FOREWORD

The information, procedures and specifications provided in this repair manual are current as of the date of publication and subject to change without notice. Appropriate changes will be included in the next revision of this manual.

Note: Manufacturing standards may vary from service specifications. Always refer to the service procedures and specifications in this manual when engine service is required.

GENERAL REPAIR INSTRUCTIONS

Before attempting a B&SD engine overhaul or a tune-up, it is necessary that your shop be equipped with proper tools, equipment and mechanics who are thoroughly familiar with Briggs & Stratton engine design and construction. With your shop thus equipped, this book will serve as a guide in performing the various steps necessary to do a complete and satisfactory job. Use only genuine replacement parts. Always use recommended service tools.

This engine is designed and manufactured using metric dimensions. The English equivalents provided may have been rounded up or down to the closest numerical interpretation of the metric dimension.

The terms Inspect, Check, Test and Replace are used as follows:

- **INSPECT** – Visual inspection – look for signs of wear, scoring, cracks, stripped threads, etc.
- **CHECK** – Measure by means of plug gauges, micrometer, feeler gauges, scale, etc.
- **TEST** – Analyze with proper test equipment.
- **REPLACE** – This usually means to take off the old part and reassemble it or replace it with a new one.

Disassembly

As engine is being disassembled, mark parts which are part of an assembly, to prevent interchanging. Arrange parts in an orderly manner, keeping parts which are an assembly together.

Visually inspect each part as it is removed – look for signs of wear, scoring, cracks, stripped threads, etc.

Inspection and Measurement

Carefully check parts that can be reconditioned and/or reused.

Replace any parts that are not within specification.

Clean parts to be reused

Clean or wash disassembled parts.

Assemble

Use a torque wrench to torque bolts and nuts to required specifications.

Replace all gaskets, cotter pins, oil seals and O-rings.

ABBREVIATIONS

<table>
<thead>
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<th>Abbreviation</th>
<th>Meaning</th>
<th>Abbreviation</th>
<th>Meaning</th>
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<tr>
<td>ASSY</td>
<td>Assembly</td>
<td>OD</td>
<td>Outside Diameter</td>
</tr>
<tr>
<td>BDC</td>
<td>Bottom Dead Center</td>
<td>OPT</td>
<td>Optional</td>
</tr>
<tr>
<td>DT</td>
<td>Diesel Turbocharger</td>
<td>O/S</td>
<td>Oversize</td>
</tr>
<tr>
<td>EX</td>
<td>Exhaust</td>
<td>RH</td>
<td>Right Hand</td>
</tr>
<tr>
<td>ID</td>
<td>Inside Diameter</td>
<td>SAE</td>
<td>Society of Automotive Engineers</td>
</tr>
<tr>
<td>IN</td>
<td>Intake</td>
<td>T/C</td>
<td>Turbocharger</td>
</tr>
<tr>
<td>LH</td>
<td>Left Hand</td>
<td>TDC</td>
<td>Top Dead Center</td>
</tr>
<tr>
<td>MP</td>
<td>Multi-purpose</td>
<td>U/S</td>
<td>Undersize</td>
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ENGINE IDENTIFICATION NUMBERS
The engine model and type number are located on the vale cover, Fig. 1. The serial number is stamped into the right side of the cylinder block, behind the intake manifold, Fig. 2.
IN THE INTEREST OF SAFETY

This safety alert symbol indicates that this message involves personal safety. Signal words danger, warning and caution indicate hazard degree. Death, personal injury and/OR property damage may occur unless instructions are followed carefully.

WARNING: DO NOT

1. DO NOT run engine in an enclosed area. Exhaust gases contain carbon monoxide, an odorless and deadly poison.
2. DO NOT place hands or feet near moving or rotating parts. Keep all guards in place.
3. DO NOT place hands or feet near electric cooling fan (if equipped). Fan may start suddenly, depending on coolant temperature.
4. DO NOT store, spill, or use diesel fuel near an open flame, or devices such as a stove, furnace, or water heater which use a pilot light or devices which can create a spark.
5. DO NOT refuel indoors where area is not well ventilated. Outdoor refueling is preferred.
6. DO NOT fill fuel tank while engine is running. Allow engine to cool for 2 minutes before refueling. Store fuel in approved, correct color safety containers.
7. DO NOT remove fuel tank cap while engine is running.
8. DO NOT operate engine when smell of fuel is present or other explosive conditions exist.
9. DO NOT operate engine if diesel fuel is spilled. Move machine away from the spill and avoid creating any ignition until the spill has been wiped up.
10. DO NOT smoke when filling fuel tank.
11. DO NOT tamper with maximum speed set screw or full load set screw of the injector pump which may increase the governed engine speed.
12. DO NOT tamper with the engine speed selected by the original equipment manufacturer.
13. DO NOT operate engine with a damaged muffler or without muffler. Inspect periodically and replace, if necessary. If engine is equipped with muffler deflector(s), inspect periodically and replace, if necessary, with correct deflector(s).
14. DO NOT operate engine with an accumulation of grass, leaves, dirt or other combustible material in the muffler area.
15. DO NOT use this engine on any forest covered, brush covered, or grass covered unimproved land unless a spark arrester is installed on the muffler. The arrester must be maintained in effective working order by the operator. In the State of California the above is required by law (Section 4442 of the California Public Resources Code). Other states may have similar laws. Federal laws apply on federal lands.
16. DO NOT touch hot muffler(s) or cylinder(s) because contact may cause burns.
17. DO NOT remove the radiator cap while the engine is hot. To avoid scalding from hot coolant or steam blowing out of the radiator, use extreme care when removing the radiator cap. If possible, wait for engine to cool. If not possible, wrap a thick rag around cap while removing. To release pressure, slowly turn cap counter clockwise to the first stop. When all pressure has been released, press down on cap and continue turning.
18. DO NOT start or run engine with air cleaner or air cleaner cover removed.

WARNING: DO

1. ALWAYS DO disconnect the negative wire from the battery terminal when servicing the engine or equipment, TO PREVENT ACCIDENTAL STARTING.
2. ALWAYS DO disconnect fuel shut off solenoid wire from injection pump before checking compression, TO PREVENT ACCIDENTAL STARTING.
3. DO wear eye protection when operating or repairing equipment.
4. DO keep governor parts free of grass and other debris which can affect engine speed.
5. DO examine muffler(s) periodically to be sure it is functioning effectively. A worn or leaking muffler(s) should be repaired or replaced as necessary.
6. DO check fuel lines and fittings frequently for cracks or leaks. Replace if necessary.

CAUTION:

DO use clean fresh diesel fuel with a minimum of 40 cetane.

DO NOT use kerosene. The injection pump requires diesel fuel for lubrication. Damage to the injection pump and/or engine may result if kerosene is used.

NOTE: Use Original Briggs & Stratton-Daihatsu Service Replacement Parts when servicing your engine. Authorized Briggs & Stratton-Daihatsu Service Centers carry a stock of such parts. The use of Briggs & Stratton-Daihatsu parts preserves the original design of your engine. Imitation replacement parts may not fit or function as original Briggs & Stratton-Daihatsu parts and can expose the operator to potential personal injury. Contact any Authorized Briggs & Stratton-Daihatsu Service Center for Original Briggs & Stratton-Daihatsu Replacement Parts.
**GENERAL INFORMATION**

**ENGINE VIEWS**

**Diesel**

1. Thermostat
2. Oil filler cap
3. Electric starter
4. Oil pan
5. Alternator

6. Injector nozzle
7. Glow plug
8. Oil drains
9. Oil filter
10. Dipstick
11. Injector pump
12. Engine Date code
   xxxxxxxx
13. Engine Model & Type number
   xxxxxx  xxxx-xx

**Turbo-charged Diesel**

1. Thermostat
2. Oil filler cap
3. Turbocharger
4. Electric starter
5. Alternator
6. Oil pan

7. Injector nozzle
8. Glow plug
9. Oil drains
10. Oil cooler (if equipped)
11. Oil filter
12. Dipstick
13. Injector pump
14. Engine Date code
   xxxxxxxx
15. Engine Model & Type number
   xxxxxx  xxxx-xx
**GENERAL INFORMATION**

### ENGINE SPECIFICATIONS

<table>
<thead>
<tr>
<th>Model</th>
<th>432447</th>
<th>522447</th>
<th>582447 @58A447 @588447</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
<td>Diesel, 4-cycle, 3 cylinder, in-line, liquid cooled</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Valve mechanism</strong></td>
<td>OHV, gear driven</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Bore x stroke mm (in)</strong></td>
<td>68 x 64 (2.680 x 2.520)</td>
<td>68 x 78 (2.680 x 3.070)</td>
<td>72 x 78 (2.834 x 3.070)</td>
</tr>
<tr>
<td><strong>Piston displacement cc (cu in)</strong></td>
<td>697 (42.5)</td>
<td>850 (52.0)</td>
<td>952 (58.1)</td>
</tr>
<tr>
<td><strong>Firing order</strong></td>
<td>1-2-3 (front, center, back)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Compression ratio</strong></td>
<td>25.0:1</td>
<td>24.4:1</td>
<td>24.0:1 @ 24.8:1</td>
</tr>
<tr>
<td><strong>Compression pressure (normal) @ 300 RPM</strong></td>
<td>Bar (psi)</td>
<td>33.0 (469)</td>
<td>32.0 (455)</td>
</tr>
<tr>
<td><strong>Compression pressure (minimum) @ 300 RPM</strong></td>
<td>Bar (psi)</td>
<td>30.0 (425)</td>
<td>29.0 (412)</td>
</tr>
<tr>
<td><strong>Gross HP @ 3600 RPM</strong></td>
<td>19.5</td>
<td>23.6</td>
<td>26.5 @ 28.0</td>
</tr>
<tr>
<td><strong>Gross Torque @ 2400 RPM</strong></td>
<td>32.5</td>
<td>40.0</td>
<td>44.1 @ 49.2</td>
</tr>
<tr>
<td><strong>Dimensions (L x W x H) mm (in)</strong></td>
<td>441.8 x 440.4 x 523.9 (17.4 x 17.34 x 20.6)</td>
<td>434.4 x 442.9 x 548.4 (17.1 x 17.44 x 21.59)</td>
<td>434.4 x 442.9 x 548.4 (17.1 x 17.44 x 21.59)</td>
</tr>
<tr>
<td><strong>Dry weight kg (lbs)</strong></td>
<td>76 (168)</td>
<td>78 (172)</td>
<td>89 (196)</td>
</tr>
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</table>
### GENERAL INFORMATION

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<th>Cylinder Head</th>
<th>Type</th>
<th>Single piece casting</th>
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<td></td>
<td>Material</td>
<td>Cast Iron</td>
</tr>
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<th>Combustion Chamber</th>
<th>Swirl Type</th>
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<td>Valve seat angle</td>
<td>Intake</td>
<td>45°</td>
</tr>
<tr>
<td></td>
<td>Exhaust</td>
<td>45°</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Valve timing</th>
<th>Intake</th>
<th>Opens 10° BTDC</th>
<th>235°</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Closes</td>
<td>45° ABDC</td>
<td></td>
</tr>
</tbody>
</table>

| Exhaust | Opens 45° BBDC | 235° |
|         | Closes        | 10° ATDC |

<table>
<thead>
<tr>
<th>Valve clearance (cold)</th>
<th>Intake mm (in)</th>
<th>0.20 (.008 in)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Exhaust mm (in)</td>
<td>0.20 (.008 in)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cylinder Block &amp; Camshaft</th>
<th>Cylinder block</th>
<th>Mono-block, three cylinder, cast iron</th>
</tr>
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<tbody>
<tr>
<td>Camshaft</td>
<td>Carbon steel</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Connecting Rod &amp; Piston</th>
<th>Connecting rod</th>
<th>Carbon steel</th>
</tr>
</thead>
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<tr>
<td>Piston Pin Bearing</td>
<td>Machined – Piston pin, slip fit</td>
<td></td>
</tr>
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</table>

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<thead>
<tr>
<th>Crankpin Bearing</th>
<th>Material aluminum alloy – replaceable insert</th>
</tr>
</thead>
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<tr>
<td>Piston</td>
<td>Heat resistant aluminum alloy</td>
</tr>
<tr>
<td>Piston ring</td>
<td>Compression ring Two, chrome plated</td>
</tr>
<tr>
<td>Oil ring</td>
<td>One, combination type, chrome plated</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Crankshaft &amp; Crankshaft Bearing</th>
<th>Crankshaft</th>
<th>One piece cast iron</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crankshaft main bearing</td>
<td>Material</td>
<td>Replaceable insert – aluminum alloy</td>
</tr>
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</table>
## GENERAL INFORMATION

### LUBRICATING SYSTEM

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<th>Lubricating Method</th>
<th>Pressure lube</th>
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<tr>
<td>Oil Pump Type</td>
<td>Trochoid</td>
</tr>
<tr>
<td>Oil Pump Drive</td>
<td>Gear drive</td>
</tr>
<tr>
<td>Oil Filter Type</td>
<td>Full flow, paper</td>
</tr>
<tr>
<td>Oil Capacity</td>
<td>3.3 ltr (3.5 qt)</td>
</tr>
<tr>
<td>Oil Pump Relief Valve Opening Pressure</td>
<td>4.6 Bar (65 psi)</td>
</tr>
<tr>
<td>Lubrication Oil</td>
<td>API SE/CD class or higher</td>
</tr>
</tbody>
</table>

### COOLING SYSTEM

<table>
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<tr>
<th>Cooling Method</th>
<th>Liquid cooled, forced circulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coolant Capacity (engine only)</td>
<td>Approximately 1.8 ltr (1.9 qt)</td>
</tr>
<tr>
<td>Cooling System Pressure</td>
<td>1.0-0.75 Bar (15-11 psi)</td>
</tr>
<tr>
<td>Pressure Cap Capacity</td>
<td>0.9 Bar (13 psi)</td>
</tr>
<tr>
<td>Water Pump Type</td>
<td>Centrifugal</td>
</tr>
<tr>
<td>Water Pump Drive</td>
<td>V-belt</td>
</tr>
<tr>
<td>Thermostat Type</td>
<td>Wax pellet with bypass</td>
</tr>
<tr>
<td>Thermostat Specification</td>
<td>82° C (180° F)</td>
</tr>
<tr>
<td>Cooling Fan Drive</td>
<td>V-belt</td>
</tr>
</tbody>
</table>

### FUEL SYSTEM

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<th>Fuel Requirements</th>
<th>Diesel fuel (Cetane number 40 or higher)</th>
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<tr>
<td>Injector Pump</td>
<td>Bosch VE (distributor type)</td>
</tr>
<tr>
<td>Injector Timing (Plunger stroke) #1 Cyl. TDC</td>
<td>See Tables 1 &amp; 2, Page 6</td>
</tr>
<tr>
<td>Injector Nozzle</td>
<td>Throttle type</td>
</tr>
<tr>
<td>Nozzle Type</td>
<td>Throttle type</td>
</tr>
<tr>
<td>Injector pressure Bar (psi)</td>
<td>140 (1,991)</td>
</tr>
<tr>
<td>Idle Speed RPM</td>
<td>See Table 3, Page 7</td>
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### ELECTRICAL SYSTEM

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<th>Battery</th>
<th>12V (negative ground)</th>
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<tr>
<td>Capacity</td>
<td>24 AH (28 AH cold)</td>
</tr>
<tr>
<td>Alternator</td>
<td>28 Volt AC output – Minimum</td>
</tr>
<tr>
<td>Regulator/rectifier</td>
<td>14 Amp DC output with charge indicator circuit</td>
</tr>
<tr>
<td>Alternator (Optional)</td>
<td>40 Amp DC output – Internally regulated</td>
</tr>
<tr>
<td>Glow Plug Voltage/Current V/A</td>
<td>11 Volts / 9.5 Amps</td>
</tr>
<tr>
<td>Starter Voltage/Kilowatt V/K</td>
<td>Reduction gear type – 12 Volts / 1.0 kw (12 Volts / 1.2 kw, optional)</td>
</tr>
</tbody>
</table>
### TABLE 1
Injection Pump Timing
Engine Date Code Before 99010100

