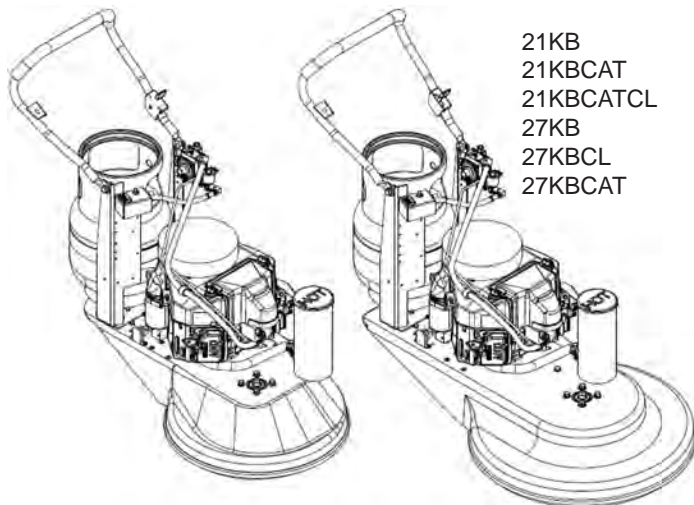
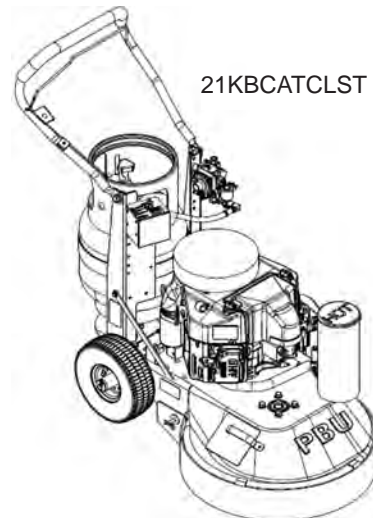


# PBU Propane Floor Burnisher

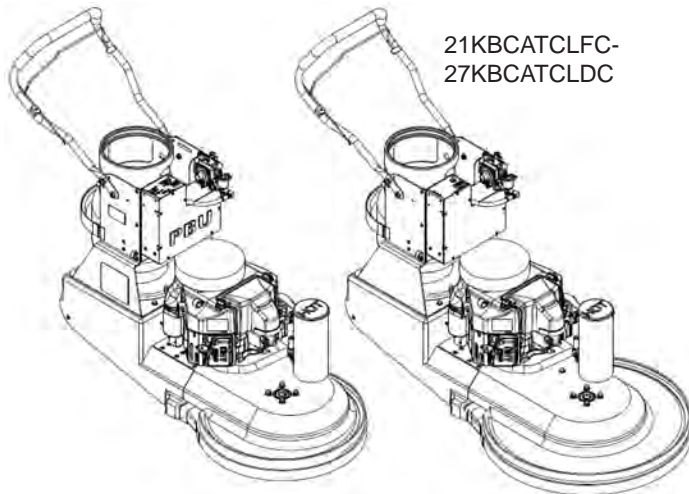
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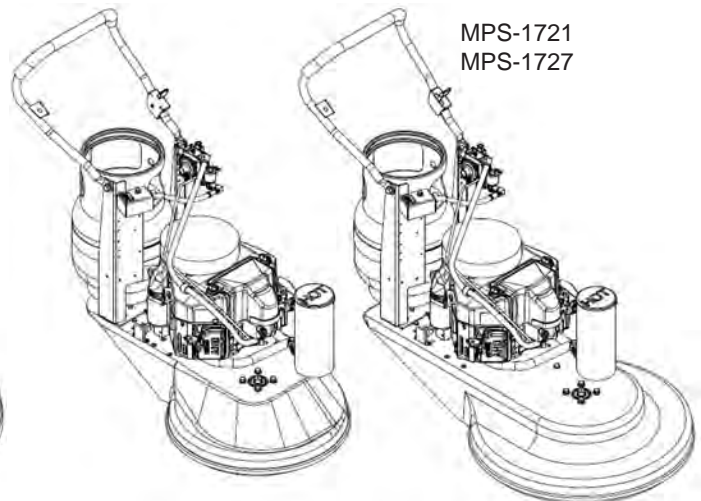
21KB  
21KBCAT  
21KBCATCL  
27KB  
27KBCL  
27KBCAT



21KBCATCLST



21KBCATCLFC-  
27KBCATCLDC



MPS-1721  
MPS-1727

## Service Manual

Nilfisk-Advance “PBU” Machines: 56381402, 56381404, 56381405, 56381406, 56381407, 56381408 (Dust control unit), 56381409 (Dust control unit), 56381454

Nilfisk-Advance “Propane Stripper” Machine: 56381410

Diamatic Machines: 56381412, 56381413

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English

03/11 Revised 07/12 Form No. 56043153

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## General Information

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### Service Manual Purpose and Application

This Service Manual is a resource for professional service technicians. It provides information for understanding how the machine operates, where components are located, basic troubleshooting, maintenance and mechanical service operations.

This manual covers the Nilfisk-Advance models 56381402, 56381404, 56381405, 56381406, 56381407, 56381408, 56381409, 56381410 (propane stripper), 56381412 (21" Diamatic machine), and 56381413 (27" Diamatic machine). The cover page of this manual lists each machine part number that the manual applies to. Compare the model number of the machine you are working on to the model numbers listed on the cover page to be sure you are using the correct manual.

### Document Revision History

- November 2011
  - Engine Fuel System and RPM changes.
    - General Information - Brush Speed specifications
    - Engine System - Added section for adjusting regulator after serial number 3000083760. Updated Specification table High Idle Speed values.
  - Burnishing System - Added information for replacing the drive belt tensioner

### Other Reference Manuals

The following documents contain parts information and instructions for machine operation:

- Parts List Form # 56091022 applies to the following models: 56381402 (21KBCAT), 56381404 (21KB), 56381405 (27KB), 56381406 (27KBCL), 56381407 (27KBCAT)
- Parts List Form # 56091023 applies to the following models: 56381408 (21KBCATCLDC), 56381409 (27KBCATCLDC)
- Parts List Form # 56091024 applies to the following model: 56381410 (21KBCATCLST))
- Parts List Form # 56091025 applies to the following models: 56381412 (MPS-1721), 56381413 (MPS-1727)

### Conventions

Forward, backward, front, rear, left or right are intended with reference to the operator's position, that is to say in operating position with the hands on the handlebar.

## Transporting the Machine



**Caution!** Before transporting the machine on an open truck or trailer, make sure that

- The machine is tied down securely.
- All access doors and covers are secured (tape and strap as needed).

## Cautions and Warnings



**Danger!** It is the owner/operator's responsibility to ensure that an air exchange blower either of positive or negative pressure is used in any location where a propane floor care machine is being operated to support a sufficient fresh air supply to the operator during use of such a machine. OSHA and other County, State, or Federal Agencies publish guidelines for safe machine usage regarding exhaust emissions and CO exposure in the workplace. Failure on the part of the owner/operator to ensure that a propane floor care machine is operated safely in accordance with OSHA or local state indoor air quality guidelines in a given location may lead to injury, sickness or even loss of life. To be completely aware of what local authorities may require, contact the Fire Marshal of your community.

*This Owner's Manual/Safety Procedures Guide has been prepared for the promotion of educational purposes only and does not claim or assume any responsibility for the operator's actions or safety.*



**Danger!** All LPG (Liquid Propane Gas) powered engines, including this engine, produce Carbon Monoxide (CO). It is a LETHAL POISON that is a colorless, odorless, tasteless, and non-irritating gas. It is produced by incomplete combustion of carbonaceous material such as propane (LPG).

*Failure to provide for proper venting of CO produced during the operation of combustion powered engines may result in SERIOUS INJURY OR DEATH to the operator and those in the contaminated area.*

*The effects of CO can be experienced at different exposure levels, depending on the health of the individual. Conditions that affect the tolerance of the individual are smoking, age, temperature, humidity, and other conditions.*



**Warning:** Read and understand The Operators Manual completely before using this machine. This document explains how CO produced can be managed to reduce the risk of carbon monoxide poisoning. All distributors, owners, and operators should be aware of the potential effects of CO and the methods used to prevent over exposure. We are dedicated to our customers, their safety, and providing information, services, and products that meet those needs.



**Warning:** *The Products sold with this Manual contain or may contain chemicals that are known to certain governments (such as the State of California, as identified in its Proposition 65 Regulatory Warning Law) to cause cancer, birth defects or other reproductive harm. In certain locations (including the State of California) purchasers of these Products that place them in service at an employment job site or a publicly accessible space are required by regulation to make certain notices, warnings or disclosures regarding the chemicals that are or may be contained in the Products at or about such work sites. It is the purchaser's responsibility to know the content of, and to comply with, any laws and regulations relating to the use of these Products in such environments. The Manufacturer disclaims any responsibility to advise purchasers of any specific requirements that may be applicable to the use of the Products in such environments.*



**Warning:** *Deployment of a monitor/detector is essential for the safe operation of any equipment that has the potential to produce CO. CO sensors/detectors became available on the mass market around 1978. At present several brands sell in the fifty-dollar range. The main differences between the technologies involved are battery or electric and Semiconductor or Biomimetic types. Detectors for carbon monoxide (CO) are manufactured and marketed for use in either the home or occupational industrial settings. The detectors for home use are devices that will sound an alarm before CO concentrations in the home become hazardous. There is an Underwriters Laboratories, Inc., performance standard (UL 2034) for residential CO detectors. Detectors currently available on the market are battery-powered, wall mount, Operator worn portable personal protective, plug-in, or hard-wired. Some models incorporate a visual display of the parts per million (ppm) concentration of CO present in the home. For more information on CO detectors for home use, call the Consumer Product Safety Commission Hotline at 1-800-638-2772. CO detectors for use in residential settings are not designed for use in typical workplace settings. Monitoring requirements in an occupational setting are different from monitoring requirements in the home. In the workplace, it is frequently necessary to monitor a worker's exposure to carbon monoxide over an entire work shift and determine the time-weighted average (TWA) concentration of the exposure. It may also be necessary to have carbon monoxide monitors with alarm capabilities in the workplace. The direct-reading instruments are frequently equipped with audio and/or visual alarms and may be used for area and/or personal exposure monitoring. Some have microprocessors and memory for storing CO concentration readings taken during the day. It is significant to note that some of the devices mentioned for workplace CO monitoring are not capable of monitoring TWAs, and not all are equipped with alarms. The appropriate personal protective monitor must be chosen on an application-by-application basis. For more information on the availability of workplace CO monitors or their application, call the National Institute for Occupational Safety and Health at 1-800-35-NIOSH (1-800-356-4674).*





