FOREWORD

This manual has been written and published by GENERAC® POWER SYSTEMS, INC. to aid our dealers' mechanics, company service personnel and general consumers when servicing the products described herein.

It is assumed that these personnel are familiar with the servicing procedures for these products, or like or similar products, manufactured and marketed by GENERAC® POWER SYSTEMS, INC. It is also assumed that they have been trained in the recommended servicing procedures for these products, which includes the use of mechanics hand tools and any special tools that might be required.

Proper service and repair is important to the safe, economical and reliable operation of the products described herein. The troubleshooting, testing, service and repair procedures recommended by GENERAC® POWER SYSTEMS, INC. and described in this manual are effective methods of performing such operations. Some of these operations or procedures may require the use of specialized equipment. Such equipment should be used when and as recommended.

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

All information, illustrations and specifications contained in this manual are based on the latest product information available at the time of publication. However, GENERAC® POWER SYSTEMS, INC. reserves the right to change, alter or otherwise improve the product at any time without prior notice.

Some components or assemblies of the product described in this manual may not be considered repairable. Disassembly, repair and reassembly of such components may not be included in this manual.

The engines described herein may be used to power a wide variety of products. Service and repair instructions relating to any such products are not covered in this manual. For information pertaining to use of these engines with other products, refer to any owner’s or service manuals pertaining to said products.
RULES FOR SAFE OPERATION

4-CYCLE ENGINE THEORY

SECTION 1: GENERAL INFORMATION

SECTION 2: IGNITION

SECTION 3: AIR INTAKE SYSTEM AND CARBURETION

SECTION 4: MECHANICAL GOVERNOR

SECTION 5: OPTIONAL IDLE CONTROL

SECTION 6: CYLINDER HEAD AND VALVES

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A WORD ABOUT SPECIAL TOOLS

Many of the procedures depicted in this manual require the use of special tools. Some of the tools required are available as Generac parts and are listed as such in this manual.

ATTENTION!

Generac Power Systems does not approve or authorize the use of these engines on All Terrain Vehicles (ATVs), go-carts, motorbikes, aircraft products, personal watercraft, or vehicles intended for use in competitive events. The use of this product in any other than it's intended application will void the warranty! Use of these engines in such applications could result in property damage, serious injury (including paralysis), or even death.
RULES FOR SAFE OPERATION

If you do not understand any portion of this manual, contact Generac or your nearest Generac Authorized Service Dealer for starting, operating and servicing procedures.

Throughout this publication and on tags and decals affixed to the engine, DANGER, WARNING and CAUTION blocks are used to alert you to special instruction about a particular operation that may be hazardous if performed incorrectly or carelessly. Observe them carefully.

These safety warnings cannot eliminate the hazards that they indicate. Strict compliance with the special instructions while performing the service plus “common sense” are major measures to prevent accidents.

The following definitions apply to DANGER, WARNING, CAUTION and NOTE blocks found throughout the manual. These safety symbols indicate the following:

⚠️ DANGER: After this heading you can read handling, installing, operating or servicing instructions that, if not strictly complied with, will result in personal injury.

⚠️ WARNING: After this heading you can read handling, installing, operating or servicing instructions that, if not strictly complied with, may result in personal injury.

⚠️ CAUTION: After this heading you can read instructions for handling, installing, operating or servicing the engine that, if not strictly complied with, may result in damage to equipment and/or property.

NOTE: After this heading you can read explanatory statements that require special emphasis.

These symbols indicate the following:

⚠️ Points out important safety information that, if not followed, could endanger personal safety and/or property of yourself and others.

⚠️ Potential explosion hazard.

⚠️ Potential fire hazard.

⚠️ Potential fire hazard.

RULES FOR SAFE OPERATION

Study these RULES FOR SAFE OPERATION carefully before operating or servicing this equipment. Become familiar with the OWNER’S MANUAL and with the engine. The engine can operate safely, efficiently and reliably only if it is properly operated and maintained. Many accidents are caused by failing to follow simple and fundamental rules or precautions.

Generac cannot possibly anticipate every possible circumstance that might involve a hazard. The warnings in this manual and on tags and decals affixed to the equipment, are therefore, not all-inclusive. If you use a procedure, work method or operating technique Generac does not specifically recommend, you must satisfy yourself that it is safe for you and others. You must also make sure the procedure, work method or operating technique that you choose does not render the engine to be unsafe.

⚠️ DANGER: Do not tamper with the engine governed speed. High operating speeds are dangerous and increase the risk of personal injury or damage to the equipment. Operating at low speeds with heavy load may shorten the engine’s life.

BEFORE OPERATING

- Gasoline is highly FLAMMABLE and its vapors are EXPLOSIVE. Do not permit smoking, open flames, sparks or heat in the area while handling gasoline. Avoid spilling gasoline on a hot engine. Comply with all of the laws regulating storage and handling of gasoline.
- Store gasoline and other fuels only in containers designed and approved for the storage of such materials.
- Add gasoline in a clean, well-ventilated area. Wipe up any spilled gasoline immediately. If gasoline has been spilled, let it dry completely before starting the engine.
- Do not overfill the fuel tank. Always allow room for fuel expansion. If the tank is overfilled, the fuel can overflow onto a hot engine and cause a FIRE or an EXPLOSION.
- Allow at least two (2) feet of clearance on all sides of the engine, even while operating it outdoors, or you could damage the engine.
- Thoroughly inspect the engine for loose or damaged parts before each use. Do not use the engine until adjustments or repairs are made.
- Check the oil level in the engine before each use.
- Inspect the engine periodically. Repair or replace all damaged or defective parts immediately.
• Inspect fuel system frequently for leaks or damage. Repair or replace any damaged or leaking component immediately. Never attempt to change, alter or modify the engine fuel system in any way that might affect safety or compliance with applicable codes and standards.

WHILE OPERATING
• This engine was designed and manufactured for specific applications. Do not attempt to modify the equipment or use it for any application for which it was not designed.
• Generac Power Systems does not approve or authorize the use of these engines on All Terrain Vehicles (ATV’s), go-carts, motorbikes, aircraft products, personal watercraft, or vehicles intended for use in competitive events. The use of this product in any other than its intended application will void the warranty! Use of these engines in such applications could result in property damage, serious injury (including paralysis), or even death.
• Engine exhaust gases contain DEADLY carbon monoxide gas. This dangerous gas, if breathed in sufficient concentrations, can cause unconsciousness or even death. Operate this equipment only in the open air where adequate ventilation is available.
• Do not insert any object through the cooling slots of the engine. You could damage the equipment or injure yourself.
• Do not operate the engine faster than the speed necessary to operate the equipment. Do not run the engine at high speed when not operating the equipment.
• This engine requires an adequate flow of cooling air for its continued proper operation. Never operate the equipment inside any room or enclosure where the free flow of cooling air into and out of the equipment might be obstructed. Without sufficient cooling air flow, the engine quickly overheats, damaging the engine or nearby property.
• Do not smoke around the engine. Wipe up any fuel or oil spills immediately. Never leave oily or fuel soaked rags around the engine. Keep the area around the engine clean and free of debris.
• Keep hands, feet, clothing, etc., away from moving parts of this engine.
• Never operate the engine (a) in the rain; (b) in any enclosed compartment; (c) if the engine speed changes; (d) if the engine sparks; (e) if flame or smoke is observed while the engine is running.
• Never work on this engine or handle any electrical device while standing in water, while barefoot, or while hands or feet are wet. DANGEROUS ELECTRIC SHOCK will result.

WARNING:
The engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.

SERVICE INFORMATION
Service on this engine within and after the warranty period can be performed by any authorized service dealer. Service technicians are factory trained and capable of handling all service needs.

When contacting an authorized service dealer about parts and service, always supply the complete model number and serial number of your unit as given on its data plate decal. See the illustration below for the location of the decal.

The warranty for this engine is included in the owner's manual.
If the engine is to run properly, four (4) events must occur in the proper sequence and at the correct time. These events are (A) intake, (B) compression, (C) ignition and power, and (D) exhaust.

(A) INTAKE
The piston is travelling from top dead center (TDC) to bottom dead center (BDC). The cam has opened the intake valve. The piston’s downward movement in the cylinder creates a partial vacuum in the cylinder. Air at atmospheric pressure is drawn into the cylinder through the carburetor and is mixed with fuel in the carburetor. The fuel-air mixture flows through the open intake valve into the cylinder. When the piston reaches BDC, the intake stroke is over.

(B) COMPRESSION
As the piston reaches bottom dead center (BDC), both the intake and exhaust valves are closed. The piston moves upward toward TDC and the fuel-air mixture is compressed. Just before the piston reaches TDC, ignition occurs.

(C) IGNITION AND POWER
By the time the piston reaches TDC, combustion is already in progress. The intake and exhaust valves remain closed as the expanding gases of combustion force the piston downward.

(D) EXHAUST
The exhaust stroke begins when the piston has reached BDC and has started its upward movement. The intake valve is closed. The exhaust valve is open to let gases escape.
SECTION 1: GENERAL INFORMATION

MAINTENANCE SCHEDULE

<table>
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<th>Every 8 Hours or Daily</th>
<th>Every 25 Hours Season</th>
<th>Every 50 Hours Season</th>
<th>Every 100 Hours Season</th>
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<tbody>
<tr>
<td>Check Oil Level</td>
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<tr>
<td>Change Oil</td>
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<td>Note 1</td>
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<td>Change Oil Filter</td>
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<td>Service Air Filter</td>
<td>Foam Pre-Filter if equipped</td>
<td>Filter (Note 2)</td>
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<tr>
<td>Replace or Clean Spark Plug</td>
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<td>Clean Spark Arrestor Screen</td>
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<tr>
<td>Valve Clearance</td>
<td>Note 3</td>
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</table>

**NOTE 1:** Change oil after the first eight hours of operation on a new engine. Thereafter, change oil every 50 hours of operation, or after every 100 hours if the engine is equipped with an oil filter, or every season. Change oil sooner when operating under heavy loads or in dirty or dusty environments, or under higher ambient temperatures.

**NOTE 2:** Clean more often when operating in dirty or dusty conditions.

**NOTE 3:** Check valve lash and adjust if necessary after first 50 hours of operation and every 100 hours thereafter.

FUEL AND OIL RECOMMENDATIONS

**GASOLINE:**

We recommend the use of clean, fresh lead-free gasoline. A minimum of 85 octane is recommended. The use of lead-free gasoline results in fewer combustion deposits and longer valve life.

**NOTE:** Using a fuel additive such as STA-BIL® fuel stabilizer, or an equivalent, will prevent gum deposits from forming in the engine’s fuel system.

**NOTE:** Some fuels, called oxygenated or reformulated gasolines, are gasolines blended with alcohols or ethers. Excessive amounts of these blends can damage the fuel system or cause performance problems. Do not use gasoline which contains Methanol. If any undesirable operating symptoms occur, use gasoline with a lower percentage of alcohol or ether.

It is also recommended that gasoline be purchased in small quantities, not more than a 30 day supply. FRESH gasoline minimizes gum deposits, and also will ensure fuel volatility tailored for the season in which the engine will be operated.

**LUBRICATION:**

Oil has four purposes. It cools, cleans, seals and lubricates. During normal operation, small particles of metal from the cylinder walls, pistons, bearings and combustion deposits will gradually contaminate the oil. Dust particles from the air also contaminate the oil forming an abrasive mixture which can cause wear to all of the internal moving parts of the engine, if the oil is not changed regularly. Fresh oil also assists in cooling. OId oil gradually becomes thick and loses its cooling ability as well as its lubricating qualities.

**RECOMMENDED OIL TYPE:**

Using the proper type and weight of oil in the crankcase is extremely important. Check the oil before each use and change the oil regularly (see Figures 1-1, 1-2 & 1-3). Failure to use the correct oil, or using dirty oil, can cause premature engine wear and failure.

Use only high quality detergent oil rated with API service classification SF, SG or SH. The recommended oil weights include the following:

- **During summer months:** SAE 30. An acceptable substitute is SAE 10W-30. After first oil change, synthetic oil is acceptable.
- **During winter months:** SAE 5W-30 or Synthetic 5W-30. **DO NOT USE SAE 10W-40.**

**CHANGE OIL:**

See “Section 14: SPECIFICATIONS” for crankcase oil capacities. Use no special additives. Make sure that the unit is level when filling with oil. **DO NOT OVERFILL.**

**IMPORTANT:** **DO NOT OVERFILL.** Check and maintain oil level regularly. Change oil and filter after first eight (8) hours of operation.

Thereafter, change oil and filter every 100 hours of operation. Change oil more often if engine is operated in dirty or dusty conditions or if engine is operated under heavy loads or in high ambient air temperatures.

Remove oil drain plug and drain oil while engine is still warm, Figure 1-2. Change oil filter (Figure 1-3) and replace drain plug.
SECTION 1: GENERAL INFORMATION

Figure 1-1. Oil Fill

Remove oil fill cap and refill slowly with new oil of proper service classification and viscosity grade. Refill to bottom of threads in oil fill opening.

If engine has optional dipstick, remove dipstick and refill slowly with new oil of proper service classification and viscosity grade. Refill to full mark on dipstick. When checking oil level, dipstick must be turned all the way in for accurate readings.

Start and run engine to check for oil leaks.

CHANGE OIL FILTER:

Replace oil filter every 00 hours. Before installing new filter, lightly oil filter gasket with fresh clean engine oil. Screw filter on by hand until gasket contacts filter adapter. Tighten 3/4 to one full turn farther, Figure 1-3.

Start and run engine at idle for 30 seconds and stop engine. Recheck oil level and add if required. Restart engine and check for oil leaks.

Figure 1-2. Oil Drain

REPLACE SPARK PLUGS:

Replace spark plugs every 00 hours of operation or every season, whichever occurs first. Replace spark plugs if electrodes are burned away, or the porcelain is cracked. Set spark plug gap at .76 mm (.030") for all models. Torque spark plugs to 20.0 Nm (180 in. lbs.).

Figure 1-3. Oil Filter

SET PLUG GAP AT 0.76 mm (0.030 inch)

Figure 1-4. Setting Spark Plug Gap

Note: For proper spark plug replacement, refer to the owner’s manual for the specific product.

AIR CLEANER MAINTENANCE:

WARNING: NEVER OPERATE ENGINE WITH AIR CLEANER ASSEMBLY OR AIR CLEANER CARTRIDGE REMOVED. FIRE MAY RESULT.

A properly serviced air cleaner protects internal parts of the engine from dirt and dust particles in the air. If air cleaner instructions are not carefully followed, dirt and dust which should be collected in the cleaner, will be drawn into the engine. These particles are highly abrasive and will cause the piston rings and cylinder bore to wear quickly. As the rings and cylinder bore become worn, these abrasive particles enter the
crankcase and contaminate the oil, forming an abrasive mixture which will cause wear on all of the internal moving parts.

The air cleaner on every engine brought in for a check up or repair should be examined and serviced. If the air cleaner shows signs of neglect, show it to the customer before cleaning. Instruct the customer on proper care, to assure long engine life.

*Note: Replace air cleaner gaskets and mounting gaskets that are worn or damaged, to prevent dirt and dust from entering engine due to improper sealing. Replace bent air cleaner mounting bracket if necessary.*

**SERVICE DUAL ELEMENT AIR CLEANERS:**

Remove and service foam pre-cleaner every 25 hours or every season, whichever occurs first. Service cartridge every 50 hours or every season, whichever occurs first.

*Note: The air cleaner assemblies on some equipment may have been supplied by the equipment manufacturer. See the equipment manufacturer’s owner’s manual for service information specific to that product.*

**TROUBLESHOOTING**

Most complaints concerning engine operation can be classified as one or a combination of the following:

1. Will not start
2. Hard starting
3. Lack of power
4. Runs rough
5. Vibration
6. Overheating
7. High oil consumption

*Note: What appears to be an engine malfunction may be a fault of the powered equipment rather than the engine. If equipment is suspect, see equipment affecting engine operation.*

**SYSTEMATIC CHECK:**

If the engine will not start and the cause of malfunction is not readily apparent, perform a systematic check in the following order:

1. Fuel
2. Ignition
3. Compression

This check-up, performed in a systematic manner, can usually be done in a matter of minutes. It is the quickest and surest method of determining the cause of failure. The basic check-up procedure is the same for all engine models, while any variation, by model, will be shown under the subject heading.

**CHECK FUEL:**
- Are the tanks full?
- Is the fuel stale?
- Is the tank vent open?
- Is the fuel shutoff valve open?

**CHECK IGNITION:**

See Section 2 “IGNITION”.

**CHECK COMPRESSION:**

To check engine compression, remove the spark plug. Insert an automotive type compression gauge into the spark plug hole. Crank the engine until there is no further increase in pressure. The highest reading obtained is the engine compression pressure.

- **190-220cc Engines: Minimum 60psi**
- **320-410cc Engines: Minimum 55psi**

These minimum readings may appear low. This is due to the engine being equipped with a compression release mechanism to minimize starting effort. Actual running compression will be much higher (see Page 11-3).

If compression is poor, look for one or more of the following causes:
- Loose cylinder head bolts.
- Failed cylinder head gasket.
- Burned / worn valves or valve seats.
- Insufficient valve clearance.
- Warped cylinder head.
- Warped valve stem or worn valve guides.
- Worn or broken piston ring(s).
- Worn or damaged cylinder bore.
- Broken connecting rod.

**CYLINDER LEAKDOWN TEST**

A cylinder leakdown tester may be used to test the sealing capability of the compression components of each cylinder and quickly identify the problem component.

A cylinder leak down test will indicate the condition of the cylinder. It will assist in troubleshooting the engine’s condition such as leaking valves or rings.

On the tester there will be two gauges, one will be the incoming air pressure and the other will measure the percent of cylinder leakage.
SECTION 1: GENERAL INFORMATION

CYLINDER LEAK DOWN TEST PROCEDURE:
1. Piston must be at TDC.
2. Install the tester into the spark plug hole
3. Pressurize the cylinder to 90 psi.
4. Observe the leakage of the cylinder and where the air is coming from.

NOTE: If leaking into intake or exhaust port, check lash, valve face, and seat condition.

RESULTS:
1. 0-10% Cylinder is good
2. 10-30% there may be a problem
3. 30-100% Cylinder requires repair

THINGS WHICH AFFECT BOTH CYLINDERS:
1. Carburetion
2. Crankcase vacuum
3. Ignition timing
   a. A partially sheared flywheel key will effect ignition timing and engine performance.

