

# GENERAC®

## Service and Repair Manual for Small Frame GN Engines

190/191/220



P/N C1103

includes 320/360/41



# 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.

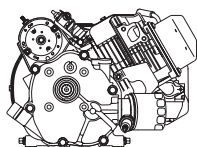
Proper service and repair is important to the safe, economical and reliable operation of the products described herein. The troubleshooting, testing, service and repair procedures recommended by GENERAC® POWER SYSTEMS, INC. and described in this manual are effective methods of performing such operations. 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.

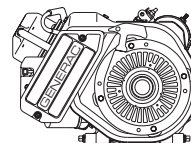
All information, illustrations and specifications contained in this manual are based on the latest product information available at the time of publication. However, GENERAC® POWER SYSTEMS, INC. reserves the right to change, alter or otherwise improve the product at any time without prior notice.

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.



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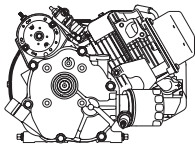
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### SMALL FRAME ENGINES

ENGINE MODEL	DESCRIPTION
GN190H	60 Hz "XL" style, tapered shaft
GN190H	Keyed 3/4" unthreaded straight shaft
GN190RV	Vertical tapered shaft
GN191H	60 Hz "XE" or "XL" style, no oil filter
GN191H	3/4" straight shaft (SAE J609a)
GN191H	3/4" keyed straight shaft
GN191RV	Vertical tapered shaft
GN220H	Horizontal tapered shaft
GN220H	3/4" straight shaft
GN220H	1" straight shaft
GN220H	3/4" keyed straight shaft
GN220H	5/8" threaded straight shaft
GN220RV	No governor parts; for use in computer controlled generators

If you don't understand any portion of this manual, contact an authorized Generac service dealer.

Throughout this publication, 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.



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



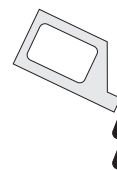
**WARNING:** After this heading you can read handling, installing, operating or servicing instructions that, if not strictly complied with, may result in personal injury.



**CAUTION:** After this heading you can read instructions for handing, 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.

In addition to the DANGER, WARNING, CAUTION and NOTE blocks, the following blocks indicate specifications or capacities as noted.



Indicates a fluid capacity.



Indicates a measurement.



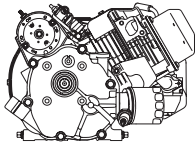
Indicates a torque specification.



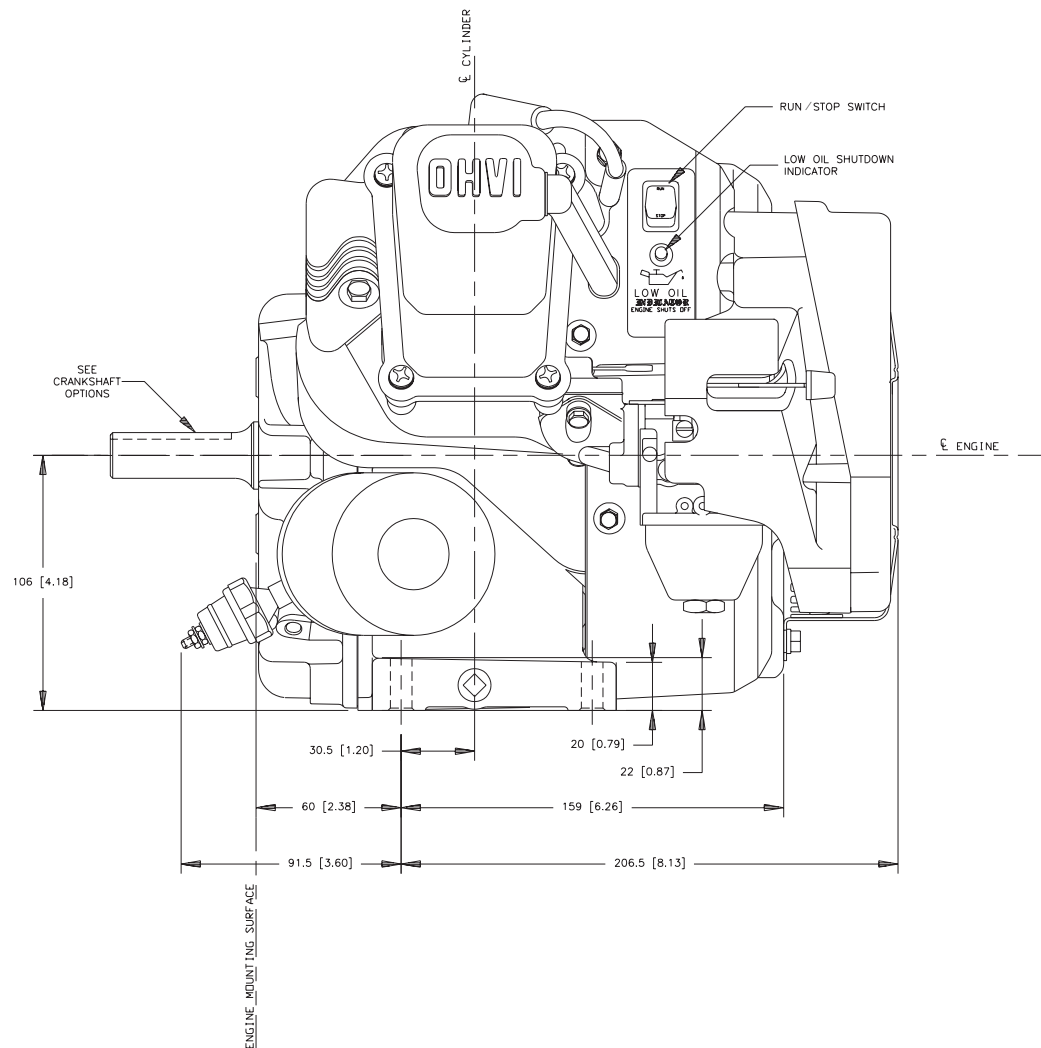
Indicates a load specification.

Technical drawing of the Honda GX390 engine, showing dimensions and labels. The drawing includes the following dimensions and labels:

- 92.2 [3.63]
- 125.3 [4.93]
- 42 [1.65]
- 244 [9.61]
- 210 [8.27]
- 256 [10.08]
- 184.15 [7.25]
- 308 [12.13]
- 46 [1.8]
- 1 [0.04]
- 4X 5/16-24 UNF-2B 18mm DEEP
- Ø92.075 [Ø3.625]
- Ø ENGINE
- ENGINE
- 45° TYP
- OIL PRESSURE SWITCH
- OIL FILTER OPTIONAL
- OIL FILL
- EXHAUST OUTLET
- 2X M8-1.25X15 DEEP
- IDLE CONTROL OPTIONAL
- ELECTRIC STARTER OPTIONAL
- GENERAC



## FRONT VIEW





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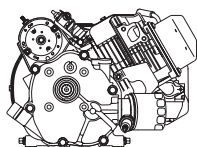
61.6 [2.4]

5/8-18 UNF-2B  
25.4mm LONG MIN.

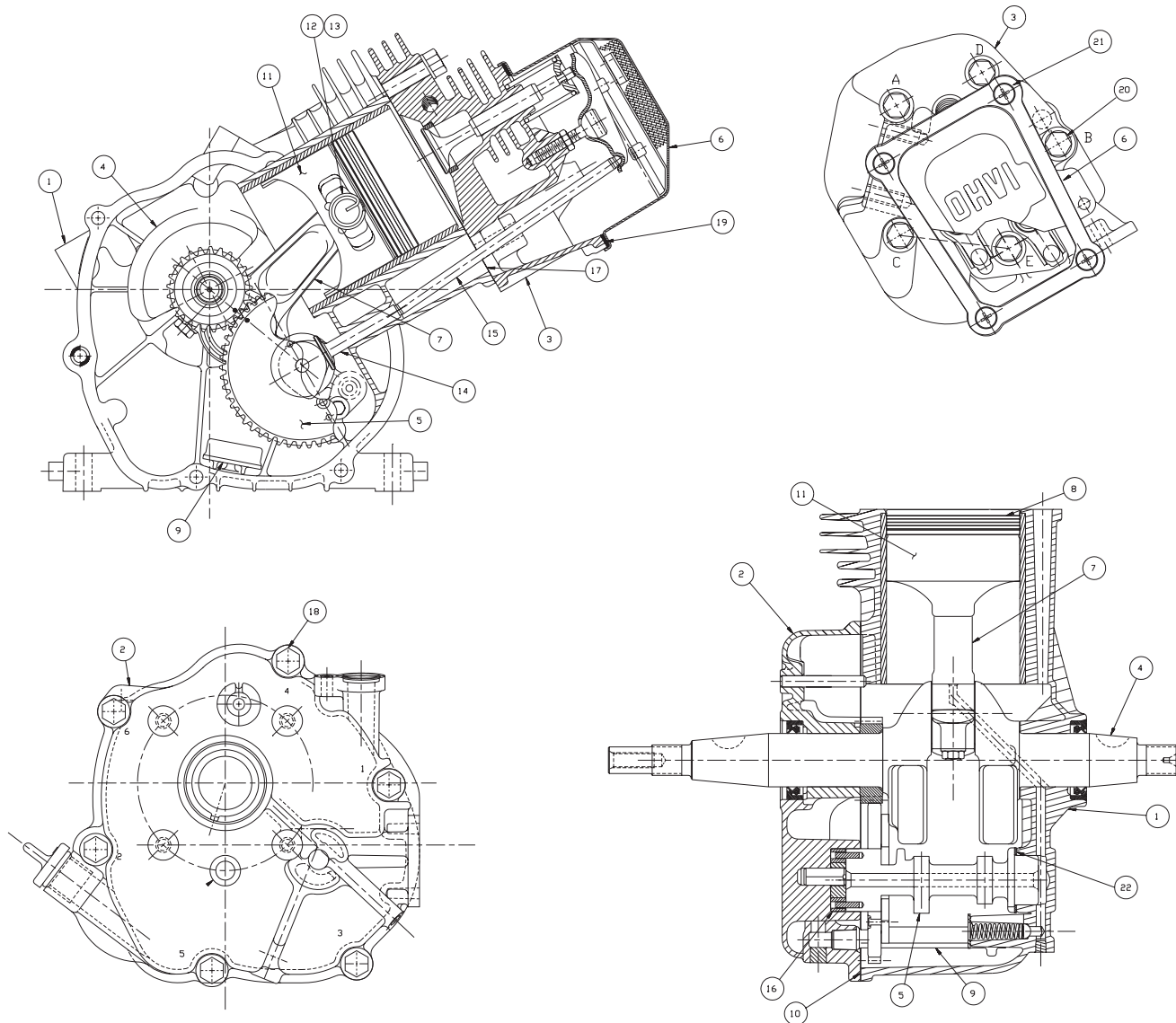
61.6 [2.4]

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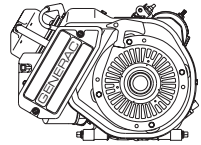
INC WTG SURFACE



## CUTAWAY VIEWS



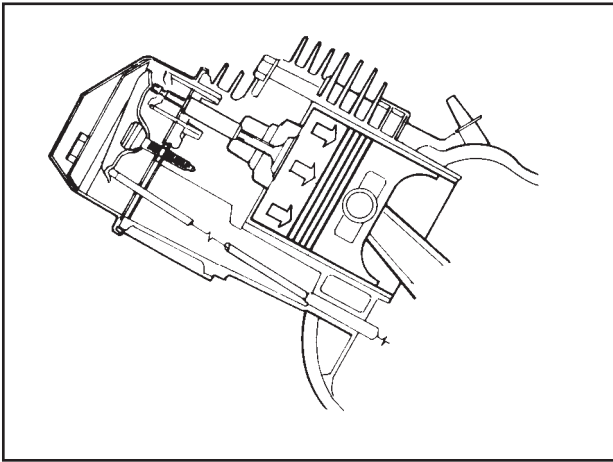
ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	CRANKCASE	12	PISTON PIN
2	CRANKCASE COVER	13	SNAP RING
3	CYLINDER HEAD	14	TAPPET
4	CRANKSHAFT	15	PUSH ROD
5	CAMSHAFT	16	OIL PUMP
6	ROCKER COVER / BREATHER	17	CYLINDER HEAD GASKET
7	CONNECTING ROD	18	CRANKCASE COVER BOLT
8	PISTON RING SET	19	ROCKER COVER GASKET
9	OIL PICK-UP ASSEMBLY	20	CYLINDER HEAD BOLT
10	CRANKCASE COVER GASKET	21	ROCKER COVER SCREW
11	PISTON	22	SPRING WASHER



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.

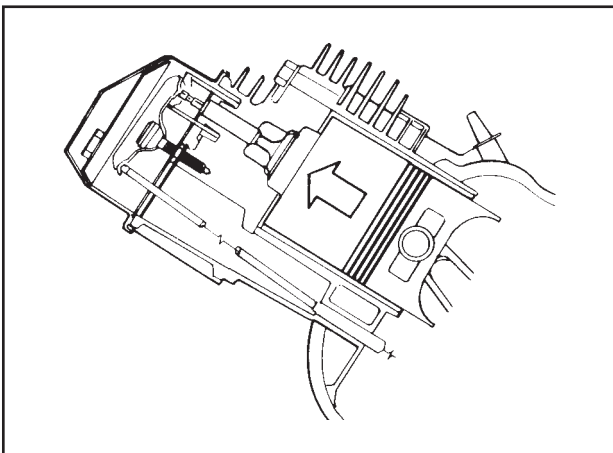
### A INTAKE

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.



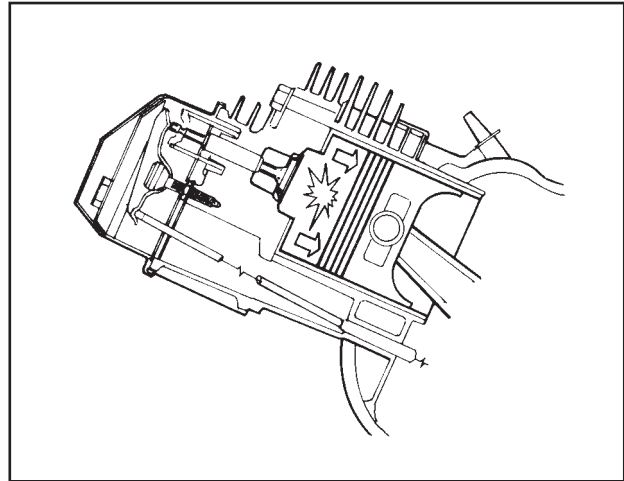
### B COMPRESSION

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.



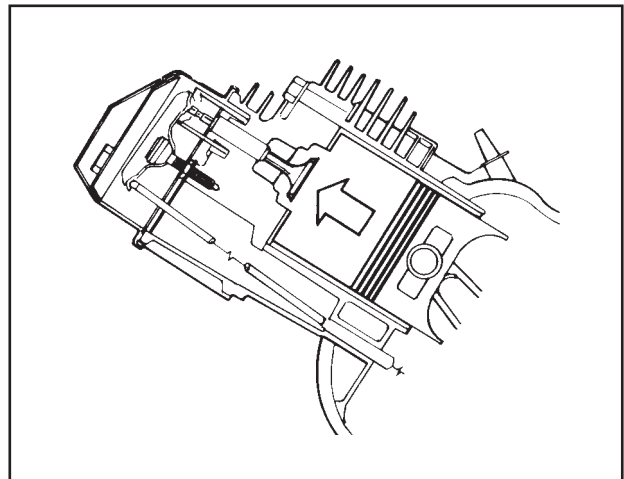
### C IGNITION AND POWER

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.

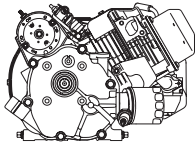


### D EXHAUST

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.







## Purpose and Scope of Manual

This manual contains all information normally required to service or repair the Models GN-190, GN-191 and GN-220 horizontal shaft engines. Applicable procedures are carefully explained and illustrated.

For exploded views and listings of engine parts, refer to the *Owner's Manual* for the specific device on which the engine is used.

When ordering parts, always include the model and serial number of the engine. **Be sure to insist on genuine Generac repair parts.**

**NOTE: Engine Models GN-190RV, GN-191RV and GN-220RV (Engine block Part Numbers 86923, 90993 and 90306, respectively) are vertical shaft long blocks. They are used in Generac's computer controlled, variable speed RV generator set. Service and repair information for these vertical shaft long blocks is not included in this manual. For specific information on these engines, refer to "SERVICE MANUAL- COMPUTER CONTROLLED VARIABLE SPEED RV GENERATORS," Part No. 94468-A.**

## Small Frame Engines

Engine Models GN-190, GN-191 and GN-220 are designated as "small frame" engines. The CHART on Page 3 lists most engine models that were available at the time this manual was published. Some of the differences between specific engine models listed in the CHART are as follows:

1. Differences in the type of crankshaft
  - a. Some engine models may be equipped with a tapered crankshaft.
  - b. Some models may have an unthreaded and keyed 3/4 or 1 inch crankshaft.
  - c. A 5/8 inch diameter threaded crankshaft is used on some engines.
2. Some engine models are equipped with automatic idle control, other models are not.
3. Some models may have an oil filter, others may not be so equipped.

## Long Block

The term "long block" refers to a basic engine which does not include such items as a blower housing, air cleaner, carburetor, etc. Figure 1.1 shows a typical engine long block.

Figure 1.2 shows a typical complete engine.

## Engine I.D. Number/Serial Number

The part number and serial number of the engine long block can be found on a nameplate, located on the engine crankcase (see Figure 1.3).

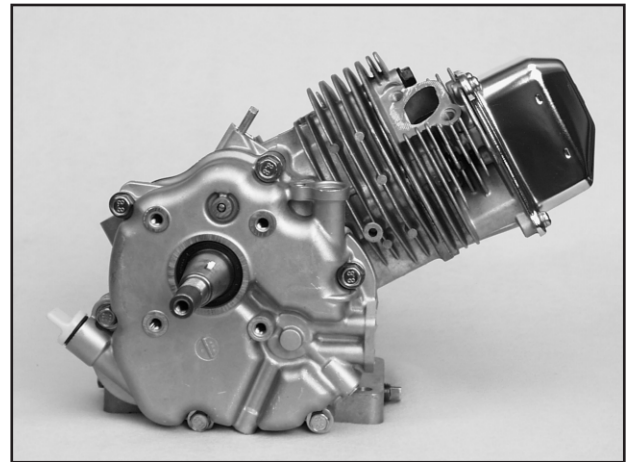


Figure 1.1 — Typical Long Block

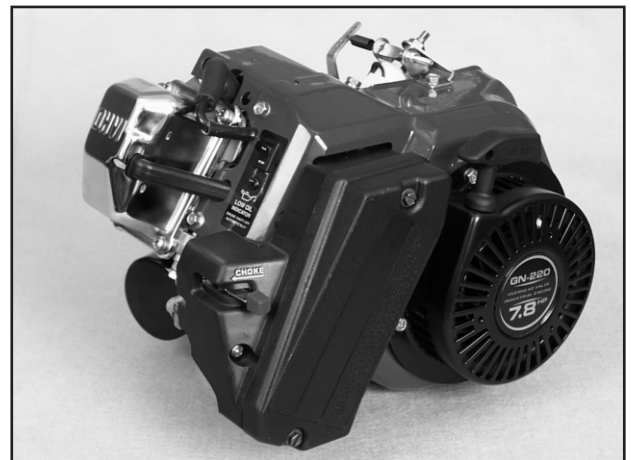
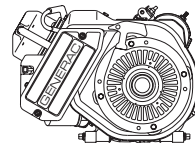


Figure 1.2 — Typical Complete Engine



Figure 1.3 — Location of Part and Serial Numbers



## ENGINE CARE

### RECOMMENDED FUELS:

Use clean, fresh, UNLEADED regular grade gasoline. Unleaded gasoline burns cleaner, extends engine life and promotes easier starting by reducing combustion chamber deposits. The use of gasohol is NOT recommended. If gasohol must be used, it should contain not more than 10 percent ethanol. If gasohol containing ethanol is used, special care is required when preparing the engine for storage (see "Storage Instructions").

- **DO NOT USE GASOLINE CONTAINING METHANOL.**
- **DO NOT MIX OIL WITH THE GASOLINE.**



**DANGER! GASOLINE IS EXTREMELY FLAMMABLE, AND ITS VAPORS ARE EXPLOSIVE. DO NOT PERMIT SMOKING, OPEN FLAME OR HEAT IN THE VICINITY WHILE HANDLING GASOLINE. AVOID SPILLAGE OF GASOLINE ON A HOT ENGINE. COMPLY WITH ALL LAWS PERTAINING TO THE STORAGE AND HANDLING OF GASOLINE.**

### RECOMMENDED ENGINE OIL:

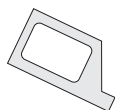
Use a clean, high quality, detergent oil classified "For Service SC, SD, SE, SF or SG." No special additives should be used with the recommended oil. Detergent oils keep the engine cleaner and retard the formation of gum and varnish deposit.

Synthetic oil can be used in place of petroleum based oils.

During summer months (above 32 F or 0 C), use SAE 30 oil. SAE 10W-30 oil is an acceptable substitute.

During winter (below 32 F or 0 C) use SAE 5W-20 or 5W-30 oil.

- **DO NOT USE SAE 10W-40 OIL.**



**CRANKCASE OIL CAPACITY  
GN190, GN191, GN220 ENGINES  
WITHOUT OIL FILTER CHANGE —  
21 ounces (620 ml)  
WITH OIL FILTER CHANGE —  
29.5 ounces (870 ml)**

### CHANGE OIL FILTER:

Replace oil filter with every oil change. Before installing a new oil filter, put a light coat of clean oil on rubber o-ring on filter base. Screw the filter on by hand until o-ring touches filter adapter base, then tighten 3/4 turn. Check for leaks after starting.

Check engine oil level each time the equipment is used. When checking oil level, make sure the equipment is level.

Change oil after the first eight hours of operation on a new engine. Thereafter, change oil and filter every 50 hours of operation. Change oil every 25 hours if operating under extremely dusty or dirty conditions, or in very hot weather.