**Warning:** *The proper maintenance of equipment is vital to safe operation. LPG engines are dependent on engine tune up, and air filter replacement. CO concentration (production) skyrockets when the air to fuel ratio becomes fuel rich. Follow the recommended Maintenance Schedule for the engine found in the Engine Operator/ Owner Manual as well as the Maintenance And Adjustments schedule found in the Propane Floor Equipment Operator's Manual that were supplied with the equipment.*

#### **CO SAFETY EQUIPMENT AVAILABLE BY MANUFACTURER**

- Carb Gard automated emissions monitoring will shut down the engine when high emissions are detected.
- Three-way type catalytic converter to scrub CO, Hydro Carbons (HC), and Nitrides of Oxygen (NOx) from the engine exhaust providing the lowest possible emissions
- NOTE: Dead Stop CO Detector provided in Literature Pack. Replacement part number 98758A.

#### **CO SAFETY EQUIPMENT AVAILABLE ON THE MARKET**

- Positive or negative pressure high volume ventilation blower capable of exchanging complete room air volume to maintain CO levels below OSHA exposure limits.
- Digital combustion analyzers for tail pipe emissions monitoring
- OSHA Approved CO Monitor



**Caution:** *Overfilling the propane tank is the number one cause of problems with a propane machine. This can cause the engine to run poorly or not at all.*

*In addition, overfilling allows liquid propane to enter the fuel control system, possibly ruining the lockoff/regulator assembly. This voids the warranty on affected parts of the machine. To avoid problems, read and understand fully, the section "Filling and Storing Propane Tanks."*

## **General Machine Description**

The PBU (Propane Floor Burnisher) is manufactured for two applications: a buffer/burnisher and a floor stripper. Both designs are portable. Buffers operate at high speed to produce high gloss floor surfaces. The unit is powered by a 4-stroke, air-cooled, v-twin, liquid propane-fueled engine. During operation the unit buffing wheel contacts the floor to provide buffing action. Operator walking speed behind the unit determines results. The operator should avoid loose tile, electric outlets, door thresholds and any object which may come in contact with the pad, other than the floor itself. When equipped, the Carb Gard system is a warning device that alerts the operator to the need for engine service. Carb Gard monitors an oxygen sensor for an indication of relative air/fuel mixture. If the mixture exceeds an allowable limit for more than one minute, Carb Gard will shut down the engine.

## Nameplate

The nameplate contains important identification information which will be needed when ordering parts: Model (Name), Part No. (Part number of the machine which is often referred to as the “Model Number”), and Serial Number.



Figure 1. Nameplate Location

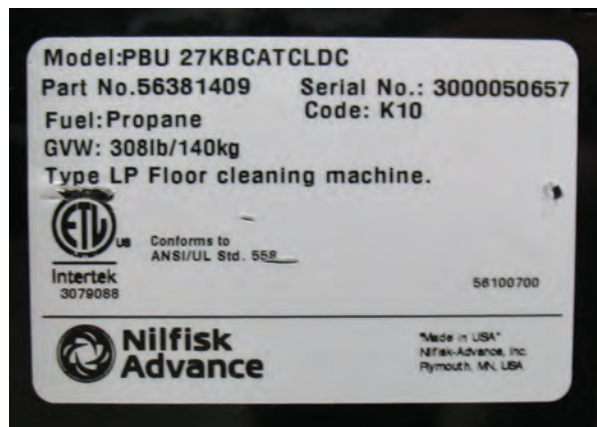


Figure 2. Nameplate Location

## Operator Controls

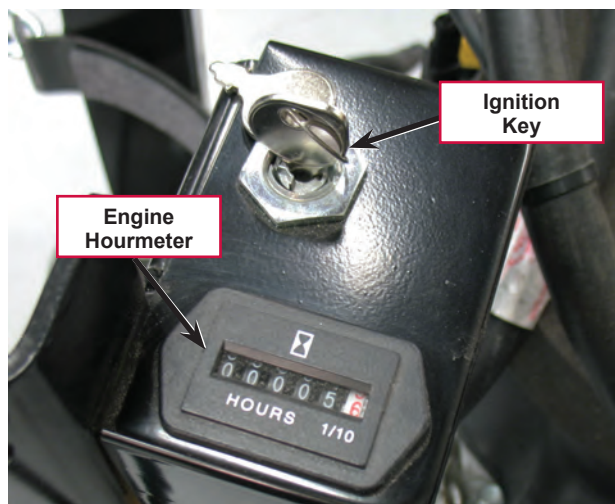


Figure 4. Controls, Non-Carb Gard

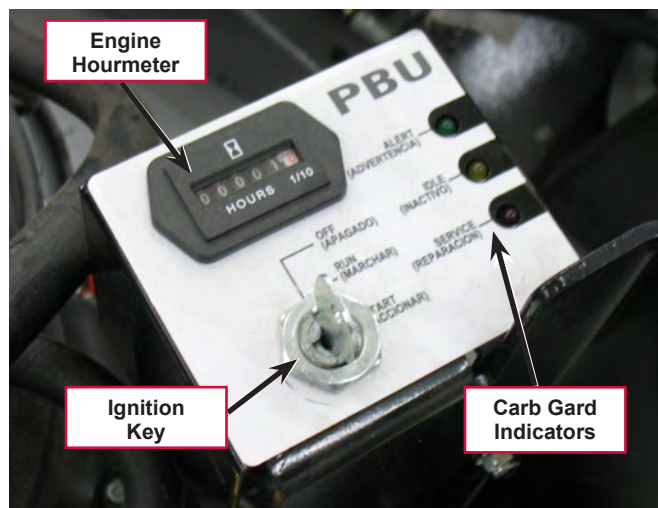


Figure 5. Controls, Carb Gard



## Know Your Machine — Major components:

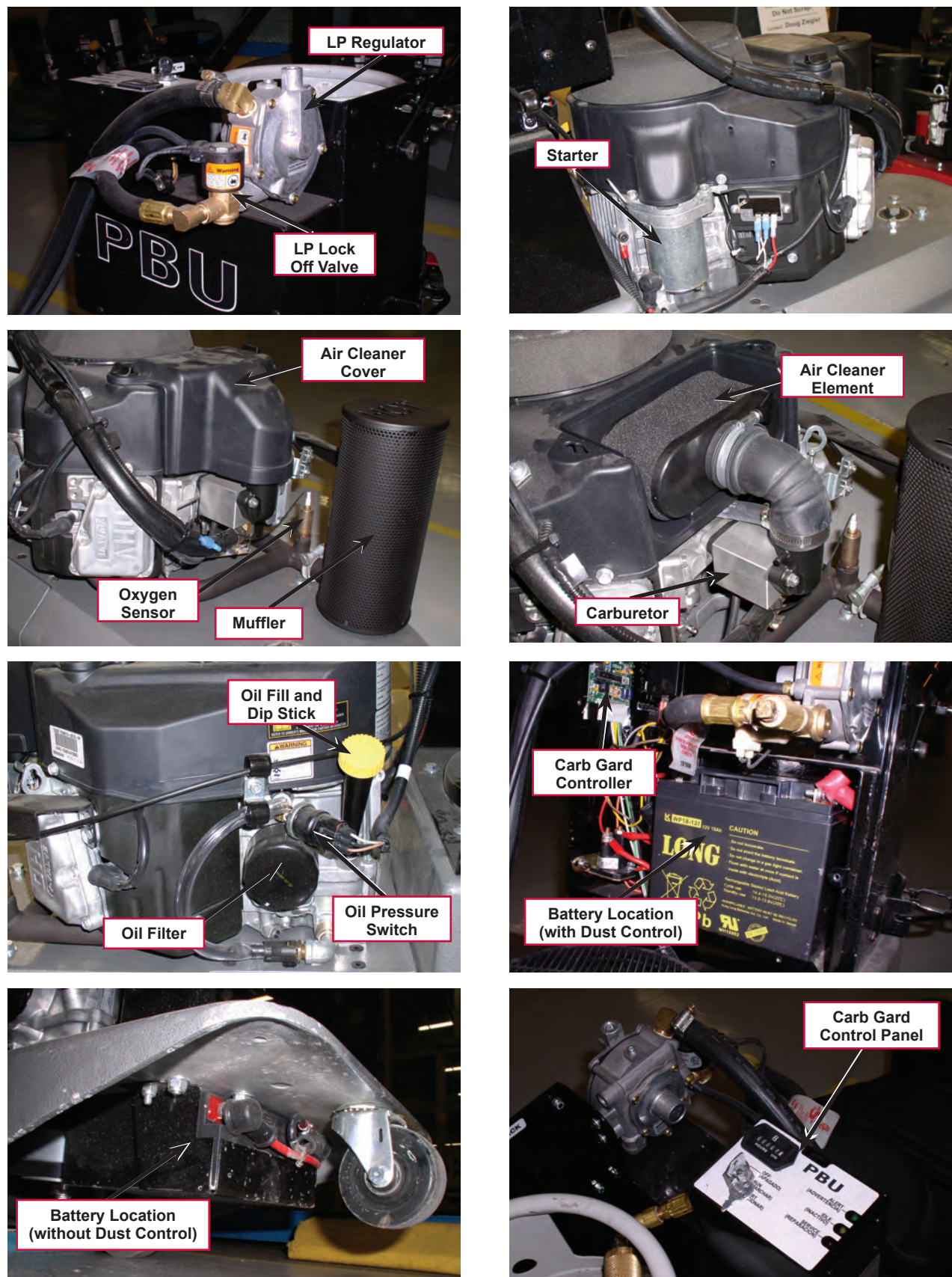


Figure 3. Major Components

## Specifications

(See other system chapters for specifications not listed here.)

