C /80 / 90 / 115 / 120 / 140	4, 5, 6, and 7
60B and 70B	4, 5, 6, 7, 8, and 9

2. Set the digital multimeter to ohms and connect the leads between the following terminals to read the resistance of the exciter coil:

Engine Models	Connect Multimeter Between These Terminals
40 / 50 / 60C / 70C / 80 / 90 / 115 / 120 / 140	4 and 6
60B and 70B	**Test 1** - 4 and 8 **Test 2** - 6 and 8

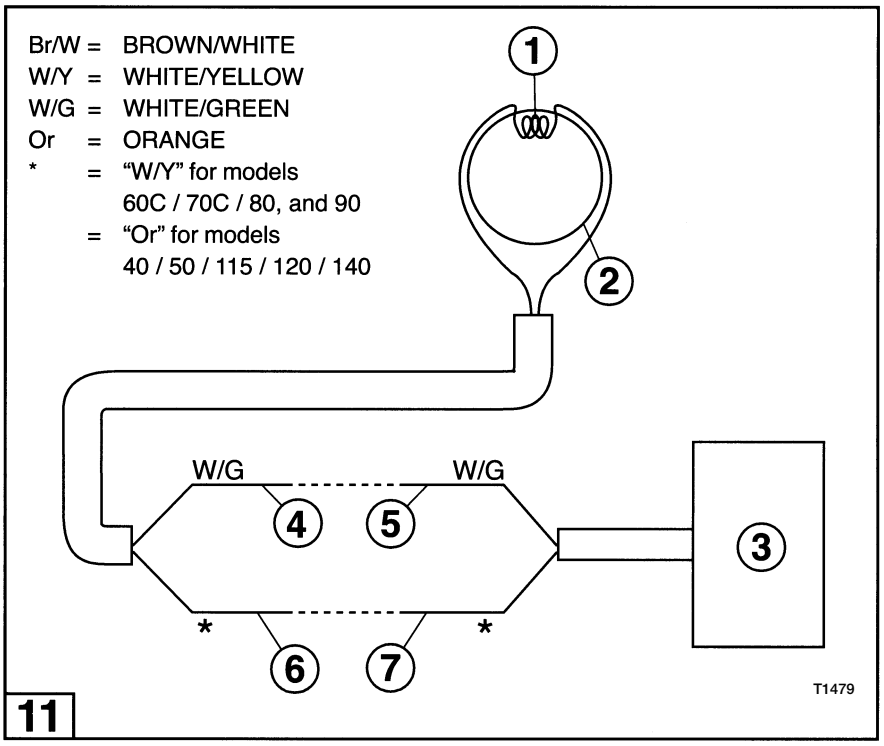


3. The meter should indicate the following resistance:

Engine Models	Results
40 and 50	530 - 720 Ω ± 25%
60B and 70B	**Test 1**: 216 - 324Ω ± 25% **Test 2**: 16 - 24Ω ± 25%
60C and 70C	220 - 330 Ω ± 25%
80 and 90	174 - 236 Ω ± 25%
115 / 120 / 140	255 - 345 Ω ± 25%

4. If the resistance is not within the indicated range, replace the exciter coil set. See Ignition System Repair Procedures - Exciter Coil. After repairs are made, return to Ignition System Performance Testing Flow Chart.

If the resistance is within the indicated range, proceed to the next step.

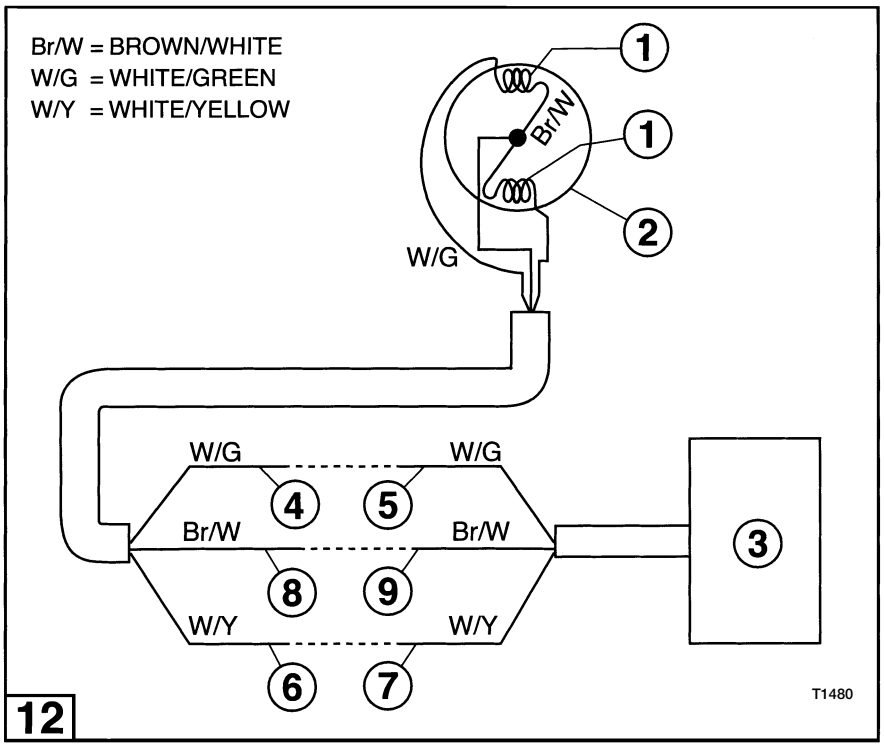


11 5. For models 40 / 50 / 60C / 70C / 80 / 90 / 115 / 120 / 140: Set the analog multimeter to "400" on the "DVA" scale. Connect the RED tester lead to terminal **(6)** and BLACK tester lead to terminal **(4)**.

Black Lead	Red Lead
Terminal 4	Terminal 6

For models 60B and 70B: Set the analog multimeter to "20" (Test 1) and "200" (Test 2) on the "DVA" scale. Connect the RED and BLACK tester leads as follows to check the output voltage (DVA) of the exciter coil at cranking speed:

Black Lead	Red Lead
Test 1 - Terminal 8 **Test 2** - Terminal 4	**Test 1** - Terminal 6 **Test 2** - Terminal 6



6. Attach lanyard to emergency stop switch.

7. Crank engine.

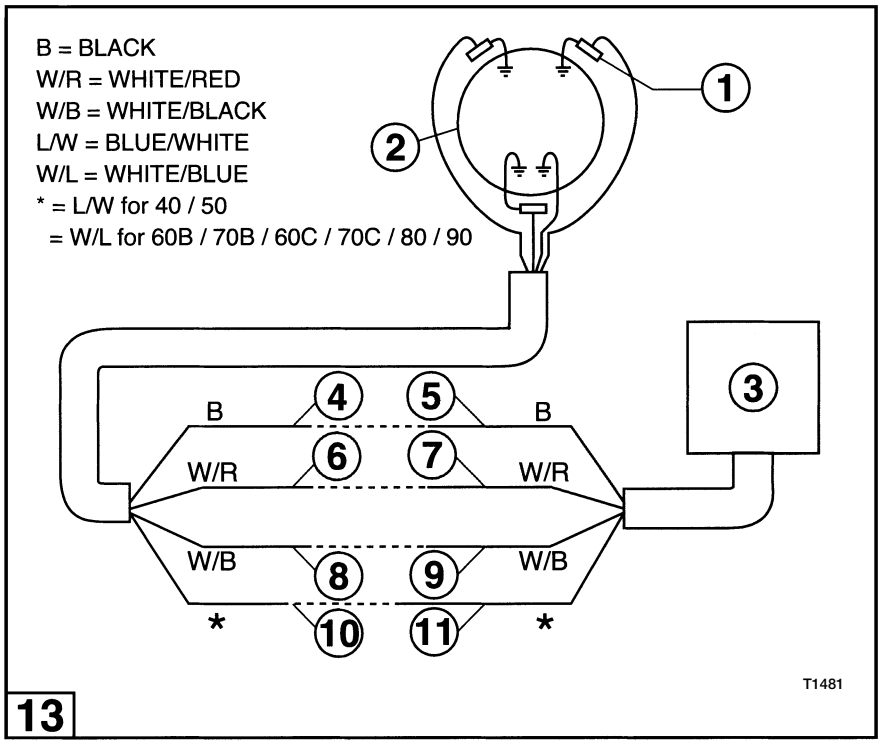
8. At cranking RPM, the tester should show the following results:

Engine Models	Test Results
40 / 50 / 60 / 70 / 80 / 90 / 115 / 120 / 140	130 DVA Minimum
	Test 1 - 10 - 15 DVA **Test 2** - 100 - 200 DVA

9. If the exciter coil test results are not within the acceptable range, replace the exciter coil set. See Ignition System Repair Procedures-Exciter Coil.

10. Reconnect all wires disconnected during test.

11. Return to flow chart.



Test 4 - Pulser Coil Test

NOTE

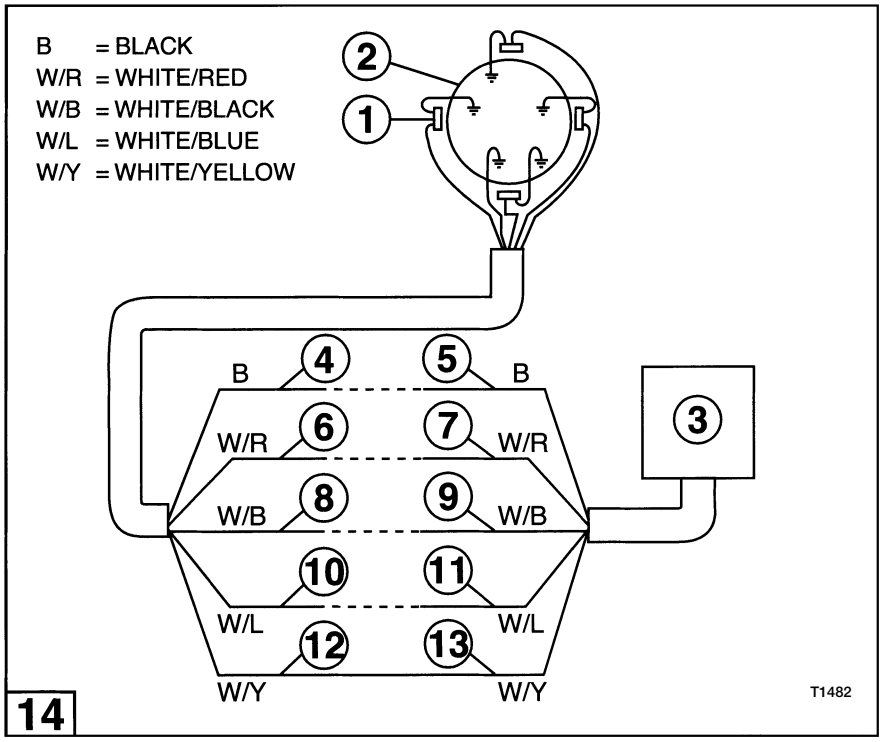
Make sure all electrical terminals are connected during this test except those that are noted in the test procedure.

Check for continuity between chassis ground and the ground connection for the magneto plate, CD Unit, and ignition coils before conducting the following procedure.

Reference the following electrical drawings for the pulser coil test. The exciter and alternator coils have been removed from both illustrations for clarity.

13 *- Figure 2 - models 40 / 50 / 60B / 70B / 60C / 70C / 80 / 90.*

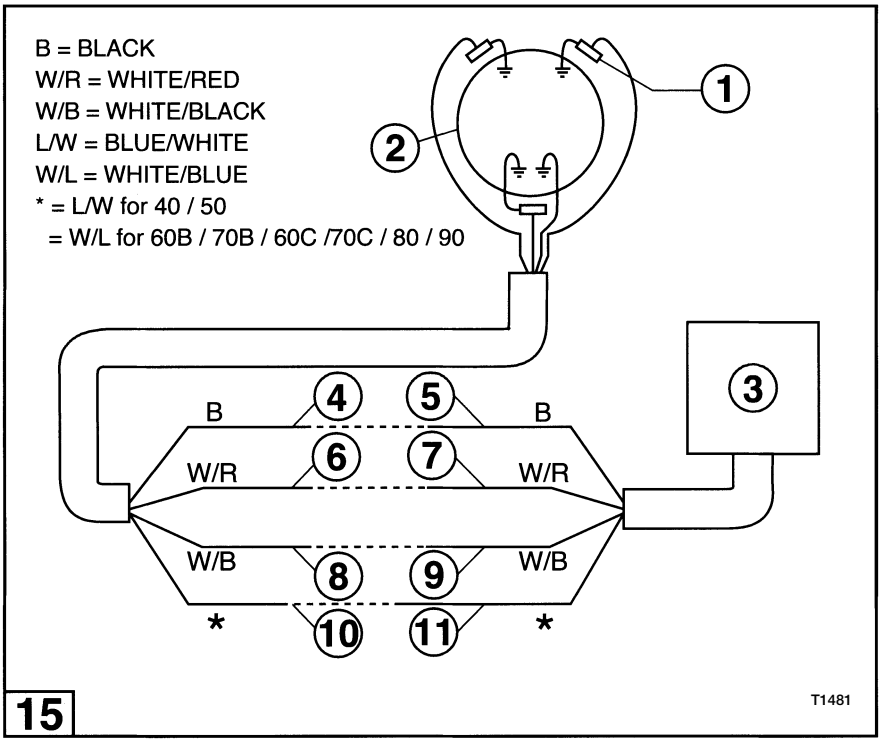
14 *- Figure 3 - models 115 / 120 / 140.*



13 **14** The pulser coil test is used to determine the output voltage, in DMA, from the pulser coil **(1)**, located on the coil plate assembly **(2)** [pulser coil assembly on models 115 / 120 / 140], to the CD Unit **(3)** while you are cranking the engine.

1. Disconnect the following terminals:

Engine Models	Disconnect Terminals
40 / 50 / 60B / 70B / 60C / 70C / 80 / 90	4, 5, 6, 7, 8, 9, 10, and 11
115 / 120 / 140	4,5, 6, 7, 8, 9, 10, 11, 12, and 13



15

14 15 2. Setthe digital multimeter to ohms and connect the leads to (one terminal at a time) to test the resistance of each pulser coil:

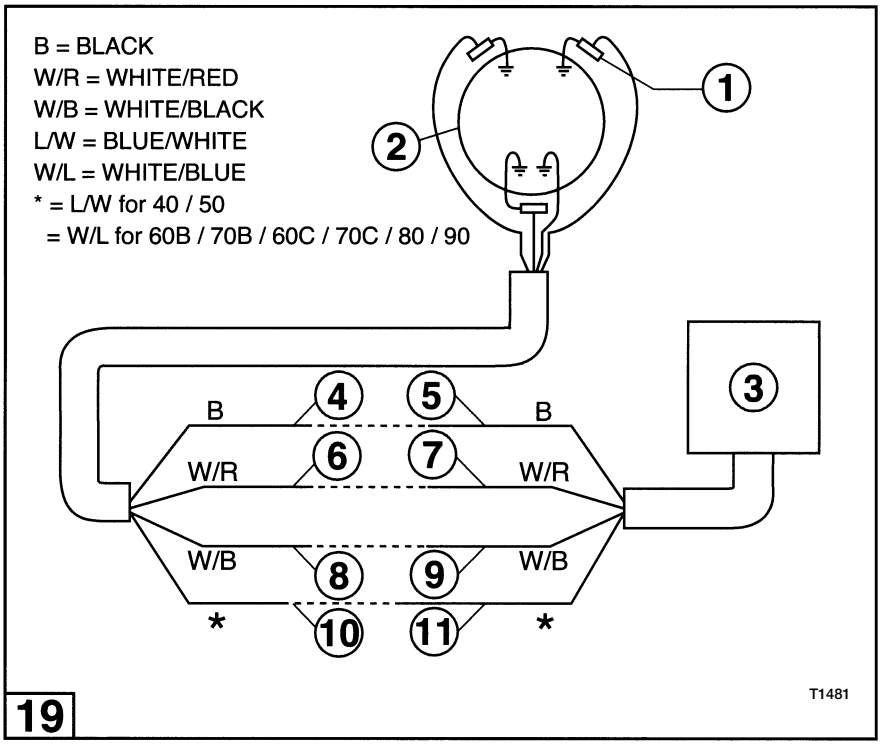
Engine Models	Connect Multimeter Between These Terminals
40 / 50 / 60B / 70B / 60C / 70C / 80 / 90	• 4 and 6 • 4 and 8 • 4 and 10
115 / 120 / 140	• 4 and 6 • 4 and 8 • 4 and 10 • 4 and 12

3. The meter should indicate the following resistance for each pulser coil:

Engine Models	Results
40 / 50 / 60 / 70 / 80 / 90	160 - 220 Ω ± 25%
115 / 120 / 140	187 - 253 Ω ± 25%

4. If the resistance is not within the indicated range, replace the pulser coil set. See Ignition System Repair Procedures - Pulser Coil. After repairs are made, return to Ignition System Performance Testing Flow Chart.

If the resistance is within the indicated range, proceed to the next step.



5. Set the analog multimeter to “20” on the “DVA” scale.

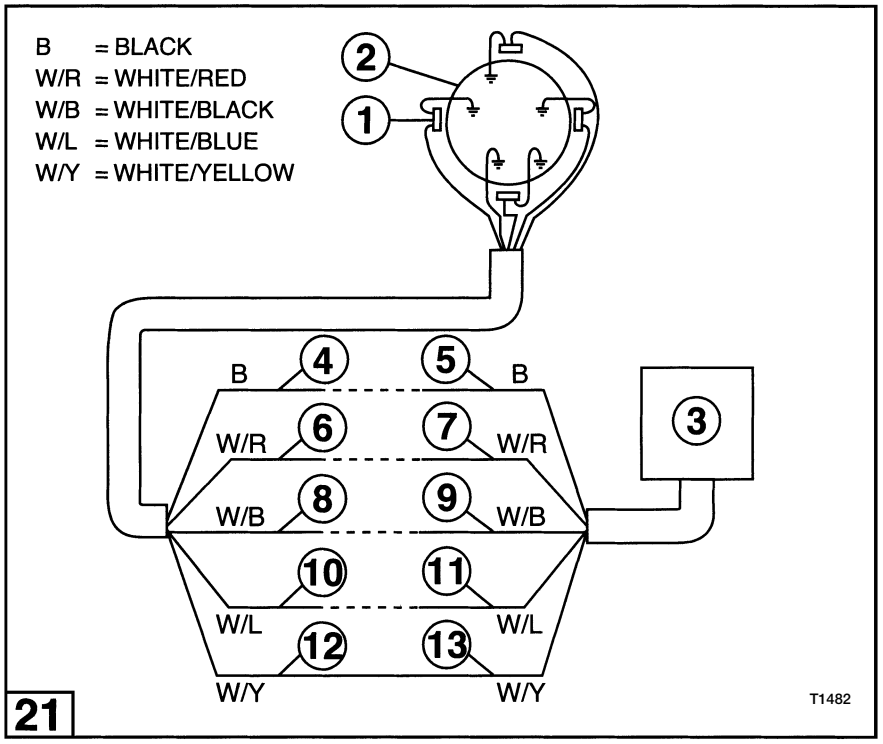
6. Insert the banana plug of the RED tester lead into the meter connection labeled “DVA” and the banana plug of the BLACK tester lead into the meter connection labeled “-COM”.

- Terminal 6.
- Terminal 8.
- Terminal 10.
- Terminal 12 (models 60B and 70B only).

8. Attach lanyard to emergency stop switch.

9. Crank engine.

10. See Ignition System Repair Procedures - Pulser Coil. After repairs are made, return to Ignition System Performance Testing Flow Chart.



19 21 11. Set the analog multimeter to “20” on the “DVA” scale. Connect the RED and BLACK tester leads as follows (one terminal at a time) to check the output voltage (DVA) of each pulser coil at cranking speed:

Engine Models	Black Lead	Red Lead
40 / 50 / 60B / 70B / 60C / 70C / 80 / 90	• Terminal 4	• Terminal 6 • Terminal 8 • Terminal 10
115 / 120 / 140	• Terminal 4	• Terminal 6 • Terminal 8 • Terminal 10 • Terminal 12

12. Attach lanyard to emergency stop switch.

13. Crank engine.

14. At cranking RPM, the tester should show the following results:

- Minimum 3.0DVA

15. If the pulser coil test results are not within the acceptable range, replace the pulser coil set. See Ignition System Repair Procedures Pulser Coil.

16. Reconnect all wires disconnected during test.

Test 5 - CD Unit Output Test - Cranking RPM

NOTE

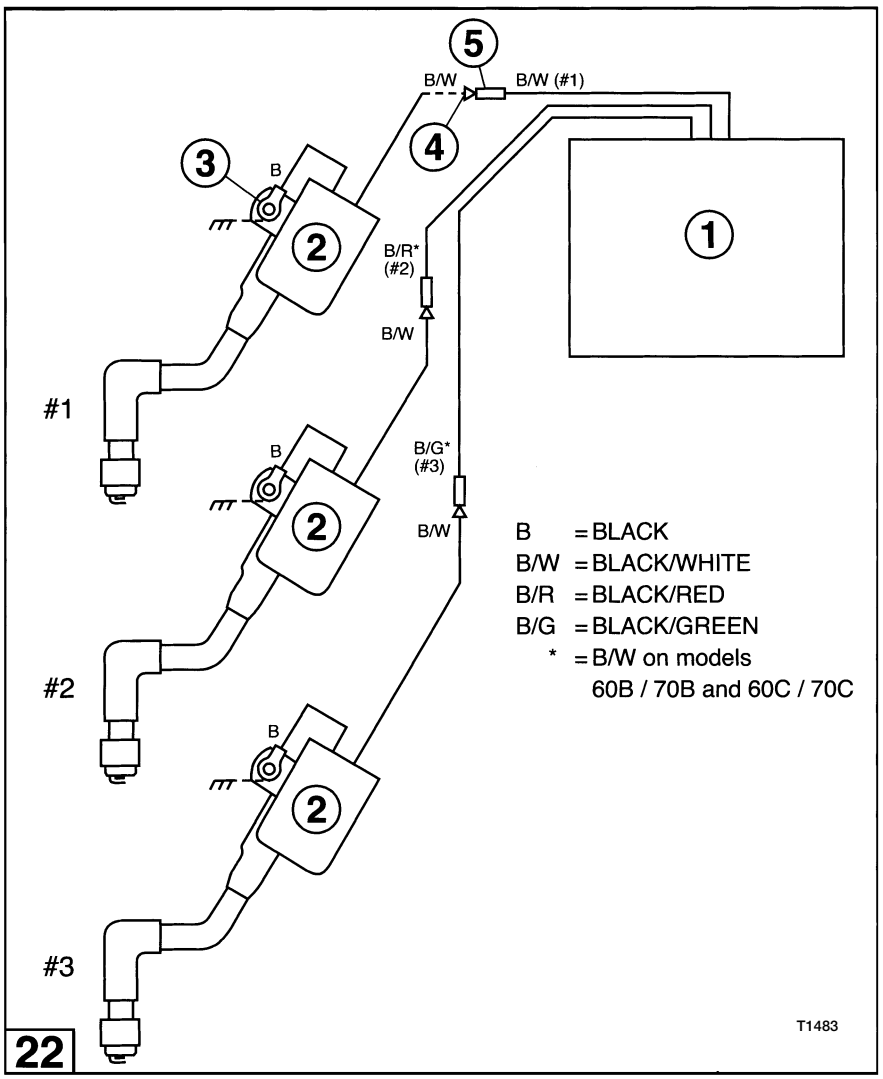
Make sure all electrical terminals are connected during this test except those that are noted in the test procedure.

Check for continuity between chassis ground and the ground connection for the magneto plate, CD Unit, and ignition coils before conducting the following procedure.

Reference the following electrical drawings for the CD Unit Output Test - Cranking RPM:

22 *- Figure 4 - models 40 / 50 / 60B / 70B / 60C / 70C / 80 / 90.*

23 *- Figure 5 - models 115 / 120 / 140.*



22 **23** The CD Unit Output Test - Cranking RPM is used to determine the output voltage, in DVA, from the CD Unit **(1)**, to each ignition coil **(2)** while you are cranking the engine.

1. Remove all spark plug caps.

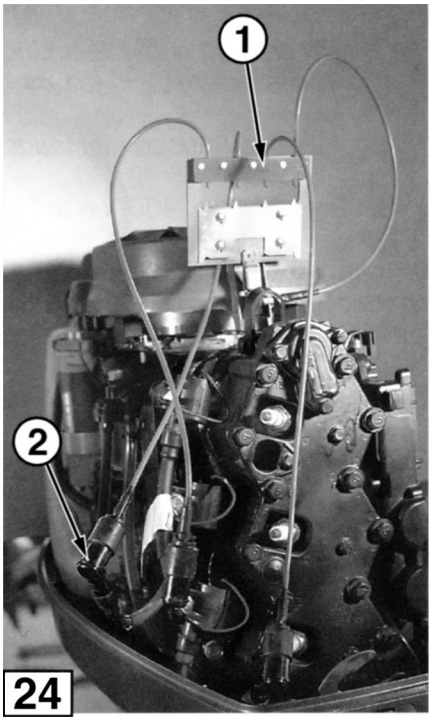
24 2. Adjust spark gap tester **(1)** to 7/16 in [11 mm].

24 3. Connect each spark plug cap **(2)** to spark gap tester **(1)**.

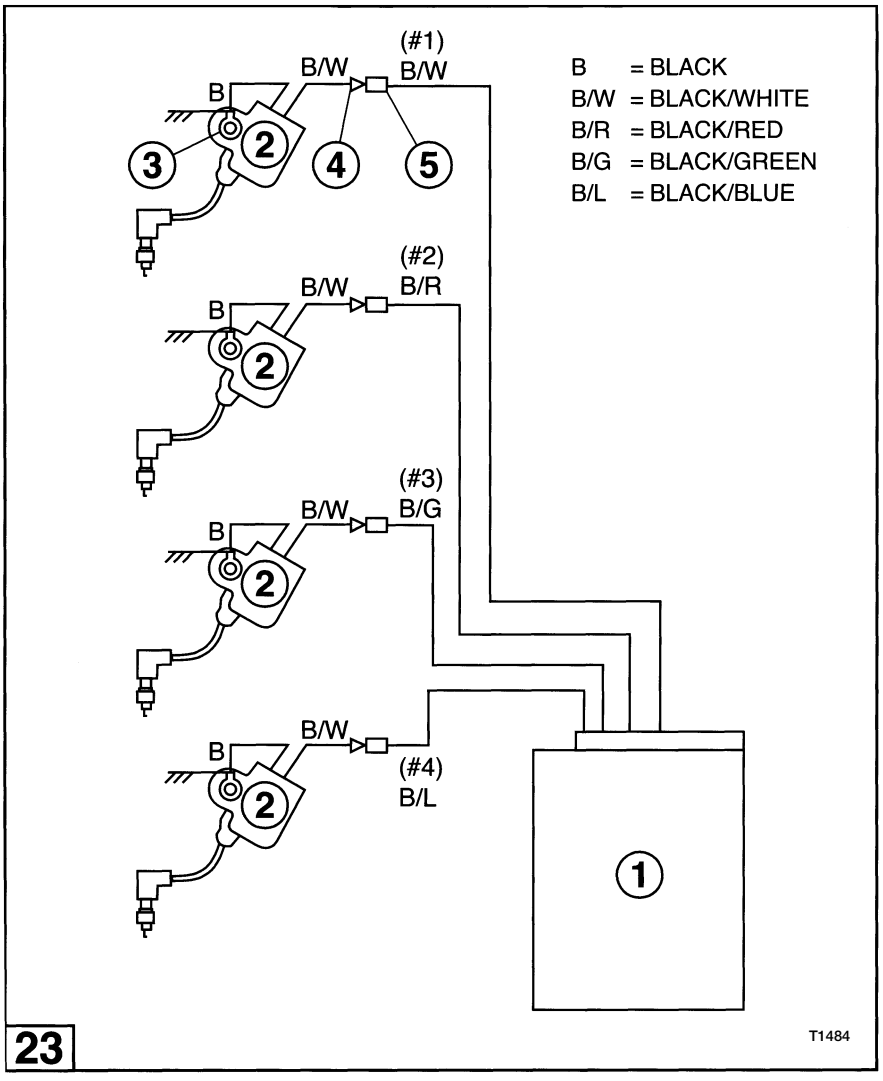
4. Secure spark gap tester to a clean ground on engine block.

⚠⚠ WARNING

To avoid possible shock hazard, do not handle ignition coils or spark gap tester during cranking tests.



T1474



T1484

NOTE

To prevent possible arcing of high voltage, route tester leads at least 2 in [51 mm] from any metal surface.

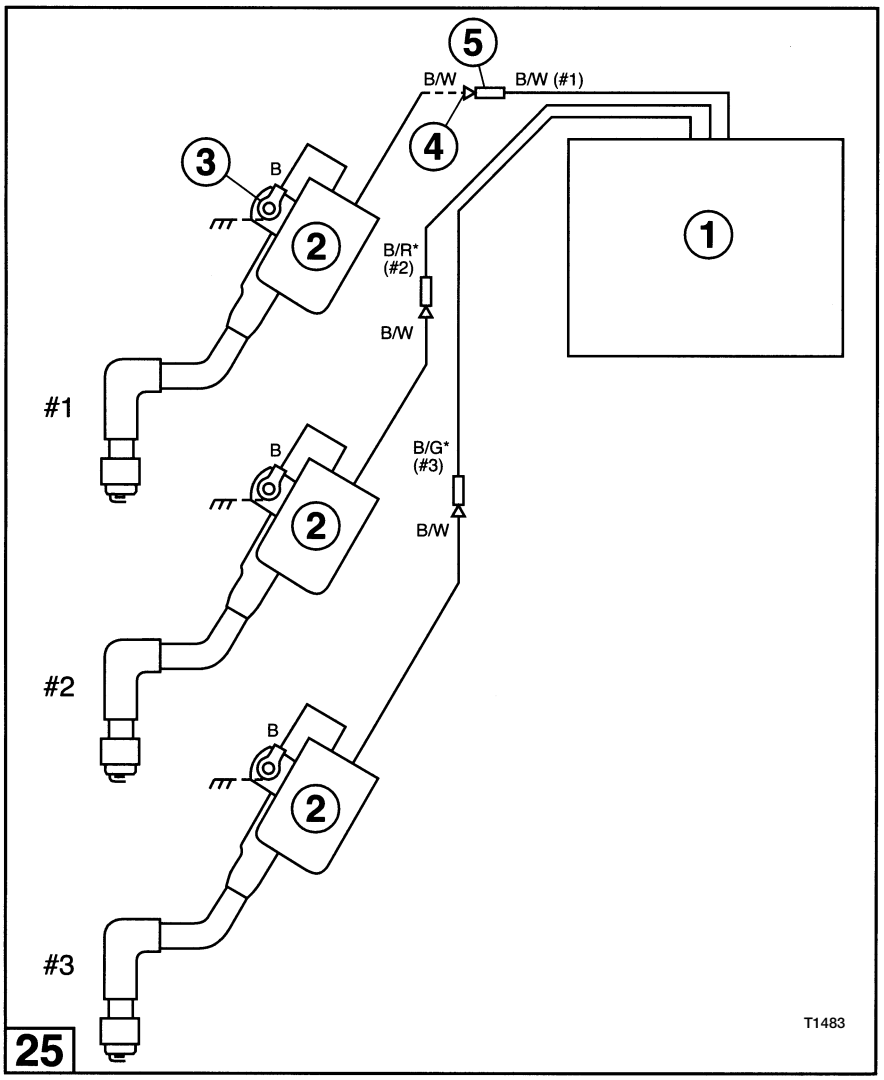
Ground unused test leads to a clean engine ground.

5. Set the tester to “400” on the “DVA” scale.

6. Insert the banana plug of the RED tester lead into the meter connection labeled “DVA” and the banana plug of the BLACK tester lead into the meter connection labeled “-COM”.

7. Connect the BLACK tester lead to terminal **(3)**.

25 26 8. Carefully slide the RED tester into the bullet connector [terminal **(4)**] sleeve until it makes contact with the terminal.



NOTE

25 26 *DO NOT disconnect the CD Unit output connector [terminals **(4)** and **(5)**]. Damage to the CD Unit may result.*

Repeat for each CD Unit output connector.

9. Attach lanyard to emergency stop switch.

10. Crank engine.

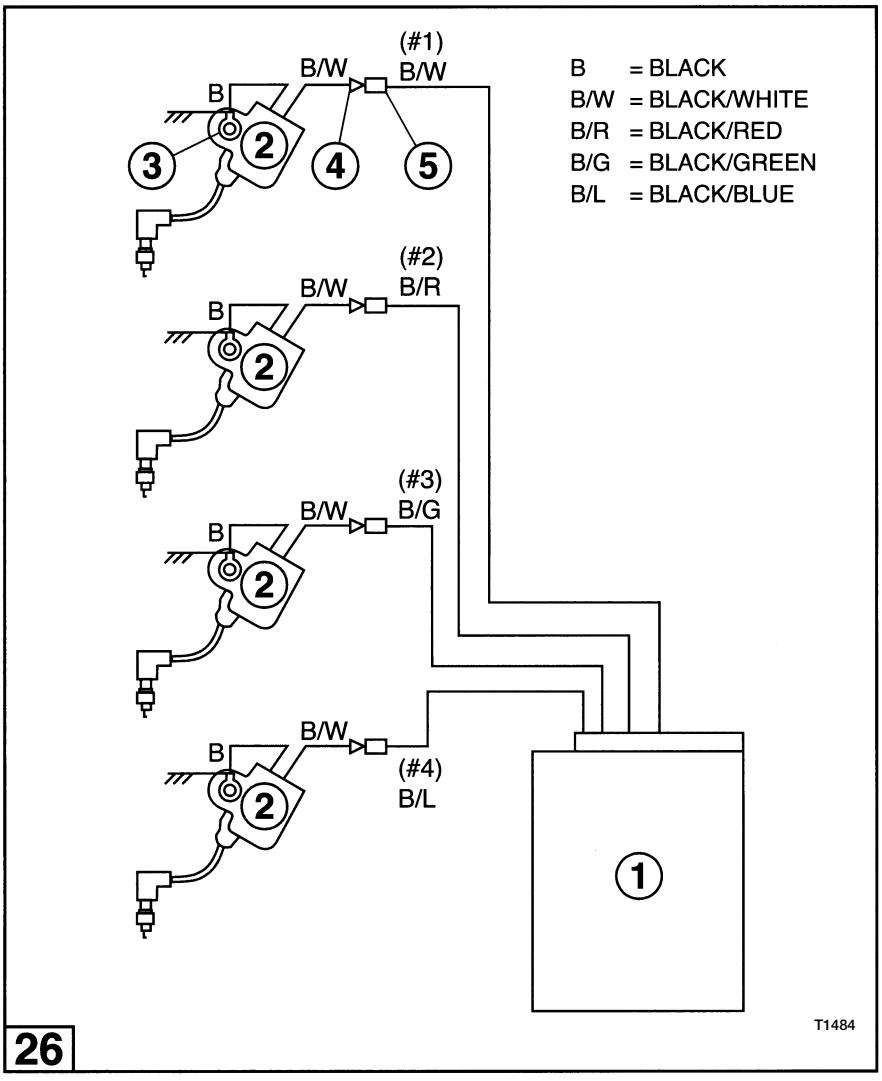
11. At cranking RPM, the tester should show the following result for each CD Unit output:

- 130 DVA Minimum

12. If the test results for any CD Unit output is not within acceptable range, replace the CD Unit. See Ignition System Repair Procedures-CD Unit.

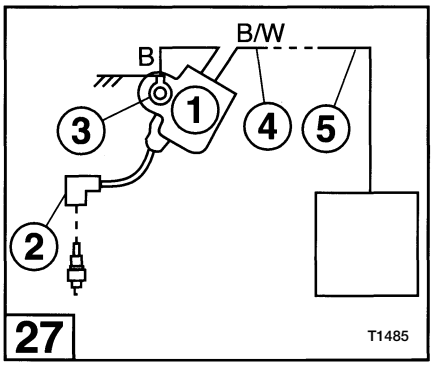
13. Reconnect all wires disconnected during test.

14. Return to flow chart.



26

Test 6 - Ignition Coil Tests



NOTE

Make sure all electrical terminals are connected during this test except those that are noted in the test procedure.

Check for continuity between chassis ground and the ground connection for the magneto plate, CD Unit, and ignition coils before conducting the following procedure.

27 The following tests check the resistance of the primary and secondary windings in each ignition coil **(1)**.

27 1. Remove spark plug cap **(2)**.

2. Set digital multimeter to ohms.

27 3. Disconnect terminals **(4)** and **(5)**.

27 4. Connect one tester lead to terminal **(3)** and the other terminal **(4)**.

5. The meter should indicate the following readings for the primary winding.

Repeat readings for each ignition coil:

Engine Models	Results
40 and 50	0.18 - 0.24 Ω ± 25%
60B / 70B / 60C / 70C	0.18 - 0.24 Ω ± 25%
80 and 90	0.19 - 0.25 Ω ± 25%
115 / 120 / 140	0.18 - 0.24 Ω ± 25%

6. If primary winding for any ignition coil is not within the acceptable range, replace the ignition coil. See Ignition System Repair Procedures - Ignition Coil. After repairs are made, return to Ignition System Performance Testing Flow Chart.

If the primary windings are within the acceptable range, proceed to the next step.

27 7. Connect one tester lead to terminal **(3)** and the other to spark plug cap [terminal **(2)**].

8. The meter should indicate the following readings for the secondary winding.

Repeat readings for each ignition coil:

Engine Models	Results
40 and 50, 60C / 70C	2.7 - 3.7 KΩ ± 25%
60B / 70B	2.7 - 3.7 KΩ ± 25%
80 / 90	3.6 - 4.8 KΩ ± 25%
115 / 120 / 140	2.7 - 3.7 KΩ ± 25%

9. If secondary winding for any ignition coil is not within the acceptable range, replace the ignition coil. See Ignition System Repair Procedures - Ignition Coil. After repairs are made, return to Ignition System Performance Testing Flow Chart.

10. Reconnect all wires disconnected during test.

11. Return to flow chart.

Test 7 - Output Tests - Engine Running

⚠ CAUTION

The following tests must be performed with correct test propeller and with the engine in a test tank. Note that some performance problems cannot be duplicated in a test tank, in these cases the tests must be conducted with the engine mounted on a boat and operated in open water.

NOTE

Make sure all electrical terminals are connected during this test except those that are noted in the test procedure.

Check for continuity between chassis ground and the ground connection for the magneto plate, CD Unit, and ignition coils before conducting the following procedure.

These series of tests are designed to efficiently find faulty ignition components that can cause an engine to run poorly. Use the flow chart to systematically eliminate the possible causes to the problems.

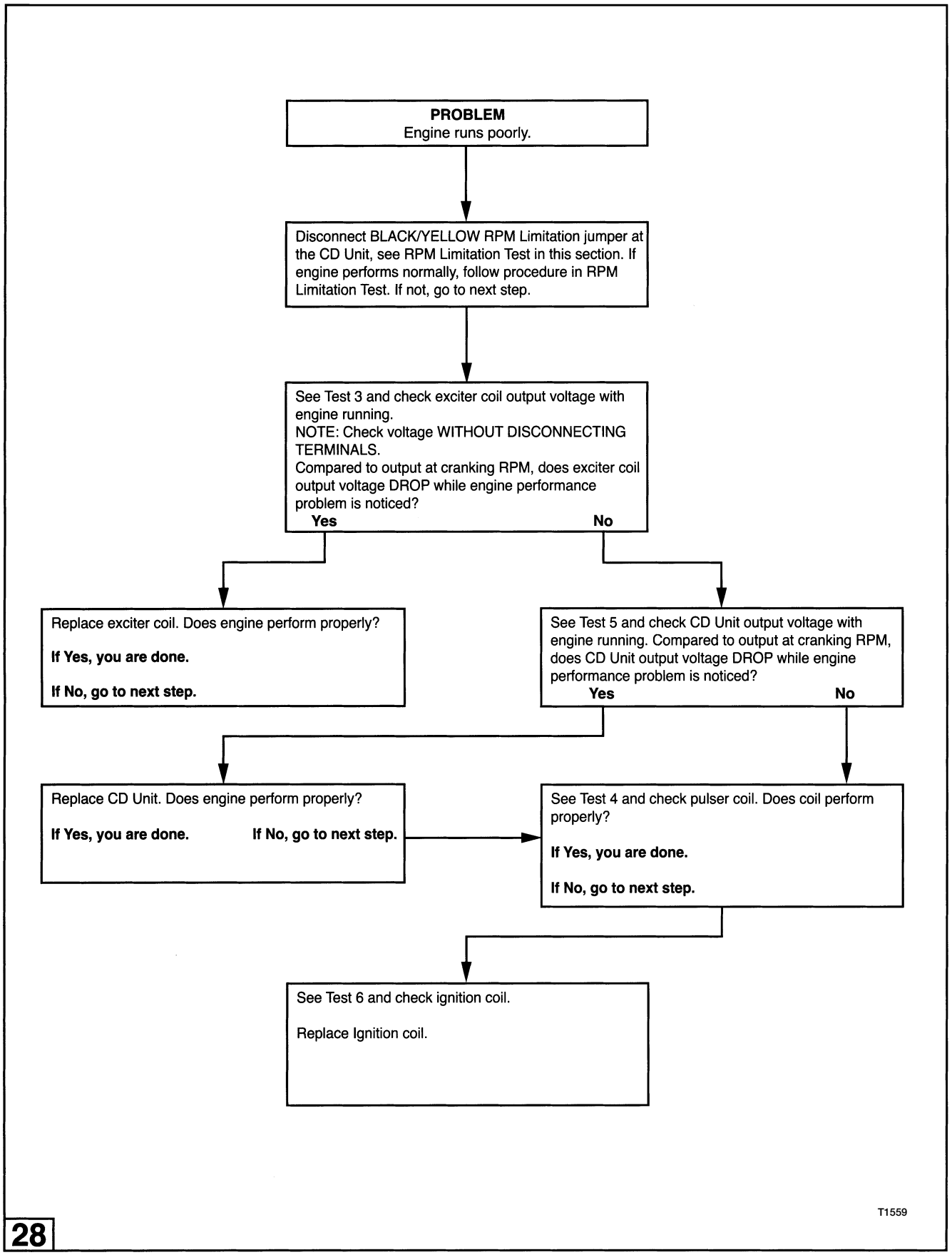
The tests assume that:

- The engine starts.
- Tune-Up Procedure has been performed, see Section 2.
- Ignition Timing and the Carburetor Synchronization Procedure has been performed, see Section 2.
- Engine is at operating temperature.
- Tests are performed with engine running in forward gear.
- Tachometer is installed.

NOTE

Some steps refer to other ignition tests. After you complete those tests, return to the flow chart for further instructions.

28 Output Tests - Engine Running - Flow chart



RPM LIMITATION TEST

⚠ CAUTION

The following tests must be performed with correct test propeller and with the engine in a test tank. Note that some performance problems cannot be duplicated in a test tank, in these cases the tests must be conducted with the engine mounted on a boat with the correct propeller installed and operated in open water.

⚠ CAUTION

Avoid electrical shock:

- **Do not touch ignition coils, exciter coil, pulser coils, or alternator coils while the engine is cranking or running.**

⚠ CAUTION

Use proper precautions when performing tests with the engine cover removed. Do not wear loose clothing or jewelry. Keep hair, hands, and clothing away from the flywheel and other moving parts.

⚠ CAUTION

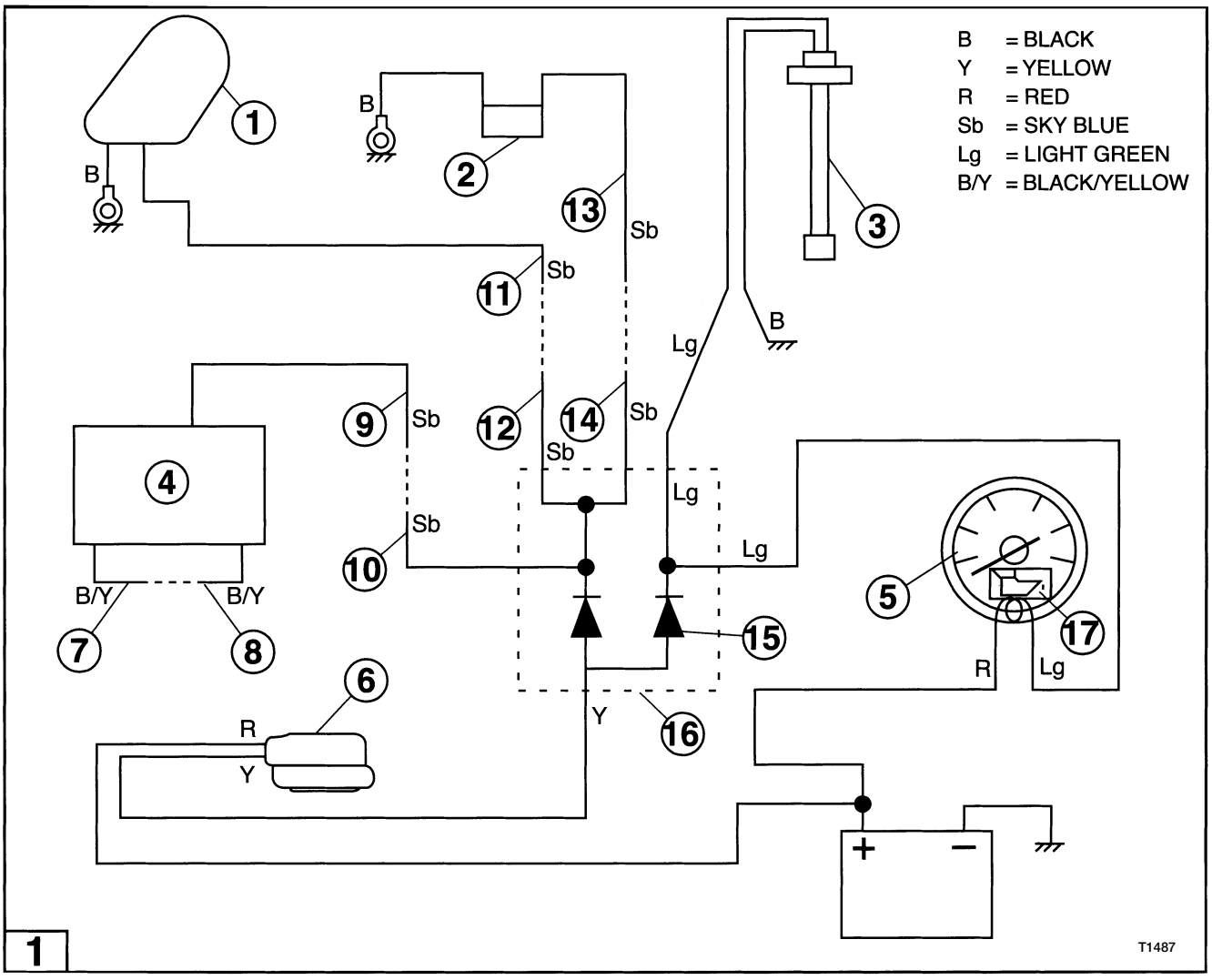
When repairs are complete, make sure all ignition and electrical leads are properly routed and clamped in their original positions and the start-ingear prevention system must be tested before returning engine to customer.