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<thead>
<tr>
<th>Model/Type No.</th>
<th>Timing Specification</th>
</tr>
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<tbody>
<tr>
<td>432447-0150-E2</td>
<td>0.93 ± .03 mm (.0365” ± .001”)</td>
</tr>
<tr>
<td>522447-0105-E2</td>
<td>0.93 ± .03 mm (.0365” ± .001”)</td>
</tr>
<tr>
<td>522447-0106-E2</td>
<td>0.93 ± .03 mm (.0365” ± .001”)</td>
</tr>
<tr>
<td>522447-0107-E2</td>
<td>0.93 ± .03 mm (.0365” ± .001”)</td>
</tr>
<tr>
<td>522447-0108-E2</td>
<td>0.93 ± .03 mm (.0365” ± .001”)</td>
</tr>
<tr>
<td>522447-0109-E2</td>
<td>0.93 ± .03 mm (.0365” ± .001”)</td>
</tr>
<tr>
<td>582447-0105-E2</td>
<td>0.93 ± .03 mm (.0365” ± .001”)</td>
</tr>
<tr>
<td>582447-0125-E2</td>
<td>0.81 ± .03 mm (.032” ± .001”)</td>
</tr>
<tr>
<td>582447-0130-E2</td>
<td>0.93 ± .03 mm (.0365” ± .001”)</td>
</tr>
<tr>
<td>582447-0131-E2</td>
<td>0.81 ± .03 mm (.032” ± .001”)</td>
</tr>
</tbody>
</table>

### TABLE 2
Injection Pump Timing
Engine Date Code After 98123100

<table>
<thead>
<tr>
<th>Model Series</th>
<th>Timing Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>432447 – All</td>
<td>0.90 ± .03 mm (.035” ± .001”)</td>
</tr>
<tr>
<td>522447 – All</td>
<td>0.90 ± .03 mm (.035” ± .001”)</td>
</tr>
<tr>
<td>582447 – All</td>
<td>0.81 ± .03 mm (.032” ± .001”)</td>
</tr>
<tr>
<td>58A447 – All</td>
<td>0.90 ± .03 mm (.035” ± .001”)</td>
</tr>
<tr>
<td>588447</td>
<td></td>
</tr>
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</table>
**TABLE 3**  Engine Speed Specification Chart

<table>
<thead>
<tr>
<th>Pump Mfg. Part No.</th>
<th>ID Code</th>
<th>Model &amp; Type No.</th>
<th>Idle Speed (rpm)</th>
<th>Top No Load (rpm)</th>
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<tbody>
<tr>
<td>22100-87801</td>
<td>7U1</td>
<td>432447-0105-E2</td>
<td>1200±50</td>
<td>3850±50</td>
</tr>
<tr>
<td>22100-8713</td>
<td>7U2</td>
<td>432447-0205-E2</td>
<td>1200±50</td>
<td>3850±50</td>
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<tr>
<td>22100-87802</td>
<td>9U1</td>
<td>582447-0105-E2</td>
<td>1200±50</td>
<td>3850±50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>582447-0130-E2</td>
<td>1200±50</td>
<td>3300±50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>582447-0130-E2</td>
<td>1600±50</td>
<td>3600±50</td>
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<tr>
<td></td>
<td></td>
<td>582447-0130-E2</td>
<td>1800±50</td>
<td>3420±50</td>
</tr>
<tr>
<td>22100-87806</td>
<td>9U2</td>
<td>582447-0125-E2</td>
<td>1850±50</td>
<td>3420±50</td>
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<tr>
<td>22100-87807</td>
<td>8U1</td>
<td>522447-0105-E2</td>
<td>1200±50</td>
<td>3850±50</td>
</tr>
<tr>
<td>22100-87809</td>
<td>8U2</td>
<td>522447-0106-E2</td>
<td>1850±50</td>
<td>3420±50</td>
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<tr>
<td>22100-87810</td>
<td>8U3</td>
<td>522447-0107-E2</td>
<td>1525±50</td>
<td>2775±50</td>
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<tr>
<td>22100-87815</td>
<td>8U4</td>
<td>522447-0107-E2</td>
<td>1540±50</td>
<td>2790±50</td>
</tr>
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<td>22100-87817</td>
<td>8U5</td>
<td>522447-0107-E2</td>
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<td>2790±50</td>
</tr>
<tr>
<td>22100-87811</td>
<td>9U4</td>
<td>58A447–0205–E2</td>
<td>1200±50</td>
<td>3850±50</td>
</tr>
<tr>
<td>22100-87818</td>
<td>9U5</td>
<td>588447–0205–E2</td>
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<td>3850±50</td>
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<td></td>
<td>588447–0216–E2</td>
<td>1800±50</td>
<td>3600±50</td>
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<td>588447–0230–E2</td>
<td>1600±50</td>
<td>3600±50</td>
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<td></td>
<td></td>
<td>588447–0225–E2</td>
<td>1050±50</td>
<td>3850±50</td>
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<tr>
<td>Description</td>
<td>Wrench/Socket Size</td>
<td>Torque</td>
<td></td>
<td></td>
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<td>---------------------------------</td>
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<td></td>
</tr>
<tr>
<td>Alternator Adjust. Bracket</td>
<td>12 mm</td>
<td>19.0 Nm (170 in. lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternator – 14 Amp (to bracket)</td>
<td>12 mm</td>
<td>19.0 Nm (170 in. lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternator – 40 Amp (to bracket)</td>
<td>12 mm</td>
<td>61.0 Nm (45 ft. lbs.)</td>
<td></td>
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</tr>
<tr>
<td>Alternator Bracket (to block)</td>
<td>12 mm</td>
<td>19.0 Nm (170 in. lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Camshaft Gear</td>
<td>17 mm</td>
<td>41.0 Nm (30 ft. lbs.)</td>
<td></td>
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<tr>
<td>Camshaft Retainer</td>
<td>10 mm</td>
<td>8.0 Nm (70 in. lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conn. Rod Nuts</td>
<td>12 mm</td>
<td>36.0 Nm (320 in. lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crankshaft Pulley</td>
<td>19 mm</td>
<td>88.0 Nm (65 ft. lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cyl. Head Bolts (8 mm dia.)</td>
<td>12 mm</td>
<td>34.0 Nm (25 ft. lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cyl. Head Bolts (9 mm dia.)</td>
<td>13 mm</td>
<td>43.0 Nm (32 ft. lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cyl. Head Bolts (10 mm dia.)</td>
<td>14 mm</td>
<td>68.0 Nm (50 ft. lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exhaust Manifold</td>
<td>12 mm</td>
<td>19.0 Nm (170 in. lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fan Pulley</td>
<td>10 mm</td>
<td>7.0 Nm (60 in. lbs.)</td>
<td></td>
<td></td>
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<tr>
<td>Flywheel</td>
<td>14 mm</td>
<td>47.0 Nm (35 ft. lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel Delivery Lines</td>
<td>17 mm</td>
<td>25.0 Nm (220 in. lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel Return Line</td>
<td>17 mm</td>
<td>27.0 Nm (20 ft. lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glow Plug</td>
<td>12 mm Deep</td>
<td>17.0 Nm (150 in. lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Idler Gear</td>
<td>12 mm</td>
<td>25.0 Nm (220 in. lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Injector Pump (mounting)</td>
<td>12 mm</td>
<td>19.0 Nm (170 in. lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Injector Pump Drive Gear</td>
<td>19 mm</td>
<td>61.0 Nm (45 ft. lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Injector Pump Bracket</td>
<td>12 mm</td>
<td>19.0 Nm (170 in. lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Injector Nozzle</td>
<td>21 mm Deep</td>
<td>61.0 Nm (45 ft. lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Injector Pump Distributor Bolt</td>
<td>14 mm</td>
<td>17.0 Nm (150 in. lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intake Manifold</td>
<td>10 mm</td>
<td>8.0 Nm (70 in. lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main Bearing Screws</td>
<td>14 mm</td>
<td>58.0 Nm (43 ft. lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil Drain Plug</td>
<td>14 mm</td>
<td>25.0 Nm (220 in. lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil Pan</td>
<td>10 mm</td>
<td>8.0 Nm (70 in. lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil Pressure Relief Valve</td>
<td>19 mm</td>
<td>34.0 Nm (25 ft. lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil Pump Gear</td>
<td>12 mm</td>
<td>19.0 Nm (170 in. lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil Pump Pickup</td>
<td>10 mm</td>
<td>8.0 Nm (70 in. lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rear Seal Support</td>
<td>10 mm</td>
<td>6.0 Nm (50 in. lbs.)</td>
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<tr>
<td>Rocker Arm Assy.</td>
<td>12 mm Deep</td>
<td>19.0 Nm (170 in. lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rocker Arm Adjustment</td>
<td>10 mm</td>
<td>11.0 Nm (95 in. lbs.)</td>
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<td></td>
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<tr>
<td>Starter</td>
<td>14 mm</td>
<td>40.0 Nm (30 ft. lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Starter Bracket</td>
<td>14 mm</td>
<td>34.0 Nm (25 ft. lbs.)</td>
<td></td>
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</tr>
<tr>
<td>Starter Solenoid</td>
<td>Phillips</td>
<td>9.0 Nm (80 in. lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Starter Motor Thru Bolts</td>
<td>10 mm</td>
<td>9.0 Nm (80 in. lbs.)</td>
<td></td>
<td></td>
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<tr>
<td>Timing Gear Case</td>
<td>10 mm</td>
<td>8.0 Nm (70 in. lbs.)</td>
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<tr>
<td>Timing Gear Cover (3 different lengths)</td>
<td>10 mm</td>
<td>8.0 Nm (70 in. lbs.)</td>
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<tr>
<td>Valve Cover</td>
<td>10 mm</td>
<td>6.0 Nm (50 in. lbs.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Pump</td>
<td>12 mm</td>
<td>19.0 Nm (170 in. lbs.)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
GENERAL INFORMATION

BRIGGS & STRATTON DAIHATSU NUMERICAL NUMBER SYSTEM

All Briggs & Stratton Daihatsu engines have a unique numerical designation system. Each engine is identified by a Model, Type and Code/Serial number. Example: Model Type Code/Serial
432447 0125 01 020521145

This chart explains the numerical model designation system. It is possible to determine most of the important mechanical features of the engine by merely knowing the model number. Here is how it works.

<table>
<thead>
<tr>
<th>FIRST DIGIT AFTER DISPLACEMENT</th>
<th>SECOND DIGIT AFTER DISPLACEMENT</th>
<th>THIRD DIGIT AFTER DISPLACEMENT</th>
<th>FOURTH DIGIT AFTER DISPLACEMENT</th>
<th>TYPE OF STARTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>CUBIC INCH DESIGN SERIES</td>
<td>CRANKSHAFT, CARBURATOR, GOVERNOR</td>
<td>PTO BEARING, REDUCTION GEAR, AUXILIARY DRIVE, LUBRICATION</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>0 - Horizontal Shaft</td>
<td>0 - Plain Bearing/Non-Flange Mount</td>
<td>0 - Without Starter</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>1 - Natural Gas-Mechanical</td>
<td>1 - Plain Bearing</td>
<td>1 - Rope Starter</td>
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<tr>
<td>9</td>
<td>2 - Diesel-Mechanical</td>
<td>2 - Sleeve Bearing</td>
<td>2 - Rewind Starter</td>
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</tr>
<tr>
<td>10</td>
<td>3 - Gas-Electronic</td>
<td>3 - Ball Bearing</td>
<td>3 - Electric Starter Only</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>4 - Natural Gas-Electronic</td>
<td>4 - Flange Mounting</td>
<td>4 - Electric Starter/Generator</td>
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<tr>
<td>12</td>
<td>5 - Diesel-Electronic</td>
<td>5 - Pressure Lubrication on Horizontal Shaft</td>
<td>5 - Electric Starter Only</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>6</td>
<td>6 - Plain Bearing Gear Reduction</td>
<td>5 - Electric Starter Only</td>
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</tr>
<tr>
<td>16</td>
<td>7</td>
<td>7 - CCW Rotation</td>
<td>6 - Electric Starter Only</td>
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<tr>
<td>17</td>
<td>A - Diesel Turbo</td>
<td>8 - Vertical Pull Starter</td>
<td>7 - Electric Starter Only</td>
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<tr>
<td>18</td>
<td>B to Z</td>
<td>Side Pull Starter</td>
<td>8 - Vertical Pull Starter or Side Pull Starter</td>
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<td>19</td>
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</tbody>
</table>

The type number identifies certain unique features such as the crankshaft or governor spring used on an engine.

The code/serial number identifies the assembly date of the engine and serial number. In some instances it is necessary to know the code/serial number as well as the model and type number when performing adjustments, repairs or ordering replacement parts for an engine. Here is how it works.

Example: 990521150

A. The first two digits, 02, indicate the calendar year, 2002.

B. The second two digits, 05, indicate the calendar month, May.

C. The third two digits, 21, indicate the calendar month day.

D. The last three digits, 145, indicate the serial number.
## MAINTENANCE SCHEDULE

More frequent service is required when operating in adverse conditions (note 4 below).

<table>
<thead>
<tr>
<th>System</th>
<th>Maintenance Operation</th>
<th>Daily</th>
<th>Every 50 hours</th>
<th>Every 100 hours</th>
<th>Every 200 hours</th>
<th>Every 600 hours</th>
<th>Every 800 hours</th>
<th>Yearly</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lubrication system</strong></td>
<td>Check oil level</td>
<td>•</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Check for oil leaks</td>
<td>•</td>
<td></td>
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1. Perform first maintenance operation after 50 hours.
2. Then perform maintenance operation at this interval.
3. Replace after every 600 hours of operation.
4. Service more often when operating under heavy load or in high temperatures.
5. Perform maintenance annually if operated less than 100 hours.
6. Follow manufacturer’s maintenance schedule if non-B&SD approved part is used.
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Section 2
Cylinder Head and Valves

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Overhead Valve Train
CYLINDER HEAD AND VALVES

REMOVE CYLINDER HEAD

ALWAYS disconnect fuel shut off solenoid wire from injection pump before checking compression, to prevent accidental starting.

Drain cooling system and disconnect radiator hoses.

1. Remove the following parts from engine, Fig. 1-Fig. 5:
   a. Alternator adjusting bracket screw
   b. V-belt
   c. Fan (if equipped)

Fig. 1 – Remove V-belt And Fan

Fig. 2:
   d. Water pump
   e. Exhaust manifold

NOTE: Remove exhaust system before removing exhaust manifold.

Fig. 2 – Remove Water Pump And Exhaust Manifold

Fig. 3:
   f. Valve cover
Discard rubber seal.

Fig. 3 – Remove Valve Cover

NOTE: Clean areas around fuel lines and injectors to prevent dirt entry.

Fig. 4:
   g. Fuel delivery lines
   h. Fuel return line
   i. Glow plug wiring
   j. Breather tube and intake manifold

Fig. 4 – Remove Fuel Lines
2. Set No. 1 piston at TDC, Fig. 6:
   a. Rotate crankshaft pulley until timing mark on pulley is aligned with reference point on timing cover.
   b. If intake and exhaust valves have clearance, No. 1 piston is at TDC – compression stroke.
   c. If intake and exhaust valves do not have clearance, turn crankshaft pulley one complete revolution. Valves will then have clearance.

3. Remove rocker arm assembly and push rods, Fig. 7.
   a. Remove valve stem caps.
   NOTE: Mark push rods so that they may be reassembled in their original position.

4. Remove cylinder head assembly, Fig. 8.
   a. Loosen cylinder head bolts in the order shown.
   NOTE: Current style head bolts are 9 mm diameter. Early style head bolts are 8 mm diameter. Torque specifications are different.
Remove valves, Fig. 10.
1. Use valve spring compressor, Tool #19417, to compress valve springs. Remove the following parts, Fig. 9:
   a. Valve spring retainer locks – 4
   b. Valve spring retainer – 5
   c. Valve spring – 6
   d. IN and EX valve – 7
   e. Valve spring seats – 8

2. Remove and discard valve stem seals, Fig. 11.
INSPECT AND REPAIR

1. Check cylinder head mounting surfaces, Fig. 12 and Fig. 13.

Be sure all gasket material is removed from surfaces before checking. Use a gasket scraper if necessary.

   a. Inspect cylinder head for cracks or damage.
   b. Use a straight edge and check cylinder head lower surface for distortion.