Model	21KBCAT	21KB	27KB	27KBCL	27KBCAT 21KBCATCLST
Part Number	56381402	56381404	56381405	56381406	56381407
Pad Size	21" (53 cm)	21" (53 cm)	27" (68 cm)	27" (68 cm)	27" (68 cm)
Engine	603CC KAWASAKI				
Catalytic Muffler	Yes	No	No	No	Yes
Carb Gard	No	No	No	No	No
Clutch	None	None	None	Centrifugal	None
Pad Speed Eng. @ 3600 RPM	Pad Speed 2100 RPM	Pad Speed 2100 RPM	Pad Speed 1500 RPM	Pad Speed 1500 RPM	Pad Speed 1500 RPM
Pad Speed Eng. @ 3000 RPM	Pad Speed 1750 RPM	Pad Speed 1750 RPM	Pad Speed 1250 RPM	Pad Speed 1250 RPM	Pad Speed 1250 RPM
Propane Tank	20 lb. (9.1 kg) Capacity, 80% Safety Fill				
Auto Fuel Shutoff	Yes	Yes	Yes	Yes	Yes
Low Oil Shutdown	Yes	Yes	Yes	Yes	Yes
Hour Meter	Yes	Yes	Yes	Yes	Yes
Sound Pressure (ISO 11201)	87 dB LpA, 3dB KpA				
Productivity Rate	25,000 ft²/hr (2,322 m³/hr)		25,000 ft²/hr (3,066 m³/hr)		
Agency Approvals	EPA plus UL Approved Propane Components				
"CARB Certified (California Air Re-source Board)"	Yes	Yes	Yes	Yes	Yes
Weight	212 lbs. / 96 kg.	214 lbs. / 97 kg.	240 lbs. / 109 kg.	246 lbs. / 111 kg.	238 lbs. / 108 kg.
Length	51.5" (131.8 cm)	51.5" (131.8 cm)	59" (149.9 cm)	59" (149.9 cm)	59" (149.9 cm)
Width	23.3" (59 cm)	23.3" (59 cm)	29.3" (74.4 cm)	29.3" (74.4 cm)	29.3" (74.4 cm)
Height	43" (109.2 cm)	43" (109.2 cm)	43" (109.2 cm)	43" (109.2 cm)	43" (109.2 cm)
Warranty	2 Years Parts & Labor				

Model	21KBCATCLDC	27KBCATCLDC	27KBCATCLST	MPS-1721	MPS-1727
Part Number	56381408	56381409	56381410	56381412	56381413
Pad Size	21" (53 CM)	27" (68 cm)	21" (53 CM)	21" (53 CM)	27" (68 cm)
Engine	603CC KAWASAKI				
Catalytic Muffler	Yes	Yes	Yes	Yes	Yes
Carb Gard	Yes	Yes	Yes	Yes	Yes
Clutch	Centrifugal	Centrifugal	Centrifugal	Centrifugal	Centrifugal
Pad Speed Eng. @ 3600 RPM	2100 RPM	1500 RPM	1400 RPM	1400 RPM	1400 RPM
Pad Speed Eng. @ 3000 RPM	1750 RPM	1250 RPM	1170 RPM	1170 RPM	1170 RPM
Propane Tank	20 lb. (9.1 kg) Capacity, 80% Safety Fill				
Auto Fuel Shutoff	Yes	Yes	Yes	Yes	Yes
Low Oil Shutdown	Yes	Yes	Yes	Yes	Yes
Hour Meter	Yes	Yes	Yes	Yes	Yes
Sound Pressure (ISO 11201)	87 dB LpA, 3dB KpA				
Agency Approvals	EPA plus UL Approved Propane Components				
"CARB Certified (California Air Resource Board)"	Yes	Yes	Yes	Yes	Yes
Weight	292 lbs / 132.5 kg.	302 lbs / 137 kg	242 lbs / 110 kg.	248 lbs / 112.5 kg.	292 lbs / 132.5 kg.
Length	66" (167.4 cm)	69" (175.3 cm)	51.5" (131.8 cm)	51.5" (131.8 cm)	59" (149.9 cm)
Width	23.3" (59 cm)	29.5" (74.9 cm)	23.3" (59 cm)	23.3" (59 cm)	29.3" (74.4 cm)
Height	43" (109.2 cm)	43" (109.2 cm)	43" (109.2 cm)	43" (109.2 cm)	43" (109.2 cm)
Warranty	2 Years Parts & Labor				

Model	21KBCATCL
Part Number	56381454
Pad Size	21" (53 CM)
Engine	603CC KAWASAKI
Catalytic Muffler	Yes
Carb Gard	No
Clutch	Centrifugal
Pad Speed Eng. @ 3600 RPM	2100 RPM
Pad Speed Eng. @ 3000 RPM	1750 RPM
Propane Tank	20 lb. (9.1 kg) Capacity, 80% Safety Fill
Auto Fuel Shutoff	Yes
Low Oil Shutdown	Yes
Hour Meter	Yes
Sound Pressure (ISO 11201)	87 dB LpA, 3dB KpA
Agency Approvals	EPA plus UL Approved Propane Components
"CARB Certified (California Air Resource Board)"	Yes
Weight	218 lbs / 99 kg.
Length	51.5" (131.8 cm)
Width	23.3" (59 cm)
Height	43" (109.2 cm)
Warranty	2 Years Parts & Labor

## Maintenance Schedule

ITEM	Interval						
	Daily	8 Hour (Break In)	Every 25 Hours	Every 50 Hours	Every 100 Hours	Every 200 Hours	Every 300 Hours
Check or clean air intake screen	•						
Check for fuel and oil leakage	•						
Check for loose or lost nuts and screws	•						
Tighten nuts and screws					•		
Check battery electrolyte level	•						
Check and add engine oil	•						
Change engine oil		•		•			
Change oil filter					•		
Clean air cleaner foam element			•				
Replace air cleaner paper element						•	
Check pad driver for loose parts		•		•			
Check belt for wear or slippage		•		•			
Check engine pulley for tightness		•		•			
Check wheel bolts		•		•			
Check engine mount bolts		•		•			
Check handle bolts		•		•			
Check for leakage of engine oil at the various seals		•		•			
Change dust control filter					•		
Check and adjust engine valve clearance						•	
Clean and lap valve seating surface							•
Clean dust and dirt from cylinder and cylinder head fins				•			
Clean and re-gap spark plugs					•		
Clean combustion chambers							•
Return machine to authorized service center for overall checkup.							•



## Burnishing System

### Maintenance and Adjustments

#### Replace burnishing disc pad gripper assembly.

1. Use an open end wrench to grip the bolt that secures the burnishing disc assembly bearing. Brace wrench against adjacent bolt to prevent the bearing from rotating.



Figure 6 Grip Bolt, Burnishing Disc Assembly

2. Rotate the pad gripper assembly counter-clockwise to remove.



Figure 7 Remove Pad Gripper Assembly

3. To replace, thread pad gripper assembly onto shaft and rotate clockwise until secure.



Figure 8 Replace Pad Gripper Assembly

## Replace Burnishing Disc Assembly Drive Belt.

An idler assembly is used to keep the burnishing disc drive belt tight. The idler assembly must be rotated slightly to free the belt for removal.

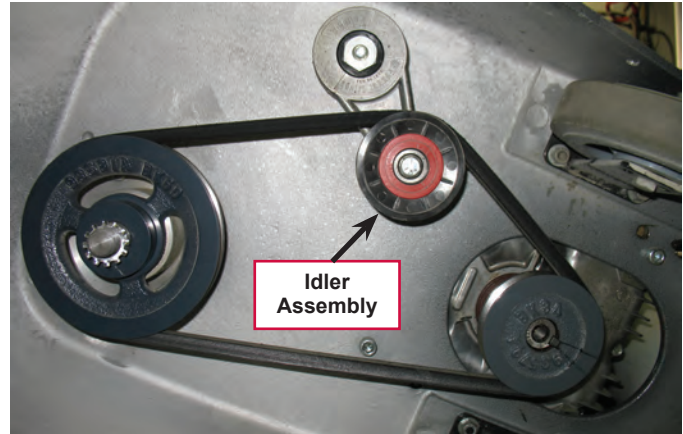


Figure 9 Idler Assembly, No Clutch

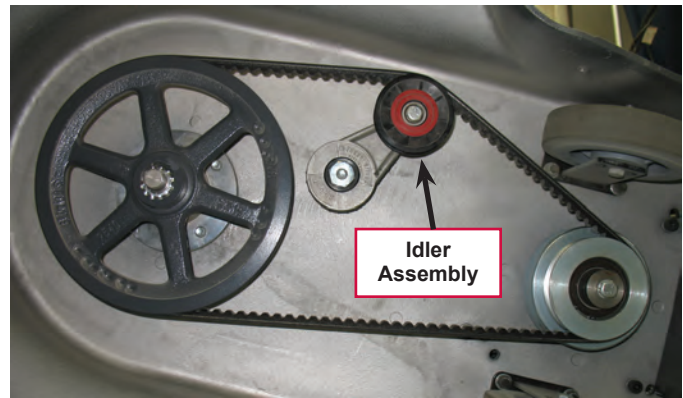


Figure 10 Idler Assembly, With Clutch

1. To remove tension on the drive belt, use a wrench to grip the idler assembly. Pull down on the wrench to rotate the idler assembly slightly and free the belt.
2. Position the replacement belt on the drive (or clutch) and burnishing disc pulleys. Again, use the wrench to pull the idler assembly down slightly. Position the belt in the idler assembly pulley and allow the idler assembly to return to its normal position. Check the belt to make certain that it is fully seated in all three pulleys.