**NOTE: Engine may be equipped with automatic low oil shutdown capability. If so equipped, it will not start when oil level is low. See Section 12, "Lubrication."**

## STORAGE INSTRUCTIONS

The engine should be started at least once every seven days and allowed to run for at least 30 minutes. If this cannot be done and the engine is to remain unused longer than 30 days, it must be prepared for storage.



**DANGER ! NEVER STORE THE ENGINE WITH FUEL IN TANK INDOORS OR IN ANY ENCLOSED, POORLY VENTILATED AREA WHERE FUEL VAPORS MIGHT REACH AN OPEN FLAME (AS ON A FURNACE, WATER HEATER, DRYER, ETC.). FIRE OR AN EXPLOSION COULD RESULT.**

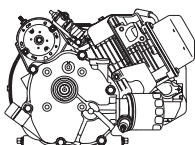
To prepare an engine for storage, proceed as follows:

1. Run the engine for about five minutes to warm it up.
  - a. If gasohol was used, drain the fuel tank, then run the engine until it shuts down due to lack of fuel.
  - b. Use of a good fuel stabilizer will prevent gum deposits from forming in the engine fuel system.
2. While engine is still warm from running, drain oil from crankcase and refill with new oil.
3. Remove the spark plug and pour about 1/2 ounce (15ml) of clean, fresh engine oil into cylinder. Crank the engine over slowly to distribute the oil. Then, install spark plug but do not connect the spark plug wire.
4. Clean dirt, oil, grease, etc., from the engine.
5. Store the engine in a clean, dry area.

## TUNE-UP PROCEDURE

Following is a minor tune-up procedure. When the procedure has been completed, either the engine will run properly or further repairs may be required.

1. Service or replace engine air cleaner as needed.
2. Check level and condition of oil. Add or change oil as necessary.
3. Remove the blower housing. Clean dirt from intake screen, head and cylinder cooling fins. Also, remove dirt from carburetor and governor lever(s) and linkage.
4. Clean fuel tank, fuel filter(s) and fuel lines.
5. Replace any damaged governor springs.
6. If required, adjust the carburetor and governor.



7. Replace the spark plug. Use a Champion RC12YC (or equivalent) spark plug.
  - a. Set spark plug gap to 0.030 inch (0.76mm).
  - b. Install new plug, tighten to 13 ft-lbs (156 in-lbs).
  - c. If torque wrench is not available, tighten plug with fingers. Then, tighten NEW plug 1/2 turn further; or USED plug 1/4 turn further.
8. Check that ignition wires are free of breaks and abrasions and are properly routed.
9. Install the blower housing.
10. Run engine and adjust engine speed.

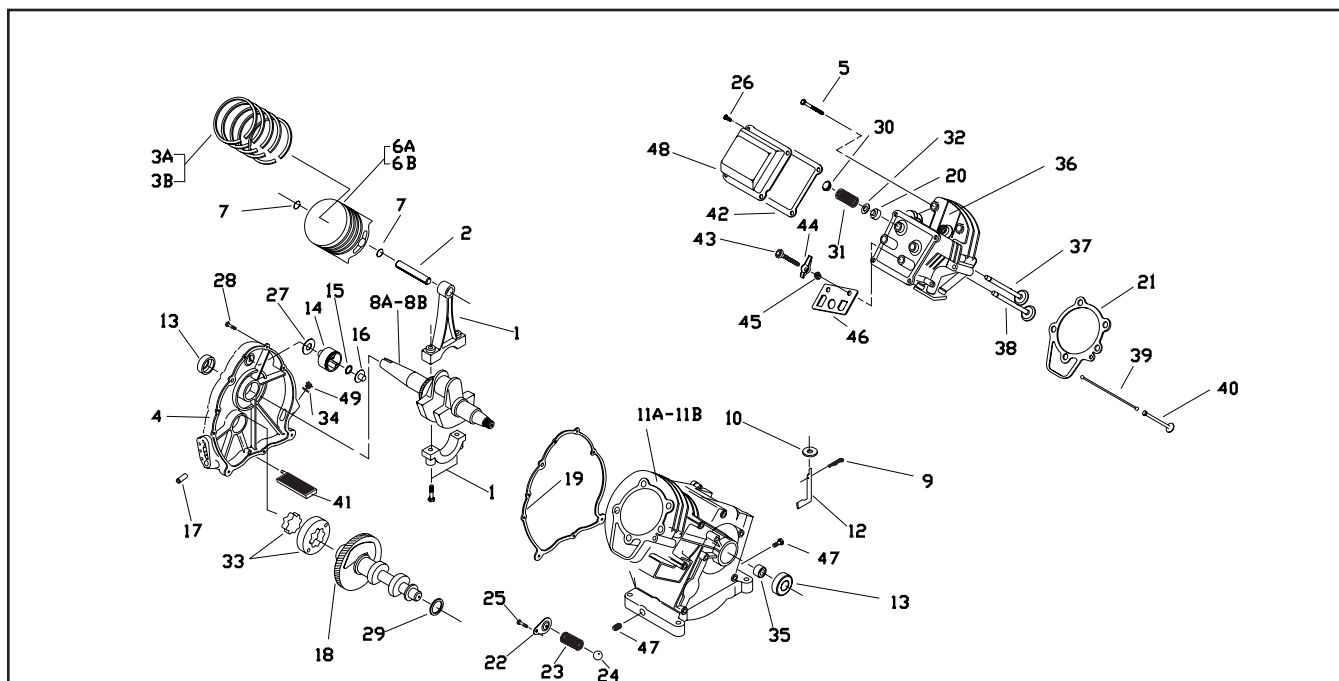
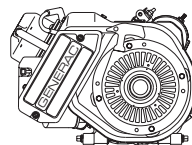


Figure 1.4 — Exploded View — Typical Horizontal Shaft Long Block

ITEM	DESCRIPTION	QTY	ITEM	DESCRIPTION	QTY
1	Control Rod Assembly	1	25	M5 Form Screw	1
2	Piston Pin	1	26	M6-1.0 x 12mm Screw	4
3	Piston Ring Set	1	27	Gov. Gear Thrust Washer	1
4	Gear Cover Assembly	1	28	M8-1.25 x 35mm Screw	6
5	M8 x 52mm Head Bolt	5	29	Spring Washer	1
6	Piston	1	30	Valve Spring Retainer	2
7	Pin Retainer Ring	2	31	Valve Spring	2
8	Crankshaft Assm.	1	32	Valve Spring Wear Washer	2
9	Governor "R" Pin	1	33	Geroter Set	1
10	Gov. Arm Thrust Washer	1	34	"O" Ring	1
11	Crankcase Assembly.	1	36	Cylinder Head Assembly	1
11B	Crankcase Assembly.	1	37	Exhaust Valve	1
12	Governor Arm	1	38	Intake Valve	1
13	Oil Seal	2	39	Push Rod	2
14	Governor Gear Assembly	1	40	Tappet	2
15	Governor Gear C-Ring	1	41	Oil Pick-up Assembly	1
16	Governor Spool	1	42	Rocker Cover Gasket	1
17	1/8" NPT Pipe Plug	1	43	Pivot Ball Stud	2
18	Camshaft Assembly	1	44	GN-190/220 Rocker Arm	2
19	Crankcase Gasket	1	45	Rocker Arm Jam Nut	2
20	Valve Stem Seal	1	46	Push Rod Guide Plate	1
21	Cylinder Head Gasket	1	47	1/4" NPT Pipe Plug	2
22	Oil Pressure Relief Cover	1	48	Rocker Cover Assembly	1
23	Oil Pressure Spring	1	49	Plastic Oil Fill Plug	1
24	11/32" Ball	1			





### OVERSIZE PARTS

#### GENERAL:

At the time this manual was published, oversize pistons, rings, valves, etc., were not available. Worn or damaged parts must be replaced.

#### OVERSIZE PISTONS AND RINGS:

Oversize pistons and rings are not available at this time. The engine cylinder cannot be rebored to an oversize dimension. If the cylinder is worn excessively or damaged, the crankcase must be replaced. A standard size piston and rings can then be used.

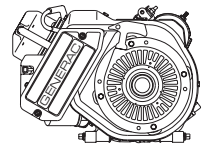
#### OVERSIZE VALVES:

Oversize valves are not available at this time. Valve guides cannot be rebored to an oversize dimension. If valve guides are worn or damaged, the cylinder head must be replaced. Standard size valves can then be used. Valve guides cannot be replaced.

***NOTE: Always use original GENERAC® replacement parts.***



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### 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.

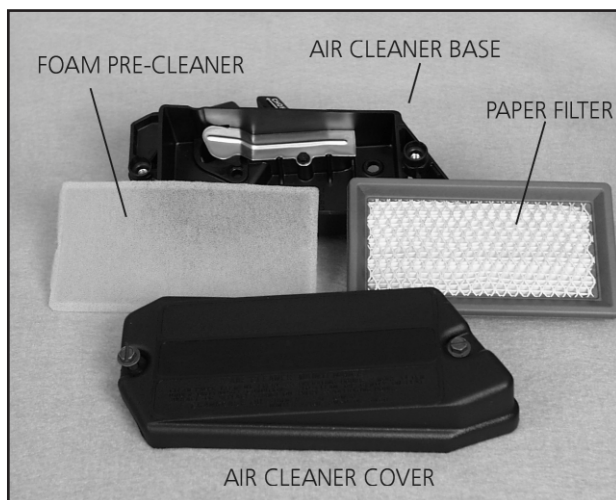
#### FOAM PRE-CLEANER:

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.



**Figure 2.1 — Typical Air Cleaner**

#### 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.

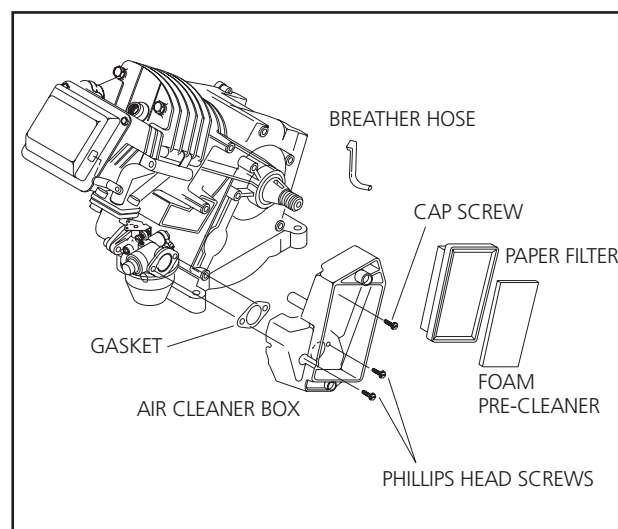
#### AIR CLEANER BOX REMOVAL:

If the air cleaner box must be removed for further engine disassembly, do the following (see Figure 2.2):

1. Remove the air cleaner cover.
2. Remove the foam pre-cleaner and paper filter.
3. Remove the choke knob (units with choke style carburetor).
4. Remove the breather hose.
5. 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.

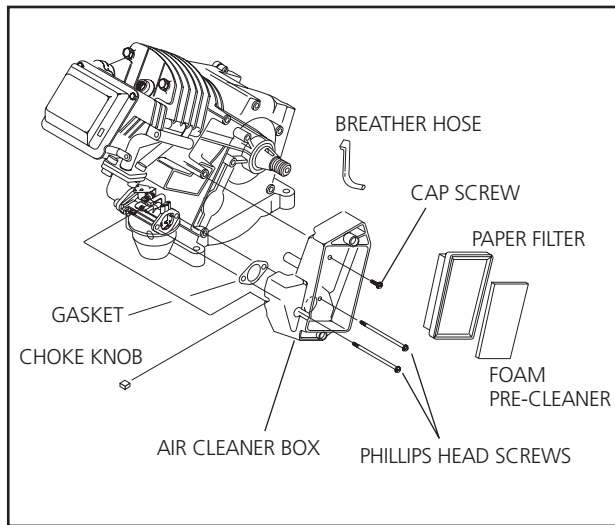
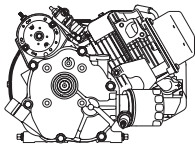


**CAUTION! Removal of the two phillips head screws on a choke style carburetor/air cleaner box combination also will loosen the carburetor from its mount. Be careful not to let the carburetor drop, as damage to the carburetor and/or governor rod and anti-lash spring may result.**



**Figure 2.2 — Removal of Air Cleaner Box, Primer Style Carburetor**





**Figure 2.3 — Removal of Air Cleaner Box, Choke 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 phillips head screws (see Figure 2.2). If reinstalling the air cleaner box with a choke style carburetor, line up the holes of the carburetor and air cleaner box with the holes on the intake manifold before installing the phillips head screws (see Figure 2.3). Refer to "Torque Specifications" on page 59 for proper torque.
2. Install the cap screw in the upper part of the air cleaner box. Refer to Torque Specifications on page 59 for proper torque.
3. Reinstall the breather hose.
4. Reinstall the choke knob (units with choke type carburetor).
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 in most automotive repair facilities or in lawn and garden centers.

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.

### ADJUSTABLE AND FIXED MAIN JET:

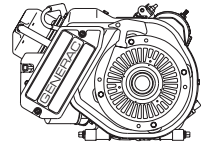
Some early production GN series engines were equipped with a carburetor having an adjustable main jet. On later production engines, a carburetor with fixed main jet is used.



**Figure 2.4 — Typical Carburetor with Primer**



**Figure 2.5 — Typical Carburetor with Choke**

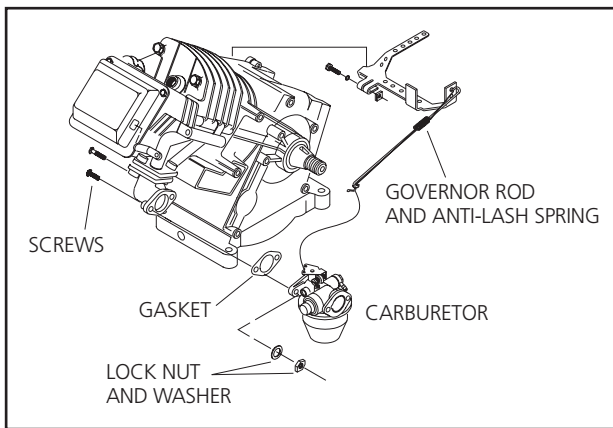


### CARBURETOR REMOVAL:

A choke style carburetor will already be loosened from its mount following step 5 in "AIR CLEANER BOX REMOVAL" on page 14.

For primer style carburetor, remove the two screws that hold it to the intake manifold, being careful not to drop the lock nuts and washers on the opposite ends of the screws (see Figure 2.6).

The governor rod and lash spring must now be detached from the throttle rod on either style of carburetor. Simply tilt the carburetor until the rod and spring can slip out of the hole on the lever.



**Figure 2.6 — Removal of Primer Style Carburetor**

### CARBURETOR DISASSEMBLY:

See Figure 2.7. The carburetor can be disassembled as follows:

1. Remove the BOWL NUT (Item 4) and the FIBER WASHER (Item 5). Then, remove the FLOAT BOWL (Item 3).
2. Remove the FLOAT PIN (Item 7). Then, remove the FLOAT (Item 2) and INLET VALVE (Item 8).
3. Remove the IDLE SPEED SCREW (Item 18) along with SPRING (Item 17).
4. Rotate the THROTTLE VALVE (Item 14) to its closed position and remove the SCREW (Item 13). The THROTTLE VALVE can now be removed.
5. Remove the THROTTLE SHAFT (Item 15), along with the THROTTLE SHAFT SPRING (Item 12) and the THROTTLE SHAFT SEAL (Item 11).

### CLEANING AND INSPECTION:

1. Separate out all nonmetallic parts. Then, clean metallic parts with solvent or commercial carburetor cleaner. **DO NOT ALLOW NONMETALLIC PARTS TO CONTACT SOLVENT.**

2. Inspect the THROTTLE SHAFT (Item 15) and THROTTLE VALVE (Item 10). Replace if damaged.
3. Inspect the IDLE JET (Item 16). Check the passages as well as its seating surface for damage. Replace if worn, damaged or defective.
4. If so equipped, inspect the MAIN JET ADJUSTMENT. Replace, if necessary.

**NOTE: Later production carburetor may not be equipped with a MAIN JET ADJUSTMENT:**

5. The FLOAT BOWL (Item 3) must be free of dirt and corrosion. Use a new gasket when assembling the FLOAT BOWL.
- NOTE: The float setting is FIXED and NONADJUSTABLE.**
6. Replace the FLOAT (Item 3) if necessary.
7. After cleaning metal parts in cleaner, blow out all carburetor passages with compressed air.



**DO NOT ALLOW CARBURETOR METAL PARTS TO SOAK FOR LONGER THAN 10 MINUTES OR THEY MAY BE DAMAGED.**

### **NEW STYLE, NONADJUSTABLE TYPE EMISSION CARBURETOR**



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.

**NOTE: 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.**

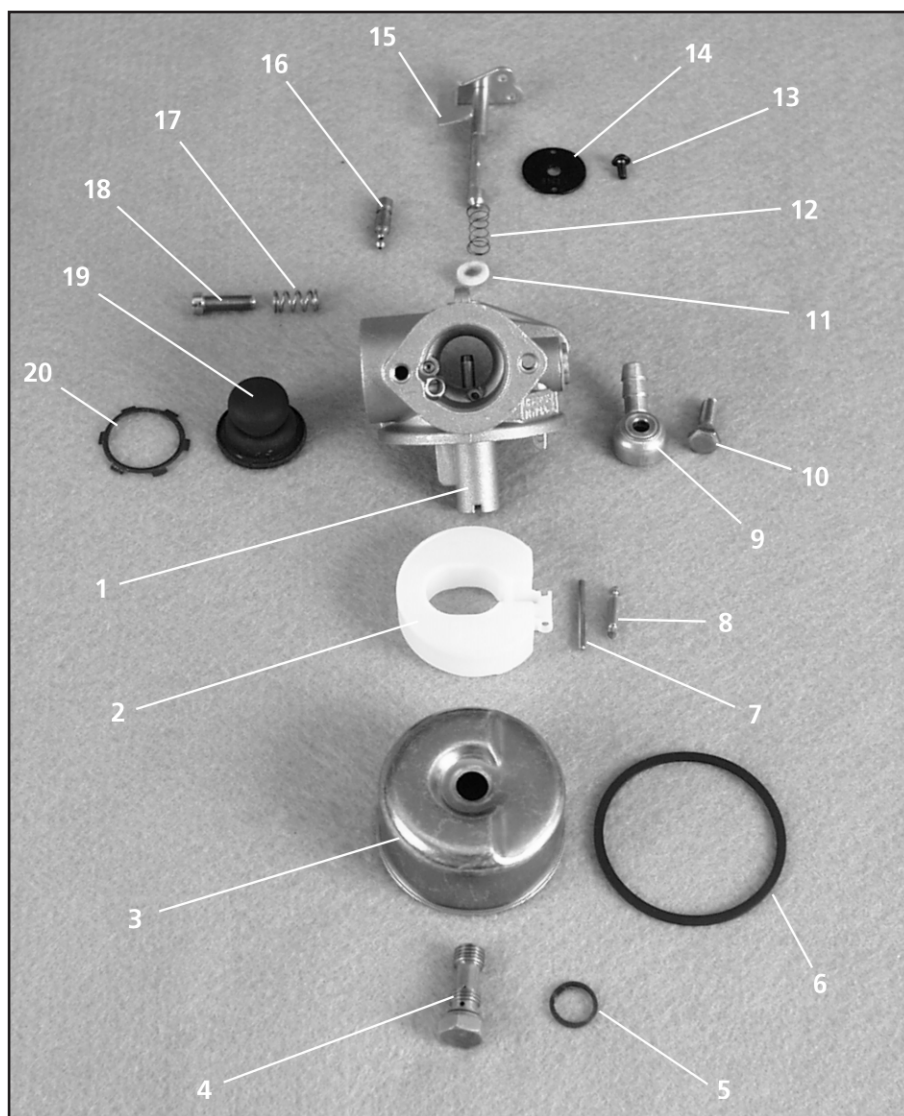
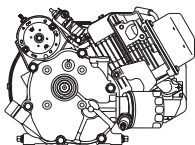
### CARBURETOR INSTALLATION:

To reinstall a primer style carburetor, line up the mounting holes on the carburetor with the holes on the intake manifold and install the two screws. Then install the lock nuts and washers onto the screws (see Figure 2.6).

To reinstall a choke type carburetor, see Step 1 under AIR CLEANER BOX INSTALLATION on Page 15.

Refer to TORQUE SPECIFICATIONS on Page 59 for proper tightness of carburetor and air box screws.

**NOTE: Always use a new gasket when reinstalling the carburetor and/or air cleaner box.**



**Figure 2.7 — Exploded View of Typical Carburetor**

ITEM	QTY	DESCRIPTION	ITEM	QTY	DESCRIPTION
1	1	Carburetor Body	11	1	Throttle Shaft Felt Washer
2	1	Float	12	1	Throttle Shaft Spring
3	1	Float Bowl	13	1	Screw
4	1	Bowl Nut (Main Jet)	14	1	Throttle Valve
5	1	Fiber Washer	15	1	Throttle Shaft
6	1	Bowl Gasket	16	1	Idle Jet
7	1	Float Pin	17	1	Spring
8	1	Inlet Valve	18	1	Idle Speed Screw
9	1	Fuel Inlet	19	1	Primer Bulb
10	1	Cap Screw	20	1	Primer Bulb Retainer

1. The governor SPRING tends to pull the LEVER and THROTTLE LINK toward the "INC. 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 SHAFT to rotate, which then moves the LEVER and THROTTLE LINK toward a "DEC. 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 THROTTLE LINK toward "INC. 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.



See Figure 3.2. 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 SHAFT. A lockpin and washer retain the governor shaft in the crankcase cover.

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

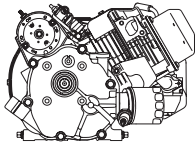


Tension of the governor SPRING can be adjusted by means of the SPEED ADJUST NUT (Figure 3.3).



Before any covers and shrouds can be removed from the engine, the governor external parts must be removed. Refer to Figure 3.3 for the identification of the parts described in the following procedure.