THINGS WHICH AFFECT ONE CYLINDER:
1. Spark plug
   a. A fouled spark plug may indicate that carburetor is out of adjustment.
2. Leak in spark plug wire
3. Head gasket
4. Intake manifold
   a. A leak at either end of the intake manifold will only affect one cylinder, not both.
5. Valves
6. Rings
7. Piston
8. Cylinder

EQUIPMENT AFFECTING ENGINE OPERATION
Frequently, what appears to be a problem with engine operation, such as hard starting, vibration, etc., may be the fault of the equipment powered rather than the engine itself. Listed are the most common effects of equipment problems, and what to look for as the most common cause.

HARD STARTING OR WILL NOT START:
1. Loose belt - a loose belt like a loose blade can cause a backlash effect, which will counteract engine cranking effort.
2. Starting under load - see if the unit is disengaged when engine is started; or if engaged, should not have a heavy starting load.
3. Check remote control assembly for proper adjustment.
4. Check interlock system for shorted wires, loose or corroded connections, or defective modules or switches.

ENGINE WON'T STOP:
1. Check equipment ignition stop switch.
2. Check for loose or disconnected equipment stop switch wire.
3. Check ground wire harness on engine.
   a. See Section 2 for test procedure.

VIBRATION:
1. Unit load out of balance - remove and balance.

POWER LOSS:
1. Bind or drag in unit- if possible, disengage engine and operate unit manually to feel for any binding action.
2. Unit load has excess drag.

NOISE:
1. Engine coupling or pulley - an oversize or worn coupling can result in knocking, usually under acceleration. Check for fit or tightness.
2. Equipment needs lubrication.
SECTION 2: IGNITION

GENERAL
The ignition system typically used on single cylinder engines is a solid-state (breakerless) type. The system utilizes a magnet on the engine flywheel to induce a relatively low voltage into an ignition coil assembly. Ignition coil internal components increase the voltage and deliver the resulting high voltage across the spark plug gap.

The ignition coil houses a solid-state circuit board that controls ignition timing. Timing is fixed, nonadjustable and spark advance is automatic.

MAJOR COMPONENTS
Major components of the ignition system include (a) the ignition coil assembly, (b) the spark plug, (c) the engine run switch and (d) the engine flywheel (see Figures 2-1 and 2-4).

SPARK PLUG
The spark plug should be cleaned and regapped periodically. The plug should be replaced every 00 hours of operation or once annually, whichever comes first.

Set spark plug gap to 0.030 inch (0.76mm) (Figure 2-3).

Note: For proper spark plug replacement, refer to the owner’s manual for the specific product. Always use original GENERAC® replacement parts.

FLYWHEEL
CHECKING FLYWHEEL MAGNET:
The flywheel magnet rarely loses its magnetism. If you suspect a magnet might be defective, a rough test can be performed as follows:

1. Place the flywheel on a wooden surface.
2. Hold a screwdriver at the extreme end of its handle and with its point down.
3. Move the tip of the screwdriver to about 1 inch (9mm) from the magnet. The screwdriver blade should be pulled in against the magnet.

FLYWHEEL KEY:
The flywheel’s taper is locked on the crankshaft taper by the torque of the flywheel nut. A keyway is provided for alignment only and theoretically carries no load.

If the flywheel key becomes sheared or even partially sheared, ignition timing can change. Incorrect timing can result in hard starting or failure to start.

FLYWHEEL REMOVAL:
Use a strap wrench to prevent the flywheel from turning. Remove the FLYWHEEL NUT. Then, remove the CONICAL WASHER and the STARTER CUP.

Use a commercially available flywheel puller to remove the flywheel from the engine tapered shaft.
SECTION 2: IGNITION

FLYWHEEL INSTALLATION:
Align the keyway in the flywheel with the woodruff key on the crankshaft. Install the flywheel, the starter cup and the conical washer. Install the flywheel nut and tighten to the proper torque.

NOTE: The conical washer must be installed in the proper direction (see Figure 2-4) with the convex side facing out (away from the flywheel).

TESTING THE IGNITION SYSTEM
The condition of the ignition system can be accurately diagnosed using an ignition tester, (Generac P/N 0C5969) as follows:

1. Disconnect the high tension lead from the spark plug.
2. See Figure 2-5. Attach the spark tester clamp to the engine cylinder head (frame ground). Attach the spark plug high tension lead to the tester terminal.
3. Crank the engine rapidly. If spark jumps the gap of the spark tester, you may assume the ignition system is operating satisfactorily.

NOTE: If the flywheel key is sheared or partially sheared, spark can jump the tester gap. However, loss of correct ignition timing may result in hard starting or no starting at all.

4. To determine if an engine miss is ignition related, connect the spark tester in series with the high tension lead and the spark plug (Figure 2-6). Then, test the system as follows:
   a. Start the engine.
   b. If spark jumps the tester gap regularly but the miss continues, the problem is in the spark plug or in the fuel system. A spark miss will be readily apparent.

NOTE: The ignition system described in this section is typically used on horizontal shaft engines. The ignition system used on all vertical shaft (RV) engines differs from that of horizontal shaft engines. See "SERVICE MANUAL COMPUTER CONTROLLED VARIABLE SPEED RV GENERATORS," Manual Part No. 094468-A.
AIR CLEANER

SERVICING:
The engine will not run properly and may be damaged if it is run with a dirty air cleaner.

Clean or replace the paper filter every 25 hours of operation or once annually, whichever occurs first. Clean or replace the paper filter more often if operating in extremely dusty or dirty conditions.

Clean or replace the foam pre-cleaner every 25 hours of operation; more frequently under dirty or dusty conditions.

FOAM PRE-CLEANER:
To clean or replace the foam pre-cleaner:
1. Remove the air cleaner cover, then remove the foam pre-cleaner.
2. Wash the foam pre-cleaner in soapy water.
3. Squeeze the pre-cleaner dry with a clean cloth. DO NOT TWIST.

NOTE: If the pre-cleaner is still dirty after washing and drying it, replace it with a new filter
4. Apply enough clean engine oil to saturate the pre-cleaner.
5. Wrap the pre-cleaner in a clean dry cloth and squeeze out excess oil. DO NOT TWIST. Set the pre-cleaner aside.

PAPER FILTER:
1. Remove the air cleaner cover.
2. Remove the foam pre-cleaner and service it, if necessary.
3. Remove the paper filter.
4. Clean the paper filter by tapping gently on a flat surface. If it is very dirty, replace it.
5. Clean the air cleaner cover. Then, install the foam pre-cleaner into the cover.
6. Insert the paper filter into the cover so it holds the pre-cleaner in place.
7. Assemble the pre-cleaner, paper filter and cover to the air cleaner base.

AIR CLEANER BOX REMOVAL (LARGE FRAME):
If the air cleaner box must be removed for further engine disassembly, do the following (see Figure 3-2):
1. Remove the air cleaner cover.
2. Remove the foam pre-cleaner and paper filter.
3. Remove the choke knob.
4. Remove the breather hose.
5. Remove the two nuts and corresponding washers from the carburetor mounting bolts.
6. Remove the two capscrews and corresponding washers from the lower part of the air cleaner box.

NOTE: The carburetor will be loose after removal of the air cleaner box. Do not allow the carburetor to drop.

Note: Be careful not to stretch or bind the wires connected to the Low Oil Indicator and Start/Stop switch.

Figure 3-1. Typical Air Cleaner

Figure 3-2. Exploded View of Air Cleaner Box
SECTION 3: AIR INTAKE SYSTEM AND CARBURETION

AIR CLEANER BOX REMOVAL (SMALL FRAME):

If the air cleaner box must be removed for further engine disassembly, follow Steps 1-4 from Large Frame Air Cleaner Box Removal. Then do the following:

1. Remove the cap screw in the upper part of the air cleaner box and the two phillips head screws in the lower part of the air cleaner box (see Figure 3-3).

CAUTION! Removal of the two phillips head screws on a choke style carburetor/air cleaner box combination also will loosen the carburetor from its mount. Be careful not to let the carburetor drop, as damage to the carburetor and/or governor rod and anti-lash spring may result.

Figure 3-3. Removal of Air Cleaner Box, Primer Style Carburetor

AIR CLEANER BOX INSTALLATION:

Install the air cleaner box to the engine and carburetor as follows:

1. Using a new gasket, place the air cleaner box on the carburetor, line up the holes and install the two nuts and corresponding washers to the carburetor mounting bolts (see Figure 3-2). Refer to “TORQUE SPECIFICATIONS” in the back of this manual for proper torque.

Note: On large frame engines the nut on the right side (toward the rear of the engine) uses only a flat washer. The nut on the left side (toward the front of the engine) uses a lock washer and a flat washer (see Figure 3-2).

2. Install the cap screws in the air cleaner box (see Figure 3-2). Refer to “TORQUE SPECIFICATIONS” in the back of this manual for proper torque.

3. Reinstall the breather hose.

4. Reinstall the choke knob.

5. Install the filters and cover as stated in the preceding sections on filter maintenance.

CARBURETION

GENERAL:

Proper engine performance depends on the carburetion system. The use of clean, fresh fuel and a well maintained air cleaner is extremely important to engine operation, as well as engine reliability and power.

COMMON CARBURETOR PROBLEMS:

Most causes of carburetor problems are related to the use of stale, gummy fuel and the ingestion of dirt. Prior to servicing any carburetor, be sure to check for evidence of these conditions.

Gasoline that is left in the system for long periods can form gum or varnish deposits that will adversely affect carburetor operation.

NOTE: Use of a good fuel stabilizer will minimize the formation of gum deposits during storage. Add the stabilizer to the gasoline in the fuel tank or in the storage container. Follow the mix ratio recommended on the stabilizer container. After adding the stabilizer to the engine fuel tank, run the engine for about ten (10) minutes so it will enter the carburetor. A brand name stabilizer can be purchased at a Generac Air-Cooled Industrial Engine Dealer.

SERVICE TIP:

Carefully inspect the carburetor choke and throttle shafts for wear. Grasp each shaft and attempt to move it horizontally and vertically. Maximum allowable end play for choke and throttle shafts is 0.004 inch (0.1mm). Replace if excessive play is evident.

CARBURETOR REMOVAL:

1. Remove the air cleaner box as outlined in “AIR CLEANER BOX REMOVAL.”

2. Disconnect the governor rod and anti-lash spring from the throttle arm of the carburetor.

3. Slide the carburetor off of its mounting bolts.

CARBURETOR DISASSEMBLY:

To disassemble the carburetor, proceed as follows (See Figure 3-5 or 3-6):

1. Remove the FLOAT BOWL NUT and the FIBER WASHER. Then remove the FLOAT BOWL.

2. Remove the FLOAT PIN. Then remove the FLOAT, and FUEL INLET VALVE.

3. Remove the IDLE SPEED STOP SCREW along with its SPRING.
SECTION 3: AIR INTAKE SYSTEM AND CARBURETION

4. Rotate the THROTTLE PLATE to its closed position and remove two THROTTLE PLATE SCREWS.
5. Rotate the CHOKE PLATE (if equipped) to its closed position and remove the CHOKE RETAINER SPRING.
6. Remove the CHOKE SHAFT (if equipped) and the CHOKE SHAFT SEAL.
7. Remove the THROTTLE SHAFT and the THROTTLE SHAFT SEAL.

NOTE: On small frame engines a MAIN JET TUBE is pressed into the carburetor body to a measured depth. Do NOT attempt to remove this tube. Tube movement will adversely affect carburetor metering characteristics.

CARBURETOR REASSEMBLY:

Reassemble the carburetor in the reverse order of disassembly. The following rules apply:
1. Blow metallic parts dry with compressed air.
2. A notch on the FUEL INLET VALVE mates with the FLOAT (See Figures 3-5 and 3-6).
3. The FLOAT SETTING is FIXED and NONADJUSTABLE.
4. Before tightening the FLOAT BOWL NUT (Item 4), make sure the FLOAT BOWL is properly aligned with the GASKET and the CARBURETOR BODY.

CARBURETOR INSTALLATION:

Using a new gasket, reinstall the carburetor as follows:
1. Slide the new carburetor gasket over the carburetor mounting bolts followed by the carburetor.
2. Connect the governor rod and anti-lash spring.
3. Install the air cleaner box, filters and air cleaner cover as described in “AIR CLEANER BOX INSTALLATION.”

CARBURETOR ADJUSTMENT

INITIAL ADJUSTMENTS:

(See Figure 3-7)
1. The IDLE SPEED STOP SCREW is located at top of the carburetor and contacts the THROTTLE SHAFT. After reassembling the carburetor, complete an initial adjustment of the STOP SCREW as follows:
   a. Close the THROTTLE PLATE.
   b. Hold the throttle plate in its closed position and back out the idle speed stop screw.
   c. Turn the idle speed stop screw until it just contacts the stop tang of the throttle shaft. Then turn the idle speed stop screw in one turn further.

NOTE: Final adjustment of idle speed can be accomplished with the engine running. Engines equipped with optional automatic idle control require a special procedure for idle speed adjustment. See Section 4, “Optional Idle Control.”

NOTE: The carburetor is equipped with a fixed main jet, which requires no adjustment.

When working with compressed air and solvents or cleaners, be sure to wear appropriate eye protection to avoid personal injury.

Generac recognizes that there are spray type carburetor cleaners on the market; however, Generac does not authorize the use of carburetor cleaners. Also, Generac does not recommend soaking a carburetor in any cleaners since the carburetor might be damaged.
Figure 3-5. Exploded View of Typical Carburetor (Small Frame Engine)

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Figure 3-6. Exploded View of Typical Carburetor (Large Frame Engine)

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<td>Main Jet</td>
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<td>Spring</td>
</tr>
</tbody>
</table>
FINAL ADJUSTMENT

The following instructions apply to engines NOT equipped with automatic idle control. If the unit has an automatic idle control, refer to the Section 5, “Optional Idle Control.”

If the engine is used to drive an AC generator set, use an AC frequency meter to measure engine speed/frequency. Connect the AC frequency meter across one of the generator’s AC output receptacles or across the generator’s AC power winding output leads. Read the AC output frequency in HERTZ (cycles per second).

If the engine is used in some other application (pressure washer, pump, air compressor, etc.), use a tachometer to read the engine rpm.

1. Start the engine and allow a sufficient warm-up period.
2. Hold the carburetor throttle lever against the idle speed stop screw, then turn the idle speed stop screw until the correct idle speed is obtained.

a. If the driven unit is an AC generator and an AC frequency meter is used, the correct high no-load speed is between 62-63 Hertz. (3720-3780 rpm).

b. If the unit is not a generator, adjust the high no-load speed stop screw to obtain about 3750 rpm.
SECTION 4: MECHANICAL GOVERNOR

GOVERNOR OPERATION
1. The GOVERNOR SPRING tends to pull the LEVER and GOVERNOR ROD toward the "INCREASE RPM" direction.

2. As engine speed increases, centripetal force acts on the FLYWEIGHT. When FLYWEIGHT centripetal force exceeds SPRING force, the governor SPOOL is moved axially by FLYWEIGHT force. This causes the GOVERNOR ARM to rotate, which then moves the LEVER and GOVERNOR ROD toward a "DECREASE RPM" direction.

3. As engine speed decreases, a point is reached where governor SPRING force is greater than FLYWEIGHT centripetal force. SPRING force then moves the LEVER and GOVERNOR ROD toward "INCREASE RPM."

4. Governor action consists of a series of small rpm overshoots and undershoots, as SPRING force increases rpm and FLYWEIGHT centripetal force decreases rpm.

5. The point at which SPRING tension and FLYWEIGHT force are equal is the governed speed of the engine.

GOVERNOR INTERNAL PARTS
See Figure 4-2. A governor gear shaft is pressed into a bore in the engine crankcase cover. Internal governor components include (a) a THRUST WASHER, (b) GOVERNOR GEAR ASSEMBLY, (c) SNAP RING, (d) GOVERNOR SPOOL, and (e) GOVERNOR ARM. A lock pin and washer retain the governor arm in the crankcase cover.

The governor gear assembly houses the governor flyweights.

Flyweight movement causes the spool to move axially. In turn, axial movement of the spool results in rotation of the governor arm.

Figure 4-1. Governor Operating Diagram

GOVERNOR EXTERNAL PARTS
 WITHOUT AUTOMATIC IDLE CONTROL:

External governor parts for units without automatic idle control are shown in Figure 4-3. Parts include (a) a GOVERNOR LEVER, (b) a GOVERNOR ROD, (c) ANTI-LASH SPRING, (d) a SPEED ADJUST BOLT, (e) a SPEED ADJUST NUT, and (f) a GOVERNOR SPRING.

The governor lever is clamped to the governor arm, so that arm rotation is imparted to the lever. The governor rod connects to the governor lever at one end and to the carburetor throttle arm at its other end. Governor spring tension is adjustable by means of the speed adjust bolt and nut.

Engine speed can be adjusted by changing the tension of the governor spring. Governor spring tension can be changed by turning a locknut on the governor adjusting bolt.

Figure 4-2. Internal Governor Parts

Figure 4-3. External Governor Parts (Units without Idle Control)
SECTION 4: MECHANICAL GOVERNOR

WITH AUTOMATIC IDLE CONTROL:

Models equipped with automatic idle control (Section 5) have the same external governor parts as shown in Figure 4-3 with the addition of an idle control solenoid as shown in Figure 4-4.

1. Reattach the GOVERNOR ROD and ANTI-LASH SPRING to the GOVERNOR LEVER.
2. Slide the GOVERNOR LEVER onto the GOVERNOR ARM.
3. Tighten the GOVERNOR LEVER CLAMP BOLT.
4. Reinstall the GOVERNOR SPRING to the GOVERNOR LEVER and SPEED ADJUST SCREW, then tighten the SPEED ADJUST NUT accordingly.
5. Reinstall the CAPSCREW into the IDLE CONTROL BRACKET if equipped with automatic idle control (Figure 4-4). See BLOWER HOUSING SCREW under “TORQUE SPECIFICATIONS,” in the back of this manual, for proper tightness.

For proper governor adjustment, refer to “GOVERNOR ADJUSTMENT” on the next page.