Figure 11 Pull Down on Idler Assembly

## Replace Drive Belt Tensioner.

Note: On some 27 inch models (56381405, 56381406, 56381407, 56381413) the tensioner location should be updated when replacing the tensioner, if it has not already been moved. See “**Relocating Belt Tensioner Mounting Position**” below for further information.

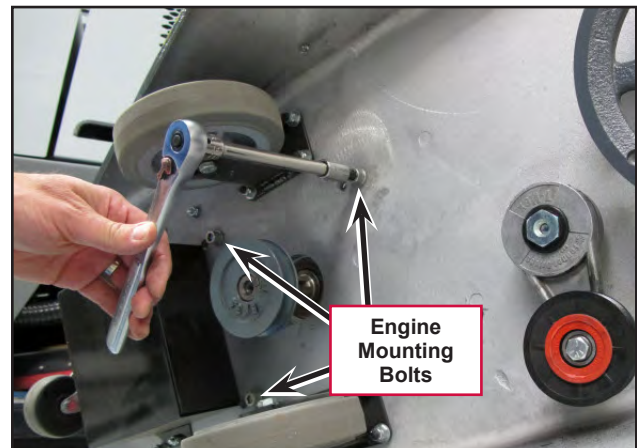
1. Remove the drive belt.
2. Remove the tensioner.
3. Install the tensioner with the mounting bolt finger tight and install the drive belt.
4. Using a large wrench on the large nut of the tensioner arm and a back up wrench on the mounting bolt, rotate the arm against spring pressure until the indicator marks on the tensioner arm align near the third index mark on the stationary tensioner body as shown in the photo. Tighten the mounting bolt to hold the tensioner in place. Crank the engine over a few times to seat the belt and then recheck the belt tension. If it is incorrect, loosen the mounting screw and reposition the tensioner as necessary.



## Relocating Belt Tensioner Mounting Position - Some 27 Inch Models

These instructions only apply to the following models: 56381405, 56381406, 56381407, 56381413

1. Remove the drive belt.
2. Loosen all 3 engine mounting bolts and back out approximately 1/2 inch (13mm). This will allow you to lift the engine slightly and will aid in installing the tensioner mounting bolt in the new location later.
3. Remove the tensioner.





4. Working from the bottom of the deck, locate the position of the new mounting bolt hole by scribing two arcs from fixed positions and finding their intersecting point.

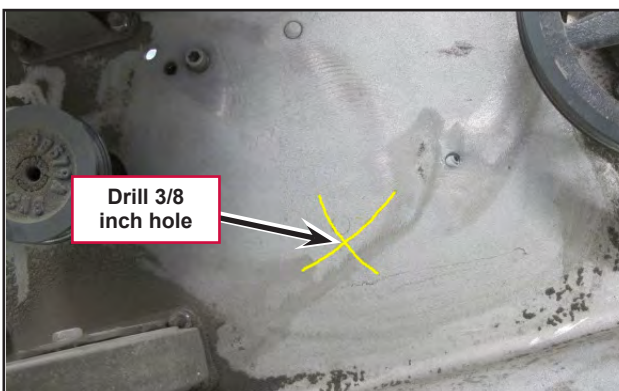
- a. Using a tape measure scribe the first arc 3 11/16<sup>th</sup> inches from the center of the original tensioner mounting bolt.



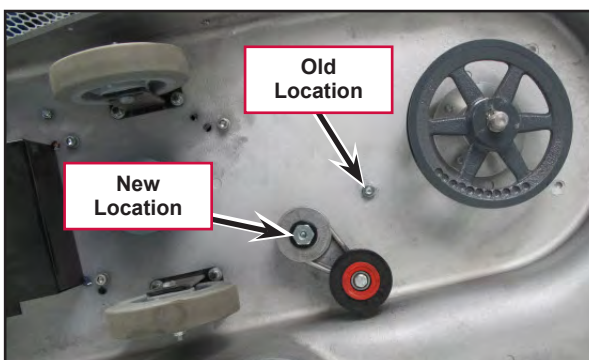
- b. Using a tape measure scribe the second arc 7 inches from the center of the forward engine mounting bolt head.



5. Drill a 3/8 inch hole where the arcs intersect.



6. Install tensioner mounting bolt through the new hole just made and install the tensioner finger tight.
7. Plug the old mounting bolt hole using a bolt and nut.
8. Tighten the engine mounting bolts.



- Using a large wrench on the large nut of the tensioner arm and a back-up wrench on the mounting bolt, rotate the arm against spring pressure until the indicator marks on the tensioner arm align near the third index mark on the stationary tensioner body as shown in the photo. Tighten the mounting bolt to hold the tensioner in place. Crank the engine over a few times to set the belt and then recheck the belt tension. If it is incorrect, loosen the mounting screw and reposition the tensioner as necessary.



### Replace Drive Clutch

- To replace the drive clutch, first remove the drive belt. See “Replace Burnishing Disc Assembly Drive Belt” above for the procedure to remove the drive belt.
- Using an impact wrench, remove the bolt that secures the clutch. Remove clutch.
- Apply Loctite 243 to the bolt that secures the clutch. Position the replacement clutch. Insert the bolt and **torque to 40 ft-lb.**

An alternate method can be used to remove the clutch. This method requires a vicegrip or channel locking pliers.

- Use the vicegrip or pliers to grip the washer at the end of the clutch.
- Use a wrench or socket to remove the bolt that secures the clutch. Remove clutch.
- Apply Loctite 243 to the bolt that secures the clutch. Position the replacement clutch. Insert the bolt and secure the washer with the vicegrip or pliers. Tighten the bolt. If a torque wrench is available, **torque the bolt to 40 ft-lb.**

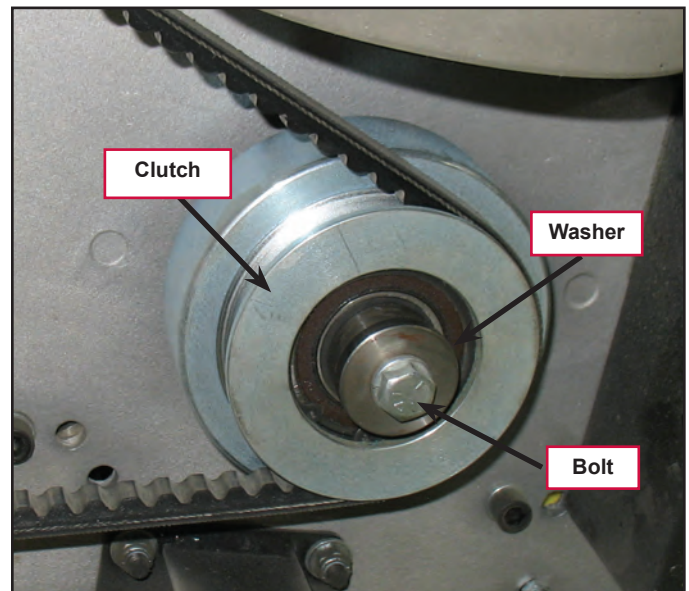


Figure 12 Replace Clutch



# Electrical System

## Functional Description

### Carb Gard

Carb Gard is a warning device to alert the operator that the engine needs to be serviced. The Carb Gard system includes an oxygen (O<sub>2</sub>) sensor. The oxygen sensor is mounted in the exhaust manifold to monitor how much unburned oxygen is in the exhaust as the exhaust exits the engine. The O<sub>2</sub> sensor produces electrical voltage when it gets hot. It will generate approximately 1.0 volts when the fuel mixture is rich and there is little unburned oxygen in the exhaust. When the mixture is lean, the sensor output voltage will drop down to 0.2 volts or less. When the air/fuel mixture is balanced the oxygen sensor will generate around .5 volts.

Carbon monoxide (CO) may be produced if the engine operates with a fuel mixture that is too rich. Carbon monoxide can be highly toxic. If the Carb Gard system senses too high of a voltage from the oxygen sensor (resulting from a fuel mixture that is too rich), the engine will be shut down to prevent a possible build-up of carbon monoxide in the work area. See Carb Gard Normal Operation description below.

### Carb Gard Normal Operation

1. Upon starting the engine, the GREEN “Alert” LED will begin flashing. It will continue flashing for 3 minutes. This allows the engine and the oxygen sensor (mounted in the exhaust manifold) enough time to warm up. During this time, it is okay to operate the burnisher.
2. After 3 minutes, the Alert LED will stop flashing.
  - (a) If the engine is idling, then the YELLOW “Idle” LED will begin flashing. This allows the engine to idle for up to 2 minutes.
  - (b) After 2 minutes, the engine will shut down and the idle LED will remain solid to notify the operator why the machine shut down. (Note: If this occurs, simply turn the key switch to OFF. This will reset the Carb Gard. Restart the engine normally to continue operation).
  - (c) If at any time before the 2 minute countdown, the engine is revved up to full throttle, the LED will stop flashing and the Carb Gard will begin monitoring the oxygen sensor.
  - (d) If the engine is allowed to slow back down to the idle position, the idle LED will again start flashing for another 2 minutes.



**Note:** Every time the engine is revved up and allowed to slow down, the 2 minute countdown restarts itself

3. Once the engine is revved up, the Carb Gard begins monitoring the oxygen sensor.
  - (a) If at any time during full throttle the Carb Gard senses a higher than normal oxygen sensor output voltage, it will activate the RED “Service” LED and it will begin flashing.
  - (b) If the RED service LED flashes continuously for 1 minute, then the engine will shut down and the RED service LED will remain solid to notify the operator why the engine shut down.



**Note:** Carb Gard continuously monitors O<sub>2</sub> sensor electrical voltage. If the voltage drops into the normal range, the service LED will stop flashing. If the voltage rises to higher than normal, the service LED will start flashing again. ONLY after the service LED continuously flashes for 1 minute will it shut down the engine.