1. Remove the CAPSCREW from the IDLE CONTROL BRACKET.
2. Loosen the GOVERNOR LEVER CLAMP BOLT.
3. Loosen SPEED ADJUST SCREW and NUT until the GOVERNOR SPRING can be removed.
4. Lift the GOVERNOR LEVER from the GOVERNOR SHAFT.
5. Disconnect the GOVERNOR ROD and ANTI-LASH SPRING from the GOVERNOR LEVER.

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 3.3):

1. Reattach the GOVERNOR ROD and ANTI-LASH SPRING to the GOVERNOR LEVER.
2. Slide the GOVERNOR LEVER onto the GOVERNOR SHAFT.
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. See BLOWER HOUSING SCREW under "TORQUE SPECIFICATIONS", page 59, for proper tightness.

For proper governor adjustment, refer to "GOVERNOR ADJUSTMENT" on this 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.



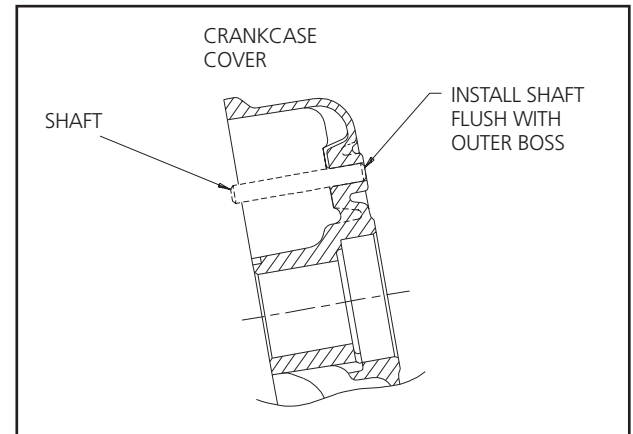
**GOVERNOR GEAR SHAFT DIAMETER**  
**GN-190, GN-191, GN-220:**  
**0.236-0.237 inch (6.004-6.012mm)**

### 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.



**Figure 3.4 — 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 3.3 (previous page), 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:

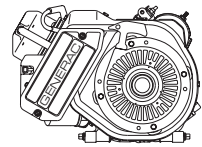
Before starting the engine, complete an initial adjustment of the governor as follows:

1. Loosen the GOVERNOR LEVER CLAMP BOLT (Figure 3.3).
2. While holding the GOVERNOR LEVER at its full "INC. RPM" position, rotate the GOVERNOR SHAFT clockwise as far as it will go. Then, tighten the GOVERNOR LEVER CLAMP BOLT.



**TORQUE SPECIFICATION**  
**GOVERNOR LEVER CLAMP BOLT:**  
**70 inch-pounds**

### SECTION 3: MECHANICAL GOVERNOR



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 3.5).
4. Turn the MAIN JET (Figure 3.5) in (clockwise) until it just bottoms. DO NOT FORCE. Then, back the MAIN JET out (counterclockwise) about 1-1/2 turns.

#### RUNNING ADJUSTMENT:

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

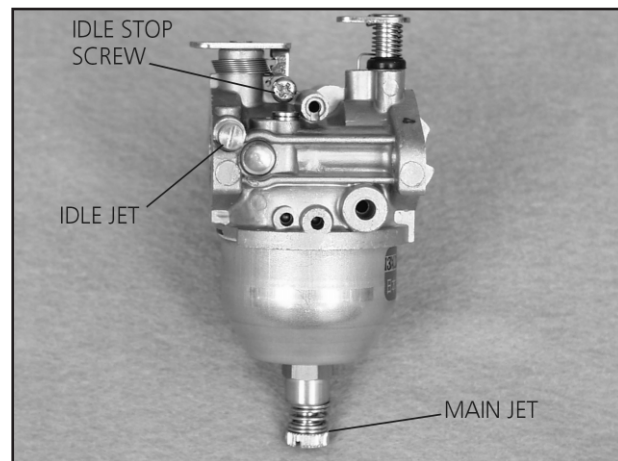
**NOTE: For AC generator applications, disconnect or turn OFF all electrical loads. For nongenerator applications, turn OFF the equipment being powered. Initial checks and adjustments will be accomplished with engine at no-load.**

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 3.3) 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 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 wattages/ampere capacity.
  - b. For nongenerator 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 SCREW to obtain best operation and highest rpm under load (see Figure 3.6). 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.

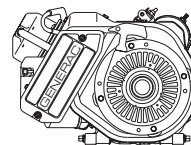


**Figure 3.5 — Adjustable Carburetor**



**Figure 3.6 — Carburetor Adjustment (Typical)**

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## GENERAL

Some applications, such as generators, may be equipped with an automatic idle control system. This type of system provides greatly improved fuel economy by running the engine at 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 idle.

## OPERATING INSTRUCTIONS

### BEFORE START-UP:



**CAUTION!** Before cranking and starting the engine, always set the idle control switch to STOP. Set the switch to its RUN position only after the engine has stabilized at high governed speed (see Figure 4.1).

### 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 electrical loads connected), set the idle control switch to OFF (Figure 4.1).

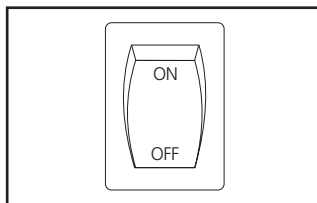


Figure 4.1 — Idle Control Switch

## CIRCUIT OPERATION

### 1. With Idle Control switch set to ON:

- AC power is delivered from the generator's AC power windings to a circuit board, for operation of the circuit board.
- 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.
- Current from the transformer secondary windings is delivered to the circuit board. Circuit board action then opens the circuit to an idle control solenoid.
- The idle control solenoid de-energizes, and engine speed is established by the engine governor.
- 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.
- 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. The solenoid energizes.
- The energized solenoid pulls the carburetor throttle arm against its idle speed stop screw. The engine decelerates to idle speed, about 2,280-2,400 rpm (38-40 Hertz).

### 2. Idle control switch set to OFF:

- AC power is not available to the circuit board. The idle control solenoid will then remain de-energized at all times.
- The engine will run at high governed speed.

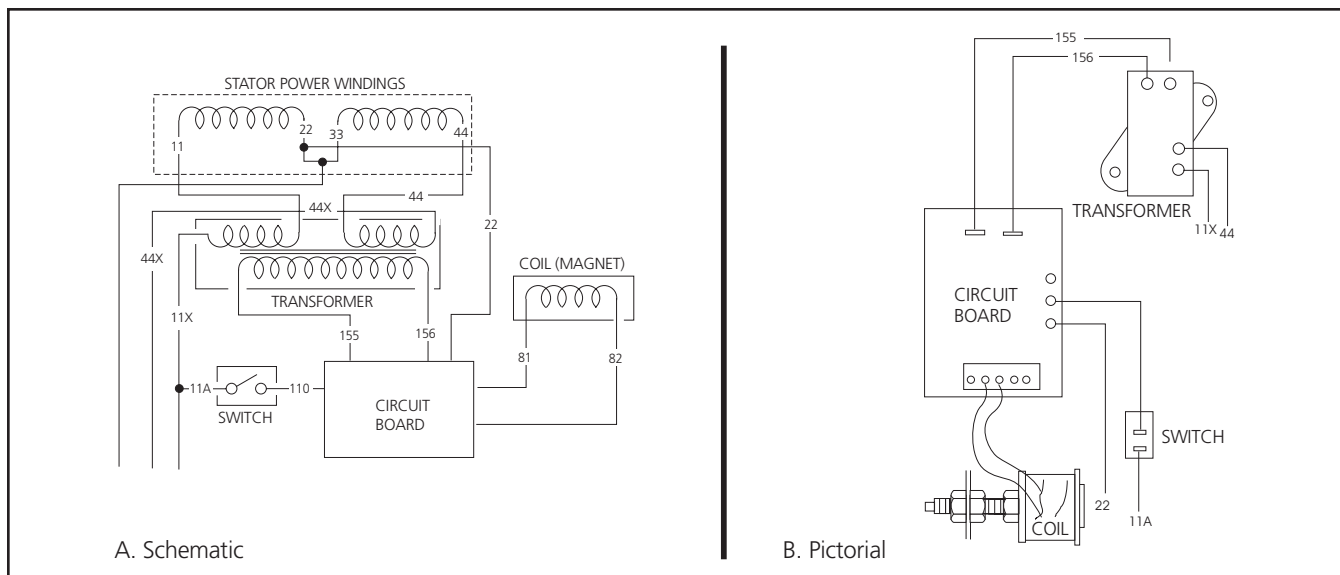
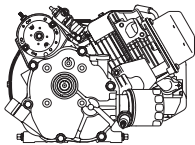


Figure 4.2 — Idle Control System (Typical AC Generator)



## IDLE CONTROL ADJUSTMENT

### GENERAL:

Idle speed will be correct when (a) the idle control solenoid is positioned to maintain an idle speed of about 1,500-2,100 rpm (25-35 Hertz), and (b) when the carburetor idle speed stop screw is adjusted to maintain an idle speed of about 2,280-2,400 rpm (38-40 Hertz).

Once the solenoid has been properly positioned, the remaining "fine adjustment" of idle speed can be accomplished with the idle speed stop screw on the carburetor.

### INITIAL ADJUSTMENT:

1. Set the idle control switch to OFF.
2. Unplug all electrical loads from the generator set.
3. Connect an AC frequency meter into one of the generator's AC 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 3,690-3,810 rpm (high governed speed). This is about 61.5-63.5 Hertz.
  - b. For units rated 50 Hertz, the meter should read 3,030-3,090 rpm (50.5-51.5 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) 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 STOP SCREW clockwise (faster speed) until engine speed increases to 2,280-2,400 rpm (38-40 Hertz) (see Figure 4.4).

**NOTE: Idle speeds less than about 38 Hertz could cause the engine to stall when loads are suddenly applied.**

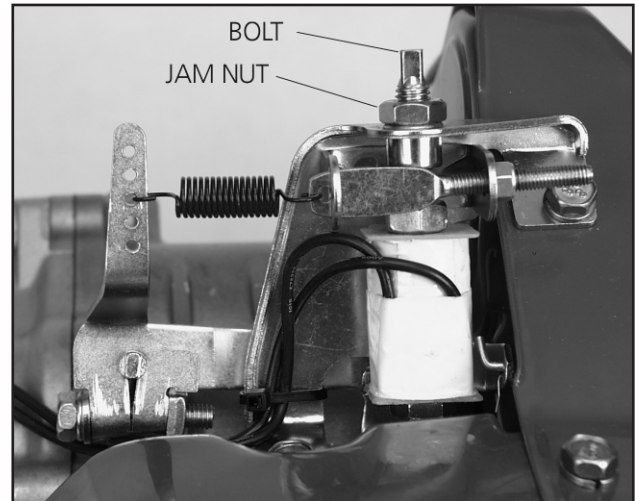
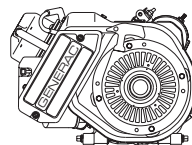


Figure 4.3 — Initial Adjustment Points



Figure 4.4 — Final Adjustment Points





### GENERAL

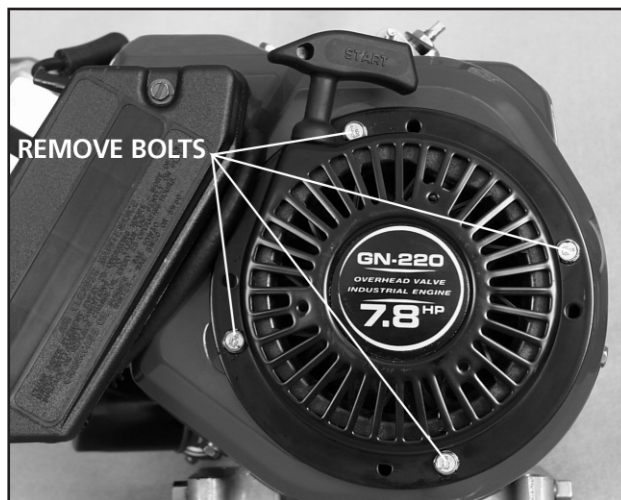
The rewind starter used on most GN series engines is a manual starter that uses a spring to rewind the starter rope after it has been pulled. Pulling the rope winds up a clock-type spiral spring in the starter housing. When the rope is released, the spring unwinds and causes the rope to wind around the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

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

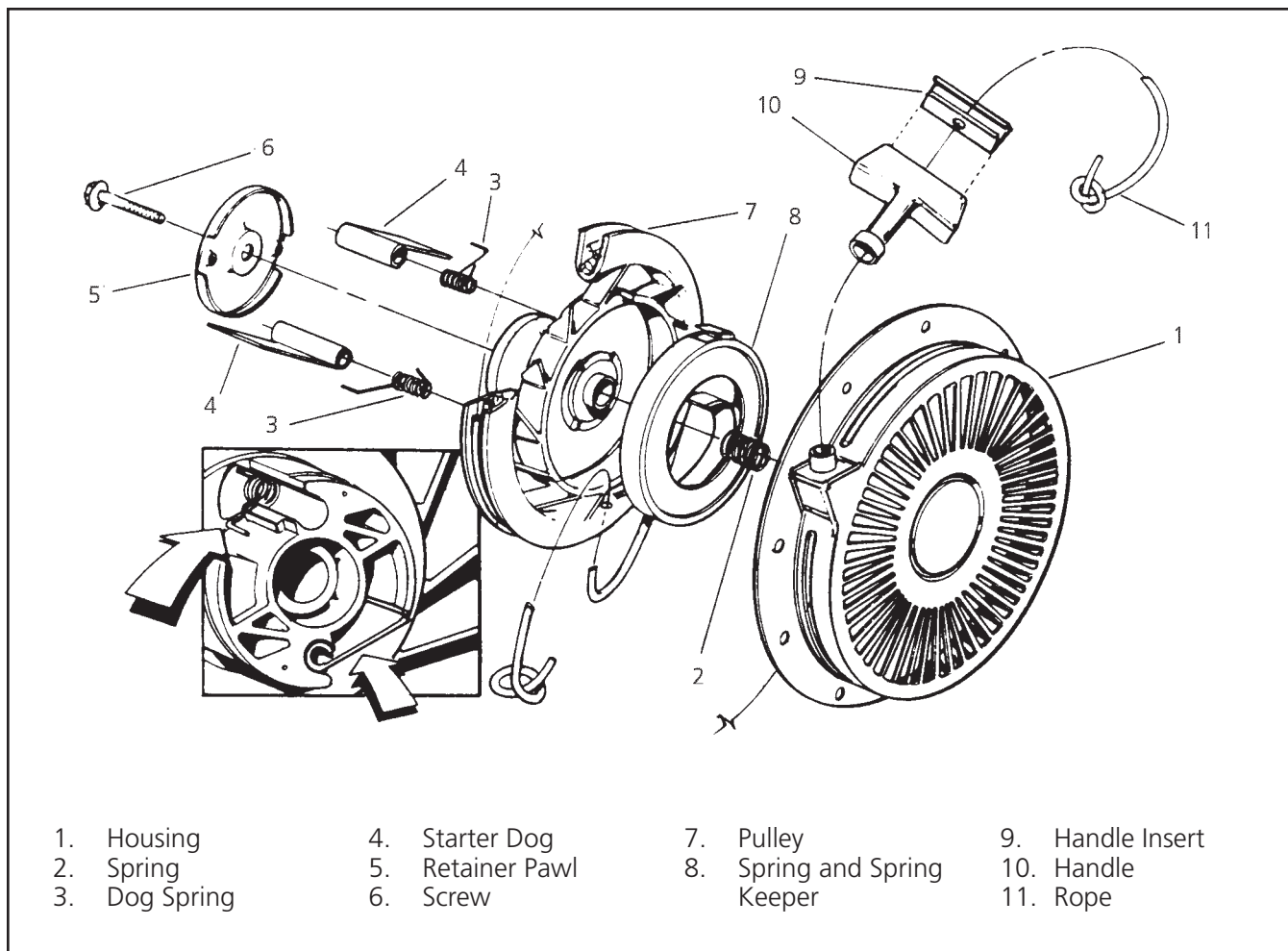
When the rope is allowed to return, the starter dogs do not engage the pulley.

### REWIND ASSEMBLY REMOVAL

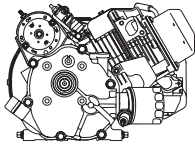
The rewind starter assembly is retained to the engine blower housing by screws and lock washers (see Figure 5.1). Remove the screws and lock washers, then remove the complete starter rewind assembly.



**Figure 5.1 — Rewind Assembly Removal**



**Figure 5.2 — Exploded View of Rewind Starter (Old Style)**



### DISASSEMBLY (OLD STYLE)

1. Pry up the HANDLE INSERT, to expose knot in ROPE (see Figure 5.2).
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 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 5.2). 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.

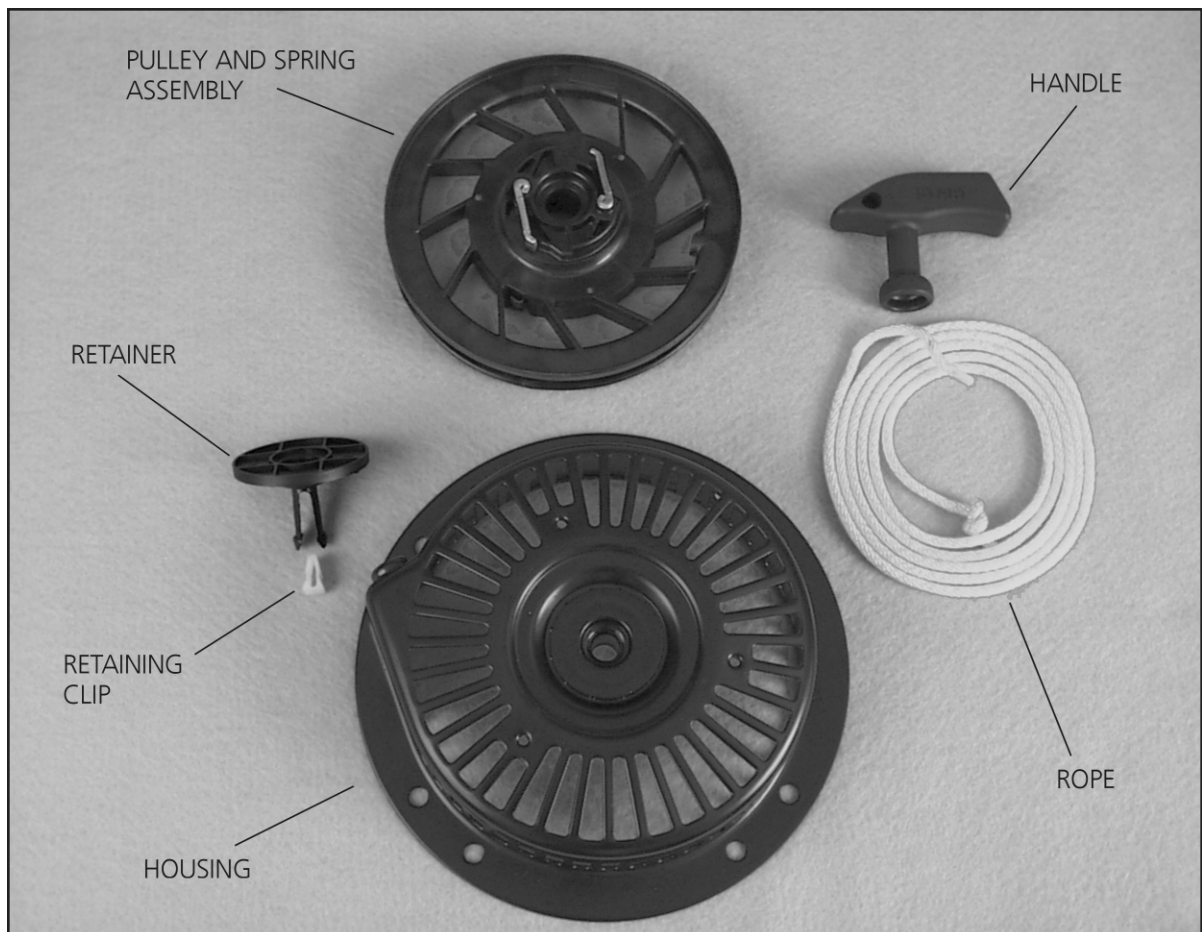
3. Install RETAINER PAWL and SCREW. Tighten the SCREW to 65-75 inch-pounds.
4. Wind the PULLEY counterclockwise until tight. Then, allow it to unwind until the hole in the PULLEY lines up with the eyelet in the HOUSING.
5. Pull the ROPE up through the eyelet in the HOUSING, then through the HANDLE and HANDLE INSERT. Tie a left-hand knot in the rope.
6. Install the HANDLE INSERT into the HANDLE.
7. Test the starter for proper operation.



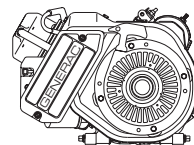
**TORQUE SPECIFICATION**  
**CAP SCREWS ON REWIND TO BLOWER COVER**  
**84 INCH POUNDS**

### DISASSEMBLY (NEW STYLE)

Disassembly of new style rewind starter is not cost effective, except for ROPE or HANDLE replacement (see Figure 5.3).



**Figure 5.3 — Exploded View of Rewind Starter (New Style)**



## INTRODUCTION

Some GN 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.

Generally, two types of cranking systems are used in GN series engine applications. These are (a) the starter contactor system and (b) the heavy duty cranking switch system.

**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.

**NOTE:** Vertical crankshaft engines used in recreational vehicle applications are equipped with a cranking and starting system that is controlled by a solid-state circuit board. This system is a "starter contactor" type, with the starter contactor energized by circuit board action. For instructions and information order "DIAGNOSTIC REPAIR MANUAL — RECREATIONAL VEHICLE GENERATORS" (Generac Part No. 94468).

## STARTER CONTACTOR SYSTEM

When the start-stop switch is held at START, battery current flows through the STARTER CONTACTOR coil and to ground via the switch. The starter contactor energizes, its contacts close, and battery output is delivered to the starter motor. The motor energizes, and the engine is cranked (Figure 6.1).