Fig. 13:

c. Check intake and exhaust manifold mounting surfaces.

If mounting surfaces are distorted more than 0.1 mm (0.004 in.), the cylinder head must be replaced.

It is not recommended that cylinder head mounting surfaces be resurfaced.

NOTE: Intake manifold and exhaust manifold may be checked in the same manner. Use same specifications as cylinder head.

CHECK COMBUSTION CHAMBER

Engine Model 522000: combustion chambers are not replaceable.

Engine Models 432000 and 582000 with date code after 990111007: combustion chambers are not replaceable.

NOTE: Only Engine Models 432000 and 582000 with date code before 981225006 have replaceable combustion chambers.

1. Check combustion chamber, Fig. 14.

   a. Use a straight edge and feeler gauge.

If combustion chamber protrudes more than 0.05 mm (.002 in.) above surface of cylinder head, it must be replaced.

2. Remove combustion chamber, Fig. 15.

Insert a 10 mm brass rod through injector nozzle hole and drive out combustion chamber.

NOTE: Do not damage threads in injector hole.
CYLINDER HEAD AND VALVES

3. Install combustion chamber, Fig. 16.
Align locating projection on combustion chamber with groove in cylinder head. Use a soft hammer and drive in new combustion chamber until it bottoms.

CHECK AND REPAIR VALVE GUIDES
1. Check valve guide bushings for wear using reject gauge, Tool #19382, Fig. 17.
Remove if damaged or if reject gauge enters valve guide.

2. Remove valve guide bushing if required, Fig. 18.
   a. Use bushing driver, Tool #19367, and press out valve guide bushing from combustion chamber side.
   b. Check valve guide bushing OD. Then see specifications below.
   Std. Bushing OD: – 11.05 mm (.435 in.)
   Replacement Bushing OD: – 11.08 mm (.4362 in.)
   c. If bushing OD measurement indicates that a replacement bushing has already been installed, the cylinder head must be replaced.
3. Using bushing driver, Tool #19416, press in new valve guide bushing until tool bottoms on cylinder head, Fig. 19.

VALVES AND SEATS

1. Valve faces may be resurfaced to 45°. See Fig. 20 for dimensions for valves. Lap valves and seats with valve lapping Tool, #19258 and valve lapping compound, Tool #94150.

2. Valve seats may be reconditioned using valve seat cutter, Tool #19446.

   **NOTE:** Check valve guide bushings first. If valve guides are worn, they must be replaced before refacing valve seats.

   If valve seat is wider than dimension shown in Fig. 21, a narrowing cutter should be used to ensure that contact area of valve seat is centered on face of valve, Fig. 20.

   a. Use a 60° cutter to narrow seat from bottom and a 30° cutter to narrow seat from top, Fig. 21.

   **NOTE:** If valve seat is loose or cracked, replace cylinder head.

3. Measure valve stem diameter at specified distance from end of valve, as shown in Fig. 22.

   **Replace IN** if less than 5.927 mm (0.2333 in.).

   **Replace EX** if less than 5.923 mm (0.2332 in.).
CYLINDER HEAD AND VALVES

4. Inspect valve stem cap for wear, Fig. 23. Replace if cap is worn recessed.

5. Check valve springs for squareness and free length, Fig. 24. Replace if out of square more than 1.0 mm (.040 in.). Replace if free length is less than 30.7 mm (1.209 in.).

DISASSEMBLE ROCKER ARM SHAFT
1. Remove snap rings from ends of rocker arm shaft. Remove set screw from center rocker arm support. Disassemble rocker arm assembly. Note position of all components, Fig. 25.
2. Check rocker arms and shaft, Fig. 26.
   a. Check rocker arm-bearing surface. **Replace** if greater than 10.03 mm (0.395 in.).
   b. Check rocker arm shaft **Replace** if less than 9.96 mm (0.392 in.).
   c. Check rocker arm studs for stripped threads and replace if required.

ASSEMBLE ROCKER ARM SHAFT
1. Oil all components before assembling. Small grooves in rocker shaft next to oil holes must face down. Assemble rocker arm components, noting order of assembly as shown in Fig. 27. Note position of three thrust washers. Install set screw in center rocker arm shaft support.
1. Install new valve stem seals, Fig. 29. Oil inner surface and lip of seal before installing. Press seal on to valve guide bushing until it bottoms.

**NOTE:** When replacing rocker arm studs, torque to 20.0 Nm (180 in. lbs.).
2. Install valve spring seats, Fig. 30.
   **NOTE:** Lightly coat valve stems with Valve Guide Lubricant #93963 before installing valves.
3. Install valves.

4. Install valve springs with valve spring compressor, Tool #19417, Fig. 31.
   **NOTE:** After installing valve spring retainer locks, tap valve spring retainer lightly with a soft hammer to ensure locks are seated.

**INSTALL CYLINDER HEAD**

1. Place cylinder head gasket over alignment dowels on cylinder block, Fig. 32.
   **NOTE:** Make sure coolant, oil passages and head bolt holes are aligned.

2. Install cylinder head assembly, Fig. 33. Lubricate threads of cylinder head bolts with engine oil. Torque head bolts in 14.0 Nm (10 ft. lbs.) increments in sequence shown.
   **NOTE:** Current style head bolts are 9 mm diameter. Early style head bolts are 8 mm diameter.
   a. Torque 9 mm head bolts to 43.0 Nm (32 ft. lbs.).
   b. Torque 8 mm head bolts to 34.0 Nm (25 ft. lbs.).
   **NOTE:** Engine Models 58A447 588447 have 10 mm diameter head bolts. Torque head bolts to 68 Nm (60 ft. lbs.).
CYLINDER HEAD AND VALVES

3. Lubricate push rods with engine oil then install with recessed end up, Fig. 34.

4. Install valve stem caps on valve stems. Install rocker arm assembly, Fig. 35. Install washers and torque nuts to 19.0 Nm (170 in. lbs.).

**NOTE:** Make sure rocker adjustment studs are seated in recessed end of push rods.

5. Install intake manifold with new gasket, Fig. 36.
   a. Torque screws to 8.0 Nm (70 in. lbs.).

6. Install Injectors, fuel lines and glow plugs, Fig. 37.
   a. Torque injectors to 61.0 Nm (45 ft. lbs.).
   b. Torque fuel return line to 27.0 Nm (20 ft. lbs.).
   c. Torque fuel delivery lines to 25.0 Nm (220 in. lbs.).
   d. Torque glow plugs to 17.0 Nm (150 in. lbs.).
7. Install exhaust manifold with new gasket, Fig. 38.
   a. Torque screws to 19.0 Nm (170 in. lbs.).

**GENERAL ASSEMBLY**

1. Install water pump with new gasket, Fig. 39.
   a. Torque screws and nuts to 19.0 Nm (170 in. lbs.).

2. Install water pump pulley, Fig. 40.
3. Install fan (if equipped).
   a. Torque screws to 7.0 Nm (60 in. lbs.).

4. Install V-belt, Fig. 41.
5. Install alternator bolts A and B.

**Belt deflection** limit is 10–12 mm/10 kg (3/8–1/2 in/22 lbs.).
   a. Torque bolt A to 19.0 Nm (170 in. lbs.).
   b. Torque bolt B to 61.0 Nm (45 ft. lbs.).
ADJUST VALVES
1. Before adjusting valves, make sure that No. 1 cylinder is at TDC – compression stroke, Fig. 42.

   a. Adjust valves and check, Fig. 43.

   Valve Clearance (cold) IN and EX 0.20 mm (0.008 in.)

   b. Torque adjusting screws and jam nuts to 11.0 Nm (95 in. lbs.).

With No. 1 piston at TDC of compression stroke, check and adjust valve clearances for cylinders shown in chart at right.

Rotate crankshaft one complete turn (360°) clockwise to check and adjust remaining valves.

2. Install valve cover with new rubber seal, Fig. 44.

   a. Torque cover nuts to 7.0 Nm (50 in. lbs.).

   **NOTE:** Make sure rubber seal is in groove in valve cover.
# Section 3

## Timing Gears and Gear Case

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### Diagram

A detailed diagram illustrating the timing gears and gear case assembly, showing various components and their arrangement in the engine. The diagram includes labels and parts typically found in engine repair manuals for clarity.

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TIMING GEARS AND GEAR CASE

REMOVING TIMING GEAR COVER AND GEARS

Make sure that #1 cylinder is at TDC, compression stroke. See Section 2, Fig. 6.
Remove V-belt and fan (if equipped). Drain oil from engine.

**NOTE:** Clean areas around fuel lines and injectors to prevent dirt entry.

1. Remove the following parts, Fig. 1.
   a. Glow plug wiring.
   b. Glow plugs.
   c. Injector pump bracket.
   d. Remove fuel delivery lines.

2. Remove the following parts, Fig. 2.
   a. Remove oil pan and discard gasket.
   b. Remove oil pick-up tube and strainer. Discard gasket.

3. Remove bell housing adapter screw if equipped. and install flywheel holder, Tool #19418.

4. **LEAVE TOOL INSTALLED.**
   a. Remove crankshaft pulley using Tool # 19420, Fig. 3.

5. Remove timing gear cover, Fig. 4.
   a. Discard timing gear cover gasket.
6. Remove oil pump drive gear, Fig. 5.
   a. Check oil pump drive gear for damaged teeth.

   **CHECKING GEARS**

   Inspect gear teeth for wear or damage.

   **CHECK GEARS IN SEQUENCE SHOWN.**

   1. Check gear backlash between idler gear and crankshaft gear using dial indicator as shown in Fig. 6.
      a. Set tip of indicator on gear tooth, then rock idler gear back and forth noting indicator reading.
      **NOTE:** Crankshaft must not turn while checking.

   2. If backlash exceeds 0.2 mm (.008") check idler gear bearing and shaft for wear, Fig. 7.
      **Reject Dimension:** Idler Gear ID – 34.17 mm (1.345")
      Idler Gear Shaft OD – 33.91 mm (1.335")
      a. If idler gear bearing and shaft are within specification, replace with new idler gear and recheck.
      b. If backlash exceeds 0.2 mm (.008") with NEW idler gear, crankshaft gear is worn.
      **NOTE:** If crankshaft gear is worn the crankshaft must be replaced.

   3. Hold idler gear as shown and check gear backlash between camshaft timing gear and idler gear using dial indicator, Fig. 8.
      Camshaft timing gear backlash must not exceed 0.2 mm (.008").
      **NOTE:** Idler gear must not turn while checking.
TIMING GEARS AND GEAR CASE

4. Hold idler gear as shown and check gear backlash between injector pump timing gear and idler gear using dial indicator, Fig. 9. Injector pump timing gear backlash must not exceed 0.2 mm (.008").

**NOTE:** Idler gear must not turn while checking. If gears are worn it is recommended that they be replaced as a set.

**REMOVE GEAR CASE**

1. Remove injector pump timing gear with a three jaw puller, Fig. 10.

2. Remove parts in sequence shown, Fig. 11.
   a. Remove 3 screws and camshaft retainer.
   b. Remove remaining 5 screws.

3. Remove timing gear case and discard gasket, Fig. 12.
   a. Remove oil pump rotor from cylinder block.
REPLACE TIMING GEAR COVER OIL SEAL
1. Drive out oil seal.
2. Use seal driver, Tool #19423, to install new oil seal, Fig. 13.

ASSEMBLE TIMING GEAR CASE AND GEARS
1. Clean and lubricate oil pump rotor with engine oil and install in cylinder block, Fig. 14.
   a. ID mark on rotor must face cylinder block.

2. Install timing gear case with new gasket. Install camshaft retainer, Fig. 15.
   **NOTE:** It may be necessary to rotate oil pump drive to engage oil pump rotors.
   **NOTE:** Position camshaft retainer so that center hole does not interfere with camshaft.
   Note position, length and number of screws as shown.
   a. M6 x 28 mm (M6 x 1.1"): 4
   b. M6 x 18 mm (M6 x 0.7"): 3
   c. M6 x 16 mm (M6 x 0.6"): 1
   Torque screws to 8.0 Nm (70 in. lbs.).

3. Assemble injector pump to gear case with new O-ring and install nuts and support bracket screw finger tight, Fig. 16.
   **NOTE:** Pump must be able to rotate.
   a. Align timing mark on injector pump with timing mark on gear case.
   **NOTE:** See Section 10 for injector pump timing procedure.
TIMING GEARS AND GEAR CASE

4. Assemble idler gear shaft with arrow up, as shown in Fig. 17.

Engine models 432000 and 582000 after date code 990111007, and all engine models 522000 are equipped with right angle helical timing gears. Timing marks are identified by letters (A, AA, B, BB, etc.), instead of numbers. The timing procedure is the same.

5. With crankshaft key at 12 o'clock position, assemble idler gear so that timing mark 11 (AA) is aligned with timing mark 1 (A) on crankshaft gear, timing mark 22 (BB) is aligned with timing mark 2 (B) on camshaft gear, and timing mark 33 (CC) is aligned with timing mark 3 (C) on injector pump gear, as shown in Fig. 18.
   a. Install oil pump gear.

6. Torque screws as shown, Fig. 19.
   a. Camshaft Gear: 41.0 Nm (30 ft. lbs.)
   b. Idler Gear: 25.0 Nm (220 in. lbs.)
   c. Injector Pump Gear: 61.0 Nm (45 ft. lbs.)
   d. Oil Pump Gear: 19.0 Nm (170 in. lbs.)

7. Install timing gear cover with new gasket. Note position, length and number of screws as shown, Fig. 20.
   a. M6 x 55 mm (M6 x 2.5\(^*\)): 3
   b. M6 x 45 mm (M6 x 2.1\(^*\)): 2
   c. M6 x 30 mm (M6 x 1.1\(^*\)): 9
   d. M6 nut: 2
   Torque screws and nuts to 8.0 Nm (70 in. lbs.).
8. Install crankshaft pulley with timing mark at 12 o’clock position (#1 cylinder), Fig. 21.  
   **NOTE:** Be sure alignment pin in crankshaft gear is seated in hole in pulley.  
   a. Torque screw to 88.0 Nm (65 ft. lbs.).  
   b. Remove flywheel holder.

9. Install oil pick-up tube and strainer with new gasket. Torque to 8.0 Nm (70 in. lbs.).  
   a. Apply a small bead of Permatex® No. 2 or similar sealant to crankcase areas shown, Fig. 22.  
   b. Install oil pan with new gasket.  
   c. Torque screws and nuts to 8.0 Nm (70 in. lbs.).

10. Install glow plugs, wiring and fuel delivery lines.  
   a. Torque glow plugs to 17.0 Nm (150 in. lbs.).  
   b. Torque fuel delivery lines to 25.0 Nm (220 in. lbs.), Fig. 23.  
11. Install V-belt and fan (if equipped).
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Section 4
Flywheel and Rear Seal Retainer

Remove oil pan screws and nuts. Remove oil pan and discard gasket Fig. 1.

2. Install flywheel holder, Tool #19418
   a. Remove flywheel screws and flywheel, Fig. 2.
   Inspect flywheel for cracks or damage. Inspect flywheel ring gear for worn, chipped or cracked teeth.
   If ring gear is worn or damaged the flywheel must be replaced.
FLYWHEEL AND REAR SEAL RETAINER

REMOVE REAR SEAL RETAINER
Remove rear seal retainer and discard gasket, Fig. 3.

REPLACING OIL SEAL
1. Remove oil seal, Fig. 4.
2. Lubricate outside diameter of oil seal.
   a. Using seal driver, Tool #19424 install new oil seal, Fig. 5.

INSTALLING REAR SEAL RETAINER AND FLYWHEEL
1. Install rear seal retainer with new gasket, Fig. 6.
   a. Torque screws to 6.0 Nm (50 in. lbs.).
2. Install flywheel, Fig. 7.
   