## Component Locations

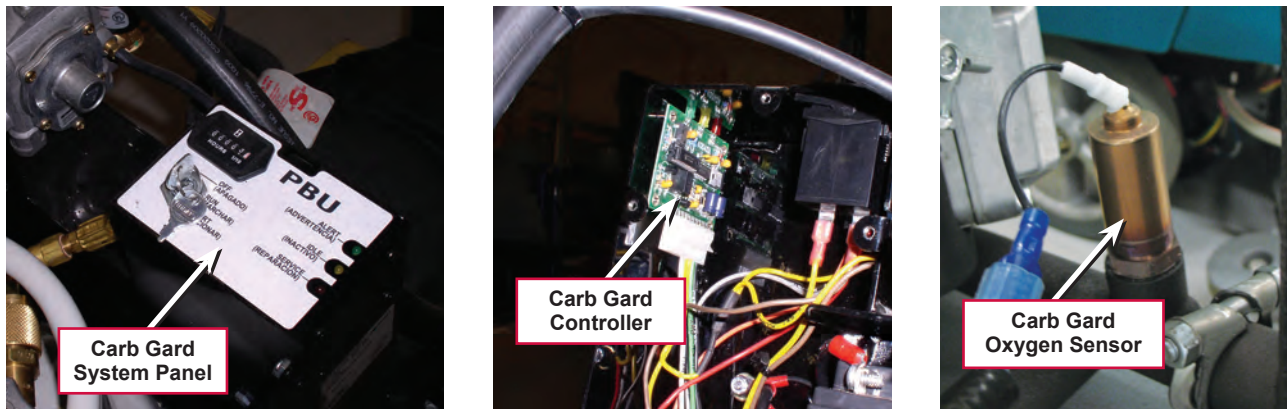


Figure 13 Carb Gard System Components

## Troubleshooting

Check the following if unexplained engine shutdown occurs:

- Oil pressure switch function (assumes engine can be restarted).
- Fuel lock off solenoid function.
- Primary regulator pressure. If too high, the regulator may require replacement.
- If the primary regulator pressure is within specifications, the regulator orifice may be faulty and the regulator may require replacement.

If the above items have been eliminated as causes of engine shut down, test the Carb Gard oxygen sensor for possible malfunction. If the oxygen sensor test described below determines that the sensor is functioning properly, replace the Carb Gard system.

## Oxygen Sensor Test

Requires digital multi-meter.

1. Connect jumper between oxygen sensor lead and harness plug.
2. Connect positive multimeter lead to the jumper wire.
3. Connect negative multimeter lead to chassis ground.
4. Remove air cleaner housing.
5. Start and warm up engine. Set the multimeter to VDC.
6. While at high idle with warm engine, note the VDC meter reading.
7. Remove the air intake filter.

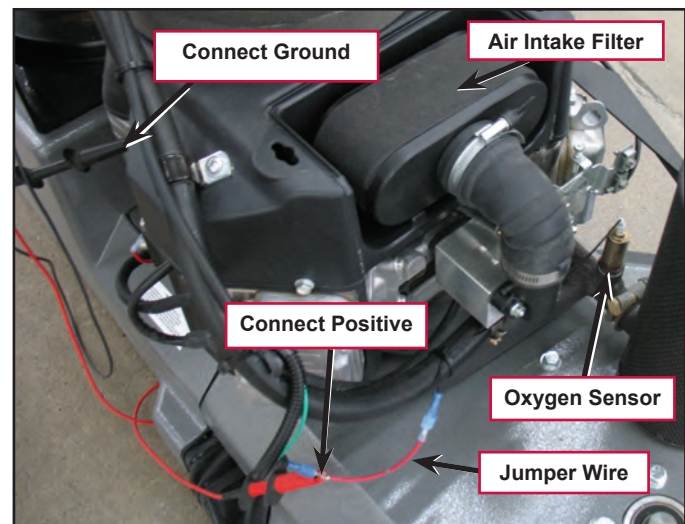
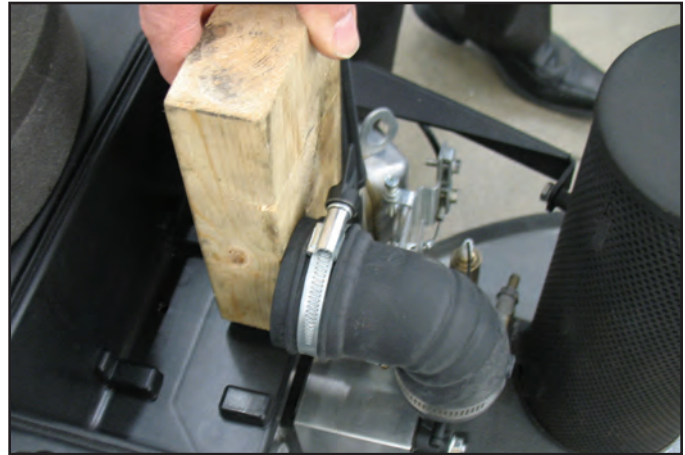


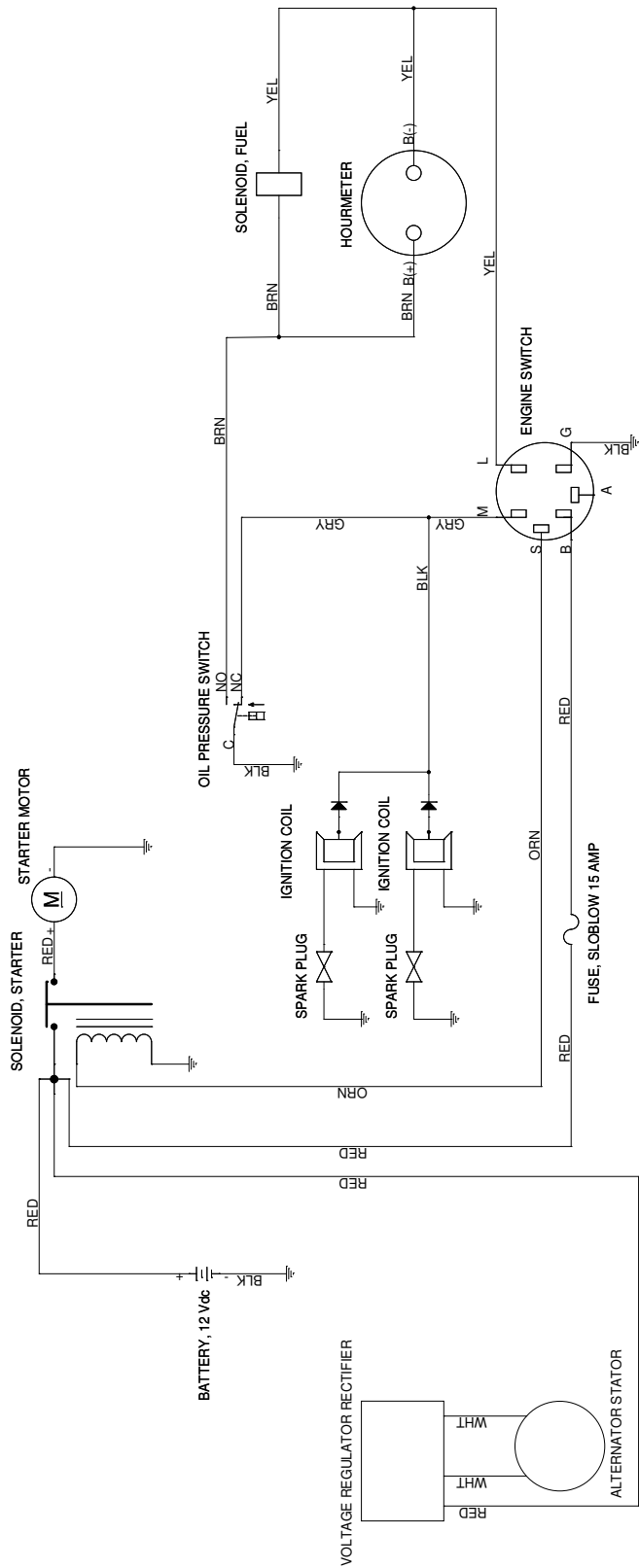
Figure 14 Sensor Test

8. Use a sturdy, clean, flat object to partially block the air intake. (NOT YOUR HAND.)
9. Note the multimeter reading while the air intake is restricted at high idle.
10. With a tuned engine and properly adjusted LP regulator, an oxygen sensor should produce .9 VDC or more when the engine is forced to run rich and below .2 VDC when the engine is forced to run lean. If the oxygen sensor does not produce these VDC values when tested, it should be replaced.