GOVERNOR GEAR SHAFT REPLACEMENT

CAUTION! DO NOT TWIST THE GEAR SHAFT WITH A VISE GRIP OR ANY OTHER TOOL. THIS COULD RESULT IN ENLARGEMENT OF THE SHAFT BOSS.

INSPECTION:

If the governor gear shaft is scored, damaged or worn, it should be replaced.

REMOVAL:

If it becomes necessary to replace the governor gear shaft, remove the crankcase cover (See Section 11). Use care to avoid damage to the shaft boss area of the crankcase cover. Clamp the shaft in a vise, then tap the flange with a wooden or plastic mallet to remove the shaft.

INSTALLATION:

Start the new shaft into the shaft boss by tapping lightly with a soft mallet. Add red Loctite® to the shaft. Then, use a press or vise to press the shaft into the boss. The shaft is properly positioned when its end is just flush with the external boss of the crankcase cover. Be sure to wipe away any excess Loctite® from the flange.

REMOVAL OF GOVERNOR EXTERNAL PARTS:

Before any covers and shrouds can be removed from the engine, the governor external parts must be removed. Refer to Figures 4-3 and 4-4 for identification of the parts described in the following procedure.

1. Remove the CAPSCREW from the IDLE CONTROL BRACKET if equipped with automatic idle control (Figure 4-4).
2. Loosen the GOVERNOR LEVER CLAMP BOLT (Figure 4-3).
3. Loosen SPEED ADJUST NUT until the GOVERNOR SPRING can be removed (Figure 4-3).
4. Lift the GOVERNOR LEVER from the GOVERNOR ARM (Figure 4-3).
5. Disconnect the GOVERNOR ROD and ANTI-LASH SPRING from the GOVERNOR LEVER (Figure 4-3).

Set the governor external parts aside.

INSTALLATION OF GOVERNOR EXTERNAL PARTS:

After the installation of the engine shrouds and covers, reinstall the governor external parts as follows (refer to Figure 4-3):

1. Reattach the GOVERNOR ROD and ANTI-LASH SPRING to the GOVERNOR LEVER.
2. Slide the GOVERNOR LEVER onto the GOVERNOR ARM.
3. Tighten the GOVERNOR LEVER CLAMP BOLT.
4. Reinstall the GOVERNOR SPRING to the GOVERNOR LEVER and SPEED ADJUST SCREW, then tighten the SPEED ADJUST NUT accordingly.
5. Reinstall the CAPSCREW into the IDLE CONTROL BRACKET if equipped with automatic idle control (Figure 4-4). See BLOWER HOUSING SCREW under “TORQUE SPECIFICATIONS,” in the back of this manual, for proper tightness.

For proper governor adjustment, refer to “GOVERNOR ADJUSTMENT” on the next page.
SECTION 4: MECHANICAL GOVERNOR

**Figure 4-5. Governor Gear Shaft**

**LINKAGE INSTALLATION**

Differences may exist between governor/carburetor linkages, depending on the type of equipment on which the engine is used.

The best method for installation of linkage and springs is to record the attachment points prior to disassembly. Reinstall the governor rod, link and spring(s) in the same manner.

In the typical connection system shown in Figure 4-3 (page 4-1), the governor rod connects to the governor lever at one end; to the carburetor throttle arm at the opposite end.

In some applications, an anti-lash spring also will be connected at these two points.

**GOVERNOR ADJUSTMENT**

**INITIAL ADJUSTMENT:**

Before starting the engine, complete an initial adjustment of the governor as follows:

1. Loosen the GOVERNOR LEVER CLAMP BOLT (see Figure 4-3).
2. While holding the GOVERNOR LEVER at its full "INCREASE RPM" position, rotate the GOVERNOR ARM clockwise as far as it will go. Then, tighten the GOVERNOR LEVER CLAMP BOLT.
3. For adjustable carburetors, turn the carburetor IDLE JET in (clockwise) until it just bottoms. DO NOT FORCE. Then, back the IDLE JET out (counterclockwise) about 1-1/2 turns (see Figure 4-6).
4. All Generac carburetors have fixed main jets. Carburetors built prior to 1997 may have been equipped with adjustable jets. If so equipped, turn the MAIN JET in (clockwise) until it just bottoms. DO NOT FORCE. Then, back the MAIN JET out (counterclockwise) about 1-1/2 turns (see Figure 4-6).

**RUNNING ADJUSTMENT:**

After completing the INITIAL ADJUSTMENT, final adjustment can be accomplished with the engine running. Proceed as follows:

**NOTE:** For AC generator applications, disconnect or turn OFF all electrical loads. For non-generator applications, turn OFF the equipment being powered. Initial checks and adjustments will be accomplished with engine at no-load.

1. If so equipped, set the idle control switch to OFF.
2. Start the engine, let it warm up and stabilize at no-load.
3. For AC generator applications, connect an AC frequency meter to one of the generator’s AC output receptacles.
   a. If the generator is rated 60 Hertz, the no-load AC frequency reading should be 61.5-63.5 Hertz.
   b. If the generator is rated 50 Hertz, the no-load AC frequency should be 50.5-51.5 Hertz.
4. For non-generator applications (pumps, pressure washers, etc.), refer to the product DATA PLATE for rated engine speed. Use a tachometer to read engine speed.

**NOTE:** Several types of inexpensive tachometers are commercially available.

5. If the frequency (or rpm) reading is incorrect, turn the SPEED ADJUST NUT (Figure 4-3) on the governor until frequency or rpm is within limits.
6. If frequency or rpm is unstable, turn the IDLE SPEED SCREW on carburetor until engine stabilizes. DO NOT TURN THE IDLE SPEED STOP SCREW IN FURTHER THAN NECESSARY. Fine tune this adjustment after the engine has warmed up and stabilized. Adjust it 1/8 turn at a time.
7. When the no-load frequency or rpm is correct, apply a load to the engine.
   a. For AC generator applications, connect electrical loads as close as possible to the unit’s rated wattage/ampere capacity.
   b. For non-generator applications, turn on the equipment being powered by the engine.
8. With a load applied to the engine, adjust the carburetor as follows:
   a. CARBURETOR WITH FIXED MAIN JET: Slowly adjust the IDLE SPEED STOP SCREW to obtain best operation and...
highest rpm under load (see Figure 4-6). DO NOT EXCEED RPM SPECIFICATION.

b. **CARBURETOR WITH ADJUSTABLE MAIN JET.** Adjust the carburetor as follows:

1. Slowly turn the MAIN JET counterclockwise (richer) until rpm or frequency starts to drop off.
2. Turn the MAIN JET clockwise (leaner) until rpm or frequency again starts to decrease.
3. Turn the MAIN JET counterclockwise (richer) until the best and most stable frequency or rpm is obtained.

9. Turn off all loads and check the no-load governor setting. Readjust governor no-load speed, if necessary.

![Figure 4-6. Adjustable Carburetor](image)
SECTION 5: OPTIONAL IDLE CONTROL

GENERAL

Some applications, such as AC generators, may be equipped with an automatic idle control system. This type of system provides greatly improved fuel economy by running the engine at a high governed speed only when electrical loads are connected to the generator. When the electrical loads are disconnected, engine speed will automatically be reduced to an idle.

OPERATING INSTRUCTIONS

BEFORE START UP

⚠️ CAUTION! Before cranking and starting the engine, always set the idle control switch to OFF. Set the switch to its ON position only after the engine has stabilized at high governed speed (see Figure 5.1).

ENGINE RUNNING:

To have the engine run at high governed speed only when electrical loads are connected and turned on, set the idle control switch to ON. The engine will decelerate to idle speed when loads are disconnected or turned off. If you wish to have the engine run at high governed speed at all times (with or without loads connected), set the idle control switch to OFF.

CIRCUIT OPERATION

1. With Idle Control switch set to ON:
   a. AC power is delivered from the generator’s AC power windings to a circuit board, for operation of the circuit board.
   b. With electrical loads connected to the generator, current will flow through the primary windings of a sensing transformer. A proportional voltage and current will then be induced into the transformer’s secondary windings.
   c. Current from the transformer secondary windings is delivered to the circuit board. Circuit board action then opens the circuit to an idle control solenoid.
   d. The idle control solenoid de-energizes and engine speed is established by the engine governor.
   e. When electrical loads are disconnected or turned off, current flow through the transformer primary windings will terminate. Voltage and current cannot be induced into the transformer secondary windings and the solenoid energizes.
   f. Zero current flow of the transformer secondary windings is sensed by the circuit board. The circuit board then closes the circuit to the idle control solenoid.
   g. The energized solenoid pulls the carburetor throttle arm against its idle speed stop screw. The engine decelerates to idle speed, about 2280-2400 rpm (38-40 Hertz).

2. Idle control switch set to OFF:
   a. AC power is not available to the circuit board. The idle control solenoid will then remain de-energized at all times.
   b. The engine will run at high governed speed.

Figure 5-1. Idle Control Switch Located on a Generator Control Panel

Figure 5-2. Idle Control System (Typical AC Generator)
SECTION 5: OPTIONAL IDLE CONTROL

IDLE CONTROL ADJUSTMENT

GENERAL:
Idle speed will be correct when (a) the idle control solenoid is positioned to maintain an idle speed equal to about 1500-2100 rpm (25-35 Hertz), and (b) when the carburetor idle speed stop screw is set to maintain an idle speed of approximately 2280-2400 rpm (38-40 Hertz). Proper adjustment consists of first positioning the idle control solenoid to obtain an idle speed of 1500-2100 rpm. Fine adjustment can then be obtained by setting the idle speed stop screw for an idle speed of 2280-2400 rpm (38-40 Hertz).

INITIAL ADJUSTMENT:
1. Set the idle control switch to OFF.
2. Unplug all electrical loads from the generator.
3. Connect an AC frequency meter into one of the generators' power receptacles.
4. Crank and start the engine as outlined in the appropriate owner's manual.
   a. For units rated 60 Hertz, the frequency meter should read about 690-80 rpm (high governed speed). This is about 6.5-6.5 Hertz.
   b. For units rated 50 Hertz, the meter should read 00-090 rpm (50.5-5.5 Hertz).
5. Let the engine stabilize and warm up.
6. Set the idle control switch to ON. The idle control solenoid should energize, and engine speed should decelerate to idle speed.
7. If necessary, back the carburetor’s idle speed stop screw out so that governor lever travel is limited by the solenoid and not by the idle stop screw.
   a. Check the frequency meter reading.
   b. Meter should indicate about 1,500-2,100 rpm (25-35 Hertz).
   c. If reading is not within the stated range, adjustment of the idle control solenoid is required.
8. To adjust the idle control solenoid, proceed as follows:
   a. Loosen the solenoid JAM NUT, then turn the solenoid BOLT clockwise (faster speed) or counterclockwise (slower).
   b. When engine speed is 1500-2100 rpm (25-35 Hertz), hold that setting and tighten the solenoid JAM NUT.
   c. When JAM NUT is tight, check that engine speed is still 1,500-2,100 rpm (25-35 Hertz).

FINAL ADJUSTMENT:
On the carburetor, turn the idle speed stop screw clockwise (faster speed) until engine speed increases to 2,280-2,400 rpm (38-40 Hertz) (see Figure 5-4).

NOTE: Idle speeds less than about 38 Hertz could cause the engine to stall when loads are suddenly applied.
SECTION 6: CYLINDER HEAD AND VALVES

MAJOR COMPONENTS

Valve train components are shown in Figure 6-1 below.

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Figure 6-1. Valve Train Components

DISASSEMBLY

1. Remove the oil breather tube. Remove the four M6-1.00 x 12mm screws. Then, remove the rocker arm cover (see Figure 6-2).

   NOTE: Whenever the rocker arm cover is removed, the cover gasket must be replaced to ensure a proper seal.

2. Loosen the rocker arm jam nuts on the pivot ball studs. Then, loosen the pivot ball studs. Remove the two pivot ball studs, rocker arms and jam nuts. Also, remove the push rod guide plate.

   NOTE: Always keep intake and exhaust valve parts separated. Intake and exhaust pivot ball studs, rocker arms and push rods are identical. However, the wear patterns will be different.

Figure 6-2. Removal of Rocker Arm Cover

3. Remove the push rods (see Figure 6-3).

4. Remove the cylinder head bolts, then the cylinder head and cylinder head gasket (see Figure 6-4).

Figure 6-3. Rocker Arms, Pivot Ball Studs, Push Rods and Push Rod Plate

Figure 6-4. Cylinder Head Removal
SECTION 6: CYLINDER HEAD AND VALVES

NOTE: Replace the cylinder head gasket every time the cylinder head is removed. The new head gasket must be free of nicks and scratches as these could cause leaks.

To prevent eye injury, always wear eye protection when removing valve springs.

5. Place a commercially available small engine valve spring compressor squarely on top of the valve spring retainer. The split valve keepers should "pop" out (see Figure 6-5).

6. With the split valve spring keepers removed, remove the valve spring retainers, valve springs, valve spring washers, and the intake and exhaust valves.

7. Clean all parts. Remove carbon from the valve heads and stems. Inspect the valves and valve seats. Service parts as outlined under "Valve Service."

NOTE: Proper lapping of valves and seats will remove grinding marks and ensure a good seal between the valve and its seat. After lapping, be sure to remove all lapping compound from the valve faces and seats. If using a Neway valve and seat system it is not required to lap the valve or seat.

VALE SERVICE

VALVES:

Replace valves if they are damaged, distorted, or if the margin is ground to less than 0.039 inch (1.0mm). If the valve is in usable condition, use a valve grinder or Neway valve refacer to grind the valve face to a 45º angle. After reconditioning, the valves should be lapped with a suitable valve lapping tool and valve lapping compound (see Figure 6-6).

Figure 6-5. Remove Valve Spring Keepers

Figure 6-6. Valve

Figure 6-7. Valve Seat

The recommended procedure for cutting a valve is to use the "Neway Valve Cutting System." This type of system uses cutters of three different degrees.

First, use the 60º cutter to clean and narrow the seat from the bottom toward the center (see Figure 6-8).

Second, use a 31º cutter to clean and narrow the seat from the top to the center.

Finally, use a 46º cutter to cut in the seat to a width of 0.039 inch (1mm).

Figure 6-8. Cutting a Valve Seat. 3 Steps
VALVE GUIDES:
Valve guides are permanently installed in the cylinder head and cannot be replaced (see Figure 6-9). At the time of this writing, oversize valves were NOT available. Thus, if valve guides are worn or damaged, the guides cannot be reamed to accommodate an oversize valve stem.

![Valve Guides](image)

Figure 6-9. Valve Guides

VALVE TAPPETS:
The valve tappets (Figure 6-10) will be removed when the camshaft is removed. Intake and exhaust valve tappets are identical. However, once a wear pattern has been established, the two parts should not be interchanged.

![Tappet](image)

Figure 6-10. Tappet

VALVE SPRINGS:
Inspect the valve springs (Figure 6-11). Measure the spring FREE LENGTH. Also measure the spring length when a known load is applied to the spring. Refer to SPECIFICATIONS in Section 14 and 15.

![Valve Spring](image)

Figure 6-11. Valve Spring

INSTALLATION
After the valve train components have been properly inspected and serviced, install the components as follows:

1. Install the intake and exhaust valves through the proper valve guides in the cylinder head.
   a. The exhaust valve has the smaller head.
   b. The intake valve has the larger head.
   c. Valve seat sizes will match their respective valve head sizes.
   d. The exhaust valve stem is smaller than the intake valve stem.

   **NOTE:** Be sure to lubricate valve stems and valve guides before assembly!

2. The intake valve has a valve stem seal.
   a. Install the intake valve stem seal.
   b. Install the valve spring washer, the valve spring and the valve spring retainer.
   c. Install the valve spring keepers.

   **NOTE:** To install valve spring keepers, use the valve spring compressor to compress the spring enough to insert one keeper half. Compress the spring again to insert the other keeper half.

3. The exhaust valve does not have a valve stem seal.
   a. Install the valve spring washer, valve spring and valve spring retainer.
   b. Install the valve spring keepers.

4. After both valves have been properly installed in the head, position the new head gasket and install the cylinder head.

   **NOTE:** The head gasket is coated with a special substance for better sealing. It must be free of nicks, scratches and other defects, or leakage could result.

5. Install the cylinder head bolts and tighten them in the sequence shown in Figure 6-13.

6. Position the push rod guide plate on the head. Then install the rocker arms and pivot ball studs. Install the jam nuts far enough to hold the guide plate in position. Valve clearance will be adjusted later.

7. Rotate the rocker arm as shown in Figure 6-15 to install the push rod. Insert the push rod through the push rod guide plate, with either end resting against the tappet. Place the rocker arm over the push rod. Alignment is correct when push rod ball rests in the rocker arm socket.
ADJUSTING VALVE CLEARANCE

Adjust valve clearance with the engine at room temperature. The piston should be at top dead center (TDC) of its compression stroke (both valves closed). Adjust valve clearance as follows:

1. Loosen the rocker arm jam nut. Use an allen wrench to turn the pivot ball stud while checking the clearance between rocker arm and valve stem with a feeler gauge (see Figure 6-16). Refer to “SPECIFICATIONS” in the back of this manual for proper clearance.

2. When clearance is correct, hold the pivot ball stud with the allen wrench and tighten the rocker arm jam nut to the specified torque with a crow’s foot. After tightening the jam nut, recheck valve clearance to make sure it did not change.
INSTALL ROCKER ARM COVER

1. Using a new rocker arm cover gasket, install the rocker arm cover and retain with four screws (see Figure 6-18).

2. Tighten each screw to 20 in-lbs (2.24 Nm) working diagonally from corner to corner as shown in Figure 6-19.

3. Repeat the same pattern, this time tightening each screw to 48 in-lbs (5.4 Nm). DO NOT EXCEED this torque value.

4. Install oil breather tube.
GENERAL

The rewind starter used on most GN/GSH series engines is a manual starter that uses a spring to rewind the starter rope after it has been pulled. Pulling the rope winds up a clock-type spiral spring in the starter housing. When the rope is released, the spring unwinds and causes the rope to wind around the pulley.

When the rope is pulled outward and away from the engine, spring-loaded “starter dogs” engage the pulley, and the engine is cranked.

When the rope is allowed to return, the starter dogs disengage from the pulley.