Half-Maximum RPM Limitation

The CD Unit will limit the engine speed to about half the maximum RPM when the overheat sensor, water pressure sensor, or oil level sensor signals an abnormal condition. Depending upon the model of the engine, one, two or all three sensors are provided.

Description of Operation for models 40 / 50 / 60 / 70 / 80 / 90 Engines

1 In these engines, the water pressure sensor **(1)** and overheat sensor **(2)** control the half-maximum RPM limitation input [terminal **(9)**] to the CD Unit **(4)**. When either, or both, of these sensors detect an abnormal condition (see Section 4), the half-maximum RPM limitation input goes low and the CD Unit limits the engine speed to about half its maximum RPM. At the same time, the abnormal condition also activates the warning horn **(6)**. Note that the oil level sensor **(3)** only activates the warning horn and the oil level light **(17)** in the tachometer **(5)** because the diodes **(15)** block the signal from CD Unit.



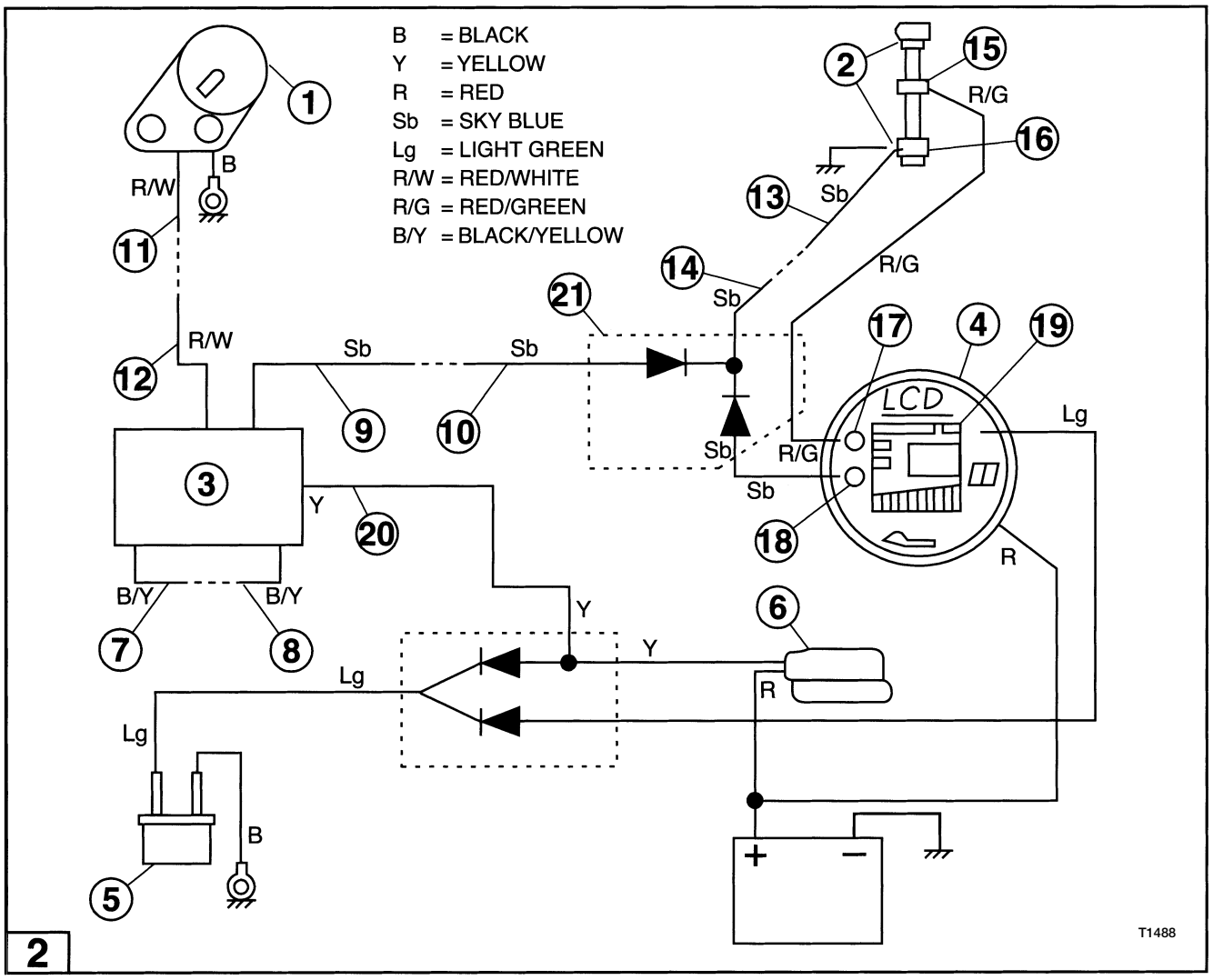
1

The following table summarizes the availability of the sensors and approximate RPM when this feature is activated:

Sensor Type	Engine Model	RPM Limitation
Overheat Sensor	40 (optional) / 50 60 / 70 / 80 / 90	3500 ± 400 RPM
Water Pressure Sensor	40 (not available) / 50 (not available) / 60 (optional) / 70 (optional) / 80 / 90	3500 ± 400 RPM
Oil Level Sensor	40 / 50 / 60 / 70 / 80 / 90	NA

Description of Operation for 115/1 20/140 Engines

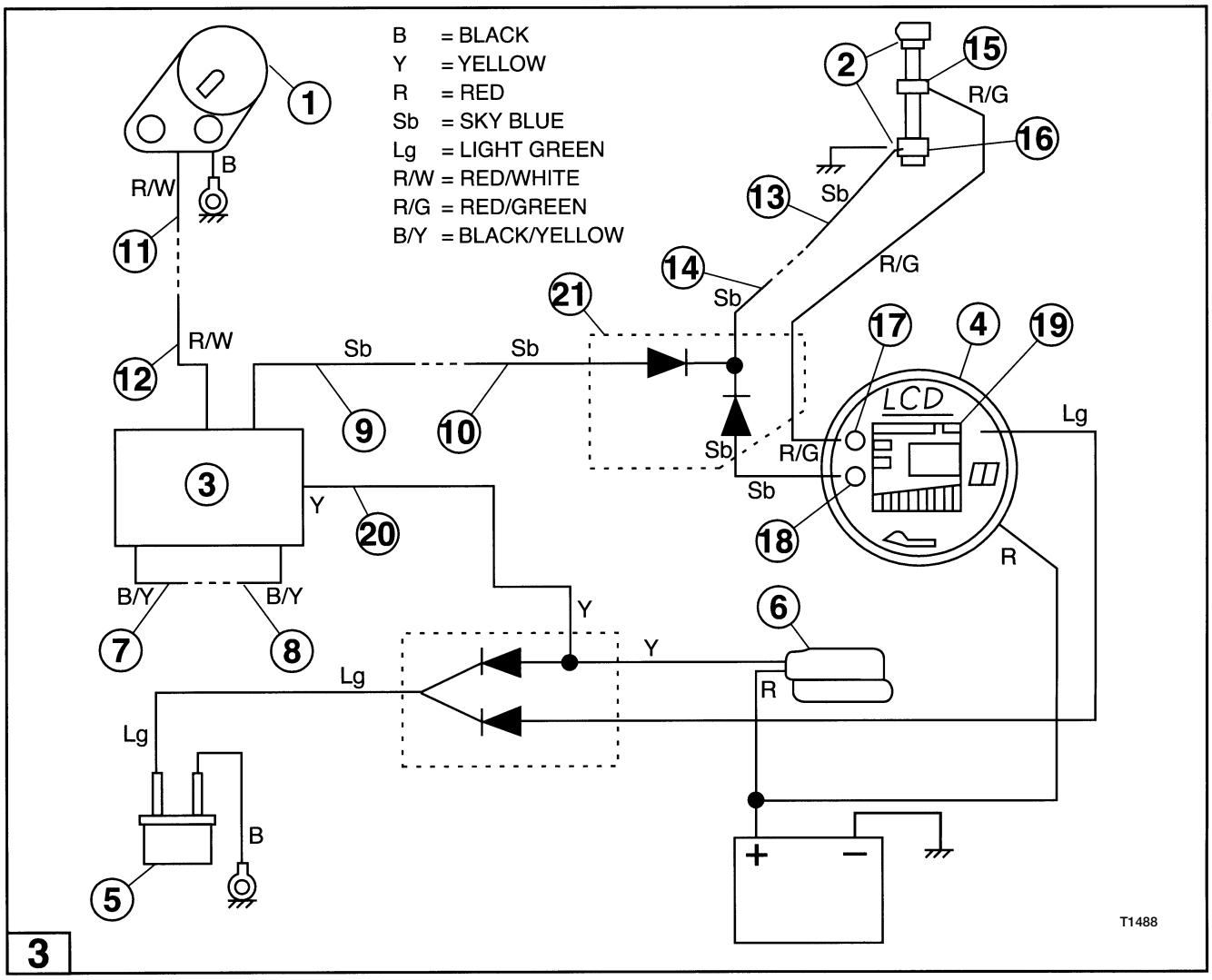
2 In these engines, the water pressure sensor **(1)** and lower oil level float **(16)** of the oil level sensor **(2)** control the half-maximum RPM limitation input [terminal **(9)**] to the CD Unit **(3)**. When either, or both, of these sensors detect an abnormal condition (see Section 4 for the water pressure sensor and Section 3 for the oil level sensor), the half-maximum RPM limitation input goes low and the CD Unit limits the engine speed to about half its maximum RPM.



3 At the same time, an abnormal condition from either sensor also activates the warning horn **(6)**. The CD Unit activates the horn by sending an output signal to lead **(20)**. Note that the lower oil level float **(16)** also causes the lower oil level indicator **(18)** in the LCD multi-purpose meter **(4)** to flash when it detects a low oil condition.

3 It is important to note that the if the upper oil level float **(15)** detects a low oil condition, it activates the upper oil level indicator **(17)** in the LCD multi-purpose meter **(4)** but will not trigger the RPM limitation feature or the RPM limitation feature is not triggered in this case.

3 An abnormal condition detected by the overheat sensor **(5)** causes the warning horn to sound and the overheat indicator **(19)** in the LCD multi-purpose meter **(4)** to flash. The RPM limitation feature is not triggered in this case.



The following table summarizes the availability of the sensors and approximate RPM when this feature is activated:

Sensor Type	RPM Limitation
Overheat Sensor	NA
Water Pressure Sensor	2800 ± 400 RPM
Oil Level Sensor	2800 ± 400 RPM (lower float only)

Half-Maximum RPM Limitation Feature - Test
Perform this test when engine speed is limited to about half maximum RPM or has a miss at about half maximum RPM.

The test assumes that:

- Tune-Up Procedure has been performed, see Section 2.
- Ignition Timing and the Carburetor Synchronization Procedure has been performed, see Section 2.
- Engine is at operating temperature.
- Tests are performed with engine running in forward gear.
- Tachometer is installed.

NOTE

Make sure all electrical terminals are connected during this test except those that are noted in the test procedure.

Check for continuity between chassis ground and the ground connection for the magneto plate, CD Unit, and ignition coils before conducting the following procedure.

1. Verify that engine operating temperature (Section 4), water pressure (Section 4), and oil level (Section 3) are in their normal range.

3 4 2. Disconnect RPM limitation jumper at terminals **(7)** and **(8)**.

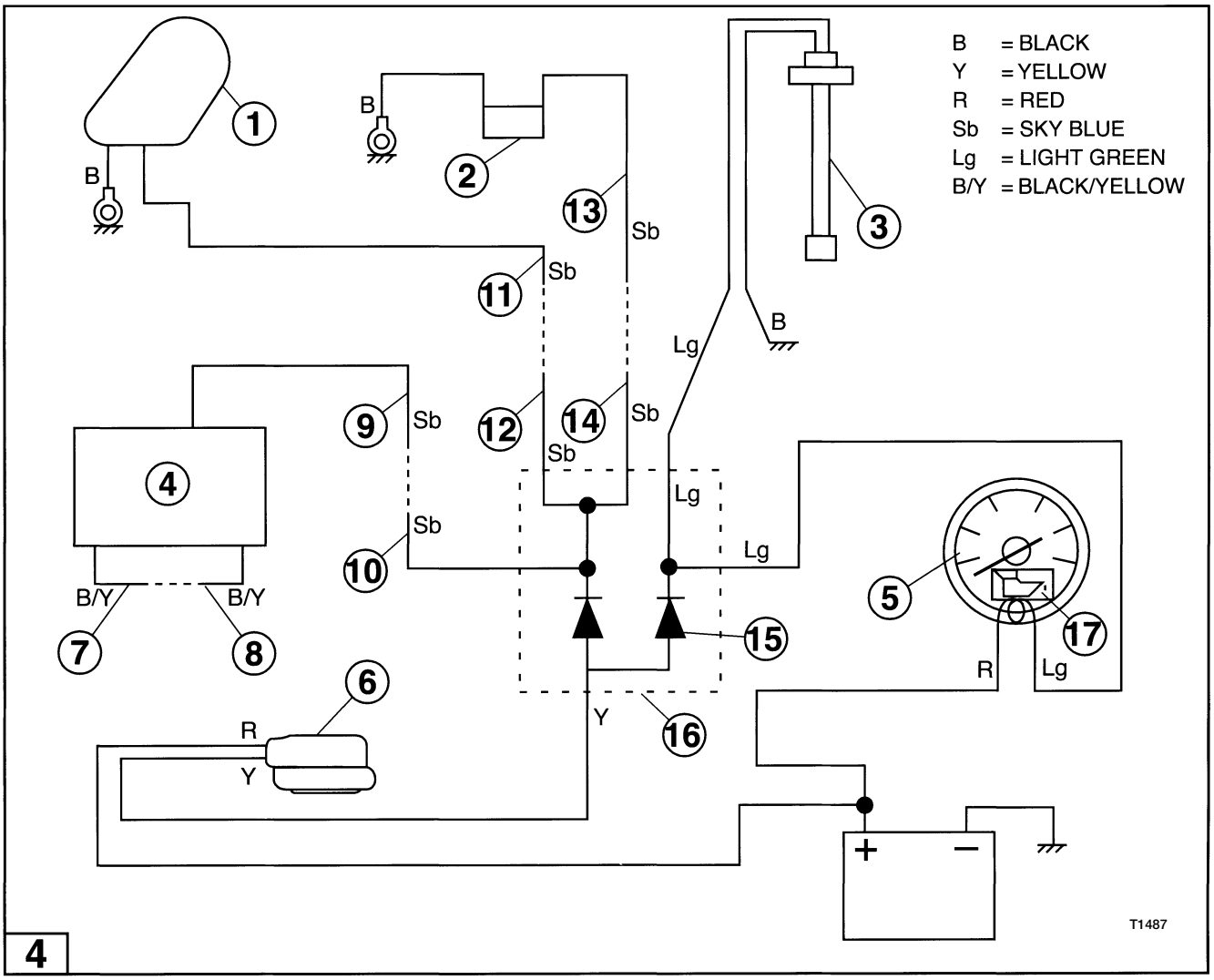
3. Run engine. Does engine performance improve?

If yes, proceed to next step. If not, see Section 3, Troubleshooting.

3 4 4. Reconnect RPM limitation jumper at terminals **(7)** and **(8)**.

5. Disconnect one sensor input at a time:

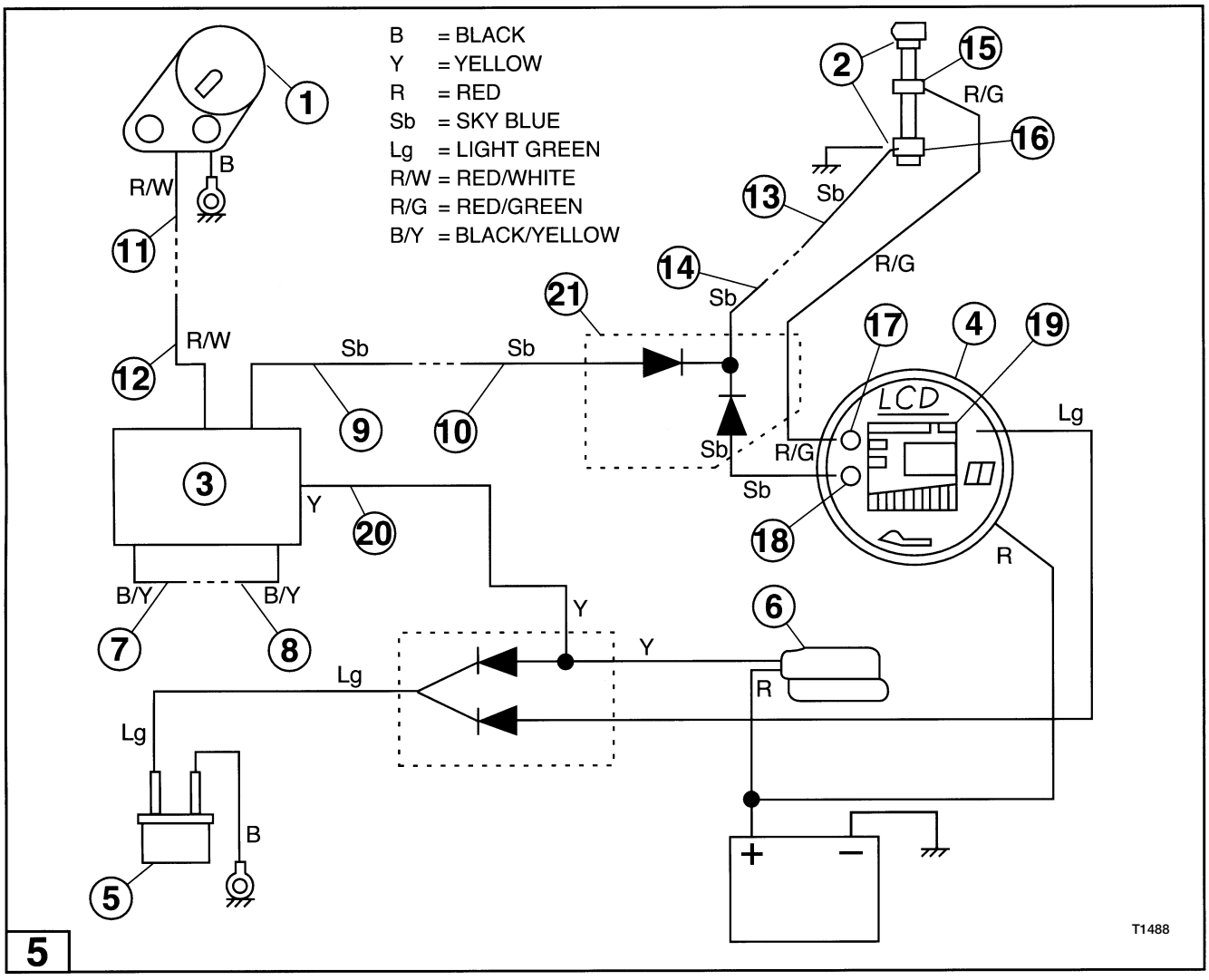
Engine Models	Sensor	Disconnect Terminals
40 / 50 / 60 / 70 / 80 / 90	Water Pressure (noton 40 and 50) (60, 70 optional)	(11) and (12)
	Overheat (40 optional)	(13) and (14)



Engine Models	Sensor	Disconnect Terminals
115 / 120 / 140	Water Pressure	(11) and (12)
	Lower Oil Level Float	(13) and (14)

- Disconnect terminals indicated.
- Run engine.
- If engine performance is acceptable, replace sensor and/or replace or repair wiring.
- If engine performance is still not acceptable, disconnect terminals for next sensor. If engine performance is acceptable, replace sensor and/or replace or repair wiring.
- Run engine with all terminals and sensors connected. If engine performance is acceptable, test is complete (reconnect all wires disconnected during test).

  If engine performance is still not acceptable, proceed with next step.



5

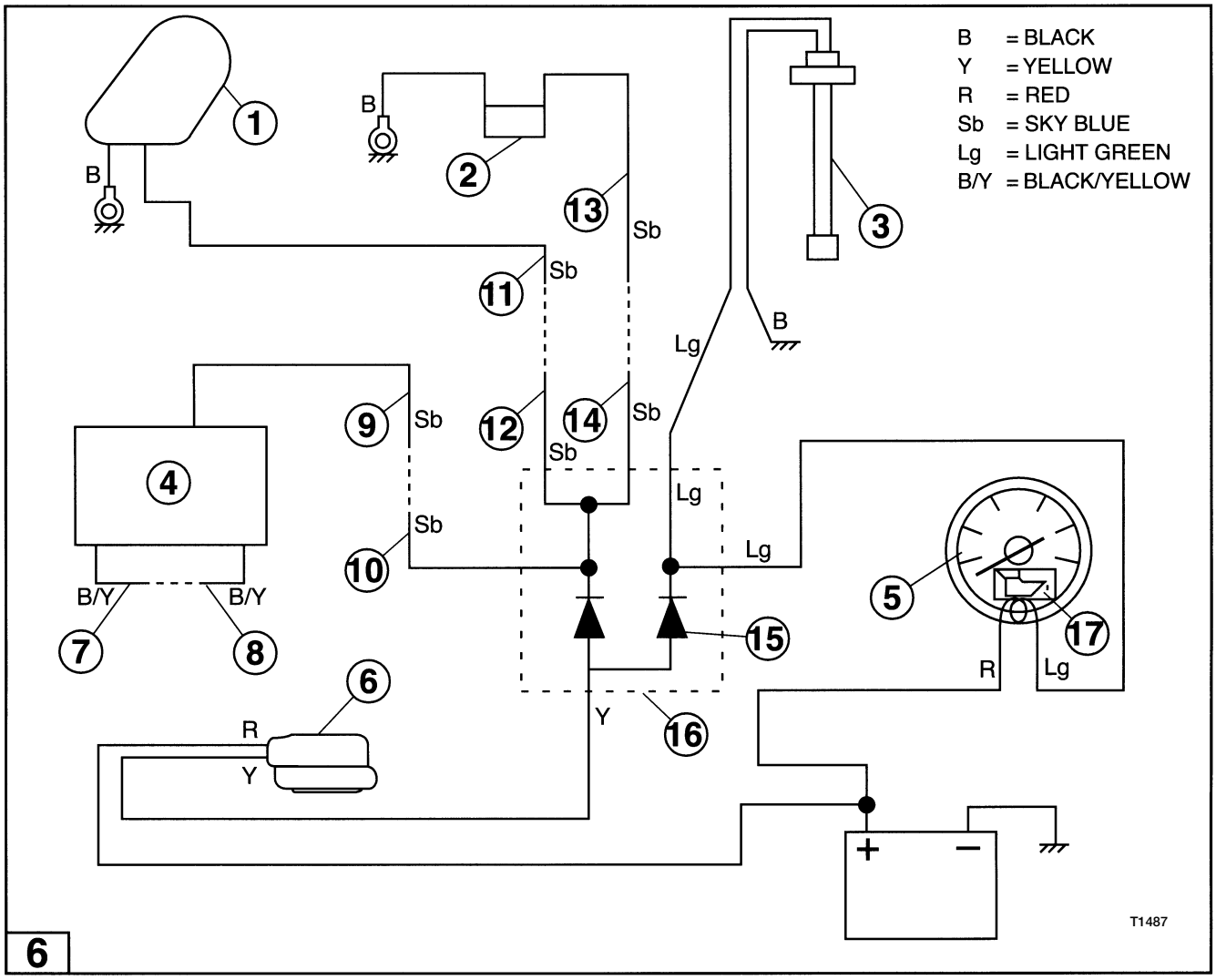
5 6 6. Disconnect half-maximum RPM limitation input terminals **(9)** and **(10)**.

5 6 7. Run engine. Is engine performance acceptable? If it is, replace the following cable harness:

Engine Models	Callout in Illustration	Name in Parts Book
40 / 50 / 60 / 70 / 80 / 90	(16)	Cable Harness A
115 / 120 / 140	(20)	Cable Harness C

8. Run engine with all terminals connected. If engine performance is acceptable, test is complete (reconnect all wires disconnected during test).

If engine performance is still not acceptable, proceed with next step.



6

9. Replace CD Unit. See Ignition System Repair Procedures - CD Unit.

Run engine. Is engine performance acceptable? If it is, test is complete (reconnect all wires disconnected during test).

If engine performance is still not acceptable, proceed with next step.

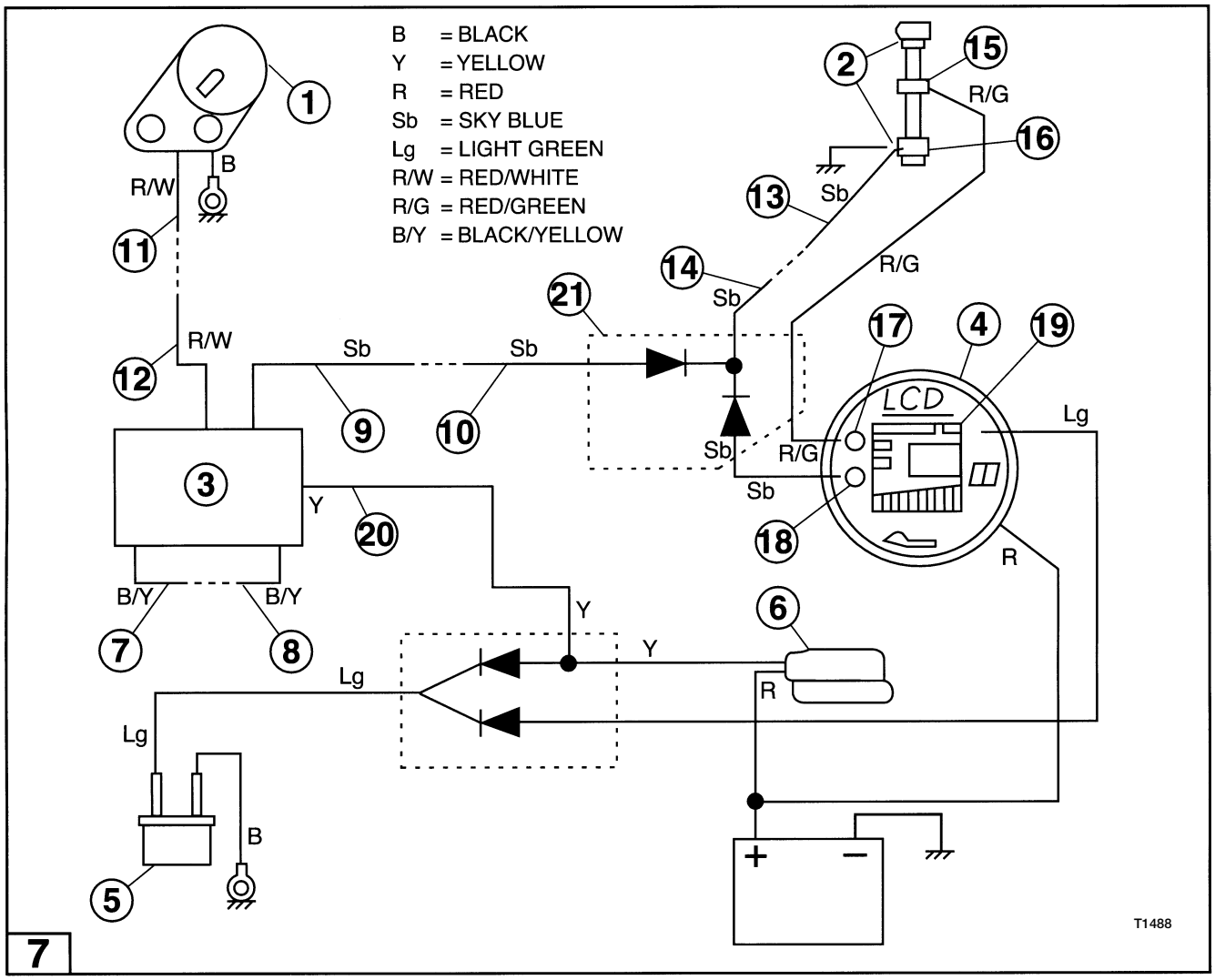
10. Replace exciter coil(s). See Ignition System Repair Procedures Exciter Coil.

Reconnect all wires disconnected during test.

Over-Speed Limitation

Another type of RPM limitation is over-speed limitation. The CD Unit will prevent the engine from going faster than the maximum RPM. The following table indicates the maximum RPM for each engine:

Engine Models	Maximum RPM
40D and 50D	5900 ± 250 RPM
40D2 and 50D2	6050 ± 250 RPM
60B and 70B	6100 ± 200 RPM
60C and 70C	6150 ± 200 RPM
80 and 90	5900 ± 250 RPM
115 / 120 / 140	6000 ± 250 RPM

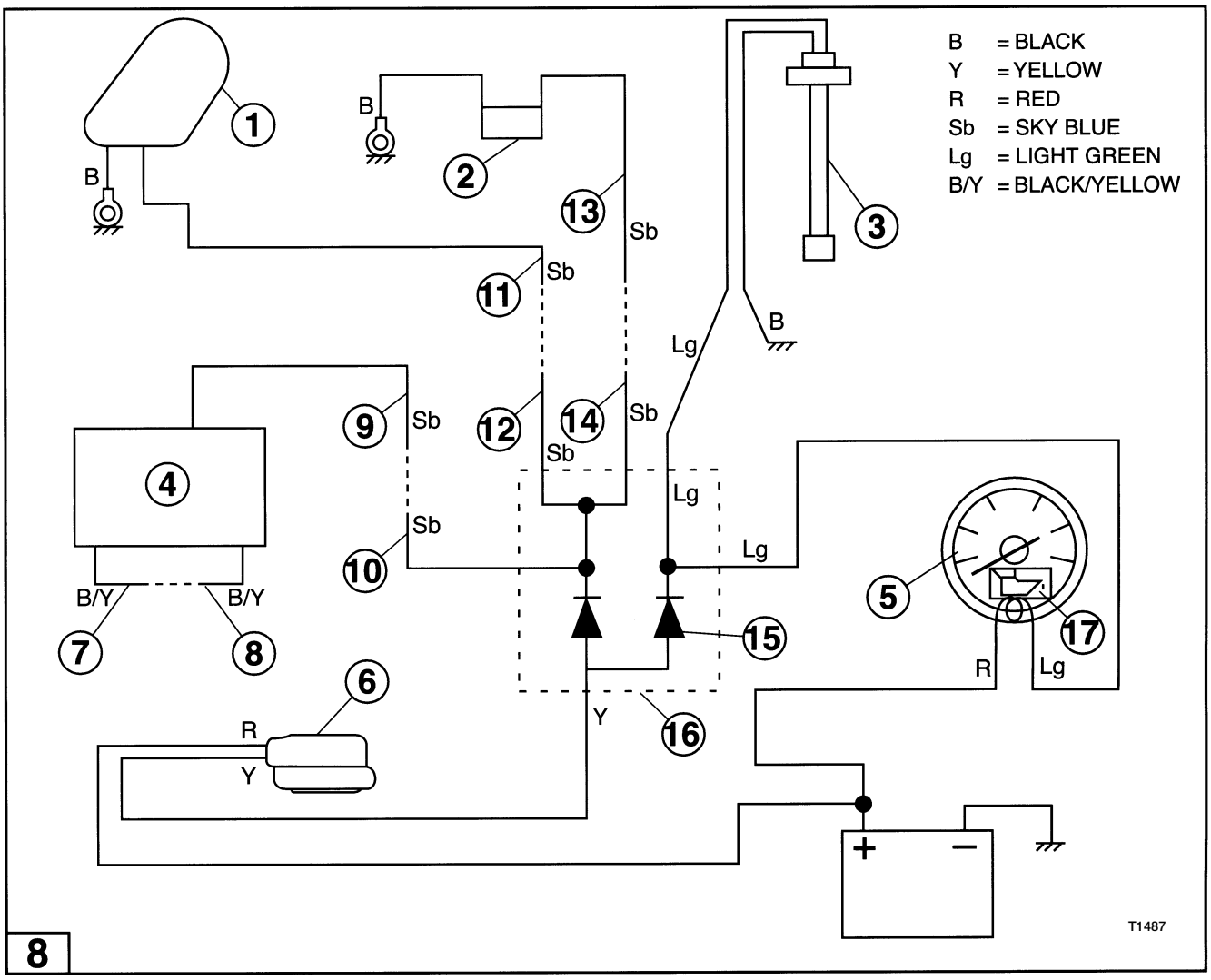


Overspeed Limitation Test
Perform this test if engine has a high speed miss.

NOTE

An engine may over-speed if the propeller is not sized correctly. Refer to the engine owner's manual to determine the correct propeller.

The test assumes that:
- Tune-Up Procedure has been performed, see Section 2.
- Ignition Timing and the Carburetor Synchronization Procedure has been performed, see Section 2.
- Engine is at operating temperature.
- Tests are performed with engine running in forward gear.
- Tachometer is installed.



NOTE

Make sure all electrical terminals are connected during this test except those that are noted in the test procedure.

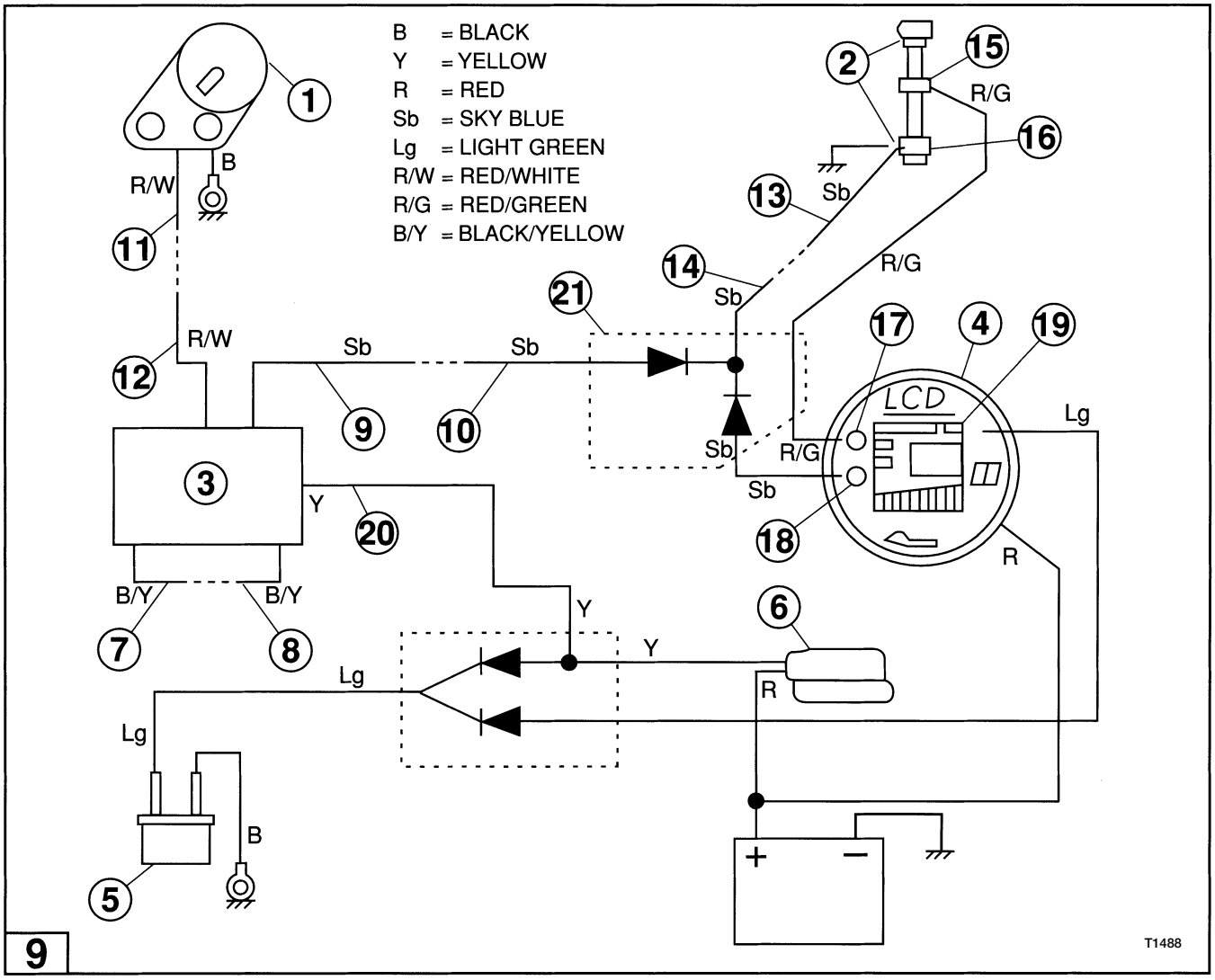
Check for continuity between chassis ground and the ground connection for the magneto plate, CD Unit, and ignition coils before conducting the following procedure.

8 **9** 1. Disconnect RPM limitation jumper at terminals **(7)** and **(8)**.

2. Run engine. Does engine performance improve?

If engine performance improves, replace CD Unit. See Ignition System Repair Procedures - CD Unit and proceed to next step.

If engine performance does not improve, see Section 3, Troubleshooting.



9

3. Run engine. Is engine performance acceptable? If it is, test is complete (reconnect all wires disconnected during test).

If engine performance is still not acceptable, proceed with next step.

4. Replace exciter coil(s). See Ignition System Repair Procedures Exciter Coil.

Reconnect all wires disconnected during test.

Low Speed RPM Limitation

The 115, 120 and 140 model engines have a third type of speed limitation. The CD Unit will limit the top engine speed to about 1500 RPM if the RED/YELLOW lead from the CD Unit to the remote control box is not properly connected.

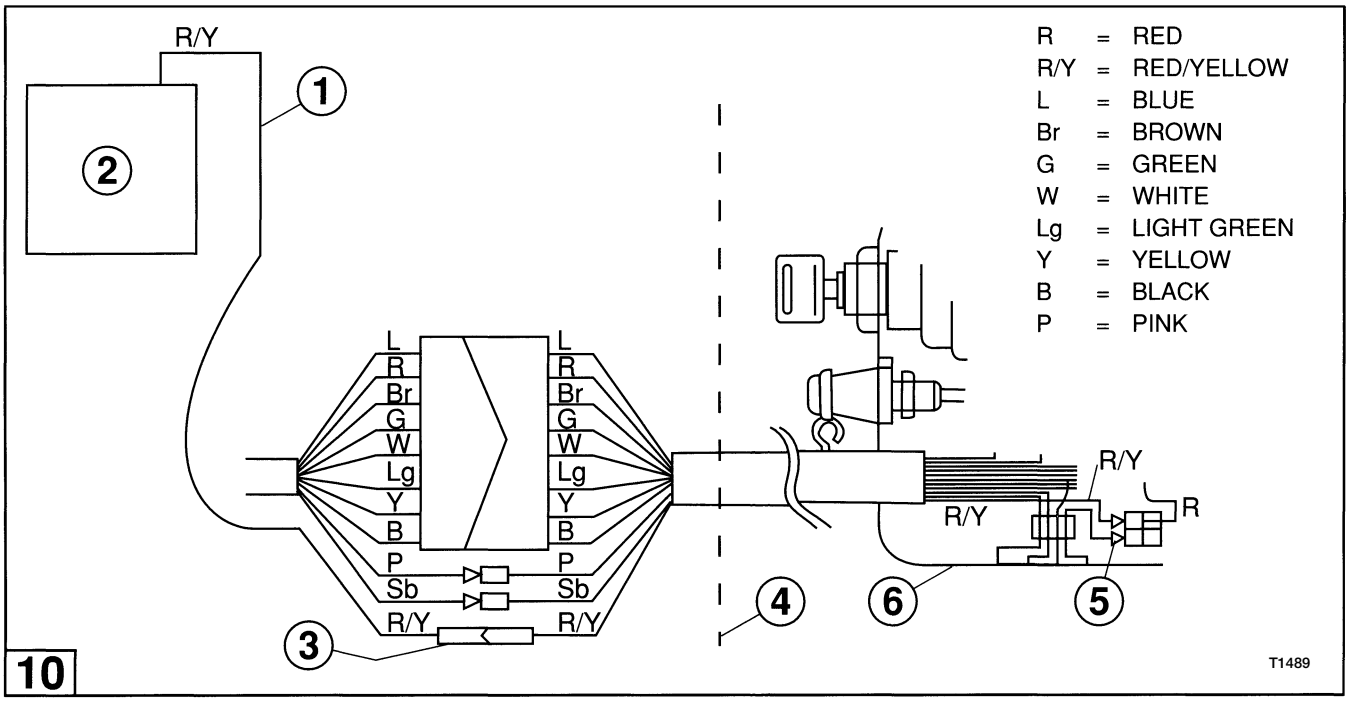
Low Speed RPM Limitation Test

If a 120 or 140 engine has a top speed of 1500 RPM, check for:

10 • RED/YELLOW wire connector **(3)** inside of engine housing **(4)** makes good contact.

10 • RED/YELLOW wire **(1)** intact at CD Unit **(2)**.

10 • RED/YELLOW wire connector **(5)** inside of remote control box **(6)** makes good contact.



IGNITION SYSTEM REPAIR PROCEDURES

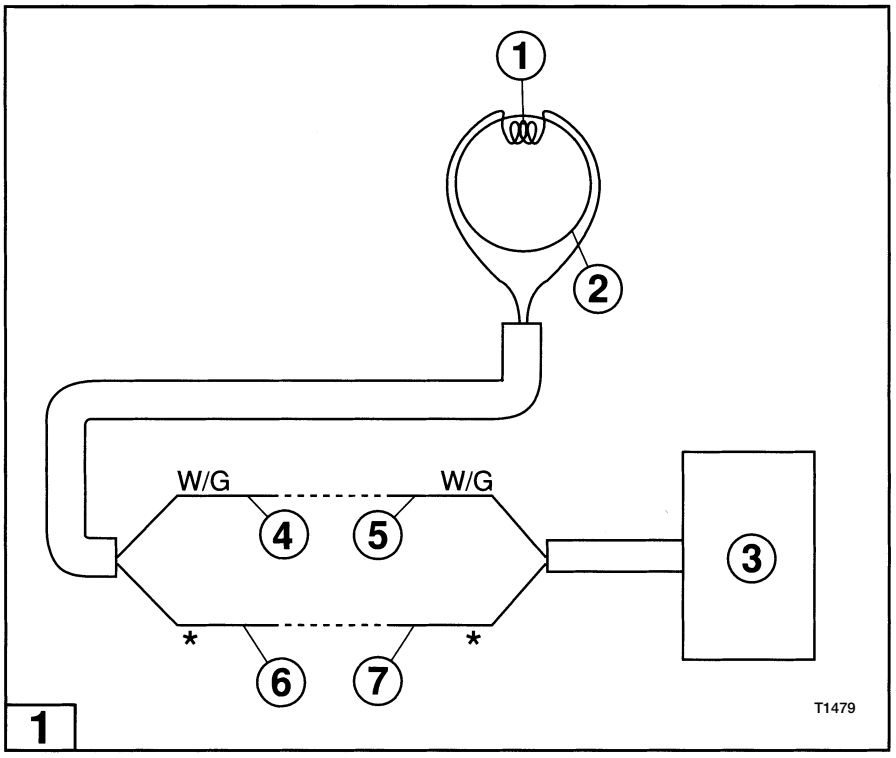
1 2

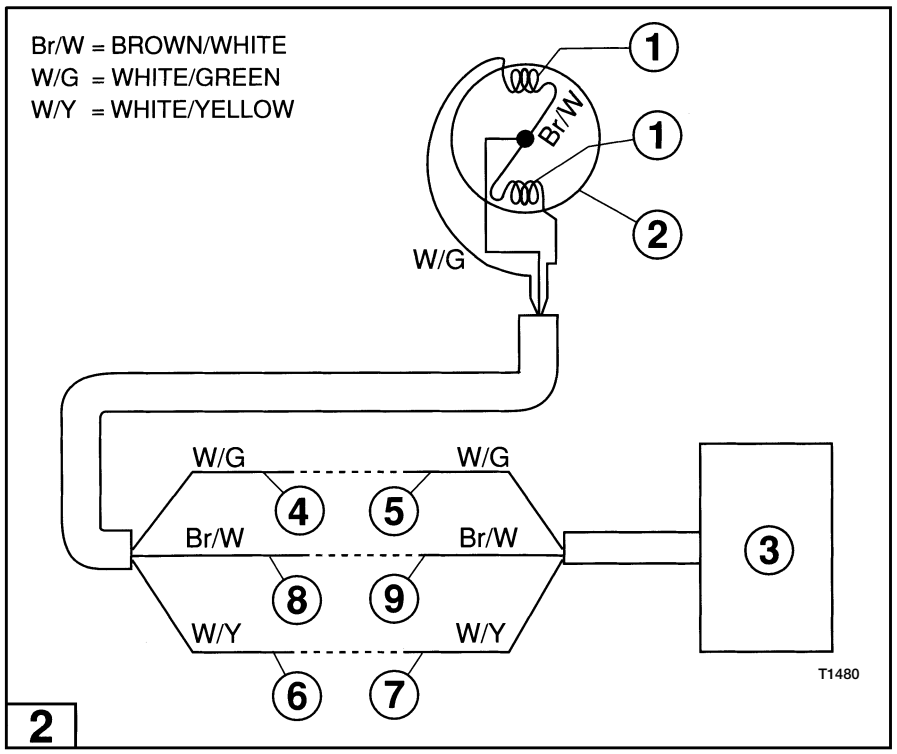
⚠⚠ WARNING

Disable ignition system, by disconnecting exciter coil terminals (4), (5), (6), (7), [(8) and (9) for models 60B and 70B only] to prevent accidental engine startup during removal and replacement of the flywheel.