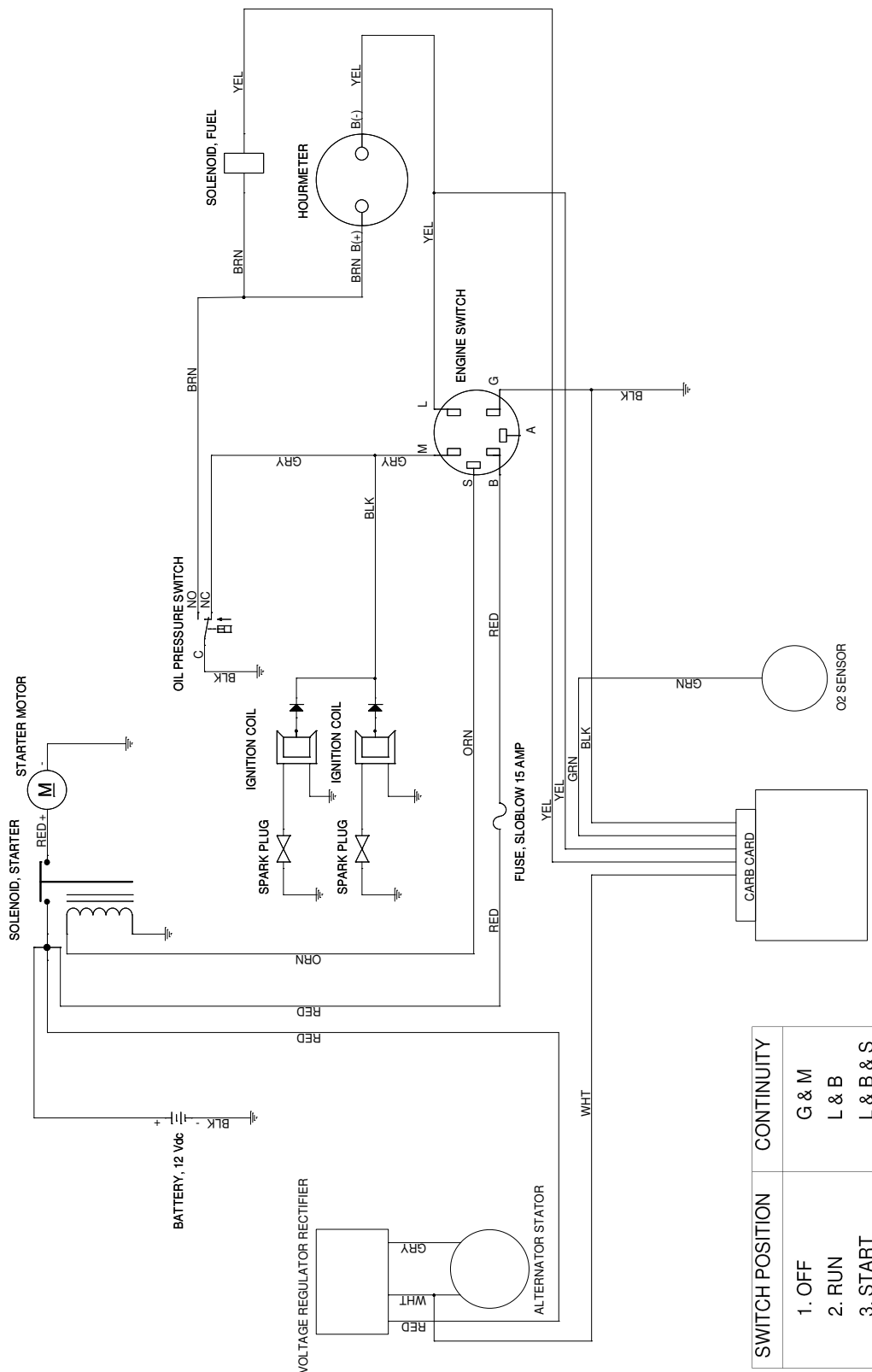
**Figure 15** Partially Blocked Air Intake

Wiring Diagrams



SWITCH POSITION	CONTINUITY
1. OFF	G & M
2. RUN	L & B
3. START	L & B & S

Figure 16 Models: 56381402 (21KBCAT), 56381404 (21KB), 56381405 (27KB), 56381406 (27KBCL), 56381407 (27KBBCAT), 56381412 (MPS-1721), 56381413 (MPS-1727)



SWITCH POSITION	CONTINUITY
1. OFF	G & M
2. RUN	L & B
3. START	L & B & S

Programming note:

1. Service LED will start flashing at an oxygen sensor reading of ~ 0.91V.
2. Idle LED will start flashing when engine speed drops below 1900 rpm.

Figure 17 Models: 56381408 (21KBCATCLDC), 56381409 (27KBCATCLDC), 56381410 (21KBCATCLST),



# Engine System

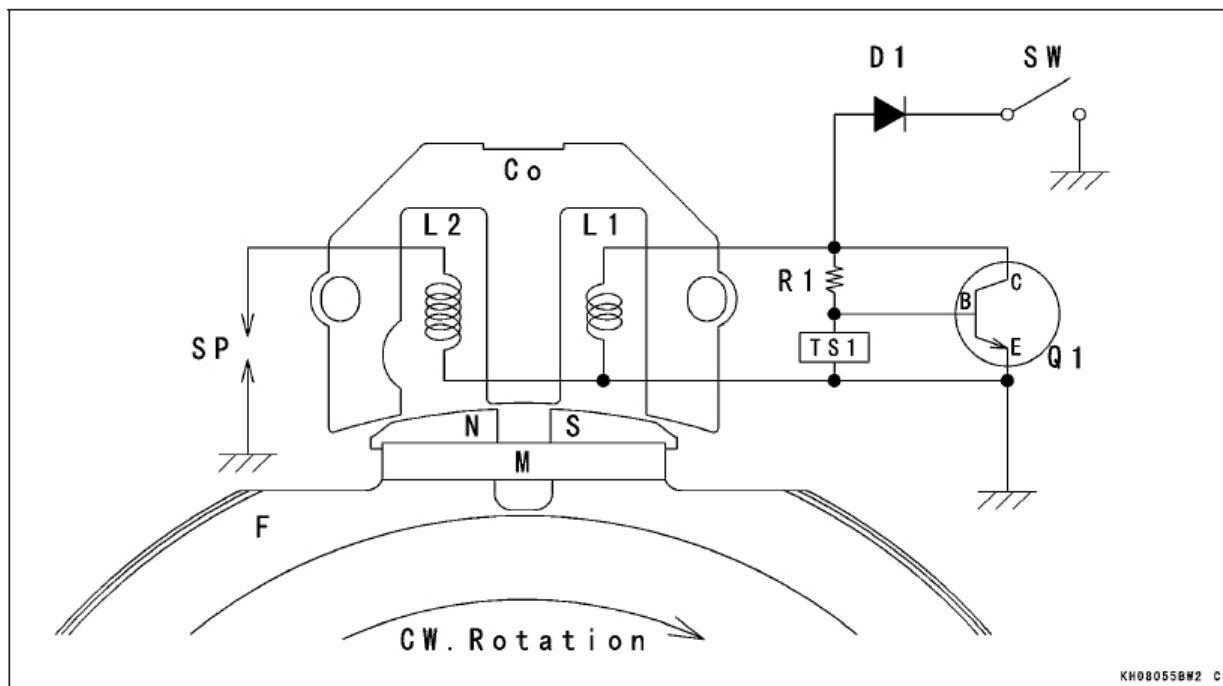
## Functional Description

### Ignition System

The engine ignition is controlled by a solid state ignition assembly and requires no periodic maintenance except for the spark plugs.

The system consists of the following:

- Inductive Ignition Assemblies
- Permanent Magnet Flywheel
- Spark Plugs
- Stop Switch



Co: Core (Lamination)  
D1: Diode  
L1: Primary Coil  
L2: Secondary Coil  
Q1: Transistor  
B: Base

C: Collector  
E: Emitter  
R1: Control Resistor  
TS1: Trigger Sensor  
SP: Spark Plug  
SW: Stop Switch

F: Flywheel  
M: Magnet  
N: North Pole  
S: South Pole

Figure 16 Ignition System

### Ignition System Operation Theory

Permanent magnets are mounted around the edge area of a flywheel. As the flywheel (magnetic pole) rotates clockwise and passes the ignition module on a laminated core group, voltage is produced at the primary winding (L1), allowing a small bias current to flow from the control resistor (R1) to the transistor (Q1) base and thereby exciting the transistor base. Thus the transistor forms (turns ON) the primary circuit. This circuit current flows from the plus (+) side of the primary winding to ground through the transistor [Collector (C) to Emitter (E)].

When the base current is flowing, the trigger sensor (TS1) detects optimum time (peak current) to shut off the transistor base current. With the transistor rapidly shutting off the current at the primary coil, counter-electromotive force is generated and voltage in hundreds-volts is induced through the primary winding (L1), thereby producing extremely high voltage at the secondary winding (L2). When this secondary voltage steps up to k-volts, “ionization” meaning “ignition” occurs across the electrodes at the spark plug (SP).

The trigger sensor located internally in the ignition system is set to give constant ignition timing according to engine speed and temperature.

The diode (D1) located at the ignition shut-off circuit prevents misconnection of battery voltage, protecting the internal components of the ignition system. When the stop switch (SW) is set at the closed position, primary voltage is routed to ground, not allowing igniting operation.

## Maintenance and Adjustments

### Air Cleaner Element Cleaning and Inspection

Cleaning of paper air cleaner elements is not recommended. Each air cleaner element should be replaced with a new air cleaner element at the maintenance time as shown in the maintenance chart.



**Note:** Operating in dusty condition may require more frequent maintenance than shown in the chart above.

- Remove the foam and paper elements
- Clean the foam element [A] in a bath of detergent and water, and let the element air-dry thoroughly.



Figure 17 Air Cleaner Element

### Engine Top End Cylinder Head Inspection

- Lay a straightedge [A] across the mating surface of the head at several different points, and measure warp by inserting a thickness gauge [B] between the straightedge and head.
- If warp exceeds the service limit, repair the head by lapping the mating surface with emery paper secured to a surface plate (first No. 200, than No. 400). If the mating surface is badly damaged, replace the cylinder head.

**Cylinder Head Warp Service  
Limit: 0.05 mm (0.002 in.)**

- Check the cylinder head for cracks or other damage.

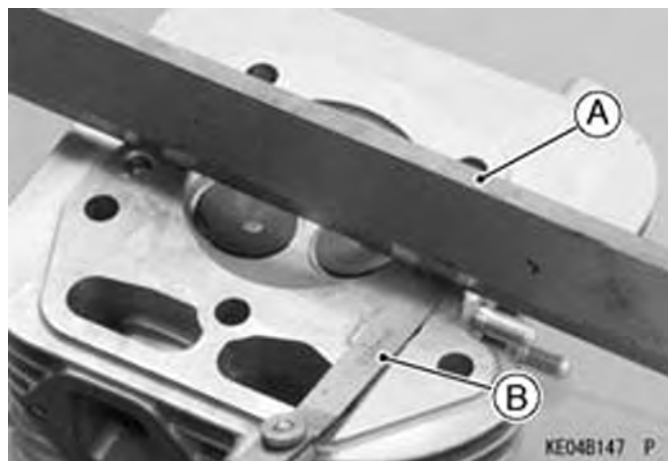


Figure 18 Cylinder Head Inspection

- Cracks not visible to the eye may be detected by coating the suspected area with mixture of 25% kerosene and 75% light engine oil.
- Wipe the area dry and immediately apply a coating of zinc oxide dissolved in wood alcohol. If a crack is present, the coating will become discolored at the defective area.
- If a crack is present in the cylinder head, replace it.
- Inspect the mating surface for burrs and nicks.