RECOIL ASSEMBLY REMOVAL

The rewind starter assembly is retained to the engine blower housing by screws and lock washers (see Figure 7-1). Remove the screws and lock washers, then remove the complete starter rewind assembly.
SECTION 7: REWIND STARTERS

DISASSEMBLY (OLD STYLE)
1. Pry up the HANDLE INSERT, to expose knot in ROPE (see Figure 7-2).
2. Untie knot in ROPE. Remove HANDLE INSERT and HANDLE.
3. Slowly release spring tension on the PULLEY, after the rope has been drawn through the HANDLE.
4. Remove the CENTER RETAINING SCREW. Then, remove the RETAINER PAWL, STARTER DOGS, DOG SPRINGS, and SPRING.
5. Lift out the PULLEY.

REASSEMBLY
1. Place SPRING and SPRING KEEPER into position, turn to lock into position (see Figure 7-2). The spring should be lightly coated with grease.
2. Place the PULLEY, along with SPRING and SPRING KEEPER, into the HOUSING. Install SPRING, STARTER DOGS and DOG SPRINGS.
3. Install retainer PAWL and SCREW.
4. Wind the pulley counterclockwise until tight, generally three to four turns. Then, allow it to unwind until the hole in the pulley lines up with the eyelet in the housing.
5. Pull the rope up through the eyelet in the housing, then through the HANDLE and HANDLE INSERT. Tie a left-hand knot in the rope (see Figure 7-2).
6. Install the HANDLE INSERT into the HANDLE.
7. Test the starter for proper operation.

DISASSEMBLY (NEW STYLE)
Disassembly of new style rewind starter is not cost effective, except for ROPE or HANDLE replacement (see Figure 7-3). Installation of the rope on the pulley is the same as for the OLD STYLE.

Figure 7-3. Exploded View of Rewind Starter (New Style)

7-2
INTRODUCTION

Some GN/GSH series engine applications may be equipped with a 12 Volt DC electric cranking system. Such a system converts electrical energy from a battery into mechanical energy at the starter motor, for the purpose of turning the engine over for starting.

NOTE: Cranking systems discussed in this manual are typical systems. The actual cranking system used in specific applications may differ. Refer to the wiring diagram and/or electrical schematic in the Owner's Manual for specific applications.

STARTER MOTOR OPERATING PRINCIPLES

Closure of the circuit to the starter motor allows battery current to flow through a commutator, to the loops of wire in the armature, and back to the battery. The interaction of the magnetic fields causes the armature to revolve.

The armature rotates at a relatively high speed to provide sufficient torque to crank the engine. The required engine cranking speed is relatively slow, so the starter motor is equipped with a small drive pinion that meshes with the teeth of a flywheel ring gear to crank the engine. The large ring gear and the small starter pinion gear results in a gear reduction that can vary in ratio up to 9-to-1. This reduction allows the starter to rotate at high speeds while cranking the engine at low speeds.

When the engine starts, its speed increases quickly. For example, if the engine reaches 100 rpm and the starter pinion remains meshed with the ring gear, the starter armature would spin at about 1,900 rpm (19-to-1 ratio). To prevent damage to the armature, a "Bendix Drive" mechanism is used to disengage the starter pinion from the ring gear when the engine has started.

THE BENDIX DRIVE

When the field coils of the starter drive are energized, the armature starts to turn. A loose fitting sleeve inside the pinion gear is turned with the armature. This sleeve has large spiral threads on its surface that match the pinion gear's internal threads. The sleeve turns with the armature, and the pinion gear rotates on the threads to move outward on the sleeve. Outward movement of the pinion gear causes that gear to mesh with the flywheel ring gear. The pinion hits a stop on the sleeve, and the pinion turns the ring gear and engine. On start-up, the engine turns faster than the armature. This causes the pinion to spin back on the spiral threads of the sleeve and out of engagement with the ring gear.

STARTER MOTOR REPAIRS

If the starter motor is defective, it should be removed and replaced. Disassembly and repair of the motor is not cost effective.

STARTER MOTOR REMOVAL:

Note: Before removing starter, disconnect the negative battery cable from the battery.

To remove the starter from the engine, loosen and disconnect the starter wire, then remove the two hex head screws that hold the starter in place.

STARTER MOTOR INSTALLATION:

To install the starter motor, reverse the previous steps.

TESTING THE STARTER MOTOR

CHECKING THE PINION:

When the starter motor is activated, the pinion gear should rise and engage the ring gear. If the pinion does not rise normally, inspect the large spiral threads of the sleeve and pinion for binding or sticking.

TOOLS FOR STARTER PERFORMANCE TEST:

The following equipment may be used to complete a performance test of the starter motor:

• A digital multimeter (VOM).
• A tachometer capable of reading up to 1,500 rpm.
• A fully charged 2 Volt battery.

STARTER PERFORMANCE TEST:

1. Set the meter to read DC amps.
2. Connect the starter motor, battery and VOM as shown in Figure 8-2.

3. Insert the tachometer at end of the pinion gear and activate the starter motor. A starter motor in good condition will be within the following specifications:
SECTION 8: ELECTRIC STARTER

STARTER MOTOR PERFORMANCE SPECIFICATIONS AT 12 VOLTS DC
MINIMUM MOTOR RPM = 800
MAXIMUM AMPS = 9

If the starter does not perform satisfactorily, it should be replaced.

BATTERY MAINTENANCE

GENERAL

Many of the batteries in use today are "maintenance free" and require little or no maintenance. In most cases, battery failure requires replacement of the battery. The lead-acid cells found in many products, however, still require maintenance. Maintenance of lead-acid batteries falls into three categories:

• Inspecting the battery.
• Maintaining proper electrolyte levels.
• Charging the battery properly.

INSPECTING THE BATTERY:

Inspect the battery case for cracks or signs of damage.

Inspect battery terminals periodically and keep them clean.

NOTE: Always make sure that the battery is fully charged.

ELECTROLYTE LEVEL (REMOVABLE VENT CAP BATTERIES ONLY):

Check the battery electrolyte level regularly. When level is low, add distilled water to the correct level.

NOTE: After adding distilled water, do not check electrolyte specific gravity until after the battery has been recharged. Adding of sulfuric acid is NOT recommended. If the battery has been recharged and specific gravity is not correct, replace the battery.

TESTING A BATTERY (REMOVABLE VENT CAP BATTERIES ONLY)

1. Visually inspect the battery case for cracks and other defects. If damaged, replace the battery.

2. Check the electrolyte level in all battery cells.
   a. If distilled water is added, recharge the battery before taking a specific gravity reading.
   b. Charge the battery until it is gassing freely, then take the specific gravity reading.

3. Begin at one end of the battery and check the first cell, using an automotive type battery hydrometer.
   a. Take two or three samples from the cell to stabilize the reading.
   b. Once stabilized, draw in the final sample.
   c. Draw in only enough electrolyte to obtain a reading. do not let the hydrometer float hit the suction bulb.
   d. Hold the hydrometer vertically and shake it gently to make sure the float is not sticking to the inside of the glass barrel.
   e. Read and record the specific gravity reading.

4. Check the temperature of the fluid. Add the required points if temperature is above 80 F. Subtract the required points if below 80 F (see Figure 8-3).

5. Check and record readings of the remaining cells in the same manner.

6. When all cells have been checked, subtract the lowest reading obtained from the highest reading. If there is more than 30 points difference, the battery is probably defective and should be replaced.

In Figure 8-3, the highest reading is 1.260, and the lowest reading is 1.225. Subtract 1.225 from 1.260 to obtain a 35 point difference.

<table>
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<tr>
<th>Cell #</th>
<th>Specific Gravity</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>1.255</td>
</tr>
<tr>
<td>2</td>
<td>1.260</td>
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<tr>
<td>3</td>
<td>1.235</td>
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<tr>
<td>4</td>
<td>1.250</td>
</tr>
<tr>
<td>5</td>
<td>1.240</td>
</tr>
<tr>
<td>6</td>
<td>1.225</td>
</tr>
</tbody>
</table>

Figure 8-3. Using a Battery Hydrometer
GENERAL

The engine lubrication system serves to (a) reduce friction between moving parts, (b) cool the engine and (c) establish a negative pressure in the crankcase to prevent oil seal leakage.

Major components include the following:

• Oil pickup assembly.
• Oil pump.
• Crankshaft oil seals.
• Pressure relief valve.
• Breather assembly.
• Crankcase cover.
• Low Oil Pressure Switch.

OPTIONAL SYSTEMS:

In addition to the major components listed above, some engines may be equipped with an optional oil filter.

OIL FLOW

(410CC, LARGE FRAME ENGINES)

See Figure 9-1. An oil pickup screen extends into the crankcase. The oil pump draws crankcase oil through the oil pickup screen and delivers it to the areas requiring lubrication as follows:

1. If so equipped, oil will pass through an oil filter and through a cored passage in the crankcase cover.
2. The cored passage in the crankcase cover allows oil to reach the oil pump and one camshaft bearing surface. Oil flows through the cored passage in the cover and also flows to one crankshaft bearing and one balancer bearing.
3. Oil flows through the hollow camshaft to lubricate the camshaft bearing at the opposite end of the camshaft.
4. Oil from the end of the camshaft enters a cored passage and flows to one crankshaft bearing and one balancer bearing.
5. Oil flows through the crankshaft and to the crank throw to lubricate the rod bearing.
6. If oil pressure exceeds 40 psi. The oil pressure relief valve opens.

If not equipped with an oil filter, oil flows through a cored passage in the crankcase cover and then to the oil pump. Oil flow is then identical to units having an oil filter.

Figure 9-1. Lubrication System Diagram

(410cc, Large Frame Engine)

OIL FLOW

(220CC, SMALL FRAME ENGINES)

See Figure 9-2. The oil pump draws crankcase oil through an oil pickup and delivers it to the areas requiring lubrication as follows:

1. Through a cored channel in the crankcase cover and to the crankshaft journal at the power take-off (PTO) end of the crankshaft.
2. Through the hollow camshaft and to the camshaft bearing at the flywheel end.
3. Through a cored passage in the crankcase housing and to the crankshaft journal at the flywheel end.
4. Through the crankshaft to the crankpin and connecting rod bearing.
5. If oil pressure exceeds 30 psi, the oil pressure relief valve opens.
DESCRIPTION:
The oil pickup assembly consists of a cylindrical plastic tube with a screen. Two O-ring seals are installed in grooves at one end of the cylinder. The pickup slides into a bore of the oil filter pad in the crankcase cover and extends into the interior of the crankcase (see Figure 9-3). Once installed in the crankcase cover bore, the pickup is retained by either of the following methods:

1. If the engine is supplied with an optional oil filter, the pickup is prevented from coming out of the bore by the oil filter adapter.
2. If the engine is not equipped with an optional oil filter, pickup is retained by an oil filter pad cover.

INSPECTION:
Remove the O-ring seals, then clean the pickup in solvent. Inspect the plastic body for cracks or other damage. Check the pickup screen for damage or clogging. Make sure the hollow tube is free of obstructions.
Install the two O-ring seals prior to reassembly. Replace the oil pickup assembly if it is damaged, if the screen is torn or plugged or if the tube is plugged. Replace damaged O-rings.

OIL PICKUP ASSEMBLY
(220cc, SMALL FRAME ENGINES)

DESCRIPTION:
The oil pickup assembly consists of a plastic body and an oil pickup screen. The pickup must be installed with its screen facing downward and parallel to the crankcase base. The tubular end of the pickup fits into a bore in the crankcase cover. When the crankcase cover is installed, a cast protrusion in the crankcase prevents the pickup from coming out (see Figure 9-4).

OIL PUMP

DESCRIPTION:
The oil pump is of the trochoid type. Its inner rotor rotates on a shaft provided in the camshaft bore of the crankcase cover. The outer rotor is installed over two drive pins on the end of the camshaft and is driven by camshaft rotation.
**PRESSURE RELIEF VALVE**

**DESCRIPTION:**
A ball type pressure relief valve is located in a bore of the crankcase cover (see Figure 9-7). The valve serves to limit oil pressure to a maximum value. The ball will remain against its seat as long as oil pressure is below about 40 psi (on Large Frame engines) or 30 psi (on Small Frame engines). Should oil pressure increase above that value, the ball will be forced off its seat to relieve excess oil pressure into the crankcase. The ball and spring are held in place by a retainer.

**INSPECTION:**
Remove the SCREW that retains the RETAINER to the crankcase. Remove the RETAINER, SPRING and BALL (Figure 9-7).

Clean all parts in solvent.

Inspect the BALL and RETAINER for damage, wear. Replace any damaged or worn part. Inspect the SPRING, replace if damaged or worn.

Measure the free length of the oil pressure relief valve spring. Replace the spring if it is not the proper length. Refer to the SPECIFICATIONS section at the back of this manual for proper spring dimensions.
SECTION 9: LUBRICATION SYSTEM

CRANKSHAFT OIL SEALS

DESCRIPTION:
An oil seal is provided in the crankcase cover and in the crankcase to prevent oil leakage past the crankshaft journals (Figure 9-8).

SEAL REPLACEMENT:
A leaking or otherwise defective oil seal can be replaced as follows:
1. If the crankshaft has been removed, old seals can be removed by tapping out with a screwdriver or by tapping them out from the inside.
2. If the crankshaft is installed, use a commercially available oil seal puller to remove the seals.
3. Always use a seal protector when installing the crankshaft into its bearing bore and when installing the crankcase cover over the crankshaft.

BREATHER ASSEMBLY

DESCRIPTION:
A crankcase breather is located in the rocker arm cover of horizontal crankshaft engines (Figure 9-9). The breather serves to maintain a reduced pressure in the engine crankcase, to prevent oil from being forced past the oil seals, gaskets or piston rings.

The CHECK VALVE allows excess pressure to be vented out of the crankcase and to the air inlet side of the carburetor through the BREATHER TUBE. Two small DRAIN HOLES allow condensed oil vapors to return to the crankcase.

NOTE: The crankcase breather on vertical shaft GN/GSH/GSV series engines is mounted on the crankcase assembly and is configured differently. See "SERVICE MANUAL. COMPUTER CONTROLLED VARIABLE SPEED RV GENERATORS," Manual Part No. 094468-A.

CRANKCASE COVER

DESCRIPTION:
The die-cast aluminum crankcase cover is retained to the crankcase with flanged head bolts.

Install a new gasket between the cover and crankcase each time the cover is removed. Machined bores are provided in the cover for (a) oil pump rotors and camshaft, (b) crankshaft, (c) balancer (Large Frame engines only), (d) governor gear assembly and (e) the oil pickup assembly. Cored oil passages are provided from the pickup bore to the pump and from the pump to the crankshaft bore.
When working with compressed air, be sure to wear appropriate eye protection to avoid personal injury.

INSPECTION:
Clean the cover and blow dry with compressed air. Use compressed air to blow out all bores and oil passages. Inspect the cover for cracks, damage, etc. Check the crankshaft, camshaft and balancer bearing bore diameters as outlined in Section 14 (Small Frame) or Section 15 (Large Frame).

GOVERNOR GEAR INSTALLATION:
1. Apply engine oil to the governor gear shaft (Figure 9-10).
2. Install the governor gear thrust washer over the governor gear shaft followed by the governor gear assembly.
3. Slide the governor retainer ring to a distance of 8mm down over the governor gear shaft.
4. Lift the gear assembly up to the governor retainer ring.
5. Install the spool over the shaft so that the flange is under the flyweights.
6. Slide the governor gear assembly, retainer ring, and spool down the shaft until bottomed out.

Figure 9-10. Governor Assembly

CRANKCASE COVER INSTALLATION (LARGE FRAME ENGINE):
Install the crankcase cover as follows:
1. Rest the engine on its side with the crankcase cover flange facing upward.
2. Install the valve tappets, crankshaft, connecting rod assembly, camshaft and balancer as described in Section 11.
3. Make sure the timing marks on the crankshaft, camshaft and balancer gears are properly aligned. Refer to Figure 11-11.
4. Place the crankcase cover gasket onto the crankcase flange.
5. Apply clean engine oil to the crankshaft, camshaft and balancer journals.
6. Apply clean engine oil to the crankshaft, camshaft and balancer bores in the crankcase cover.
7. Install the oil pickup screen. A locating tang on the outer periphery of the oil pickup tube must mate with a locating slot in the crankcase cover bore.

Figure 9-11. Reassembly of Crankcase Cover and Oil Pump

NOTE: If the engine is equipped with an optional oil filter, install the filter adapter, gasket and filter. If not equipped with an oil filter, install adapter gasket and oil block off cover.

8. Make sure the camshaft bore in crankcase cover and the oil pump’s inner rotor shaft have been coated with oil.
9. Apply a small amount of general purpose grease to the oil pump inner rotor. The grease will help prevent the rotor from dropping out when the cover is inverted for installation.
10. Install the oil pump inner rotor over the rotor shaft and into the camshaft bore.
11. Install the oil pump outer rotor onto the two drive pins at the end of the camshaft (see Figure 9-12).

12. Carefully install the crankcase cover. Align the cover with dowel pins on the crankcase flange, as well as with the crankshaft, camshaft and balancer. Make sure the cover gasket is on. Rotate the crankshaft to align the oil pump inner and outer rotors. The cover should fall easily into place. DO NOT FORCE.

13. Install the crankcase cover bolts and tighten (see Figure 9-13). Refer to Section 5 for torque specifications.

CRANKCASE COVER INSTALLATION (SMALL FRAME ENGINE):

Install the crankcase cover as follows:

1. Rest the crankcase on its side with the crankcase cover flange facing upward.
2. Check that the valve tappets, crankshaft, connecting rod assembly, and camshaft have been properly installed into the crankcase.
3. Make sure the timing marks on the crankshaft and camshaft gears are properly aligned. See Figure 9-15.
4. Place the crankcase cover gasket onto the crankcase flange.
5. Apply engine oil to the crankshaft and camshaft journals.
6. Apply engine oil to the crankshaft and camshaft bores in the crankcase cover.
7. Insert tubular end of oil pickup into its crankcase cover bore. The pickup screen must face downward and the pickup must be parallel to the crankcase base.

NOTE: When the crankcase cover is installed, the groove at tip of pickup must mate with a cast protrusion on the crankcase floor. The pickup must be properly positioned to ensure it will be retained by the cast protrusion after the cover has been installed.

8. Make sure the camshaft bore in crankcase cover and the oil pump’s inner rotor shaft have been coated with oil.
9. Apply a small amount of general purpose grease to the oil pump inner rotor. The grease will help prevent that rotor from dropping out when the cover is inverted for installation.
10. Install the oil pump inner rotor over the rotor shaft and into the camshaft bore.
11. Install the oil pump outer rotor onto the two drive pins at the end of the camshaft (see Figure 9-15).