⚠ CAUTION

Flywheel is under high torque and requires the use of special tools for removal and installation. Failure to use the specified tools can result in injury or damage to the flywheel or coil plate electrical components.





⚠ CAUTION

The force needed to loosen and tighten the flywheel nut requires flywheel be removed and installed with engine mounted and secured on an engine stand.

⚠ CAUTION

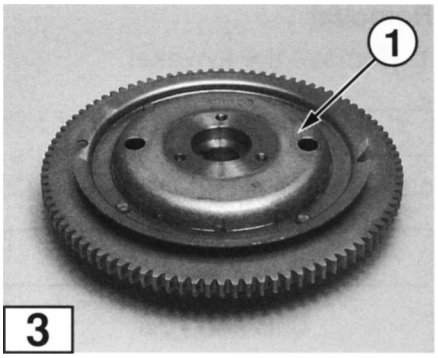
Use proper precautions when performing tests with the engine cover removed. Do not wear loose clothing or jewelry. Keep hair, hands, and clothing away from the flywheel and other moving parts.

⚠ CAUTION

When repairs are complete, make sure all ignition and electrical leads are properly routed and clamped in their original positions and the start-ingear prevention system must be tested before returning engine to customer.

Flywheel

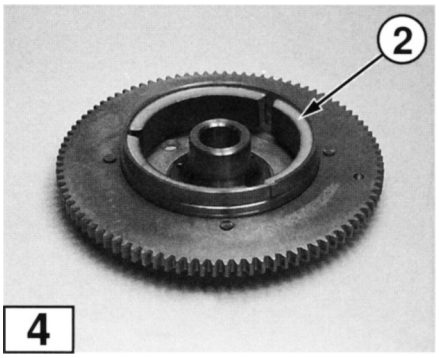
Replacing the exciter coil or coil plate assembly requires the removal of the flywheel, see Section 4, Flywheel, for the proper procedure.



T1490

NOTE

Flywheel magnets must be of a particular strength in order to run the ignition system. Weak magnets can cause low ignition voltage which may affect engine performance. Flywheels seldom go bad and would only be replaced as a last resort in solving an ignition problem.



T1491

3 4 Carefully inspect flywheel **(1)** for cracks, chips, and worn taper after it is removed. Also inspect the magnets **(2)** for cracks and chips and make sure they are firmly attached to the flywheel.

Exciter Coil

NOTE

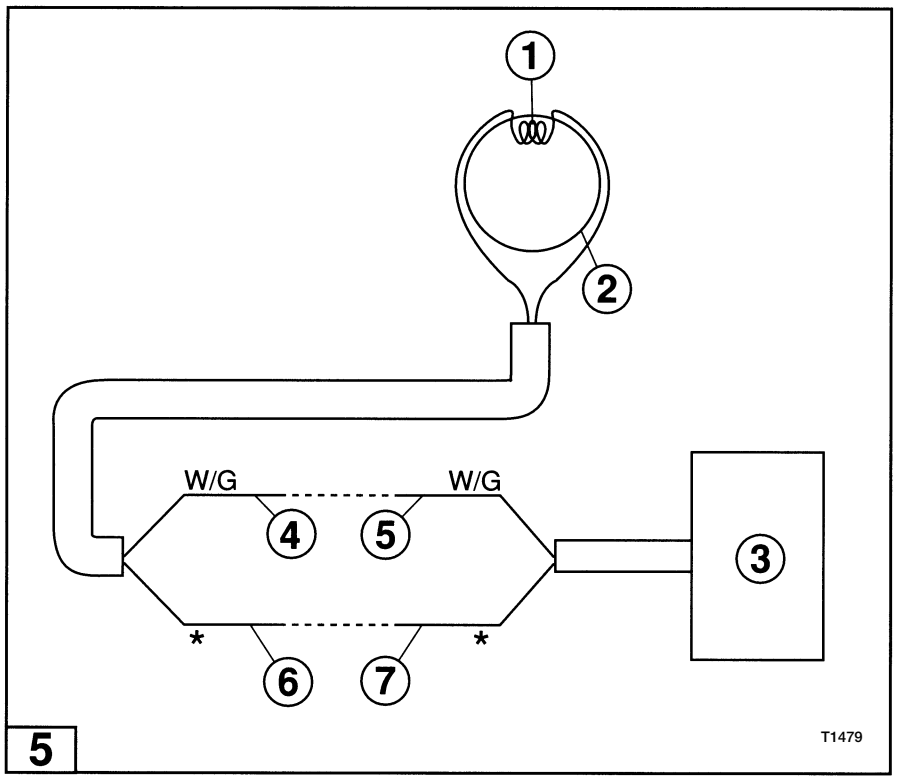
Disconnect negative battery cable from battery before removing exciter coil.

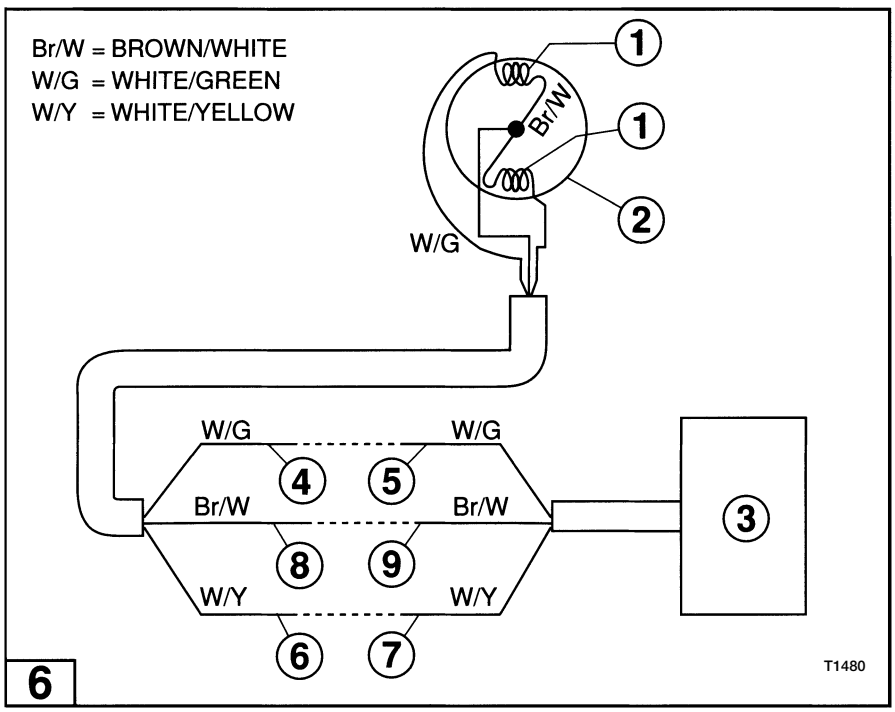
This procedure assumes exciter coil is available as a separate replaceable component. Some engine configurations might require replacement of entire coil plate assembly. Check current Parts Catalog for availability.

Removal
1. Remove the flywheel.

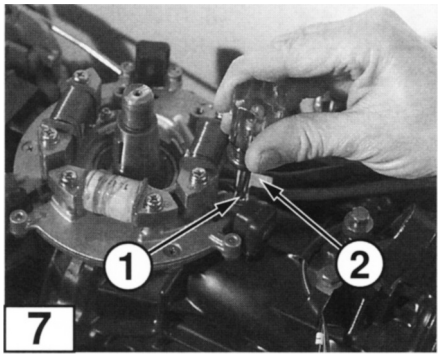
5 6 2. Disconnect following terminals for exciter coil **(1)** connectors. Note that these terminals interconnect cable from coil plate assembly **(2)** to cable from CD Unit **(3)**:

Engine Models	Disconnect Terminals
60B and 70B	④ ⑤ ⑥ ⑦ ⑧ and ⑨





7 3. For models 40 / 50 / 60 / 70 / 80 / 90 ONLY: Remove coil plate assembly cable clamp screws **(1)** and cable clamp **(2)**.



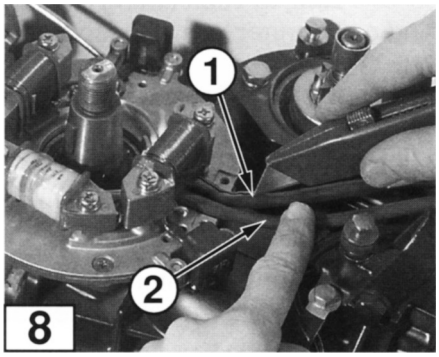
T1492

8 4. For models 40 / 50 / 60 / 70 / 80 / 90 ONLY: Carefully slit coil plate assembly cable shield **(1)**.

NOTE

Make sure you don't cut electrical conductors inside of coil plate assembly cable when you slit cable shield.

*On models 60B / 708 / 60C / 70C there are two coil plate assembly cables **(1)** and **(2)**. Make sure you slit the cable shield for coil plate assembly cable that contains the electrical conductors for the exciter coil(s).*



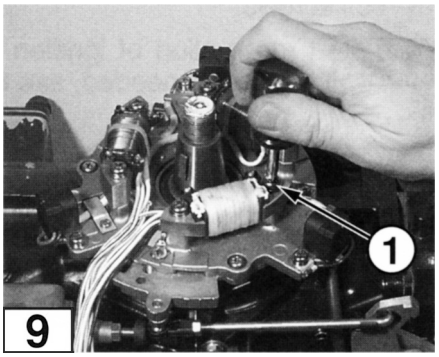
T1493

5. For models 40 / 50 / 60 / 70 / 80 / 90 ONLY: Cut tie wrap.

9 6. For models 40 / 50 / 80 / 90 ONLY: Remove exciter coil screws **(1)** and exciter coil from the mounting bracket.

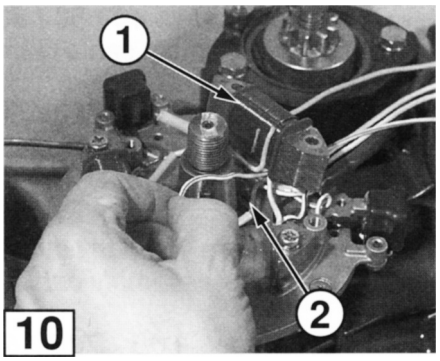
NOTE

On models 60B / 70B remove both exciter coils, they are replaced as a pair.



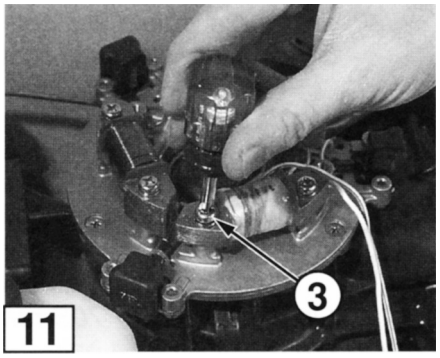
T1495

10 **11** For models 60B / 70B / 60C / 70C ONLY: Remove alternator coil screws and move alternator coil **(1)** out of way. Pull exciter coil leads **(2)** out of way of way of alternator coil. Remove exciter coil screws **(3)** and exciter coil from the mounting bracket.



T1496

12 For models 115 / 120 / 140 ONLY: Remove mounting screws **(1)** and alternator assembly **(2)** from the mounting bracket **(3)**.



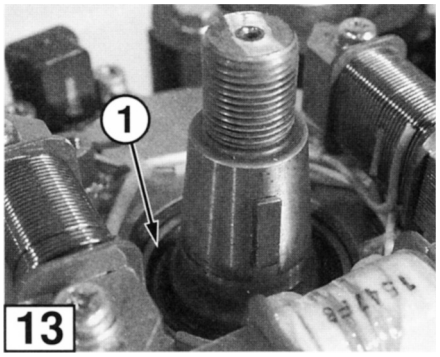
T1497

Cleaning and Inspection

13 Clean coil plate assembly, upper main bearing seal **(1)**, set ring, ignition timing link, alternator coils, pulser coils, coil leads, and coil connectors with isopropyl alcohol as required.

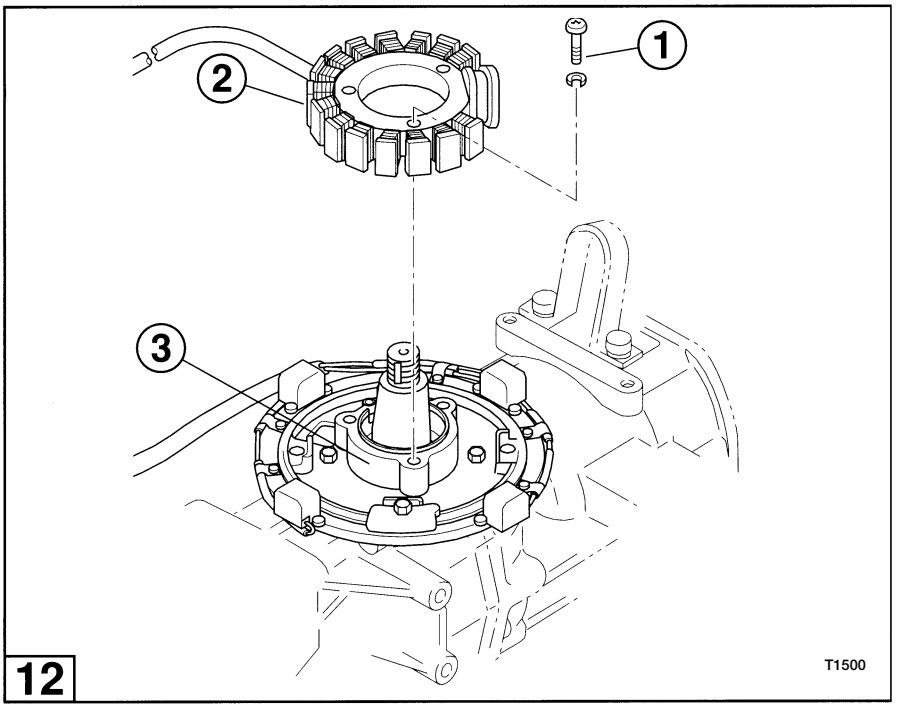
Check for the following and repair or replace as required:

- Bent, chipped, cracked, or corroded coil plate assembly.
- Coil leads for integrity, cut or cracked insulation, and damaged connectors.
- Broken or bent alternator coil laminations damaged alternator coil windings and missing alternator coil screws.
- Broken, cracked, or misaligned pulser coils and missing pulser coil screws.

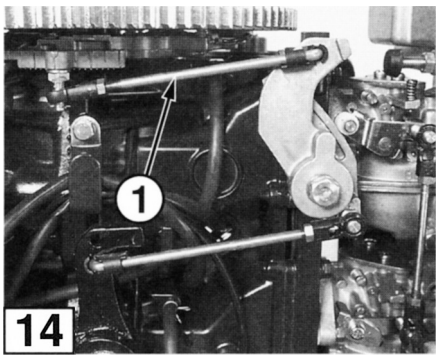


T1498

14 • Free motion of ignition timing link **(1)**. Repair, adjust, and lubricate as needed, see Section 2.



T1500



T1499

Installation
Install in reverse order of removal.

NOTE

Disconnect negative battery cable from battery before installing exciter coil.

Use threadlocker on screw threads before installing screws.

Use a length of shrink tube to fabricate a new coil plate assembly cable shield as required. Inside diameter of shrink tubing must be large enough to pass over the largest connector.

Pulser Coil Assembly

NOTE

On models 115 / 120 / 140 you must replace the pulser coil assembly. Individual pulser coils are not available.

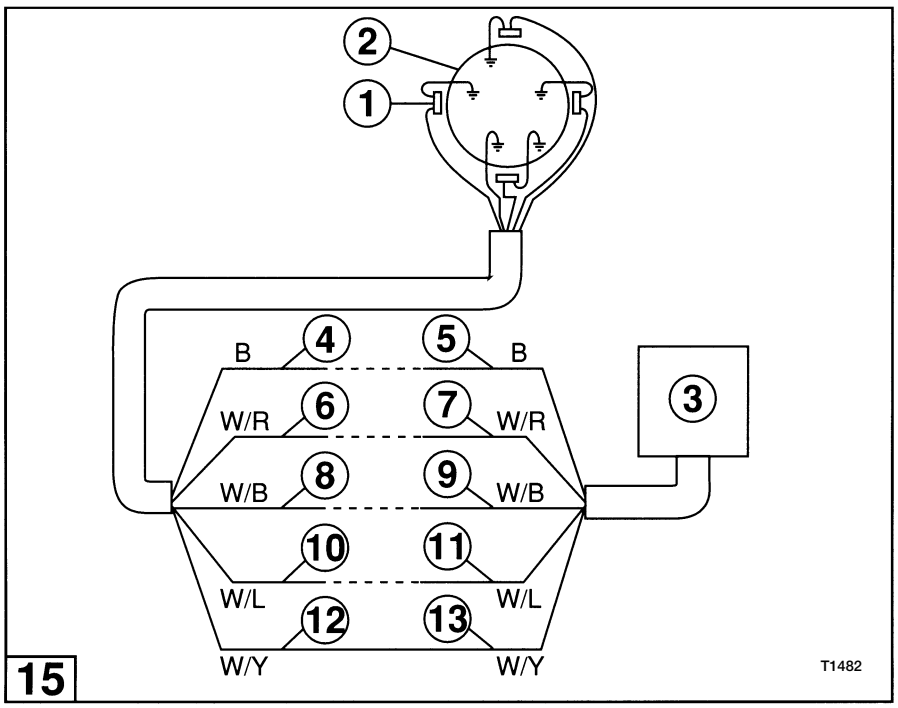
On models 40 / 50 / 60B / 70B / 60C / 70C / 80 / 90 you must replace the entire coil plate assembly (see procedure later in this section). Individual pulser coils are not available.

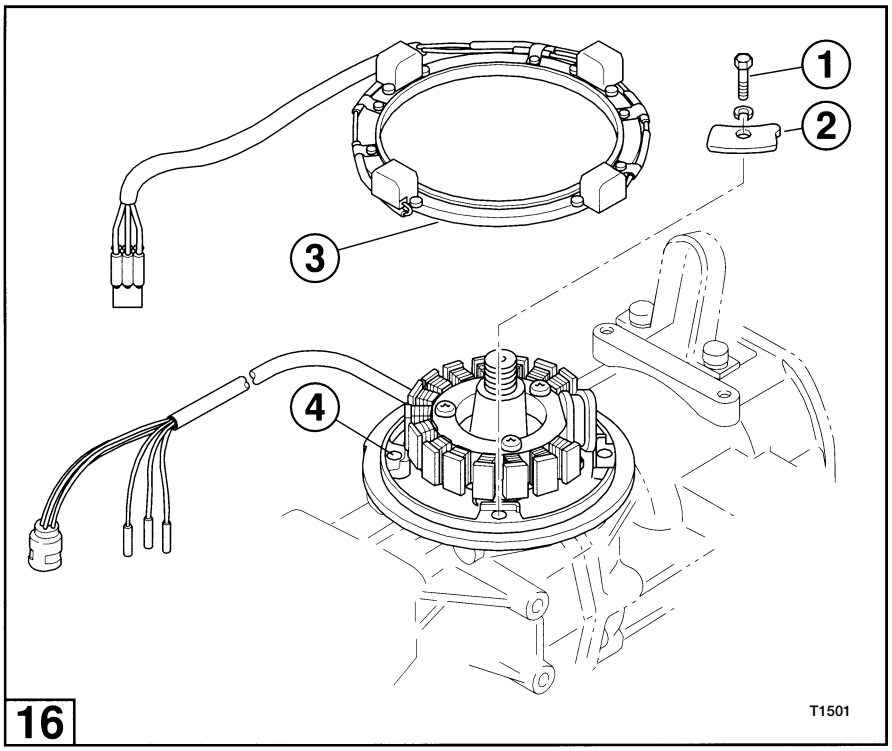
Disconnect negative battery cable from battery before removing pulser coil assembly

Removal (models 115 / 120 / 140)
1. Remove the flywheel.

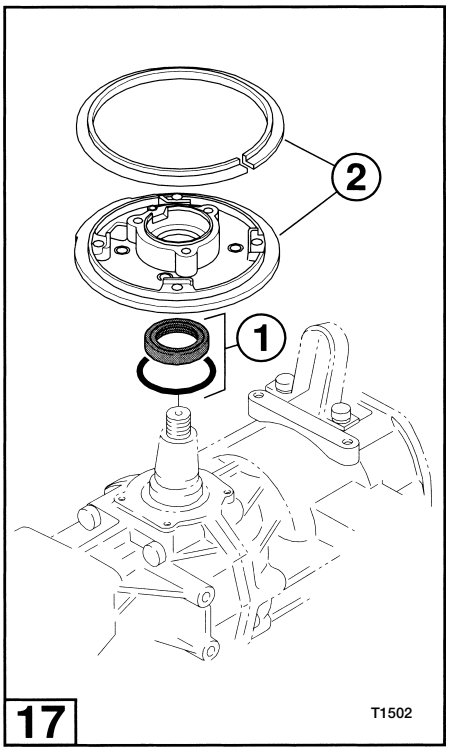
15 2. Disconnect the following pulser coil **(1)** terminals. Note that these terminals interconnect cable from coil plate assembly **(2)** to cable from CD Unit **(3)**:

• Pulser coil terminals **(4), (5), (6), (7), (8), (9), (10), (11), (12),** and **(13)**.





16



17

16 3. Remove the screws **(1)** and clamps **(2)** and remove pulser coil assembly **(3)** from the mounting bracket **(4)**.

Cleaning and Inspection

17 Clean upper main bearing seal and o-ring **(1)** guide plate and bushing, ignition timing link, alternator assembly, electrical leads and connectors with isopropyl alcohol as required.

Check for the following and repair or replace as required:

- Bent, chipped, cracked, or corroded guide plate and bushing.
- Electrical leads and connectors for integrity, cut or cracked insulation.
- Broken or bent alternator assembly and missing screws.

17 Apply light coat of low temperature lithium grease to guide plate and bushing **(2)**.

Installation
Install in reverse order of removal.

NOTE

Disconnect negative battery cable from battery before installing pulser coil assembly.

Use threadlocker on screw threads before installing screws.

Coil Plate Assembly

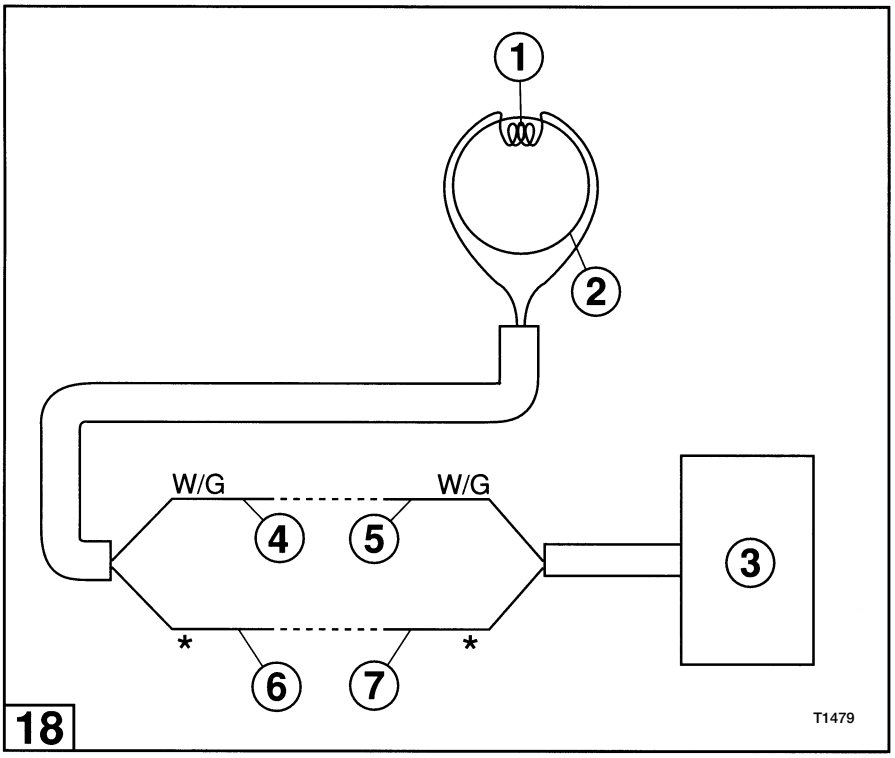
NOTE

Disconnect negative battery cable from battery before removing coil plate assembly.

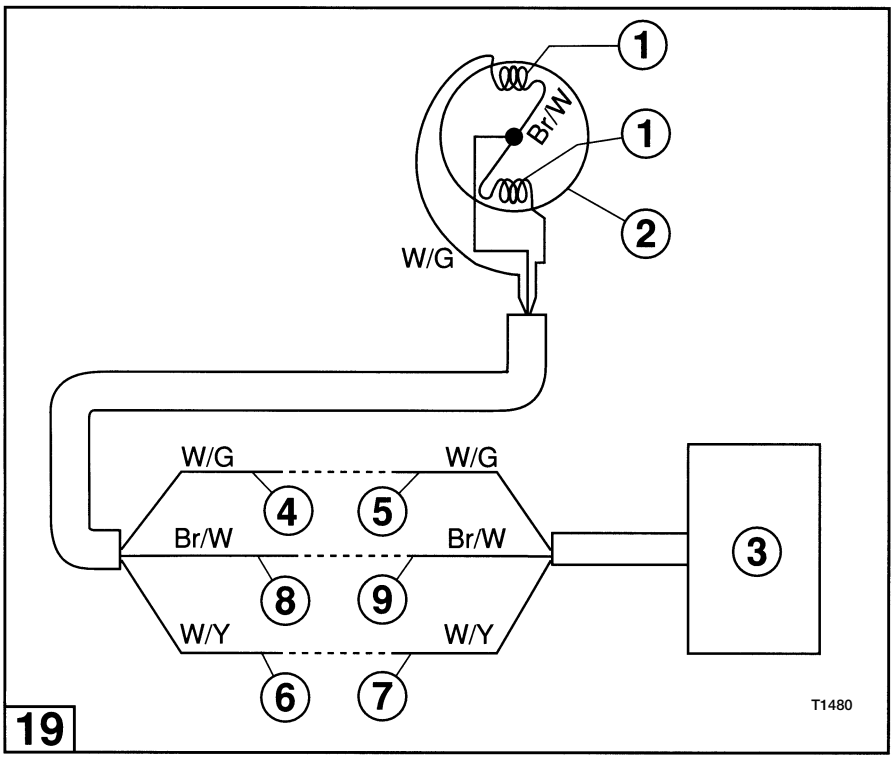
On models 40 / 50 / 60B / 70B / 60C / 70C / 80 / 90 the pulser coils cannot be replaced individually. You must replace the entire coil plate assembly.

On models 115 / 120 / 140 the pulser coils cannot be replaced individually. You must replace the pulser coil assembly (see previous procedure).

Removal (models 40D / 50D / 60B / 70B / 60C / 70C / 80 / 90)
1. Remove the flywheel.



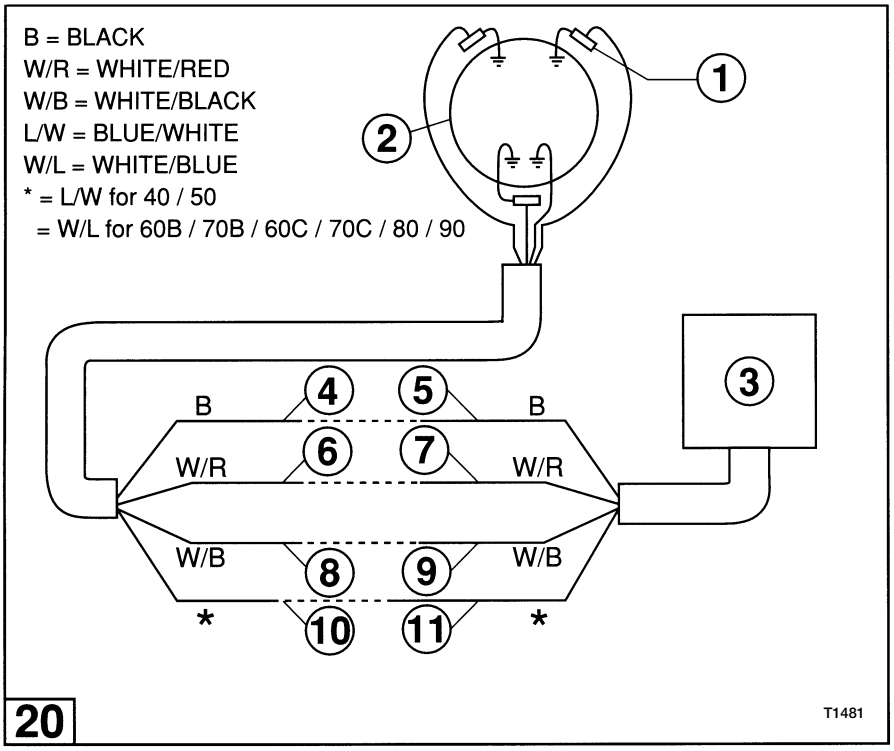
18



19

2. Disconnect the following terminals:

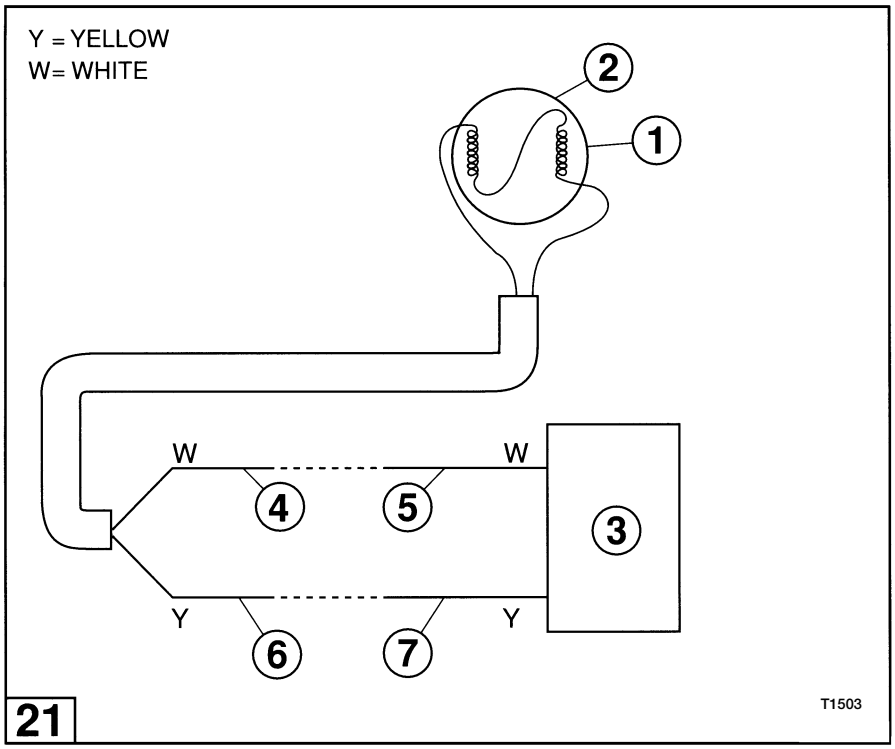
18 19 Exciter coil **(1)** terminals. Note that these terminals interconnect cable from coil plate assembly **(2)** to cable from CD Unit **(3)**:

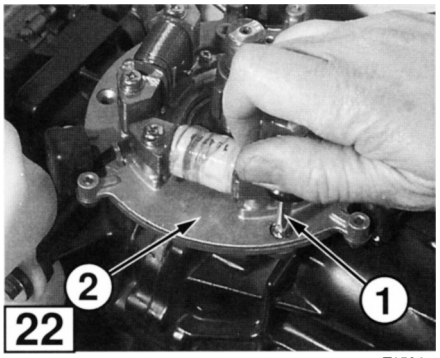


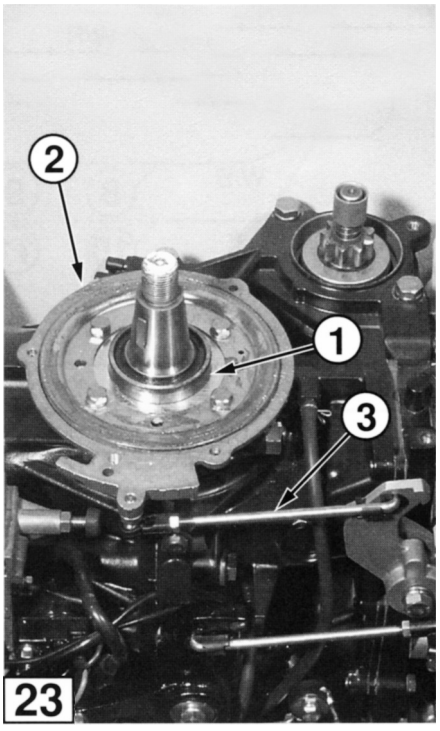
Engine Models	Disconnect Terminals
40 / 50 / 60C / 70C / 80 / 90	④ ⑤ ⑥ and ⑦
60B and 70B	④ ⑤ ⑥ ⑦ ⑧ and ⑨

20 Pulser coil **(1)** terminals. Note that these terminals interconnect cable from coil plate assembly **(2)** to cable from CD Unit **(3)**:

Engine Models	Disconnect Terminals
40 / 50 / 60B / 70B / 60C / 70C / 80 / 90	④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩ and ⑪







21 Alternator coil **(1)** terminals. Note that these terminals interconnect cable from coil plate assembly **(2)** to rectifier / regulator **(3)**:

Engine Models	Disconnect Terminals
40 / 50 / 60B / 70B / 60C / 70C / 80 / 90	④ ⑤ ⑥ ⑦

22 3. Remove the screws **(1)** and remove coil plate assembly **(2)** from the mounting bracket.

Cleaning and Inspection

23 Clean upper main bearing seal **(1)**, guide plate **(2)** and ignition timing link **(3)** with isopropyl alcohol as required.

Check for the following and repair or replace as required:
- Bent, chipped, cracked, or corroded guide plate.
- Broken or bent ignition timing link.

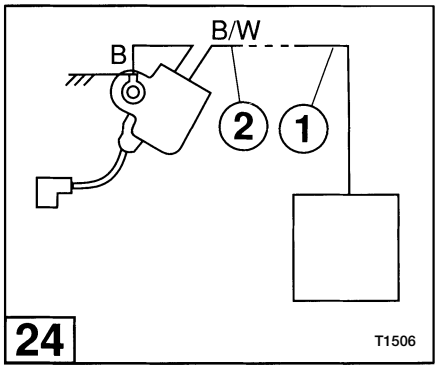
Installation
Install in reverse order of removal.

NOTE

Disconnect negative battery cable from battery before installing coil plate assembly.

Use threadlocker on screw threads before installing screws.

Apply light coat of low temperature lithium grease to the upper main bearing outer and guide plate.



Ignition Coil

NOTE

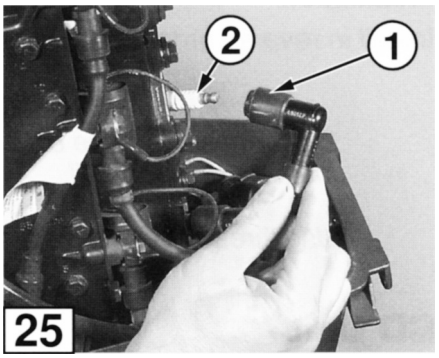
Disconnect negative battery cable from battery before removing ignition coil.

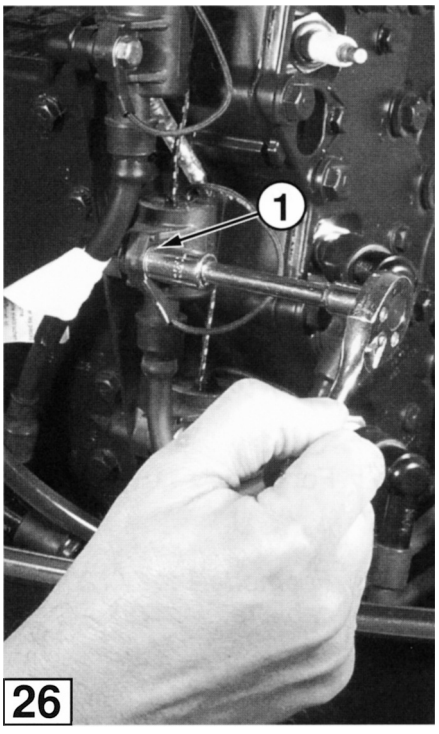
Removal

24 1. Disconnect CD Unit output lead **(1)** from ignition coil primary cable **(2)**.

25 2. Disconnect spark plug cap **(1)** from spark plug **(2)**.

26 3. Remove bolts **(1)** and remove ignition coil.



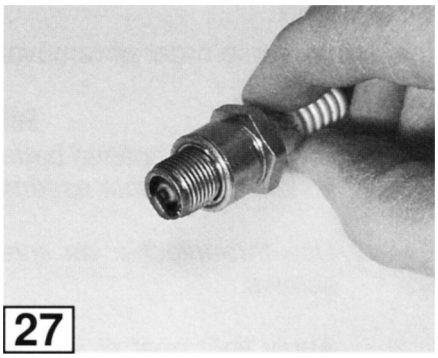


Cleaning and Inspection
Clean mounting area with isopropyl alcohol.

Check for the following and repair or replace as required:

27 Remove spark plug(s) and inspect for fouling, damaged electrodes, or damaged ceramic insulator.

CD Unit output connectors and leads for integrity, cut or cracked insulation.



T1509

Installation
Install in reverse order of removal.

NOTE

Disconnect negative battery cable from battery before installing ignition coil.

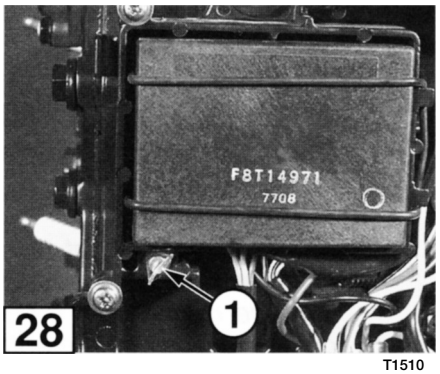
Use threadlocker on bolt threads before installing bolts.

CD Unit

NOTE

28 *Disconnect negative battery cable from battery before removing CD Unit.*

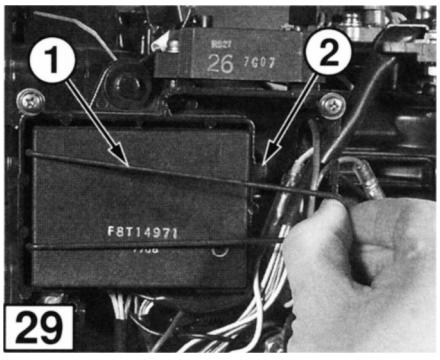
*Make note of the location of the spare 20A engine fuse **(1)**. It is usually located near the CD Unit and can easily be misplaced when the CD Unit is serviced.*



T1510

Removal

29 1. For models 40 / 50 / 60B / 70B / 60C / 70C / 80 / 90: Carefully stretch elastic CD Unit hold down **(1)** and remove it from CD Unit retaining groove **(2)**.



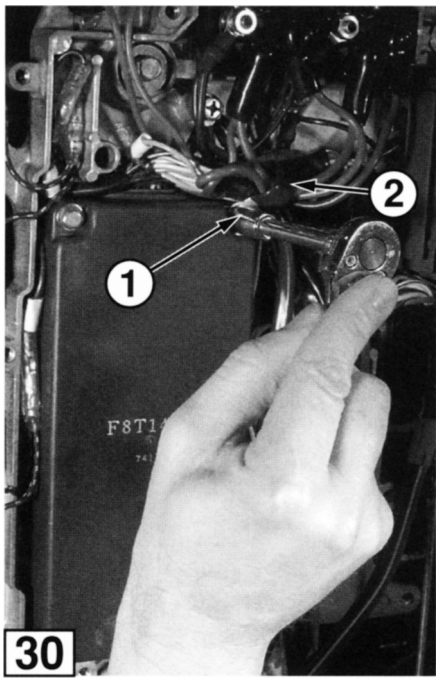
T1511

30 For models 115 / 120 / 140: Remove bolts **(1)**.

NOTE

30 *Formodels 115 / 120 / 140 make note of the location of cable retainer **(2)**.*

2. Remove CD Unit.



T1512

Cleaning and Inspection
Examine electrical conductors and connectors.

Installation
Install in reverse order of removal.

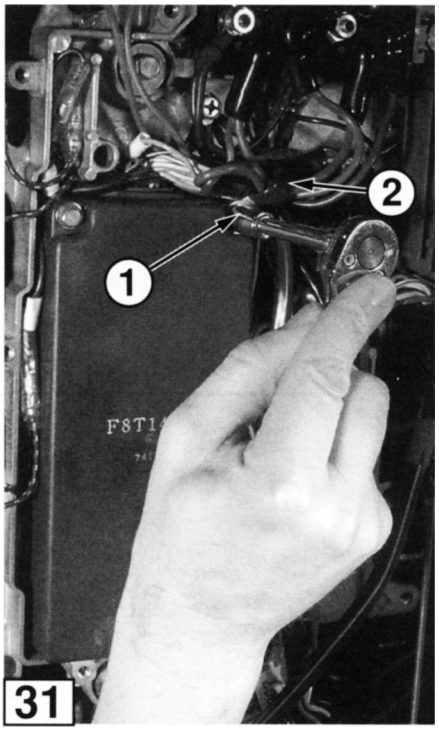
NOTE

Disconnect negative battery cable from battery before installing CD Unit.

For models 115 / 120 / 140: Use threadlocker on bolt threads before installing bolts.

Make sure that all electrical conductors are properly routed before you insert CD Unit to avoid pinching them.