   **NOTE:** Apply Permatex® No. 2 or similar sealant to flywheel screws.
   a. Torque flywheel screws to 47.0 Nm (35 ft. lbs.).

   Remove flywheel holder.

**INSTALL OIL PAN**

1. Install oil pan with new gasket, Fig. 8.
   a. Apply a small bead of Permatex® No. 2 or similar sealant to crankcase areas shown.
   b. Torque screws and nuts to 8.0 Nm (70 in. lbs.).
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Section 5

Cylinder Block Disassembly

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CYLINDER BLOCK DISASSEMBLY

ENGINE STAND
An automotive type engine stand is recommended when complete engine disassembly is required. See drawings below for dimensions to make an engine stand mounting fixture. The engine stand shown below is manufactured by Snap-On®.
CYLINDER BLOCK DISASSEMBLY

1. Remove cylinder head. See Sec. 2.
2. Remove oil pan, oil pick up tube, timing cover, gears and gear case. See Sec. 3.
3. Remove flywheel and rear seal retainer. See Sec. 4.
4. Remove starter motor, Fig. 1.

5. Remove alternator bracket and alternator, Fig. 2.

6. Remove valve lifters, Fig. 3.
   a. Number lifters so that they may be re-installed in the same position.

7. Remove camshaft, Fig. 4.

   NOTE: Use care when removing camshaft to prevent damaging cam bearing, journals and lobes.
CYLINDER BLOCK DISASSEMBLY

8. Remove connecting rod and piston assemblies, Fig. 5.

   NOTE: Remove carbon or ridge from cylinder and number connecting rod/piston assemblies before removing from cylinders.
   a. Remove connecting rod cap with lower bearing.
   b. Push connecting rod and piston out through top of cylinder.
   c. Reassemble connecting rod cap to connecting rod to prevent interchanging components.

9. Remove crankshaft main bearing caps, keeping main bearings with their respective caps, Fig. 6.

   NOTE: Main bearing caps are numbered 1 through 4.

10. Remove crankshaft, Fig. 7.

   a. Remove crankshaft thrust washers (#3 main bearing).
   b. Remove upper main bearings from saddles and place with respective bearing caps.
Section 6
Cylinder Block Inspection and Repair

CHECKING CYLINDER BLOCK
Remove all traces of sealant and gasket material from mounting surfaces. Inspect cylinder block for damage, cracks and stripped threads. Inspect cylinder bores for damage or scores.

1. Check cylinder block deck for distortion, Fig. 1.
   Distortion Limit: 0.08 mm (.003")

2. If cylinder block exceeds limit shown, it may be resurfaced, Fig. 2.

   Cylinder Block Height
   Model Series 430000
   Std: 229.20-229.80 mm (9.023-9.047")
   Minimum Dimension:
   229.10 mm (9.019") (After Resurfacing)
   Model Series 520000 & 580000 Std:
   238.70-239.30 mm (9.397-9.421")
   Minimum Dimension:
   238.60 mm (9.393") (After Resurfacing)
3. Check cylinder bores for wear, Fig. 3.

**Standard Bore Size:**
- **Model Series 430000 & 520000:**
  - 68.00-68.030 mm (2.6770-2.6783”)
- **Model Series 580000:**
  - 72.00-72.030 mm (2.8346-2.8358”)

  a. Measure cylinder bore in 6 points at right angles as shown, Fig. 3.
  b. If cylinder bore is worn more than 0.075 mm (.003”) or more than 0.035 mm (.0015”) out of round, it must be resized.

Always resize to exactly .25 mm (.010”) over standard bore size. If this is done accurately, the service oversize rings and pistons will fit perfectly and proper clearances will be maintained.

4. Check valve lifter bore, Fig. 4.

**Std. Dimension:** 18.018 mm (.7094”)
**Reject:** 18.05 mm (.711”)

5. Check valve lifter, Fig. 4.

**Std. Dimension:** 17.98 mm (.708”)
**Reject:** 17.91 mm (.7051”)

6. Check camshaft bearing, Fig. 5.

Replace if greater than 36.06 mm (1.420”).

---

**REPLACING CAMSHAFT BEARING**

1. Remove camshaft bearing, Fig. 6.
   a. Use camshaft bearing puller, Tool #19421.
2. Install camshaft bearing, Fig. 7.
   a. Use camshaft bearing driver, Tool #19422.
   **NOTE:** Notch on camshaft bearing must face out. Be sure oil hole in bearing is aligned with oil hole in cylinder block.

**REPLACING CAMSHAFT PLUG**

1. Remove rear camshaft plug, Fig. 8.
   a. Use a wood dowel or brass rod to prevent damage to camshaft bearing.

2. Install new camshaft plug using camshaft bearing driver, Tool #19422.
   a. Install camshaft plug flush with cylinder block, Fig. 9.

If cylinder block is being resized, the following parts should be removed so that cylinder block may be thoroughly cleaned.

1. Remove oil pressure switch, water gallery plug and oil filter adapter, Fig. 10.
CYLINDER BLOCK INSPECTION AND REPAIR

2. Remove timing gear oil nozzle, Fig. 11.

3. When re-installing oil nozzle, oil hole must be positioned at 45° angle, pointing towards idler gear, Fig. 12.
# Section 7
## Crankshaft, Camshaft and Bearings

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### CHECKING CRANKSHAFT

Inspect crankshaft journals for grooves or signs of scoring. If found, crankshaft must be re-ground or replaced.

1. Check the main bearing and crankpin journals for wear and taper, Fig. 1.

   **Standard size:**
   - Main – 41.976-42.000 mm (1.6526-1.6535”)
   - Crankpin – 36.976-37.000 mm (1.4557-1.4567”)
   - Maximum out of round and taper: 0.02 mm (0.0008”).

   If crankshaft journals are not within specification, the crankshaft may be re-ground and .25 mm (.010”) undersize bearings installed. See illustrated parts list for part numbers.

2. Check the crankshaft for run-out at #3 main bearing journal, Fig. 2.

   **Maximum Run-out:** 0.06 mm (0.0024”)
   - a. If run-out exceeds specification shown, the crankshaft must be replaced.
CRANKSHAFT, CAMSHAFT AND BEARINGS

3. Check crankshaft timing gear teeth for damaged teeth, Fig. 3.
   **NOTE:** See Section 3 for procedure to check crankshaft timing gear for wear.
   If crankshaft timing gear teeth are damaged or worn, the crankshaft must be replaced.

CHECKING MAIN BEARING CLEARANCES

If main bearings show signs of flaking or scoring, bearings must be replaced.
Main bearing saddles in cylinder block, main bearing caps, main bearings and crankshaft journals must be clean and free of oil.

1. With upper main bearings installed, install crankshaft.
   a. Lay a strip of plastigage lengthwise on journal, Fig. 4.
      Do not lay plastigage across oil hole in crankshaft journal.

2. Assemble main bearing cap with bearing and torque to 58.3 Nm (43 ft. lbs.), Fig. 5.
   **DO NOT ALLOW CRANKSHAFT TO Rotate.**

3. Remove the bearing cap. Measure the plastigage at its widest point, Fig. 6. If the clearance is not within specification, replace the bearings.
   **Crankshaft Main Bearing Clearance:**
   STD: 0.020-0.044 mm (0.0008-0.0017”)
   Reject: 0.07 mm (0.0028”)
   Repeat procedure for each main bearing.
CHECKING CONNECTING ROD BEARING CLEARANCES

If connecting rod bearings show signs of flaking or scoring, bearings must be replaced.

Connecting rod bearings and crankpin journals must be clean and free of oil.

1. With upper bearing assembled to connecting rod, install connecting rod.
   a. Lay a strip of plastigage lengthwise on journal, Fig. 7.
   Do not lay plastigage across oil hole in crankpin journal.

2. Assemble connecting rod cap with bearing and torque to 36.0 Nm (320 in. lbs.), Fig. 8.
   DO NOT ALLOW CRANKSHAFT TO ROTATE.

3. Remove the connecting rod cap. Measure the plastigage at its widest point, Fig. 9. If the clearance is not within specification, replace the bearings.

   Connecting Rod Bearing Clearance:
   STD: 0.020-0.044 mm (0.0008-0.0017”)
   Reject: 0.07 mm (0.0028”)
   Repeat procedure for each connecting rod.

CHECKING CRANKSHAFT END PLAY

With thrust washers installed, check crankshaft end play at #3 main bearing as shown, Fig. 10.

   Crankshaft End Play:
   STD: 0.020-0.24 mm (0.0008-0.0094”)
   Limit: 0.30 mm (0.012”)

   If end play exceeds limit, .125 mm (.005”) over size thrust washers are available. See illustrated parts list.
CRANKSHAFT, CAMSHAFT AND BEARINGS

CHECKING CAMSHAFT
1. Measure camshaft lobe height, Fig. 11. If lobes are not to specification, replace the camshaft.
   Intake and Exhaust:
   STD: 30.065-30.135 mm (1.184-1.186")
   Reject: 29.965 mm (1.18")

2. Measure camshaft journals, Fig. 12.
   STD:  Front – 35.959-35.975 mm (1.4157-1.4163")
   Reject: 35.890 mm (1.413")
   STD:  Center – 35.910-35.955 mm (1.4138-1.4155")
   Reject: 35.84 mm (1.411")
   STD:  Rear – 35.910-35.955 mm (1.4138-1.4155")
   Reject: 35.84 mm (1.411")

3. Measure camshaft run-out, Fig. 13.
   Maximum Run-out: 0.03 mm (0.0012").
   a. If run-out exceeds specification shown, the camshaft must be replaced.

Fig. 11 – Checking Camshaft Lobes
Fig. 12 – Checking Camshaft Journals
Fig. 13 – Checking Run-out
## Section 8

Piston, Rings and Connecting Rod

Inspection and Assembly

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<tr>
<td>ASSEMBLE PISTON RINGS TO PISTON</td>
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</tbody>
</table>

### DISASSEMBLE PISTON AND CONNECTING ROD

1. Remove compression rings and oil ring using ring expander, Tool #19340, Fig. 1.
   a. Then remove coil expander.

2. Disassemble piston from connecting rod, Fig. 2.
   a. Remove piston pin retainers.
   b. Piston pin is a slip fit.
CHECKING PISTON AND RINGS

If the cylinder bore is to be resized there is no reason to check the piston as a new oversized piston will be used.

If the cylinder is not going to be resized and the piston shows no signs of scoring, the piston should be checked.

1. Check side clearance of ring grooves using NEW rings, Fig. 3. If a 0.12 mm (0.005”) feeler gauge can be inserted, the ring groove is worn. The piston must be replaced.

2. Check ring end gap, Fig. 4.
   a. Clean carbon from end of rings and using the piston, insert approximately 100 mm (3.9”) into cylinder (below ring travel).

<table>
<thead>
<tr>
<th>Ring End Gap Reject Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compression Rings</td>
</tr>
<tr>
<td>0.70 mm (0.028”)</td>
</tr>
</tbody>
</table>

3. Check piston pin bore, Fig. 5.
   - Engine Models: 432447, 522447, 582447
     a. Replace if greater than 18.03 mm (0.710”) or .01 mm (.0004”) out of round.
   - Engine Models: 58A447, 588447
     b. Replace if greater than 21.03 mm (0.828”) or .01 mm (.0004”) out of round.

CHECKING PISTON PIN AND CONNECTING ROD

1. Check piston pin, Fig. 6.
   - Engine Models: 432447, 522447, 582447
     a. Replace if less than 17.98 mm (0.708”) or .01 mm (.0004”) out of round.
   - Engine Models: 58A447, 588447
     b. Replace if less than 20.98 mm (0.826”) or .01 mm (.0004”) out of round.
2. Check piston pin bearing, Fig. 7.
   **Engine Models: 432447, 522447, 582447**
   a. Replace if greater than 18.03 mm (0.710”) or .01 mm (.0004”) out of round.
   **Engine Models: 58A447, 588447**
   b. Replace if greater than 21.03 mm (0.828”) or .01 mm (.0004”) out of round.

3. Check crankpin bearing end of connecting rod for out of round, Fig. 8.
   a. With bearing inserts removed, assemble connecting rod cap and torque to 36.0 Nm (320 in. lbs.).
   **Maximum out of round: 0.02 mm (0.0008”)**
   b. If out of round exceeds specification shown, the connecting rod must be replaced.

4. Check for bent or twisted connecting rod, Fig. 9.
   **NOTE:** Thrust faces must be free of any burrs or nicks or connecting rod will not lay flat on surface plate.
   a. With connecting rod on a surface plate, any distortion will be evident by a rocking motion.
   b. If a 0.05 mm (0.002”) feeler gauge can be inserted at piston pin end of connecting rod the rod must be replaced.

**ASSEMBLE PISTON AND CONNECTING ROD**

Assemble piston to connecting rod, Fig. 10.
   **NOTE:** Arrow on piston and ID mark on rod must face same side.

1. Lubricate piston pin with engine oil before assembly.
   a. Be sure retainers are seated properly in piston.
ASSEMBLE PISTON RINGS TO PISTON
1. Install piston rings using ring expander, Tool #19340, Fig. 11.
   a. Install oil ring coil expander making sure wire is inserted fully into coil.
   b. Install oil ring.
   c. Install center compression ring then, top compression ring with ID marks up.

2. Stagger ring end gaps as shown, Fig. 12.
INSTALL CRANKSHAFT
Install main bearings in cylinder block, Fig. 1.

NOTE: Upper bearing has an oil groove and oil holes.

1. Install upper main bearings in their respective saddles.
   a. Be sure bearing is seated in saddle and tang in bearing is aligned with notch in saddle.
   b. Lubricate bearings with engine oil.

2. Install lower main bearings in bearing caps, Fig. 2.
   a. Be sure bearing is seated in bearing cap and tang in bearing is aligned with notch in bearing cap.
   b. Lubricate bearings with engine oil.
CYLINDER BLOCK ASSEMBLY

3. Install crankshaft with gear facing front of cylinder block, Fig. 3. Take care not to damage journals or bearings.
   a. Install crankshaft shims on #3 main bearing web with grooves facing out.
   b. Lubricate journals with engine oil.

4. Install main bearing caps, Fig. 4. Lubricate threads of screws with engine oil.
   a. Install bearing caps in their respective positions with arrows facing front.
   b. Starting with #3 bearing cap, torque bearing caps one at a time in sequence shown to 58.0 Nm (43 ft. lbs.).
   c. Recheck crankshaft end play.

   **Crankshaft End Play: 0.025-0.24 mm (0.0008-0.0094")**

   **NOTE:** After torquing bearing cap, make sure crankshaft rotates freely before proceeding to next bearing cap.

INSTALL PISTONS AND CONNECTING RODS

1. Install connecting rod bearings, Fig. 5. Be sure tang on bearing is seated in notch in connecting rod and cap.
   a. Install a piece of vinyl tubing over each connecting rod screw to prevent damage to screw threads or crankpin when installing piston and connecting rod.
Rotate crankshaft so that crankpin is at bottom of stroke. Then, lubricate cylinder walls, piston and rings, bearings and crankpins.

2. Using ring compressor, Tool #19070, install piston and connecting rod assemblies with arrow on piston facing front, Fig. 6.
   a. Install connecting rod cap with ID mark facing front. Lubricate threads and torque nuts to 34.0 Nm (320 in. lbs.).

   **NOTE:** After torquing rod cap, make sure crankshaft rotates freely before proceeding to next cylinder.

**GENERAL ASSEMBLY**

1. Install gasket, oil pick-up tube and strainer, Fig. 7.
   a. Torque screws to 8.0 Nm (70 in. lbs.).

2. Install gasket and rear seal retainer, Fig. 8.
   a. Torque screws to 6.0 Nm (50 in. lbs.).

3. Install starter motor.
   a. Torque screws to 34.0 Nm (25 ft. lbs.).

4. Install flywheel, Fig. 9.
   a. Install flywheel holder, Tool #19418.
   b. Apply Permatex® No. 2 or similar sealant to flywheel screws and torque to 47.0 Nm (35 ft. lbs.).
CYLINDER BLOCK ASSEMBLY

INSTALL TIMING GEAR CASE, CAMSHAFT AND GEARS

1. Lubricate oil pump rotor with engine oil and install in cylinder block, Fig. 10.
   a. ID mark on rotor must face cylinder block.