### Engine Top End, Cylinder Head Cleaning

- Scrape the carbon deposits from the cylinder head and the exhaust port with a suitable tool [A].



**Note:** To avoid gouging, use scrapers that are made of a material that will not cause damage.

- Clean the head in a bath of high-flash point solvent and dry it with compressed air.

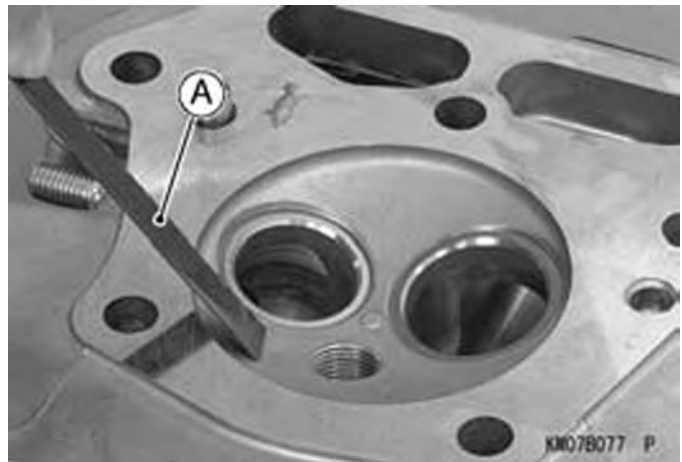


Figure 19 Cylinder Head Cleaning



**Warning:** Clean the cylinder head in a well-ventilated area, and take care that there are no sparks or flame anywhere near the working area; this includes any appliance with a pilot light. Do not use gasoline or a low-flash point solvent to clean the cylinder head. A fire or explosion could result.

### Engine Top End, Cylinder Head Assembly Removal

- Remove:
  - Fan Housing
  - Bolt [A]
  - Lift Hook [B]

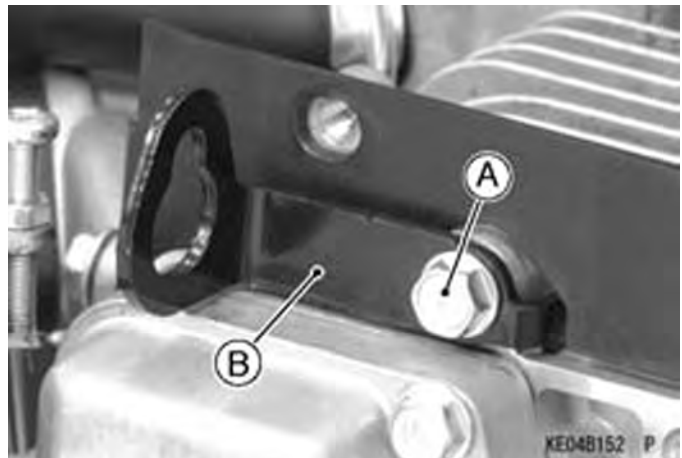


Figure 20 Cylinder Head Assembly Removal

- Remove:
  - Intake Manifold
  - Engine Shroud
  - Spark Plugs
- Unscrew the rocker cover bolts in the order shown [1 to 5].
- Remove the cover [A] and the gasket.

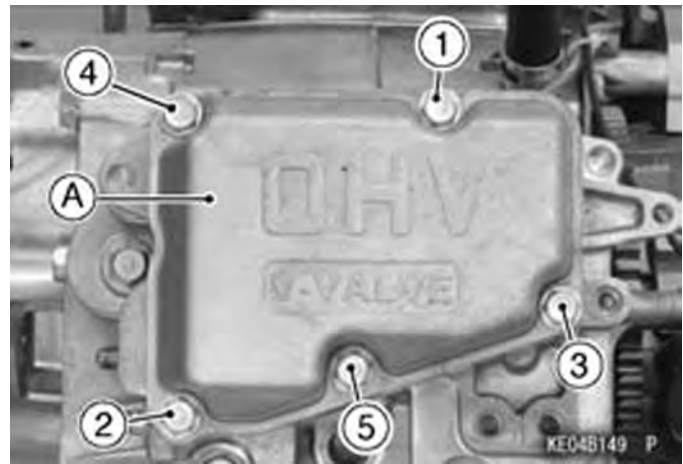


Figure 21 Cylinder Head Assembly Removal

- When removing the #1, #2 cylinder head, set each piston at the top dead center (T.D.C) [A] of the compression stroke.

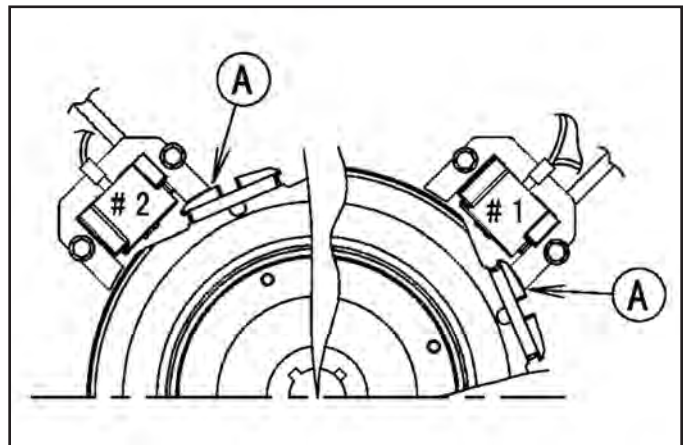


Figure 22 Cylinder Head Assembly Removal

- Remove:
  - Rocker Arm
  - Push Rod
  - Rocker Arm Bracket
- Loosen the cylinder head bolts 1/4 turn in the sequence as shown in the figure.



**Caution:** If the above procedure is not followed, the cylinder head may be warped during removal.

- Repeat the sequence until all bolts are removed and lift off the cylinder head assembly.



**Note:** Mark the push rods and rocker arms so they can be installed in their original position during assembly.

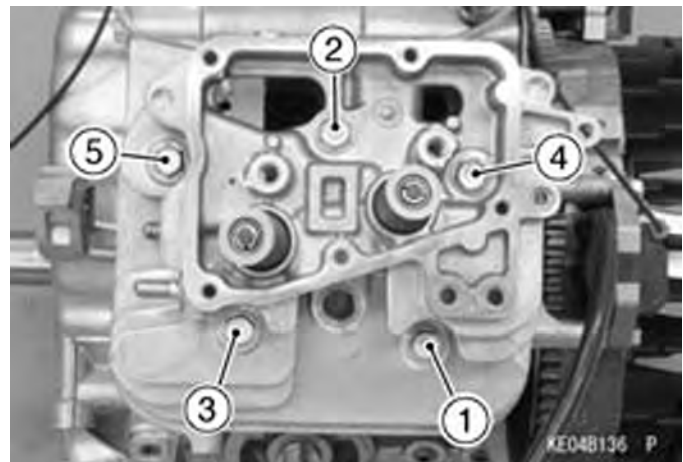


Figure 23 Cylinder Head Assembly Removal

## Engine Top End, Cylinder Head Assembly Installation

- Clean the mating surfaces of the cylinder heads and cylinders.
- Replace the gaskets with new ones.
- Install the dowel pins [A]



Figure 24 Install Dowel Pins

- Set each piston at the T.D.C [A] of the compression stroke.
- Put new gaskets and the cylinder head assemblies on each cylinder.



**Note:** As the head gaskets are coated with sealing agents, be careful not to damage the surfaces

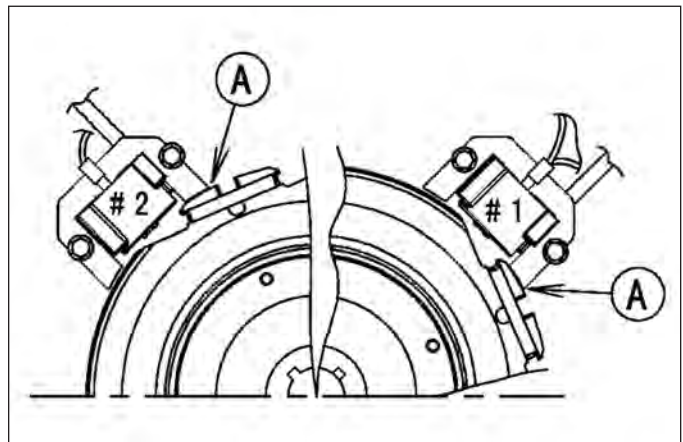


Figure 25 Set Piston at TDC

- Tighten the cylinder head bolts following the tightening sequence as shown in the figure.

**Torque - Cylinder Head Bolts:**  
27.4 N·m (2.8 kgf·m, 20 ft·lb)



**Caution:** A torque wrench must be used to assure proper torque. Improper tightening of the head bolts may result in warping of the cylinder head.

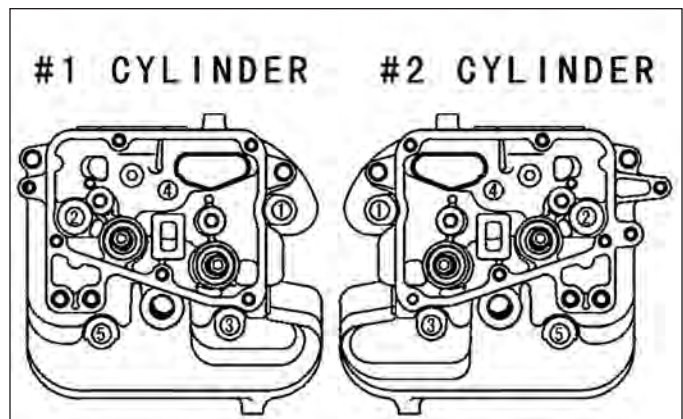
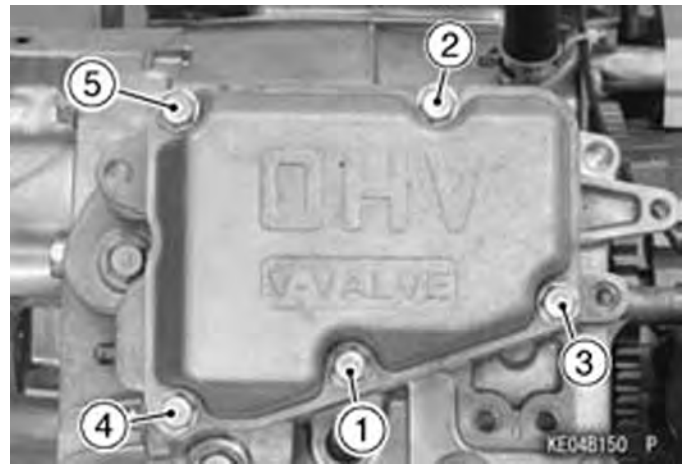


Figure 26 Cylinder Head Bolt Tightening Sequence



- Install:
  - Rocker Arm Bracket
  - Push Rod
  - Rocker Arm (
- Install the new gaskets and rocker covers.
- Tighten the rocker cover bolts following the tightening sequence as shown in the figure.