31 *For models 40 / 50 / 60B / 70B / 60C / 70C / 80 / 90 make sure that BLACK/YELLOW connector is tucked behind CD Unit before you install it **(1)**.*

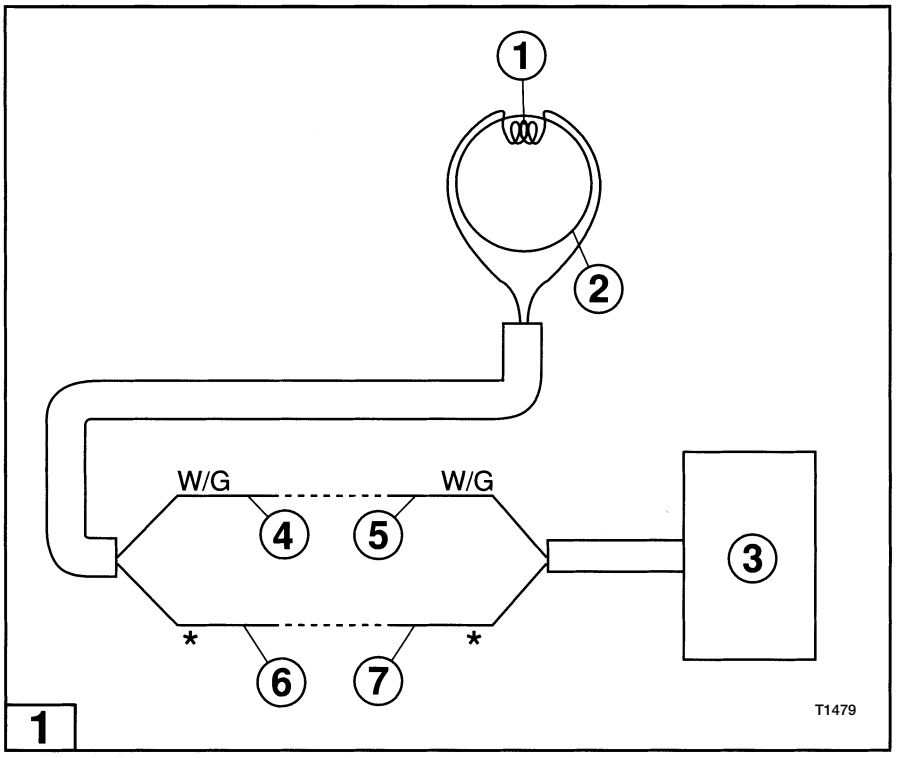


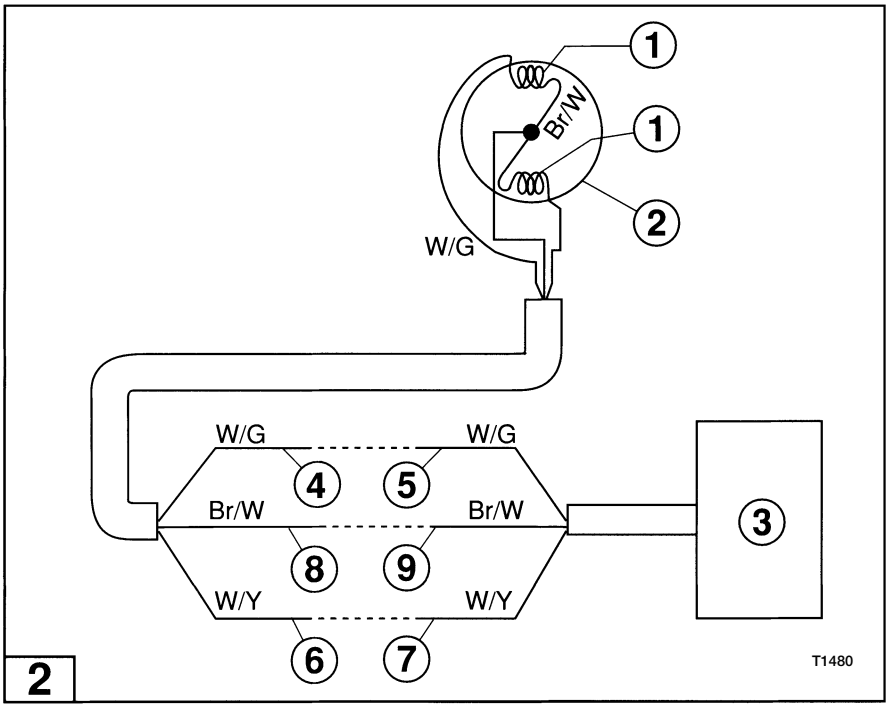
T1512

STARTING SYSTEM

1 2 **⚠⚠ WARNING**

Disable ignition system, by disconnecting exciter coil terminals (4), (5), (6), (7), [(8) and (9) for models 60B and 70B only] to prevent accidental engine startup during testing of starter circuit.





⚠ CAUTION

Flywheel is under high torque and requires the use of special tools for removal and installation. Failure to use the specified tools can result in injury or damage to the flywheel or coil plate electrical components.

⚠ CAUTION

The force needed to loosen and tighten the flywheel nut requires flywheel be removed and installed with engine mounted and secured on an engine stand.

⚠ CAUTION

Use proper precautions when performing tests with the engine cover removed. Do not wear loose clothing or jewelry. Keep hair, hands, and clothing away from the flywheel and other moving parts.

⚠ CAUTION

When repairs are complete, make sure all ignition and electrical leads are properly routed and clamped in their original positions and the start-in-gear prevention system must be tested before returning engine to customer.

Starter System Testing

The starter system may cause three types of problems:

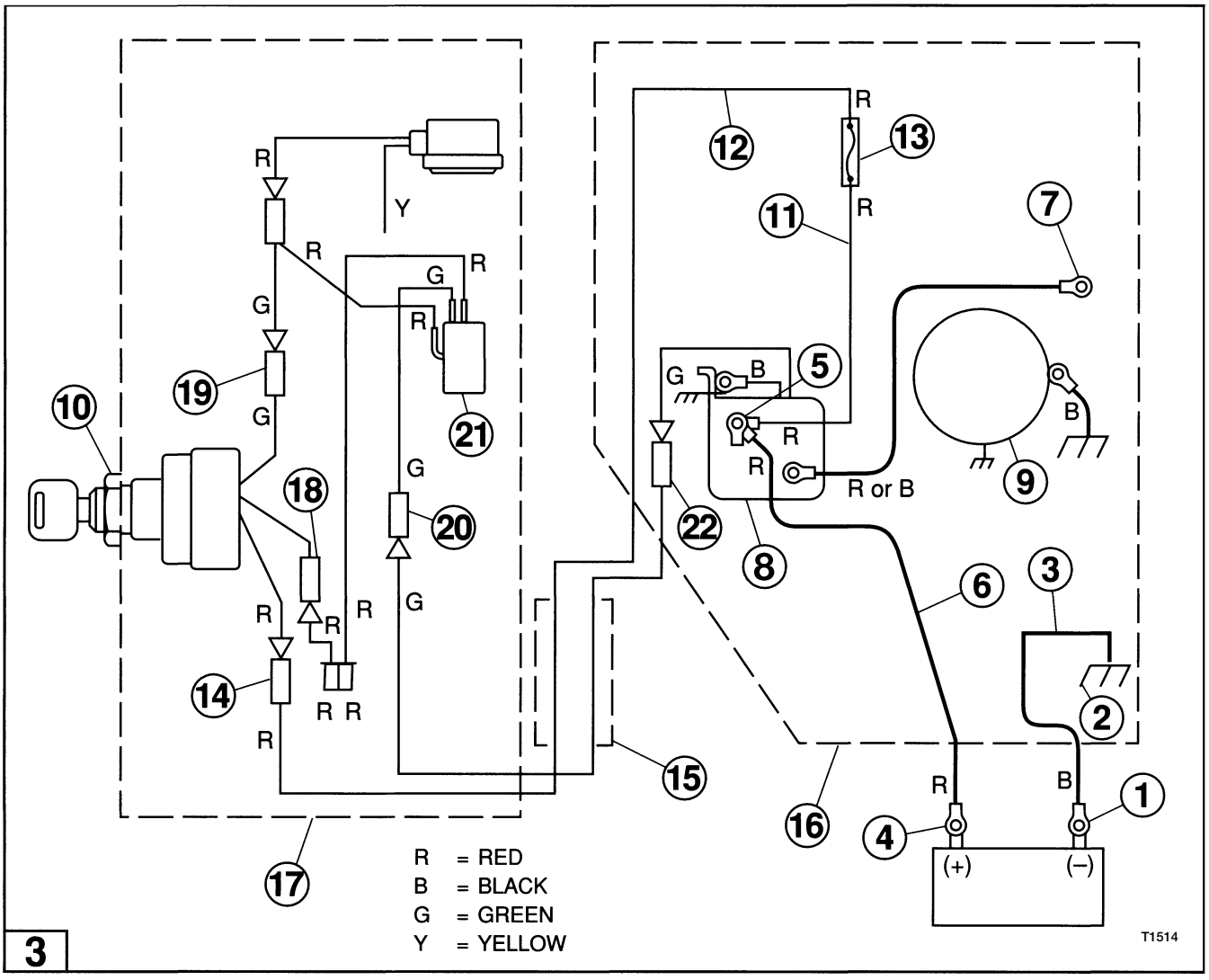
- The engine does not crank, see Starter Circuit Tests inthis section.
- The starter motor runs but does not engage or disengage from the flywheel, see Starter Motor Test in this section.
- The starter motor will not shut off, see Starter Solenoid Test in this section.

Before you begin testing of starting system :

- Check battery fluid level and specific gravity. Charge or replace as required. See Battery Care and Maintenance, this section.
- Checkthe following electrical connections and make sure they are secure and free of corrosion:
  - Battery cables and clamps.
  - Starter solenoid wiring (including ground connection).
  - Starter motor wiring (including ground connection to engine block and/or cowling).
  - Main key switch and neutral start switch cables.
- Make sure shift lever or remote control lever is in NEUTRAL and it operates freely.
- Set main key switch to OFF position unless otherwise directed in instructions.

Starter Circuit Tests

These tests are designed to quickly isolate the faulty starter circuit component if the engine does not crank.



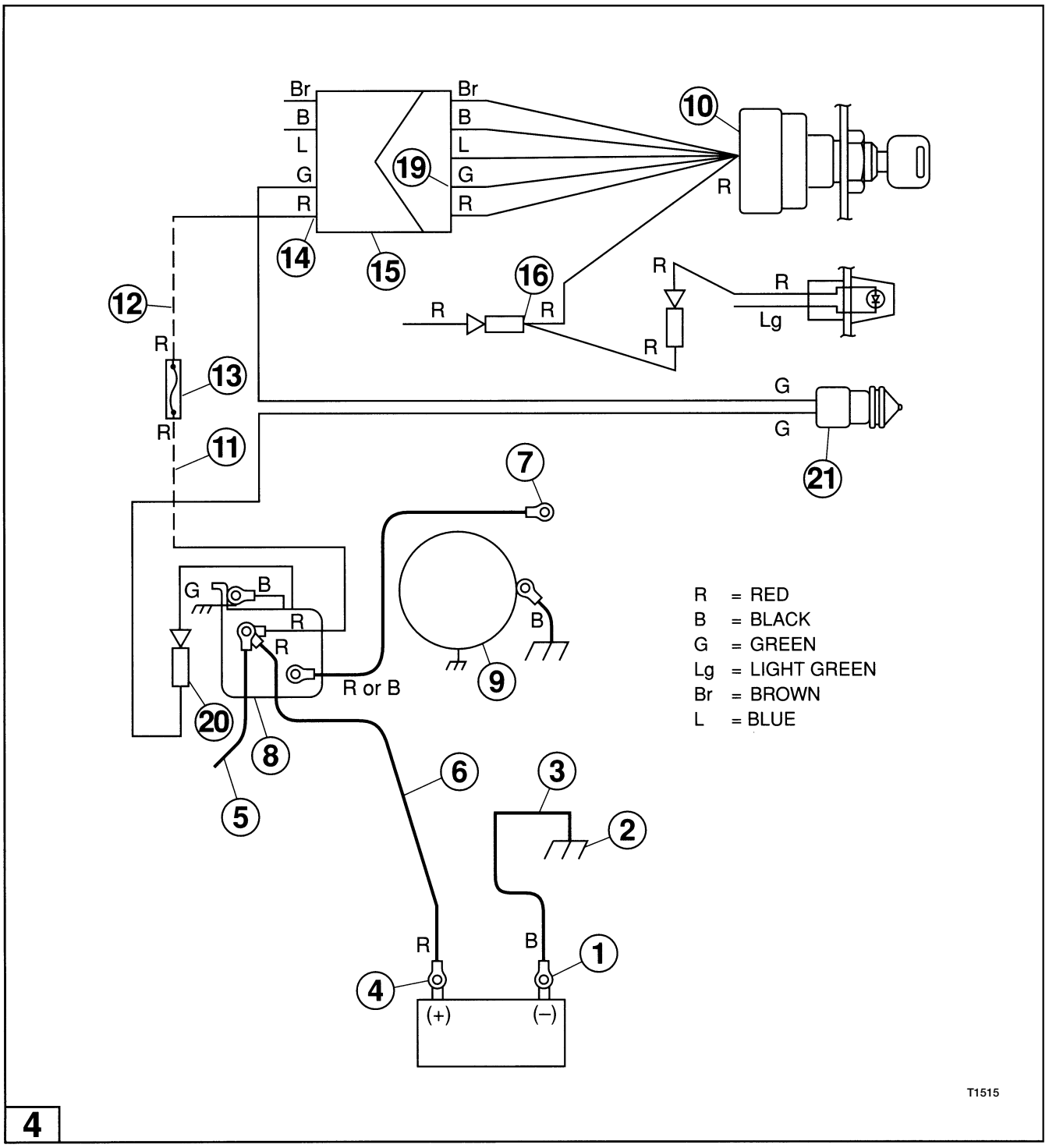
NOTE

The electrical drawings have been simplified to show only those elements necessary to test the starter circuit.

Two types of starter circuits are used and illustrated in:

3 • *Figure 1 - models with remote control box.*

4 • *Figure 2 - models without remote control box.*



4

5 6 1. Disconnect negative battery cable **(3)** from negative battery terminal **(1)**.

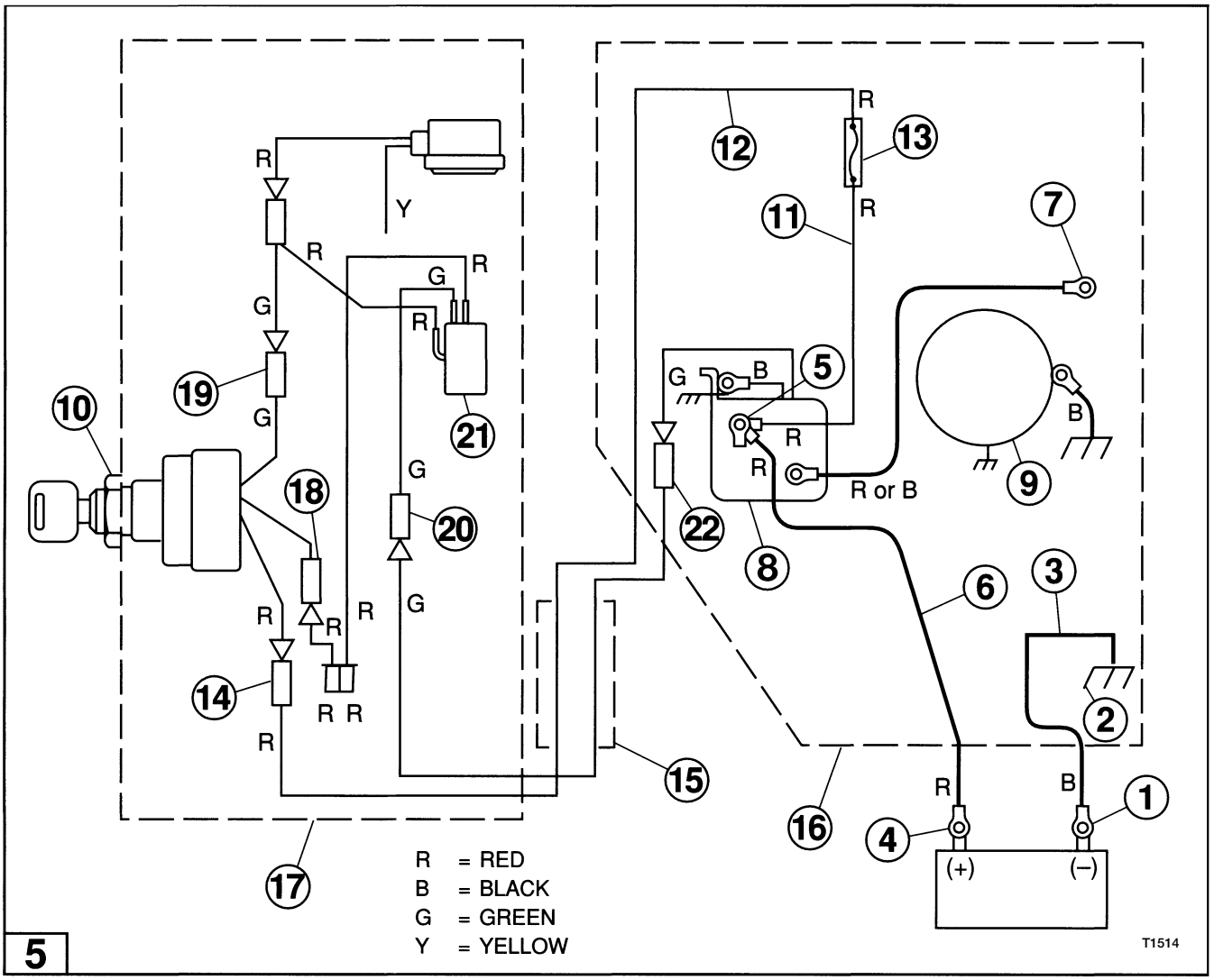
5 6 2. Set analog multimeter to check continuity. Connect one tester lead to negative battery terminal **(1)** and the other tester lead to the ground connection **(2)** for negative battery cable **(3)**.

If the meter does not indicate continuity, clean connections and/or replace negative battery cable.

If the meter indicates continuity, go to the next step.

3. Set analog multimeter to “DCV” and set range to “20”. Connect BLACK tester lead to “- COM” and the RED tester lead to “+ VΩ”.

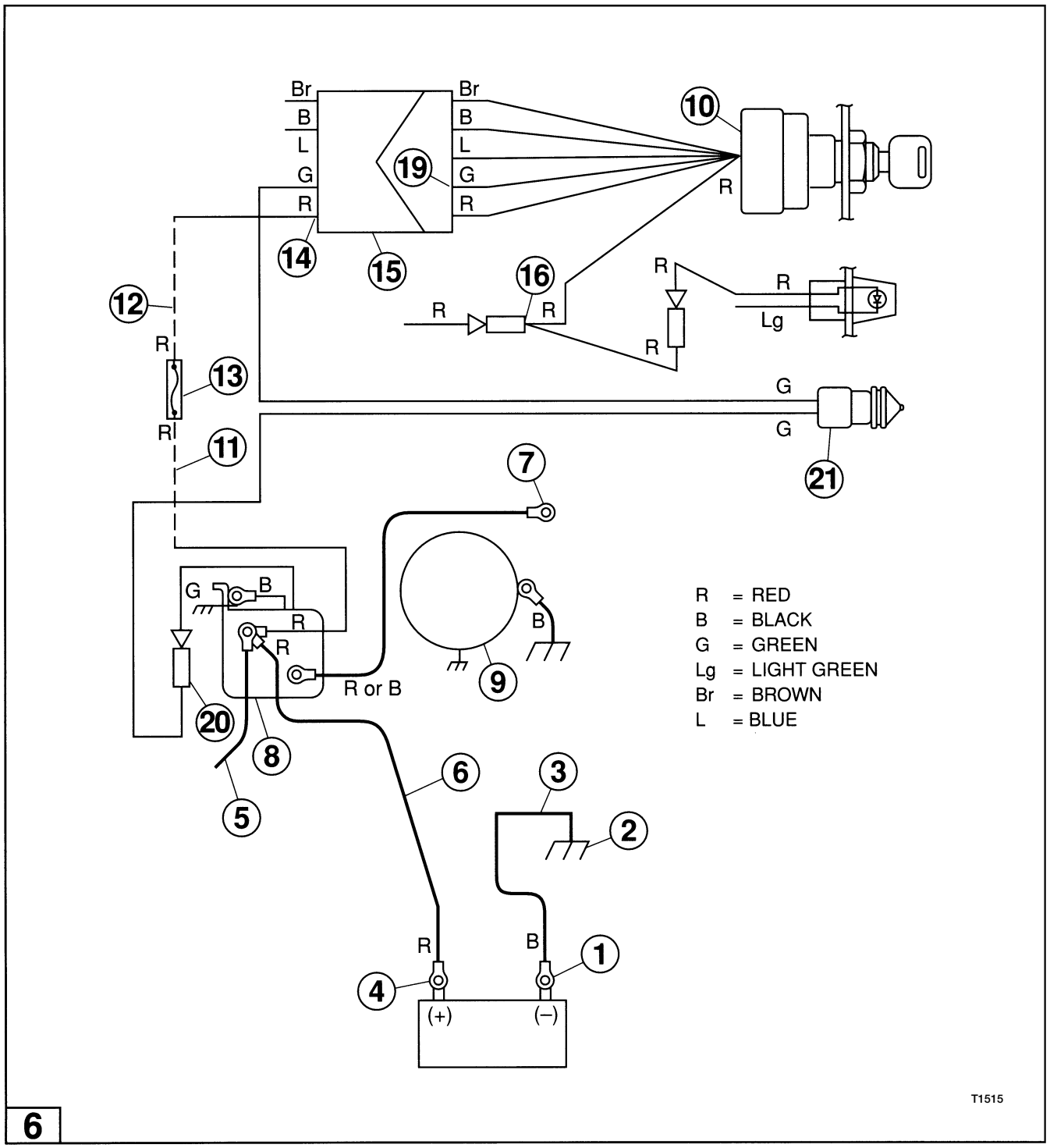
4. Connect BLACK tester lead to clean engine ground.



5 6 5. Connect RED tester lead to positive battery terminal **(4)**.

If meter does not indicate 11.8 to 13.2 VDC (battery voltage), see Battery Care and Maintenance, this section.

If meter indicates battery voltage go to next step.



7 8 6. Reconnect negative battery cable **(3)** to negative battery terminal **(1)**.

7 8 7. Connect RED tester lead to starter solenoid terminal **(5)**.

7 8 If meter does not indicate battery voltage, replace battery cable **(6)**.

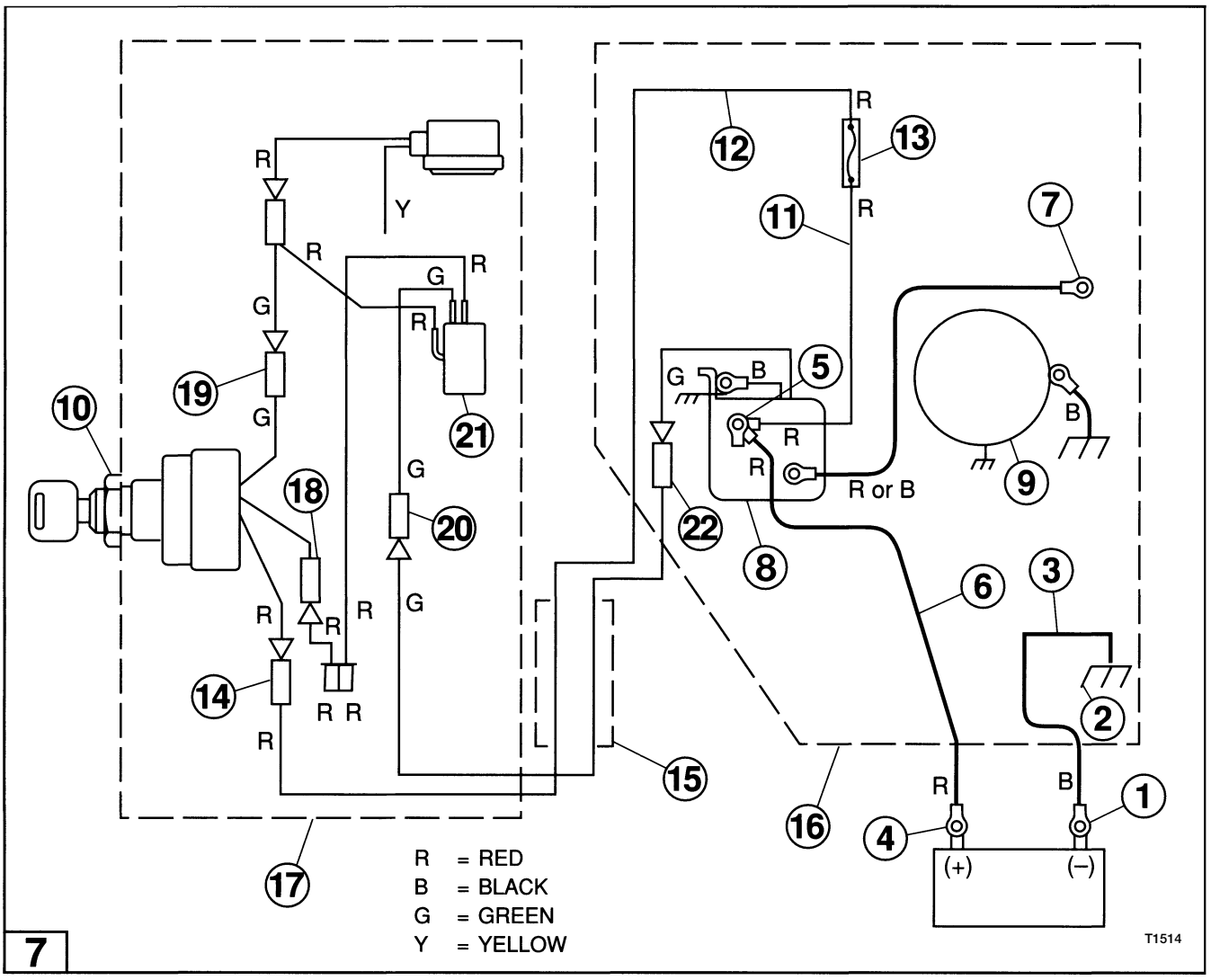
If meter indicates battery voltage go to next step.

7 8 8. Disconnect lead **(7)** from starter solenoid **(8)** to starter motor **(9)**.

7 8 9. Connect RED tester lead to starter solenoid lead **(7)** and turn main key switch **(10)** to START position.

If meter indicates battery voltage, repair or replace starter motor, see Starter Motor Tests in this section.

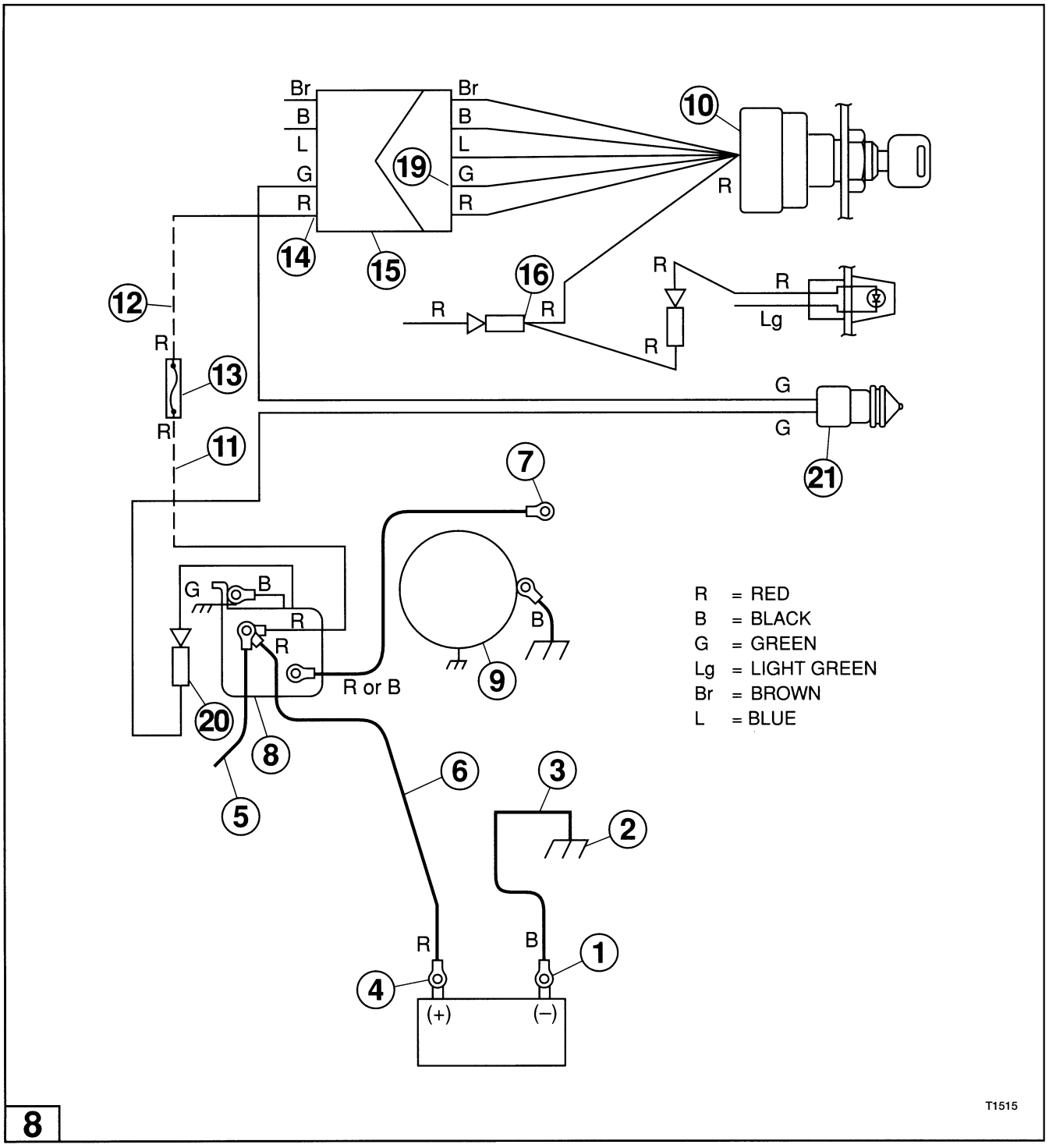
If meter does not indicate battery voltage, go to next step.



7 8 10. Connect RED tester lead to connector closest to fuse holder **(11)**.

7 8 If meter does not indicate battery voltage, repair or replace cable between **(5)** and **(11)**.

If meter indicates battery voltage, go to next step.



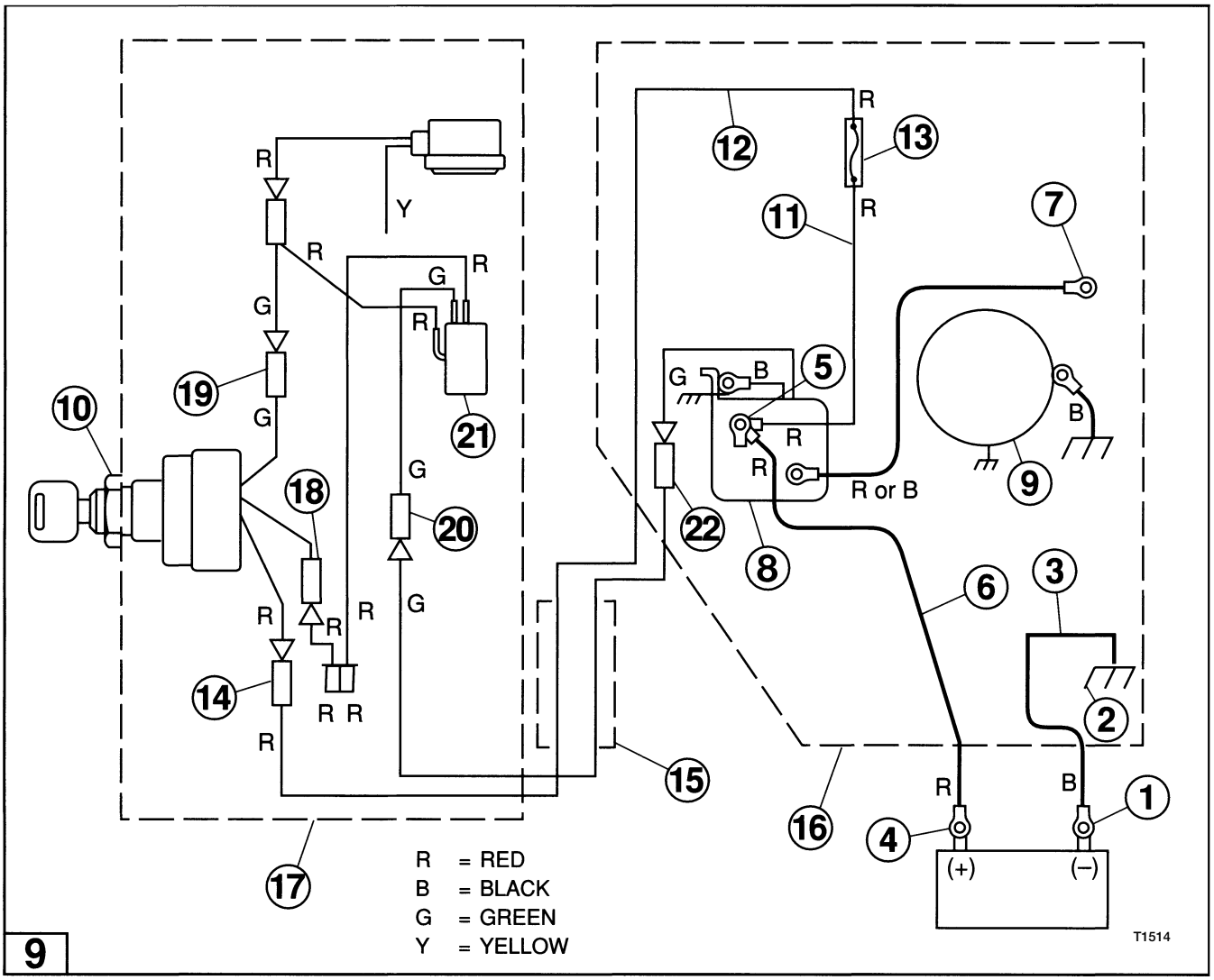
9 10 11. Connect RED tester lead to connector closest to fuse holder **(12)**.

9 10 If meter does not indicate battery voltage, find source of overload or short and replace 20A engine fuse **(13)**.

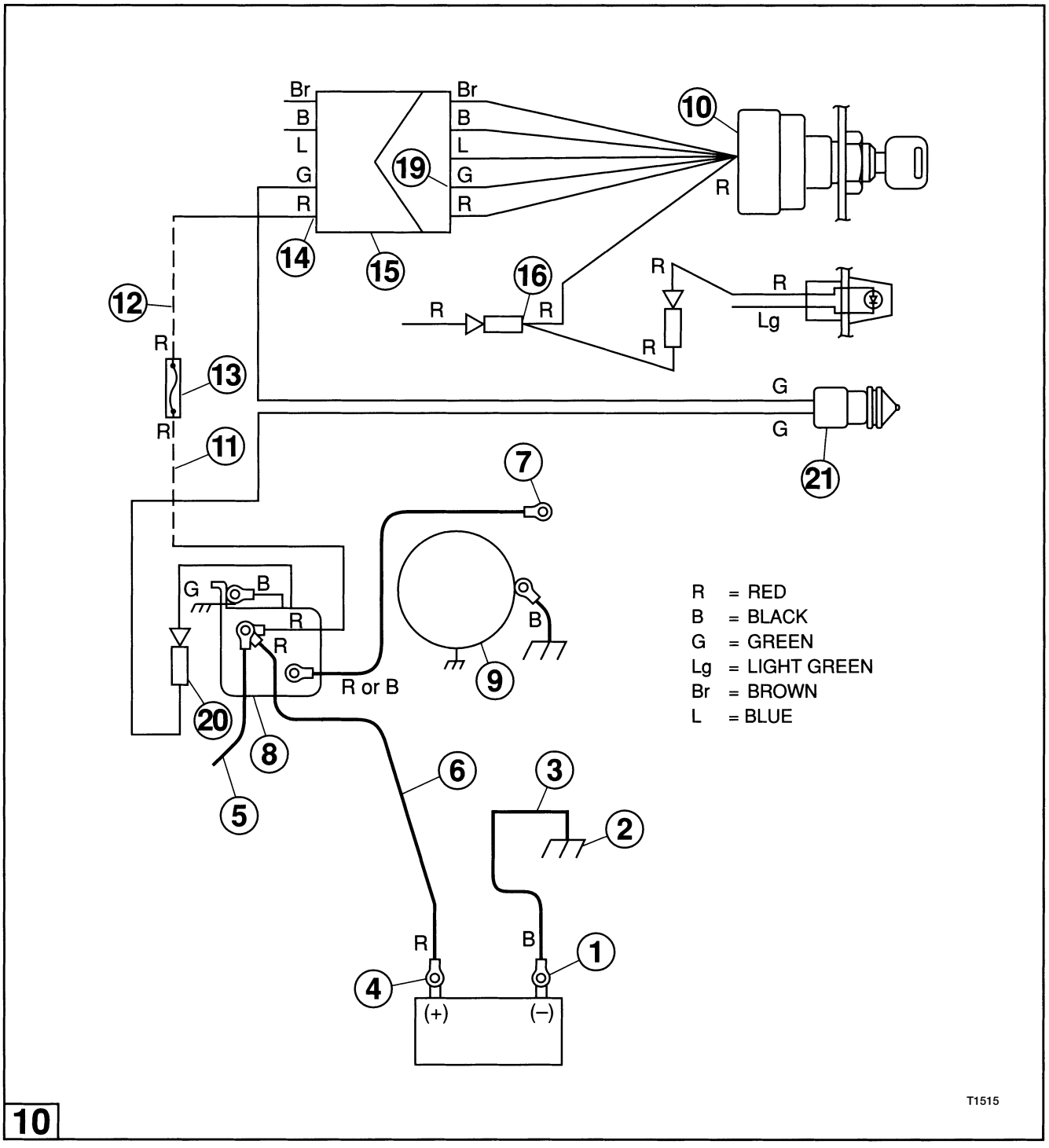
Possible sources of short or overload:

- Short in starter circuit wiring or components, such as starter solenoid, main key switch, or neutral start switch.
- Short in charging circuit wiring or components, such as the alternator coils or rectifier/regulator.
- Short in accessories such as power trim/tilt.
- Overload in starter motor or power trim/tilt motor.

If meter indicates battery voltage, go to next step.



9 **10** 12. Connect RED tester lead to connector closest to main key switch **(14)**.



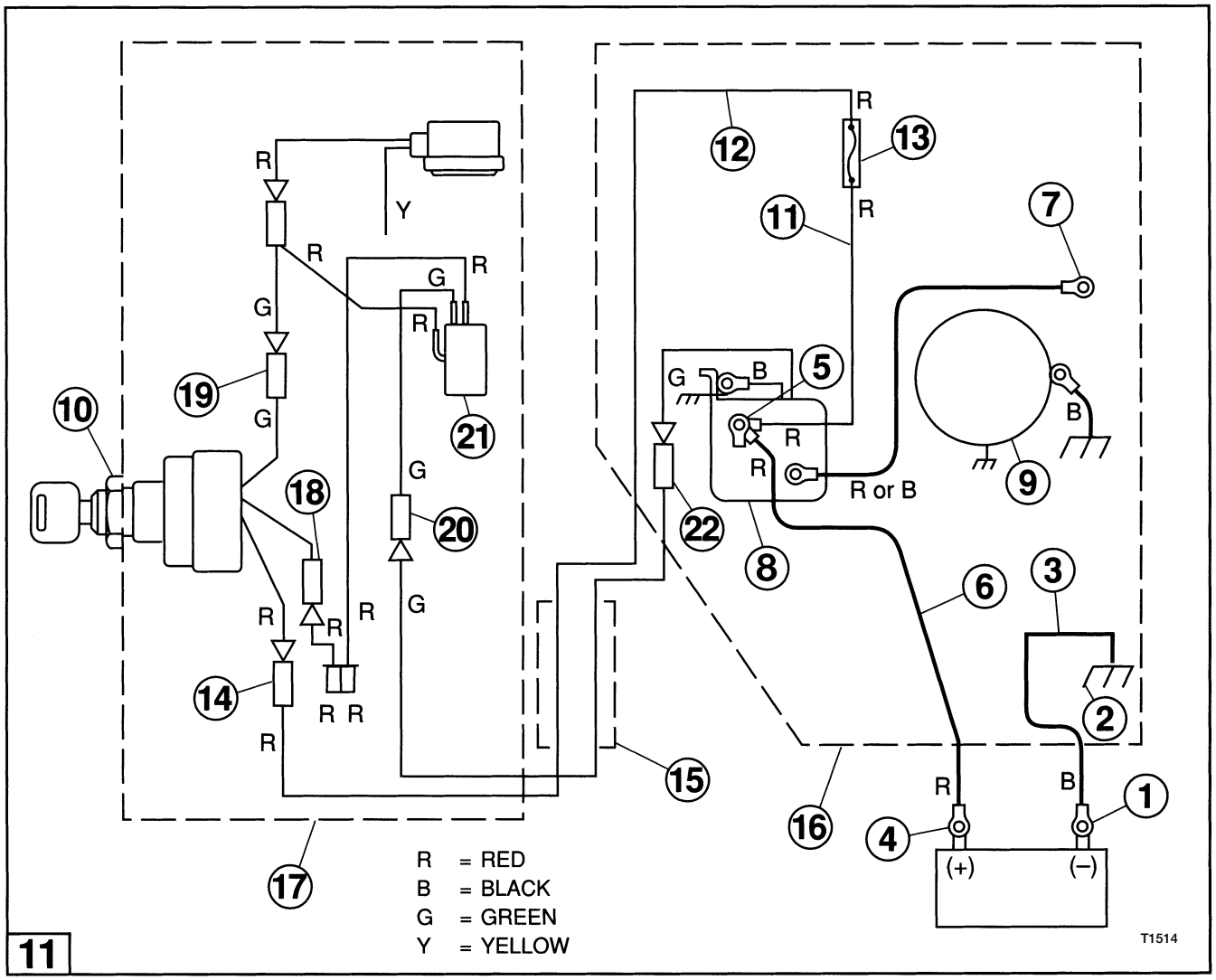
10

NOTE

11 *For models with remote control box - Make sure you test the correct terminal in this step. Terminal **(14)** is connected directly to the main key switch **(10)** and the RED lead that comes out of the large cable **(15)** that connects the engine compartment **(16)** to the remote control box **(17)**. DO NOT CONFUSE TERMINAL **(14)** WITH TERMINAL **(18)**.*

NOTE

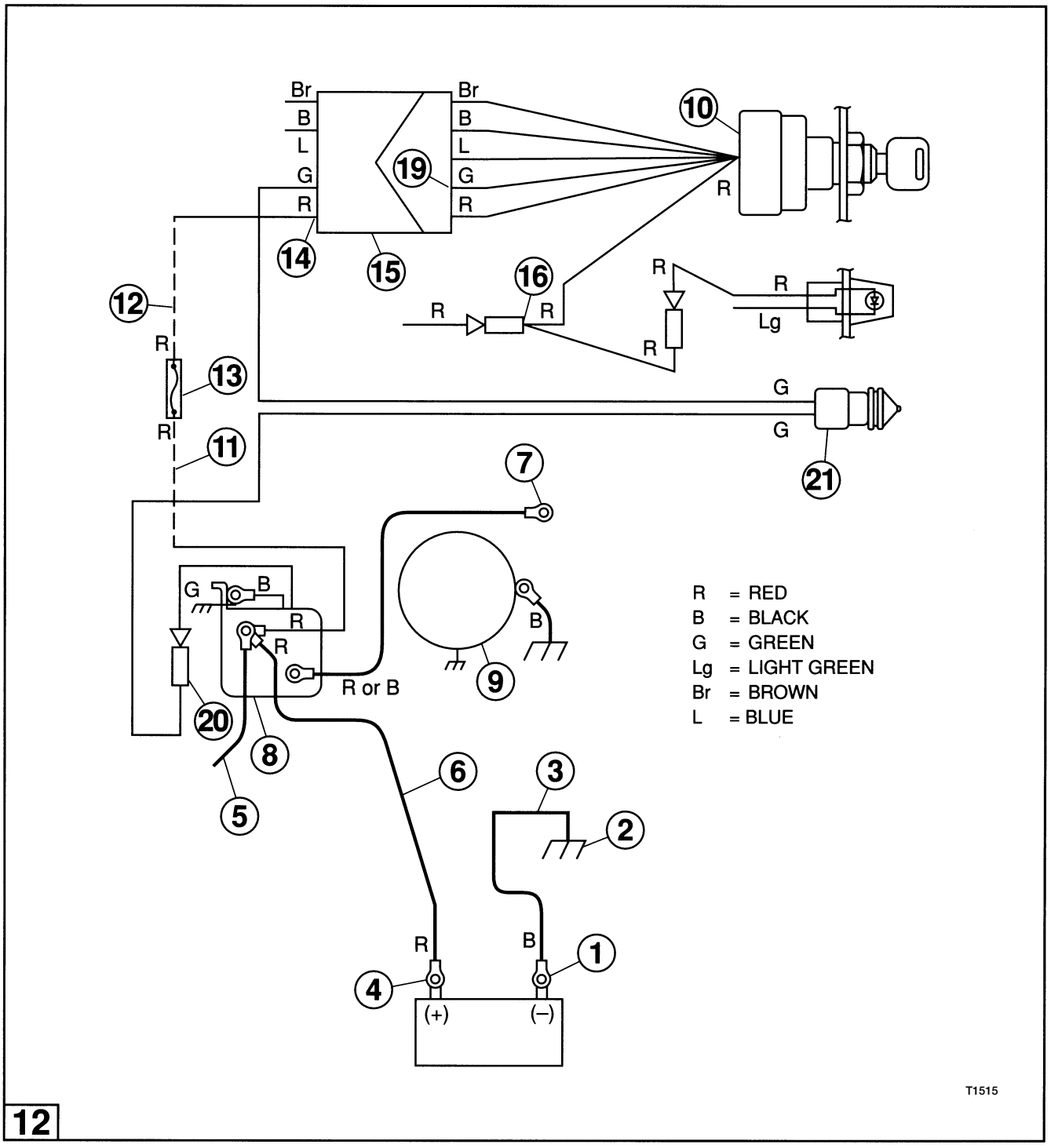
12 *For models without remote control box - You might have to pull connector **(15)** apart and measure voltage at terminal indicated in drawing.*



11 **12** If meter does not indicate battery voltage, repair or replace cable between **(12)** and **(14)**.

If meter indicates battery voltage, go to next step.

11 **12** 13. Connect RED tester lead to main key switch lead **(19)** and turn main key switch **(10)** to START position.