2. Install timing gear case with new gasket.
   **NOTE:** It may be necessary to rotate oil pump drive to engage oil pump rotors.
   Note position, length and number of screws as shown, Fig. 11.
   a. M6 x 28 mm (M6 x 1.1"): 4
   b. M6 x 16 mm (M6 x .6"): 1
   Torque screws to 8.0 Nm (70 in. lbs.).

3. Lubricate, then install camshaft in cylinder block, Fig. 12. Take care not to damage lobes or cam bearing.
   a. Install camshaft retainer.
   b. M6 x 18 mm (M6 x 0.7"): 3
   Torque screws to 8.0 Nm (70 in. lbs.).
   **NOTE:** Position camshaft retainer so that center hole does not interfere with camshaft.

4. Rotate crankshaft so that crankshaft key is at 12 o’clock position as shown in Fig. 13.
5. Assemble injector pump to gear case with new O-ring and install nuts and support bracket screw finger tight, Fig. 14.

**NOTE:** Pump must be able to rotate
a. Align timing mark on injection pump with timing mark on gear case.

**NOTE:** See Section 10 for injector pump timing procedure.

6. Assemble idler gear shaft with ID mark up, as shown in Fig. 15.

Engine models 432000 and 582000 after date code 990111007, and all engine models 522000 are equipped with right angle helical timing gears. Timing marks are identified by letters (A, AA, B, BB, etc.), instead of numbers. The timing procedure is the same.

7. With crankshaft key at 12 o'clock position, assemble idler gear so that timing mark 11 (AA) is aligned with timing mark 1 (A) on crankshaft gear, timing mark 22 (BB) is aligned with timing mark 2 (B) on camshaft gear, and timing mark 33 (CC) is aligned with timing mark 3 (C) on injector pump gear, as shown in Fig. 16.
   a. Install oil pump gear.

8. Torque screws as shown, Fig. 17.
   a. Camshaft Gear: 41.0 Nm (30 ft. lbs.)
   b. Idler Gear: 25.0 Nm (220 in. lbs.)
   c. Injector Pump Gear: 61.0 Nm (45 ft. lbs.)
   d. Oil pump Gear: 19.0 Nm (170 in. lbs.)
CYLINDER BLOCK ASSEMBLY

9. Install timing gear cover with new gasket. Note position, length and number of screws as shown, Fig. 18.
   a. M6 x 55 mm (M6 x 2.5”): 3
   b. M6 x 45 mm (M6 x 2.1”): 2
   c. M6 x 30 mm (M6 x 1.1”): 9
   d. M6 nut: 2

Torque screws and nuts to 8.0 Nm (70 in. lbs.).

10. Install crankshaft pulley with timing mark at 12 o’clock position (#1 cylinder), Fig. 19.

   NOTE: Be sure alignment pin in crankshaft gear is seated in hole in pulley.
   a. Torque screw to 88.0 Nm (65 ft. lbs.).
   b. Remove flywheel holder.

INSTALL ALTERNATOR

1. Install alternator bracket and alternator, Fig. 20.
   a. Torque screws to 19.0 Nm (170 in. lbs.).

GENERAL ASSEMBLY

1. Lubricate tappets with engine oil and install in cylinder block.
2. See Section 2 for installation of cylinder head and related components.
The fuel system consists of a gear driven injector pump with fuel delivery and return lines and injector nozzles for each cylinder. Diesel fuel is drawn from the fuel tank through the fuel filter by the feed pump which is incorporated in the injection pump and delivers fuel to the injectors at a constant volume regardless of pump RPM. The feed pump also circulates fuel through the pump for lubrication purposes.

A single pump plunger meters and distributes fuel in the correct firing order through an injector nozzle in each combustion chamber. Excess fuel from the injector nozzles and pump is returned to the fuel tank by way of the overflow valve and return line. This system of fuel circulation lubricates and cools the injection pump and also warms the fuel in the fuel tank to help prevent fuel waxing in cold weather.

**CAUTION:** Always use clean fresh diesel fuel with a minimum of 40 cetane. DO NOT use kerosene. The injection pump requires diesel fuel for lubrication. Damage to the injection pump and/or engine may result if kerosene is used.

Servicing the fuel injection system requires highly specialized equipment and procedures. Consult the Yellow Pages™ under Engines-Diesel-Fuel Injection Service & Parts for the nearest diesel fuel injection specialist if the injector pump or injector nozzles require servicing.

See Section 3 for procedure for removing and installing injector pump.
FUEL SYSTEM COMPONENTS

FUEL INJECTION SYSTEM COMPONENTS

- FUEL FILTER
- FUEL DELIVERY LINE
- INJECTOR PUMP
- INJECTOR
- FUEL RETURN LINE
- FUEL RETURN LINE
- FUEL RETURN LINE
- FUEL TANK
- FUEL LINE
### TABLE 1
Injection Pump Timing
**Engine Date Code Before 99010100**

<table>
<thead>
<tr>
<th>Model/Type No.</th>
<th>Timing Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>432447-0150-E2</td>
<td>0.93 ± 0.03 mm (0.0365&quot; ± 0.001&quot;)</td>
</tr>
<tr>
<td>522447-0105-E2</td>
<td>0.93 ± 0.03 mm (0.0365&quot; ± 0.001&quot;)</td>
</tr>
<tr>
<td>522447-0106-E2</td>
<td>0.93 ± 0.03 mm (0.0365&quot; ± 0.001&quot;)</td>
</tr>
<tr>
<td>522447-0107-E2</td>
<td>0.93 ± 0.03 mm (0.0365&quot; ± 0.001&quot;)</td>
</tr>
<tr>
<td>522447-0108-E2</td>
<td>0.93 ± 0.03 mm (0.0365&quot; ± 0.001&quot;)</td>
</tr>
<tr>
<td>522447-0109-E2</td>
<td>0.93 ± 0.03 mm (0.0365&quot; ± 0.001&quot;)</td>
</tr>
<tr>
<td>582447-0105-E2</td>
<td>0.93 ± 0.03 mm (0.0365&quot; ± 0.001&quot;)</td>
</tr>
<tr>
<td>582447-0125-E2</td>
<td>0.81 ± 0.03 mm (0.032&quot; ± 0.001&quot;)</td>
</tr>
<tr>
<td>582447-0130-E2</td>
<td>0.93 ± 0.03 mm (0.0365&quot; ± 0.001&quot;)</td>
</tr>
<tr>
<td>582447-0131-E2</td>
<td>0.81 ± 0.03 mm (0.032&quot; ± 0.001&quot;)</td>
</tr>
</tbody>
</table>

### TABLE 2
Injection Pump Timing
**Engine Date Code After 98123100**

<table>
<thead>
<tr>
<th>Model Series</th>
<th>Timing Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>432447 – All</td>
<td>0.90 ± 0.03 mm (0.035&quot; ± 0.001&quot;)</td>
</tr>
<tr>
<td>522447 – All</td>
<td>0.90 ± 0.03 mm (0.035&quot; ± 0.001&quot;)</td>
</tr>
<tr>
<td>582447 – All</td>
<td>0.81 ± 0.03 mm (0.032&quot; ± 0.001&quot;)</td>
</tr>
<tr>
<td>58A447 – All</td>
<td>0.90 ± 0.03 mm (0.035&quot; ± 0.001&quot;)</td>
</tr>
<tr>
<td>588447</td>
<td></td>
</tr>
</tbody>
</table>
INJECTOR PUMP

Checking Injector Pump Timing

NOTE: Clean areas around fuel lines and injectors to prevent any dirt from entering injector nozzles or delivery valve ports when fuel delivery lines are removed.

1. Remove fuel delivery lines from injector pump and injector nozzles, Fig. 1.

2. Set No. 1 piston at TDC:
   a. Rotate crankshaft until timing mark on pulley is aligned with reference point on timing cover, Fig. 2.
   b. If intake and exhaust valves have clearance, No. 1 piston is at TDC – compression stroke.
   c. If intake and exhaust valves do not have clearance, turn crankshaft pulley one complete revolution. Valves will then have clearance.

3. Remove distributor head screw with washer and install injector pump timing gage, dial indicator Tool # 19441, Fig. 3.

4. Slowly rotate crankshaft counter-clockwise until dial indicator needle just stops moving. Set dial indicator at “0,” Fig. 4.

   NOTE: When indicator needle just stops moving, carefully rock crankshaft clockwise slightly, then counter-clockwise slightly to verify absolute “0.”
5. Slowly rotate crankshaft clockwise until timing mark on pulley aligns with reference point on gear case cover (TDC), Fig. 5. Note dial indicator reading.

**NOTE:** Do not rotate crankshaft past TDC. If crankshaft is rotated past TDC rotate crankshaft back to “0” and repeat procedure.

6. Refer to timing specification tables on page 3 for correct specification by engine model and type or code number.

If indicator reading is within specification, injector pump is properly timed. Proceed to step 6.

If indicator reading is not within specification, see procedure for adjusting injector pump timing.

7. Remove timing gage and install distributor screw with new washer, Fig. 6.
   a. Torque screw to 17.0 Nm (150 in. lbs.).

8. Install fuel delivery lines.
   a. Torque to 25.0 Nm (220 in. lbs.).

**Adjusting Injector Pump Timing**

Refer to timing specification tables on page 3 for correct specification by engine model and type or code number.

1. Loosen injector pump mounting nuts and pump support bracket screw, Fig. 7. Rotate pump toward cylinder head as far as it will go.

**NOTE:** Loosen nuts and screw only enough to allow pump to be rotated with some resistance.

Perform Steps 2 through 4 as described in “Checking Injector Pump Timing”.

2. Slowly rotate crankshaft clockwise until timing mark on pulley aligns with reference point on gear case cover (TDC), Fig. 8.

**NOTE:** Do not rotate crankshaft past TDC. If crankshaft is rotated past TDC rotate crankshaft back to “0” and repeat procedure.
INJECTOR PUMP

3. While observing dial indicator, slowly rotate injector pump away from cylinder head until indicator shows correct specification. Hold injector pump in this position and tighten outside pump mounting nut, Fig. 9.

**NOTE:** Do not rotate pump past specification. If pump is rotated past specification, rotate pump back toward cylinder head and repeat procedure.

4. To verify that timing is correct, rotate crankshaft counter-clockwise until dial indicator reads "0." Then rotate crankshaft clockwise until timing mark on pulley aligns with reference point on gear case cover (TDC). Indicator should be within specification, Fig. 10.

5. Torque injector pump mounting nuts and pump support bracket screw to 19.0 Nm (170 in. lbs.).

6. Remove timing gage and install distributor screw with new washer, Fig. 11.
   a. Torque screw to 17.0 Nm (150 in. lbs.).

7. Install fuel delivery lines.
   a. Torque to 25.0 Nm (220 in. lbs.).

INJECTORS

**Remove Injectors**

**NOTE:** Use care to prevent any dirt from entering injector holes or delivery valve ports when fuel delivery lines are removed.

1. Remove fuel delivery lines, Fig. 12.
2. Disconnect fuel return line hose.
3. Remove nuts and fuel return line.
   a. Discard fuel return line gaskets.
4. Remove injector nozzles, Fig. 13.
   a. Discard injector gaskets.

   **NOTE:** Handle injectors with extreme care. Do not drop!

   Always use new fuel return line and injector nozzle gaskets when servicing fuel system.

---

**Checking Injectors**

Fuel injector nozzle testing requires highly specialized equipment and procedures. Consult the Yellow Pages™ under Engines-Diesel-Fuel Injection Service & Parts for the nearest diesel fuel injection specialist.

The procedures and specifications listed are provided as an aid to the fuel injection specialist when testing injector nozzles.

1. With injector installed on a nozzle tester, operate the handle rapidly several times to clean off any carbon deposits on the injector port, Fig. 14.

2. Check “pop off” pressure of injector.

   **Specification:** 135 – 145 Bar
   
   (1955 – 2100 psi)

If injector is not within specification, the injector shim may be changed, Fig. 15.

Replacement shims are available in .025 mm increments from .7 to 1.95 mm.

   **NOTE:** As the shim thickness increases or decreases by .025 mm, injection pressure will vary about 5 Bar (71 psi).

Torque nozzle holder and injector body to 47.0 Nm (35 ft. lbs.).
INJECTORS

3. Check injector for leakage, Fig. 16. Maintain injector pressure at approximately 120 Bar (1707 psi), for about 10 seconds. Make sure there is no leakage from nozzle or retaining nut area.

4. Check spray pattern of nozzle, Fig. 17. Operate tester handle rapidly while observing pattern. Spray pattern should be uniform and centered under nozzle.

   NOTE: A buzzing or chattering sound should also occur while operating handle. Nozzle should not drip between pump strokes.

Install Injectors
Install injectors and fuel return line with new gaskets, Fig. 18. Install fuel delivery lines.
   a. Torque injectors to 61.0 Nm (45 ft. lbs.).
   b. Torque fuel return line to 27.0 Nm (20 ft. lbs.).
   c. Torque fuel delivery lines to 25.0 Nm (220 in. lbs.).

FUEL FILTER – GENERAL
The fuel filter consists of a replaceable cartridge type filter with a water level sensor and priming pump, Fig. 19.
Replace fuel filter cartridge every 800 hours of engine operation.
The water collector contains a float type sensor that activates a warning lamp when it collects a minimum of 80 cc's (2.5 fl. oz.) of water.
Draining Water Collector
When warning lamp comes on, drain water collector as follows:
1. Stop engine.
2. Place a drain pan under filter and loosen vent plug.
3. Loosen drain plug approximately 1 turn and drain water from filter until only fuel flows from filter.
4. Tighten drain plug and vent plug and wipe up any spills.
5. Start engine, making sure warning lamp goes out. Check for leaks.

Change Fuel Filter
1. Disconnect sensor wire and remove drain plug. Discard O-ring.
2. Remove fuel filter with a filter wrench.
3. Screw new filter on by hand until gasket contacts housing. Then tighten 1/3 turn more.
4. Install drain plug with new O-ring and connect sensor wire.
5. Activate primer button until resistance is felt.

Checking Float Sensor
The following test will be made with the meter in the “Diode Test Position”.
Disconnect sensor wire from equipment harness and remove float sensor from fuel filter.
1. Attach a meter test lead to each terminal in connector.
2. While holding drain plug in vertical position, raise float to end of travel, Fig. 20.
   a. Meter should make a continuous tone.
3. Now lower float
   a. Meter should display OL.
Replace drain plug and float sensor if not to specification.

FUEL SHUT-OFF SOLENOID
When the ignition switch is turned to the “On” and “Start” position the fuel shut off solenoid valve opens allowing fuel to enter the fill port and pressure chamber. When the keysitich is turned “Off” the solenoid closes shutting off the fuel supply and the engine, Fig. 21.
Solenoid is operating if a click is heard when keysitich is turned “On” and “Off.”
If solenoid does not click, problem may be in equipment wiring to solenoid.

Checking Fuel Shut-Off Solenoid Wiring
The following test will be made with the meter in the V (DC Volts position).
Turn keysitich to “Off” position and disconnect equipment solenoid wire.
1. Attach BLACK meter test lead to a good ground.
2. Attach RED meter test lead to connector in equipment solenoid wire and turn keysitich to “On” position.
3. Meter should display battery voltage, Fig. 22.
   a. If meter does not display battery voltage, check for broken solenoid wire, blown fuse (if equipped) or defective keysitich.
### TABLE 3
Engine Speed Specification Chart

<table>
<thead>
<tr>
<th>Pump Mfg. Part No.</th>
<th>ID Code</th>
<th>Model &amp; Type No.</th>
<th>Idle Speed (rpm)</th>
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**ADJUST IDLE SPEED**

Engine should be at operating temperature before adjusting idle speed.

Make sure speed control lever contacts idle speed screw with engine at idle.