14. After torquing crankcase cover bolts, make sure the crankshaft turns freely.
2. Carefully install the crankcase cover. Align the cover with dowel pins on the crankcase flange, as well as with the crankshaft and camshaft. Make sure the cover gasket is on. Rotate the crankshaft to align the oil pump inner and outer rotors. The cover should fall easily into place. DO NOT FORCE.

13. Install the crankcase cover bolts and torque (see Figure 9-16). Refer to Section 14 for torque specifications.

14. After tightening the crankcase cover bolts, make sure the crankshaft turns freely.

**OPTIONAL OIL FILTER**

The optional oil filter is a "spin-on" type. An oil filter adapter is bolted to the oil filter pad. When installing the oil filter, coat the filter seal with engine oil. Then install the filter and tighten until its seal contacts the filter adapter. After the filter seal contacts the adapter, tighten 3/4 to 1 turn more. (See Figure 9-17)
SECTION 9: LUBRICATION SYSTEM

LOW OIL PRESSURE SYSTEM

Some engine applications may be equipped with a low oil pressure switch (see Figure 9-19). The switch is a normally closed type, but is held open by engine oil pressure during cranking and running. Should engine oil pressure drop below approximately 10 psi for any reason, the switch contacts will close. With the switch contacts closed, the following will occur:

- A low oil pressure indicator will turn on and glow as power is available for its operation.
- The closure of the switch contacts will connect the primary ignition circuit to ground. Ignition will terminate, and the engine will shut down.

NOTE: Some differences may exist between low oil pressure systems. Refer to the electrical schematic/wiring diagram in the Owner's Manual for the specific application using this engine.

Figure 9-18. Low Oil Indicator

Figure 9-19. Low Oil Switch With Oil Filter

Figure 9-20. Low Oil Switch Without Oil Filter
GENERAL

In the course of tearing down a complete engine for service and repairs, the engine shrouds and housing will need to be removed. The following section briefly describes the order in which these items should be removed.

1. Remove air cleaner assembly and carburetor as described in Section 2, "AIR CLEANERS AND CARBURETION."

2. Disconnect the governor rod and anti-lash spring from the carburetor.

3. Remove the five capscrews from the blower housing assembly (see Figure 0-).

   Carefully remove the blower housing, making sure not to stretch the wires from the RUN/STOP switch and low oil pressure switch (LOPS). When the housing is far enough away from the engine, these wires may be unplugged.

4. Remove the capscrew from the lower shroud (see Figure 10-1).

5. Remove the two capscrews from the upper shroud (see Figure 10-1).

NOTE: The blower housing is notched at the point where the governor rod and anti-lash spring pass through it. This allows the housing to be removed without disconnecting the governor rod from the governor arm.

NOTE: It will be helpful to make note of the locations of the screws that hold the covers in place.

INSTALLATION OF HOUSING AND SHROUDS:

To reinstall the housing and shrouds, reverse the previous steps. Make sure that the wires for the RUN/STOP switch and low oil pressure switch (LOPS) are not in the way of the housing during reassembly.

Figure 10-1. Exploded View of Engine housing and Shrouds
**CRANKCASE COVER REMOVAL**

Before attempting to remove the crankcase cover, remove all rust, burrs and paint from the power take-off (PTO) end of the crankshaft. This will reduce the possibility of damaging the oil seal in the crankcase cover during cover removal. Remove the crankcase cover as follows:

1. Drain oil from the crankcase.
2. Remove the engine cylinder head, push rods and push rod guide plate (see Section 6).
3. Remove all flange head bolts that retain the crankcase cover.
4. Remove the crankcase cover (Figure 11-1). If necessary, tap lightly with a soft hammer on alternate sides of cover. Be aware that the oil pump rotors may drop out as the crankcase cover is removed.

**Note:** Some models may be equipped with a camshaft spring washer.

3. Remove the balancer (large frame engine only).
4. Before removing the crankshaft, remove the engine flywheel (see Section 2).
5. Turn the crankshaft to access the two (2) connecting rod bolts.
6. Remove the connecting rod bolts and connecting rod cap.
7. Push connecting rod and piston up and out of cylinder.

**BALANCER INSPECTION**

**(LARGE FRAME ENGINES, FIGURE 11-3)**

Clean the balancer in solvent. Then inspect the balancer as follows:

1. Check for physical damage. Replace the balancer if damaged.
2. Measure the outside diameter (O.D.) of the balance shaft ends. Replace balancer if wear limits are exceeded.

**NOTE:** Refer to “ENGINE SPECIFICATIONS”, Section 15, in this manual for design sizes and wear limits.

3. Measure the inside diameter (I.D.) of the balancer shaft bearing bore in the crankcase cover and in the crankcase.
   a. If balancer bearing bore in crankcase cover exceeds wear limits, replace the crankcase cover (see Section 15).
   b. If balancer bearing bore in crankcase exceeds wear limits, replace the crankcase assembly (see Section 15).

---

**CRANKSHAFT CAMSHAFT AND BALANCER REMOVAL**

With the crankcase cover removed, the crankshaft and camshaft (and balancer on large frame engines) can be removed from their crankcase bores. Remove these components as follows (see Figure 11-2):

1. Tip the engine over onto the flywheel end of the crankshaft.
2. Reach in with two fingers and hold the tappets up and clear of the camshaft lobes. Then, remove the camshaft, both tappets, and the inner and outer oil pump rotors.

---

**Figure 11-1. Crankcase Cover Removal**

**Figure 11-2. Crankshafts, Camshafts and Balancer Removal**
SECTION 11: CRANKSHAFT & CAMSHAFT

CAMSHAFT INSPECTION

Carefully inspect the entire camshaft for wear, nicks or other damage. All areas indicated in Figure 11-4 should be inspected.

3. Inspect the crankpin for nicks, scratches or other damage. Small scratches and nicks can be polished out using fine emery cloth. ALL EMERY CLOTH RESIDUE MUST BE COMPLETELY REMOVED USING A SOLVENT (SUCH AS KEROSENE).

4. Carefully measure the diameters of the crankpin, crankshaft journal at flywheel end, and the crankshaft journal at PTO end. Replace the crankshaft if it is worn beyond the stated repair limits. See SPECIFICATIONS in Section 14 (Small Frame) or Section 15 (Large Frame) for crankshaft diameters.

NOTE: The crankpin must NOT be ground to any smaller diameter. Undersize connecting rods are NOT available.

CRANKSHAFT SLEEVE BEARING:

The crankshaft bore in the crankcase is a pressure lubricated oil bearing that may or may not include an additional sleeve bearing, depending on the vintage of the engine (Figure 11-6).

The crankshaft bore in the crankcase cover is also a pressure lubricated oil bearing.

Inspect the bearing and bearing bore as follows:

1. Where applicable, check the sleeve bearing in the crankcase for damage.

a. Measure the inside diameter of the sleeve or bearing bore. Replace the bearing (if equipped) if it is worn excessively.

b. Press out the old bearing and press a new bearing into place (if equipped).

See SPECIFICATIONS in Section 14 (Small Frame) or Section 15 (Large Frame) for bearing and bore dimensions.

NOTE: Alignment of the oil holes in the sleeve bearing and bearing bore in the crankcase is critical.
2. Inspect the crankshaft bearing bore in the crankcase cover for damage and wear (Figure 11-7).
   a. Measure the Inside diameter of the bearing bore.
   b. If the bore is worn excessively, replace the crankcase cover.

**Figure 11-6. Crankshaft Sleeve Bearing**

**Figure 11-7. Bearing Bore in Crankcase Cover**

**COMPRESSION RELEASE**

A mechanical compression release is provided on the camshaft (Figure 11-8). A flyweight pivots on a pin mounted in the camshaft gear. The pin itself has a cam action. When the engine is not running, the pin holds the tappet up just slightly, which in turn holds the exhaust valve slightly open. This relieves compression for easier cranking.

When the camshaft spins, the flyweight moves, causing the pin to turn. The tappet is then free to move normally.

Measure the amount of compression relief lift at the tappet (see Figure 11-9). See SPECIFICATIONS in Section 14 (Small Frame) or Section 15 (Large Frame) for measurements.

**Figure 11-8. Compression Release Mechanism**

**Figure 11-9. Compression Relief Lift**

**CRANKSHAFT INSTALLATION**

Before installing the crankshaft, lubricate all bearing surfaces with engine oil. Seal protectors should be used to prevent damage to oil seals during installation. Install the crankshaft as follows:

1. Lubricate all bearing surfaces with engine oil.
2. Install the valve tappets.
3. Support both ends of the crankshaft and carefully install into the crankcase.
SECTION 11: CRANKSHAFT & CAMSHAFT

Figure 11-10. Timing Mark on Crankshaft Gear

NOTE: If the crankshaft gear is spun on the crankshaft, the timing will be off. If this happens, the crankshaft must be replaced. On a fully assembled engine, the keyway on the end of the crankshaft should be in line with the center of the ignition coil when the piston is at top dead center (TDC). See Figure 11-10.

CAMSHAFT INSTALLATION

Apply oil to camshaft bearing and to bearing bore in crankcase. Install the camshaft into the crankcase camshaft bore. Hold the valve tappets out of the way during installation.

NOTE: Some models may have been equipped with a camshaft spring washer. Be sure to use this washer during reassembly, and that it is properly seated between the camshaft and crankcase (see Figure 11-13).

Align the timing mark on the camshaft gear with the timing mark on the crankshaft gear (Figure 11-11). The piston must be at top dead center (TDC).

After installing the crankshaft, the piston and connecting rod can be installed. (See Section 12)

BALANCER INSTALLATION (LARGE FRAME ENGINES)

Apply oil to balancer bearing surfaces and to bearing bore surfaces. Install the balancer into the balancer bearing bore of the crankcase.

The balancer gear must mate with the crankshaft large gear and timing marks must be aligned as shown in Figure 11-11

NOTE: For installation of the oil pump, oil pickup and crankcase cover, see Section 9; "LUBRICATION."

Figure 11-12. Alignment of Timing Marks (Small Frame Engine)

Figure 11-13. Location of Camshaft Spring Washer on Some Models
SECTION 12: PISTON, RINGS & CONNECTING ROD INSPECTION & ASSEMBLY

GENERAL
There are no oversize pistons or rings available for these engines. For that reason, if the cylinder is damaged or worn excessively, the crankcase must be replaced.

REMOVAL FROM CONNECTING ROD:
An oil hole in the wrist pin area of the piston helps distribute oil to aid in cooling. This oil hole is also provided to assist in removing the wrist pin snap ring. To remove the piston from the rod, proceed as follows:

1. Move the snap ring around until its protruding wire is aligned with the notched-out oil hole. Use needle nose pliers to turn the snap ring and pull it toward you.
2. With one snap ring removed, slide the wrist pin out of its piston boss. Completely remove the wrist pin and separate the piston from the connecting rod.

CHECK PISTON FOR WEAR:
The piston is slightly elliptical. Its larger diameter is 90° from the wrist pin boss; its smaller diameter is in line with the wrist pin boss (see Figure 12-3).

NOTE: An assembly mark dimple is provided on top of the piston. This mark must face the flywheel end of crankshaft (3:00 position) during reassembly.

REMOVAL
Before attempting to remove the piston and connecting rod, clean all carbon from the cylinder bore (to prevent ring breakage). Then remove the piston and rod as follows:
1. Remove the cylinder head (see Section 6).
2. Remove the crankcase cover (see Section 11)
3. Remove the connecting rod cap bolts and the connecting rod cap.
4. Push the piston and rod out through top of cylinder.

PISTON
To check the piston for wear, proceed as follows:
1. Check the piston’s MAJOR DIAMETER.
   a. At a point 90° from the wrist pin hole, measure down from top of piston to a distance of 1.4-1.6 inches (35.5-40.5mm) (see Figure 12-3).
   b. Measure at this point to check for wear. If wear is excessive, replace the piston. See SPECIFICATIONS in Section 14 (Small Frame) or Section 15 (Large Frame) for proper dimensions.
2. Check wrist pin for looseness.
   a. A quick check for wear in (a) the wrist pin, (b) wrist pin bore in piston or (c) wrist pin bore in rod is to check for looseness or play with the piston assembled to the rod.
   b. Looseness or play indicates a worn wrist pin, or a worn wrist pin bore in the piston or rod.
NOTE: Tolerances between the wrist pin and wrist pin bores are extremely close. Always apply engine oil to the pin and its bores prior to installation.

3. Check wrist pin and wrist pin bores for wear.
   a. Measure the outside diameter of the wrist pin.
   b. Measure the inside diameter of the wrist pin bore in piston.
   c. Measure the inside diameter of the wrist pin bore in connecting rod.
   d. Measure the wrist pin length.

4. If excessive wear is found, replace the worn part. See SPECIFICATIONS in Section 14 (Small Frame) or Section 15 (Large Frame) for proper dimensions.

PISTON RINGS

GENERAL:
The following general rules pertaining to piston rings must always be complied with:
- Always replace piston rings in sets.
- Use a ring expander to remove or install piston rings, or breakage could result. Do not spread the rings too far apart or they might break.
- Use a ring compressor when installing the piston into the cylinder.
- When installing NEW rings, deglaze the cylinder walls with a commercially available deglazing tool.

DESCRIPTION:
A piston ring set consists of (a) a top compression ring, (b) a second compression ring and (c) an oil ring assembly.
- The OIL CONTROL RING is a three-piece assembly consisting of two oil rails and an oil spacer ring. Oil rails have a rounded face and may be installed with either side up.
- The second compression ring has an inside chamfer. This chamfer must face upward when installing the ring.
- The top compression ring has a barrel shaped face and can be installed with either side facing up.

RING END GAP:
Inside the cylinder, locate a point that is 2.75 inches (70mm) down from the top of the cylinder (about halfway down). Place ring into cylinder and use the piston to push the ring down to the stated depth. Check ring end gap with a feeler gauge. See Figure 12-5.

If the end gap of a new ring is excessive, the cylinder is worn excessively. See SPECIFICATIONS in Section 14 (Small Frame) or Section 15 (Large Frame) for proper dimensions.

NOTE: Oversize pistons and rings are not available. If the cylinder is worn or damaged, the crankcase must be replaced.

Figure 12-4. Location of Rings in Piston Grooves

Figure 12-5. Measuring Ring End Gap

CONNECTING ROD
The connecting rod is manufactured of die-cast aluminum. Match marks on the rod and on the rod cap must be aligned when assembling the rod to the crankshaft. See Figure 12-6.

CAUTION! DO NOT USE A WASHER WHEN ASSEMBLING THE ROD CAP.
SECTION 12: PISTON, RINGS & CONNECTING ROD INSPECTION & ASSEMBLY

**ASSEMBLY AND INSTALLATION**

**ASSEMBLY:**

1. Install the rings (Figure 12-4).
   a. Use a ring expander when installing rings into the piston grooves.
   b. Install the oil ring assembly first.
   c. Install the second compression ring with its inside chamfer facing up.
   d. Finally, install the top compression ring.
2. Assemble piston, rod and wrist pin.
   a. The assembly mark on piston must be toward the engine flywheel side.
   b. Coat the wrist pin, wrist pin bore in piston and the wrist pin bore in rod with clean engine oil.
   c. Install one snap ring into the piston’s wrist pin bore.

**NOTE:** Use new snap rings when reassembling the piston.

   d. Assemble the piston to the connecting rod. The assembly mark dimple on top of the piston should be opposite the match marks on the rod. See Figure 12-7.

e. Slide the wrist pin through the piston bore opposite the side with the snap ring (installed in Step 2c), then through the rod and the second piston bore until it contacts the snap ring.

f. Finally, install the second snap ring to retain the wrist pin in the piston and rod bores.

**INSTALLATION:**

1. Coat the cylinder walls with clean engine oil.
2. Coat crankshaft crankpin, connecting rod bearing and connecting rod cap bearing with engine oil.
3. Reinstall the crankshaft.
4. Stagger the ring end gaps so that they are 90° apart.
5. Use a ring compressor to compress the piston rings back into their grooves in the piston. Rings must be fully compressed.
6. Guide the connecting rod into the cylinder carefully. The assembly mark dimple on the piston must be toward the flywheel side of engine (3 o’clock position).

**NOTE:** The connecting rod has a large offset bearing end, therefore it MUST be installed exactly the way in which it was removed, with the match marks facing the governor arm.

7. When the ring compressor contacts top of cylinder, use a wood handle or rubber mallet to gently tap the piston down into the cylinder.
8. Check that the connecting rod large diameter bearing is coated with clean engine oil, as well as the crankpin and connecting rod cap.
9. Guide the connecting rod large diameter bearing over the crankshafts crankpin (rod journal).
10. Install the connecting rod cap with its match mark aligned with identical mark on rod.

11. Install the connecting rod cap bolts and tighten to the proper torque.

**CYLINDER SERVICE**

**INSPECTION:**
1. Inspect cylinder for dirty, broken or cracked cooling fins.
2. Check cylinder wall for wear, scoring or other damage.
3. Check all bearing surfaces for wear, scoring or other damage.

**REBORING THE CYLINDER:**
At the time this Manual was published, oversize pistons and rings were not available and reboring of the cylinder to an oversize cannot be done.

⚠ **CAUTION! DO NOT ATTEMPT TO REBORE THE CYLINDER. OVERSIZE PARTS ARE NOT AVAILABLE.**
INTRODUCTION:

Problems that affect engine operation may be classified as one of, or a combination of two or more of the following:

- Engine will not start.
- Engine starts with difficulty.
- Engine lacks power.
- Engine vibrates.
- Engine overheats.
- Engine burns oil.

In many cases, the cause of a problem will be readily apparent. If this is not the case, check the fuel system, as well as the ignition system and engine compression. Such a check can be performed quickly and is the best method of finding the cause of a failure. In addition, such a check may provide early detection of future failures.

CHECK FUEL SYSTEM:

Make sure the fuel tank has been properly filled with the correct fuel. If the engine is equipped with a fuel shutoff valve, make sure the valve is open. Make sure fuel is flowing through the fuel line and to the carburetor. Adjust the carburetor as needed. Make sure the choke closes all the way. If engine still will not start, remove and inspect the spark plug.