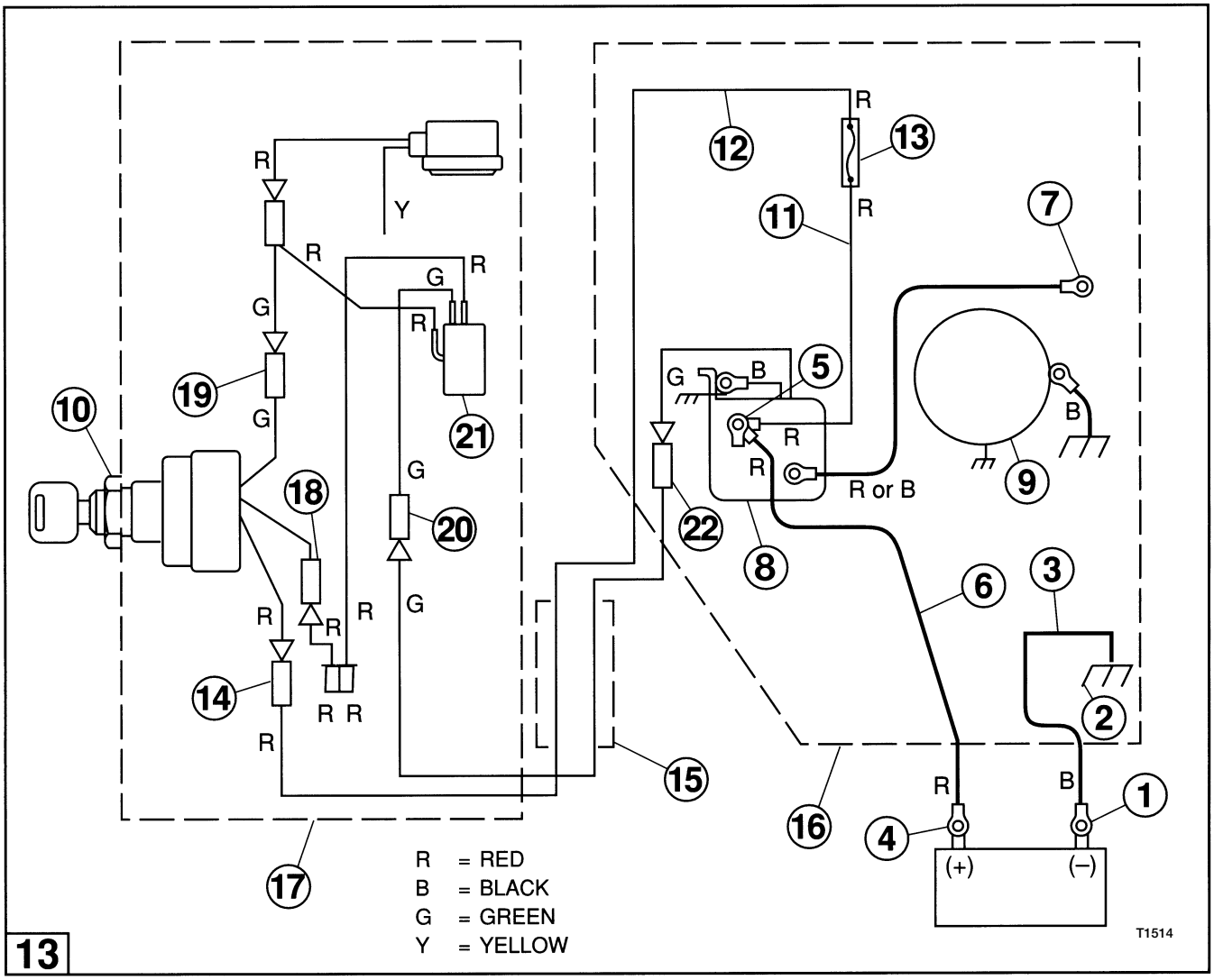


NOTE

13 *For models without remote control box - You might have to pull connector **(15)** apart and measure voltage at terminal indicated in drawing.*

13 **14** If meter does not indicate battery voltage, test main key switch. Refer to Main Key Switch Test in this section.

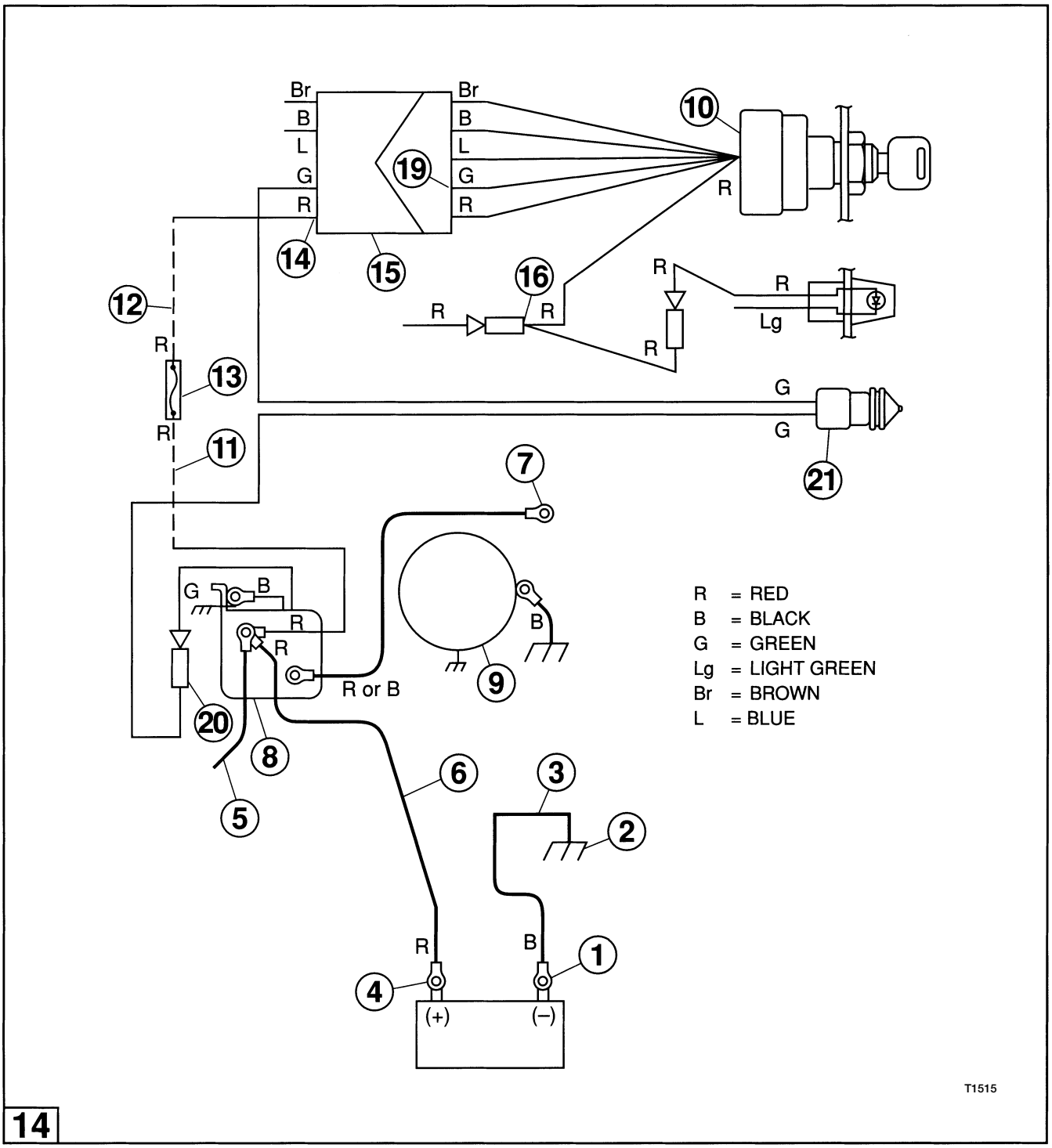
If meter indicates battery voltage, go to next step.



13 **14** 14. Connect RED tester lead to neutral start switch lead **(20)** and turn main key switch **(10)** to START position.

13 **14** If meter does not indicate battery voltage, test neutral start switch **(21)**. Refer to Neutral Start Switch Test in this section.

If meter indicates battery voltage, go to next step.

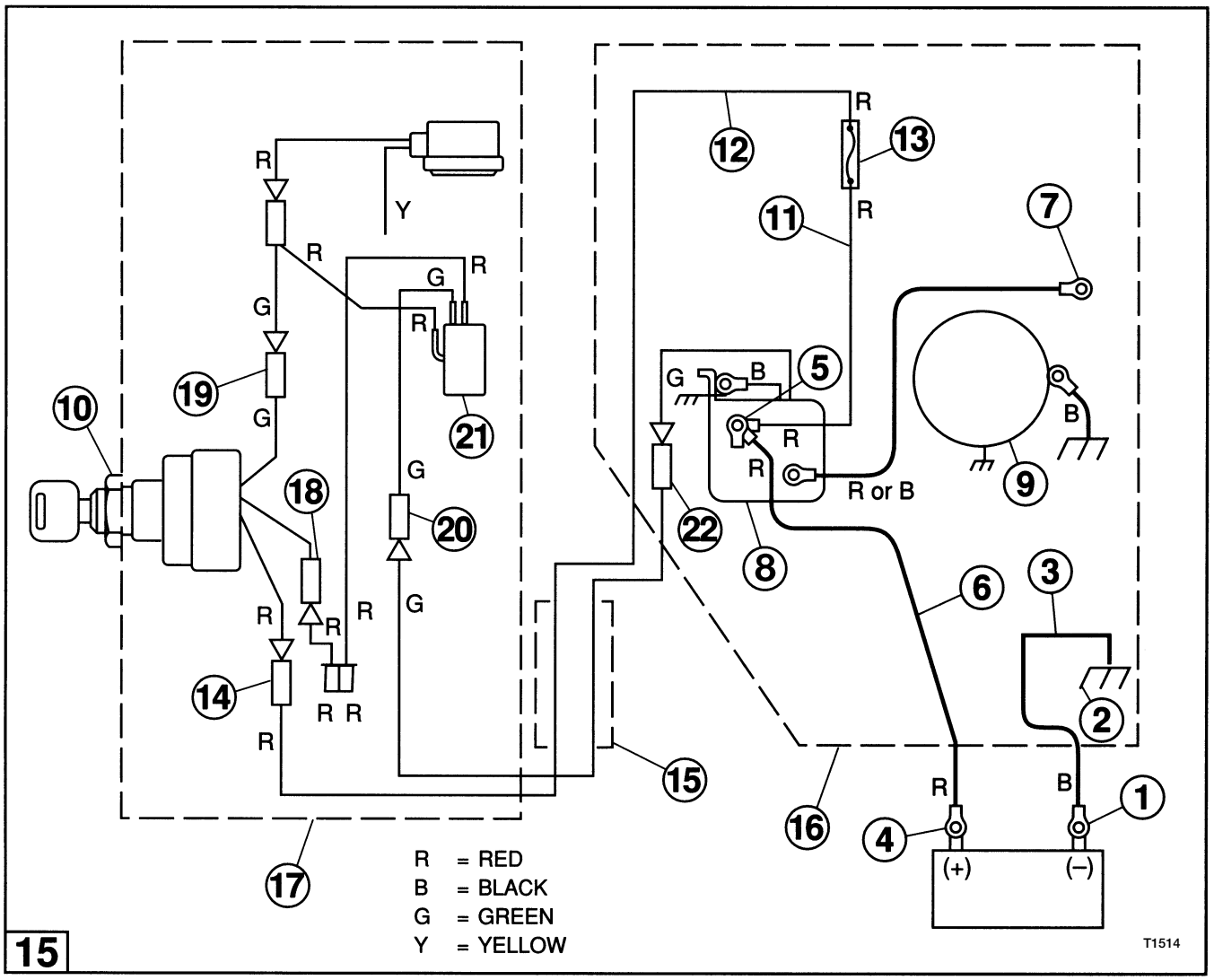


14

15 15. For models with remote control box ONLY - Connect RED tester lead to starter solenoid lead **(22)** and turn main key switch **(10)** to START position.

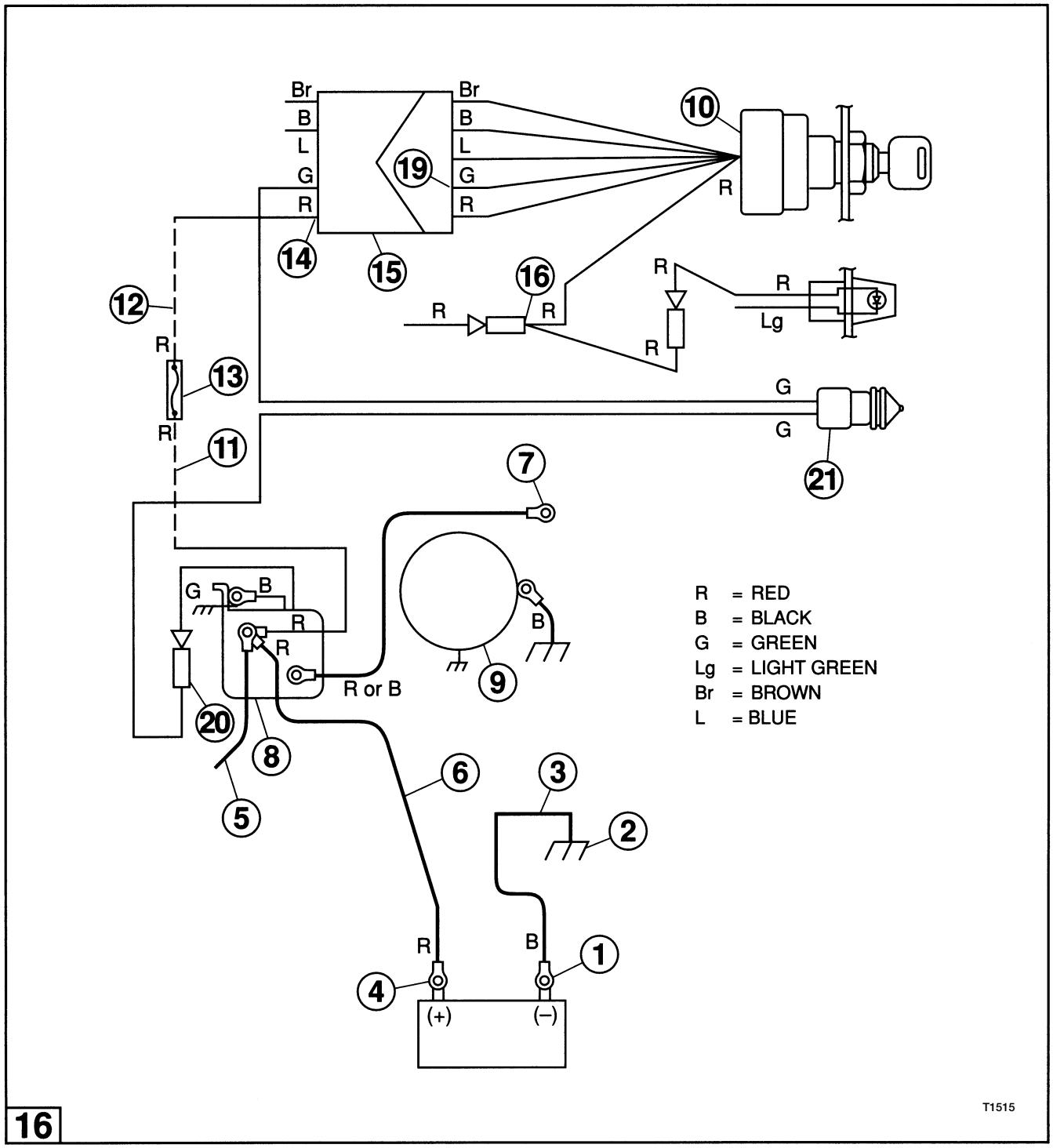
15 If meter does not indicate battery voltage, repair or replace cable between **(20)** and **(22)**.

If meter indicates battery voltage, go to next step.



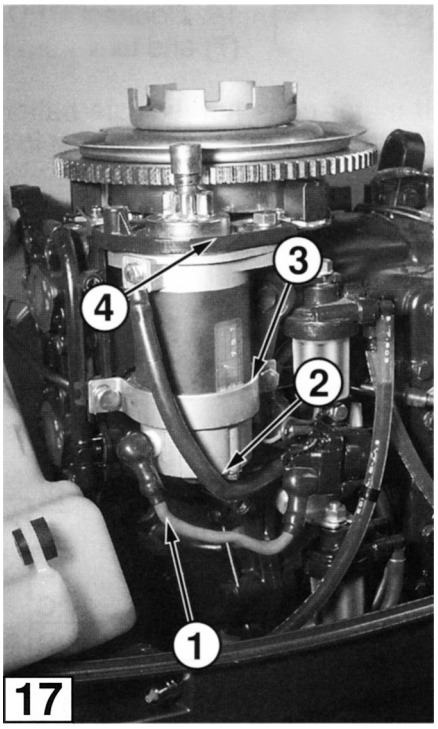
15 16 16. Connect RED tester lead to starter solenoid lead **(7)** and turn main key switch **(10)** to START position.

If meter does not indicate battery voltage, test starter solenoid **(8)**.
Refer to Starter Solenoid Test in this section.



Starter Motor Tests

- If the engine does not crank and you completed the Starter Circuit Tests previously described, remove the starter motor and inspect the brush assembly. If the brush assembly meets specifications, replace the starter motor or have it rebuilt.
- If the starter motor runs but the starter motor does not engage or disengage from the flywheel, remove the starter motor and inspect the pinion assembly. If the pinion assembly meets specifications, inspect the flywheel for chipped or worn teeth and replace as needed.



T1516

Remove Starter Motor

NOTE

Disconnect negative battery cable from battery before removing starter motor.

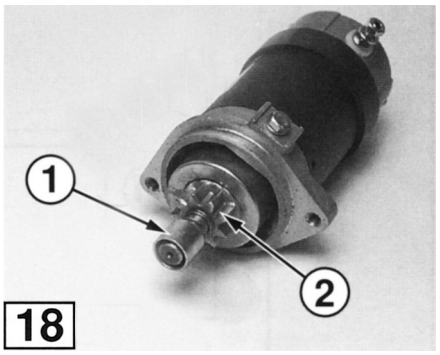
For models 40 / 50 / 80 / 90 / 115 / 120 / 140 move oil tank out of the way for access.

17 1. Disconnect starter solenoid cable **(1)** and ground cable **(2)**.

17 2. Remove starter motor band bolts and starter motor band **(3)**.

17 3. Remove mounting bolts and slide starter motor out of bracket **(4)**.

4. Clean bracket with cleaning solvent.



T1524

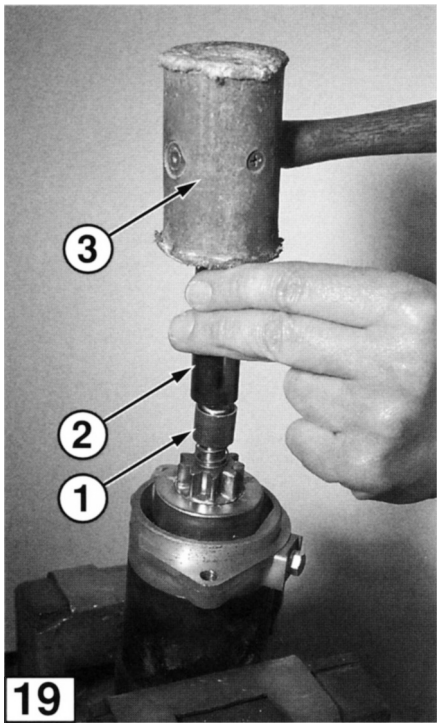
Inspect and Remove Pinion Assembly

18 1. Grasp pinion collar **(1)** and wind pinion gear **(2)** in a clockwise direction (view from top). Make sure gear moves freely and returns to original position. If any binding is noted, remove and replace pinion assembly.

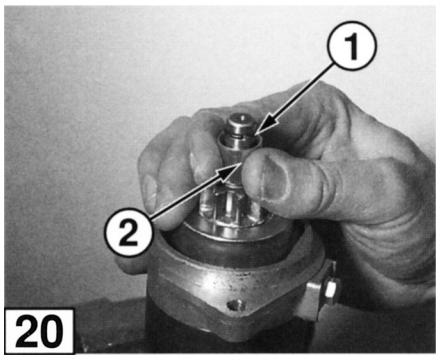
19 2. Release pinion collar **(1)** by tapping it with a socket **(2)** [with same outside diameter as pinion collar and clearance for motor shaft] and mallet **(3)**.

20 3. Push down on pinion collar **(2)** and remove locking ring **(1)**.

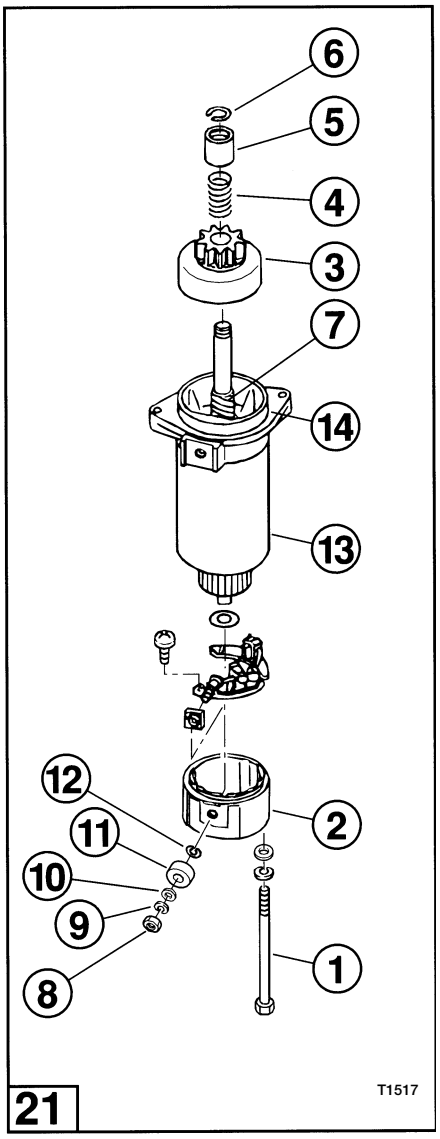
21 **22** 4. Remove pinion gear **(3)**, spring **(4)** and pinion collar **(5)**.



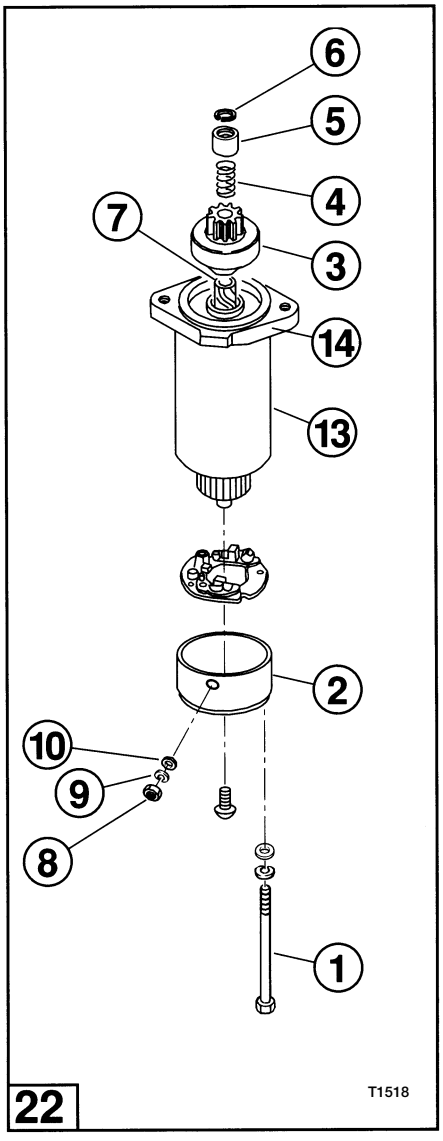
T1522



T1523



T1517



T1518

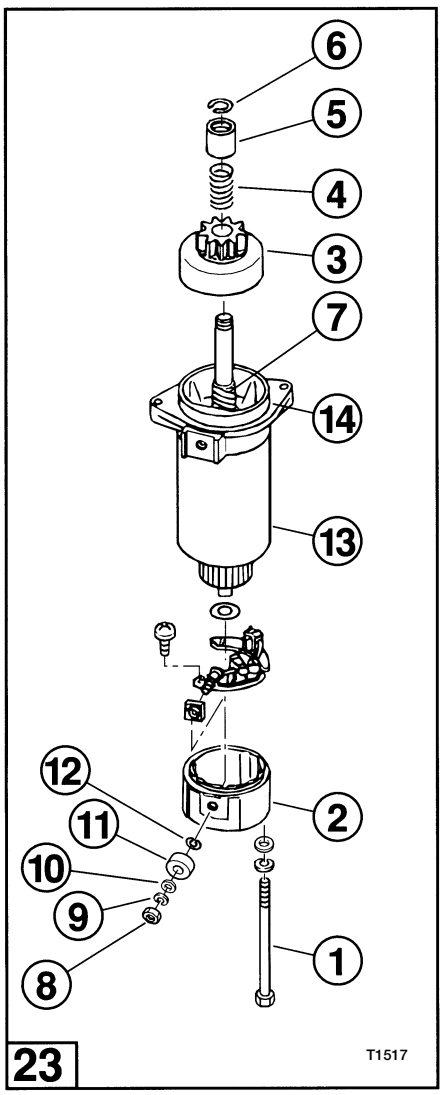
5. Clean removed components with cleaning solvent and examine pinion gear for wear and chipped teeth and spring for tension or distortion and replace assembly as required.

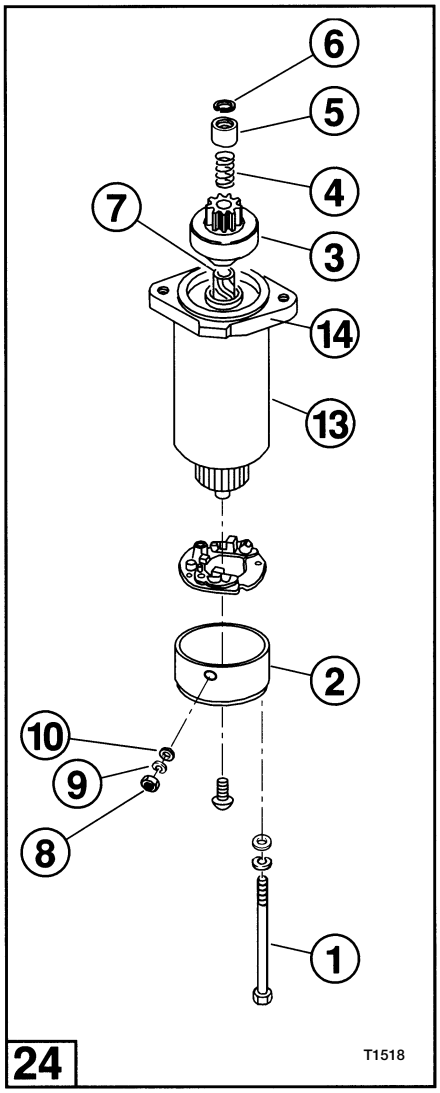
NOTE

Do not allow cleaning solvent to come in contact with starter motor.

23 24 6. Aoolv a liaht coat of low temperature lithium grease to motor shaft **(7)** and slide on pinion gear **(3)**, wind counterclockwise to seat.

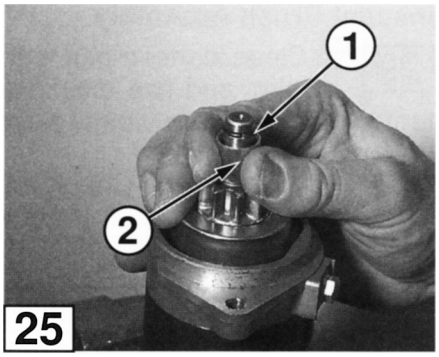
23 24 7. Slide spring **(4)** and pinion collar **(5)** on motor shaft **(7)**.





25 8. Push down on pinion collar **(2)** and install locking ring **(1)**.

26 9. Tap pinion collar **(1)** in place.



T1523

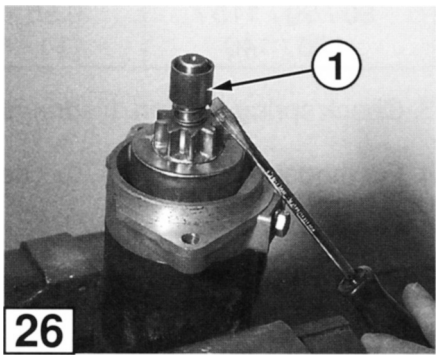
Disassemble Starter Motor

NOTE

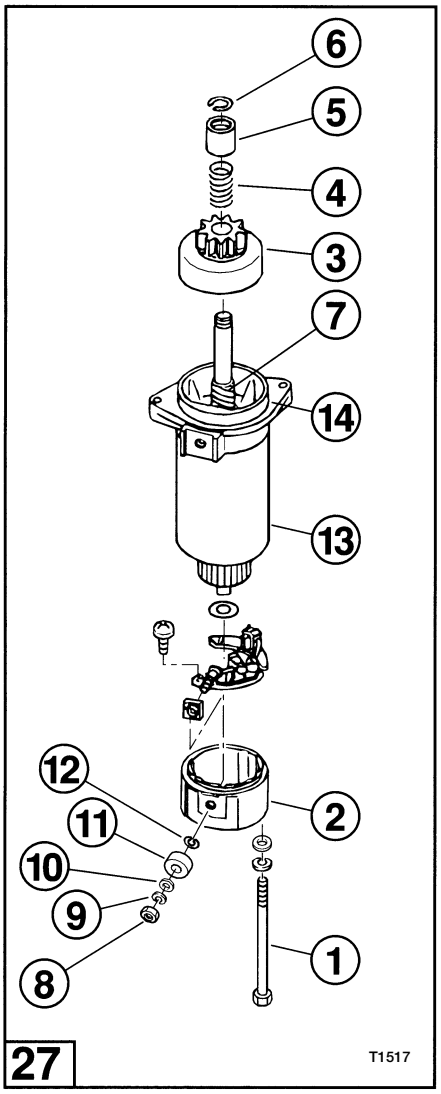
Bolts for models 80 / 90 / 115 /120 / 140 may not be available as separate parts. Check current Parts Catalog for availability.

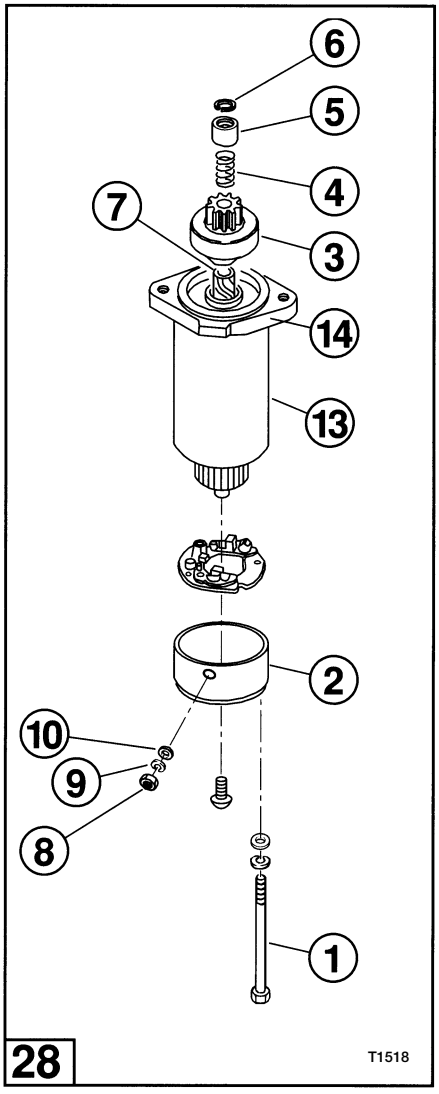
27 28 1. Remove bolts **(1)**.

27 28 2. Remove motor base **(2)**.

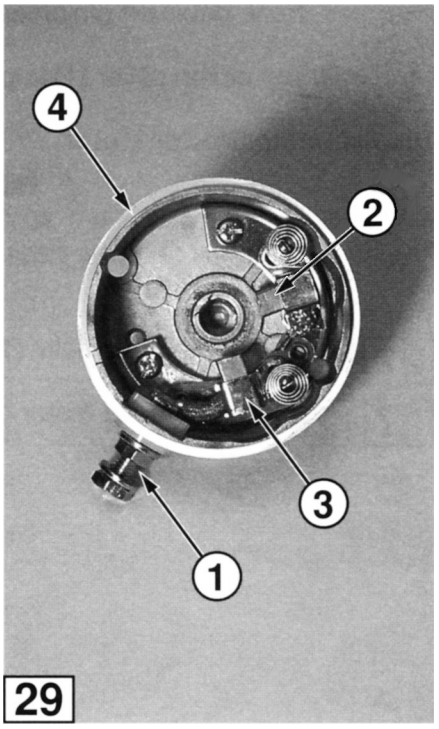


T1525





Inspect Brush Assembly



T1520

29 1. Clean starter motor terminal and hardware **(1)** with isopropyl alcohol and fine emery cloth and replace brush assembly if terminal or hardware cannot be restored to original condition.

29 **30** **31** 2. Check brushes **(2)** and **(3)** for chips, fractures, and wear. If not within specifications, replace brush assembly:

Engine Models	Original Length (a)	Repair Limit (b)
40 / 50 / 60 / 70	0.49 in [12.5 mm]	0.37 in [9.5 mm]
80 / 90 / 115 / 120 / 140	0.55 - 0.59 in [14 - 15mm]	0.47 in [12.0 mm]

3. Check spring tension. If springs are weak, replace brush assembly.

4. For models 40 / 50 / 60 / 70 - check continuity with analog multimeter between :

29 Brush **(2)** and **(3)**. Replace brush assembly if meter indicates continuity.

29 Brush **(3)** and the motor base **(4)**. Replace brush assembly if meter indicates continuity.

29 Brush **(3)** and the starter motor terminal **(1)**. Replace brush assembly if meter does not indicate continuity.

29 Brush **(2)** and the motor base **(4)**. Replace brush assembly if meter does not indicate continuity.

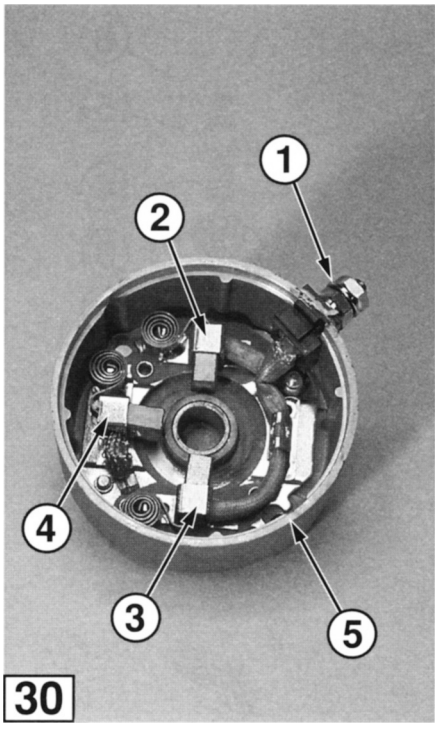
For models 80 / 90/ 115 / 120 / 140 - check continuity with an analog multimeter between:

30 Brush **(2)** and **(4)** and between brush **(3)** and **(4)**. Replace brush assembly if meter indicates continuity.

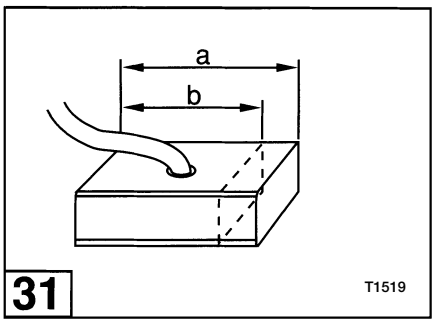
30 Brush **(2)** and the motor base **(5)** and between brush **(3)** and the motor base **(5)**. Replace brush assembly if meter indicates continuity.

30 Brush **(2)** and the starter motor terminal **(1)** and between brush **(3)** and the starter motor terminal **(1)**. Replace brush assembly if meter does not indicate continuity.

30 Brush **(4)** to the and the motor base **(5)**. Replace brush assembly if meter does not indicate continuity.



T1521



T1519

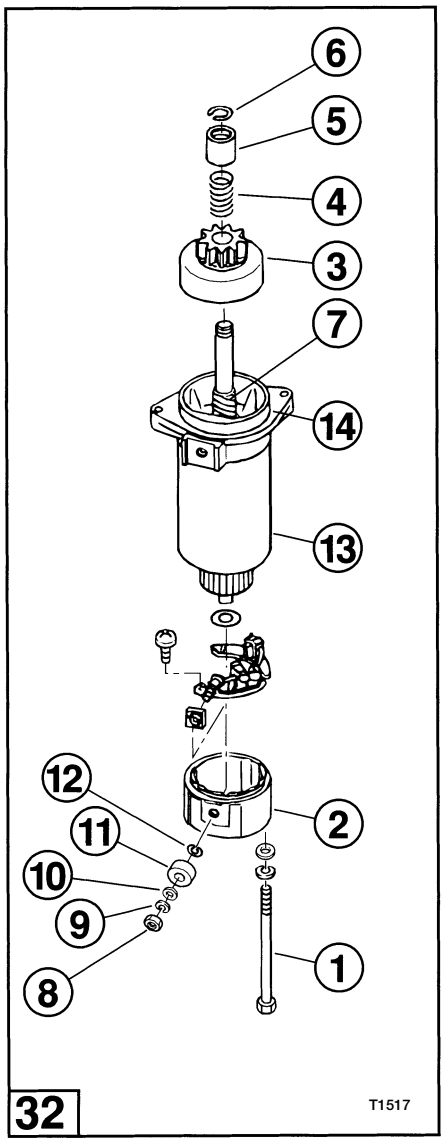
Remove Brush Assembly

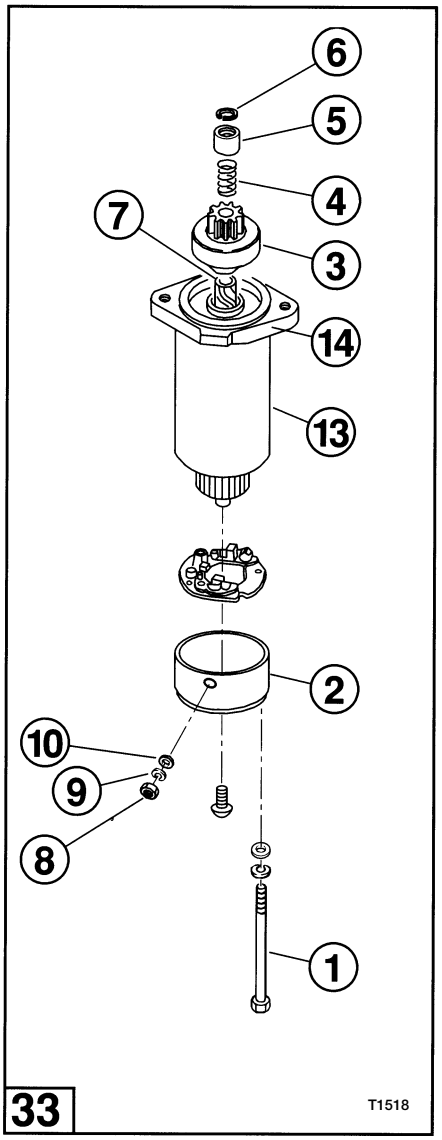
NOTE

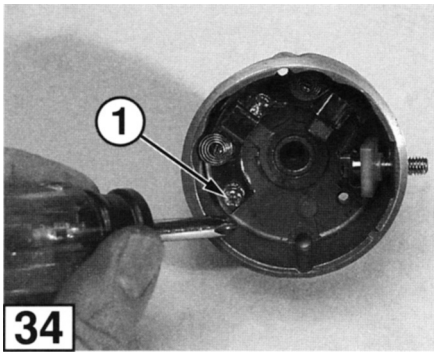
Hardware for models 80 / 90 / 115 / 120 / 140 may not be available as separate parts. Check current Parts Catalog for availability.

32 1. For models 40 / 50 / 60 / 70: Remove nut **(8)**, washer **(9)**, washer **(10)**, bushing **(11)** and o-ring **(12)**.

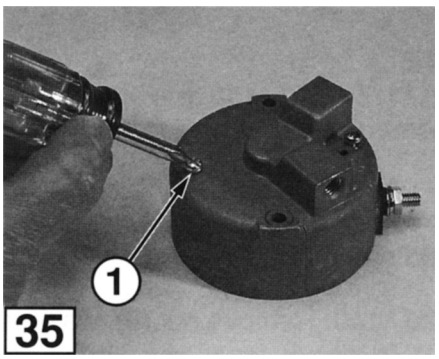
33 For models 80 / 90 / 115 / 120 / 140: Remove nut **(8)**, washer **(9)** and washer **(10)**.



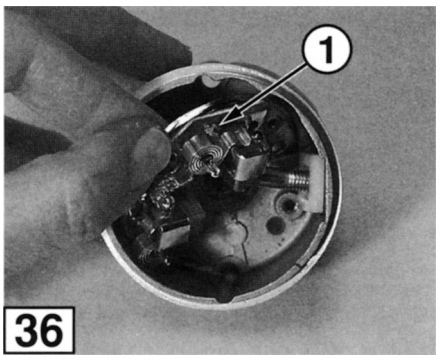




T1526



T1529



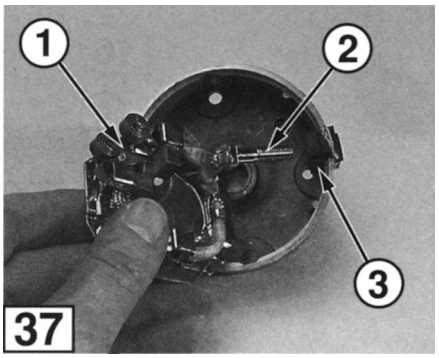
T1527

34 **35** 2. Remove screws **(1)**.

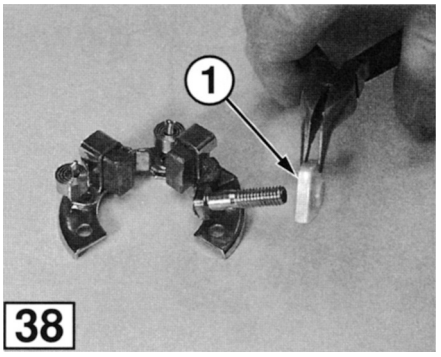
36 3. For models 40 / 50 / 60 / 70: Remove brush assembly **(1)**.

37 For models 80 / 90 / 115 / 120 / 140: Remove brush assembly **(1)** carefully guiding the starter motor terminal **(2)** through the bushing **(3)**.

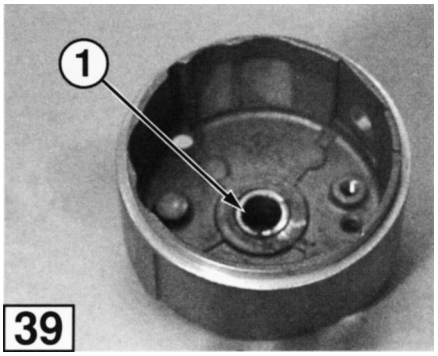
38 4. For models 40 / 50 / 60 / 70 ONLY: Remove bushing **(1)**.



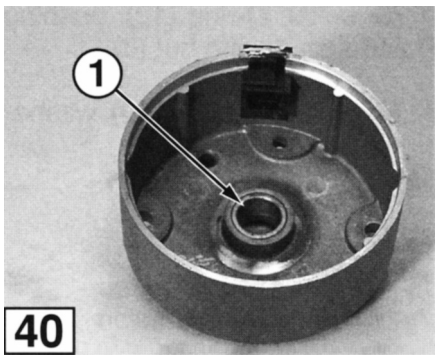
T1530



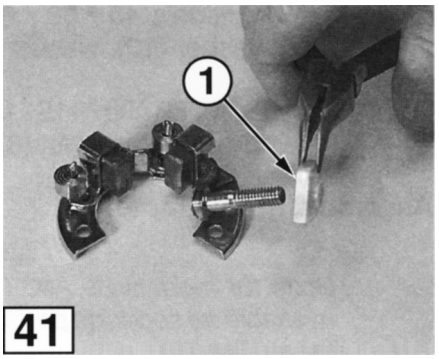
T1528



T1531



T1532



T1528

Install Brush Assembly

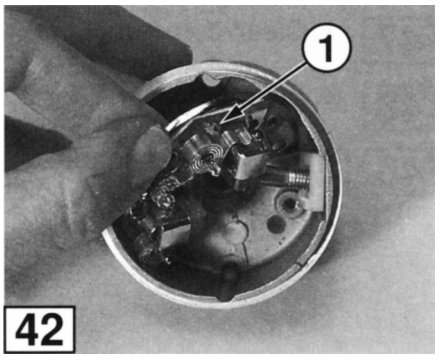
39 40 1. Apply genuine grease to bearing cup **(1)**.

41 2. For models 40 / 50 / 60 / 70 ONLY: Install bushing **(1)**.

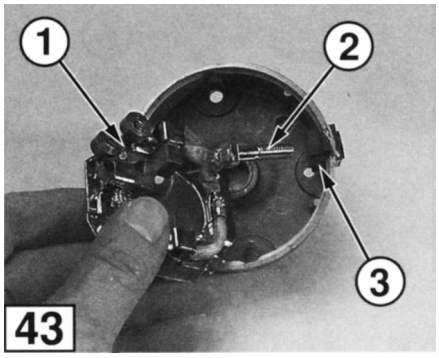
42 3. For models 40 / 50 / 60 / 70: Install brush assembly **(1)**.