1. Loosen idle speed screw lock nut and adjust idle speed screw to obtain RPM specified by model and type number shown in chart, Fig. 23.

   **NOTE:** Do not exceed RPM shown for specific model and type number.

   a. Torque lock nut to 6.0 Nm (50 in. lbs.).

---

**ADJUST TOP NO LOAD SPEED**

Engine should be at operating temperature before adjusting idle speed.

Temporarily disconnect speed control wire at control bracket on pump.

1. Remove and discard top no load wire and seal.
2. Loosen top no load speed screw lock nut.
3. Move speed control lever to FAST position and adjust top no load speed screw to RPM specified by model and type number shown in chart, Fig. 24.

   **NOTE:** Do not exceed RPM shown for specific model and type number.

4. Stop engine and torque lock nut to 6.0 Nm (50 in. lbs.).
5. Reassemble speed control wire at bracket.
   a. Tighten screws securely.
   b. Make sure speed control lever contacts top no load screw when throttle lever is in FAST position.
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# Section 11
## Electrical System

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Electrical System Components
(Typical 40 Amp Alternator Shown)

Fig. 1

NOTE: TERMINALS 1, 3, 6 NOT USED

PART NO. 493625
GLOW PLUG SYSTEM

Glow Plug
The glow plug is a self-regulating type, consisting of two metal heating element coils; a rush coil and a brake coil, Fig. 2. The rush coil provides rapid heating of the tip of the glow plug. The brake coil decreases current to the glow plug by increasing resistance as the temperature rises, regulating the temperature of the glow plug.

Glow Plug Specifications

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<tr>
<td>Rated Current</td>
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</tr>
<tr>
<td>Normal Resistance</td>
<td>1.0 Ω</td>
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</table>

Remove Glow Plug
Disconnect glow plug wiring from connector.
1. Remove glow plug connector nuts and connector.
2. Remove glow plugs, Fig. 3.
Handle glow plugs with care. Do not drop. Do not scratch heater section.

Test Equipment
The digital multimeter, Tool #19390 is required to test the glow plug.

Testing Glow Plug
With meter selector switch in position, a continuous tone indicates continuity (complete circuit). No tone indicates no continuity (incomplete circuit). An incomplete circuit will be displayed as “OL.”
1. Check glow plug for continuity as shown, Fig. 4.
   a. If meter indicates NO continuity, replace glow plug.
**GLOW PLUG SYSTEM**

**PREHEAT TIMER AND GLOW RELAY**

The preheat timer and glow relay regulate current to the glow plugs for preheating and starting. When the keyswitch is turned to the “On” position, with the engine cold, the preheat timer activates the glow plugs. An indicator light lights and remains on while the glow plugs are preheating the combustion chamber. When the indicator light goes out, the engine may be started. When the keyswitch is in the “Start” position, the glow plugs and light are activated again as the engine is cranking.

See Fig. 5 for terminal positions of the preheat timer and glow relay.

**Testing Preheat Timer**

The following test will be made with the meter in the **V ——— (DC Volts position)**, Fig. 6.

1. Turn keyswitch to “Off” position.
   1. Insert BLACK meter test lead probe into terminal #4.
   2. Insert RED meter test lead probe into terminal #3.
   3. Turn keyswitch to “On” position.
      a. Glow light should light. Meter should display 1.5 volts maximum.
      b. After 5 seconds (approximately), glow light should go out. Meter should display approximately battery voltage.
   4. Replace preheat timer if not to specification.

   **NOTE:** If glow light does not light, replace bulb.

**Testing Glow Relay**

The following test will be made with the meter in the **V ——— (DC Volts position)**, Fig. 7.

1. Turn keyswitch to “Off” position.
   1. Insert BLACK meter test lead probe into terminal #8.
   2. Insert RED meter test lead probe into terminal #7.
      a. Meter should display battery voltage.
   3. Turn keyswitch to “On” position.
      a. Glow light should light. Meter should display 0.5 volts maximum.
      b. After 5 seconds (approximately), glow light should go out. Meter should display approximate battery voltage.
   4. Replace glow relay if not to specification.
GLOW PLUG SYSTEM

KEYSWITCHES
Two types of keyswitches may be used on Briggs & Stratton Daihatsu diesel engines.

Fixed Timer Preheat Keyswitch – Part No. 493625
Keyswitch, Part No. 493625, is used with a preheat timer and glow relay, Fig. 8. With the keyswitch in the “On” and “Start” position, battery current is supplied to the preheat timer and glow relay. See keyswitch terminal positions and functions, Fig. 8.

See Fig. 78 and Fig. 79 at end of section, for wiring diagrams for keyswitch No. 493625.

Manual Preheat Keyswitch – Part No. 825129
The manual preheat keyswitch, Part No. 825129, is equipped with four positions and six terminals, Fig. 9. The “G1” terminal provides current to the glow plugs only when the switch is in the “Heat” position. When the keyswitch is turned to the “Start” position the “G2” terminal provides current to the glow plugs while the engine is cranking. See keyswitch terminal positions and functions, Fig. 10.

Symbols are shown as they appear on rear of keyswitch. Note that “B” terminal is connected to terminal below it, Fig. 10. Keyswitch will not function without connector.

Test switch terminals for continuity with keyswitch in positions shown.

Fig. 8 – Keyswitch – Fixed Timer Preheat

Fig. 9 – Keyswitch – Manual Preheat

See Fig. 80 and Fig. 81 for wiring diagrams for keyswitch No. 825129.
14 AMP CHARGING SYSTEM

The 14 amp charging system consists of two components:

1. The belt driven permanent magnet alternator produces AC voltage, Fig. 11. AC output will vary with engine RPM, from approximately 7 volts AC at 1000 RPM to 32 volts AC at 3000 RPM.

   **NOTE:** A loose V-belt will cause low AC output.

   **Belt deflection** limit is 9.5-11.5 mm/10 kg.
   (3/8-7/16 in./22 lb.).

2. The regulator-rectifier converts the AC current to DC and regulates current to the battery, Fig. 12. The charging rate will vary with engine RPM. The regulator-rectifier is equipped with a charging indicator light circuit.

   **NOTE:** The regulator-rectifier requires a minimum battery voltage of 6 volts to function. **There will be no charging output if battery voltage is below 6 volts.**

Fig. 78 and Fig. 80 at end of section, show wiring diagrams for typical 14 amp charging system.

---

**Test Equipment**

The digital multimeter, Tool #19464 and the DC shunt, Tool #19468, Fig. 13, are required to test the charging system.

   **NOTE:** The digital multimeter will withstand DC input of 10-20 amps for up to 30 seconds. To avoid blowing fuse in meter, the DC shunt is required.

   Replacement fuse is available from your Briggs & Stratton source of supply. Order Part No. 19449.
CHARGING SYSTEMS

Testing Alternator – AC Output
The alternator output test will be performed with the meter in the V– (AC volts) position, Fig. 14.
Disconnect alternator wires at connector.
Attach meter test leads to alternator output connectors BEFORE starting engine, Fig. 14.
1. With the engine running at 3300 RPM the output should be no less than 28 volts AC.
   a. If no output or low output is found, replace alternator.
   b. If alternator output is within specification, re-connect alternator wires and test regulator rectifier.

Testing Regulator-Rectifier – DC Output
The DC Shunt must be installed on the negative (-) terminal of the battery, Fig. 15. All connections must be clean and tight for correct amperage readings.
Attach meter test leads BEFORE starting engine.
The regulator-rectifier test will be performed with the meter in the 300mV — position.
1. Attach RED meter test lead to RED post terminal on shunt.
2. Attach BLACK meter test lead to BLACK post terminal on shunt.
3. With the engine running at 3300 RPM, the output should be:
   * 4 – 14 Amps
   * Depending upon battery voltage and/or current draw on system.
4. If no or low output is found, be sure that regulator-rectifier is grounded properly and all connections are clean and secure. If there is still no or low output, replace the regulator-rectifier.
Charging Indicator Circuit

The green wire from the regulator-rectifier is used to activate the charging indicator light. With the keyswitch in the “ON” position and the engine not running the charge indicator light should light, Fig. 16. With the engine running the light should go out, indicating that the battery is being charged.

If the charge indicator light does not light when the keyswitch is in the “ON” position (engine not running), check the bulb and wiring.

Testing Charging Indicator Bulb And Wiring

The following test will be made with the meter in the “Diode Test Position” Fig. 17.

With meter selector switch in position, a continuous tone indicates continuity (complete circuit). No tone indicates no continuity (incomplete circuit). An incomplete circuit will be displayed as “OL.”

Keyswitch must be in OFF position.
1. Disconnect output harness at regulator-rectifier.
2. Check continuity between charging indicator wire (green) and ground, Fig. 18.
   a. If meter indicates continuity, bulb and wiring are OK. Replace regulator-rectifier.
   b. If meter indicates NO continuity, replace bulb and re-test.
   c. If meter indicates NO continuity with new bulb, the problem must be a broken wire (open circuit) in the charging indicator circuit.

If the charge indicator light remains on with the engine running, test the regulator-rectifier DC output. If output is within specification and charge indicator light remains on, replace the regulator-rectifier.
40 AMP CHARGING SYSTEM
Fig. 1 shows wiring diagram for 40 amp charging system.

The 40 amp charging system consists of a belt driven, internally regulated alternator, Fig. 19.

The alternator contains a charge light circuit (“L” terminal). With the keyswitch in the ON position and the engine not running the charge indicator light should light. With the engine running the light should go out, indicating that the battery is being charged.

If the charge indicator light does not light when the keyswitch is in the ON position (engine not running), check the bulb and wiring.

Note: A loose V-belt will cause low DC output.

Belt deflection limit is 9.5-11.5 mm/10 kg (3/8-7/16 in./22 lbs.).

TEST EQUIPMENT
The digital multimeter, Tool #19464 and the DC shunt, Tool #19468, Fig. 20, are required to test the charging system.

Note: The digital multimeter will withstand DC input of 10-20 amps for up to 30 seconds. To avoid blowing fuse in meter, the DC shunt is required.

Replacement fuse is available from your Briggs & Stratton source of supply. Order Part No. 19449.

TESTING ALTERNATOR – DC OUTPUT
The DC Shunt must be installed on the negative (-) terminal of the battery, Fig. 21. All connections must be clean and tight for correct amperage readings.

Attach meter test leads BEFORE starting engine.
The regulator-rectifier test will be performed with the meter in the 300mV position.
1. Attach RED meter test lead to RED post terminal on shunt.
2. Attach BLACK meter test lead to BLACK post terminal on shunt.
3. With the engine running at 2000 RPM, the output should be:
   * 4 – 20 Amps
   * Depending upon battery voltage and/or current draw on system.
4. If no or low output is found, be sure that all connections are clean and secure.
5. If all connections are OK, replace or repair the alternator.
DISASSEMBLE ALTERNATOR

1. Remove pulley nut using tool #19491 and 10 mm deep socket as shown in Fig. 22.
   a. Remove pulley and spacer.
   Replace pulley if damaged or worn.

2. Remove nut and insulator at “B” terminal.
3. Remove three screws and brush cover, Fig. 23.

4. Remove two screws, then brush retainer assembly, Fig. 24.

   **Important:** Length of brush retainer screws are different. Do not mix.
   Screw “A”: 11.5 mm
   Screw “B”: 9.0 mm

5. Remove three screws and regulator, Fig. 25.
**CHARGING SYSTEMS**

6. Remove four stator lead screws from rectifier, Fig. 26.
   a. Carefully straighten stator leads.
   b. Remove rectifier.

7. Scribe or place a reference mark on drive end and brush end housing so that they may be re-assembled in original position.

8. Remove two nuts and two thru bolts.

9. Remove brush end housing being careful not to damage stator leads, Fig. 27.

10. Remove rotor from drive end housing, Fig. 28.
    
    **Note:** Stator is NOT removable.

**CHECKING BEARINGS**

Ball bearings must rotate freely. If any rough spots are felt the ball bearing must be replaced.

**Note:** Rotor and ball bearing are an assembly. If bearing is worn, replace rotor assembly.

**Remove Ball Bearing**

1. Remove four screws and bearing retainer, Fig. 29.
2. Support drive housing on blocks.
3. Press out bearing from pulley side of drive end housing using driver #19416.

**DO NOT** re-use ball bearings that have been removed from drive end housing. The bearing races are usually damaged during removal.
INSTALL BALL BEARING
1. Lightly lubricate bearing O.D. with engine oil.
2. Press in new bearing using bearing driver #19226, Fig. 30.
3. Install retainer and four screws.

CHECKING ROTOR
The following test will be made with the meter in the “Diode Test Position”.
1. Use digital multimeter and check for continuity between slip rings as shown, Fig. 31.
   a. Meter should make continuous tone (continuity).
   b. If meter displays “OL”, (no continuity) replace rotor.
2. Check for continuity between slip ring and rotor shaft.
   a. Meter should display “OL”, (no continuity).
3. Measure slip ring diameter, Fig. 32.
   STD: 14.4 mm (.567")
   Reject: 14.0 mm (.551")
Slip rings may be cleaned with fine sandpaper (#300 – 500 grit).

CHECK BRUSHES
Measure length of brushes protruding from brush holder, Fig. 33.
STD: 10.5 mm (.413")
Reject: 8.0 mm (.315")
CHARGING SYSTEMS

CHECK REGULATOR

The following test will be made with the meter in the “Diode Test Position” 
1. Attach BLACK meter test lead to terminal “A” as shown, Fig. 34.
2. Contact terminal “B” with RED meter test lead, Fig. 34.
   a. Meter should “beep” once.
   b. If meter displays “OL” or makes a continuous tone, regulator is defective. Replace regulator.

CHECK RECTIFIER

The following test will be made with the meter in the “Diode Test Position” 
1. Attach BLACK meter test lead to “B” terminal, Fig. 35. Leave attached through Step 3.
2. Contact #1 terminal with RED meter test lead, Fig. 35.
   a. Meter should “beep” once.
   b. If meter displays “OL” or makes a continuous tone, diode is defective. Replace rectifier.
3. Repeat test at #2, #3 and #4 terminals.
   a. Results must be the same.
4. Attach RED test lead to one of the three rectifier mounting holes, Fig. 36. Leave attached through Step 6.
5. Contact #1 terminal with BLACK meter test lead, Fig. 36.
   a. Meter should “beep” once.
   b. If meter displays “OL” or makes a continuous tone, diode is defective. Replace rectifier.
6. Repeat test at #2, #3 and #4 terminals.
   a. Results must be the same.

ASSEMBLE ALTERNATOR

1. Assemble rotor to drive end housing, Fig. 37.
2. Assemble spacer, pulley and nut to rotor shaft.
   a. Do not tighten nut at this time.
   b. Place pulley side down on work surface.
3. Assemble brush end housing to drive end housing with reference marks aligned, Fig. 38.  
   **Note:** Do not damage stator leads.  
4. Install thru bolts and nuts.  
   a. Torque to 5.0 Nm (45 in. lbs.).  

5. Align stator wires with holes in rectifier and assemble rectifier to brush end housing, Fig. 39.  
6. Carefully form a “U” bend in stator wires.  
   a. Install screws and tighten securely.  

7. Install regulator with three screws shown, Fig. 40.  

8. Assemble cover to brush holder, Fig. 41.
9. Install brush holder.

**Important:** Length of brush retainer screws are different. Install as shown, Fig. 42.
Screw “A”: 11.5 mm
Screw “B”: 9.0 mm

10. Install rear cover and three screws, Fig. 43.
   a. Torque screws to 3.0 Nm (25 in. lbs.).

11. Install insulator and nut.
   a. Torque nut to 4.0 Nm (35 in. lbs.).

Torque drive pulley using the following procedure, Fig. 44.
1. Hold nut with tool #19491.
2. With torque wrench, turn 10 mm deep socket COUNTERCLOCKWISE.
   a. Torque to 70.0 Nm (50 ft. lbs.).
STARTER SYSTEM – GENERAL INFORMATION

Two different starter motors are used on Briggs & Stratton Daihatsu diesel engines. The standard motor is rated at 1.0 Kw., Fig. 45. The optional starter is rated at 1.2 Kw., Fig. 46. The starters are identified by their identification numbers. The starters are similar enough that service procedures and specifications are the same. Where differences occur, they will be shown.