If the plug is WET, look for the following:

1. Overchoking.
2. Dirty air cleaner.
3. Excessively rich fuel-air mixture.
5. Fuel leaking past the carburetor float needle.

If the plug is DRY, look for the following:

1. Carburetor mounting gasket leaks.
2. Dirt or gum in carburetor or fuel line.
3. Carburetor float needle stuck closed.
4. Inoperative fuel pump (if so equipped).
5. Clogged fuel filter (if so equipped).

CHECK IGNITION SYSTEM:

See “Testing the Ignition System” in Section 8.

CHECK COMPRESSION:

To check engine compression, remove the spark plug. Insert an automotive type compression gauge into the spark plug hole. Crank the engine until there is no further increase in pressure. The highest reading obtained is the engine compression pressure.

If compression is poor, look for one or more of the following causes:

- Loose cylinder head bolts.
- Failed cylinder head gasket.
- Burned valves or valve seats.
- Insufficient valve clearance.
- Warped cylinder head.
- Warped valve stem.
- Worn or broken piston ring(s).
- Worn or damaged cylinder bore.
- Broken connecting rod.
- Worn valve seats or valves.
- Worn valve guides.
### SECTION 13: TROUBLESHOOTING

<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>POSSIBLE CAUSES</th>
<th>REMEDY</th>
</tr>
</thead>
</table>
| 1. Engine will not start or starts with difficulty. | a. Fuel tank is empty.  
 b. Low oil level.  
 c. Dirty air cleaner.  
 d. Obstructed fuel line.  
 e. Fuel tank cap vent hole is obstructed.  
 f. Spark plug is fouled.  
 g. Incorrect spark plug.  
 h. Loose or defective ignition wiring.  
 i. No ignition spark.  
 j. Incorrect valve clearance.  
 k. Poor compression. | a. Fill fuel tank.  
 b. Replenish oil as necessary.  
 c. Clean or replace air cleaner element.  
 d. Clean fuel line or replace.  
 e. Open cap vent hole.  
 f. Replace spark plug.  
 g. Replace with correct spark plug.  
 h. Check wiring, repair or replace.  
 i. Check ignition system, replace defective part(s).  
 j. Reset valve clearance.  
 k. Check for worn or scored cylinder. |
| 2. Engine knocks. | a. Carbon in combustion chamber.  
 b. Loose flywheel.  
 c. Worn cylinder.  
 d. Loose or worn connecting rod.  
 e. Incorrect valve clearance.  
 f. Engine is overloaded. | a. Clean carbon from head and piston.  
 b. Check flywheel key and keyway, replace part(s) if necessary. Tighten flywheel nut.  
 c. Replace crankcase.  
 d. Replace connecting rod. Check crankpin diameter to see if crankshaft is bad.  
 e. Reset to correct clearance.  
 f. Reduce excessive load. |
 b. Spark plug is fouled.  
 c. Spark plug porcelain is cracked.  
 d. Incorrect spark plug gap.  
 e. Incorrect valve clearance.  
 f. Weak valve springs. | a. Install correct spark plug.  
 b. Replace spark plug.  
 c. Replace spark plug.  
 d. Regap the spark plug.  
 e. Reset valve clearance.  
 f. Replace weak valve spring(s). |
| 4. Engine lacks power. | a. Governor not set correctly.  
 b. Incorrect spark plug  
 c. Incorrect valve clearance.  
 d. Worn piston rings.  
 e. Low oil level.  
 f. Air cleaner is obstructed.  
 g. Valves or valve seats worn or burned. | a. Adjust governor.  
 b. Install correct spark plug.  
 c. Reset valve clearance.  
 d. Replace piston rings.  
 e. Replenish oil to proper level.  
 f. Clean or replace air cleaner.  
 g. Grind valves and valve seats. |
| 5. Engine overheats. | a. Air flow is obstructed.  
 b. Cooling fins are clogged.  
 c. Carbon buildup in combustion chamber.  
 d. Engine is overloaded.  
 e. Lack of lubrication. | a. Remove obstructions.  
 b. Clean cooling fins.  
 c. Remove cylinder head and clean carbon.  
 d. Reduce excessive loading.  
 e. Replenish oil to proper level. |
 b. Bent crankshaft.  
 c. Problem in equipment connected to engine. | a. Tighten mounting bolts.  
 b. Replace crankshaft.  
 c. Check equipment driven by engine. |
### SECTION 13: TROUBLESHOOTING

<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>POSSIBLE CAUSES</th>
<th>REMEDY</th>
</tr>
</thead>
</table>
| 7. Engine surges or runs unevenly | 1. Vent hole in fuel tank cap plugged.  
2. Governor parts sticking or binding.  
3. Carburetor throttle linkage, throttle shaft binding.  
4. Intermittent ignition spark.  
5. Improper carburetor adjustment.  
2. Clean governor parts and replace as necessary.  
3. Clean, lubricate, adjust or repair sticking parts.  
4. Test ignition as per Section 8, repair or replace bad parts as necessary.  
5. Adjust carburetor.  
6. Clean carburetor. |
2. Oil level too high.  
3. Oil filler cap loose, or cap gasket damaged.  
4. Breather damaged or dirty.  
5. Drain holes in breather clogged.  
6. Gaskets or seals leaking.  
7. Valve guides worn excessively.  
9. Piston rings and/or grooves worn.  
10. Oil passages obstructed. | 1. Adjust engine speed to specifications.  
2. Drain excess oil from crankcase.  
3. Replace cap gasket and tighten cap.  
4. Clean or replace breather as necessary.  
5. Unclog drain holes in breather.  
6. Replace gaskets or seals  
7. Replace cylinder head.  
8. Replace crankcase.  
9. Install new rings and/or piston.  
10. Clean out oil passages. |
2. Oil seal hardened or worn.  
3. Crankshaft seal contact surface is worn.  
5. Seal not seated squarely in bore.  
6. New seal damaged during installation.  
2. Replace oil seal.  
3. Check crankshaft size and replace if worn.  
4. Replace sleeve bearing.  
5. Replace with new seal.  
6. Replace with new seal.  
7. Check crankshaft for straightness, replace if necessary. |
2. Oil level too high.  
3. Oil filler cap loose, or cap gasket damaged.  
4. Breather damaged or dirty.  
5. Drain holes in breather clogged.  
6. Piston ring end gaps are aligned.  
7. Rings not properly seated. | 1. Adjust engine speed to specifications.  
2. Drain excess oil from crankcase.  
3. Replace cap gasket and tighten cap.  
4. Clean or replace breather as necessary.  
5. Unclog drain holes in breather.  
6. Rotate ring end gaps, stagger 90° apart.  
7. Check for worn or “out of round” cylinder. Install new rings. Break in new rings with engine under varying loads. |
### GENERAL SPECIFICATIONS

<table>
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<tr>
<th>MODEL</th>
<th>GN-190</th>
<th>GN-191</th>
<th>GN/GSH-220</th>
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<tbody>
<tr>
<td>BORE</td>
<td>2.76 inches (70mm)</td>
<td>2.76 inches (70mm)</td>
<td>2.95 inches (75mm)</td>
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<tr>
<td>STROKE</td>
<td>1.93 inches (49mm)</td>
<td>1.93 inches (49mm)</td>
<td>1.93 inches (49mm)</td>
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<tr>
<td>DISPLACEMENT</td>
<td>188.6cc</td>
<td>188.6cc</td>
<td>216.5cc</td>
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<tr>
<td>OIL CAPACITY</td>
<td>24 ounces (700 ml)</td>
<td>24 ounces (700 ml)</td>
<td>24 ounces (700 ml)</td>
</tr>
<tr>
<td>OIL CAPACITY</td>
<td>14 ounces (400 ml)</td>
<td>14 ounces (400 ml)</td>
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### COMPRESSION PRESSURE

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<th>GN-191</th>
<th>GN/GSH-220</th>
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<tr>
<td>WHILE CRANKING</td>
<td>55 psi min.</td>
<td>55 psi min.</td>
<td>55 psi min.</td>
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### VALVE TRAIN

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<th>GN-191</th>
<th>GN/GSH-220</th>
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<tbody>
<tr>
<td>VALVE SEAT WIDTH</td>
<td>0.034-0.044 inch (0.87-1.13mm)</td>
<td>0.034-0.044 inch (0.87-1.13mm)</td>
<td>0.034-0.044 inch (0.87-1.13mm)</td>
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<tr>
<td>VALVE SEAT ANGLE</td>
<td>46 degrees</td>
<td>46 degrees</td>
<td>46 degrees</td>
</tr>
<tr>
<td>VALVE MARGIN</td>
<td>0.058-0.060 inch (1.48-1.52mm)</td>
<td>0.034-0.044 inch (0.87-1.13mm)</td>
<td>0.034-0.044 inch (0.87-1.13mm)</td>
</tr>
<tr>
<td>INTAKE VALVE STEM DIAMETER</td>
<td>0.215-0.216 inch (5.465-5.480mm)</td>
<td>0.2348-0.2354 inch (5.965-5.980mm)</td>
<td>0.2348-0.2354 inch (5.965-5.980mm)</td>
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<tr>
<td>EXHAUST VALVE STEM DIAMETER</td>
<td>0.214-0.215 inch (5.445-5.460mm)</td>
<td>0.234-0.2346 inch (5.945-5.960mm)</td>
<td>0.234-0.2346 inch (5.945-5.960mm)</td>
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<tr>
<td>TAPPET DIAMETER INTAKE AND EXHAUST</td>
<td>0.294-0.295 inch (7.461-7.475mm)</td>
<td>0.293-0.294 inch (7.457-7.475mm)</td>
<td>0.293-0.294 inch (7.457-7.475mm)</td>
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<tr>
<td>VALVE SPRINGS FREE LENGTH</td>
<td>1.910 inch (48.48mm)</td>
<td>2.074 inch (52.69mm)</td>
<td>2.074 inch (52.69mm)</td>
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<tr>
<td>FORCE REQUIRED TO COMPRESS SPRING TO 1.39 INCH (35.2mm)</td>
<td>14.8-16.3 pounds (6.7-7.4kg)</td>
<td>19.8-21.8 pounds (9.0-9.9kg)</td>
<td>19.8-21.8 pounds (9.0-9.9kg)</td>
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<tr>
<td>VALVE CLEARANCE INTAKE AND EXHAUST</td>
<td>0.002-0.004 inch (0.05-0.10mm)</td>
<td>0.002-0.004 inch (0.05-0.10mm)</td>
<td>0.002-0.004 inch (0.05-0.10mm)</td>
</tr>
<tr>
<td>VALVE GUIDE DIAMETER</td>
<td>0.216-0.217 inch (5.505-5.520mm)</td>
<td>0.237-0.2364 inch (6.02-6.005mm)</td>
<td>0.237-0.2364 inch (6.02-6.005mm)</td>
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## SECTION 14: SPECIFICATIONS - SMALL FRAME ENGINES

### CRANKCASE ASSEMBLY

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<th>GN-191</th>
<th>GN/GSH-220</th>
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<td>CYLINDER BORE DIAMETER</td>
<td>2.756-2.757 INCH (70.000-70.025MM)</td>
<td>2.756-2.757 INCH (70.000-70.025MM)</td>
<td>2.953-2.954 INCH (75.000-75.025MM)</td>
</tr>
<tr>
<td>VALVE TAPPET BORE DIAMETER</td>
<td>0.295-0.296 INCH (7.494-7.520MM)</td>
<td>0.295-0.296 INCH (7.494-7.520MM)</td>
<td>0.295-0.296 INCH (7.494-7.520MM)</td>
</tr>
<tr>
<td><em>(WHERE APPLICABLE)</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GOVERNOR ARM BORE DIAMETER</td>
<td>0.239-0.240 INCH (6.07-6.10MM)</td>
<td>0.239-0.240 INCH (6.07-6.10MM)</td>
<td>0.239-0.240 INCH (6.07-6.10MM)</td>
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<tr>
<td>CAMSHAFT BEARING DIAMETER</td>
<td>1.024-1.025 INCH (26.00-26.03MM)</td>
<td>1.024-1.025 INCH (26.00-26.03MM)</td>
<td>1.024-1.025 INCH (26.00-26.03MM)</td>
</tr>
<tr>
<td>GOVERNOR ARM DIAMETER</td>
<td>0.235-0.237 INCH (5.97-6.03MM)</td>
<td>0.235-0.237 INCH (5.97-6.03MM)</td>
<td>0.235-0.237 INCH (5.97-6.03MM)</td>
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*Later model small frame GN engines have no crankshaft sleeve bearing.*

### CRANKCASE COVER ASSEMBLY

<table>
<thead>
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<th>MODEL</th>
<th>GN-190</th>
<th>GN-191</th>
<th>GN/GSH-220</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAMSHAFT BEARING BORE DIAMETER</td>
<td>1.299-1.300 inch (33.00-33.03mm)</td>
<td>1.299-1.300 inch (33.00-33.03mm)</td>
<td>1.299-1.300 inch (33.00-33.03mm)</td>
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<tr>
<td>GOVERNOR GEAR SHAFT DIAMETER</td>
<td>0.236-0.237 inch (6.004-6.012mm)</td>
<td>0.236-0.237 inch (6.004-6.012mm)</td>
<td>0.236-0.237 inch (6.004-6.012mm)</td>
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<tr>
<td>OIL PUMP INNER ROTOR SHAFT DIAMETER</td>
<td>0.353-0.354 inch (8.969-8.987mm)</td>
<td>0.353-0.354 inch (8.969-8.987mm)</td>
<td>0.353-0.354 inch (8.969-8.987mm)</td>
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### CRANKSHAFT

<table>
<thead>
<tr>
<th>MODEL</th>
<th>GN-190</th>
<th>GN-191</th>
<th>GN/GSH-220</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALLOWABLE END PLAY</td>
<td>0.006-0.023 inch (0.14-0.60mm)</td>
<td>0.006-0.023 inch (0.14-0.60mm)</td>
<td>0.006-0.023 inch (0.14-0.60mm)</td>
</tr>
<tr>
<td>CRANKPIN DIAMETER</td>
<td>1.180-1.181 inch (29.99-30.01mm)</td>
<td>1.180-1.181 inch (29.99-30.01mm)</td>
<td>1.180-1.181 inch (29.99-30.01mm)</td>
</tr>
<tr>
<td>MAIN BEARING DIAMETER (FLYWHEEL END)</td>
<td>1.102-1.103 inch (28.000-28.012mm)</td>
<td>1.102-1.103 inch (28.000-28.012mm)</td>
<td>1.102-1.103 inch (28.000-28.012mm)</td>
</tr>
<tr>
<td>MAIN BEARING DIAMETER (PTO END)</td>
<td>1.102-1.103 inch (28.000-28.012mm)</td>
<td>1.102-1.103 inch (28.000-28.012mm)</td>
<td>1.102-1.103 inch (28.000-28.012mm)</td>
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## SECTION 14: SPECIFICATIONS - SMALL FRAME ENGINES

### CONNECTING ROD ASSEMBLY

<table>
<thead>
<tr>
<th>MODEL</th>
<th>GN-190</th>
<th>GN-191</th>
<th>GN/GSH-220</th>
</tr>
</thead>
<tbody>
<tr>
<td>LARGE END INSIDE</td>
<td>1.183-1.184 inch (30.06-30.07mm)</td>
<td>1.183-1.184 inch (30.06-30.07mm)</td>
<td>1.183-1.184 inch (30.06-30.07mm)</td>
</tr>
<tr>
<td>DIAMETER:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMALL END INSIDE</td>
<td>2.196-2.213 inch (55.8-56.2mm)</td>
<td>2.196-2.213 inch (55.8-56.2mm)</td>
<td>2.196-2.213 inch (55.8-56.2mm)</td>
</tr>
<tr>
<td>DIAMETER:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PISTON PIN LENGTH:</td>
<td>1.102-1.103 inch (28.000-28.012mm)</td>
<td>1.102-1.103 inch (28.000-28.012mm)</td>
<td>1.102-1.103 inch (28.000-28.012mm)</td>
</tr>
<tr>
<td>PISTON PIN: OUTSIDE</td>
<td>0.708-0.709 inch (17.989-18.000mm)</td>
<td>0.708-0.709 inch (17.989-18.000mm)</td>
<td>0.708-0.709 inch (17.989-18.000mm)</td>
</tr>
<tr>
<td>DIAMETER:</td>
<td></td>
<td></td>
<td></td>
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</table>

### PISTON

<table>
<thead>
<tr>
<th>MODEL</th>
<th>GN-190</th>
<th>GN-191</th>
<th>GN/GSH-220</th>
</tr>
</thead>
<tbody>
<tr>
<td>PISTON MAJOR DIAMETER</td>
<td>2.753-2.754 inch (69.939-69.959mm)</td>
<td>2.753-2.754 inch (69.939-69.959mm)</td>
<td>2.950-2.951 inch (74.939-74.959mm)</td>
</tr>
<tr>
<td>WRIST PIN BORE DIAMETER</td>
<td>0.708-0.709 inch (18.000-18.011mm)</td>
<td>0.708-0.709 inch (18.000-18.011mm)</td>
<td>0.708-0.709 inch (18.000-18.011mm)</td>
</tr>
<tr>
<td>TOP RING GROOVE WIDTH</td>
<td>0.059-0.061 inch (1.52-1.54mm)</td>
<td>0.059-0.061 inch (1.52-1.54mm)</td>
<td>0.059-0.061 inch (1.52-1.54mm)</td>
</tr>
<tr>
<td>SECOND RING GROOVE WIDTH</td>
<td>0.059-0.061 inch (1.52-1.54mm)</td>
<td>0.059-0.061 inch (1.52-1.54mm)</td>
<td>0.059-0.061 inch (1.52-1.54mm)</td>
</tr>
<tr>
<td>OIL CONTROL RING GROOVE WIDTH</td>
<td>0.118-0.119 inch (3.01-3.03mm)</td>
<td>0.118-0.119 inch (3.01-3.03mm)</td>
<td>0.118-0.119 inch (3.01-3.03mm)</td>
</tr>
<tr>
<td>TOP RING WIDTH</td>
<td>0.057-0.059 inch (1.47-1.49mm)</td>
<td>0.057-0.059 inch (1.47-1.49mm)</td>
<td>0.057-0.059 inch (1.47-1.49mm)</td>
</tr>
<tr>
<td>TOP RING END GAP: *</td>
<td>0.005-0.016 inch (0.15-0.40mm)</td>
<td>0.005-0.016 inch (0.15-0.40mm)</td>
<td>0.005-0.016 inch (0.15-0.40mm)</td>
</tr>
<tr>
<td>SECOND RING WIDTH:</td>
<td>0.057-0.059 inch (1.465-1.490mm)</td>
<td>0.057-0.059 inch (1.465-1.490mm)</td>
<td>0.057-0.059 inch (1.465-1.490mm)</td>
</tr>
<tr>
<td>SECOND RING END GAP: *</td>
<td>0.006-0.016 inch (0.15-0.40mm)</td>
<td>0.006-0.016 inch (0.15-0.40mm)</td>
<td>0.006-0.016 inch (0.15-0.40mm)</td>
</tr>
<tr>
<td>OIL CONTROL RING WIDTH</td>
<td>0.111-0.118 inch (2.825-3.003mm)</td>
<td>0.111-0.118 inch (2.825-3.003mm)</td>
<td>0.111-0.118 inch (2.825-3.003mm)</td>
</tr>
<tr>
<td>OIL CONTROL RING END GAP</td>
<td>0.015-0.055 inch (0.38-1.40mm)</td>
<td>0.015-0.055 inch (0.38-1.40mm)</td>
<td>0.015-0.055 inch (0.38-1.40mm)</td>
</tr>
</tbody>
</table>