43 For models 80 / 90 / 115 / 120 / 140: Install brush assembly **(1)**. Make sure that the starter motor terminal **(2)** is fully seated in the bushing **(3)**.

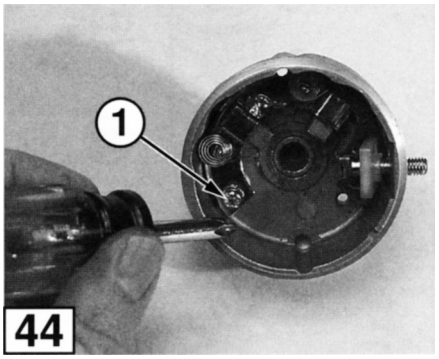
44 4. For models 40 / 50 / 60 / 70 ONLY: Apply threadlocker to screw threads and install screws **(1)**.



T1527



T1530



T1526

45 5. For models 40 / 50 / 60 / 70: Install O-ring **(12)**, bushing **(11)**, washer **(10)**, washer **(9)** and secure with nut **(8)**.

46 For models 80 / 90 / 115 / 120 / 140: Install washer **(10)**, washer **(9)** and secure with nut **(8)**.

Assemble Starter Motor

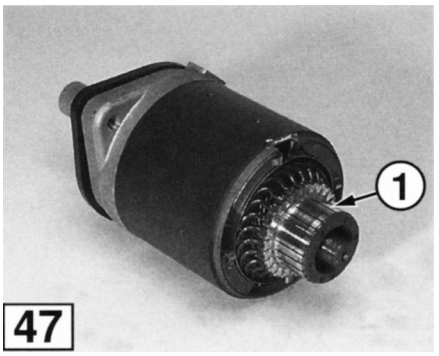
NOTE

Bolts for models 80 / 90 / 115 / 120 / 140 may not be available as separate parts. Check current Parts Catalog for availability.

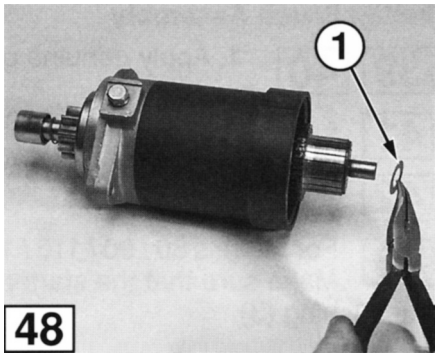
47 1. Clean commutator **(1)** with fine emery cloth.

48 2. For models 40 / 50 / 60 / 70 ONLY: Install washer **(1)**.

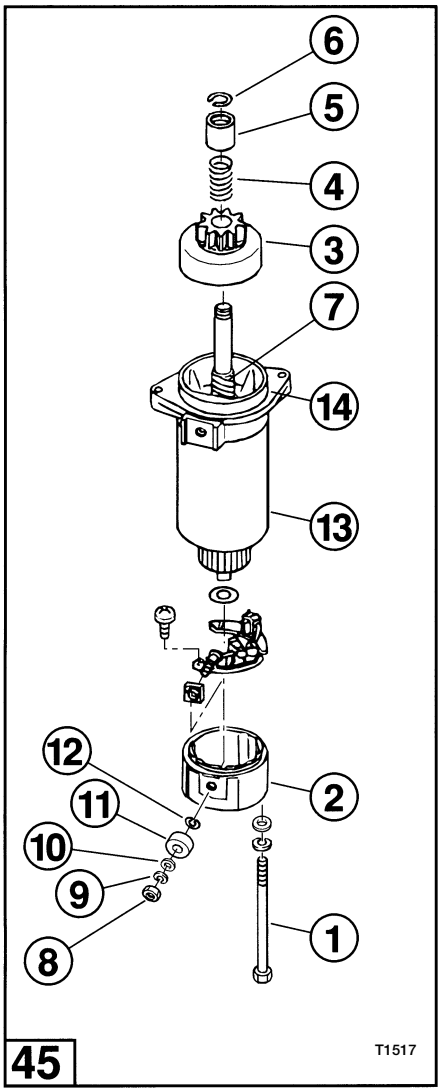
45 46 3. Align clearance holes for bolt **(1)** in starter motor body **(13)** with bolt holes in mounting collar **(14)**.



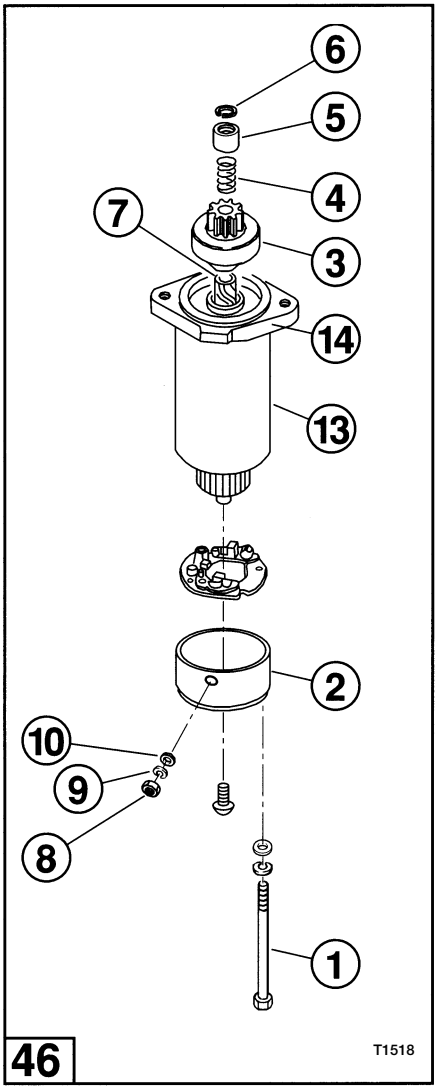
T1535



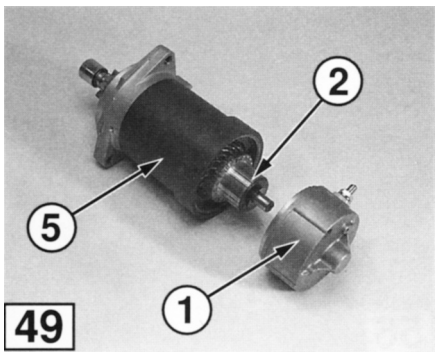
T1534



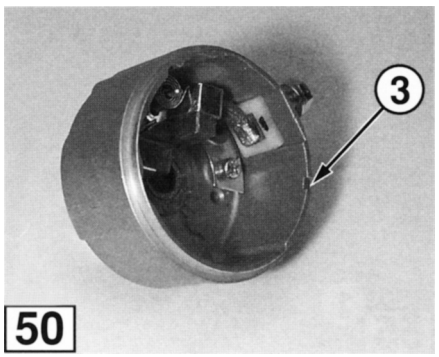
T1517



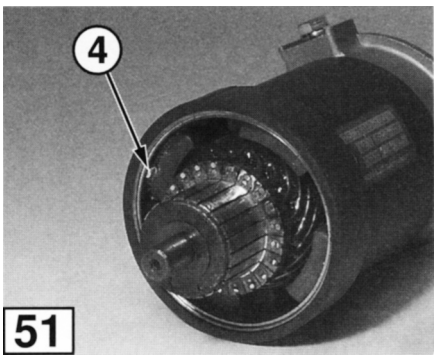
T1518



T1533



T1536



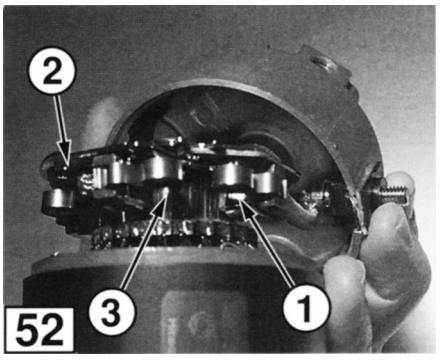
T1537

49 **50** **51** 4. For models 40 /50 / 60 / 70: Retract brushes as you slide motor base **(1)** over commutator **(2)**. Align notch **(3)** in motor base with tab **(4)** in motor body **(5)** and seat motor base to motor body.

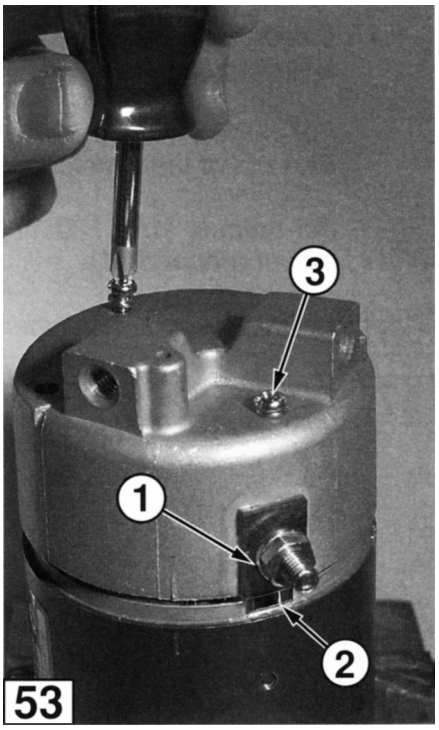
52 For models 80 / 90 / 115 / 120 / 140: Retract brushes **(1)** as you slide brush assembly **(2)** over commutator **(3)**.

53 5. For models 80 / 90 / 115 / 120 / 140 ONLY: Align tab **(1)** in motor base with notch **(2)** in motor body and seat motor base to motor body.

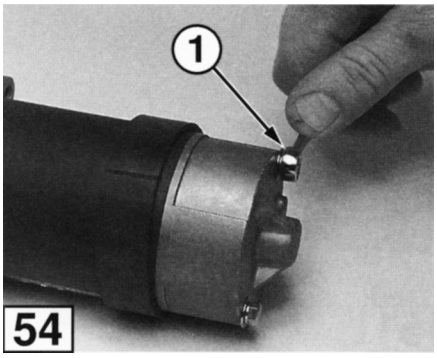
53 6. For models 80 / 90 / 115 / 120 / 140 ONLY: Apply threadlocker to brush assembly screw threads. Align clearance holes for brush assembly screws in motor base with screw holes in brush assembly and secure with screws **(3)**.



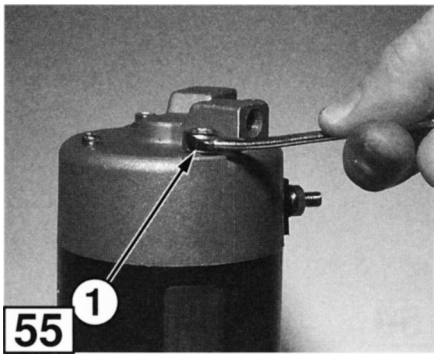
T1539



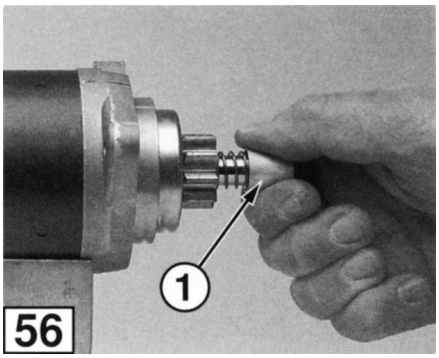
T1540



T1538



T1541



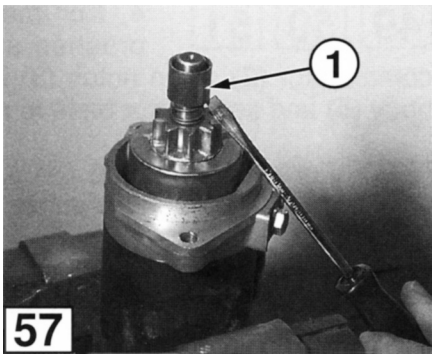
T1542

54 **55** 7. Apply threadlocker to bolt threads and install bolts **(1)**.

56 8. Grasp pinion collar **(1)** and rotate several times to make sure brushes are seated.

NOTE

57 *If pinion collar **(1)** rotates freely without turning motor shaft, seat pinion collar.*



T1525

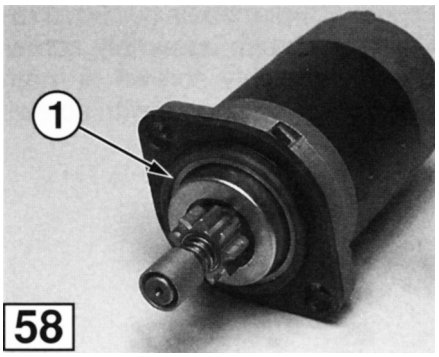
Install Starter Motor

NOTE

Disconnect negative battery cable from battery before installing starter motor.

For models 40 / 50 / 80 / 90 / 115 / 120 / 140 move oil tank out of the way for access.

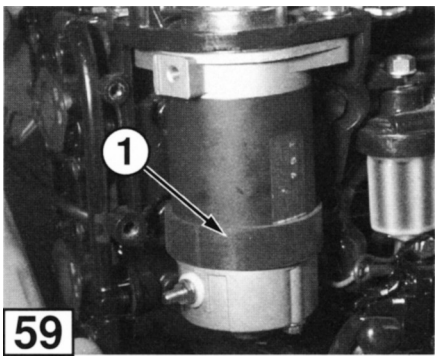
58 *For models 115 / 120 / 140 make sure you install the mount rubber B **(1)**.*



T1543

59 *Make sure you install the starter motor rubber **(1)**.*

57 *If pinion collar **(1)** rotates freely without turning motor shaft, seat pinion collar.*



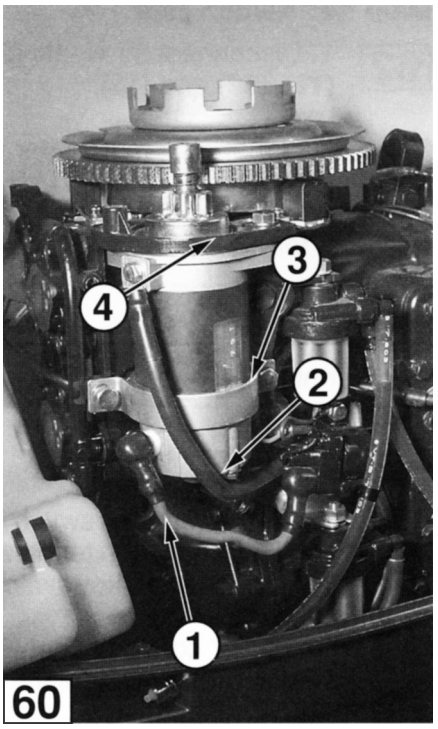
T1544

60 1. Slide starter motor into bracket **(4)**, apply threadlocker to bolt threads, and install mounting bolts.

60 2. Install starter motor band **(3)** apply threadlocker to bolt threads, and starter motor band bolts.

60 3. Connect starter solenoid cable **(1)** and ground cable **(2)**.

4. Coat terminals with battery spray protector.



T1516

Starter Solenoid Test

61 1. Disconnect terminals **(4)** and **(5)** and disconnect terminal **(3)** from chassis ground.

2. Set analog multimeter for continuity. Check for continuity between terminals:

61 **(3)** and **(5)**. If meter does not show continuity, replace starter solenoid **(1)**.

61 **(5)** and clean chassis ground. If meter shows continuity, replace starter solenoid.

61 **(3)** and clean chassis ground. If meter shows continuity, replace starter solenoid.

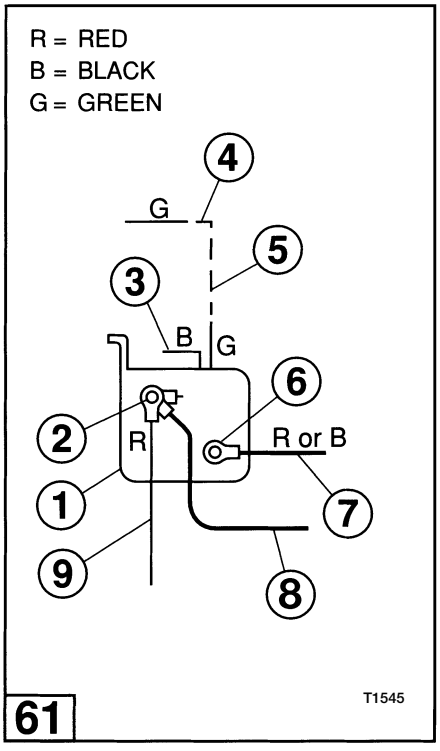
61 3. Disconnect positive battery lead **(8)** and RED starter switch lead **(9)** from starter terminal **(2)** and disconnect starter motor lead **(7)** from starter terminal **(6)**.

4. Check for continuity between terminals:

61 **(2)** and **(6)**. If meter shows continuity, replace starter solenoid.

61 **(2)** and clean chassis ground. If the meter shows continuity, replace starter solenoid.

61 **(6)** and clean chassis ground. If the meter shows continuity, replace starter solenoid.



T1545

Main Key Switch Test

62 1. Disconnect terminals **(2), (3), (4), (5), (6), (7), (8), (9), (10), (11), (12)** and **(13)**.

62 2. Set analog multimeter for continuity. With main key switch **(1)** set to OFF, ON, START, and PUSH IN positions, check for continuity between a clean chassis ground and one of these terminals (test one terminal at a time):

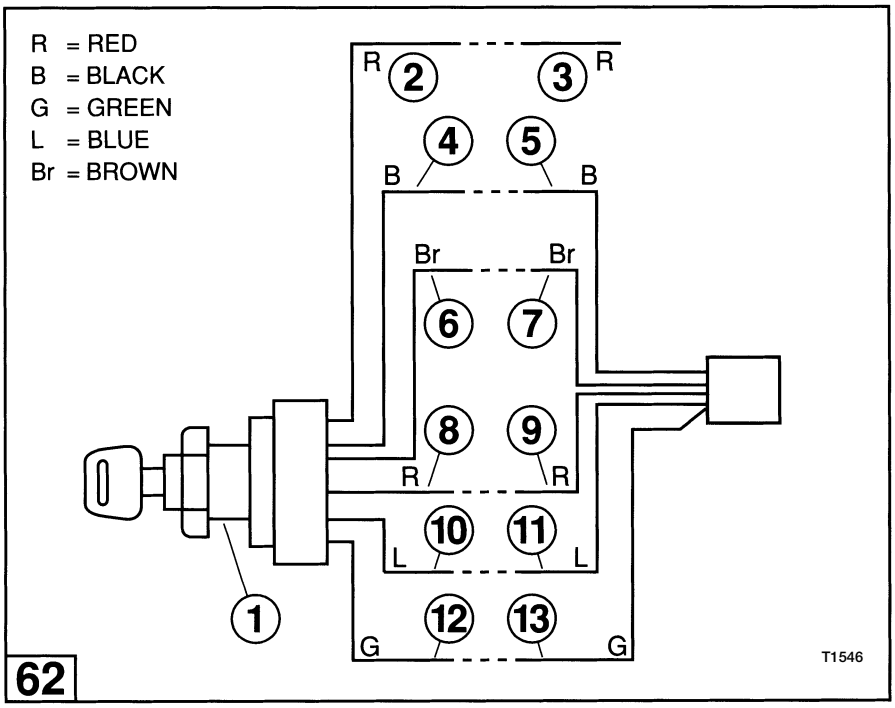
Terminal (2)	Terminal (4)	Terminal (6)
Terminal (8)	Terminal (10)	Terminal (12)

If meter shows continuity in any of these tests, replace main key switch.

62 3. With main key switch set to the OFF position, check for continuity between terminals **(4)** and **(6)**. If meter does not show continuity, replace main key switch.

62 Check for continuity between the following terminals, if meter shows continuity, replace main key switch.

Terminal (2) and (8)	Terminal (2) and (10)	Terminal (2) and (12)
Terminal (8) and (10)	Terminal (8) and (12)	Terminal (10) and (12)



63 4. With main key switch set to the ON position, check for continuity between terminals **(2)** and **(8)**. If meter does not show continuity, replace main key switch.

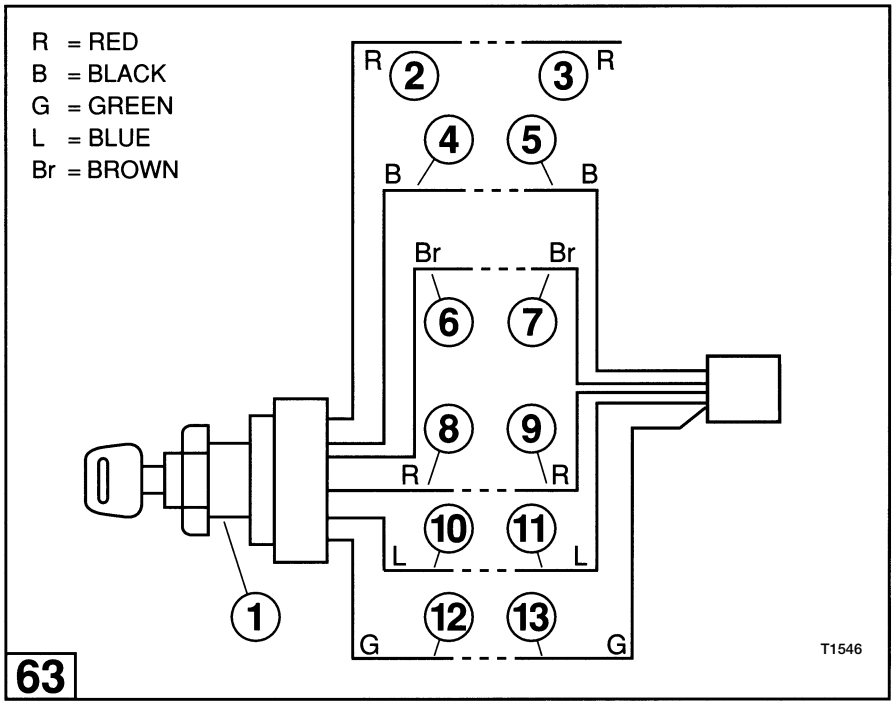
63 Check for continuity between the following terminals, if meter shows continuity, replace main key switch.

Terminal ④ and ⑥	Terminal ④ and ⑩	Terminal ④ and ⑫
Terminal ⑥ and ⑩	Terminal ⑥ and ⑫	Terminal ⑩ and ⑫

63 5. With main key switch set to the START position, check for continuity between terminals **(2)**, **(8)** and **(12)**. If meter does not show continuity between all three terminals, replace main key switch.

63 Check for continuity between the following terminals, if meter shows continuity, replace main key switch.

Terminal ④ and ⑥	Terminal ④ and ⑩	Terminal ⑥ and ⑩



64 6. With main key switch set to the OFF position, PUSH IN the key, check for continuity between terminals **(4)** and **(6)**. If meter does not show continuity, replace main key switch. Check for continuity between all remaining terminals, if meter shows continuity, replace main key switch.

64 Check for continuity between the following terminals, if meter shows continuity, replace main key switch.

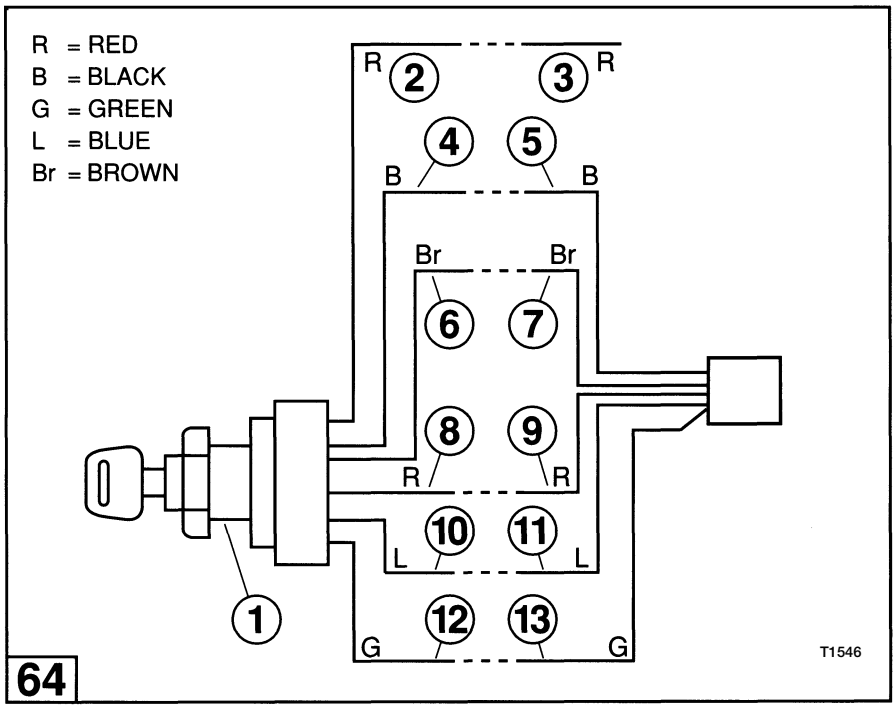
Terminal ② and ⑧	Terminal ② and ⑩	Terminal ② and ⑫
Terminal ⑧ and ⑩	Terminal ⑧ and ⑫	Terminal ⑩ and ⑫

64 7. With main key switch set to the ON position, PUSH IN the key, check for continuity between terminals **(2)**, **(8)** and **(10)**. If meter does not show continuity between all three terminals, replace main key switch. Check for continuity between all remaining terminals, if meter shows continuity, replace main key switch.

64 Check for continuity between the following terminals, if meter shows continuity, replace main key switch.

Terminal ④ and ⑥	Terminal ④ and ⑫	Terminal ⑥ and ⑫

64 8. With main key switch set to the START position, PUSH IN the key, check for continuity between terminals **(2)**, **(8)**, **(10)** and **(12)**. If meter does not show continuity, between all four terminals replace main key switch. Check for continuity between all terminals **(4)** and **(6)**, if meter shows continuity, replace main key switch.



Neutral Start Switch Test

65 1. For models without remote control box: Disconnect terminals **(2)** and **(3)**.

66 For models with remote control box: Disconnect terminals **(2)**, **(3)** and **(4)**.

2. For models without remote control box: Set analog multimeter for continuity. With shift lever set at NEUTRAL, FORWARD, and REVERSE positions, check for continuity between a clean chassis ground and one of these terminals (test one terminal at a time):

Terminal (2)	Terminal (3)

65 If meter shows continuity in any of these tests, replace neutral start switch **(1)**.

66 For models with remote control box: Set analog multimeter for continuity. With remote control lever set at NEUTRAL, FORWARD, and REVERSE positions, check for continuity between a clean chassis ground and one of these terminals (test one terminal at atime):

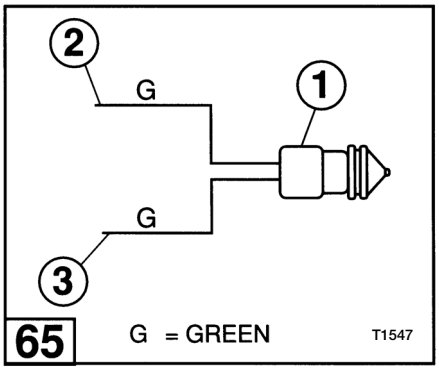
Terminal (2)	Terminal (3)	Terminal (4)

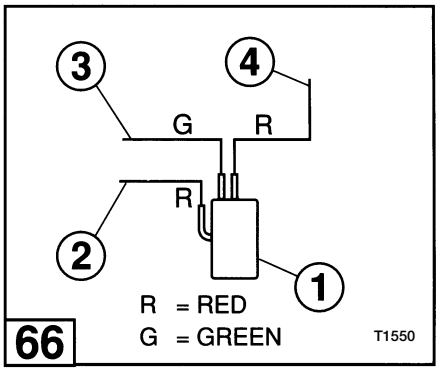
If meter shows continuity in any of these tests, replace neutral start switch.

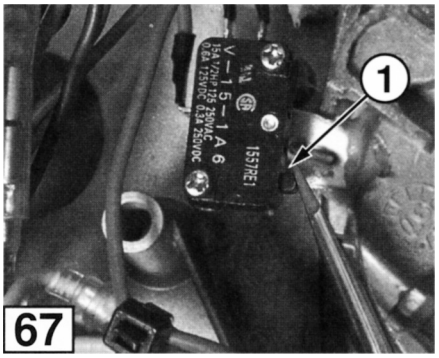
65 **66** 3. With shift lever set at NEUTRAL, check for continuity between terminals **(2)** and **(3)**.

67 **68** If meter does not show continuity, put shift lever in FORWARD gear and press in neutral start switch plunger **(1)** all the way in. If meter shows continuity, adjust, repair, or replace shift lever linkage. If meter does not show continuity, replace the neutral start switch.

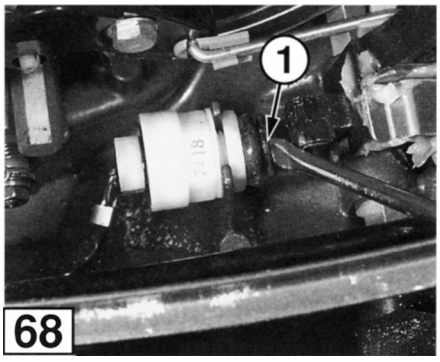
66 4. For models with remote control box ONLY: With remote control lever set at FORWARD and then REVERSE, check for continuity between terminals **(3)** and **(4)**. If meter does not show continuity in either test, replace the neutral start switch.







T1548



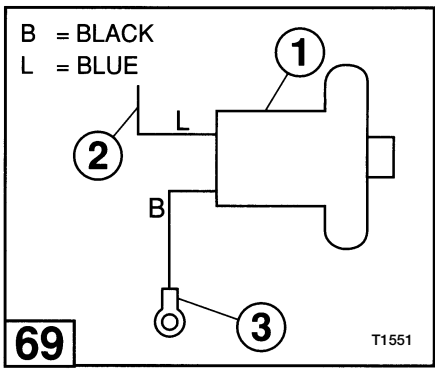
T1549

Choke Solenoid Test

69 1. Disconnect terminals **(2)** and **(3)**.

2. Set analog multimeter for continuity. Check for continuity between a clean chassis ground and one of these terminals (test one terminal at a time):

Terminal (2)	Terminal (3)



69 If meter shows continuity in any of these tests, replace choke solenoid **(1)**.

69 3. Check for continuity between terminals **(2)** and **(3)**. If meter does not show continuity, replace choke solenoid.

CHARGING SYSTEM

⚠ CAUTION

Avoid electrical shock:

- **Do not handle spark gap tester leads during performance testing.**
- **Do not touch ignition coils, exciter coil, pulser coils, or alternator coils while the engine is cranking or running.**

⚠ CAUTION

Use proper precautions when performing tests with the engine cover removed. Do not wear loose clothing or jewelry. Keep hair, hands, and clothing away from the flywheel and other moving parts.

⚠ CAUTION

When repairs are complete, make sure all ignition and electrical leads are properly routed and clamped in their original positions and the start-ingear prevention system must be tested before returning engine to customer.

⚠ CAUTION

The following tests must be performed with correct test propeller and with the engine in a test tank.

If the battery fails to maintain a charge:

1. Check battery, see Battery Care and Maintenance in this section.

2. Check 20 A engine fuse. If it is blown, check the following short or overload conditions:

- Short in charging circuit wiring or components, such as the alternator coils or rectifier/regulator.
- Short in starter circuit wiring or components, such as starter solenoid, main key switch, or neutral start switch.
- Short in accessories such as power trim/tilt.
- Overload in starter motor or power trim/tilt motor.

3. Check main key switch for continuity between RED leads with switch in OFF position, see Main Key Switch Test in this section.

4. Check alternator coils, see Alternator Coil Tests in this section.

5. Check rectifier/regulator, see Rectifier/Regulator Tests in this section.

Alternator Coil Tests

NOTE

Make sure all electrical terminals are connected during this test except those that are noted in the test procedure.

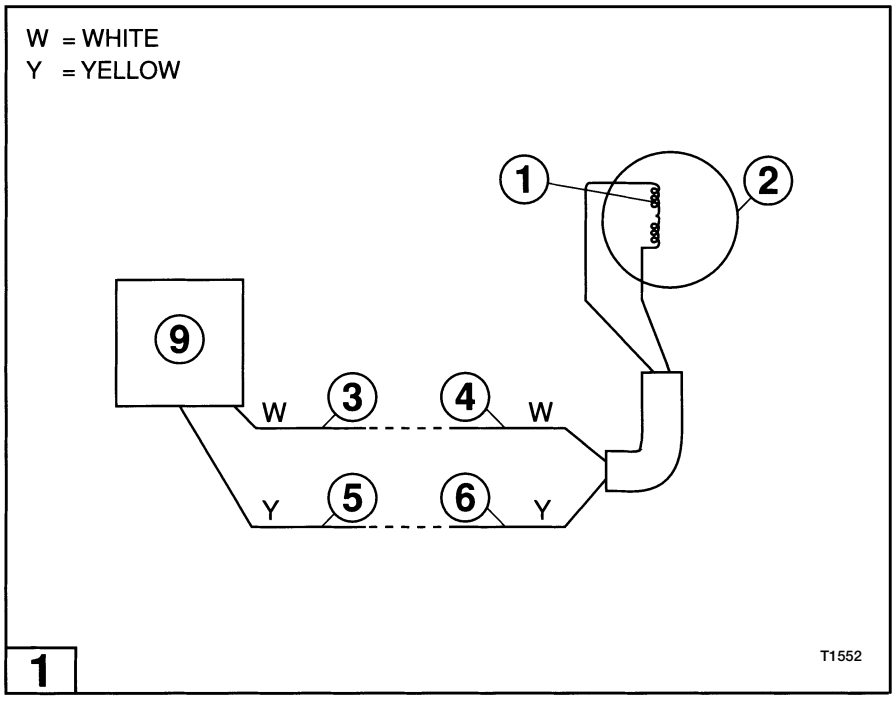
Check for continuity between chassis ground and the ground connection for the magneto plate, CD Unit, and ignition coils before conducting the following procedure.

Reference the following electrical drawings for the alternator coil test. The pulser and exciter coils have been removed from both illustrations for clarity.

1 *- Figure 1 - models 40 / 50 / 60 / 70 / 80 / 90.*

2 *- Figure 2 - models 115 / 120 / 140.*

1 **2** The alternator coil test is used to determine whether the alternator coils **(1)**, located on the coil plate assembly **(2)** [models 40 / 50 / 60 / 70 / 80 / 90] or the alternator assembly **(2)** [models 115 / 120 / 140] are open or shorted. The output from the alternator coil goes to the rectifier/regulator **(9)**.



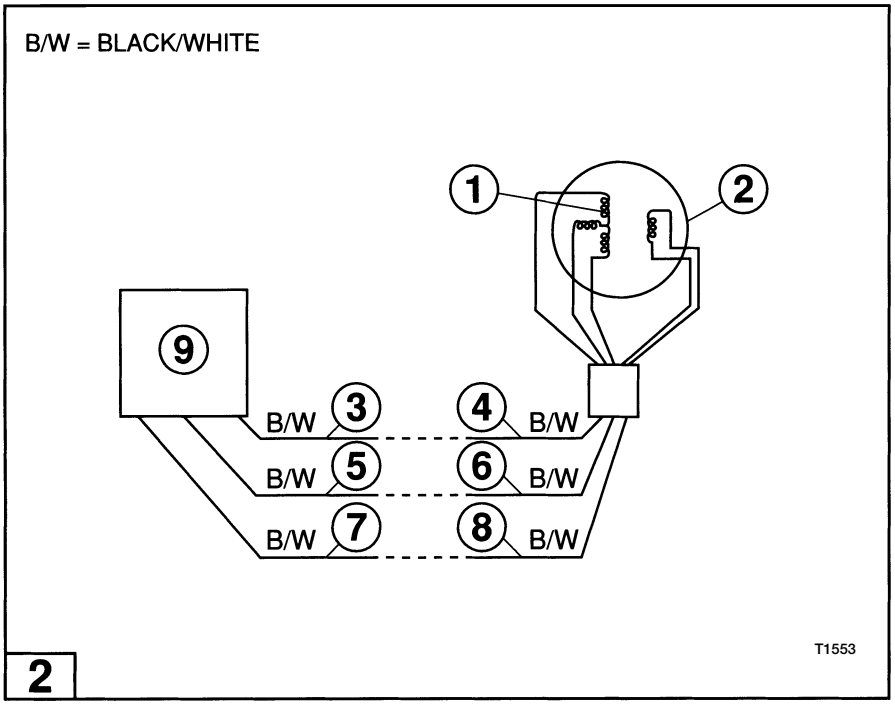
1

1 2 1. Disconnect the following terminals:

Engine Models	Disconnect Terminals
40 / 50 / 60 / 70 / 80 / 90	(2) (4) (5) and (6)
115 / 120 / 140	(3) (4) (5) (6) (7) and (8)

1 2 2. Set the digital multimeter to ohms and connect the leads between the following terminals to read the resistance of the alternator coil:

Engine Models	Connect Multimeter Between These Terminals
40 / 50 / 60 / 70 / 80 / 90	(4) and (6)
115 / 120 / 140	**Tesf1** - (4) and (6) **Test2** - (6) and (8)



3. The meter should indicate the following resistance:

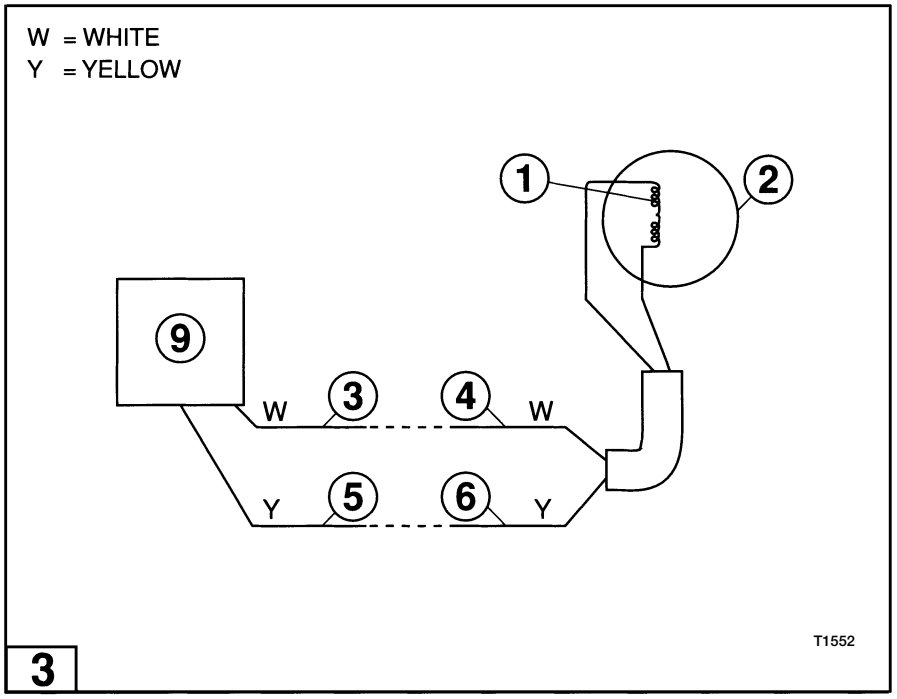
Engine Models	Results
40 and 50 60 and 70 80 and 90 115 / 120 / 140	W-Y, 0.2 - 0.3 Ω W-Y, 0.2 - 0.3 Ω 0.2 - 0.3 Ω (Test 1 and 2) 0.26 - 0.40 Ω

3 4 4. If the resistance is not within the indicated range, replace the alternator coils. See Charging System Repair Procedures - Alternator Coils.

If the resistance is within the indicated range, proceed to the next step.

3 4 5. Connect one tester lead to a clean engine ground and connect the other tester lead to the following terminals (one terminal at a time) to check for any resistance to ground:

Engine Models	Connect Multimeter Between These Terminals
40 / 50 / 60 / 70 / 80 / 90	• Terminal 4
	• Terminal 6
115 / 120 / 140	• Terminal 4
	• Terminal 6
	• Terminal 8



6. If the meter indicates any resistance to ground, replace the alternator coils. See Charging System Repair Procedures - Alternator Coils.

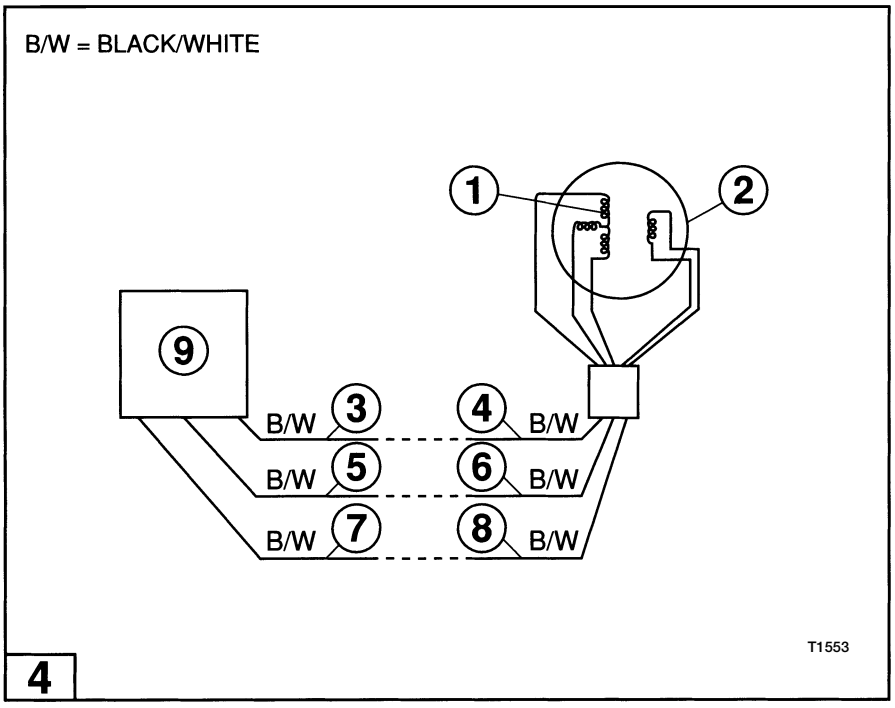
If the meter does not indicate any resistance to ground, proceed to the next step.

7. Set the analog multimeter to “40” on the “ACV” scale.

8. Insert the banana plug of the RED tester lead into the meter connection labeled “+VΩ” and the banana plug of the BLACK tester lead into the meter connection labeled “-COM”.

3 4 9. Connect the BLACK tester lead to a clean engine ground and the RED tester lead to following terminals (one terminal at a time) to check for any voltage to ground:

Engine Models	Connect Multimeter Between These Terminals
40 / 50 / 60 / 70 / 80 / 90	• Terminal 4
	• Terminal 6
115 / 120 / 140	• Terminal 4
	• Terminal 6
	• Terminal 8



10. Start engine.

11. At idle and full throttle, if the meter indicates any voltage to ground, replace alternator coils. See Charging System Repair Procedures Alternator Coils.

If no voltage to ground is indicated, the test is complete.

12. Reconnect alternator terminals.

Rectifier/Regulator Tests

NOTE

Make sure all electrical terminals are connected during this test except those that are noted in the test procedure.

Check for continuity between chassis ground and the ground connection for the magneto plate, CD Unit, and ignition coils before conducting the following procedure.

Reference the following electrical drawings for the rectifier/regula tor test.

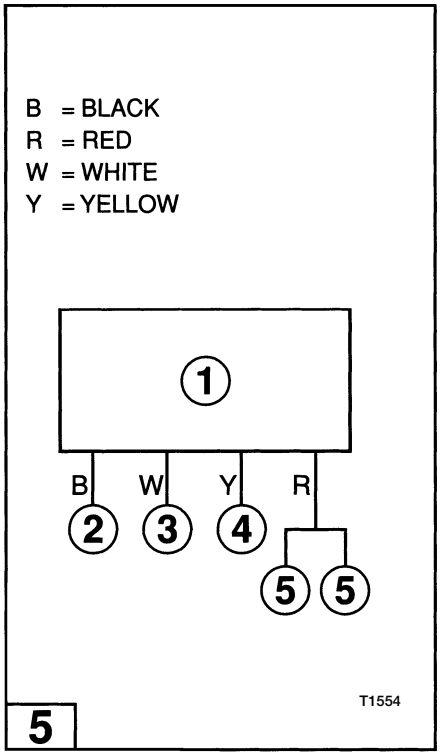
5 *- Figure 1 - models 40 / 50 / 60 / 70 / 80 / 90.*

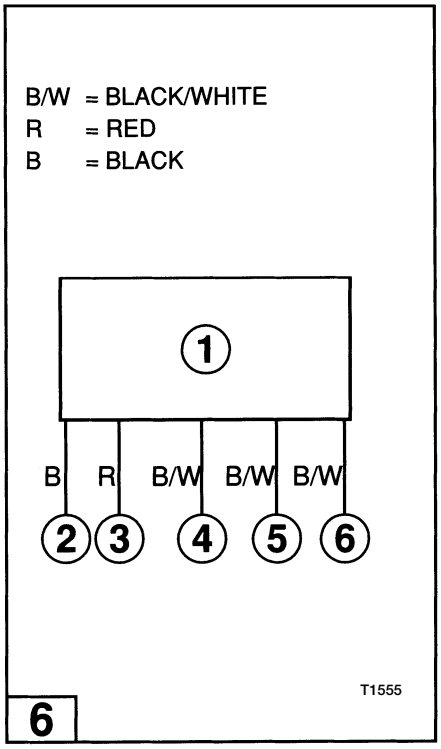
6 *- Figure 2 - models 115 / 120 / 140.*

The rectifier/regulator tests check whether the rectifier/regulator **(1)** is shorted or open.