STARTER CURRENT DRAW TEST – ALL (Starter Installed)

Important: When making the starter current draw test make sure that all parasitic load is removed from the engine and that engine has the correct viscosity oil. Engine temperature should be at least 21° C (70° F). Make sure battery and solenoid connections are clean and tight.

NOTE: Battery voltage must not be below 11.7 volts.

Test Equipment

The following equipment is required to test current draw of starter, Fig. 47.

1. Digital multimeter, Tool #19464.
2. DC shunt, Tool #19468.
3. Two battery cables with alligator clips.
4. One jumper wire with alligator clips.
5. A fully charged 12 volt battery.
STARTER SYSTEM

Testing Starter – All

NOTE: To prevent engine from starting, remove fuel shut off solenoid wire from injector pump.

The starter current draw test will be performed with the meter in the 300mV position.

The DC Shunt must be installed on the negative (-) terminal of the battery, Fig. 48.

1. Attach RED meter test lead to RED post terminal on shunt.
2. Attach BLACK meter test lead to BLACK post terminal on shunt.
3. Activate starter.
   a. Allow 3 seconds for meter reading to stabilize.
4. Current draw should not exceed 140 amps DC.

If amperage draw exceeds specification, remove starter from engine and perform No Load starter current draw test.

STARTER CURRENT DRAW TEST – NO LOAD

Remove starter motor.

To hold starter securely while testing, clamp starter mounting bracket in a vise. DO NOT clamp starter housing in a vise or field windings or magnets may be damaged.

Testing Starter (No Load)

The No Load starter current draw test will be performed with the meter in the 300mV position.

The DC Shunt must be installed on the negative (-) terminal of the battery, Fig. 49.

1. Attach RED meter test lead to RED post terminal on shunt.
2. Attach BLACK meter test lead to BLACK post terminal on shunt.
3. Attach negative battery cable to a good ground such as drive housing.
4. Attach positive battery cable to battery terminal on solenoid.
5. Attach one end of jumper wire to solenoid tab terminal, Fig. 49.
6. Activate starter by contacting positive battery terminal with other end of jumper wire, Fig. 49.
   a. Allow 3 seconds for meter reading to stabilize.
7. Current draw should not exceed 90 amps DC.

If amperage draw exceeds specification, replace starter.
STARTER SOLENOID

Test Equipment
The starter solenoid test is performed with the starter removed from the engine.
The following equipment is recommended to test the solenoid.
1. One battery cable with alligator clips. Fig. 50.
2. A jumper wire.
3. A fully charged 12 volt battery.

Testing Starter Solenoid
1. Attach one end of battery cable to negative battery terminal and other end of cable to a good ground such as drive housing. Fig. 51.
2. Attach jumper wire to tab terminal on solenoid.
3. Activate solenoid by contacting positive battery terminal with other end of jumper wire.
   a. Pinion must move outward quickly (engage).
4. Remove jumper wire from positive battery terminal.
   a. Pinion must return quickly (disengage).
If pinion does not move, replace the solenoid.
STARTER SYSTEM

Remove Solenoid
1. Remove nut and field coil wire from stud terminal on solenoid, Fig. 52.

2. Remove through bolts and starter motor, Fig. 53. DO NOT remove armature from starter housing or it will be necessary to re-assemble brushes to armature.

3. Remove two drive end cap screws. Hold starter in vertical position with drive housing down and separate solenoid housing from drive housing, Fig. 54. Note position of solenoid return spring and ball.

NOTE: The solenoid must be replaced as an assembly.

Remove Pinion And Clutch Assembly
1. Remove drive gear from bearing. Remove bearing retainer and five roller bearings, Fig. 55.
2. Remove pinion and clutch assembly from drive housing.
Check Pinion And Clutch Assembly

Check pinion and gear for damage, Fig. 56. Pinion and shaft must rotate in clutch in clockwise direction only. Bearings must turn freely.

NOTE: The pinion and clutch must be replaced as an assembly.

Assemble Pinion And Clutch Assembly

1. Lubricate the following components with silicone grease before assembly, Fig. 57.

NOTE: See insert for correct assembly for type starter.

a. Clutch gear.
b. Bearing retainer and roller bearings.
c. Drive gear.
d. Pinion shaft bearings.
e. Return spring ball.
f. Return spring.

2. Assemble roller bearings and retainer to drive gear shaft, Fig. 58.

NOTE: Roller bearings must face drive housing. Retainer must face solenoid housing.

3. Mesh drive gear with clutch gear. Install pinion and clutch assembly and drive gear into drive housing together, Fig. 59. Install return spring ball in clutch.

Make sure roller bearings remain in position.
STARTER SYSTEM

Install Solenoid
1. Insert return spring into solenoid plunger.
2. Align pilot hole in solenoid with drive gear shaft and assemble solenoid to drive housing, Fig. 60.
   a. Torque screws to 9.0 Nm (80 in. lbs.).
3. Assemble starter motor to drive housing. Align tab on starter with notch in drive housing, Fig. 61.
   a. Torque screws to 9.0 Nm (80 in. lbs.).
4. Install field coil wire.
   a. Torque nut to 8 Nm (70 in. lbs.).

Replace Solenoid Plunger And Contacts
Place starter in a vise with cover plate up.
1. Remove three screws and cover plate.
   a. Discard gasket.
2. Remove plunger and spring.
3. Replace contacts if burned or worn.
   Note: Contacts and plunger must be replaced as an assembly.
4. Measure thickness of contact plates with calipers.
   Reject Dimension: 0.9 mm (0.035”).
5. Remove two nuts with 14 mm wrench, Fig. 64.
6. Remove components in sequence shown, Fig. 65.

**Field Wire Terminal Side:**

(1) G  
(2) F  
(3) E  
(4) D  
(5) C  
(6) B  
(7) A

**Battery Wire Terminal Side:**

Before 99010100: 1.0 KW / After 98123100: 1.0 KW  
Before 98083100: 1.2 KW / After 98090100: 1.2 KW

(1) N  
(2) M  
(3) L  
(4) K  
(5) J  
(6) I  
(7) H  
(8) H

7. Install components in sequence shown, Fig. 65.

**Field Wire Terminal Side:**

(1) A  
(2) B  
(3) C  
(4) D  
(5) E  
(6) F  
(7) G

**Battery Wire Terminal Side:**

Before 99010100: 1.0 KW / After 98123100: 1.0 KW  
Before 98083100: 1.2 KW / After 98090100: 1.2 KW

(1) H  
(2) I  
(3) J  
(4) K  
(5) L  
(6) M  
(7) N  
(8) N

8. Do not tighten terminal nuts at this time.
STARTER SYSTEM

9. Install new plunger and spring.
10. Place bearing driver, Tool #19422 on plunger and compress plunger to end of travel. Maintain pressure.
   a. Torque nuts to 17 Nm (150 in. lbs.).
   Note: This provides proper contact alignment with plunger and contact plates.
11. Clean contact plates and plunger contacts.
12. Install cover plate with new gasket.
   a. Torque screws to 4 Nm (35 in. lbs.).

DISASSEMBLE STARTER MOTOR
1. Remove starter motor from drive housing.
2. Remove screws and end cap.
3. Remove armature from motor housing, Fig. 67.
   If armature drive splines or armature bearings are damaged or worn, replace armature.

Inspect Armature Commutator
The armature commutator may be cleaned with fine sandpaper. DO NOT use emery cloth. Commutator may be machined to no less than 29.0 mm (1.142”), Fig. 68.

   NOTE: Minimum depth of slots between commutator bars after machining is 0.2 mm (.008”).

The armature should be checked for shorts with a growler.

Inspect Brushes
Minimum brush dimension is shown below Fig. 69.
   1.0 KW Starter: 9 mm (.350”).
   1.2 KW Starter: 10 mm (.400”).
   If brushes are worn less than specification, replace as follows.
   1.0 KW Starter: Replace brush retainer and brushes on starter housing.
   1.2 KW Starter: Starter housing and brush retainer must be replaced as an assembly.
Use digital multimeter and check for continuity between field coil wire and brushes shown, Fig. 70.

The following test will be made with the meter in the “Diode Test Position”.

1. Attach either meter test lead to field coil wire.
2. Contact first one positive brush, then opposite brush with other test lead as shown.
   a. Meter should make continuous tone (continuity).
   b. If meter does not make a tone, (no continuity) replace starter housing.

3. Attach either test lead to brush retainer, Fig. 71.
4. Contact first one negative brush, then opposite brush with other test lead as shown.
   a. Meter should make continuous tone (continuity).
   b. If meter does not make a tone, (no continuity) replace brush retainer.

Replace Brushes – 1.0 KW Starter
1. Cut off brush lead wires at terminals as shown.
2. Use a fine file and carefully remove remaining lead wire from terminals.
   \[ L: 2.3 – 2.7 \text{ mm (0.090 – 0.106”)} \]
   \[ W: 6.5 – 7.5 \text{ mm (0.255 – 0.295”)} \]

3. Crimp replacement brushes over terminals so that wires face in counterclockwise direction.
4. Solder brush lead wires to terminals.
5. Insert brushes into brush retainer.
ASSEMBLE STARTER MOTOR

For ease of assembly, clamp splined end of armature in a vise as shown. Use soft jaws to prevent damage to spline, Fig. 74.

1. Place green seal protector from Kit #19356 over commutator.

2. Using seal protector as a guide, slide motor housing with brush retainer into position, Fig. 75. Remove seal protector.
   a. Make sure brush wires are not grounding on brush retainer.

3. Align notch in end cap with rubber seal and install end cap, Fig. 76.
   a. Make sure brush wires are not grounding on end cap.
   
   Tighten screws securely.

4. Assemble starter motor to drive housing. Align tab on starter with notch in drive housing, Fig. 77.
   a. Torque screws to 9.0 Nm (80 in. lbs.).

5. Install field coil wire.
   a. Torque nut to 9.0 Nm (80 in. lbs.).

6. Install starter
   a. Torque screws to 34.0 Nm (25 ft. lbs.).
Wiring Diagram – 14 Amp Alternator (Typical)
493625 Keyswitch With Fixed Preheat Timer and Glow Relay

Fig. 78

Regulator Connector

12 VOLT BATTERY

STARTER MOTOR

KEYSWITCH PART NO.
493625

NOTE: TERMINALS 1, 3, 6 NOT USED

Regulator Rectifier

14 AMP ALTERNATOR

BATTERY

REGULATOR

RECTIFIER

SOLENOID

FUEL FILTER

INJECTION PUMP

WATER INDICATOR LIGHT

PREHEATING TIMER

GLOW RELAY

GLOW LIGHT

GLOW PLUGS

INJECTION PUMP

ACCESSORY & PREHEAT TIMER

SOLENOID & PREHEAT TIMER

BATTERY

TERMINAL FUNCTION

2
3
4
5

1

NOTE:

1, 3, 6 NOT USED

PART NO.
493625

14 AMP ALTERNATOR
Fig. 79

Wiring Diagram – 40 Amp Alternator (Typical)
493625 Keyswitch With Fixed Preheat Timer and Glow Relay

- Fuel Filter
- Water Indicator Light
- Injection Pump
- Preheating Timer
- Glow Relay
- Glow Plugs
- Charge Indicator Light
- Starter Motor
- Battery
- 12 Volt Battery
- Accessory & Preheat Timer
- Solenoid & Preheat Timer
- Battery

Keyswitch Terminal Function:

1. Keyswitch
2. Accessory & Preheat Timer
3. Solenoid & Preheat Timer
4. Battery

Note: Terminals 1, 3, 6 not used

Part No. 493625
Wiring Diagram – 40 Amp Alternator (Typical)
825129 Keyswitch – Manual Preheat

Keyswitch

Part No. 825129

Terminal Function

B Battery
S Solenoid
G1 Glow Plug (Preheat)
G2 Glow Plug (Cranking)
M Accessory

Fig. 81
Section 12
Lubrication System

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Recommended SAE Viscosity Grades

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<td>5W-30</td>
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<td>70</td>
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<td>90</td>
<td>30</td>
</tr>
<tr>
<td>110</td>
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* A synthetic 5W-30 oil may be used.

Use a high quality detergent oil classified “For Service SE/CD” or higher. Use no special additives with recommended oils.
LUBRICATION SYSTEM

DESCRIPTION
Briggs & Stratton Daihatsu gasoline and diesel engines use a full pressure lubrication system with an oil filter. The gear driven oil pump draws oil from a screened oil pickup in the oil pan and pumps the oil through the oil filter. The filtered oil flows through oil galleries in the cylinder block and is distributed to the main bearings, connecting rod bearings, camshaft bearings and rocker arm shaft.
A pressure relief valve limits the maximum oil pressure in the system.

CHANGE OIL
Change oil and filter after first 50 hours of operation. Thereafter, change oil every 100 hours of operation. Change oil filter every 200 hours of operation. Change oil and filter more often if engine is operated in dusty or dirty conditions or if engine is operated under heavy loads or high ambient air temperatures.
Remove oil drain plug and drain oil while engine is still warm, Fig. 1. Check oil drain plug gasket and replace if necessary. Install and torque drain plug to 24.8 Nm (220 in. lbs.).

Remove oil fill cap and refill with oil of recommended grade and viscosity. See Page 1.
Oil Capacity: 3.3 liters (3.5 quarts)
Fill to FULL mark on dipstick.

CHANGE OIL FILTER
Change oil filter every 200 hours of operation.
Before installing new filter, lightly oil filter gasket with fresh clean engine oil.
NOTE: Hand tighten 1/2 turn after gasket contacts mounting surface.
### CHECK OIL PRESSURE

1. Oil level should be between the LOW and FULL marks on dipstick. If oil level is low, check for leaks and add to FULL mark.

2. Remove oil pressure switch.
3. Install oil pressure gauge.
4. Start the engine and allow it to reach normal operating temperature.
5. Check oil pressure at 3000 RPM.

**Oil Pressure: 2.0 ~ 5.0 Bar (28 ~ 70 psi)**

See charts below for troubleshooting guide.

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![Fig. 4 – Oil Level](image)

![Fig. 5 – Checking Oil Pressure](image)
DISASSEMBLE GEAR CASE
Remove Oil Pump

Make sure that #1 cylinder is at TDC, compression stroke. See Section 2.

Remove V-belt and fan (if equipped). Drain oil from engine.

**NOTE:** Clean areas around fuel lines and injectors to prevent dirt entry.

1. Remove the following parts, Fig. 6.
   a. Glow plug wiring.
   b. Glow plugs.
   c. Injector pump bracket.
   d. Remove fuel delivery lines.

---

Fig. 6 – Remove Fuel Delivery Lines
2. Remove oil pan screws and nuts.
   a. Remove oil pan and discard gasket.
   b. Remove oil pick-up tube and strainer. Discard gasket, Fig. 7.

3. Remove bell housing adapter screw if equipped. 
   and install flywheel holder, Tool #19418.
   LEAVE TOOL INSTALLED.
   a. Remove crankshaft pulley using Tool #19420, 
      Fig. 8.

4. Remove timing gear cover, Fig. 9.
   a. Discard timing gear cover gasket.

5. Remove the following parts, Fig. 10.
   a. Camshaft timing gear.
   b. Oil pump gear.
   c. Injector pump nut.
   d. Idler gear.
LUBRICATION SYSTEM

6. Remove injector pump timing gear with a three jaw puller, Fig. 11.

7. Remove parts in sequence shown, Fig. 12.
   a. Remove 3 screws and camshaft retainer.
   b. Remove remaining 5 screws.
   c. Remove timing gear case and discard gasket.

8. Inspect rotors for wear or damage, Fig. 13.
   **NOTE:** If pump rotors are worn or damaged, replace the gear case.

9. Remove and check pressure relief valve assembly, Fig. 14.
   a. Make sure plunger has no nicks or burrs.
   b. Check pressure relief valve spring free length.
10. **Spring free length:** 35.5 mm ± (1.400” ± .040”)
ASSEMBLE GEAR CASE

Install Oil Pump

1. Lubricate oil pump rotor with engine oil and install in cylinder block, Fig. 15.
   a. ID mark on rotor must face cylinder block.