*NOTE 1: Measure end gap with ring pushed down in cylinder to depth of 2.75 inches (69.85mm)*
# SECTION 14: SPECIFICATIONS - SMALL FRAME ENGINES

## CAMSHAFT ASSEMBLY

<table>
<thead>
<tr>
<th>MODEL</th>
<th>GN-190</th>
<th>GN-191</th>
<th>GN/GSH-220</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAIN CAMSHAFT BEARING DIAMETER (FLYWHEEL END):</td>
<td>1.022-1.023 inch (25.96-25.98mm)</td>
<td>1.022-1.023 inch (25.96-25.98mm)</td>
<td>1.022-1.023 inch (25.96-25.98mm)</td>
</tr>
<tr>
<td>MAIN CAMSHAFT BEARING DIAMETER (PTO END):</td>
<td>1.022-1.023 inch (25.96-25.98mm)</td>
<td>1.297-1.298 inch (32.96-32.98mm)</td>
<td>1.297-1.298 inch (32.96-32.98mm)</td>
</tr>
<tr>
<td>CAM LIFT</td>
<td>0.210-0.212 inch (5.34-5.38mm)</td>
<td>0.210-0.212 inch (5.34-5.38mm)</td>
<td>0.210-0.212 inch (5.34-5.38mm)</td>
</tr>
<tr>
<td>BASE CIRCLE DIAMETER OF CAM:</td>
<td>0.978-0.990 inch (24.85-25.15mm)</td>
<td>0.978-0.990 inch (24.85-25.15mm)</td>
<td>0.978-0.990 inch (24.85-25.15mm)</td>
</tr>
<tr>
<td>COMPRESSION RELEASE LIFT (MEASURED AT TAPPET):</td>
<td>0.019-0.026 inch (0.495-1.665mm)</td>
<td>0.019-0.026 inch (0.495-1.665mm)</td>
<td>0.019-0.026 inch (0.495-1.665mm)</td>
</tr>
</tbody>
</table>

## OIL PUMP

<table>
<thead>
<tr>
<th>MODEL</th>
<th>GN-190</th>
<th>GN-191</th>
<th>GN/GSH-220</th>
</tr>
</thead>
<tbody>
<tr>
<td>PUMP TIP CLEARANCE *:</td>
<td>0.0000-0.0010 inch (0.000-0.025mm)</td>
<td>0.0000-0.0010 inch (0.000-0.025mm)</td>
<td>0.0000-0.0010 inch (0.000-0.025mm)</td>
</tr>
<tr>
<td>INNER ROTOR BORE:</td>
<td>0.354-0.355 inch (9.000-9.019mm)</td>
<td>0.354-0.355 inch (9.000-9.019mm)</td>
<td>0.354-0.355 inch (9.000-9.019mm)</td>
</tr>
<tr>
<td>INNER ROTOR THICKNESS:</td>
<td>0.312-0.315 inch (7.95-8.00mm)</td>
<td>0.312-0.315 inch (7.95-8.00mm)</td>
<td>0.312-0.315 inch (7.95-8.00mm)</td>
</tr>
<tr>
<td>INNER ROTOR SHAFT OUTSIDE DIAMETER:</td>
<td>0.353-0.354 inch (8.969-8.987mm)</td>
<td>0.353-0.354 inch (8.969-8.987mm)</td>
<td>0.353-0.354 inch (8.969-8.987mm)</td>
</tr>
<tr>
<td>OUTER ROTOR SHAFT OUTSIDE DIAMETER:</td>
<td>1.296-1.297 inch (32.92-32.95mm)</td>
<td>1.296-1.297 inch (32.92-32.95mm)</td>
<td>1.296-1.297 inch (32.92-32.95mm)</td>
</tr>
<tr>
<td>OUTER ROTOR THICKNESS</td>
<td>0.314-0.316 inch (8.000-8.025mm)</td>
<td>0.314-0.316 inch (8.000-8.025mm)</td>
<td>0.314-0.316 inch (8.000-8.025mm)</td>
</tr>
<tr>
<td>OIL PRESSURE RELIEF VALVE SPRING: Force required to compress spring to 1.035 inch (26.3mm)</td>
<td>0.85-0.95 pounds (0.39-0.43kg)</td>
<td>0.85-0.95 pounds (0.39-0.43kg)</td>
<td>0.85-0.95 pounds (0.39-0.43kg)</td>
</tr>
</tbody>
</table>

*NOTE 2: Measure pump tip clearance with rotor on shaft in crankcase cover.*
### Torque Specifications

<table>
<thead>
<tr>
<th>Model</th>
<th>GN-190</th>
<th>GN-191</th>
<th>GN/GSH-220</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rocker Cover Screws</td>
<td>5.4 Nm (48 in-lbs)</td>
<td>5.4 Nm (48 in-lbs)</td>
<td>5.4 Nm (48 in-lbs)</td>
</tr>
<tr>
<td>Rocker Arm Jam Nut</td>
<td>8.1 Nm (72 in-lbs)</td>
<td>8.1 Nm (72 in-lbs)</td>
<td>8.1 Nm (72 in-lbs)</td>
</tr>
<tr>
<td>Cylinder Head Bolts</td>
<td>29.8 Nm (22 ft-lbs)</td>
<td>29.8 Nm (22 ft-lbs)</td>
<td>29.8 Nm (22 ft-lbs)</td>
</tr>
<tr>
<td>Connecting Rod Bolts</td>
<td>13.6 Nm (120 in-lbs)</td>
<td>13.6 Nm (120 in-lbs)</td>
<td>13.6 Nm (120 in-lbs)</td>
</tr>
<tr>
<td>Flywheel Nut</td>
<td>111.1 Nm (82 ft-lbs)</td>
<td>111.1 Nm (82 ft-lbs)</td>
<td>111.1 Nm (82 ft-lbs)</td>
</tr>
<tr>
<td>Crankcase Cover Bolts</td>
<td>24.4 Nm (216 in-lbs)</td>
<td>24.4 Nm (216 in-lbs)</td>
<td>24.4 Nm (216 in-lbs)</td>
</tr>
<tr>
<td>Ignition Coil Bolts</td>
<td>10.8 Nm (96 in-lbs)</td>
<td>10.8 Nm (96 in-lbs)</td>
<td>10.8 Nm (96 in-lbs)</td>
</tr>
<tr>
<td>Spark Plug</td>
<td>20.3 Nm (180 in-lbs)</td>
<td>20.3 Nm (180 in-lbs)</td>
<td>20.3 Nm (180 in-lbs)</td>
</tr>
<tr>
<td>Rewind Starter Screws</td>
<td>10.8 Nm (96 in-lbs)</td>
<td>10.8 Nm (96 in-lbs)</td>
<td>10.8 Nm (96 in-lbs)</td>
</tr>
<tr>
<td>Starter Motor Bolts</td>
<td>24.4 Nm (216 in-lbs)</td>
<td>24.4 Nm (216 in-lbs)</td>
<td>24.4 Nm (216 in-lbs)</td>
</tr>
<tr>
<td>Intake Manifold Screws</td>
<td>10.8 Nm (96 in-lbs)</td>
<td>10.8 Nm (96 in-lbs)</td>
<td>10.8 Nm (96 in-lbs)</td>
</tr>
<tr>
<td>Carburetor to Intake</td>
<td>4.5 Nm (40 in-lbs)</td>
<td>4.5 Nm (40 in-lbs)</td>
<td>4.5 Nm (40 in-lbs)</td>
</tr>
<tr>
<td>Manifold</td>
<td>5.6 Nm (50 in-lbs)</td>
<td>5.6 Nm (50 in-lbs)</td>
<td>5.6 Nm (50 in-lbs)</td>
</tr>
<tr>
<td>Air Cleaner Box (to Carburetor)</td>
<td>12.2 Nm (108 in-lbs)</td>
<td>12.2 Nm (108 in-lbs)</td>
<td>12.2 Nm (108 in-lbs)</td>
</tr>
<tr>
<td>Governor Lever Clamp Bolt</td>
<td>12.2 Nm (108 in-lbs)</td>
<td>12.2 Nm (108 in-lbs)</td>
<td>12.2 Nm (108 in-lbs)</td>
</tr>
<tr>
<td>Oil Filter Adapter Bolts</td>
<td>12.2 Nm (108 in-lbs)</td>
<td>12.2 Nm (108 in-lbs)</td>
<td>12.2 Nm (108 in-lbs)</td>
</tr>
<tr>
<td>Low Oil Switch</td>
<td>12.2 Nm (108 in-lbs)</td>
<td>12.2 Nm (108 in-lbs)</td>
<td>12.2 Nm (108 in-lbs)</td>
</tr>
<tr>
<td>Blower Housing Screws</td>
<td>4.5 Nm (40 in-lbs)</td>
<td>4.5 Nm (40 in-lbs)</td>
<td>4.5 Nm (40 in-lbs)</td>
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### SECTION 15: SPECIFICATIONS - LARGE FRAME ENGINES

#### GENERAL SPECIFICATIONS

<table>
<thead>
<tr>
<th>MODEL</th>
<th>GN-320</th>
<th>GN-360</th>
<th>GN/GSH-410</th>
</tr>
</thead>
<tbody>
<tr>
<td>BORE</td>
<td>3.15 inches (80mm)</td>
<td>3.35 inches (85mm)</td>
<td>3.54 inches (90mm)</td>
</tr>
<tr>
<td>STROKE</td>
<td>2.52 inches (64mm)</td>
<td>2.52 inches (64mm)</td>
<td>2.52 inches (64mm)</td>
</tr>
<tr>
<td>DISPLACEMENT</td>
<td>322cc</td>
<td>363cc</td>
<td>407cc</td>
</tr>
<tr>
<td>OIL CAPACITY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WITH OIL FILTER CHANGE</td>
<td>47 ounces (1.40 L)</td>
<td>47 ounces (1.40 L)</td>
<td>47 ounces (1.40 L)</td>
</tr>
<tr>
<td>OIL CAPACITY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>W/O OIL FILTER CHANGE</td>
<td>37 ounces (1.10 L)</td>
<td>37 ounces (1.10 L)</td>
<td>37 ounces (1.10 L)</td>
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#### COMPRESSION PRESSURE

<table>
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<tr>
<th>MODEL</th>
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<th>GN-191</th>
<th>GN/GSH-220</th>
</tr>
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<tbody>
<tr>
<td>WHILE CRANKING (COLD ENGINE)</td>
<td>55 psi min.</td>
<td>55 psi min.</td>
<td>55 psi min.</td>
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#### VALVE TRAIN

<table>
<thead>
<tr>
<th>MODEL</th>
<th>GN-320</th>
<th>GN-360</th>
<th>GN/GSH-410</th>
</tr>
</thead>
<tbody>
<tr>
<td>VALVE SEAT WIDTH:</td>
<td>0.034-0.044 inch (0.87-1.13 mm)</td>
<td>0.034-0.044 inch (0.87-1.13 mm)</td>
<td>0.034-0.044 inch (0.87-1.13 mm)</td>
</tr>
<tr>
<td>VALVE SEAT ANGLE</td>
<td>46 degrees</td>
<td>46 degrees</td>
<td>46 degrees</td>
</tr>
<tr>
<td>INTAKE VALVE STEM DIAMETER</td>
<td>0.274-0.275 inch (6.965-6.980 mm)</td>
<td>0.274-0.275 inch (6.965-6.980 mm)</td>
<td>0.274-0.275 inch (6.965-6.980 mm)</td>
</tr>
<tr>
<td>EXHAUST VALVE STEM DIAMETER</td>
<td>0.273-0.274 inch (6.945-6.960 mm)</td>
<td>0.273-0.274 inch (6.945-6.960 mm)</td>
<td>0.273-0.274 inch (6.945-6.960 mm)</td>
</tr>
<tr>
<td>TAPPET DIAMETER INTAKE AND EXHAUST:</td>
<td>0.352-0.353 inch (8.957-8.975 mm)</td>
<td>0.352-0.353 inch (8.957-8.975 mm)</td>
<td>0.352-0.353 inch (8.957-8.975 mm)</td>
</tr>
<tr>
<td>VALVE SPRINGS: FREE LENGTH</td>
<td>1.752-1.764 inch (44.5-44.8 mm)</td>
<td>1.752-1.764 inch (44.5-44.8 mm)</td>
<td>1.752-1.764 inch (44.5-44.8 mm)</td>
</tr>
<tr>
<td>FORCE REQUIRED TO COMPRESS SPRING TO 1.59 INCH (4.33 mm)</td>
<td>15.3-16.9 pounds (6.9-7.6 kg)</td>
<td>15.3-16.9 pounds (6.9-7.6 kg)</td>
<td>15.3-16.9 pounds (6.9-7.6 kg)</td>
</tr>
<tr>
<td>VALVE CLEARANCE: INTAKE &amp; EXHAUST</td>
<td>0.002-0.004 inch (0.05-0.10 mm)</td>
<td>0.002-0.004 inch (0.05-0.10 mm)</td>
<td>0.002-0.004 inch (0.05-0.10 mm)</td>
</tr>
<tr>
<td>VALVE GUIDE DIAMETER</td>
<td>0.275-0.276 inch (7.005-7.020 mm)</td>
<td>0.275-0.276 inch (7.005-7.020 mm)</td>
<td>0.275-0.276 inch (7.005-7.020 mm)</td>
</tr>
</tbody>
</table>
### SECTION 15: SPECIFICATIONS - LARGE FRAME ENGINES

#### CRANKCASE ASSEMBLY

<table>
<thead>
<tr>
<th>Model</th>
<th>GN-320</th>
<th>GN-360</th>
<th>GN/GSH-410</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylinder Bore Diameter</td>
<td>3.150-3.151 inch (80.000-80.025 mm)</td>
<td>3.346-3.347 inch (85.000-85.025 mm)</td>
<td>3.543-3.544 inch (90.000-90.025 mm)</td>
</tr>
<tr>
<td>Valve Tappet Bore Diameter</td>
<td>0.354-0.355 inch (8.994-9.020 mm)</td>
<td>0.354-0.355 inch (8.994-9.020 mm)</td>
<td>0.354-0.355 inch (8.994-9.020 mm)</td>
</tr>
<tr>
<td>Crankshaft Sleeve Bearing Diameter (Where Applicable)</td>
<td>1.380-1.381 inch (35.065-35.090 mm)</td>
<td>1.380-1.381 inch (35.065-35.090 mm)</td>
<td>1.380-1.381 inch (35.065-35.090 mm)</td>
</tr>
<tr>
<td>Governor Arm Bore Diameter</td>
<td>0.239-0.240 inch (6.07-6.10 mm)</td>
<td>0.239-0.240 inch (6.07-6.10 mm)</td>
<td>0.239-0.240 inch (6.07-6.10 mm)</td>
</tr>
<tr>
<td>Camshaft Bearing Diameter</td>
<td>1.083-1.084 inch (27.50-27.53 mm)</td>
<td>1.083-1.084 inch (27.50-27.53 mm)</td>
<td>1.083-1.084 inch (27.50-27.53 mm)</td>
</tr>
<tr>
<td>Governor Arm Diameter</td>
<td>0.234-0.238 inch (5.95-6.05 mm)</td>
<td>0.234-0.238 inch (5.95-6.05 mm)</td>
<td>0.234-0.238 inch (5.95-6.05 mm)</td>
</tr>
</tbody>
</table>

*Later model large frame GN engines have no crankshaft sleeve bearing.