5 **6** 1. Disconnect the following terminals from all other wiring:

Engine Models	Disconnect Terminals
40 / 50 / 60 / 70 / 80 / 90	② ③ ④ and ⑤
115 / 120 / 140	② ③ ④ ⑤ and ⑥





2. Set analog multimeter to check continuity.

3. Insert the banana plug of the RED tester lead into the meter connection labeled "+VΩ" and the banana plug of the BLACK tester lead into the meter connection labeled "-COM".

4. For models 40 / 50 / 60 / 70 / 80 / 90: Connect the RED and BLACK tester leads to the terminals as shown and note the results:

- Follow the tests listed in the chart starting at the TOP of each COLUMN and going DOWN.
- Follow the tests listed in the chart starting at the LEFT of each ROW and going to the RIGHT.

Replace rectifier/regulator if continuity tests are not as shown. If continuity checks are within specifications, proceed to next step.

NOTE

Continuity on chart means that the meter showed continuity (some resistance indicated by meter - exact value depends on test conditions). No Continuity on chart means that meter had no deflection.

		RED Tester Lead			
		Terminal (2)	**Terminal (3)**	**Terminal (4)**	**Terminal (5)**
BLACK Tester Lead	**Terminal (2)**	NA	Continuity	Continuity	Continuity
	Terminal (3)	No Continuity	NA	No Continuity	Continuity
	Terminal (4)	No Continuity	No Continuity	NA	Continuity
	Terminal (5)	No Continuity	No Continuity	NA	NA

For models 115 / 120 / 140: Connect the RED and BLACK tester leads to the terminals as shown and note the results:

- Follow the tests listed in the chart starting at the TOP of each COLUMN and going DOWN.
- Follow the tests listed in the chart starting at the LEFT of each ROW and going to the RIGHT.

Replace rectifier/regulator if continuity tests are not as shown. If continuity checks are within specifications, proceed to next step.

NOTE

Continuity on chart means that the meter showed continuity (some resistance indicated by meter - exact value depends on test conditions). No Continuity on chart means that meter had no deflection.

		RED Tester Lead				
		Terminal ②	Terminal ③	Terminal ④	Terminal ⑤	Terminal ⑥
BLACK Tester Lead	Terminal ②	NA	Continuity	Continuity	Continuity	Continuity
	Terminal ③	No Continuity	NA	No Continuity	No Continuity	No Continuity
	Terminal ④	No Continuity	Continuity	NA	No Continuity	No Continuity
	Terminal ⑤	No Continuity	Continuity	No Continuity	NA	No Continuity
	Terminal ⑥	No Continuity	Continuity	No Continuity	No Continuity	NA

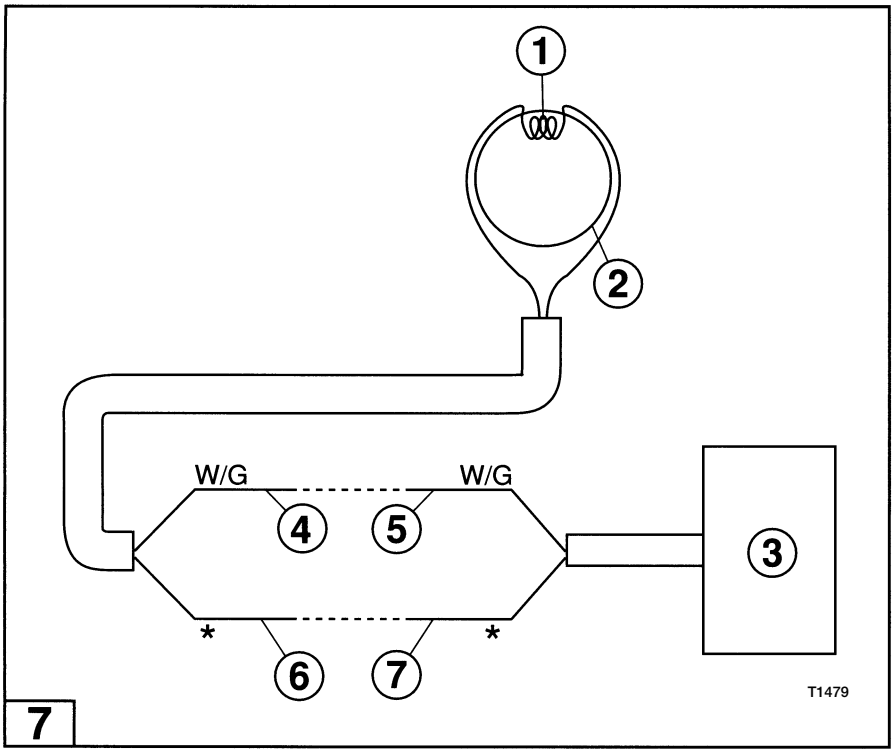
5. Connect rectifier/regulator leads.

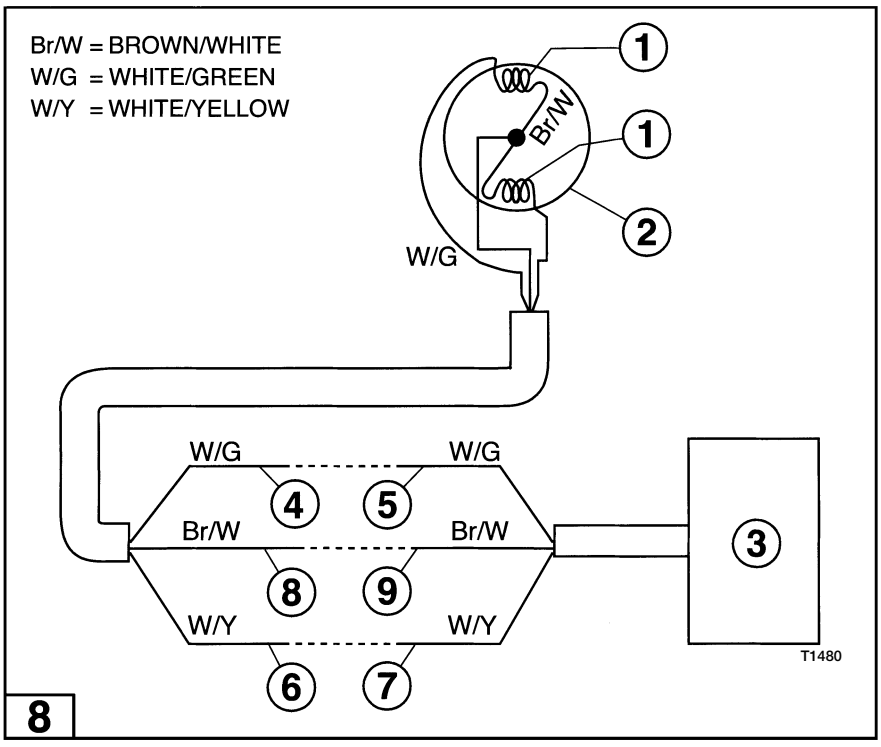
Charging System Repair Procedures

7 8

⚠⚠ WARNING

Disable ignition system, by disconnecting exciter coil terminals (4), (5), (6), (7), [(8) and (9) for 60B/ 70B only] to prevent accidental engine startup during removal and replacement of the flywheel.





⚠ CAUTION

Flywheel is under high torque and requires the use of special tools for removal and installation. Failure to use the specified tools can result in injury or damage to the flywheel or coil plate electrical components.

⚠ CAUTION

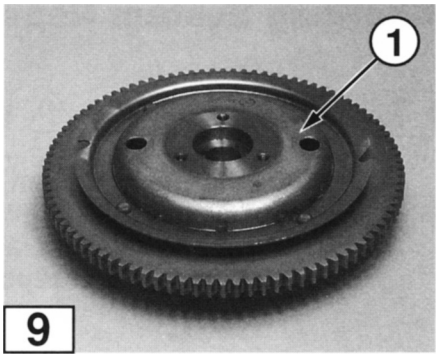
The force needed to loosen and tighten the flywheel nut requires flywheel be removed and installed with engine mounted and secured on an engine stand.

⚠ CAUTION

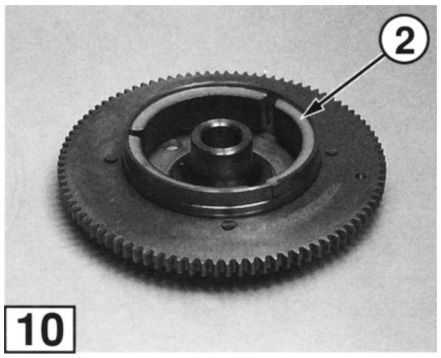
Use proper precautions when performing tests with the engine cover removed. Do not wear loose clothing or jewelry. Keep hair, hands, and clothing away from the flywheel and other moving parts.

⚠ CAUTION

When repairs are complete, make sure all ignition and electrical leads are properly routed and clamped in their original positions and the start-in-gear prevention system must be tested before returning engine to customer.



T1490



T1491

Flywheel

Replacing the exciter coil or coil plate assembly requires the removal of the flywheel, see Section 4, Flywheel, for the proper procedure.

NOTE

Flywheel magnets must be of a particular strength in order to run the ignition system. Weak magnets can cause low ignition voltage which may affect engine performance. Flywheels seldom go bad and would only be replaced as a last resort in solving an ignition problem.

9 **10** Carefully inspect flywheel **(1)** for cracks, chips, and worn taper after it is removed. Also inspect the magnets **(2)** for cracks and chips and make sure they are firmly attached to the flywheel.

Alternator Coils

NOTE

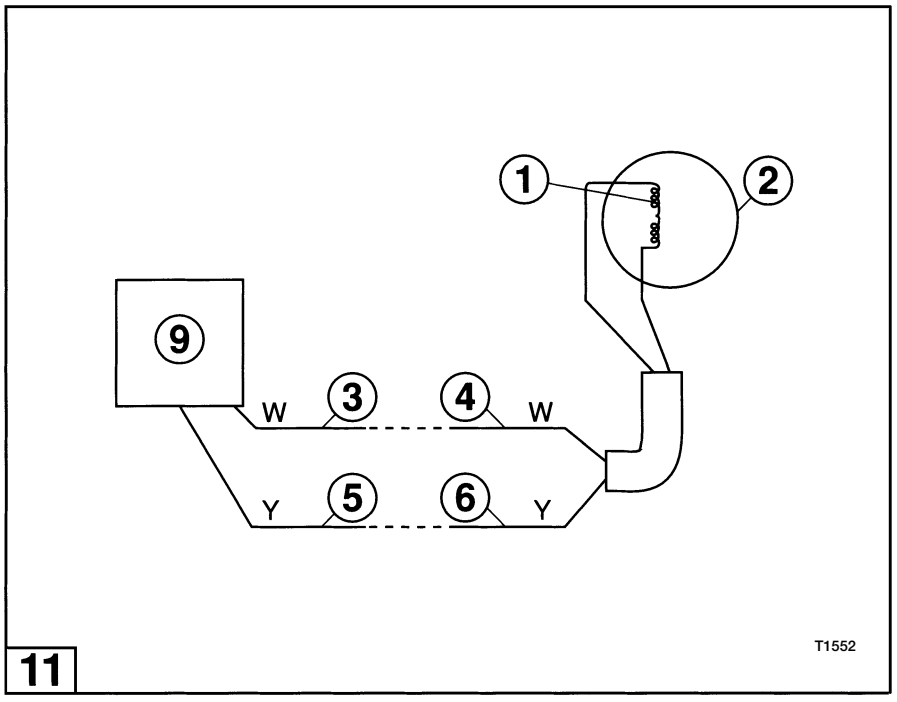
Disconnect negative battery cable from battery before removing alternator coils.

This procedure assumes alternator coils are available as a separate replaceable component. Some engine configurations might require replacement of entire coil plate assembly. Check current Parts Catalog for availability.

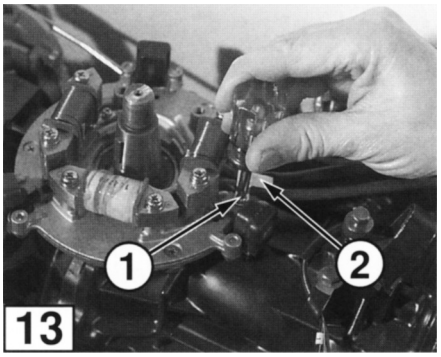
Removal

1. Remove the flywheel.

11 12 2. Disconnect following terminals for alternator coils **(1)**. Alternator coils are located on the coil plate assembly **(2)** [models 40 / 50 / 60 / 70 / 80 / 90] or the alternator assembly **(2)** [models 115 / 120 / 140].



Engine Models	Disconnect Terminals
40 / 50 / 60 / 70 / 80 / 90	③ ④ ⑤ and ⑥
115 / 120 / 140	③ ④ ⑤ ⑥ ⑦ and ⑧



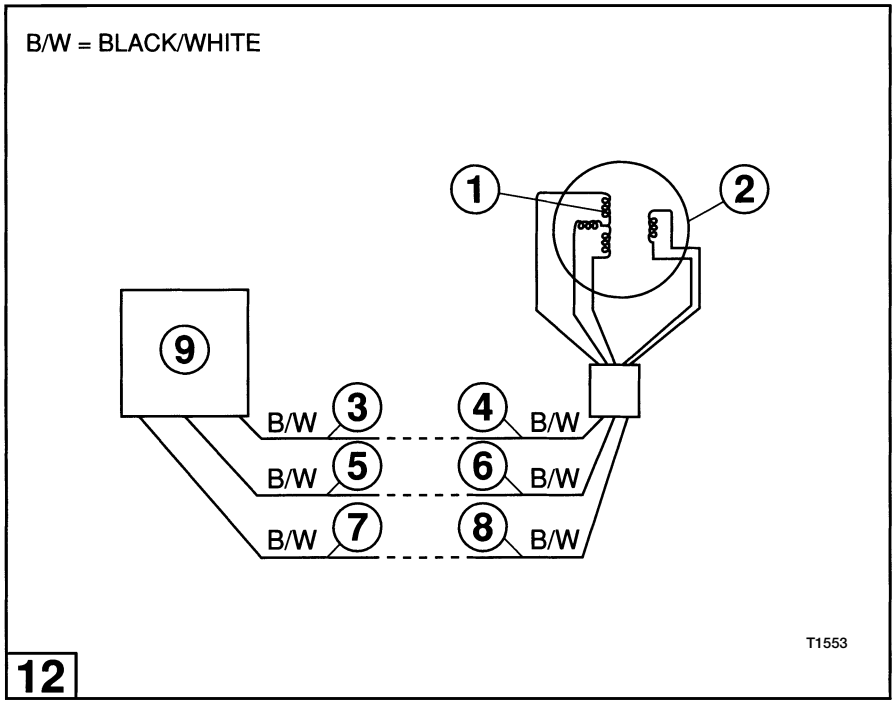
T1492

13 3. For models 40 / 50 / 60 / 70 / 80 / 90 ONLY: Remove coil plate assembly cable clamp screws **(1)** and cable clamp **(2)**.

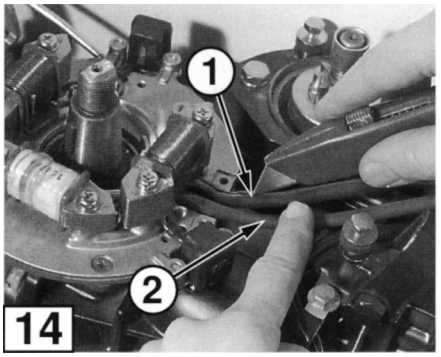
NOTE

Make sure you don't cut electrical conductors inside of coil plate assembly cable when you slit cable shield.

13 *On models 60B / 708 / 60C / 70C there are two coil plate assembly cables **(1)** and **(2)**. Make sure you slit the cable shield for coil plate assemble cable that contains the electrical conductors for the alternator coil.*



14 4. For models 40 / 50 / 60 / 70 / 80 / 90 ONLY: Carefully slit coil plate assembly cable shield **(1)**.



T1493

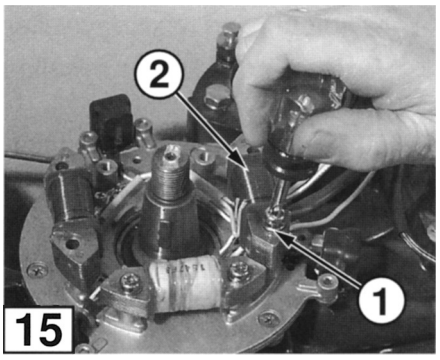
NOTE

Make sure you don't cut electrical conductors inside of coil plate assembly cable when you slit cable shield.

14 *On models 60B / 70B / 60C / 70C there are two coil plate assembly cables **(1)** and **(2)**. Make sure you slit the cable shield for coil plate assembly cable that contains the electrical conductors for the exciter coil(s).*

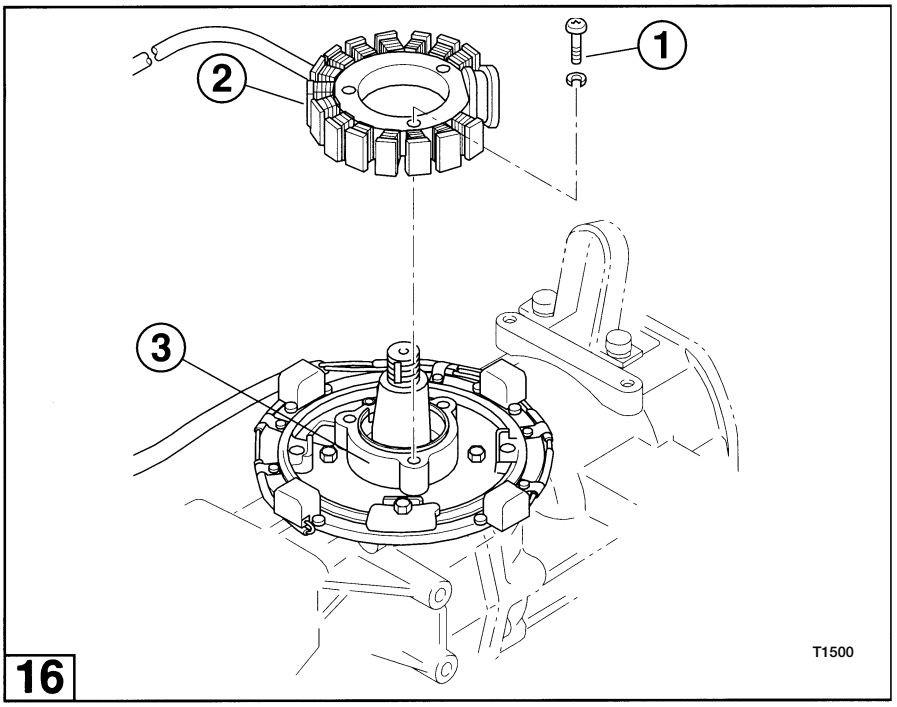
5. For models 40 / 50 / 60 / 70 / 80 / 90 ONLY: Cut tie wrap.

15 6. For models 40 / 50 / 60 / 70 / 80 / 90 ONLY: Remove alternator coil screws **(1)** and alternator coils **(2)** from the mounting bracket.



T1556

16 For models 115 / 120 / 140 ONLY: Remove mounting screws **(1)** and alternator assembly **(2)** from the mounting bracket **(3)**.



T1500

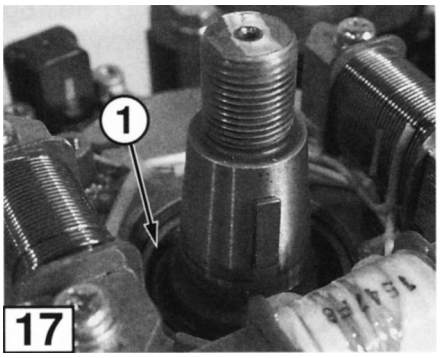
Cleaning and Inspection

17 Clean coil plate assembly, upper main bearing seal **(1)**, set ring, ignition timing link, exciter coil(s), pulser coils, coil leads, and coil connectors with isopropyl alcohol as required.

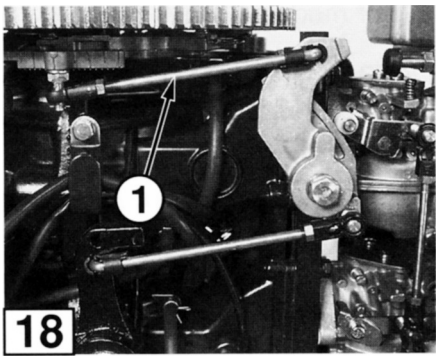
Check for the following and repair or replace as required:

- Bent, chipped, cracked, or corroded coil plate assembly.
- Coil leads for integrity, cut or cracked insulation, and damaged connectors.
- Broken or bent exciter coil laminations, damaged exciter coil windings, and missing exciter coil screws.
- Broken, cracked, or misaligned pulser coils and missing pulser coil screws.

18 • Free motion of ignition timing link **(1)**. Repair, adjust, and lubricate as needed, see Section 2.



T1498



T1499

Installation

Install in reverse order of removal.

NOTE

Use threadlocker on screw threads before installing screws.

SECTION 8
POWER TRIM/TILT

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Trim Sender/Trim Meter Test 8-7

Power Trim/Tilt 8-11

Troubleshooting 8-19

SECTION 8

GENERAL PRECAUTIONS

Before performing any service work on the power trim/tilt system, read and understand the Service Safety section at the beginning of this manual.

Pressurized hydraulic oil in the PT/T unit can cause serious injury. Always wear safety glasses and skin protection when servicing the system.

Before disassembly, always depressurize the PT/T unit as follows:

- Fully extend the tilt cylinder rod and engage the tilt stopper.
- Open the manual valve in increments.
- Allow PT/T unitto fully depressurize.

Do not fully open the manual valve when the engine is tilted down. Oil pressure is at its highest when engine is in this position.

Never apply heat to the PT/T manifold or cylinder body. Heat can cause high pressure leaks and failure of parts.

If manual valve is opened for manual tilting, engine cannot be held in the UP position by closing the manual valve. Engine must be safely supported using the tilt stopper or a suitable trailering bracket or hoist.

Significant residual pressure can exist behind components when removed. Always cover each part with a shop rag when removing it.

Replace locking fasteners when their locking feature becomes weak. Once removed, always install new snap rings. Use only factory replacement parts.

When using compressed air to clean or dry parts, make sure air supply is regulated not to exceed 25 psi [172 kPa / 1.76 kg/cm^2].

Before returning the engine to customer:

- Make sure the manual valve is torqued to specification.
- Make sure the thrust rod is installed in its original location. Leaving the rod out or moving it closer to the boat will allow the engine to trim in farther than expected by the customer and could result in loss of control.

Serial Number Breakpoints
Reference is made to differences between old and new Style Power Trim and Tilt Units (PT/T). The following **Serial Numbers** indicate breakpoints between older and newer Power Trim and Tilt models:

HP	New Style PT/T
60 B	11646 or higher
60 C	10001 or higher
70 B	23401 - 23413, 23439 or higher
70 C	10001 or higher
90	22313 - 22342, 22348 - 22358, 22365 or higher
115/120	21739 or higher
140	12174 or higher

SERVICE SPECIFICATIONS

Special Torque Values

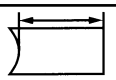
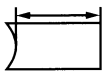
Description	Torque in-lb (ft-lb) N·m kg-m			Threadlocker
	40 / 50	Old Style PT/T	New Style PT/T	
PT/T Assembly Mounting Bolt	—	(17 - 22) 23 - 31 2 - 3	—	—
Oil Reservoir Mounting Bolt	—	43 - 60 5 - 7 0.5 - 0.7	35 - 52 4 - 6 0.4 - 0.6	—
Oil Reservoir Cap	26 - 43 3 - 5 0.3 - 0.5	26 - 43 3 - 5 0.3 - 0.5	43 - 87 5 - 10 0.5 - 1.0	—
Manual Valve	26 - 35 3 - 4 0.3 - 0.4	18 - 26 2 - 3 0.2 - 0.3	26 - 35 3 - 4 0.3 - 0.4	—
Oil Tube Nut	—	96 - 112 11 - 13 1.1 - 1.3	—	—
Motor Assembly Mounting Bolt	43 - 60 5 - 7 0.5 - 0.7	43 - 60 5 - 7 0.5 - 0.7	26 - 35 3 - 4 0.3 - 0.4	—
Motor Through Bolt	—	30 - 39 3 - 4 0.3 - 0.4	—	—
Motor Cable Outlet Plate Screw	—	30 - 39 3 - 4 0.3 - 0.4	—	—
Oil Pump Mounting Bolt	43 - 47 5 - 6 0.5 - 0.6	43 - 47 5 - 6 0.5 - 0.6	61 - 87 7 - 10 0.7 - 1.0	—
Relief Valve Up	104 - 121 12 - 14 1.2 - 1.4	104 - 121 12 - 14 1.2 - 1.4	—	—
Relief Valve Down	—	104 - 121 12 - 14 1.2 - 1.4	—	—
Pilot Relief Valve Down	—	104 - 121 12 - 14 1.2 - 1.4	—	—
Spool Check Valve	78 - 87 9 - 10 0.9 - 1.0	78 - 87 9 - 10 0.9 - 1.0	—	—
Trim Rod Guide	—	(51 - 65) 69 - 88 6.9 - 8.8	(55 - 60) 75 - 81 7.5 - 8.1	—
Tilt Rod Guide	(58 - 87) 78 - 118 7.8 - 11.8	(58 - 87) 78 - 118 7.8 - 11.8	(80 - 108) 108 - 147 10.8 - 14.7	—

Description	Torque in-lb (ft-lb) N·m kg-m			Threadlocker
	40 / 50	Old Style PT/T	New Style PT/T	
Tilt Rod Nut	(36 - 54) 49 - 74 4.9 - 7.4	(58 - 87) 78 - 118 7.8 - 11.8	(58 - 87) 78 - 118 7.8 - 11.8	Loctite 242
PT/T Switch (P Type) Mounting Screw	4 - 6 0.45 - 0.7 0.05 - 0.07	4 - 6 0.45 - 0.7 0.05 - 0.07	4 - 6 0.45 - 0.7 0.05 - 0.07	—
PT/T Switch (F Type) Mounting Screw	13 - 26 2 - 3 0.2 - 0.3	13 - 26 2 - 3 0.2 - 0.3	13 - 26 2 - 3 0.2 - 0.3	—
Lower Cylinder Pin Nut	(51 - 65) 69 - 88 6.9 - 8.8	—	—	—

Refer to Section 2 for Standard Torque Values chart.

Power Trim/Tilt Specifications

Description	Unit	Specification		
		40 / 50	Old Style PT/T	New Style PT/T
Pump Manifold Assembly				
Pump Type	—	Geared oil pump	Geared oil pump	Geared oil pump
Relief Valve UP Opening Pressure	psi kPa kg/cm²	1991 - 2417 13729 - 16671 140 - 170	1706 - 1991 11767 - 13728 120 - 140	1280 - 1706 8825 - 11768 90 - 120
Relief Valve DOWN Opening Pressure	psi kPa kg/cm²	284 - 483 1961 - 3334 20 - 34	—	568 - 1066 3922 - 7354 40 - 75
Pilot Relief Valve DOWN Opening Pressure	psi kPa kg/cm²	—	569 - 995 3922 - 6864 40 - 70	—
Free Piston Relief Valve Opening Pressure	psi kPa kg/cm²	—	36 - 50 245 - 343 2.5 - 3.5	—
Upper Chamber Side Check Valve (Valve Seat Assembly A) Opening Pressure	psi kPa kg/cm²	34 235 2.4	34 235 2.4	—
Lower Chamber Side Check Valve (Valve Seat Assembly B) Opening Pressure	psi kPa kg/cm²	17 118 1.2	17 118 1.2	—
Oil Type	—	Nisseki® Power Torque Fluid (as shipped from factory) or any GM approved automatic transmission fluid (see Engine Specifications, Section 2)		
Oil Capacity	fl oz cm³	18.6 550	24.7 730	23.0 682

Description	Unit	Specification		
		40 / 50	Old Style PT/T	New Style PT/T
Motor				
Rated Time	—	60 sec.	60 sec.	60 sec.
Rated Voltage	VDC	12	12	12
Output	kW	0.4	0.3	0.4
Direction of Rotation	—	Forward / reverse	Forward / reverse	Forward / reverse
Circuit Breaker Type	—	Internal, bi-metallic, current-sensitive		
Circuit Breaker Activation	—	—	40- 120 sec. at 52A	20 sec. (minimum) at 80A
Circuit Breaker Reset	—	—	Within 35 sec.	—
Commutator Standard O.D.	in mm	—	1.10 28.0	0.87 22.1
Commutator Wear Limit O.D.	in mm	—	1.06 27.0	0.82 21.0
Brush Standard Length  T1316	in mm	—	0.45 11.5	0.39 10.0
Brush Wear Limit Length  T1316	in mm	—	0.29 7.5	0.20 5.0
Field Coil Standard Resistance	Ω	—	0.05 (pink - blue)	—
Trim Cylinder				
Piston Diameter	in mm	—	1.50 38.0	1.50 38.0
Piston Rod Diameter	in mm	—	0.63 16.0	0.70 17.8
Piston Stroke	in mm	—	2.72 69.0	3.81 96.9
Tilt Cylinder				
Piston Diameter	in mm	2.13 54	1.77 45.0	1.77 45.0
Piston Rod Diameter	in mm	0.63 16.0	0.75 19.0	0.75 19.0
Piston Stroke	in mm	5.55 141.0	6.16 131.0	6.19 157.3
Shock Absorber Valve Opening Pressure	psi kPa kg/cm²	497 - 782 3432 - 5393 35 - 55	1778 - 2204 12258 - 15200 125 - 155	2133 - 2702 14710 - 18632 150 - 190
PT/T Switches				
Control Box (P Type)	—	3 A single-pole double-throw rocker switch		
Lower Motor Cover	—	3 A single-pole double-throw rocker switch		
Panel (F Type)	—	20 A single-pole double-throw rocker switch		
Solenoid Switches				
Rated Voltage	VDC	12	12	12
Rated Time	—	—	30sec. at 100A	60sec. at 80A
Excitation Current	—	—	3 A (maximum)	4 A (maximum)
Excitation Coil Standard Resistance	Ω	—	5.20	—

Manufacturer Special Tools Required

Tilt Rod Guide Wrench, 3B7-72791-0, 3C8-72791-0
Trim Rod Guide Wrench, 3B7-72792-0
Power Trim/Tilt Test Stand, 3B7-72794-0

General Equipment Required

Ammeter, 0 - 100A
Analog Multimeter, *Electronic Specialties® Model M-530 or equivalent*
Digital Multimeter, *Electronic Specialties® Model KD 3200 or equivalent*
Test Battery, 12 V, 500 CCAwith 105 minutes [70AH] reserve capacity

Consumable Supplies Required

Power Trim/Tilt Fluid, *Nisseki® Power Torque Fluid (as shipped from factory) or any GM approved automatic transmission fluid, see Engine Specifications in Section 2*
Genuine Grease or Equivalent Friction Surface Marine Grease
Cleaning Solvent
Threadlocker, *Loctite® 242*

AIR BLEEDING PROCEDURE

Air in the PT/T hydraulic system can sometimes be detected by the presence of muffled sounds during trim/tilt operation. Use the following procedure to bleed air from the system.

1. Ensure oil reservoir cap is tight.

2. Open the manual valve several turns.

3. Lift engine manually to fully UP position. Engage the tilt stopper to lock engine in position.

4. Confirm oil level is sufficient. Add oil if needed.

5. Fully close the manual valve and maintain the UP position for a minimum of 5 minutes.

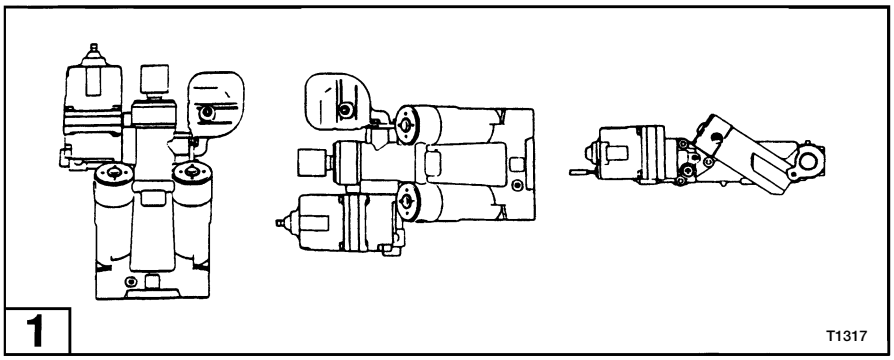
6. Disengage the tilt stopper. Operate the PT/T motor and lower engine to fully DOWN position. Maintain this position for a minimum of 5 minutes.

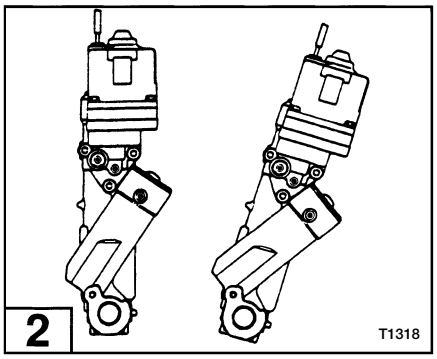
7. Operate the PT/T motor and raise engine to fully UP position. Engage the tilt stopper and check oil level. Add oil if needed. Maintain the UP position for a minimum of 5 minutes.

8. Repeat Steps 6 and 7 for a minimum of five cycles.

NOTE

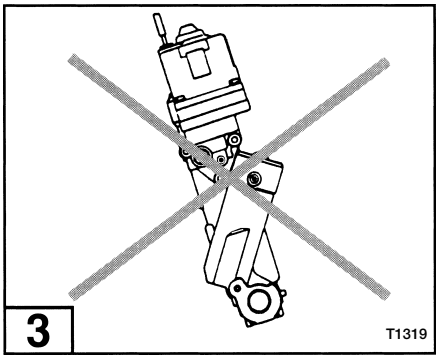
Air trapped deep within the manifold may not be easily bled from the system. If air remains trapped in the system, repeat the Air Bleeding Procedure over a period of several days.





PT/T Storage Positions

1 The engine or PT/T assembly itself should be stored so the PT/T unit is in one of the positions shown. Storing the unit in other positions will allow air to enter the system.



PT/T Oil Fill Positions

NOTE

Refer to Power Trim/Tilt Specifications for oil capacity listing.

2 Normal filling of the PT/T reservoir with no air in the system should be performed with the PT/T unit positioned vertical or slightly tilted.

3 The forward tilt position can allow for over-filling and may damage the PT/T unit.

TRIM SENDER / TRIM METER TEST

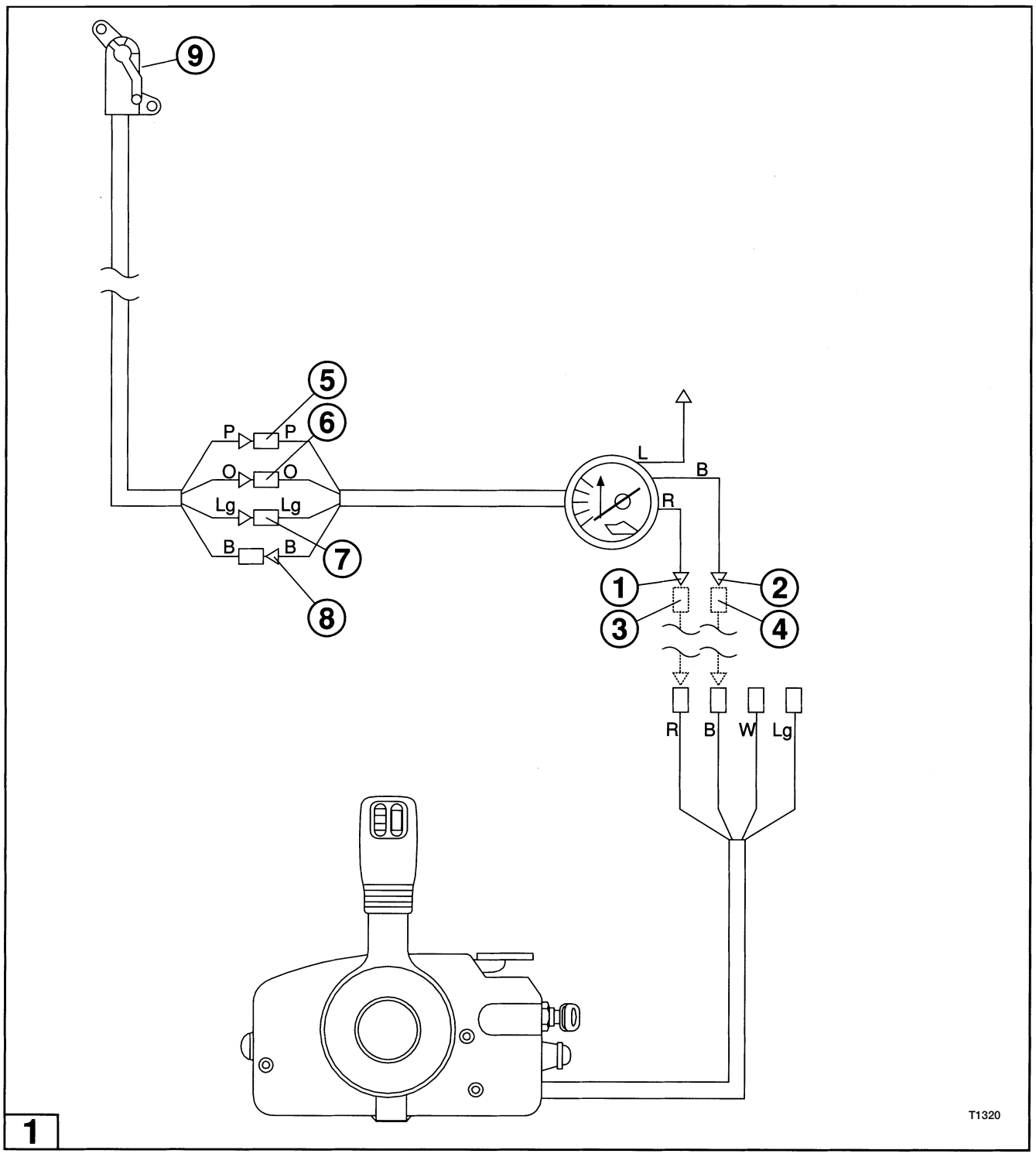
Perform this test to determine if the trim sender and trim meter (analog or LCD) are functioning properly.

NOTE

A fully charged battery rated at 12 V, 500 CCA with 105 minutes [70 AH] reserve capacity must be used for all testing.

NOTE

The main key switch must be in the ON position to obtain voltage readings during testing.



1

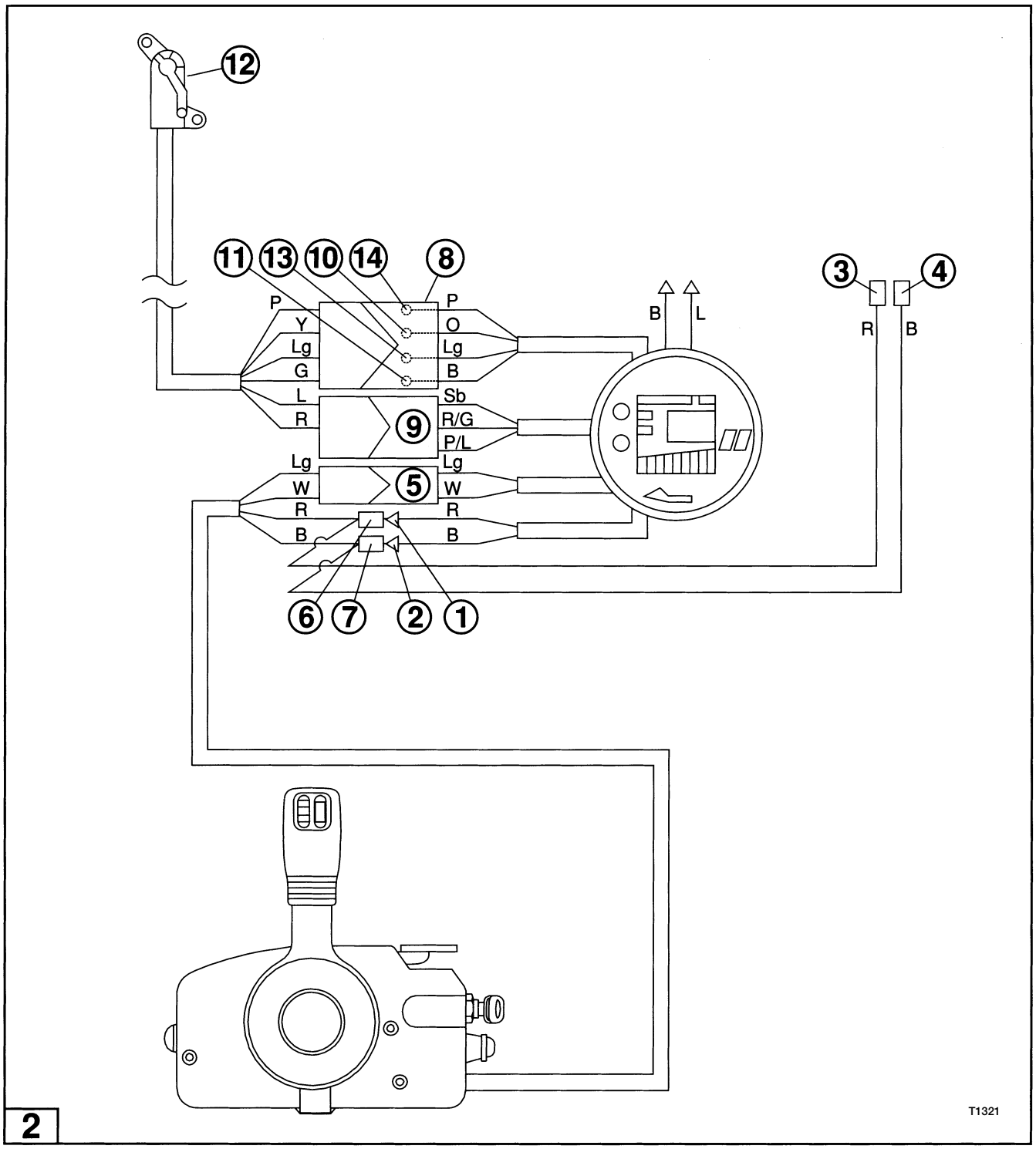
NOTE

Reference the applicable electrical diagram for all testing :

1 *Figure 1 - Models equipped with trim analog meter.*

2 *Figure 2 - Models equipped with LCD multi-purpose meter.*

R = RED	P = PINK
B = BLACK	O = ORANGE
L = BLUE	Lg = LIGHT GREEN
W = WHITE	



R = RED	Lg = LIGHT GREEN
B = BLACK	Y = YELLOW
L = BLUE	Sb = SKY BLUE
W = WHITE	R/G = RED/GREEN
P = PINK	P/L = PINK/BLUE
O = ORANGE	

Trim Indicator Input Voltage

1. Disconnect the following:

1 Analog trim meter - terminals **(1)** and **(2)**.

2 LCD trim meter - terminals **(1)**, **(2)**, **(3)**, **(4)** and connector **(5)**.

2. Using a multimeter, test for 12 VDC input to the trim meter. Connect the RED tester lead to:

1 Analog trim meter - terminal **(3)**.

2 LCD trim meter - terminal **(6)**.

Connect the BLACK tester lead to:

1 Analog trim meter - terminal **(4)**.

2 LCD trim meter - terminal **(7)**.

If no voltage or low voltage is obtained, check the following and correct the problem before proceeding:

- 20 A engine fuse.
- All input wiring to the trim meter for loose connections and shorts to-ground.
- Main switch, see Main Key Switch Test in Section 7.

3. Reconnect all wiring before proceeding.

Trim Meter Output Voltage

4. Disconnect the following:

1 Analog trim meter - terminals **(5)**, **(6)**, **(7)** and **(8)**.

2 LCD trim meter - connectors **(8)** and **(9)**.

5. Using a multimeter, test for 9 VDC output from the trim meter. Connect the RED tester lead to:

1 Analog trim meter - terminal **(6)**.

2 LCD trim meter - terminal **(10)**.

Connect the BLACK tester lead to:

1 Analog trim meter - terminal **(8)**.

2 LCD trim meter - terminal **(11)**.

If no voltage or low voltage is obtained, the trim meter or trim meter output wiring is defective. Repair or replace as needed before proceeding.

6. Reconnect all wiring and repeat voltage output test for 9 VDC. If no voltage or low voltage is obtained, perform the following:

1 Analog trim meter- Check all wiring between trim sender **(9)** and terminals **(5)**, **(6)**, **(7)**, and **(8)** for shorts-to-ground.

2 LCD trim meter - Check all wiring between trim sender **(12)** and connector **(8)** for shorts-to-ground.

If wiring is shorted, repair or replace as needed.

7. Reconnect all wiring before proceeding.

Trim Sender Output Voltage

8. Operate PT/T motor and lower engine to fully DOWN position.

9. Using a digital multimeter, connect the RED tester lead to:

1 Analog trim meter - terminal **(7)**.

2 LCD trim meter - terminal **(13)**.

Connect the BLACK tester lead to:

1 Analog trim meter - terminal **(5)**.

2 LCD trim meter - terminal **(14)**.

10. Operate the PT/T motor from DOWN to UP and verify the following:

- DOWN voltage is between - 5 and - 15 mV.
- UP voltage is between -115 and -125 mV.

If test results vary, trim sender unit is defective and must be replaced.