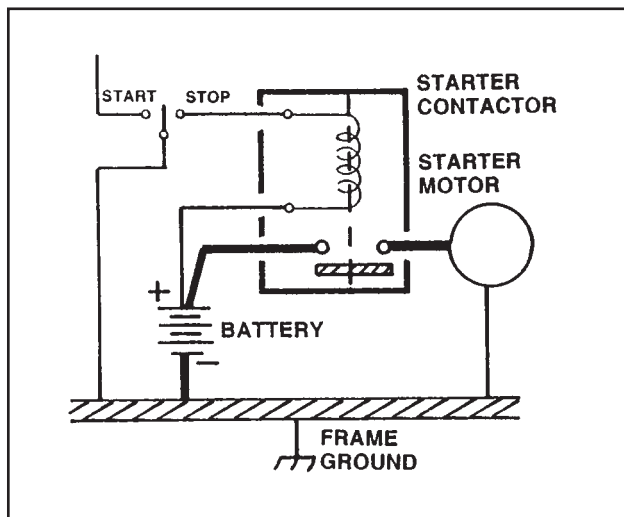


Figure 6.1— Schematic of Typical Starter Contactor System

## HEAVY DUTY SWITCH SYSTEM

The heavy duty switch contacts are closed manually to deliver battery voltage to the starter motor.

## 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 19-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:

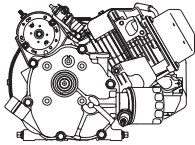
To remove the starter from the engine, loosen and disconnect the starter wire, then remove the two hex head screws that hold the starter in place.

### STARTER MOTOR INSTALLATION:

To install the starter motor, reverse the previous steps.



**TORQUE SPECIFICATION**  
**HEX HEAD SCREWS ON STARTER MOTOR**  
**216 INCH POUNDS**



**TORQUE SPECIFICATION  
STARTER MOTOR WIRE NUT  
84 INCH POUNDS**

### 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.

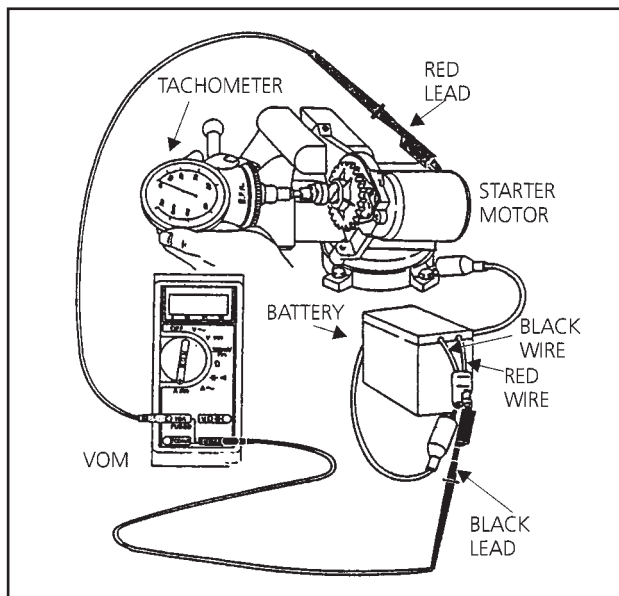
#### TOOLS FOR STARTER PERFORMANCE TEST:

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 12-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 6.2.



**Figure 6.2 — Starter Performance Test**

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:

**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.**

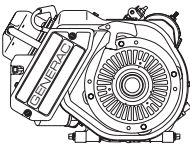
#### ELECTROLYTE LEVEL:

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

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 6.3).

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 6.3, 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.

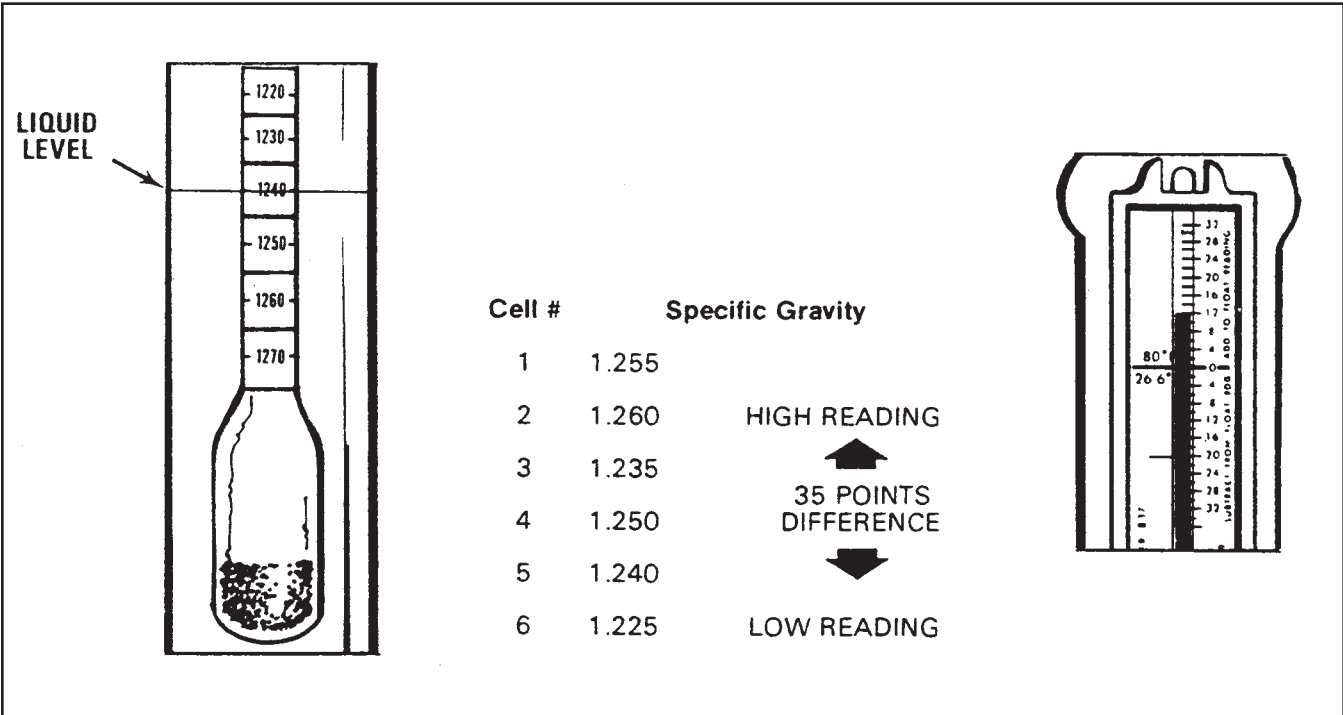
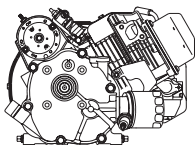


Figure 6.3 — Using a Battery Hydrometer





## GENERAL

In the course of tearing down a complete engine for service and repairs, the engine shrouds and covers may 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. Remove the nine capscrews from the BLOWER HOUSING ASSEMBLY (see Figure 7.1).

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

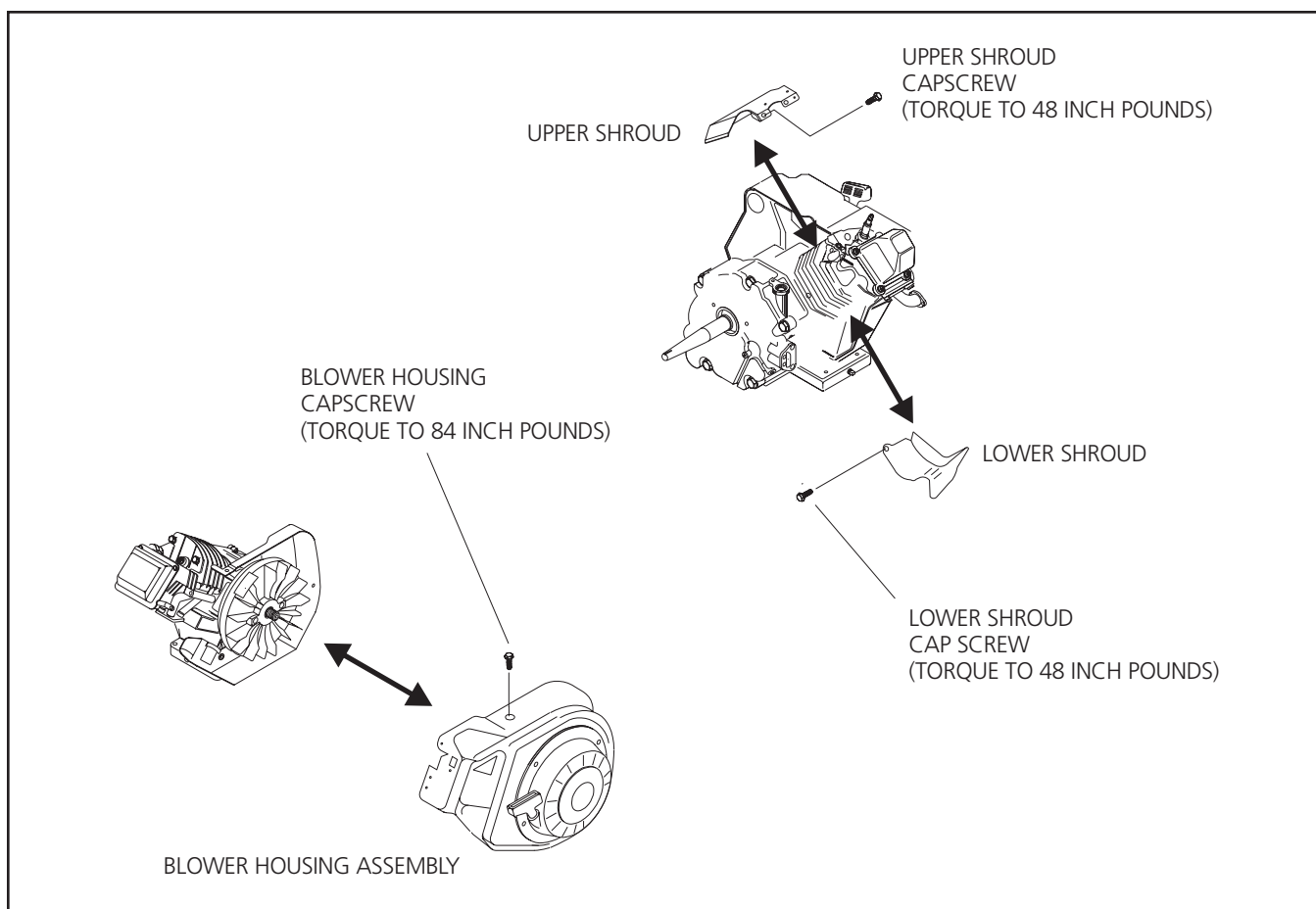
3. Remove the capscrew from the LOWER SHROUD (see Figure 7.1).
4. Remove the remaining capscrew from the UPPER SHROUD (see Figure 7.1).

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

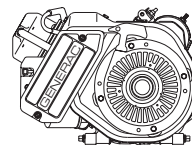
**NOTE:** It will be helpful to make note of the locations of the screws that hold the covers in place.

## INSTALLATION OF COVERS AND SHROUDS:

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



**Figure 7.1 — Exploded View of Engine Covers and Shrouds**



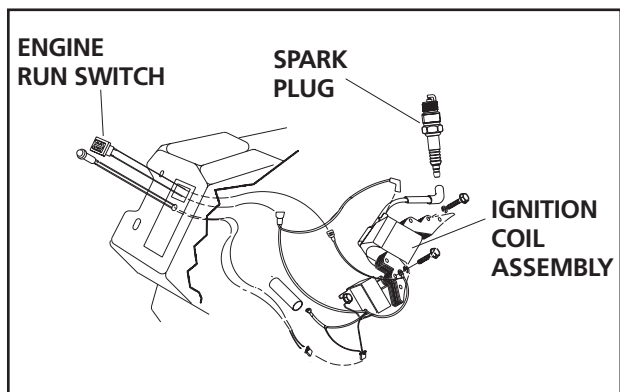
### GENERAL

The ignition system typically used on GN-190, GN-191 and GN-220 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 8.1 and 8.4).

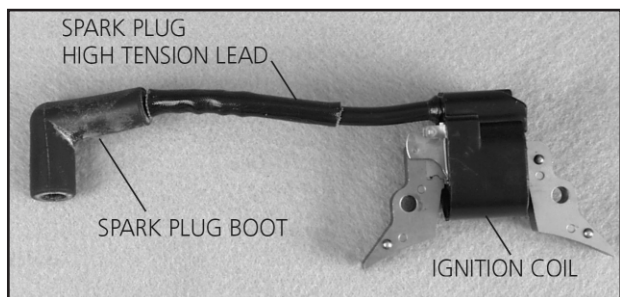


**Figure 8.1 — Ignition System Components**

### IGNITION COIL ASSEMBLY

Solid-state components encapsulated in the ignition coil are not accessible and cannot be serviced. If the coil is defective, the entire assembly must be replaced. The air gap between the coil and the flywheel magnet is fixed and nonadjustable.

The ignition coil assembly (Figure 8.2) consists of (a) ignition coil, (b) spark plug high tension lead and (c) spark plug boot.



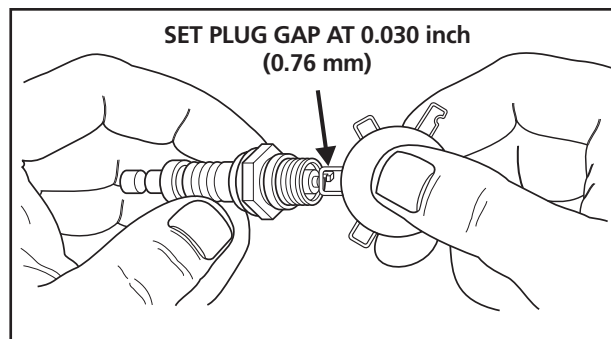
**Figure 8.2 — Ignition Coil Assembly**

### SPARK PLUG

The spark plug should be cleaned and regapped periodically. The plug should be replaced every 100 hours of operation or once annually, whichever comes first.

Recommended spark plug is a Champion RC12YC or equivalent. Set spark plug gap to 0.030 inch (0.76mm) (Figure 8.3).

**NOTE: Always use original GENERAC® replacement parts.**



**Figure 8.3 — Setting Spark Plug Gap**

### 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 3/4 inch (19mm) from the magnet. The screwdriver blade should be pulled in against the magnet.

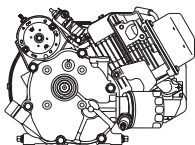
#### FLYWHEEL KEY:

In all cases, 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.

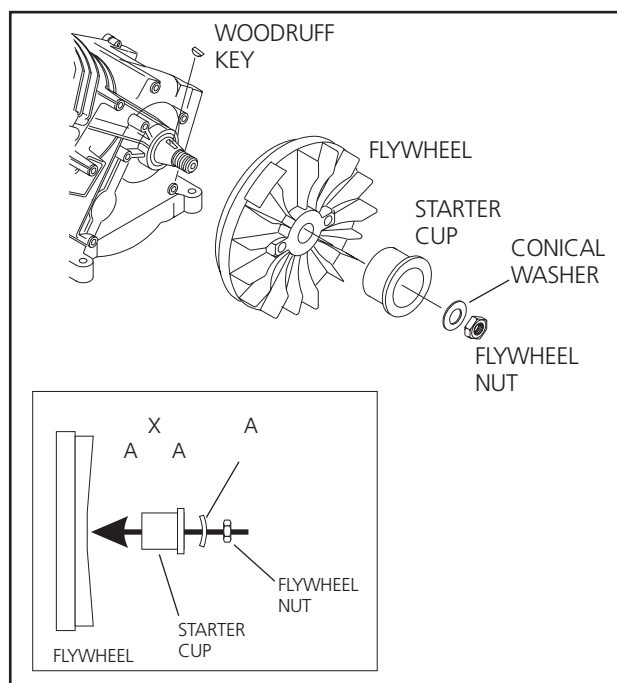
### FLYWHEEL INSTALLATION:

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

**NOTE:** The conical washer must be installed in the proper direction (see Figure 8.4) with the convex side facing out (away from the flywheel).



**TORQUE SPECIFICATION**  
**FLYWHEEL NUT**  
**75 foot-pounds**

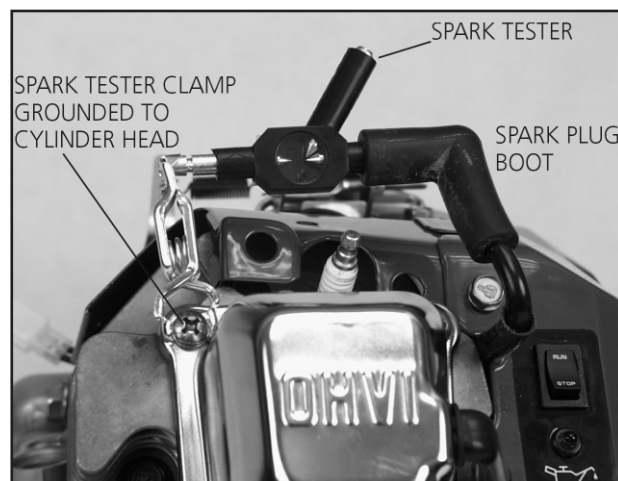


**Figure 8.4 — Exploded View of Flywheel Assembly**

### TESTING THE IGNITION SYSTEM

Use a spark tester to test the ignition system. Such spark testers are commercially available. Test the system as follows:

1. Disconnect the high tension lead from the spark plug.
2. See Figure 8.5. 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.



**Figure 8.5 — Testing Ignition System**

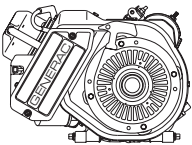
**NOTE:** If the flywheel key is sheared or partially sheared, spark can jump the tester gap. However, loss of correct ignition timing may result in hard starting or no starting at all.

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 8.6). 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.



**Figure 8.6 — Checking for Engine Miss**

**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. 94468-A.



MAJOR COMPONENTS

Valve train components are shown in Figure 9.1 below.

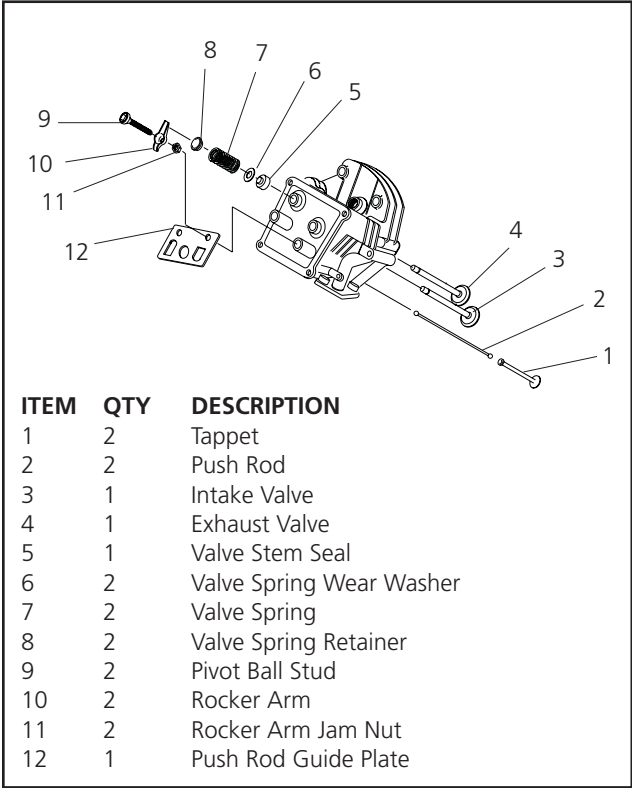


Figure 9.1 — Valve Train Components

DISASSEMBLY

1.Remove the oil breather tube. Remove the four M6-1.00 x 12mm screws. Then, remove the rocker arm cover (see Figure 9.2).

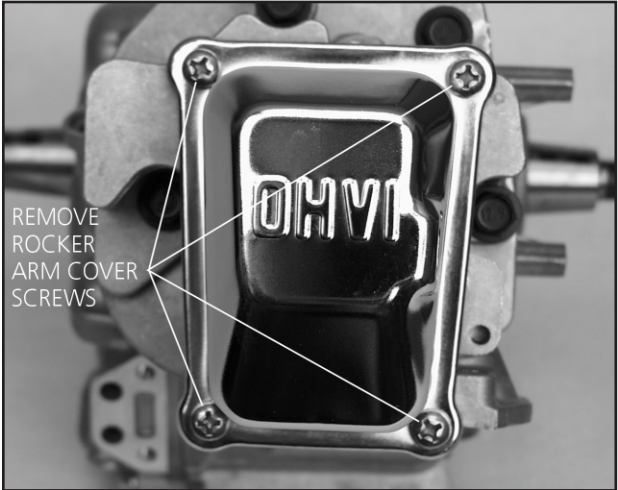


Figure 9.2 — Removal of Rocker Arm Cover

**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:** 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.

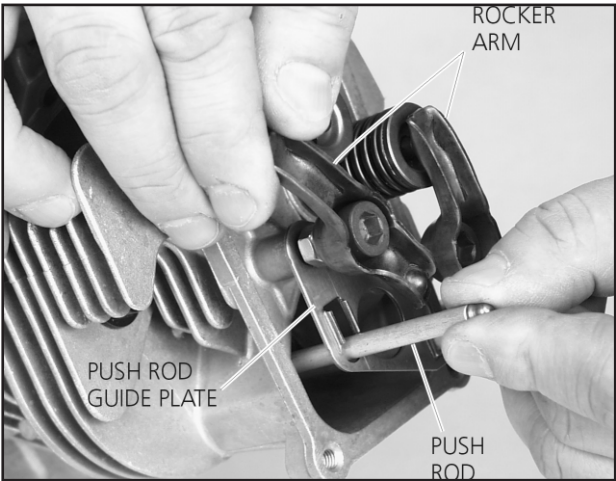


Figure 9.3 — Rocker Arms and Push Rod Guide Plate

3. Remove the PUSH RODS (see Figure 9.3).  
4. Remove the CYLINDER HEAD BOLTS, then the CYLINDER HEAD and CYLINDER HEAD GASKET (see Figure 9.4).