#### CRANKCASE COVER ASSEMBLY

<table>
<thead>
<tr>
<th>Model</th>
<th>GN-320</th>
<th>GN-360</th>
<th>GN/GSH-410</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crankshaft Bearing Bore Diameter</td>
<td>1.380-1.381 inch (35.065-35.090 mm)</td>
<td>1.380-1.381 inch (35.065-35.090 mm)</td>
<td>1.380-1.381 inch (35.065-35.090 mm)</td>
</tr>
<tr>
<td>Camshaft Bearing Bore Diameter</td>
<td>1.299-1.300 inch (33.00-33.03 mm)</td>
<td>1.299-1.300 inch (33.00-33.03 mm)</td>
<td>1.299-1.300 inch (33.00-33.03 mm)</td>
</tr>
<tr>
<td>Balancer Bearing Bore Diameter</td>
<td>0.984-0.985 inch (25.00-25.03 mm)</td>
<td>0.984-0.985 inch (25.00-25.03 mm)</td>
<td>0.984-0.985 inch (25.00-25.03 mm)</td>
</tr>
<tr>
<td>Governor Gear Shaft Diameter</td>
<td>0.236-0.237 inch (6.004-6.012 mm)</td>
<td>0.236-0.237 inch (6.004-6.012 mm)</td>
<td>0.236-0.237 inch (6.004-6.012 mm)</td>
</tr>
<tr>
<td>Oil Pump Inner Rotor Shaft Diameter</td>
<td>0.353-0.354 inch (8.969-8.987 mm)</td>
<td>0.353-0.354 inch (8.969-8.987 mm)</td>
<td>0.353-0.354 inch (8.969-8.987 mm)</td>
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</table>

#### CRANKSHAFT

<table>
<thead>
<tr>
<th>Model</th>
<th>GN-320</th>
<th>GN-360</th>
<th>GN/GSH-410</th>
</tr>
</thead>
<tbody>
<tr>
<td>Allowable End Play</td>
<td>.005-.026 inch (0.12-0.66 mm)</td>
<td>.005-.026 inch (0.12-0.66 mm)</td>
<td>.005-.026 inch (0.12-0.66 mm)</td>
</tr>
<tr>
<td>Crankpin Diameter</td>
<td>1.417-1.418 inch (35.99-36.01 mm)</td>
<td>1.417-1.418 inch (35.99-36.01 mm)</td>
<td>1.417-1.418 inch (35.99-36.01 mm)</td>
</tr>
<tr>
<td>Crankshaft Main Bearing Diameter (Flywheel End)</td>
<td>1.378-1.379 inch (35.000-35.012 mm)</td>
<td>1.378-1.379 inch (35.000-35.012 mm)</td>
<td>1.378-1.379 inch (35.000-35.012 mm)</td>
</tr>
<tr>
<td>Crankshaft Main Bearing Diameter (PTO End)</td>
<td>1.378-1.379 inch (35.000-35.012 mm)</td>
<td>1.378-1.379 inch (35.000-35.012 mm)</td>
<td>1.378-1.379 inch (35.000-35.012 mm)</td>
</tr>
</tbody>
</table>
## SECTION 15: SPECIFICATIONS - LARGE FRAME ENGINES

### CONNECTING ROD ASSEMBLY

<table>
<thead>
<tr>
<th>MODEL</th>
<th>GN-320</th>
<th>GN-360</th>
<th>GN/GSH-410</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LARGE END INSIDE</strong></td>
<td>1.419-1.420 inch</td>
<td>1.419-1.420 inch</td>
<td>1.419-1.420 inch</td>
</tr>
<tr>
<td><strong>DIAMETER</strong></td>
<td>(36.06-36.07 mm)</td>
<td>(36.06-36.07 mm)</td>
<td>(36.06-36.07 mm)</td>
</tr>
<tr>
<td><strong>SMALL END INSIDE</strong></td>
<td>0.788-0.789 inch</td>
<td>0.788-0.789 inch</td>
<td>0.788-0.789 inch</td>
</tr>
<tr>
<td><strong>DIAMETER</strong></td>
<td>(20.02-20.03 mm)</td>
<td>(20.02-20.03 mm)</td>
<td>(20.02-20.03 mm)</td>
</tr>
<tr>
<td><strong>PISTON PIN LENGTH:</strong></td>
<td>2.669-2.685 inch</td>
<td>2.669-2.685 inch</td>
<td>2.669-2.685 inch</td>
</tr>
<tr>
<td><strong>(67.8-68.2 mm)</strong></td>
<td>(67.8-68.2 mm)</td>
<td>(67.8-68.2 mm)</td>
<td>(67.8-68.2 mm)</td>
</tr>
<tr>
<td><strong>PISTON PIN OUTSIDE</strong></td>
<td>0.786-0.787 inch</td>
<td>0.786-0.787 inch</td>
<td>0.786-0.787 inch</td>
</tr>
</tbody>
</table>

### PISTON

<table>
<thead>
<tr>
<th>MODEL</th>
<th>GN-320</th>
<th>GN-360</th>
<th>GN/GSH-410</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PISTON MAJOR DIAMETER</strong></td>
<td>3.147-3.148 inch</td>
<td>3.343-3.344 inch</td>
<td>3.540-3.541 inch</td>
</tr>
<tr>
<td><strong>(79.928-79.948 mm)</strong></td>
<td>(84.928-84.948 mm)</td>
<td>(89.928-89.948 mm)</td>
<td></td>
</tr>
<tr>
<td><strong>WRIST PIN BORE DIAMETER</strong></td>
<td>0.787-0.788 inch</td>
<td>0.787-0.788 inch</td>
<td>0.787-0.788 inch</td>
</tr>
<tr>
<td><strong>(20.000-20.011 mm)</strong></td>
<td>(20.000-20.011 mm)</td>
<td>(20.000-20.011 mm)</td>
<td></td>
</tr>
<tr>
<td><strong>TOP RING GROOVE WIDTH</strong></td>
<td>0.060-0.061 inch</td>
<td>0.060-0.061 inch</td>
<td>0.060-0.061 inch</td>
</tr>
<tr>
<td><strong>(1.530-1.555 mm)</strong></td>
<td>(1.530-1.555 mm)</td>
<td>(1.530-1.555 mm)</td>
<td>(1.530-1.555 mm)</td>
</tr>
<tr>
<td><strong>SECOND RING GROOVE</strong></td>
<td>0.060-0.061 inch</td>
<td>0.060-0.061 inch</td>
<td>0.060-0.061 inch</td>
</tr>
<tr>
<td><strong>WIDTH WIDTH</strong></td>
<td>(1.530-1.555 mm)</td>
<td>(1.530-1.555 mm)</td>
<td>(1.530-1.555 mm)</td>
</tr>
<tr>
<td><strong>OIL CONTROL RING</strong></td>
<td>0.119-0.120 inch</td>
<td>0.119-0.120 inch</td>
<td>0.119-0.120 inch</td>
</tr>
<tr>
<td><strong>GROOVE WIDTH:</strong></td>
<td>(3.03-3.055 mm)</td>
<td>(3.03-3.055 mm)</td>
<td>(3.03-3.055 mm)</td>
</tr>
<tr>
<td><strong>TOP RING WIDTH:</strong></td>
<td>0.058-0.059 inch</td>
<td>0.058-0.059 inch</td>
<td>0.058-0.059 inch</td>
</tr>
<tr>
<td><strong>(1.47-1.49 mm)</strong></td>
<td>(1.47-1.49 mm)</td>
<td>(1.47-1.49 mm)</td>
<td>(1.47-1.49 mm)</td>
</tr>
<tr>
<td><strong>TOP RING END GAP:</strong></td>
<td>0.007-0.017 inch</td>
<td>0.006-0.016 inch</td>
<td>0.010-0.020 inch</td>
</tr>
<tr>
<td><strong>(0.18-0.43 mm)</strong></td>
<td>(0.15-0.40 mm)</td>
<td>(0.25-0.50 mm)</td>
<td></td>
</tr>
<tr>
<td><strong>SECOND RING WIDTH:</strong></td>
<td>0.058-0.059 inch</td>
<td>0.058-0.059 inch</td>
<td>0.058-0.059 inch</td>
</tr>
<tr>
<td><strong>(1.465-1.490 mm)</strong></td>
<td>(1.465-1.490 mm)</td>
<td>(1.465-1.490 mm)</td>
<td>(1.465-1.490 mm)</td>
</tr>
<tr>
<td><strong>SECOND RING END GAP:</strong></td>
<td>0.007-0.017 inch</td>
<td>0.009-0.024 inch</td>
<td>0.010-0.020 inch</td>
</tr>
<tr>
<td><strong>(0.18-0.43 mm)</strong></td>
<td>(0.23-0.60 mm)</td>
<td>(0.25-0.50 mm)</td>
<td></td>
</tr>
<tr>
<td><strong>OIL CONTROL RING WIDTH</strong></td>
<td>0.017-0.019 inch</td>
<td>0.017-0.019 inch</td>
<td>0.017-0.019 inch</td>
</tr>
<tr>
<td>**GAP **</td>
<td>(0.432-0.483 mm)</td>
<td>(0.432-0.483 mm)</td>
<td>(0.432-0.483 mm)</td>
</tr>
<tr>
<td><strong>OIL CONTROL RING END</strong></td>
<td>0.015-0.055 inch</td>
<td>0.015-0.055 inch</td>
<td>0.015-0.055 inch</td>
</tr>
<tr>
<td>**GAP **</td>
<td>(0.39-1.40 mm)</td>
<td>(0.39-1.40 mm)</td>
<td>(0.39-1.40 mm)</td>
</tr>
</tbody>
</table>

*NOTE 1: Measure end gap with ring pushed down in cylinder to depth of 2.75 inches (69.85mm)*

15-3
### CAMSHAFT ASSEMBLY

<table>
<thead>
<tr>
<th>MODEL</th>
<th>GN-320</th>
<th>GN-360</th>
<th>GN/GSH-410</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAIN CAMSHAFT BEARING DIAMETER (FLYWHEEL END)</td>
<td>1.081-1.082 inch (27.46-27.48 mm)</td>
<td>1.081-1.082 inch (27.46-27.48 mm)</td>
<td>1.081-1.082 inch (27.46-27.48 mm)</td>
</tr>
<tr>
<td>MAIN CAMSHAFT BEARING DIAMETER (PTO END)</td>
<td>1.297-1.298 inch (32.96-32.98 mm)</td>
<td>1.297-1.298 inch (32.96-32.98 mm)</td>
<td>1.297-1.298 inch (32.96-32.98 mm)</td>
</tr>
<tr>
<td>CAM LIFT</td>
<td>0.211 inch (5.36 mm)</td>
<td>0.211 inch (5.36 mm)</td>
<td>0.211 inch (5.36 mm)</td>
</tr>
<tr>
<td>BASE CIRCLE DIAMETER OF CAM</td>
<td>1.024 inch (26.00 mm)</td>
<td>1.024 inch (26.00 mm)</td>
<td>1.024 inch (26.00 mm)</td>
</tr>
<tr>
<td>COMPRESSION RELEASE LIFT (MEASURED AT TAPPET)</td>
<td>0.23-0.034 inch (0.595-0.885 mm)</td>
<td>0.23-0.034 inch (0.595-0.885 mm)</td>
<td>0.23-0.034 inch (0.595-0.885 mm)</td>
</tr>
</tbody>
</table>

### BALANCER ASSEMBLY

<table>
<thead>
<tr>
<th>MODEL</th>
<th>GN-320</th>
<th>GN-360</th>
<th>GN/GSH-410</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAIN BALANCER BEARING DIAMETER (FLYWHEEL END)</td>
<td>0.982-0.983 inch (24.96-24.98 mm)</td>
<td>0.982-0.983 inch (24.96-24.98 mm)</td>
<td>0.982-0.983 inch (24.96-24.98 mm)</td>
</tr>
<tr>
<td>MAIN BALANCER BEARING DIAMETER (PTO END)</td>
<td>0.982-0.983 inch (24.96-24.98 mm)</td>
<td>0.982-0.983 inch (24.96-24.98 mm)</td>
<td>0.982-0.983 inch (24.96-24.98 mm)</td>
</tr>
</tbody>
</table>

### OIL PUMP

<table>
<thead>
<tr>
<th>MODEL</th>
<th>GN-320</th>
<th>GN-360</th>
<th>GN/GSH-410</th>
</tr>
</thead>
<tbody>
<tr>
<td>PUMP TIP CLEARANCE *</td>
<td>0.0122-0.0123 inch (0.311-0.313 mm)</td>
<td>0.0122-0.0123 inch (0.311-0.313 mm)</td>
<td>0.0122-0.0123 inch (0.311-0.313 mm)</td>
</tr>
<tr>
<td>INNER ROTOR BORE</td>
<td>0.886 inch (22.5 mm)</td>
<td>0.886 inch (22.5 mm)</td>
<td>0.886 inch (22.5 mm)</td>
</tr>
<tr>
<td>INNER ROTOR THICKNESS</td>
<td>0.471-0.472 inch (11.98-12.00 mm)</td>
<td>0.471-0.472 inch (11.98-12.00 mm)</td>
<td>0.471-0.472 inch (11.98-12.00 mm)</td>
</tr>
<tr>
<td>INNER ROTOR INNER DIAMETER</td>
<td>0.886 inch (22.5 mm)</td>
<td>0.886 inch (22.5 mm)</td>
<td>0.886 inch (22.5 mm)</td>
</tr>
<tr>
<td>OUTER ROTOR OUTSIDE DIAMETER</td>
<td>1.296-1.297 inch (32.92-32.95 mm)</td>
<td>1.296-1.297 inch (32.92-32.95 mm)</td>
<td>1.296-1.297 inch (32.92-32.95 mm)</td>
</tr>
<tr>
<td>OUTER ROTOR THICKNESS</td>
<td>0.472-0.473 inch (12.00-12.03 mm)</td>
<td>0.472-0.473 inch (12.00-12.03 mm)</td>
<td>0.472-0.473 inch (12.00-12.03 mm)</td>
</tr>
<tr>
<td>OIL PRESSURE RELIEF VALVE SPRING FREE LENGTH</td>
<td>0.928 inch (23.57 mm)</td>
<td>0.928 inch (23.57 mm)</td>
<td>0.928 inch (23.57 mm)</td>
</tr>
</tbody>
</table>

*NOTE 2: Measure pump tip clearance with rotor on shaft in crankcase cover.*
## SECTION 15: SPECIFICATIONS - LARGE FRAME ENGINES

### TORQUE SPECIFICATIONS

<table>
<thead>
<tr>
<th>MODEL</th>
<th>GN-320</th>
<th>GN-360</th>
<th>GN/GSH-410</th>
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<tbody>
<tr>
<td>ROCKER COVER SCREWS</td>
<td>5.4 Nm</td>
<td>5.4 Nm</td>
<td>5.4 Nm</td>
</tr>
<tr>
<td></td>
<td>(48 in-lbs)</td>
<td>(48 in-lbs)</td>
<td>(48 in-lbs)</td>
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<tr>
<td>ROCKER ARM JAM NUT</td>
<td>19.6 Nm</td>
<td>19.6 Nm</td>
<td>19.6 Nm</td>
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<tr>
<td></td>
<td>(174 in-lbs)</td>
<td>(174 in-lbs)</td>
<td>(174 in-lbs)</td>
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<tr>
<td>CYLINDER HEAD BOLTS</td>
<td>59.6 Nm</td>
<td>59.6 Nm</td>
<td>59.6 Nm</td>
</tr>
<tr>
<td></td>
<td>44 ft-lbs</td>
<td>44 ft-lbs</td>
<td>44 ft-lbs</td>
</tr>
<tr>
<td>CONNECTING ROD BOLTS</td>
<td>24.4 Nm</td>
<td>24.4 Nm</td>
<td>24.4 Nm</td>
</tr>
<tr>
<td></td>
<td>(216 in-lbs)</td>
<td>(216 in-lbs)</td>
<td>(216 in-lbs)</td>
</tr>
<tr>
<td>FLYWHEEL NUT</td>
<td>122 Nm</td>
<td>122 Nm</td>
<td>122 Nm</td>
</tr>
<tr>
<td></td>
<td>(90 ft-lbs)</td>
<td>(90 ft-lbs)</td>
<td>(90 ft-lbs)</td>
</tr>
<tr>
<td>CRANKCASE COVER BOLTS</td>
<td>24.4 Nm</td>
<td>24.4 Nm</td>
<td>24.4 Nm</td>
</tr>
<tr>
<td></td>
<td>(216 in-lbs)</td>
<td>(216 in-lbs)</td>
<td>(216 in-lbs)</td>
</tr>
<tr>
<td>IGNITION COIL BOLTS</td>
<td>9.5 Nm</td>
<td>9.5 Nm</td>
<td>9.5 Nm</td>
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<tr>
<td></td>
<td>(84 in-lbs)</td>
<td>(84 in-lbs)</td>
<td>(84 in-lbs)</td>
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<tr>
<td>SPARK PLUG</td>
<td>20.3 Nm</td>
<td>20.3 Nm</td>
<td>20.3 Nm</td>
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<tr>
<td></td>
<td>(180 in-lbs)</td>
<td>(180 in-lbs)</td>
<td>(180 in-lbs)</td>
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<tr>
<td>REWIND STARTER SCREWS</td>
<td>6.8 Nm</td>
<td>6.8 Nm</td>
<td>6.8 Nm</td>
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<tr>
<td></td>
<td>(60 in-lbs)</td>
<td>(60 in-lbs)</td>
<td>(60 in-lbs)</td>
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<tr>
<td>STARTER MOTOR BOLTS</td>
<td>24.4 Nm</td>
<td>24.4 Nm</td>
<td>24.4 Nm</td>
</tr>
<tr>
<td></td>
<td>(216 in-lbs)</td>
<td>(216 in-lbs)</td>
<td>(216 in-lbs)</td>
</tr>
<tr>
<td>INTAKE MANIFOLD SCREWS</td>
<td>9.5 Nm</td>
<td>9.5 Nm</td>
<td>9.5 Nm</td>
</tr>
<tr>
<td></td>
<td>(84 in-lbs)</td>
<td>(84 in-lbs)</td>
<td>(84 in-lbs)</td>
</tr>
<tr>
<td>CARBURETOR TO INTAKE MANIFOLD</td>
<td>9.5 Nm</td>
<td>9.5 Nm</td>
<td>9.5 Nm</td>
</tr>
<tr>
<td></td>
<td>(84 in-lbs)</td>
<td>(84 in-lbs)</td>
<td>(84 in-lbs)</td>
</tr>
<tr>
<td>GOVERNOR LEVER CLAMP BOLT</td>
<td>7.9 Nm</td>
<td>7.9 Nm</td>
<td>7.9 Nm</td>
</tr>
<tr>
<td></td>
<td>(70 in-lbs)</td>
<td>(70 in-lbs)</td>
<td>(70 in-lbs)</td>
</tr>
<tr>
<td>OIL FILTER ADAPTER BOLTS</td>
<td>24.4 Nm</td>
<td>24.4 Nm</td>
<td>24.4 Nm</td>
</tr>
<tr>
<td></td>
<td>(216 in-lbs)</td>
<td>(216 in-lbs)</td>
<td>(216 in-lbs)</td>
</tr>
<tr>
<td>LOW OIL SWITCH</td>
<td>12.2 Nm</td>
<td>12.2 Nm</td>
<td>12.2 Nm</td>
</tr>
<tr>
<td></td>
<td>(108 in-lbs)</td>
<td>(108 in-lbs)</td>
<td>(108 in-lbs)</td>
</tr>
<tr>
<td>BLOWER HOUSING</td>
<td>12.2 Nm</td>
<td>12.2 Nm</td>
<td>12.2 Nm</td>
</tr>
<tr>
<td></td>
<td>(108 in-lbs)</td>
<td>(108 in-lbs)</td>
<td>(108 in-lbs)</td>
</tr>
</tbody>
</table>

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GSH/GSV 190-410