POWER TRIM/TILT

⚠⚠ WARNING

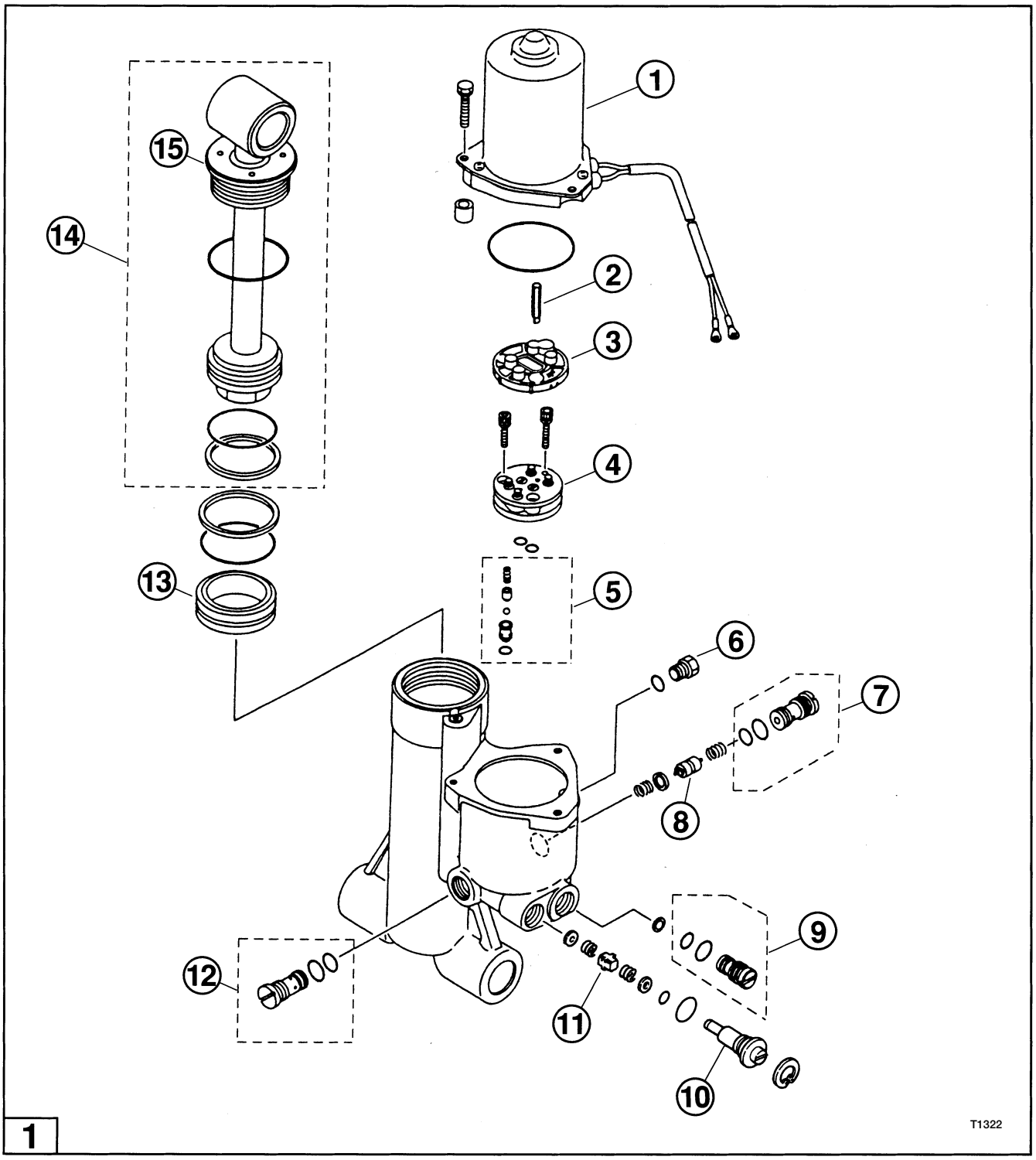
Always wear safety glasses and skin protection when servicing power trim/tilt unit.

⚠⚠ WARNING

Never fully open the manual valve when engine is tilted down – oil pressure is at its highest.

NOTE

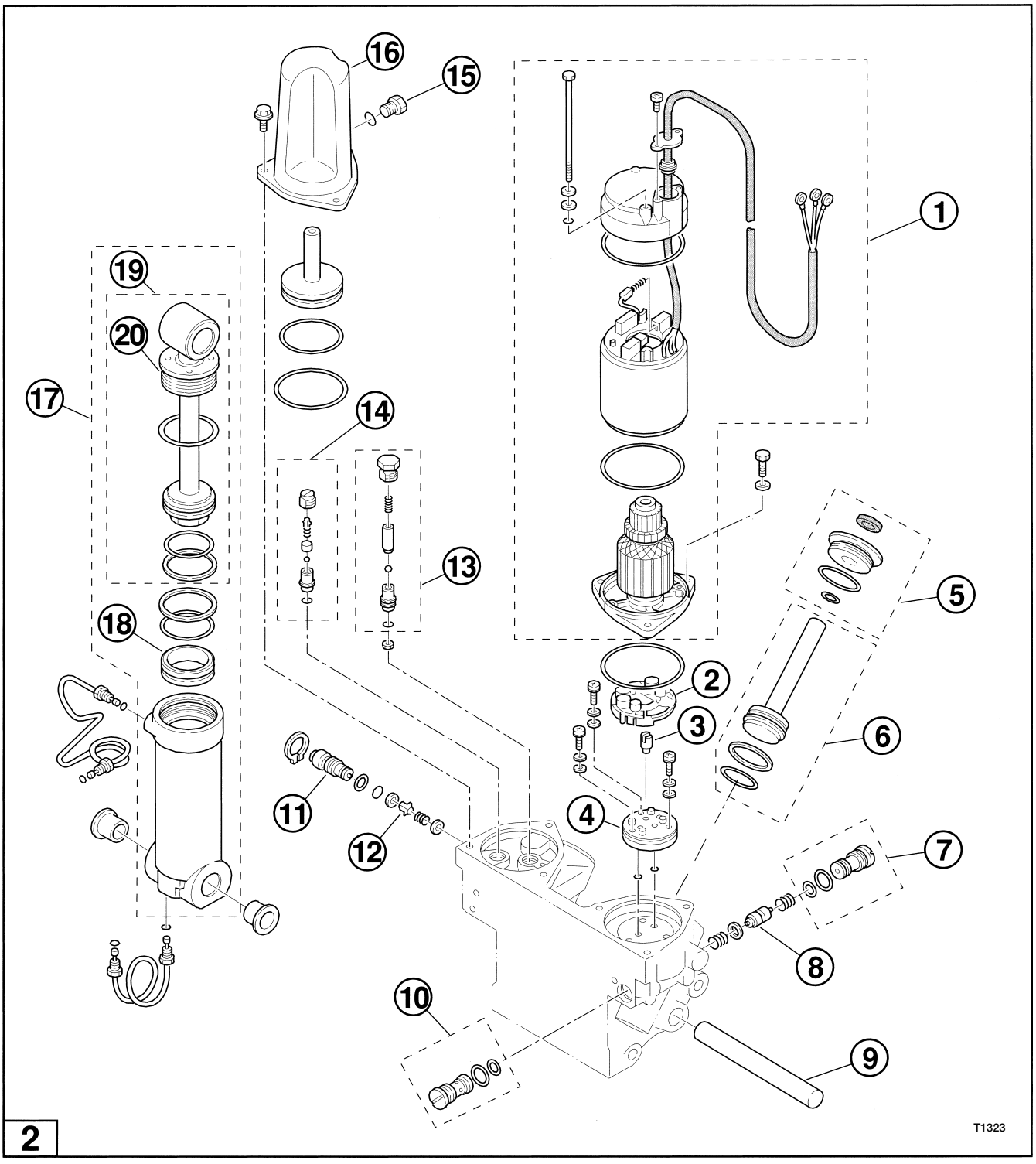
The following procedures apply to all PT/T models. New style PT/T shown in photographs.



1

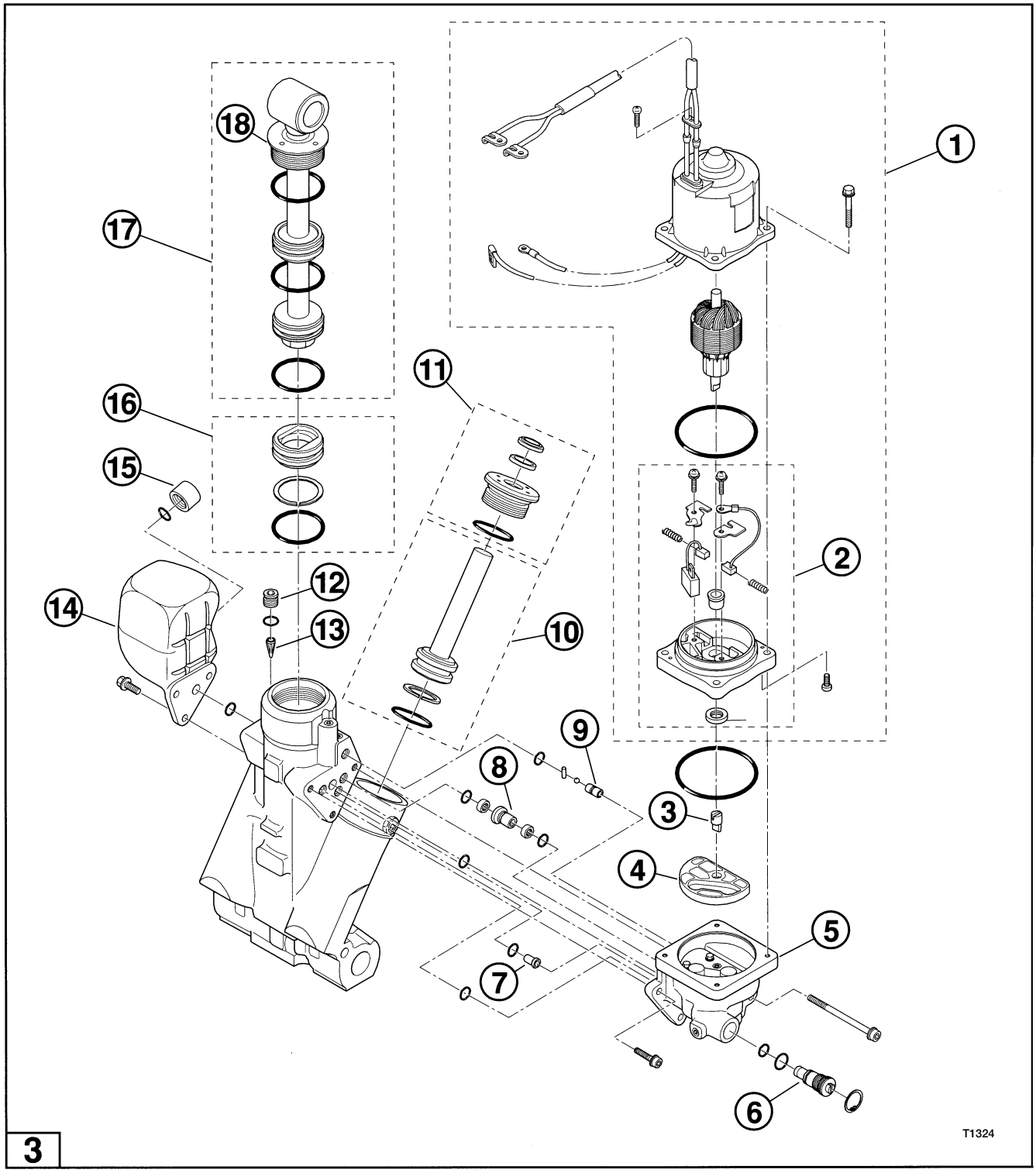
Models 40 and 50

1. Motor Assembly
2. Drive Joint
3. Filter B
4. Pump
5. Relief Valve DOWN
6. Cap
7. Upper Chamber Side Check Valve (Valve Seat Assembly A)
8. Spool
9. Relief Valve UP
10. Manual Valve
11. Inner Collar
12. Lower Chamber Side Check Valve (Valve Seat Assembly B)
13. Free Piston
14. Piston Rod Assembly
15. Rod Guide



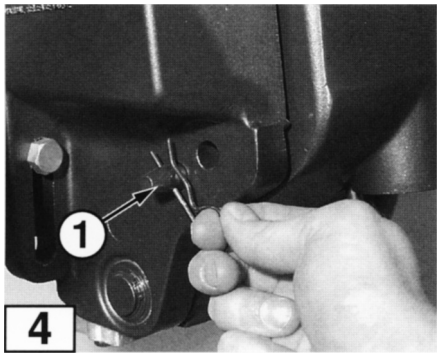
Models 60 / 70 / 80 / 90 / 115 / 120 / 140 - Old PT/T

1. Motor Assembly
2. Filter B
3. Pump Coupling
4. Pump
5. Trim Rod Guide Assembly
6. Trim Piston Rod Assembly
7. Upper Chamber Side Check Valve (Valve Seat Assembly B)
8. Spool
9. Shaft
10. Lower Chamber Side Check Valve (Valve Seat Assembly A)
11. Manual Valve
12. Inner Collar
13. Relief Valve UP
14. Pilot Relief Valve DOWN
15. Cap
16. Reservoir Tank
17. Cylinder Assembly
18. Free Piston
19. Tilt Piston Rod Assembly
20. Tilt Rod Guide

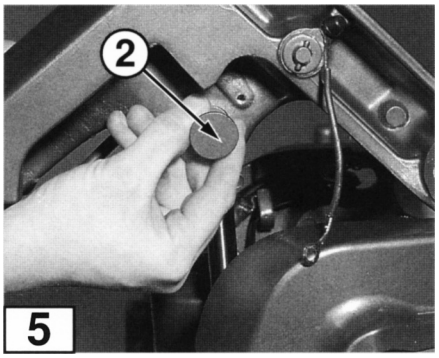


Models 60 / 70 / 80 / 90 / 115 / 120 / 140 - New PT/T

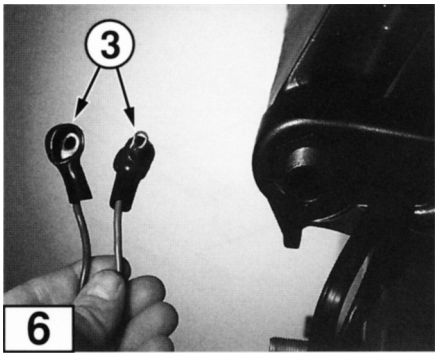
1. Motor Assembly
2. Bracket Assembly
3. Pump Coupling
4. Filter B
5. Pump
6. Manual Valve
7. Orifice
8. Valve Seat
9. Orifice
10. Trim Piston Rod Assembly
11. Trim Rod Guide Assembly
12. Plug
13. Filter
14. Reservoir Tank
15. Cap
16. Free Piston
17. Tilt Piston Rod Assembly
18. Tilt Rod Guide



T1325



T1326



T1327

Removal

1. Operatethe PT/T motor and raise engine to fully UP position. Engage the tilt stopper to lock engine in position.

NOTE

If power trim/tilt motor is not functional, open manual valve several turns and raise engine by hand.

4 5 2. Remove thrust rod **(1)** if equipped, and upper cylinder pin **(2)**.

3. With tilt stopper engaged, fully retract the piston rod(s) and disconnect the battery.

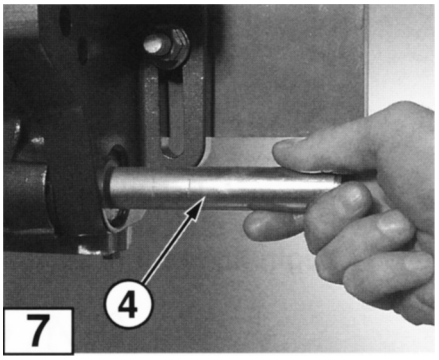
6 4. Disconnect two PT/T motor leads **(3)** from the UP and DOWN solenoid switches in the electrical box and remove them from the lower motor cover and stern bracket.

NOTE

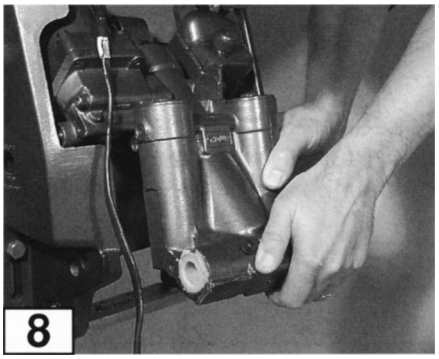
The PT/T motor cable on old style PT/T units contains an additional ground lead which must be disconnected. For ease of identification and to prevent improper wire connections during testing and installation, mark all electrical leads before disconnecting.

7 5. Remove the PT/T assembly mounting bolts (old style PT/T) and lower cylinder pin **(4)**.

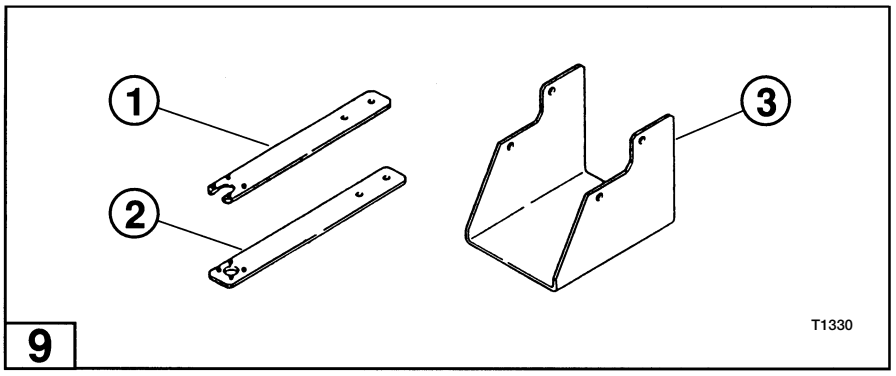
8 6. Lift the PT/T unit from between the stern brackets.



T1328



T1329



Disassembly and Assembly

⚠⚠ WARNING

DO NOT disassemble any component until all system pressure has been released and the oil reservoir has been drained. Depressurize the PT/T unit as described in General Precautions at the beginning of this section.

⚠⚠ WARNING

Significant residual pressure can exist behind components when removed. Always cover each part with a shop rag when removing it.

Disassemble and assemble the PT/T internal components in accordance with the previous system diagrams and the component guidelines contained in this section.

9 Reference the following specification table for Disassembly and Assembly special tool requirements.

Tool	Part Number	Applicability
Tilt Rod Guide Wrench (1)	3C8-72791-0	40 / 50
Tilt Rod Guide Wrench (1)	3B7-72791-0	Old Style and New Style PT/T
Trim Rod Guide Wrench (2)	3B7-72792-0	Old Style and New Style PT/T
Power Trim/Tilt Test Stand (3)	3B7-72794-0	Old Style PT/T

⚠ CAUTION

Use the following precautions during disassembly and assembly of the PT/T unit:

- **PT/T exterior must be thoroughly cleaned before disassembly to prevent contaminants from entering the hydraulic system.**
- **Use the required special tools to prevent damage to components.**
- **Perform all workwith PT/T unit secured in padded vice or test stand.**
- **DO NOT force the disassembly or assembly of any part.**
- **DO NOT attempt to disassemble the internal pump components.**
- **Clean all components removed and keep them free of dust and other debris by placing them on clean paper. DO NOT lay parts on shop rags or other cloth materials.**
- **Verify components are within wear limits and are not damaged before assembly.**
- **Apply specified PT/T oil to all internal parts before assembly.**
- **Torque all valves and fasteners to specification.**

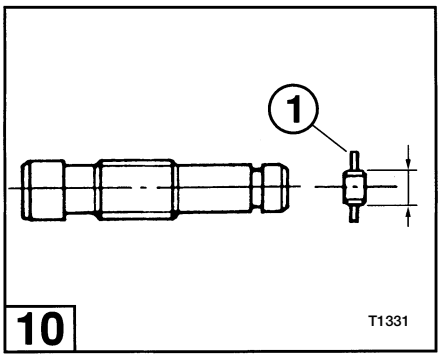
Tilt and Trim Cylinders
Guidelines:

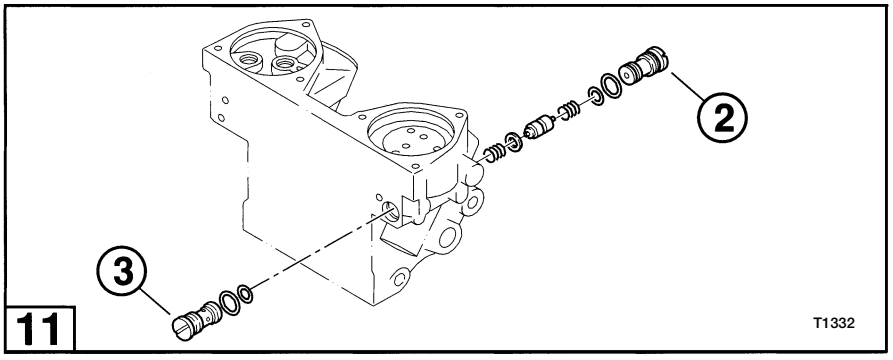
1. Use special tools as specified for removing and installing the rod guides.

2. Before assembling, apply specified PT/T oil to inner surface of tilt cylinder and/or manifold and all internal cylinder components, especially o-rings and backup rings.

3. Apply Loctite 242 to the tilt rod nut and torque to specification.

4. Install piston rods as follows:
- Fill bottom of cylinder with specified PT/T oil.
- Insert piston rods into cylinder and push downward until level with oil surface.
- Fill remaining portion of cylinder with oil.
- Tighten the rod guides.





5. On old style PT/T, thread the oil tube nuts by hand several turns before tightening with a wrench to avoid leakage caused by crossthreading.

Manual Valve

Guidelines:

10 On models 40 and 50 and old style PT/T, use caution to assemble the seal washers, spring, and inner collar in the correct order. Inner collar **(1)** must be positioned properly as shown to avoid breakage.

Spool Valve

Guidelines:

11 On old style PT/T, avoid interchanging the upper and lower chamber side check valves. Upper chamber side check valve **(2)** is identified by a black colored head stamped with a “1” marking. Lower chamber side check valve **(3)** is not marked or is stamped with a “0” marking.

Motor

Guidelines:

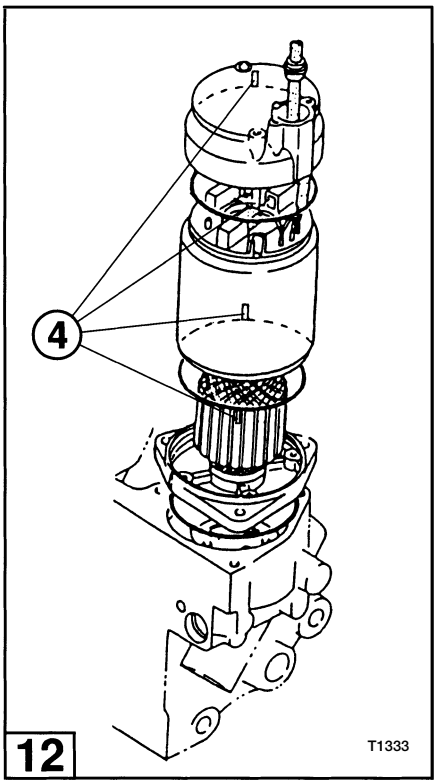
1. Perform the following checks before assembly:

- Using an ohmmeter, verify no electrical continuity between the armature and commutator. Also verify no electrical continuity between the commutator segments. Replace armature assembly if continuity is detected.
- Inspect the commutator surface and undercuts for signs of pitting and wear. Polish commutator with fine emery cloth or replace armature if wear exceeds specification limit.
- Inspect the brush lengths and replace if wear exceeds specification limit.

2. Avoid damage to the brushes during disassembly and assembly of the motor.

12 3. On old style PT/T, ensure motor match marks **(4)** are aligned when assembling the armature and yoke compressor.

4. Ensure armature shaft is seated properly in pump coupling.



Installation

Installation is done in the reverse order of Removal.

⚠ CAUTION

Use the following precautions during installation of the PT/T unit:

- **Ensure all bushings and washers have been inspected and are properly installed.**
- **Lubricate friction surfaces with genuine grease or equivalent friction surface marine grease.**
- **Replace all snap rings that have been removed.**
- **Torque fasteners to specification.**

TROUBLESHOOTING

This section is designed as a troubleshooting resource for qualified service technicians familiar with the operation and repair of PT/T electrical and hydraulic systems. Follow all information in the order indicated; an organized approach more quickly isolates the cause of the problem.

It is important when receiving the engine to question the owner and obtain any symptom information which might assist in determining and correcting the problem. Particularly ask whether symptoms occur during forward or reverse running of the engine. Document all information gathered.

⚠⚠ WARNING

Follow the Removal, Disassembly, Assembly, and Installation procedures as applicable when trouble-shooting. The procedures contain important safety information.

⚠ CAUTION

Never connect PT/T motor leads directly to battery when testing. Use battery jumper cables to prevent sparking and damage to the motor lead terminals.

NOTE

Refer to Outboard Motors Service Data publication for wiring diagrams when performing electrical testing.

NOTE

A fully charged battery rated at 12 V, 500 CCA with 105 minutes [70 AH] reserve capacity must be used for all testing.

NOTE

All worn, damaged, or missing parts identified during troubleshooting must be replaced. Refer to latest Parts Catalog for serviceable parts information.

Preliminary Service Checks

Before troubleshooting, perform the following Service Checks in the order indicated. Use these checks to help identify problems of simple origin and to obtain a complete assessment of the unit so troubleshooting can begin.

Service Check 1

1. Open the manual valve several turns and manually move the engine through the complete trim/tilt range. Verify the tilt and trim rods are straight, undamaged, and slide smoothly. Verify there is no restriction or binding of the swivel and stern brackets and bracket bolt (tilt tube).

2. Turn the manual valve fully CLOSED and torque to specification.

Service Check 2

1. Check the condition and quantity of the oil in the reservoir. If oil appears bad or level is low, completely drain, refill, and bleed the system. Check the old oil for metal fragments or signs of gelling.

⚠ CAUTION

Do not mix different brands or types of oil. Doing so can cause oil gelling which may damage the system.

Service Check 3
1. Fill a container with water and place it under the PT/T unit. Operate the PT/T motor and check the following:

NOTE

If motor does not run, proceed with next Service Check.

- Check for oil floating on the water and try to identify the point of leakage. Leakage often indicates an internal component is worn, damaged, or assembled incorrectly.
- Listen for muffled sounds which may indicate air in the system. If air is present, bleed the system.

Service Check 4
1. Disconnect customer battery from engine and replace with known good test battery.

2. Test PT/T operation. If symptoms disappear, check the capacity and charge of customer battery as described in Battery Care and Maintenance, Section 7. Make sure there is no significant drain on the battery caused by added accessories.

Service Check 5
1. Isolate the PT/T unit from the rest of the engine by disconnecting the two PT/T motor leads from the UP and DOWN solenoid switches in the electrical box. Remove the leads from the lower motor cover.

NOTE

The PT/T motor cable on old style PT/T units contains an additional ground lead which must be disconnected. For ease of identification and to prevent improper wire connections during testing and installation, mark all electrical leads before disconnecting.

2. Connect the UP and DOWN leads to a known good test battery using battery jumper cables. Connect the leads as follows and verify proper PT/T function in one direction. Then reverse the UP and DOWN lead connections and verify proper PT/T function in the opposite direction.

Old style PT/T:
- Connect either the UP or DOWN lead to positive (+).
- Connect ground lead to negative (-).

Models 40 and 50 and new style PT/T:
- Connect either lead to positive (+) and the other to negative (-).

3. Proceed as follows:
- If symptoms disappear, go to PT/T Electrical Troubleshooting in this section.
- If symptoms remain or test results vary, first perform the No Load Motor Test in this section to rule out possible motor problems. While motor is removed, verify the pump coupling is not damaged or disconnected. Repair or replace parts as needed and proceed with PT/T Component Troubleshooting in this section if symptoms are not corrected.

PT/T Electrical Troubleshooting

Use this section to troubleshoot problems with the PT/T electrical system.

NOTE

Complete all Preliminary Service Checks before troubleshooting the PT/T electrical system.

⚠⚠ WARNING

Disable the ignition system to prevent accidental engine startup.

Follow the Service Checks in the order indicated:

Service Check 1 - Engine Fuse

1. Remove upper motor cover.

2. Open fuse holder and remove engine fuse.

3. Check condition of fuse holder contacts.

4. Check fuse condition and type. Fuse must be rated at 20A.

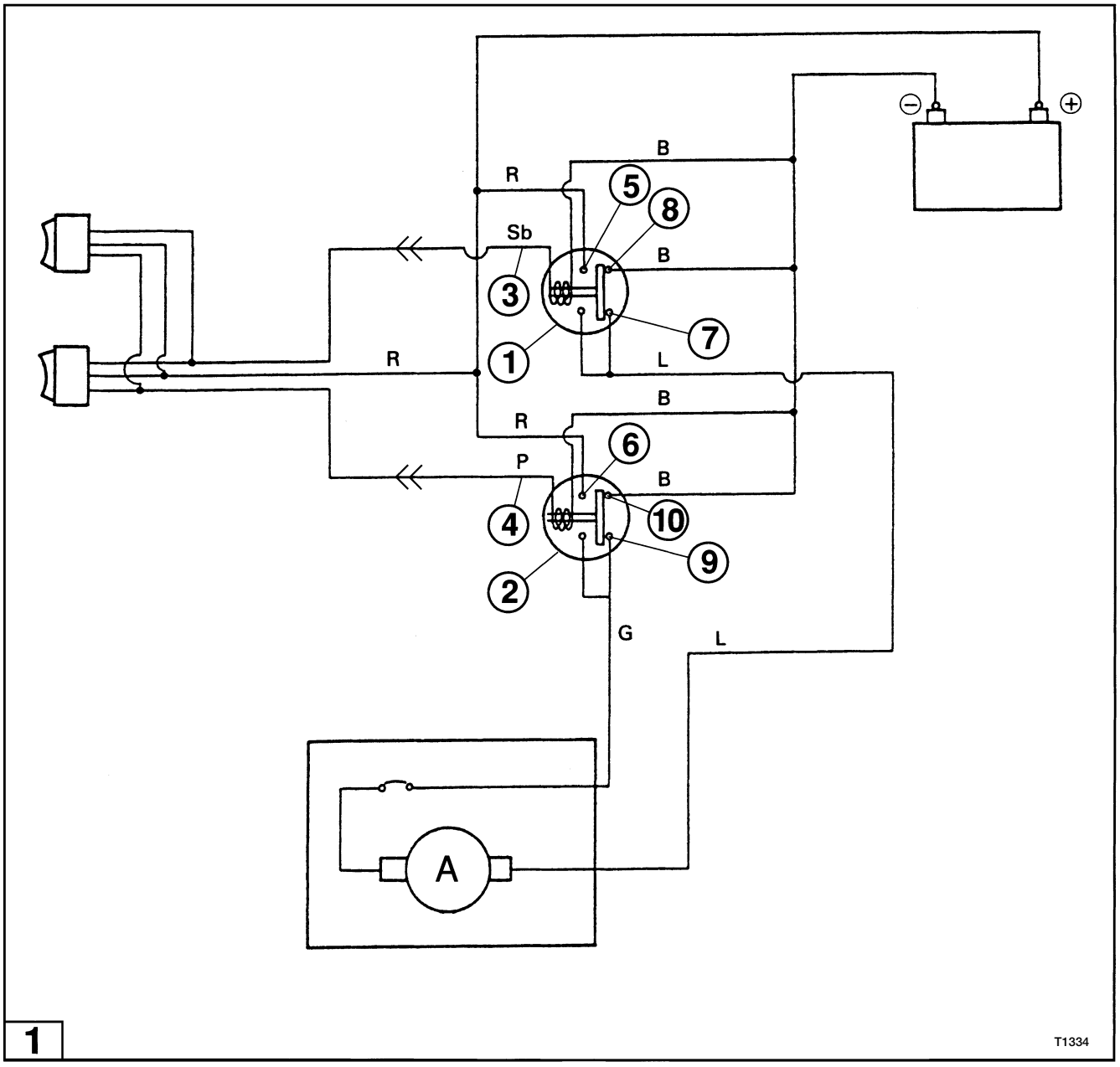
5. Proceed as follows:
- If fuse is blown, replace.
- If fuse appears not blown, test it for continuity.

Service Check 2 - Wire Connections

Verify all PT/T circuit wiring is properly terminated in accordance with the wiring diagram. Make sure all connections are secure.

NOTE

Refer to Outboard Motors Service Data publication for wiring diagrams.



1

Service Check 3 - Switches

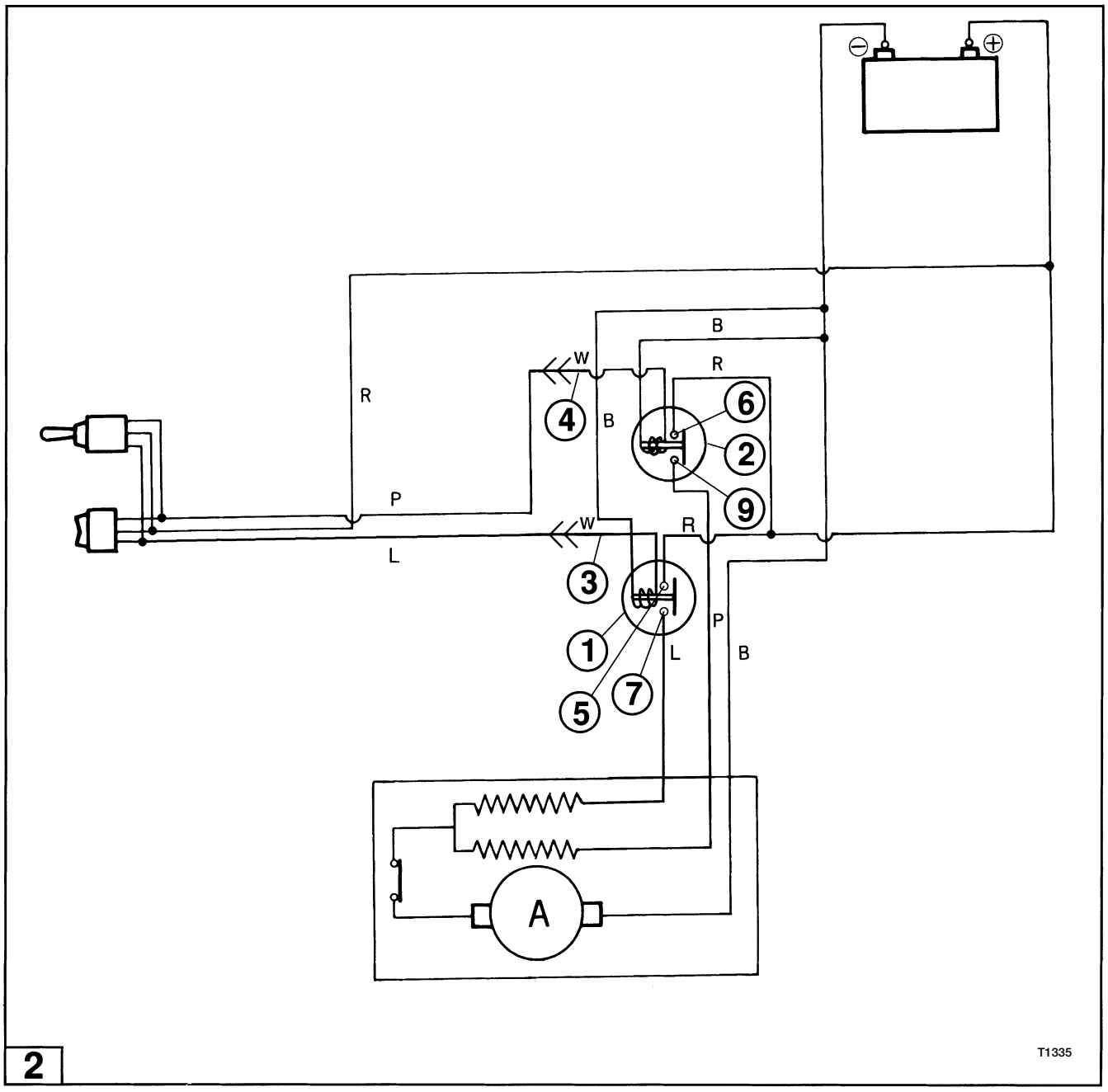
NOTE

Reference the applicable PT/T circuit diagram for the following switch tests:

1 - Figure 1 - Models 40 and 50 and new style PT/T

2 - Figure 2 - Old style PT/T

R = RED
B = BLACK
Sb = SKY BLUE
P = PINK
L = BLUE
G = GREEN



Main Switch
Operate components which run off the main switch circuit, such as starter motor, choke solenoid, and warning horn. If these components do not operate or operate improperly, the main switch may be defective. To test the main switch, see Main Key Switch Test in Section 7.

R = RED
B = BLACK
L = BLUE
P = PINK
W = WHITE

PT/T Switches

1. Operate each PT/T switch in the UP and DOWN direction and verify audible “clicking” is heard at UP solenoid switch **(1)** and DOWN solenoid switch **(2)**. If all PT/T switches function properly, proceed with Solenoid Switches. Test suspect PT/T switches as follows:

- Disconnect UP solenoid lead **(3)** and DOWN solenoid lead **(4)** at the bullet connectors closest to the solenoids.
- Place UP solenoid lead **(3)** in contact with solenoid terminal **(5)** and verify the solenoid “clicks.” Place DOWN solenoid lead **(4)** in contact with solenoid terminal **(6)** and verify the solenoid “clicks.” If the solenoids now “click,” the PT/T switch or wiring may be defective, proceed with step 2.

2. Disconnect the suspect PT/T switch leads at the bullet connectors closest to the PT/T switch and test as follows using ohmmeter:

- Verifycontinuity between the PT/T switch RED lead and PT/T switch SKY BLUE or BLUE lead when switch is in the UP position.
- Verify continuity between PT/T switch RED lead and PT/T switch PINK lead when switch is in the DOWN position.

If test results vary, replace the PT/T switch.

Solenoid Switches

1. Disconnect UP solenoid lead **(3)** and DOWN solenoid lead **(4)** at the bullet connectors closest to the solenoids.

2. Disconnect the RED leads from solenoid terminals **(5)** and **(6)**.

3. Disconnect the PT/T motor leads from the solenoid terminals.

4. Proceed as follows:

Models 40 and 50 and new style PT/T:

NOTE

Reference Figure **1** .

- Connect ohmmeter across UP solenoid terminals **(7)** and **(8)** and verify continuity is present when solenoid is OFF. Then place UP solenoid lead **(3)** in contact with the RED lead that was disconnected from terminal **(5)** and verify no continuity when solenoid is ON.
- Connect ohmmeter across UP solenoid terminals **(7)** and **(5)** and verify no continuity when solenoid is OFF. Then place UP solenoid lead **(3)** in contact with the RED lead that was disconnected from terminal **(5)** and verify continuity is present when solenoid is ON.

- Connect ohmmeter across DOWN solenoid terminals **(9)** and **(10)** and verify continuity is present when solenoid is OFF. Then place DOWN solenoid lead **(4)** in contact with the RED lead that was disconnected from terminal **(6)** and verify no continuity when solenoid is ON.
- Connect ohmmeter across DOWN solenoid terminals **(9)** and **(6)** and verify no continuity when solenoid is OFF. Then place DOWN solenoid lead **(4)** in contact with the RED lead that was disconnected from terminal **(6)** and verify continuity is present when solenoid is ON.

If test results vary, replace the defective solenoid switch.

Old Style PT/T:

NOTE

Reference Figure **2** .

- Connect ohmmeter across UP solenoid terminals **(7)** and **(5)** and verify no continuity when solenoid is OFF. Then place UP solenoid lead **(3)** in contact with the RED lead that was disconnected from terminal **(5)** and verify continuity is present when solenoid is ON.
- Connect ohmmeter across DOWN solenoid terminals **(9)** and **(6)** and verify no continuity when solenoid is OFF. Then place DOWN solenoid lead **(4)** in contact with the RED lead that was disconnected from terminal **(6)** and verify continuity is present when solenoid is ON.

If test results vary, replace the defective solenoid switch.

Service Check 4 - Wire Leakage and Shorts
Verify all PT/T circuit wiring is free from electrical leakage and shortsto-ground. Repair or replace wiring as needed.

PT/T Component Troubleshooting

Use this section to troubleshoot problems internal to the PT/T unit.

NOTE

Complete all Preliminary Service Checks before troubleshooting problems internal to the PT/T unit.

Identify the symptom below which best describes the problem at hand and follow the specified Service Checks in the order indicated:

Symptoms	Service Checks		
	40 / 50 PT/T	Old Style PT/T	New Style PT/T
Upward Trim/Tilt Problems			
Unit does not move UP.	1, 2, 3, 4, 8, 9, 11, 12, 14	1, 2, 3, 4, 8, 9, 10, 12, 14	1, 2, 3, 5, 9, 10, 12, 14
UP operation stops halfway.	3, 4, 9, 11, 12, 14	3, 4, 9, 10, 11, 12, 14	5, 9, 10, 11, 12, 14
Unit does not hold UP position when motor stops.	1, 6, 11, 14	1, 4, 6, 10, 12, 14	1, 9, 10, 12, 14
UP operation is slow.	1, 3, 4, 8, 9, 11, 12, 14	1, 3, 4, 8, 9, 10 12, 14	1, 3, 5, 9, 10, 12, 14
Downward Trim/Tilt Problems			
Unit does not move DOWN.	2, 5, 8, 9, 14	2, 5, 8, 9, 14	1, 3, 5, 9, 14
DOWN operation stops halfway.	8, 9, 14	5, 8, 9, 14	5, 9, 14
DOWN operation is slow.	1, 5, 8, 9, 14	1, 5, 8, 9, 14	1, 3, 5, 9, 14
Thrust-Related Trim/Tilt Problems			
Unit does not hold trim position during or after forward running.	1, 4, 6, 8, 11, 12, 14	1, 4, 6, 8, 10, 12, 14	1, 9, 10, 12, 14
Unit does not hold trim position during reverse running.	1, 5, 7, 8, 11, 13, 14	1, 7, 8, 11, 13, 14	1, 9, 11, 13, 14

Service Check 1 - Manual Valve

Disassemble the manual valve and check for wear or damage to applicable components:

- Valve end surface.
- O-rings and seal washers.
- Bottom surface of valve mounting hole.

Service Check 2 - Pump Coupling
1. Remove motor.

2. Inspect pump coupling for wear, damage, or separation from the geared pump.

Service Check 3 - Filters
1. Remove motor.

2. Remove and clean filter B.

3. Remove and clean manifold filter (new style PT/T).

4. Inspect filters for damage or obstruction.

Service Check 4 - Relief Valve UP
1. Remove reservoir tank (old style PT/T).

2. Remove and clean relief valve UP.

3. Inspect for the following as applicable:
- Damage to valve seat.
- Smooth operation; push ball manually and check its return.
- Wear or damage to valve ball.
- Fatigue or deformation of spring.
- Damage or deterioration of o-ring.
- Dirty filter.

Service Check 5 - Relief Valve DOWN
1. Remove pump or reservoir tank (old style PT/T).

2. Remove and clean relief valve DOWN.

3. Inspect for the following as applicable:
- Damage to valve seat.
- Smooth operation; push ball manually and check its return.
- Wear or damage to valve ball.
- Fatigue or deformation of spring.
- Damage or deterioration of o-ring.
- Dirty filter.

Service Check 6 - Lower Chamber Side Check Valve
1. Remove and clean lower chamber side check valve.

2. Inspect for thread and surface damage.

3. Inspect for damage or deterioration of o-rings.

Service Check 7 - Upper Chamber Side Check Valve
1. Remove and clean upper chamber side check valve.

2. Inspect for thread and surface damage.

3. Inspect for damage or deterioration of o-rings.

Service Check 8 - Spool
1. Remove upper chamber side valve seat.

2. Remove and clean spool components.

3. Inspect for the following:
- Smooth operation; push manually and check its return.
- Fatigue or deformation of springs.
- Damage or deterioration of back-up ring.

Service Check 9 - Oil Pump
Replace the oil pump and retest PT/T operation.

Service Check 10 - Trim Cylinder Piston
1. Remove rod guide.

2. Remove and clean trim piston components.

3. Inspect for the following:
- Damage to piston sliding surface in cylinder.
- Damage or deformation of piston rod and rod guide.
- Damage or deterioration of o-rings and back-up ring.

Service Check 11 - Tilt Cylinder Piston
1. Remove and clean tilt piston rod assembly.

2. Inspect for the following:
- Damage to piston sliding surface in cylinder.
- Damage or deformation of piston rod and rod guide.
- Damage or deterioration of o-rings and back-up ring.

Service Check 12 - Tilt Cylinder Free Piston
1. Remove tilt piston rod assembly.

2. Remove free piston.

3. Inspect for the following:
- Damage to free piston.
- Damage to free piston seating surface in cylinder.
- Damage or deterioration of o-ring and back-up ring.

Service Check 13 - Tilt Cylinder Shock Absorber Valve
1. Remove the tilt cylinder piston rod.

2. Inspect internal shock absorber valve for the following:
- Fatigue or deformation of spring.
- Damage to valve ball.
- Damage to valve seat.
- Inhibited operation caused by accumulation of dirt.

Service Check 14 - PT/T Assembly
Replace the PT/T assembly.