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

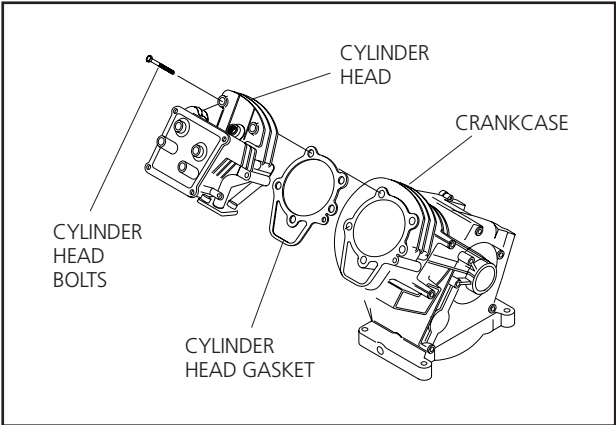
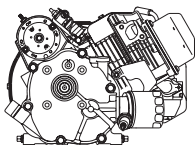


Figure 9.4 — Cylinder Head Removal





**TO PREVENT EYE INJURY, ALWAYS WEAR EYE PROTECTION WHEN REMOVING VALVE SPRINGS.**

5. Support the valves with your fingers while compressing the valve springs with your thumbs on the valve spring retainer (see Figure 9.5).
  - a. With the spring compressed, slide the larger hole of the valve spring retainer toward the valve stem.
  - b. When the larger retainer hole is around the valve stem, release the valve spring.
  - c. Remove the retainer, spring and washer.

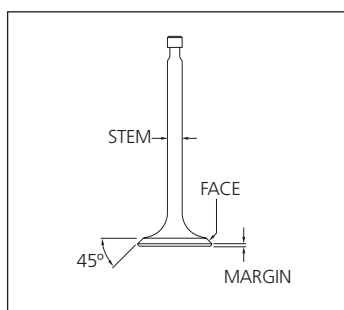


**Figure 9.5 — Compressing Valve Springs**

6. Remove the intake and exhaust valves.
7. Clean all parts.
  - a. Remove carbon from the valve heads and stems.
  - b. Inspect valves and valve seats.
  - c. Service parts as outlined under "Valve Service."

## VALVE SERVICE

### VALVE:

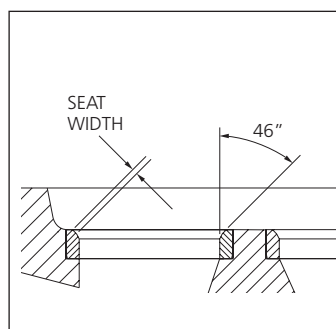


**Figure 9.6**

Replace valves if they are damaged, distorted or if the the margin is ground to less than 0.039 inch (1 mm).

If valves are in usable condition, grind or cut the valve faces to a 45° angle (see Figure 9.6).

### VALVE SEATS:



**Figure 9.7**

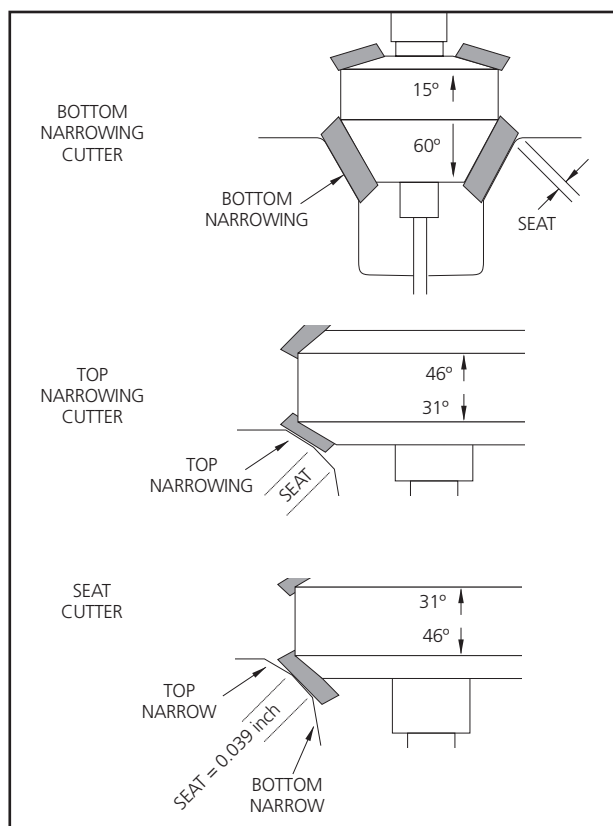
Valve seats are not replaceable. If they are burned or pitted, they can be reground using a grinding stone or Neway Valve Reseater. Grind seats at a 46° angle and to a width of 0.039 inch (1 mm) (see Figure 9.7).

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 60° cutter to clean and narrow the seat from the bottom toward the center (see Figure 9.8).

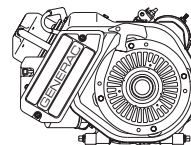
Second, use a 31° cutter to clean and narrow the seat from the top to the center.

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



**Figure 9.8 — Cutting a Valve Seat**





### VALVE SERVICE (CONTINUED)

#### VALVE GUIDES:

Valve guides are permanently installed in the cylinder head and cannot be replaced (see Figure 9.9).

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.

#### DESIGN DIAMETER OF VALVE GUIDES

GN-190 = 0.218-0.217 inch (5.445-5.460mm)

GN-191 = 0.273-0.274 inch (6.965-6.980mm)

GN-220 = 0.273-0.274 inch (6.965-6.980mm)

#### INTAKE VALVE STEM DIAMETER

GN-190 = 0.215-0.216 inch (5.465-5.480mm)

GN-191 = 0.274-0.275 inch (6.965-6.980mm)

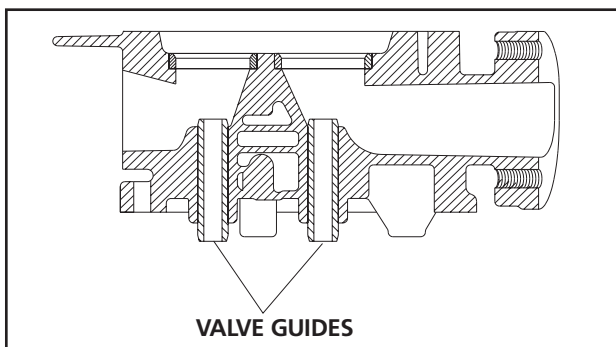
GN-220 = 0.274-0.275 inch (6.965-6.980mm)

#### EXHAUST VALVE STEM DIAMETER

GN-190 = 0.214-0.215 inch (5.445-5.460mm)

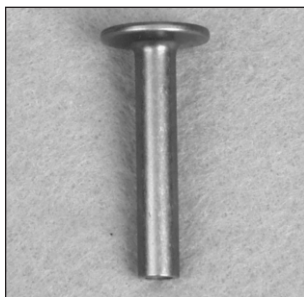
GN-191 = 0.273-0.274 inch (6.965-6.980mm)

GN-220 = 0.273-0.274 inch (6.965-6.980mm)



**Figure 9.9 — Valve Guides in Cylinder Head**

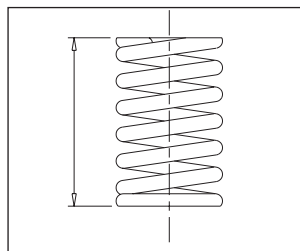
#### VALVE TAPPETS:



**Figure 9.10 — Tappet**

The valve tappets (Figure 9.10) 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.

#### VALVE SPRINGS:



**Figure 9.11 — Valve Spring**

Inspect the valve springs (Figure 9.11). Measure the spring **FREE LENGTH**. Also measure the spring length when a known load is applied to the spring.

#### VALVE SPRING FREE LENGTH

GN-190=1.910 inch (48.48 mm)

GN-191=2.074 inch (52.69 mm)

GN-220=2.074 inch (52.69 mm)

#### FORCE NEEDED TO COMPRESS SPRING TO 1.39 INCH (35.2 mm)

GN-190 = 14.8-16.3 pounds (6.7-7.4kg)

GN-191 = 19.8-21.8 pounds (9.0-9.9kg)

GN-220 = 19.8-21.8 pounds (9.0-9.8kg)

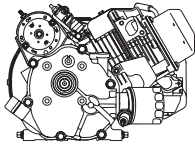
#### INSTALLATION

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.



**Figure 9.12 — Compressing Valve Spring**



2. Install the valve spring washers, valve springs and valve spring retainers over the valve guides.
  - a. Hold the valves with your fingers and use your thumbs to compress the spring (see Figure 9.12).
  - b. When the spring has been compressed sufficiently, slide the retainer's small opening over the valve stem and release the spring.
3. After both valves have been properly installed, position a 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 will result.

4. Install the cylinder head bolts and tighten them in the sequence shown in Figure 9.13 and to the first torque specification listed below. Then, tighten in the same sequence again to the second torque specification.



### TORQUE SPECIFICATION

#### CYLINDER HEAD BOLTS — First Sequence

- TORQUE = 15 foot-pounds or 180 inch-pounds

#### CYLINDER HEAD BOLTS — Second Sequence

- TORQUE = 22 foot-pounds or 264 inch-pounds

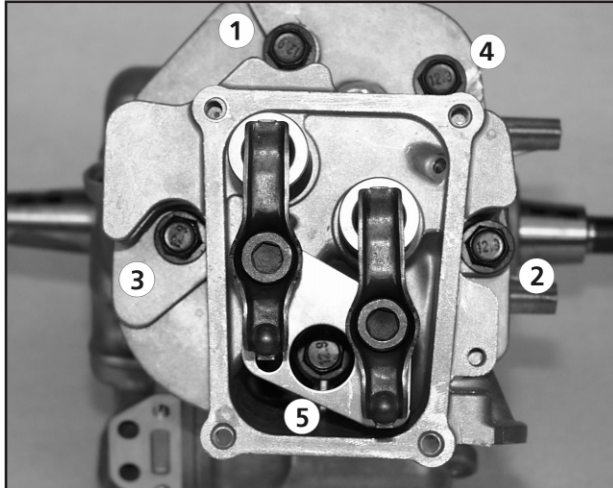


Figure 9.13 — Head Bolt Tightening Sequence

5. Position the push rod guide plate on the head. Install the rocker arm and pivot ball stud. Install the jam nut far enough to hold the guide plate in position. Valve clearance will be adjusted later.

6. Install the push rod with either end resting on the tappet (Figure 9.15).

- a. Place the push rod between the guide plate tabs, then place the rocker arm onto the end of the push rod.
- b. Push rod alignment is correct when the push rod ball rests in the rocker arm socket.

Installation of valve train parts is now complete. Valve clearance must be adjusted before the rocker arm cover is installed.

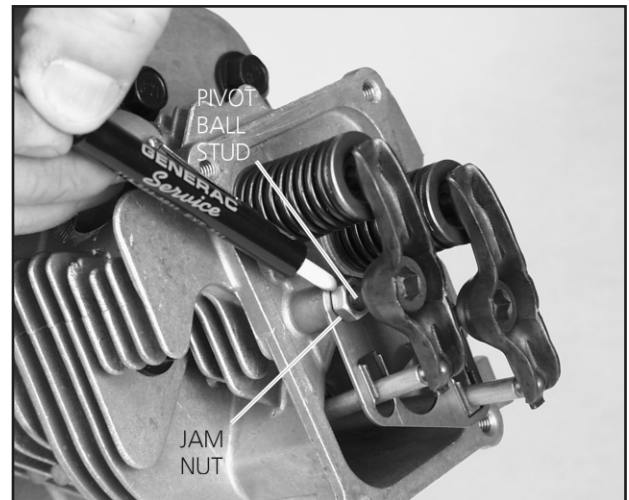


Figure 9.14 — Install Rocker Arm and Pivot Ball Stud

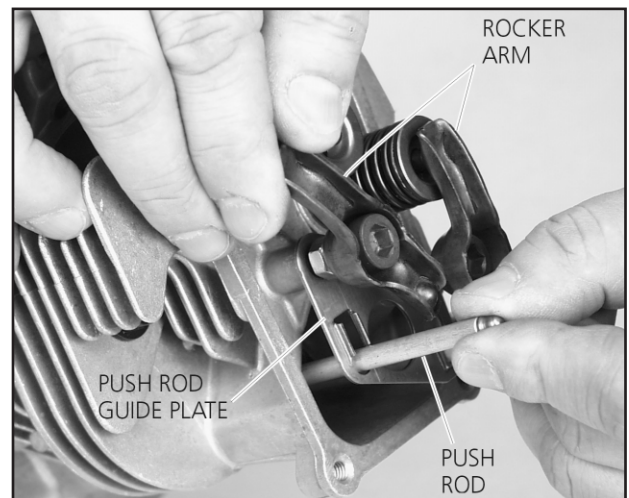
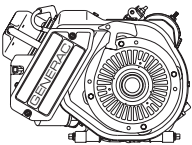


Figure 9.15 — Installing the Push Rods



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). Correct valve clearance is given below, in INCHES (MILLIMETERS).

ENGINE	GN-190	GN-191	GN-220
CLEARANCE	0.001-0.003	0.001-0.0022	0.001-0.0022
INTAKE	(0.03-0.07)	(0.03-0.056)	(0.03-0.056)
CLEARANCE	0.001-0.003	0.0018-0.003	0.0018-0.003
EXHAUST	(0.03-0.07)	(0.046-0.07)	(0.046-0.07)

- 1. Loosen the rocker arm jam nut. Use an allen wrench to turn the pivot ball stud while checking the clearance between the rocker arm and valve stem with a feeler gauge (see Figure 9.16).

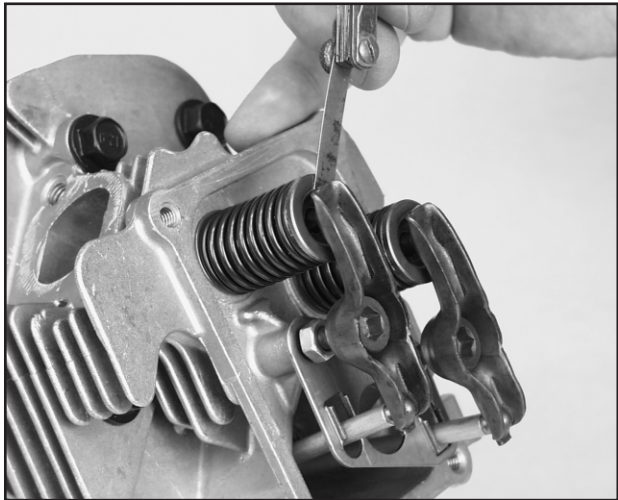


Figure 9.16 — Adjusting Valve Clearance

- 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.



TORQUE SPECIFICATION  
ROCKER ARM JAM NUT  
72 inch-pounds

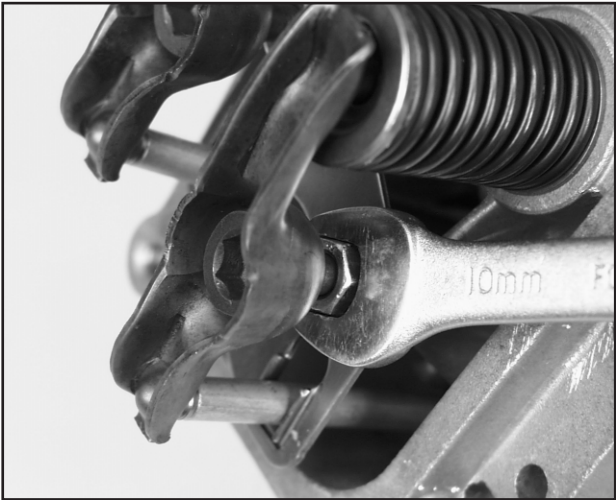


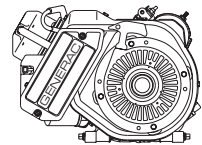
Figure 9.17 — Tightening the Jam Nut

INSTALL ROCKER ARM COVER

- 1. Use a new rocker arm cover gasket. Install the rocker arm cover and retain with four screws.
- 2. Install oil breather tube.

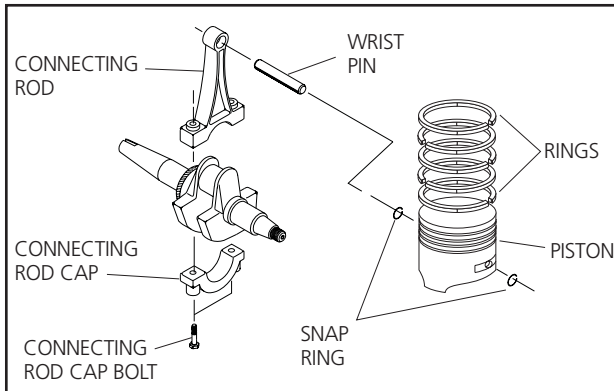


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## GENERAL

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.



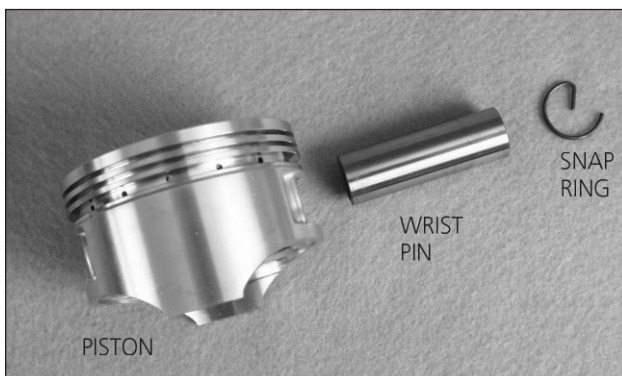
**Figure 10.1 — Pistons, Rings and Connecting Rod**

## 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 9).
2. Remove the crankcase cover (see Section 11)
2. Remove the connecting rod cap bolts and the connecting rod cap.
3. Push the piston and rod out through top of cylinder.

## PISTON



**Figure 10.2 — Piston , Wrist Pin and Snap Ring**

### REMOVAL FROM CONNECTING ROD:

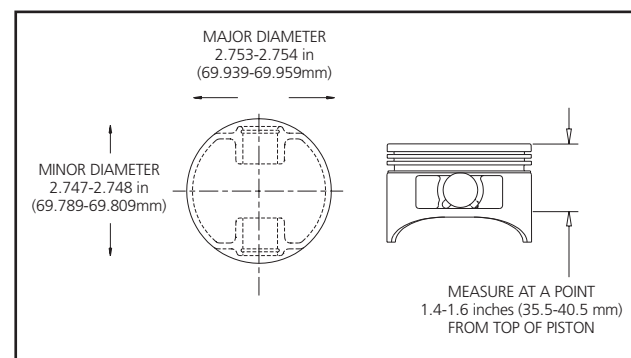
An oil hole in the wrist pin area of the piston helps distribute oil to aid in cooling. This oil hole also provides an assist in removing the wrist pin snap ring. To remove the piston from the rod, proceed as follows:

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 10.3).

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



**Figure 10.3 — Piston Major and Minor Diameter**

To check the piston for wear, proceed as follows:

1. Check the pistons MINOR DIAMETER.
  - a. At a position directly in-line with 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 10.3).
  - b. Measure at this point to check for wear. If worn excessively, replace piston.
2. 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 10.3)
  - b. Measure at this point to check for wear. If wear is excessive, replace the piston.



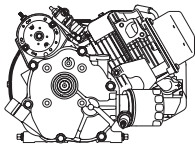
**PISTON MINOR DIAMETER**  
**GN-190, GN-191, GN-220**  
**2.747-2.748 inches (69.789-69.809mm)**



**PISTON MAJOR DIAMETER**  
**GN-190, GN-101, GN-220**  
**2.753-2.754 inches (69.939-69.959mm)**

3. Check wrist pin for looseness.





- 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.
- 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.**

- Check wrist pin and wrist pin bores for wear.
  - Measure the outside diameter of the wrist pin.
  - Measure the inside diameter of the wrist pin bore in piston.
  - Measure the inside diameter of the wrist pin bore in connecting rod.
  - Measure the wrist pin length.
- If excessive wear is found, replace the worn part.



**WRIST PIN OUTSIDE DIAMETER**  
GN-190, GN-191, GN-220  
0.708-0.709 inch (17.989-18.000mm)



**WRIST PIN LENGTH**  
GN-190, GN-191, GN-220  
2.196-2.213 inch (55.8-56.2mm)



**DIAMETER OF WRIST PIN BORE IN PISTON**  
GN-190, GN-191, GN-220  
0.708-0.709 inch (18.000-18.011mm)



**DIAMETER OF WRIST PIN BORE IN ROD**  
GN-190, GN-101, GN-220  
0.709-0.710 inch (18.02-18.03mm)

### PISTON RINGS

#### GENERAL:

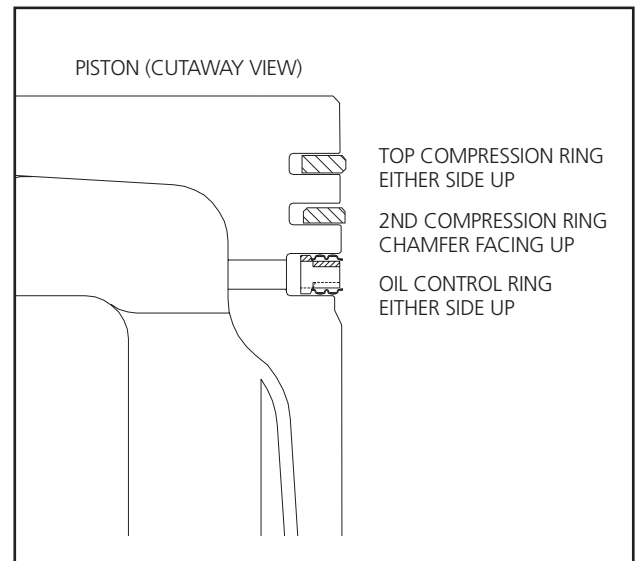
The following general rules pertaining to piston rings must always be complied with:

- 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.



**Figure 10.4 — Location of Rings in Piston Grooves**

#### 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 10.5.

If the ring end gap is excessive, the cylinder is worn excessively. See next page for ring gap tolerances.