2. Install timing gear case with new gasket. Install camshaft retainer, Fig. 16.
   NOTE: It may be necessary to rotate oil pump drive to engage oil pump rotors.
   NOTE: Position camshaft retainer so that center hole does not interfere with camshaft.
   Note position, length and number of screws as shown.
   a. M6 x 28 mm (M6 x 1.1\(^\text{\textbf{\textdollar}}\)): 4
   b. M6 x 18 mm (M6 x 0.7\(^\text{\textdollar}}\)): 3
   c. M6 x 16 mm (M6 x 0.6\(^\text{\textdollar}}\)): 1
3. Torque screws to 8.0 Nm (70 in. lbs.).

4. Assemble injector pump to gear case with new O-ring and install nuts and support bracket screw finger tight, Fig. 17.
   NOTE: Pump must be able to rotate.
   a. Align timing mark on injector pump with timing mark on gear case.
   NOTE: See Section 10 for injector pump timing procedure.

Engine models 432000 and 582000 after date code 990111007, and all engine models 522000 are equipped with right angle helical timing gears. Timing marks are identified by letters (A, AA, B, BB, etc.), instead of numbers. The timing procedure is the same.

5. With crankshaft key at 12 o’clock position, assemble idler gear so that timing mark 11 (AA) is aligned with timing mark 1 (A) on crankshaft gear, timing mark 22 (BB) is aligned with timing mark 2 (B) on camshaft gear, and timing mark 33 (CC) is aligned with timing mark 3 (C) on injector pump gear, as shown in Fig. 18.
   a. Install oil pump gear.
LUBRICATION SYSTEM

6. Torque screws as shown, Fig. 19.
   a. Camshaft gear:
      41.0 Nm (30 ft. lbs.)
   b. Idler gear:
      25.0 Nm (220 in. lbs.)
   c. Injector pump gear:
      61.0 Nm (45 ft. lbs.)
   d. Oil pump gear:
      19.0 Nm (170 in. lbs.)

7. Install timing gear cover with new gasket. Note position, length and number of screws as shown, Fig. 20.
   a. M6 x 55 mm (M6 x 2.5“): 3
   b. M6 x 45 mm (M6 x 2.1“): 2
   c. M6 x 30 mm (M6 x 1.1“): 9
   d. M6 nut: 2

8. Torque screws and nuts to 8.0 Nm (70 in. lbs.).

9. Install crankshaft pulley with timing mark at 12 o’clock position (#1 cylinder), Fig. 21.
   NOTE: Be sure alignment pin in crankshaft gear is seated in hole in pulley.
   a. Torque screw to 88.0 Nm (65 ft. lbs.).
   b. Remove flywheel holder.

10. Install oil pick-up tube and strainer with new gasket. Torque to 8.0 Nm (70 in. lbs.).
    a. Apply a small bead of Permatex® No. 2 or similar sealant to crankcase areas shown, Fig. 22.
    b. Install oil pan with new gasket.
    c. Torque screws and nuts to 8.0 Nm (70 in. lbs.).
11. Install Glow plugs, wiring and fuel delivery lines.
   a. Torque glow plugs to 17.0 Nm (150 in. lbs.).
   b. Torque fuel delivery lines to 25.0 Nm (220 in. lbs.), Fig. 23.

12. Install V-belt, Fig. 24.
13. Install alternator bolts A and B.
   Belt deflection limit is 10–12 mm/10 kg (3/8–1/2 in/22 lbs.).
   a. Torque bolt A to 19.0 Nm (170 in. lbs.).
   b. Torque bolt B to 61.0 Nm (45 ft. lbs.).
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Briggs & Stratton Daihatsu gasoline and diesel engines use a pressurized, forced circulation cooling system. The water pump circulates coolant through the cylinder block, cylinder head and radiator. The thermostat maintains optimum engine temperature. The thermostat is equipped with a by-pass valve which permits coolant to re-circulate through the cylinder block and cylinder head. As the engine warms, the by-pass valve closes as the thermostat opens, permitting complete circulation through the radiator. Always maintain a 50% solution of phosphate free antifreeze at all times for adequate heat dissipation, lubrication and protection from freezing.
COOLING SYSTEM

CHECKING COOLING SYSTEM

WARNING: The cooling system is pressurized. Do not remove the radiator cap while the engine is hot. To avoid scalding hot coolant or steam blowing out of the radiator, use extreme care when removing the radiator cap. If possible, wait for engine to cool. Wrap a thick rag around cap while removing. To release pressure, slowly turn cap counter clockwise to the first stop. When all pressure has been released, press down on cap and continue turning.

Pressure Testing Cooling System
1. Remove radiator cap and make sure coolant is at correct level.
   a. Coolant level must be no more than 25 mm (1") below bottom of filler neck.
2. Install cooling system pressure tester on radiator and pressurize system to 0.75 Bar (11 psi).
3. Check the following for any signs of leaking.
   NOTE: System must maintain pressure during test.
   a. Hoses and connections (also check hoses for excessive bulging).
   b. Radiator.
   c. Water pump.
   d. Freeze plugs (cylinder block and cylinder head).
If system does not maintain pressure and no leaks are evident externally, check for an internal leak such as a blown head gasket, warped cylinder head or cylinder block.

Testing Radiator Cap
Make sure that rubber seal on radiator cap is not damaged or distorted. Rubber seals must be clean and free of debris to seal properly.
1. Install radiator cap on pressure tester and pressurize the cap.
   Specification: 1.03 ~ 0.76 Bar (15 ~ 11 psi)
   Replace cap if not within specification shown.
   NOTE: Recommended pressure cap capacity is 0.9 Bar (13 psi).

CHANGING COOLANT
Coolant should be changed once a year. Change coolant with engine cold.
1. Remove radiator cap. Remove radiator drain plug and drain the system, Fig. 1.
2. Tighten drain plug.
   NOTE: Follow state or federal laws regarding the proper procedure for disposing of anti-freeze.
3. Fill radiator with 50% solution of phosphate free antifreeze.
4. Start and run engine until thermostat opens (when coolant level drops, thermostat is open).
5. Check coolant level in radiator and add coolant as required, Fig. 2.
THERMOSTAT

Removing Thermostat – Engine Cold
1. Drain engine coolant.
2. Remove screws and coolant outlet housing.
3. Remove locating screw and thermostat, Fig. 3.
4. Remove all traces of gasket material.

Checking Thermostat
A thermometer capable of reading 100° C (210° F) or more is required.
1. Check to make sure thermostat valve is fully closed.
2. Immerse thermostat in water and heat water gradually, Fig. 4.
3. Note temperature when thermostat starts to open.
   a. 81 ~ 84° C (178 ~ 183° F)
4. Note temperature when thermostat is fully open.
   a. 95° C (203° F)
5. Remove thermostat from water and allow to cool.
   a. Thermostat should close fully.

Installing Thermostat
1. Insert thermostat in housing and install locating screw, Fig. 5.
2. Install coolant outlet housing with new gasket.
3. Torque screws to 8.0 Nm (70 in. lbs.).
   Refill with coolant.
COOLING SYSTEM

WATER PUMP

Inspecting Water Pump
Inspect water pump for signs of leaking at vent holes, mounting surfaces and water pump pulley shaft, Fig. 6.
1. Remove V-belt, alternator adjustment bracket, fan (if equipped) and water pump pulley.
   a. Replace pulley if bent or damaged.

2. Check water pump bearings by rotating pulley flange by hand, Fig. 7.
   a. Make sure pulley rotates smoothly.

If water pump shows evidence of leaking or bearings are rough, replace the water pump.

NOTE: Most water pump and cooling system failures result from using straight water as a coolant. Without water pump lubricant and corrosion inhibitors, the water pump will fail prematurely.

Removing Water Pump
Drain engine coolant.
1. Disconnect radiator hoses, Fig. 8.

Remove the following parts, Fig. 9.
2. Temperature gauge wire (if equipped).
3. Coolant outlet.
5. Water pump.

Clean all traces of gasket material from mounting surfaces and inspect mounting surfaces for damage.
Installing Water Pump
1. Install water pump with new gasket, Fig. 10.
   a. Torque screws and nuts to 19.0 Nm (170 in. lbs.).
After installing water pump make sure pump rotates smoothly.

2. Install coolant inlet with new gasket, Fig. 11.
   a. Torque screws to 8.0 Nm (70 in. lbs.).
3. Install thermostat and coolant outlet with new gasket, Fig. 11.
   a. Torque screws to 8.0 Nm (70 in. lbs.).
4. Install temperature gauge wire (if equipped).
5. Install radiator hoses.

6. Install fan (if equipped) and water pump pulley, Fig. 12.
   a. Torque screws to 8.0 Nm (70 in. lbs.).

7. Install V-belt, Fig. 13.
   a. Belt tension adjustment: 10-12 mm/10 kg
      (3/8-1/2 in./22 lbs.).
8. Refill cooling system.
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Section 14
Turbocharger

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950 CC DIESEL TURBOCHARGED ENGINE

General Information
Models 588447 and 58A447 are turbocharged equipped diesel engines.

Turbocharger Lubrication System
Lubricating oil for the turbocharger is supplied from the rear of the cylinder head to the turbocharger via the oil inlet line. The oil supply is regulated by the inlet port diameter of the oil inlet line. The oil inlet line is installed with union screws at the cylinder head and the turbocharger. Oil returns to the cylinder block via the oil outlet line.

Full Floating Bearing
The turbine shaft for the turbocharger is equipped with a full floating bearing lubricated by engine oil.
Turbocharger Cooling System

Coolant for the turbocharger is supplied from the rear right of cylinder block and returns to the water pump inlet.

Fig. 3 – Cooling System of Turbocharger (1)

Fig. 4 – Cooling System of Turbocharger (2)
TURBOCHARGER

Turbocharger Waste Gate
The turbocharger is equipped with a waste gate to control turbocharger pressure.

Turbocharger Pressure Control System
As pressure in the turbocharger rises, the actuator for the waste gate valve opens allowing some of the exhaust gases to bypass the turbocharger.
Crankcase Blow-by Recirculating System
Crankcase blow-by is recirculated as shown in Fig. 7

CHECKING WASTE GATE ACTUATOR
1. Disconnect the waste gate actuator hose at the actuator.
2. Connect pressure/vacuum pump, Tool #19493.
3. Apply pressure of 14.2 psi (0.9 bar) and ensure that the rod and link operate.
4. When pressure is released rod and link must return to original position.
   **NOTE:** DO NOT apply pressure more than 21.3 psi (1.5 bar) to the waste gate actuator or the diaphragm will be damaged.
5. If the actuator hose is damaged or cracked it must be replaced.
TURBOCHARGER

SERVICING AND OPERATION INFORMATION

1. DO NOT disassemble the turbocharger.
2. When removing and installing turbocharger:
   a. Handle the turbocharger carefully. DO NOT drop.
   b. When removing the air intake system or lubrication system, be careful not to get dust or foreign matter into the turbocharger.
   c. Use tape to cover the oil inlet and outlet ports, coolant ports, air intake and exhaust port to prevent the turbocharger from getting dust or debris into it.
   d. After the turbocharger has been replaced, run the engine a minimum of 15 seconds at idle. If the engine speed is raised rapidly, it may cause damage to the turbocharger bearing.
   e. Check oil and coolant lines for leaks.
   f. Special heat treated mounting fasteners are used on the turbocharger. Do not substitute.

3. DO NOT lift or carry turbocharger by the waste gate actuator rod.

4. DO NOT remove residual oil from turbocharger.
5. DO NOT touch the turbocharger when the engine is running.
6. DO NOT run the engine with the intake pipe removed.
7. DO NOT place the turbocharger in a vertical position.
**TURBOCHARGER**

**REMOVE TURBOCHARGER**

1. Remove the muffler or exhaust pipe from the turbocharger.
2. Lift tab on tie strap and remove tie strap. Then remove crankcase breather tube at air intake tube.
3. Disconnect the air intake tube at the turbocharger.
4. Disconnect the air intake tube from the air intake pipe.
5. Remove the two nuts, and remove the air intake pipe from turbocharger.
6. Remove the coolant inlet hose from coolant inlet line.
7. Remove coolant outlet hose.

8. Remove coolant inlet line bracket screw.

9. Remove two nuts, then remove coolant line assembly from turbocharger.

10. Remove oil inlet line union screw at turbocharger. Discard the washer.

12. Remove oil inlet line bracket screw at the exhaust manifold.

13. Remove two screws from turbocharger and pull out the oil outlet tube from the cylinder block. Discard “O” ring and gasket.

14. Remove screws (2) and nuts (3) and remove turbocharger mounting bracket. Discard gasket.
15. Remove nuts (3), and remove the turbocharger assembly from the exhaust manifold.

**NOTE:** When removing the turbocharger assembly, DO NOT lift or carry turbocharger by the waste gate actuator rod. Use tape to cover the oil inlet and outlet ports, coolant ports, air intake and exhaust port.

**CHECKING TURBOCHARGER**

1. Check blades of turbine and compressor for damage.
2. Rotate the blades by hand, and ensure that they turn freely without contacting the housing.
3. Check that oil is not leaking at the turbine side.
4. Check oil inlet union screws for dirt or debris. If the union screw is clogged, clean it using compressed air as shown below.

**NOTE:** If union screws are clogged, clean or replace the oil inlet line.
5. Check each part for damage or cracks. Replace defective parts.
INSTALL TURBOCHARGER

1. Install the turbocharger assembly with new gasket.
   a. Torque nuts (3) to 25 Nm (18.0 ft.-lb).

2. Install the turbocharger bracket with new gasket.
   a. Temporarily tighten the nuts 1 and bolts 2 until the flange surfaces of the turbocharger, exhaust manifold and turbocharger stay in contact each other.
   b. First torque nuts 1 to 34.0 Nm (25.0 ft.-lb)
   c. Then torque screws 2 to 29.0 Nm (20.0 ft.-lb)

3. Install oil outlet line.
   a. Insert the oil outlet tube into the cylinder block with new “O” ring.
   b. Assemble to turbocharger with new gasket.
   c. Torque screws to 8.0 Nm (70.0 in-lb).
TURBOCHARGER

4. Install oil inlet line.
   a. Temporarily install the union screw with washers at the cylinder head.
   b. Temporarily install the union screw with washer at the turbocharger.
   c. Temporarily install the inlet line bracket screw.
   d. Then torque union screws and bracket screw.
      Union screws:
      Cylinder head side – Turbocharger side –
      44.0 Nm 18.0 Nm (170 in-lb)
      (32.0 ft-lb)

   Bracket screw:
   19.0 Nm (170 in-lb)

5. Install Coolant Line at turbocharger with new gasket.
   a. Torque nuts to 8.0 Nm (70 in. lbs.).

6. Install bracket screw.
   a. Torque screw to 19.0 Nm (170 in. lbs.).
7. Install coolant outlet hose from turbocharger to coolant inlet housing as shown, Fig. 36. Install clamps with tabs as shown.

8. Install coolant inlet hose over inlet tube up to yellow mark on tube. Install clamps with tabs as shown.

9. Install air intake pipe.
   a. Torque nuts to 13.0 Nm (115 in. lbs.).

10. Align the match marks (white paint), and install the air intake hose onto the air intake pipe.
    Installation direction of clamps:
    A Install the clamp so that tabs face rear of engine.
    B Install the clamp so that tabs face out.
TURBOCHARGER

11. Install breather tube as shown.
12. Install muffler or exhaust pipe.
13. Connect the air hose connecting the air cleaner to the turbocharger.

INSTALLATION OF COOLANT INLET TUBE

1. Apply sealer to the portion of tube that is to be installed in cylinder block.
2. Align the center of tube with the center of M10 thread at the rear end of the cylinder block.
3. Press-in tube until flange contacts the cylinder block.
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REPAIR MANUAL
For 3 Cylinder Liquid-Cooled Diesel Engines