**TOP RING END GAP**  
GN-190, GN-191, GN-220  
0.005-0.016 inch (0.15-0.40mm)



**SECOND RING END GAP**  
GN-190, GN-191, GN-220  
0.006-0.016 inch (0.15-0.40mm)



**OIL RING END GAP**  
GN-190, GN-191, GN-220  
0.015-0.055 inch (0.38-1.40mm)

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

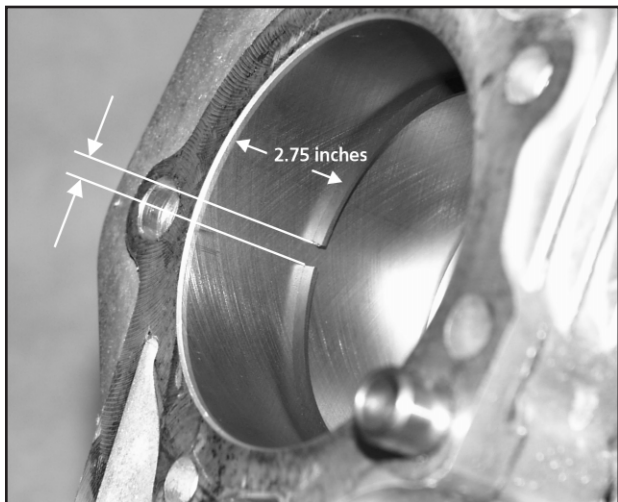
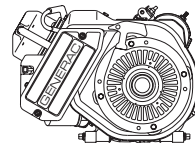


Figure 10.5 — Measuring Ring End Gap

### CONNECTING ROD

The connecting rod is manufactured of die-cast aluminum. Marks on the rod and on the rod cap must be aligned when assembling the rod to the crankshaft.



**CAUTION! DO NOT USE A WASHER WHEN ASSEMBLING THE ROD CAP.**

**NOTE: Match marks on the connecting rod and cap must face up in the general direction of the governor shaft when installed (see Figure 10.7).**

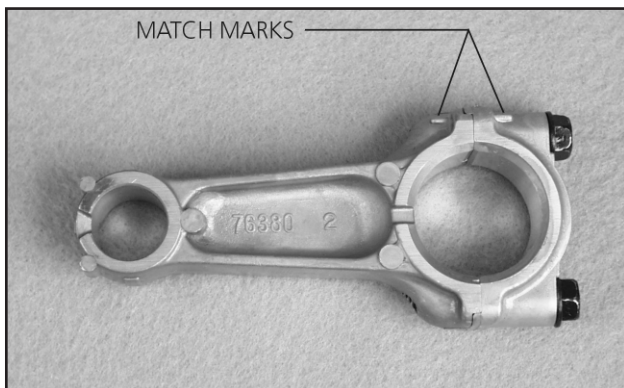


Figure 10.6 — Match Marks on Rod and Cap

### ASSEMBLY AND INSTALLATION

#### ASSEMBLY:

1. Install the rings (Figure 10.4).

- a. Use a ring expander when installing rings into the piston grooves.

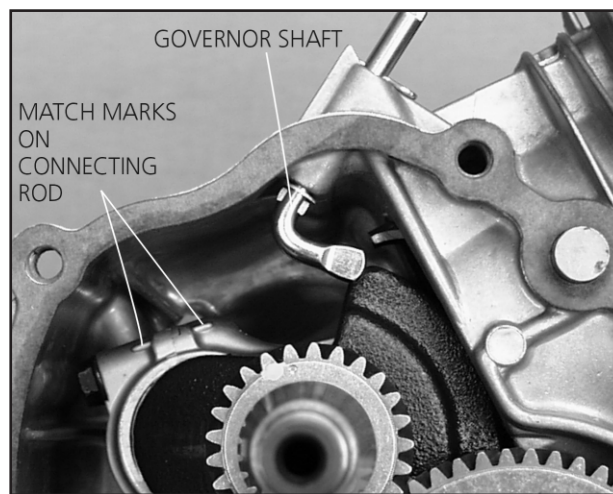
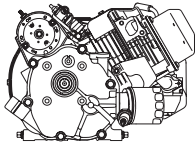


Figure 10.7 — Match Marks Facing Up

- b. Install the oil ring assembly first.
  - c. Install the second compression ring with its 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.

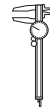
**NOTE: Use new snap rings when reassembling the piston.**

- d. Assemble the piston to the rod and slide the wrist pin through one piston bore, through the rod bore and through the second piston bore until it contacts the snap ring.
- e. 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. Use a ring compressor to compress the piston rings back into their grooves in the piston. Rings must be fully compressed.
5. Guide the connecting rod into the cylinder carefully. The assembly mark on the piston must be toward the flywheel side of engine (3 o'clock position).
6. When the ring compressor contacts top of cylinder, use a wood hammer handle to gently tap the piston down into the cylinder.
7. Check that the connecting rod large diameter bearing is coated with clean engine oil, as well as the crankpin and connecting rod cap.
8. Guide the connecting rod large diameter bearing over the crankshaft's crankpin (rod journal).
9. Install the connecting rod cap with its match mark aligned with identical mark on rod.
10. Install the connecting rod cap bolts and tighten to the proper torque.



**TORQUE SPECIFICATION  
CONNECTING ROD CAP BOLTS  
GN-190, GN-191, GN-220  
120 inch-pounds or 10 foot-pounds**

### **CYLINDER SERVICE**

#### INSPECTION:

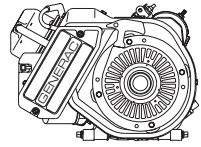
1. Inspect cylinder for dirty, broken or cracked cooling fins.
2. Check cylinder wall for wear, scoring or other damage.
3. Check all bearing surfaces for wear, scoring or other damage.

#### 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.**

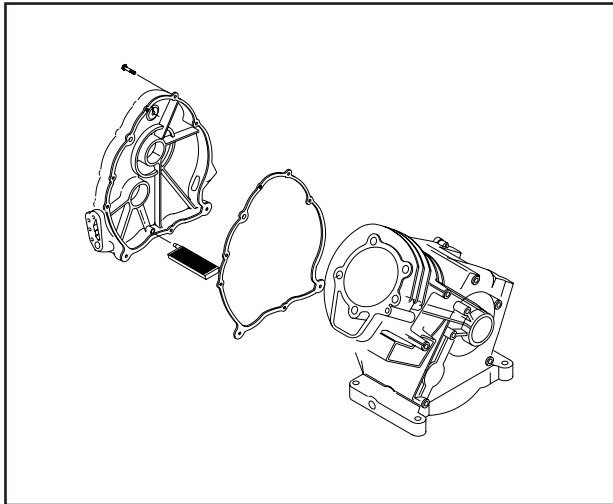


### CAMSHAFT REMOVAL

#### REMOVAL OF CRANKCASE COVER:

Before attempting to remove the crankcase cover, remove 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.

1. Drain oil from crankcase.
2. Remove engine cylinder head, push rods and push rod guide plate. See Section 9.
3. Remove all 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.

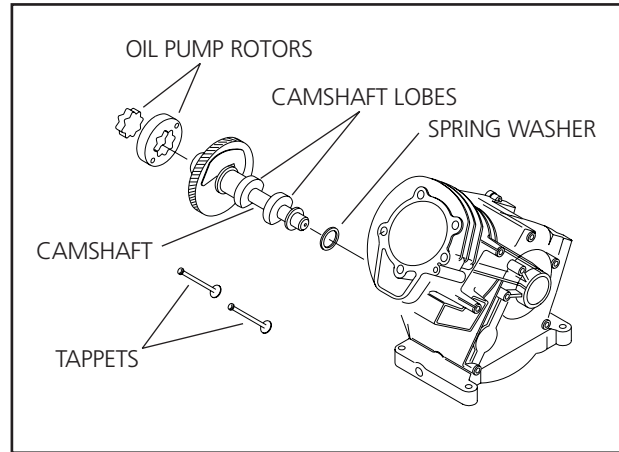


**Figure 11.1 — Crankcase Cover Removal**

#### CAMSHAFT REMOVAL:

(See Figure 11.2)

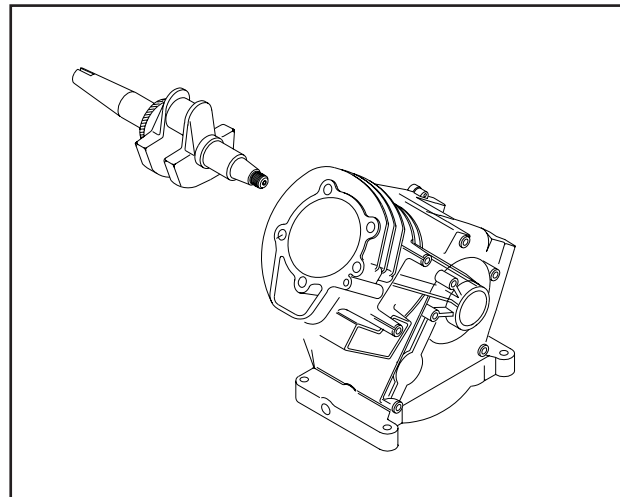
1. Tip the engine over onto the flywheel end of the crankshaft.
2. Reach in with two fingers and hold the tappets up and clear of the camshaft lobes. Then, remove the camshaft.
3. Remove the two tappets.
4. Remove the outer and inner oil pump rotors.
5. Remove the camshaft and spring washer.



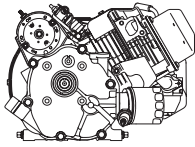
**Figure 11.2 — Camshaft Removal**

### CRANKSHAFT REMOVAL

1. The engine flywheel must be removed before attempting to remove the crankshaft. See Section 8.
2. The piston and connecting rod must be removed. Refer to Section 10.
3. Remove the crankshaft (Figure 11.3).

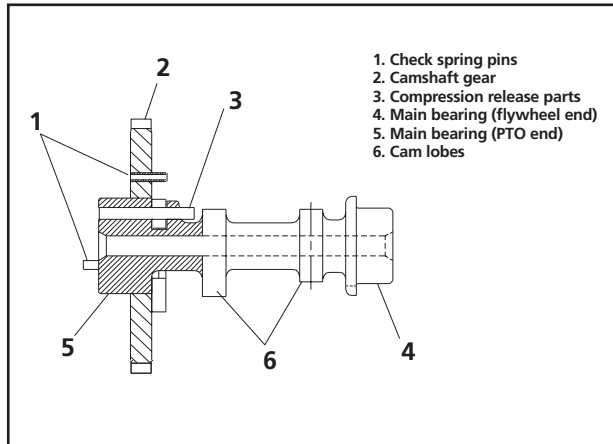


**Figure 11.3 — Crankshaft Removal**



## CAMSHAFT INSPECTION

Carefully inspect the entire camshaft for wear, nicks or other damage. All areas indicated in figure 11.4 should be inspected.



**Figure 11.4 — Points to Check on Camshaft**

Carefully measure the following to check them for wear. If wear limits are exceeded, replace the defective part.



**CRANKSHAFT BEARING BORE  
IN CRANKSHAFT COVER**  
DESIGN DIAMETER = 1.299-1.300 inch  
(33.00-33.03mm)



**CRANKSHAFT BEARING BORE  
IN CRANKCASE**  
DESIGN DIAMETER = 1.024-1.025 inch  
(26.00-26.03mm)



**CRANKCASE SLEEVE BEARING  
IN CRANKCASE**  
DESIGN DIAMETER = 1.104-1.106 inch  
(28.044-28.099mm)



**CRANKCASE BEARING BORE  
IN CRANKCASE COVER**  
DESIGN DIAMETER = 1.103-1.105 inch  
(28.030-28.058mm)



**CAM LIFT AT BOTH CAM LOBES**  
DESIGN LIFT = 0.210-0.212 inch  
(5.34-5.38mm)



**CAMSHAFT DIAMETER — FLYWHEEL END**  
DESIGN DIAMETER = 1.022-1.023 inch  
(25.96-25.98mm)



**CAMSHAFT DIAMETER — PTO END**  
DESIGN DIAMETER = 1.022-1.023 inch  
(25.96-25.98mm)

## CRANKSHAFT INSPECTION

### CRANKSHAFT PROPER:

Using a commercial solvent, clean the crankshaft thoroughly. After cleaning, inspect the crankshaft as follows:

1. Inspect keyways in crankshaft (see Figure 11.5). Make sure they are not worn or spread apart. Remove burrs from edges of keyways, to prevent scratching the bearing.
2. Inspect the crankshaft gear for chipping or cracking. If timing gear is damaged, the crankshaft must be replaced.
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.

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



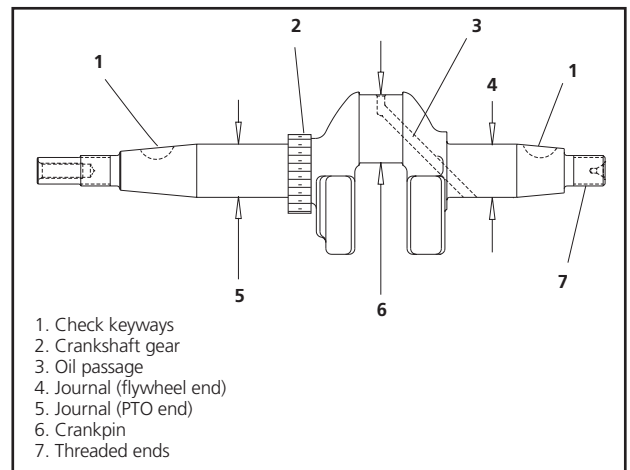
**CRANKPIN DIAMETER**  
DESIGN DIAMETER = 1.180-1.181 inch  
(29.99-30.01mm)



**CRANKSHAFT MAIN BEARING DIAMETER  
FLYWHEEL END**  
DESIGN DIAMETER = 1.102-1.103 inch  
(28.000-28.012mm)

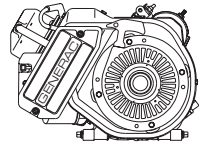


**CRANKSHAFT MAIN BEARING DIAMETER  
PTO END**  
DESIGN DIAMETER = 1.102-1.103 inch  
(28.000-28.012mm)



**Figure 11.5 — Points to Check on Crankshaft**





### 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 bearing. Replace the bearing if it is worn excessively.
  - b. Press out the old bearing and press a new bearing into place.

**NOTE: Alignment of the oil holes in the sleeve bearing and bearing bore in the crankcase is critical.**

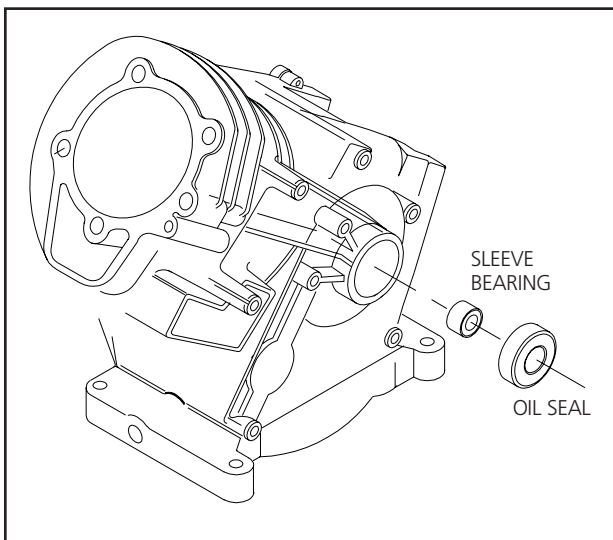


**CRANKSHAFT SLEEVE BEARING DIAMETER**  
**DESIGN DIAMETER = 1.104-1.106 inch**  
**(28.044-28.099mm)**

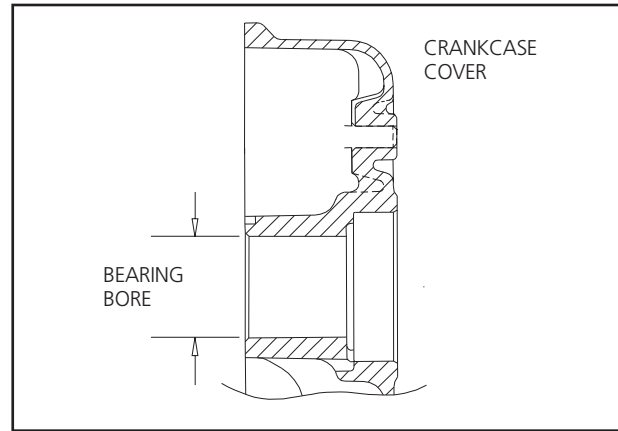
2. Inspect the crankshaft bearing bore in the crankcase cover for damage and wear (Figure 11.7).
  - a. Measure the Inside diameter of the bearing bore.
  - b. If the bore is worn excessively, replace the crankcase cover.



**CRANKCASE BEARING BORE**  
**IN CRANKCASE COVER**  
**DESIGN DIAMETER = 1.103-1.105 inch**  
**(28.030-28.058mm)**



**Figure 11.6 — Crankshaft Sleeve Bearing**

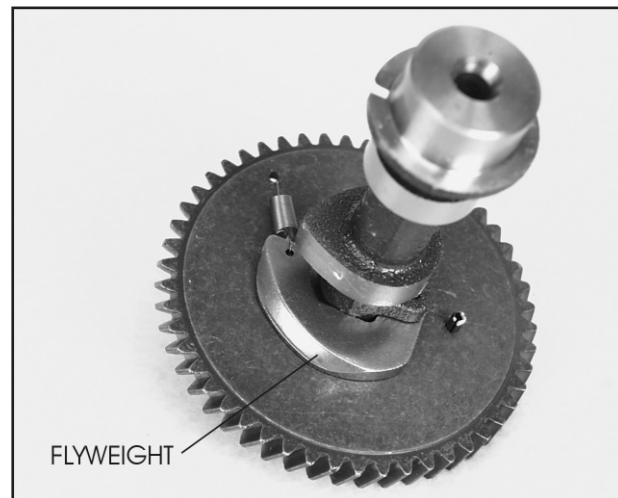


**Figure 11.7 — Bearing Bore in Crankcase Cover**

### COMPRESSION RELEASE

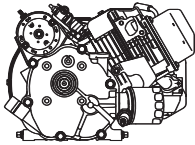
A mechanical compression release is provided on the camshaft (Figure 11.8). A flyweight pivots on a pin mounted in the camshaft gear. The pin itself has a cam action. When the engine is not running, the pin holds the tappet up just slightly, which in turn holds the exhaust valve slightly open. This relieves compression for easier cranking.

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



**Figure 11.8 — Compression Release Mechanism**

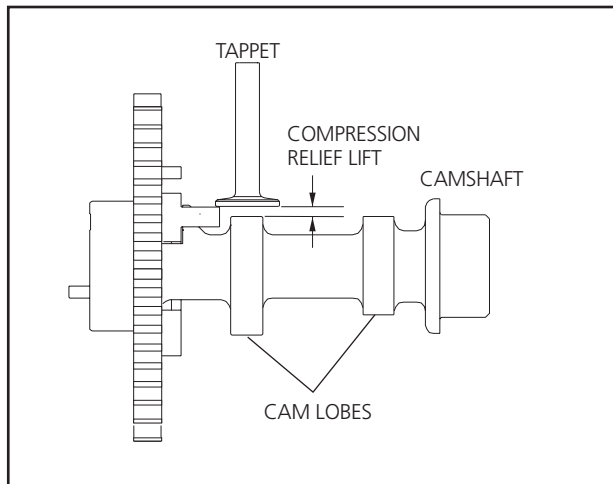
Measure the amount of compression relief lift at the tappet (see Figure 11.9).



**COMPRESSION RELEASE LIFT**  
GN-190  
DESIGN LIFT = 0.027-0.055 inch  
(0.70-1.40mm)



**COMPRESSION RELEASE LIFT**  
GN-191, GN-220  
DESIGN LIFT = 0.020-0.047 inch  
(0.5-1.2mm)

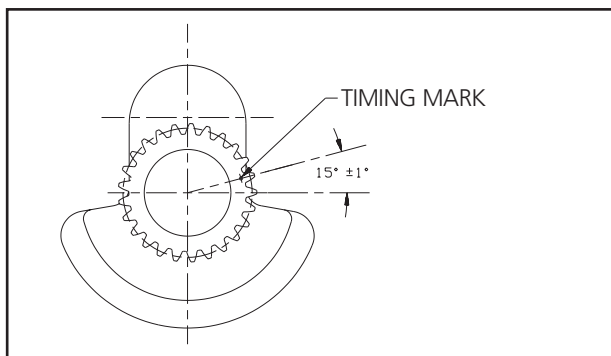


**Figure 11.9 — Compression Relief Lift**

## 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.
4. Rotate the crankshaft until the timing mark (Figure 11.10) is toward the cam gear side of the crankcase.



**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.

## CAMSHAFT INSTALLATION

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

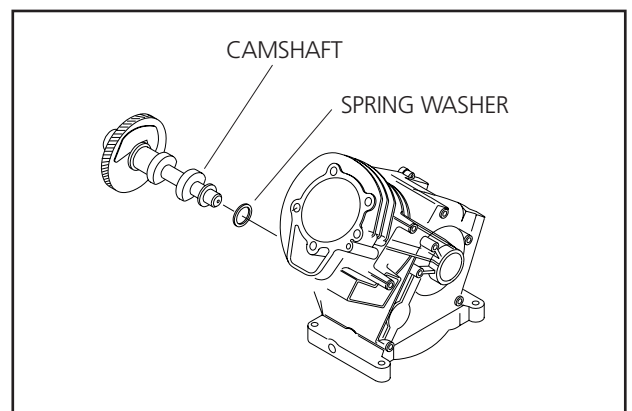
**NOTE:** Make sure the spring washer is in position (Figure 11.12).

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).

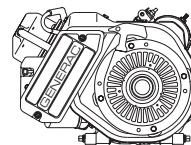
**NOTE:** For installation of the oil pump, oil pickup and crankcase cover, see Section 12; "LUBRICATION."



**Figure 11.11 — Alignment of Timing Marks**



**Figure 11.12 — Position of Spring Washer**



### 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.

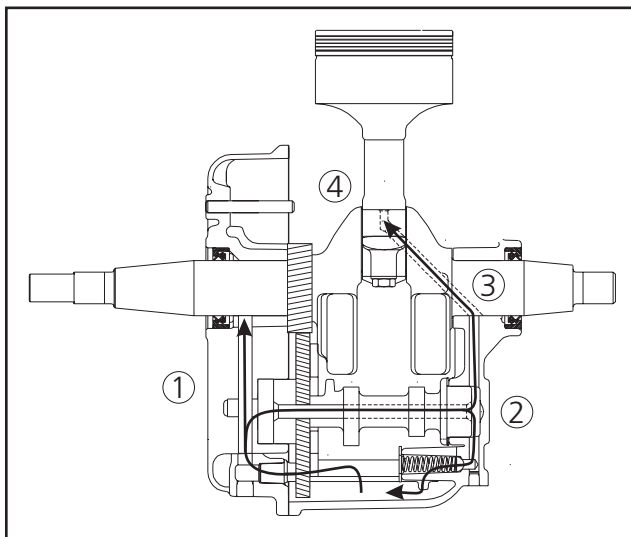
Major components include the following:

- Oil pickup assembly.
- Oil pump.
- Crankshaft oil seals.
- Pressure relief valve.
- Breather assembly.
- Crankcase cover.
- Low oil pressure switch.

### OIL FLOW

See Figure 12.1. 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.



**Figure 12.1 — Lubrication System Diagram**

### OIL PICKUP ASSEMBLY

#### 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 toward 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.



**Figure 12.2 — Oil Pickup Assembly**

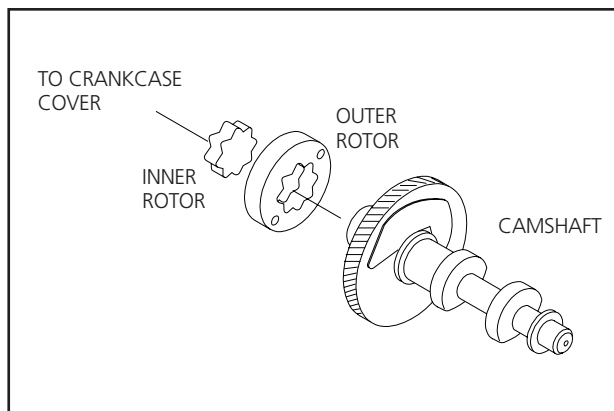
#### INSPECTION:

Clean the pickup in solvent. Inspect the plastic body for cracks or other damage. Check the screen for damage. Make sure the hollow pickup tube is clean and free of obstructions.

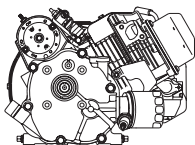
### OIL PUMP

#### DESCRIPTION:

The oil pump (Figure 12.3) is of the gerotor 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.



**Figure 12.3 — Oil Pump**



## OIL PUMP (CONTINUED)

### INSPECTION:

1. Inspect the inner and outer rotors for damage and wear (Figure 12.4).
2. Use a feeler gauge to check tip clearance of inner rotor, with rotor installed on shaft in crankcase cover.
3. Measure the bore inner diameter of the inner rotor.
4. Measure the inner rotor thickness.
5. Check the outer rotor outside diameter.
6. Inspect the outer rotor drive pins on the camshaft. Check for breaking, bending or other damage. The two roll pins can be removed and replaced with relative ease.

Replace any oil pump component that is damaged or worn excessively.

**NOTE:** The shaft on which the inner oil pump rotor rotates is NOT replaceable. If the shaft is damaged or worn, the crankcase cover must be replaced.

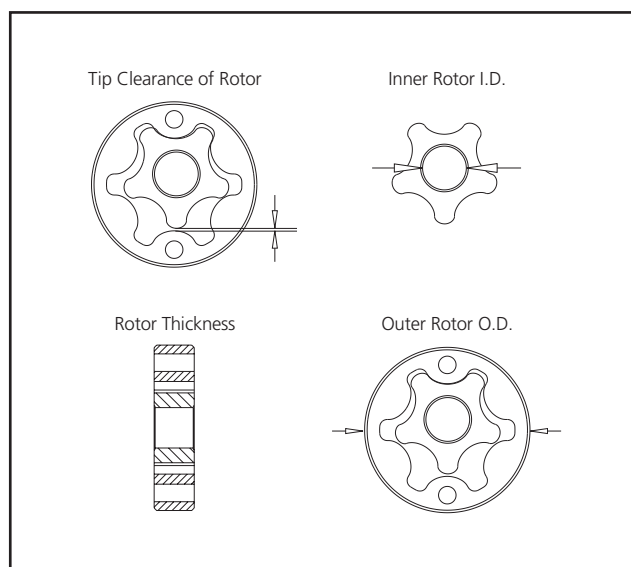


Figure 12.4 — Inner and Outer Rotor Check Points



**OIL PUMP INNER ROTOR SHAFT O.D.**  
DESIGN DIAMETER = 0.353-0.354 inch  
(8.969-8.987mm)



**OIL PUMP ROTOR TIP CLEARANCE**  
DESIGN CLEARANCE = 0.0000-0.0010 inch  
(0.000-0.025mm)



**INNER ROTOR I.D.**  
DESIGN DIAMETER = 0.354-0.355 inch  
(9.000-9.019mm)



**INNER ROTOR THICKNESS.**  
DESIGN THICKNESS = 0.312-0.315 inch  
(7.95-8.00mm)



**OUTER ROTOR THICKNESS.**  
DESIGN THICKNESS = 0.314-0.316 inch  
(8.000-8.025mm)



**OUTER ROTOR O.D.**  
DESIGN THICKNESS = 1.296-1.297 inch  
(32.92-32.95mm)

## CRANKSHAFT OIL SEALS

An oil seal is provided in the crankcase cover and in the crankcase to prevent oil leakage past the crankshaft journals (Figure 12.5).

A leaking or defective oil seal can be removed and replaced as follows:

1. If the crankshaft has been removed, old seals can be removed by tapping out with a screwdriver or by punching 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.

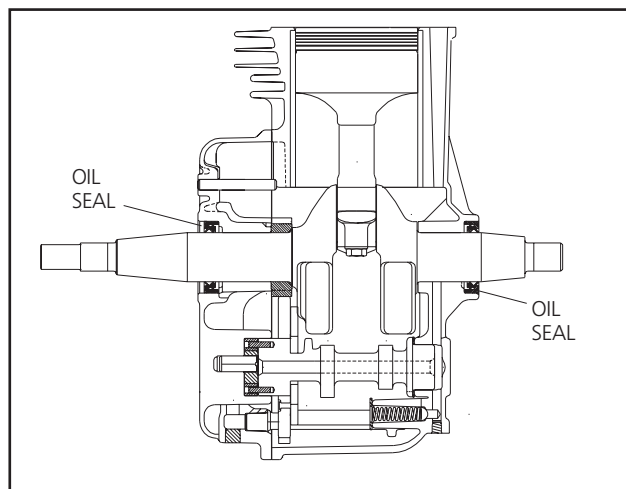
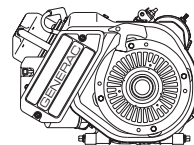


Figure 12.5 — Crankshaft Oil Seals



## PRESSURE RELIEF VALVE

### DESCRIPTION:

The ball type pressure relief valve is located in a bore of the crankcase. The ball and spring are held in place by a retainer. 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 30 psi (29 kg/cm<sup>2</sup>). Should oil pressure increase above that value, the ball will be forced off its seat to relieve excess pressure into the crankcase (see Figure 12.6).

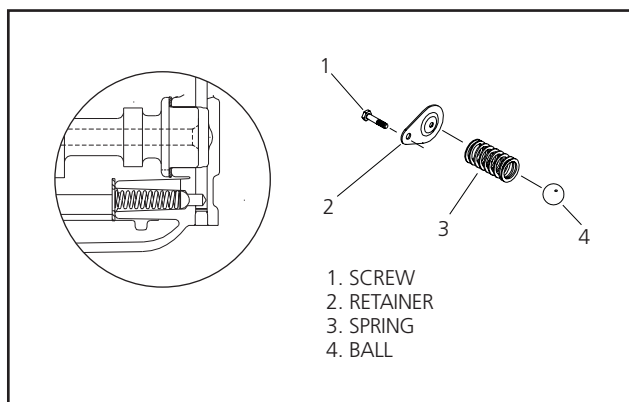


Figure 12.6 — Oil Pressure Relief Valve

### INSPECTION:

Remove the SCREW that retains the RETAINER to the crankcase. Remove the RETAINER, SPRING and BALL (Figure 12.6).

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.

Apply a known test load to the spring, sufficient to compress the spring to a length of 1.03 inch (26.3mm). The amount of test load at the stated spring length should be within the following limits:

 **0.85-0.95 pounds (0.43-0.39kg)**

Replace the spring if the test load at the stated length is not within limits.

## BREATHER ASSEMBLY

### DESCRIPTION:

A crankcase breather is located in the rocker arm cover of horizontal crankshaft engines (Figure 12.7). 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 atmosphere 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 series engines is mounted on the crankcase assembly and is configured differently. See "SERVICE MANUAL — COMPUTER CONTROLLED VARIABLE SPEED RV GENERATORS," Manual Part No.94468-A.**

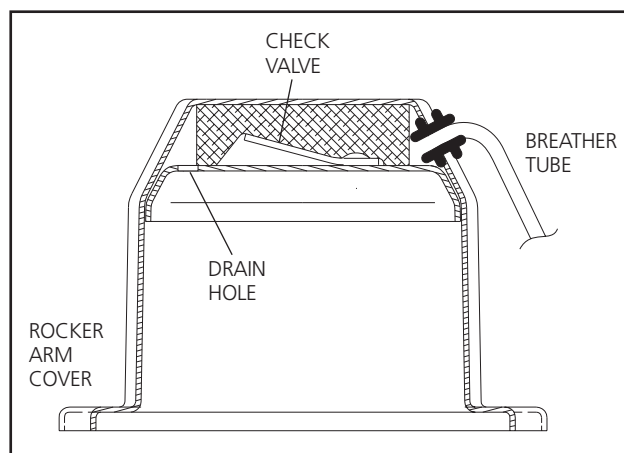


Figure 12.7 — Crankcase Breather

### INSPECTION:

1. Remove the breather tube. Check tube for cracks, hardening or other damage. Replace if necessary.
2. Clean the rocker arm cover in commercial solvent.
3. Make sure the two small drain holes are open. If necessary, use a length of wire to open the holes.
4. Check the rivets that retain the check valve, make sure they are tight.
5. The breather plate is retained in the rocker arm cover with a continuous bead of Type 103 black RTV sealant. This sealant must not leak. Test the sealant for leakage as follows:
  - a. Seal all holes on the breather plate.
  - b. Apply air pressure of 5 psi (0.352 kg/cm<sup>2</sup>) through the breather hose hole. No leakage must be observed.
  - c. If necessary, reseal the plate with Type 103 black RTV sealant.

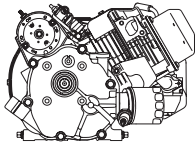
## CRANKCASE COVER

### DESCRIPTION:

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

Install a new gasket between the cover and crankcase each time the cover is removed. Bores are provided in the cover





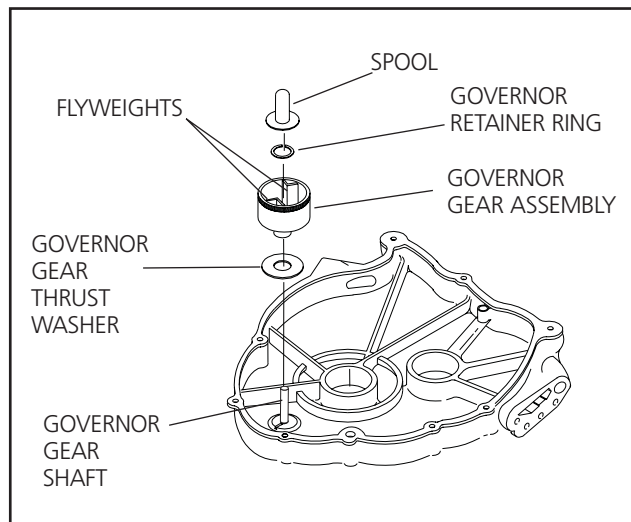
for (a) oil pump rotors and camshaft, (b) crankshaft, (c) governor gear assembly and (d) the oil pickup assembly. Cored oil passages are provided from the pickup bore to the pump and from the pump to the crankshaft bore.

### INSPECTION:

Clean the cover and blow dry with compressed air. Use compressed air to blow out all oil passages. Inspect the cover for cracks, damage, etc. Check the crankshaft and camshaft bearing bore diameters as outlined in Section 11.

### GOVERNOR GEAR INSTALLATION:

1. Apply engine oil to the governor gear shaft (Figure 12.8).
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 12.8 — Governor Assembly**

### CRANKCASE COVER INSTALLATION:

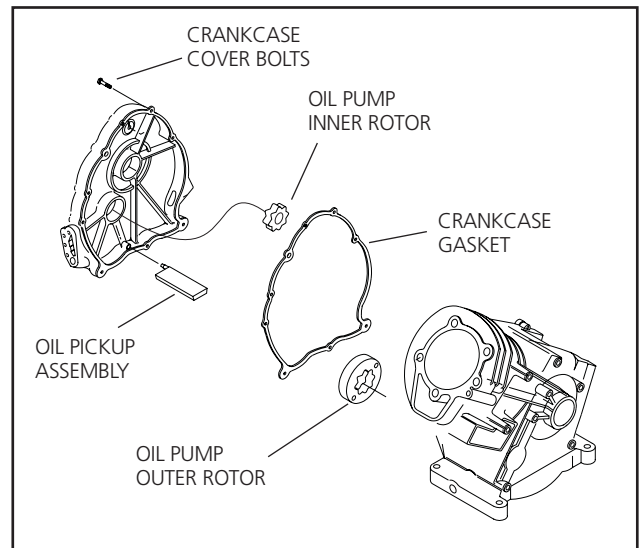
Install the crankcase cover as follows:

1. Rest the crankcase on its side with the crankcase cover flange facing upward.
2. Check that the valve tappets, crankshaft and camshaft have been properly installed into the crankcase.

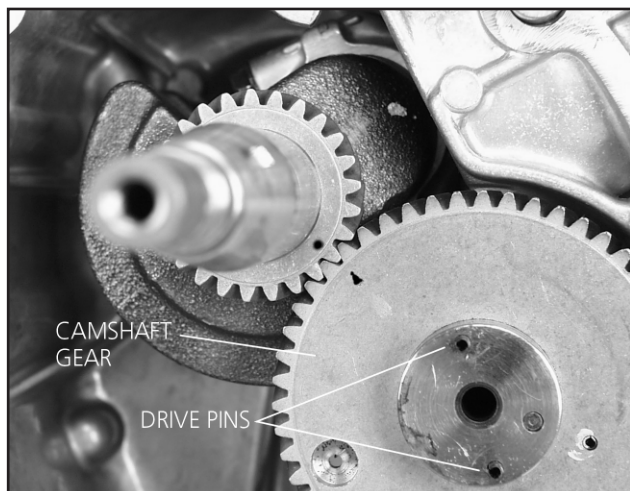
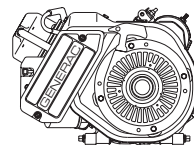
3. Make sure the timing marks on the crankshaft and camshaft gears are properly aligned.
4. Place the crankcase cover gasket onto the crankcase flange.
5. Apply engine oil to the crankshaft and camshaft journals.
6. Apply engine oil to the crankshaft and camshaft bores in the crankcase cover.
7. Insert tubular end of oil pickup into its crankcase cover bore. The pickup screen must face downward and the pickup must be parallel with the cover flange.

**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 of the camshaft (see Figure 12.10, next page).



**Figure 12.9 — Reassembly of Crankcase Cover and Oil Pump**



**Figure 12.10 — Location of Oil Pump Drive Pins**

12. Carefully install the crankcase cover. Align the cover with dowel pins on the crankshaft 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 tighten (see Figure 12.11).



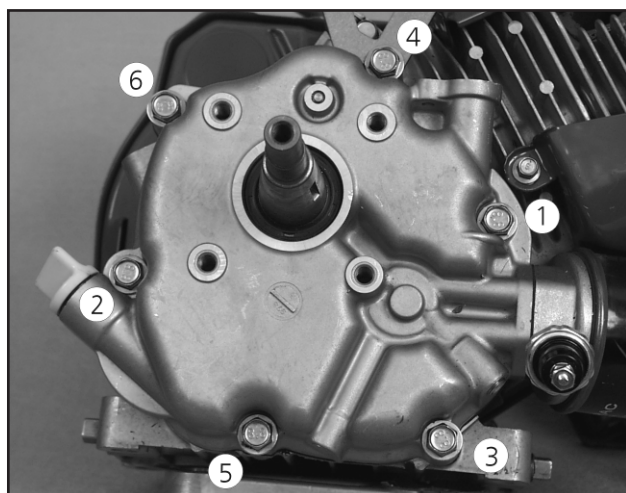
**TORQUE SPECIFICATION  
CRANKCASE COVER BOLTS  
GN-190**

**TORQUE = 8 foot-pounds or 100 inch-pounds**



**TORQUE SPECIFICATION  
CRANKCASE COVER BOLTS  
GN-191 and GN-220**

**TORQUE = 18 foot-pounds or 216 inch-pounds**

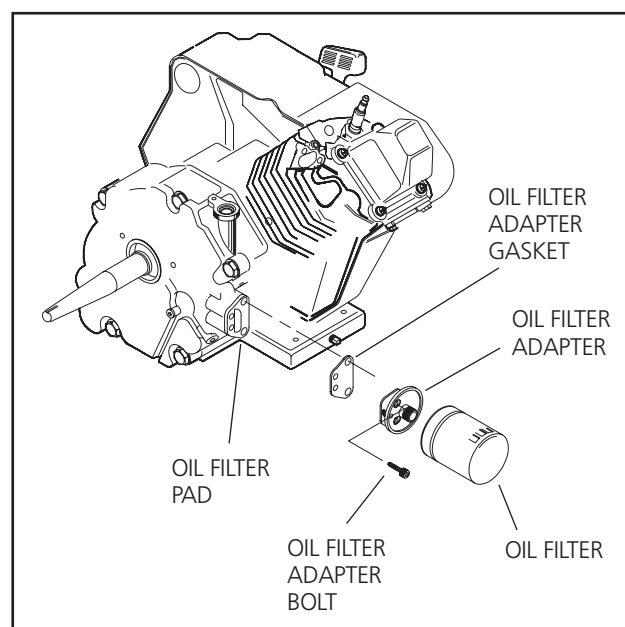


**Figure 12.11 — Crankcase Cover Bolt Tightening Sequence**

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 12.12)



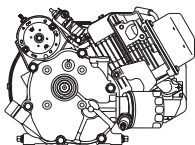
**Section 12.12 — Optional Oil Filter**

### LOW OIL PRESSURE SYSTEM

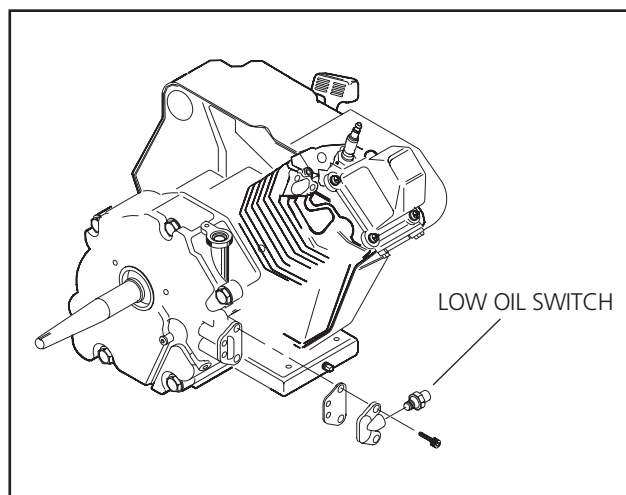
Some engine applications may be equipped with a low oil pressure switch. (See Section 12.10) The switch is a normally closed type, but is held open by engine oil pressure during cranking and running. Should engine oil pressure drop below approximately 10 psi for any reason, the switch contacts will close. 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.
- Switch contacts closure will connect the primary ignition circuit to ground, ignition will terminate, and the engine will shut down.

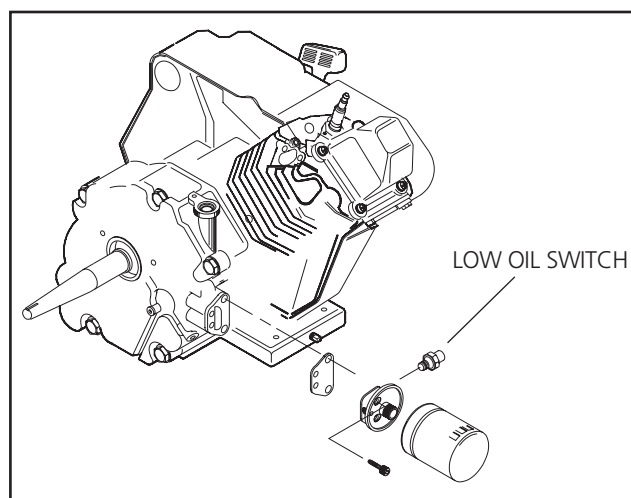
**NOTE:** Some differences may exist between low oil pressure systems. Refer to the electrical schematic/wiring diagram in the Owners Manual for the specific application using this engine.



**Figure 12.13 — Low Oil Indicator**



**Figure 12.15 — Low Oil Switch Without Optional Oil Filter**



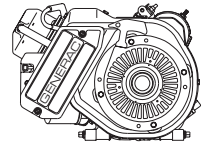
**Figure 12.14 — Low Oil Switch With Optional Oil Filter**



**TORQUE SPECIFICATION**  
**OIL FILTER ADAPTER BOLT**  
**TORQUE = 9 foot-pounds or 108 inch-pounds**



**TORQUE SPECIFICATION**  
**LOW OIL SWITCH**  
**TORQUE = 9 foot-pounds or 108 inch-pounds**



### PROBLEM SOLVING

#### 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 engine compression, as well as the ignition and fuel systems. 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 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.

#### **MINIMUM ALLOWABLE COMPRESSION PRESSURE COLD ENGINE GN-190, GN-191, GN-220 60 psi**

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.

#### CHECK IGNITION SYSTEM:

See "Testing the Ignition System" in Section 8 (Page 31).

#### 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.

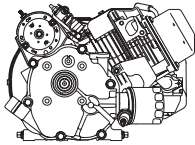
If the plug is WET, look for the following:

1. Overchoking.
2. Dirty air cleaner.
3. Excessively rich fuel-air mixture.
4. Water in the fuel.
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).

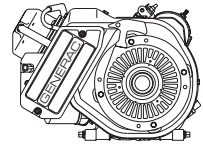
One way to determine if fuel is reaching the engine combustion chamber is to remove the spark plug and pour a small amount of gasoline into the spark plug hole. Reinstall the spark plug and crank the engine. If engine fires a few times then quits, check for the same conditions as a dry plug.



<b>PROBLEM</b>	<b>POSSIBLE CAUSES</b>	<b>REMEDY</b>
<b>1. Engine will not start or starts with difficulty.</b>	<ul style="list-style-type: none"> <li>a. Fuel tank is empty.</li> <li>b. Low oil level.</li> <li>c. Dirty air cleaner.</li> <li>d. Obstructed fuel Line.</li> <li>e. Fuel tank cap vent hole is obstructed.</li> <li>f. Spark plug is fouled.</li> <li>g. Incorrect spark plug.</li> <li>h. Loose or defective ignition wiring.</li> <li>i. No ignition spark.</li> <li>j. Incorrect valve clearance.</li> <li>k. Poor compression.</li> </ul>	<ul style="list-style-type: none"> <li>a. Fill fuel tank.</li> <li>b. Replenish oil as necessary.</li> <li>c. Clean or replace air cleaner element.</li> <li>d. Clean fuel line or replace.</li> <li>e. Open cap vent hole.</li> <li>f. Replace spark plug.</li> <li>g. Replace with correct spark plug.</li> <li>h. Check wiring, repair or replace.</li> <li>i. Check ignition system, replace defective part(s).</li> <li>j. Reset valve clearance.</li> <li>k. Check for worn or scored cylinder.</li> </ul>
<b>2. Engine knocks.</b>	<ul style="list-style-type: none"> <li>a. Carbon in combustion chamber.</li> <li>b. Loose flywheel.</li> <li>c. Worn cylinder.</li> <li>d. Loose or worn connecting rod.</li> <li>e. Incorrect valve clearance</li> </ul>	<ul style="list-style-type: none"> <li>a. Clean carbon from head and piston.</li> <li>b. Check flywheel key and keyway, replace part(s) if necessary. Tighten flywheel nut.</li> <li>c. Replace crankcase.</li> <li>d. Replace connecting rod. Check crankpin diameter to see if crankshaft is bad.</li> <li>e. Reset to correct clearance.</li> </ul>
<b>3. Engine misses under load.</b>	<ul style="list-style-type: none"> <li>a. Incorrect spark plug.</li> <li>b. Spark plug is fouled.</li> <li>c. Spark plug porcelain is cracked.</li> <li>d. Incorrect spark plug gap.</li> <li>e. Incorrect valve clearance.</li> <li>f. Weak valve springs.</li> </ul>	<ul style="list-style-type: none"> <li>a. Install correct spark plug.</li> <li>b. Clean and regap spark plug.</li> <li>c. Replace spark plug.</li> <li>d. Regap the spark plug.</li> <li>e. Reset valve clearance.</li> <li>f. Replace weak valve spring(s).</li> </ul>
<b>4. Engine lacks power.</b>	<ul style="list-style-type: none"> <li>a. Governor not set correctly.</li> <li>b. Incorrect spark plug</li> <li>c. Incorrect valve clearance.</li> <li>d. Worn piston rings.</li> <li>e. Low oil level.</li> <li>f. Air cleaner is obstructed.</li> <li>g. Valves or valve seats worn or burned.</li> </ul>	<ul style="list-style-type: none"> <li>a. Adjust governor.</li> <li>b. Install correct spark plug.</li> <li>c. Reset valve clearance.</li> <li>d. Replace piston rings.</li> <li>e. Replenish oil to proper level.</li> <li>f. Clean or replace air cleaner.</li> <li>g. Grind valves and valve seats.</li> </ul>
<b>5. Engine overheats.</b>	<ul style="list-style-type: none"> <li>a. Air flow is obstructed.</li> <li>b. Cooling fins are clogged.</li> <li>c. Carbon buildup in combustion chamber.</li> <li>d. Engine is overloaded.</li> <li>e. Lack of lubrication</li> </ul>	<ul style="list-style-type: none"> <li>a. Remove obstructions</li> <li>b. Clean cooling fine.</li> <li>c. Remove cylinder head and clean carbon.</li> <li>d. Reduce excessive loading.</li> <li>e. Replenish oil to proper level.</li> </ul>
<b>6. Engine vibrates excessively.</b>	<ul style="list-style-type: none"> <li>a. Engine mounting bolts loose.</li> <li>b. Bent crankshaft.</li> <li>c. Problem in equipment connected to engine.</li> </ul>	<ul style="list-style-type: none"> <li>a. Tighten mounting bolts.</li> <li>b. Replace crankshaft.</li> <li>c. Check equipment driven by engine.</li> </ul>



## SPECIFICATIONS



### GENERAL SPECIFICATIONS

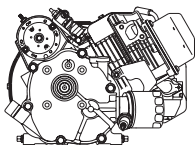
MODEL	GN-190	GN-191	GN-220
BORE	2.76 inches (70mm)	2.76 inches (70mm)	2.95 inches (75mm)
STROKE	1.93 inches (49mm)	1.93 inches (49mm)	1.93 inches (49mm)
DISPLACEMENT	188.6cc	188.6cc	216.5cc
OIL CAPACITY W/O FILTER CHANGE WITH FILTER CHANGE	21 ounces (620ml) 29.5 ounces (870 ml)	21 ounces (620ml) 29.5 ounces (870 ml)	21 ounces (620ml) 29.5 ounces (870 ml)

### VALVE TRAIN

MODEL	GN-190	GN-191	GN-220
VALVE SEAT WIDTH: DESIGN WIDTH	0.034-0.044 inch (0.87-1.13mm)		
VALVE SEAT ANGLE	45 degrees		
VALVE MARGIN: DESIGN MARGIN	0.058-0.060 inch (1.48-1.52mm)	0.034-0.044 inch (0.87-1.13mm)	0.034-0.044 inch (0.87-1.13mm)
INTAKE VALVE STEM DIAMETER: DESIGN DIAMETER	0.215-0.216 inch (5.465-5.480mm)	0.274-0.275 inch (6.965-6.980mm)	0.274-0.275 inch (6.965-6.980mm)
EXHAUST VALVE STEM DIAMETER: DESIGN DIAMETER	0.214-0.215 inch (5.445-5.460mm)	0.273-0.274 inch (6.965-6.980mm)	0.273-0.274 inch (6.965-6.980mm)
TAPPET DIAMETER INTAKE AND EXHAUST: DESIGN DIAMETER	0.294-0.295 inch (7.461-7.475mm)	0.293-0.294 inch (7.457-7.475mm)	0.293-0.294 inch (7.457-7.475mm)
VALVE SPRINGS: FREE LENGTH FORCE REQUIRED TO COMPRESS SPRING TO 1.39 INCH (35.2mm)	1.910 inch (48.48mm)  14.8-16.3 pounds (6.7-7.4kg)	2.074 inch (52.69mm)  19.8-21.8 pounds (9.0-9.9kg)	2.074 inch (52.69mm)  19.8-21.8 pounds (9.0-9.9kg)
VALVE CLEARANCE: INTAKE  EXHAUST	0.001-0.003 inch (0.03-0.07mm)  0.001-0.003 inch (0.03-0.07mm)	0.001-0.0022 inch (0.030-0.056mm)  0.0018-0.003 inch (0.07-0.046mm)	0.001-0.0022 inch (0.030-0.056mm)  0.0018-0.003 in. (0.07-0.046mm)
VALVE GUIDES: DESIGN DIAMETER	0.216-0.217 inch (5.505-5.520mm)	0.237-0.2364 inch (6.02-6.005mm)	0.237-0.2364 inch (6.02-6.005mm)

### CRANKSHAFT END PLAY

ALLOWABLE END PLAY	0.006-0.023 inch (0.14-0.60mm)	0.006-0.023 inch (0.14-0.60mm)	0.006-0.023 inch (0.14-0.60mm)
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### CRANKCASE ASSEMBLY

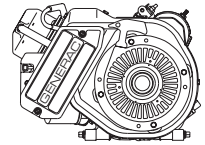
MODEL	GN-190	GN-191	GN-220
CYLINDER BORE: DESIGN DIAMETER	2.756-2.757 inch (70.000-70.025mm)	2.756-2.757 inch (70.000-70.025mm)	2.953-2.954 inch (75.000-75.025mm)
VALVE TAPPET BORE: DESIGN DIAMETER	0.295-0.296 inch (7.494-7.520mm)	0.295-0.296 inch (7.494-7.520mm)	0.295-0.296 inch (7.494-7.520mm)
CRANKSHAFT SLEEVE BEARING: DESIGN DIAMETER *(WHERE APPLICABLE)	1.104-1.106 inch (28.044-28.099mm)	1.104-1.106 inch (28.044-28.099mm)	1.104-1.106 inch (28.044-28.099mm)
GOVERNOR ARM BORE: DESIGN DIAMETER	0.239-0.240 inch (6.07-6.10mm)	0.239-0.240 inch (6.07-6.10mm)	0.239-0.240 inch (6.07-6.10mm)
CAMSHAFT BEARING: DESIGN DIAMETER	1.024-1.025 inch (26.00-26.03mm)	1.024-1.025 inch (26.00-26.03mm)	1.024-1.025 inch (26.00-26.03mm)
GOVERNOR ARM DIAMETER: DESIGN DIAMETER:	0.235-0.237 inch (5.97-6.03mm)	0.235-0.237 inch (5.97-6.03mm)	0.235-0.237 inch (5.97-6.03mm)

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

### CRANKCASE COVER ASSEMBLY

MODEL	GN-190	GN-191	GN-220
CRANKSHAFT BEARING BORE: DESIGN DIAMETER	1.104-1.105 inch (28.040-28.065mm)	1.104-1.105 inch (28.040-28.065mm)	1.104-1.105 inch (28.040-28.065mm)
CAMSHAFT BEARING BORE: DESIGN DIAMETER	1.299-1.300 inch (33.00-33.03mm)	1.299-1.300 inch (33.00-33.03mm)	1.299-1.300 inch (33.00-33.03mm)
GOVERNOR GEAR SHAFT DIAMETER	0.236-0.237 inch (6.004-6.012mm)	0.236-0.237 inch (6.004-6.012mm)	0.236-0.237 inch (6.004-6.012mm)
OIL PUMP INNER ROTOR SHAFT DIAMETER: DESIGN DIAMETER	0.353-0.354 inch (8.969-8.987mm)	0.353-0.354 inch (8.969-8.987mm)	0.353-0.354 inch (8.969-8.987mm)

## SPECIFICATIONS



### CRANKSHAFT

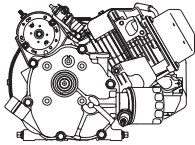
MODEL	GN-190	GN-191	GN-220
CRANKPIN DIAMETER: DESIGN DIAMETER	1.180-1.181 inch (29.99-30.01mm)	1.180-1.181 inch (29.99-30.01mm)	1.180-1.181 inch (29.99-30.01mm)
CRANKSHAFT MAIN BEARING (FLYWHEEL END): DESIGN DIAMETER	1.102-1.103 inch (28.000-28.012mm)	1.102-1.103 inch (28.000-28.012mm)	1.102-1.103 inch (28.000-28.012mm)
CRANKSHAFT MAIN BEARING (PTO END): DESIGN DIAMETER	1.102-1.103 inch (28.000-28.012mm)	1.102-1.103 inch (28.000-28.012mm)	1.102-1.103 inch (28.000-28.012mm)

### CONNECTING ROD ASSEMBLY

MODEL	GN-190	GN-191	GN-220
LARGE END INSIDE DIAMETER: DESIGN DIAMETER	1.183-1.184 inch (30.06-30.07mm)	1.183-1.184 inch (30.06-30.07mm)	1.183-1.184 inch (30.06-30.07mm)
SMALL END INSIDE DIAMETER: DESIGN DIAMETER	2.196-2.213 inch (55.8-56.2mm)	2.196-2.213 inch (55.8-56.2mm)	2.196-2.213 inch (55.8-56.2mm)
PISTON PIN LENGTH: DESIGN DIAMETER	1.102-1.103 inch (28.000-28.012mm)	1.102-1.103 inch (28.000-28.012mm)	1.102-1.103 inch (28.000-28.012mm)
PISTON PIN OUTSIDE DIAMETER: DESIGN DIAMETER	0.708-0.709 inch (17.989-18.000mm)	0.708-0.709 inch (17.989-18.000mm)	0.708-0.709 inch (17.989-18.000mm)

### PISTON

MODEL	GN-190	GN-191	GN-220
PISTON MAJOR DIAMETER: DESIGN DIAMETER	2.753-2.754 inch (69.939-69.959mm)	2.753-2.754 inch (69.939-69.959mm)	2.753-2.754 inch (69.939-69.959mm)
PISTON MINOR DIAMETER: DESIGN DIAMETER	2.747-2.748 inch (69.789-69.809mm)	2.747-2.748 inch (69.789-69.809mm)	2.747-2.748 inch (69.789-69.809mm)

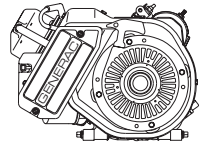


**PISTON (CONTINUED)**

<b>MODEL</b>	<b>GN-190</b>	<b>GN-191</b>	<b>GN-220</b>
WRIST PIN BORE DIAMETER: DESIGN DIAMETER	0.708-0.709 inch (18.000-18.011mm)	0.708-0.709 inch (18.000-18.011mm)	0.708-0.709 inch (18.000-18.011mm)
TOP RING GROOVE WIDTH: DESIGN WIDTH	0.059-0.061 inch (1.52-1.54mm)	0.059-0.061 inch (1.52-1.54mm)	0.059-0.061 inch (1.52-1.54mm)
SECOND RING GROOVE WIDTH: DESIGN WIDTH	0.059-0.061 inch (1.52-1.54mm)	0.059-0.061 inch (1.52-1.54mm)	0.059-0.061 inch (1.52-1.54mm)
OIL CONTROL RING GROOVE WIDTH: DESIGN WIDTH	0.118-0.119 inch (3.01-3.03mm)	0.118-0.119 inch (3.01-3.03mm)	0.118-0.119 inch (3.01-3.03mm)
TOP RING WIDTH: DESIGN WIDTH	0.057-0.059 inch (1.47-1.49mm)	0.057-0.059 inch (1.47-1.49mm)	0.057-0.059 inch (1.47-1.49mm)
TOP RING END GAP: * DESIGN END GAP	0.005-0.016 inch (0.15-0.40mm)	0.005-0.016 inch (0.15-0.40mm)	0.005-0.016 inch (0.15-0.40mm)
SECOND RING WIDTH: DESIGN WIDTH	0.057-0.059 inch (1.465-1.490mm)	0.057-0.059 inch ( 1.465-1.490mm)	0.057-0.059 inch ( 1.465-1.490mm)
SECOND RING END GAP: * DESIGN END GAP	0.006-0.016 inch (0.15-0.40mm)	0.006-0.016 inch (0.15-0.40mm)	0.006-0.016 inch (0.15-0.40mm)
OIL CONTROL RING WIDTH: DESIGN WIDTH	0.111-0.118 inch (2.825-3.003mm)	0.111-0.118 inch (2.825-3.003mm)	0.111-0.118 inch (2.825-3.003mm)
OIL CONTROL RING END GAP: * DESIGN END GAP	0.015-0.055 inch (0.38-1.40mm)	0.015-0.055 inch ( 0.38-1.40mm)	0.015-0.055 inch ( 0.38-1.40mm)

**\*NOTE 1: Measure end gap with ring pushed down in cylinder to depth of 2.75 inches**

## SPECIFICATIONS



### CAMSHAFT ASSEMBLY

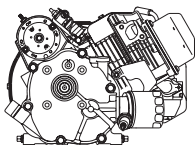
MODEL	GN-190	GN-191	GN-220
MAIN CAMSHAFT BEARING DIAMETER (FLYWHEEL END): DESIGN DIAMETER	1.022-1.023 inch (25.96-25.98mm)	1.022-1.023 inch (25.96-25.98mm)	1.022-1.023 inch (25.96-25.98mm)
MAIN CAMSHAFT BEARING DIAMETER (PTO END): DESIGN DIAMETER	1.022-1.023 inch (25.96-25.98mm)	1.297-1.298 inch (32.96-32.98mm)	1.297-1.298 inch (32.96-32.98mm)
CAM LIFT: DESIGN LIFT	0.210-0.212 inch (5.34-5.38mm)	0.210-0.212 inch (5.34-5.38mm)	0.210-0.212 inch (5.34-5.38mm)
BASE CIRCLE DIAMETER OF CAM: DESIGN DIAMETER	0.978-0.990 inch (24.85-25.15mm)	0.978-0.990 inch (24.85-25.15mm)	0.978-0.990 inch (24.85-25.15mm)
COMPRESSION RELEASE LIFT (MEASURED AT TAPPET): DESIGN LIFT	0.027-0.055 inch (0.70-1.40mm)	0.027-0.055 inch (0.70-1.40mm)	0.027-0.055 inch (0.70-1.40mm)

### OIL PUMP

MODEL	GN-190	GN-191	GN-220
PUMP TIP CLEARANCE *: DESIGN CLEARANCE	0.0000-0.0010 inch (0.000-0.025mm)	0.0000-0.0010 inch (0.000-0.025mm)	0.0000-0.0010 inch (0.000-0.025mm)
INNER ROTOR BORE: DESIGN BORE	0.354-0.355 inch (9.000-9.019mm)	0.354-0.355 inch (9.000-9.019mm)	0.354-0.355 inch (9.000-9.019mm)
INNER ROTOR THICKNESS: DESIGN THICKNESS	0.312-0.315 inch (7.95-8.00mm)	0.312-0.315 inch (7.95-8.00mm)	0.312-0.315 inch (7.95-8.00mm)
OUTER ROTOR OUTSIDE DIAMETER: DESIGN DIAMETER	1.296-1.297 inch (32.92-32.95mm)	1.296-1.297 inch (32.92-32.95mm)	1.296-1.297 inch (32.92-32.95mm)
OUTER ROTOR THICKNESS: DESIGN THICKNESS	0.314-0.316 inch (8.000-8.025mm)	0.314-0.316 inch (8.000-8.025mm)	0.314-0.316 inch (8.000-8.025mm)

**\*NOTE 2:** Measure pump tip clearance on shaft in crankcase cover.





**OIL PUMP (CONTINUED)**

<b>MODEL</b>	<b>GN-190</b>	<b>GN-191</b>	<b>GN-220</b>
OIL PRESSURE RELIEF VALVE SPRING: Force required to compress spring to 1.035 inch (26.3mm)	0.85-0.95 pounds (0.39-0.43kg)	0.85-0.95 pounds (0.39-0.43kg)	0.85-0.95 pounds (0.39-0.43kg)

**COMPRESSION PRESSURE**

<b>MODEL</b>	<b>GN-190</b>	<b>GN-191</b>	<b>GN-220</b>
WHILE CRANKING (COLD ENGINE)	60 psi min.	60 psi min.	60 psi min.

**TORQUE SPECIFICATIONS**

<b>MODEL</b>	<b>GN-190</b>	<b>GN-191</b>	<b>GN-220</b>
Rocker Cover Screws	4 ft-lbs (48 in-lbs)	4 ft-lbs (48 in-lbs)	4 ft-lbs (48 in-lbs)
Rocker Arm Jam Nut	14.5 ft-lbs (174 in-lbs)	14.5 ft-lbs (174 in-lbs)	14.5 ft-lbs (174 in-lbs)
Cylinder Head Bolts	22 ft-lbs (264 in-lbs)	22 ft-lbs (264 in-lbs)	22 ft-lbs (264 in-lbs)
Connecting Rod Bolts	10 ft-lbs (120 in-lbs)	10 ft-lbs (120 in-lbs)	10 ft-lbs (120 in-lbs)
Flywheel Nut	75 ft-lbs (900 in-lbs)	75 ft-lbs (900 in-lbs)	75 ft-lbs (900 in-lbs)
Crankcase Cover Bolts	8 ft-lbs (100 in-lbs)	18 ft-lbs (216 in-lbs)	18 ft-lbs (216 in-lbs)
Ignition Coil Bolts	5 ft-lbs (60 in-lbs)	5 ft-lbs (60 in-lbs)	5 ft-lbs (60 in-lbs)
Spark Plug	13 ft-lbs (156 in-lbs)	13 ft-lbs (156 in-lbs)	13 ft-lbs (156 in-lbs)
Rewind Starter Screws	5 ft-lbs (60 in-lbs)	5 ft-lbs (60 in-lbs)	5 ft-lbs (60 in-lbs)
Starter Motor Bolts	18 ft-lbs (216 in-lbs)	18 ft-lbs (216 in-lbs)	18 ft-lbs (216 in-lbs)
Intake Manifold Screws	4 ft-lbs (50 in-lbs)	4 ft-lbs (50 in-lbs)	4 ft-lbs (50 in-lbs)
Carburetor to Intake Manifold	3.3 ft-lbs (40 in-lbs)	3.3 ft-lbs (40 in-lbs)	3.3 ft-lbs (40 in-lbs)
Air Cleaner Box (to Carburetor)	4 ft-lbs (50 in-lbs)	4 ft-lbs (50 in-lbs)	4 ft-lbs (50 in-lbs)
Blower Housing Screws	7 ft-lbs (84 in-lbs)	7 ft-lbs (84 in-lbs)	7 ft-lbs (84 in-lbs)
Upper and Lower Shroud Screws	4 ft-lbs (48 in-lbs)	4 ft-lbs (48 in-lbs)	4 ft-lbs (48 in-lbs)
Governor Lever Clamp Bolt	5.8 ft-lbs (70 in-lbs)	5.8 ft-lbs (70 in-lbs)	5.8 ft-lbs (70 in-lbs)
Oil Filter Adapter Bolts	9 ft-lbs (108 in-lbs)	9 ft-lbs (108 in-lbs)	9 ft-lbs (108 in-lbs)
Low Oil Switch	9 ft-lbs (108 in-lbs)	9 ft-lbs (108 in-lbs)	9 ft-lbs (108 in-lbs)