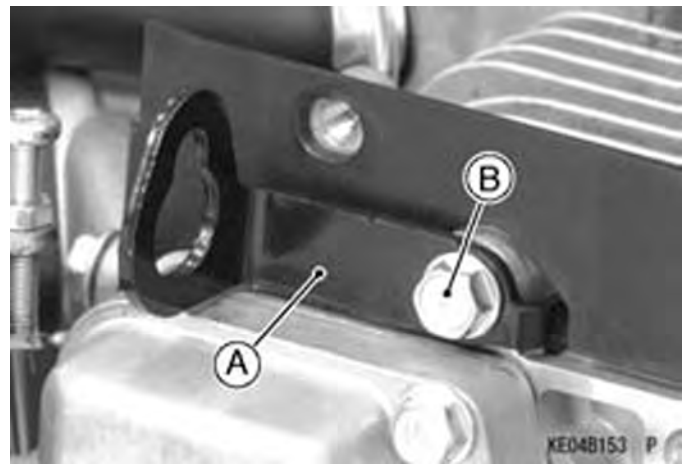
**Torque - Rocker Cover Bolts:**  
**5.9 N·m (0.60 kgf·m, 52 in·lb)**



**Figure 27 Rocker Cover Bolt Tightening Sequence**

- Install:
  - Spark Plugs
  - Engine Shroud
  - Lift Hook [A]
- Tighten:
 

**Torque - Lift Hook Bolt [B]:**  
**5.9 N·m (0.60 kgf·m, 52 in·lb)**
- Install the removed parts.



**Figure 28 Lift Hook**

## Engine Top End, Valve Clearance Inspection

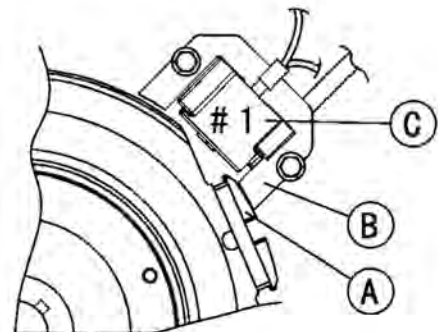


**Note:** Valve clearance must be checked when the engine is cold (at room temperature).

- Remove the rocker covers.
- Place the piston at the top dead center (TDC) of the compression stroke by turning the crankshaft clockwise facing the flywheel.

### No.1 Cylinder

- The left projection [A] on the flywheel is faced with the right leg [B] on the #1 ignition coil [C] as shown in the figure.
- Check the intake and exhaust valves are closed completely, if not, turn the flywheel one turn (360°) clockwise and face the left projection with the right leg again.



**Figure 29 Check Closing of Valves**

## No.2 Cylinder

- The left projection [A] on the flywheel is faced with the right leg [B] on the #1 ignition coil [C] as shown in the figure.
- Check the intake and exhaust valves are closed completely, if not, turn the flywheel one turn (360°) clockwise and face the left projection with the right leg again.

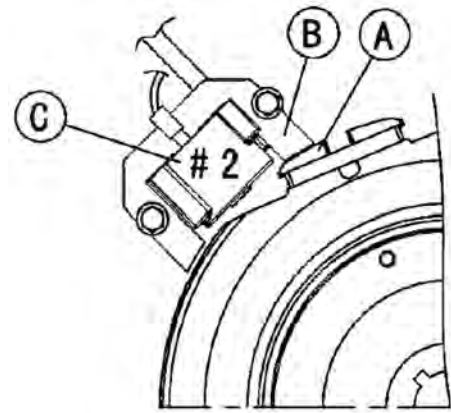


Figure 30 Check Closing of Valves

- Then check the valve clearance.
  - Using a thickness gauge [A], measure the valve clearance between the rocker arm [B] and the valve stem end.  
If the valve clearance is incorrect, adjust it.
- Valve Clearance (when cold) Intake, Exhaust  
0.10 ~ 0.15 mm (0.004 ~ 0.006 in.)

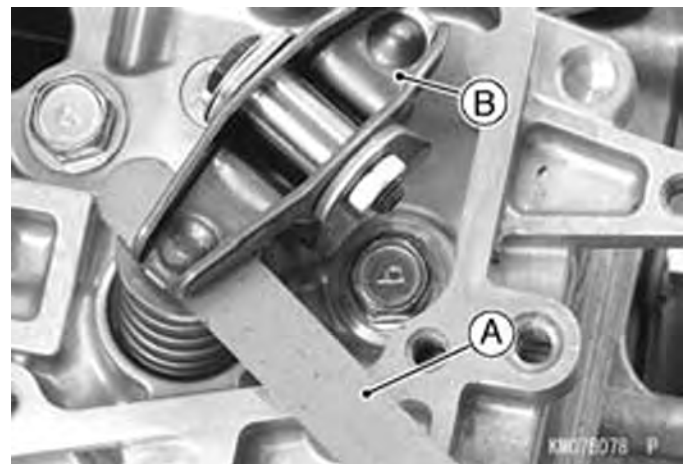


Figure 31 Check Valve Clearance

**Valve Clearance Adjustment**

- Since valve repairs change the valve clearance, adjust the valve clearance to the specification.
- Turn the crankshaft in proper direction until the piston is at the TDC of the compression stroke (as described above).
- Loosen the locknut [A] and adjusting bolt [B].
- Insert a 0.05 mm (0.0020 in.) thickness gauge [C] between the rocker arm and valve stem end, and turn the adjusting bolt until the thickness gauge begins to bind between the rocker arm and valve stem end. Sweep the thickness gauge during this adjustment.
- Valve Clearance (when cold) Intake, Exhaust:  
0.10 ~ 0.15 mm (0.004 ~ 0.006 in.)

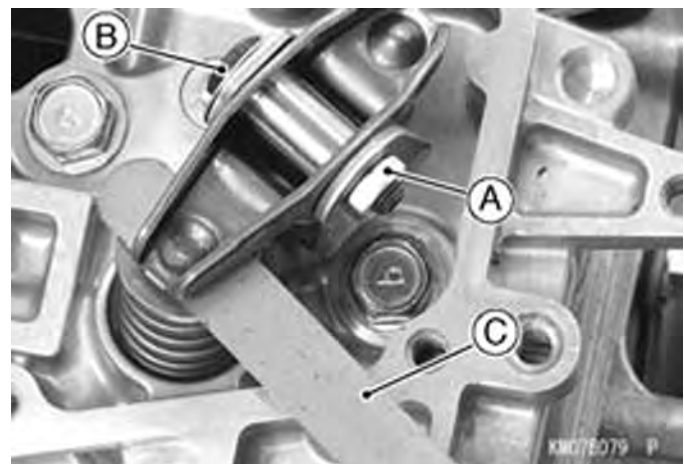


Figure 32 Thickness Gauge Between Rocker Arm and Valve Stem End

- Holding the adjusting bolt with a spanner [A], tighten the adjusting locknut [B] to the specified torque.

Torque - Valve Clearance Adjusting Locknuts: 11 N·m (1.1 kgf·m, 87 in·lb)

- Do not overtighten the valve clearance adjusting locknuts.
- After the valve clearance adjustment, measure the valve clearance again. Readjust the valve clearance if necessary.

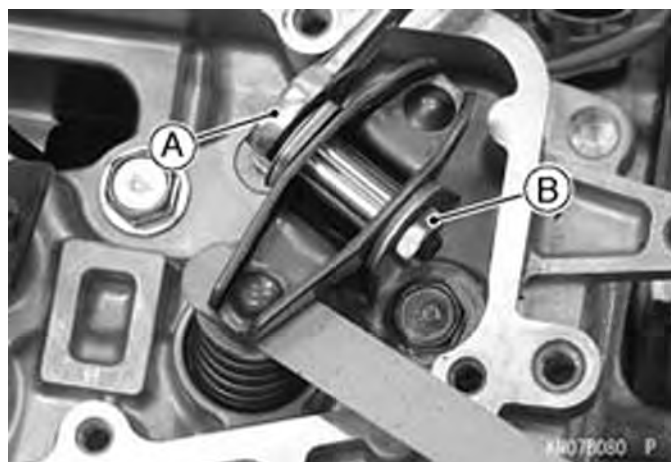


Figure 33 Tighten Locknut

### Valve Seat Inspection

- Remove the valve.
- Inspect the valve seats for damage.
- If the seats are warped or distorted beyond reconditioning, replace the cylinder head with a new one.
- Pitted or worn valve seats can be refaced. Lap the valves to the seats after refacing.
- Coat the valve seat with machinist's dye.
- Push the valve into the guide.
- Rotate the valve against the seat with a lapping tool.
- Pull the valve out, and check the seating pattern on the valve head. It must be the correct width [A] and even all the way around.



**Note:** The valve stem and guide must be in good condition or this check will not be valid.

Good [A]  
Too Wide [B]  
Too Narrow [C]  
Uneven [D]

- If the valve seating pattern is not correct, repair the seat.
- **Valve Seating Surface Width (STD)**  
Exhaust 0.8 ~ 1.4 mm (0.031 ~ 0.055 in.)  
Intake 0.8 ~ 1.4 mm (0.031 ~ 0.055 in.)

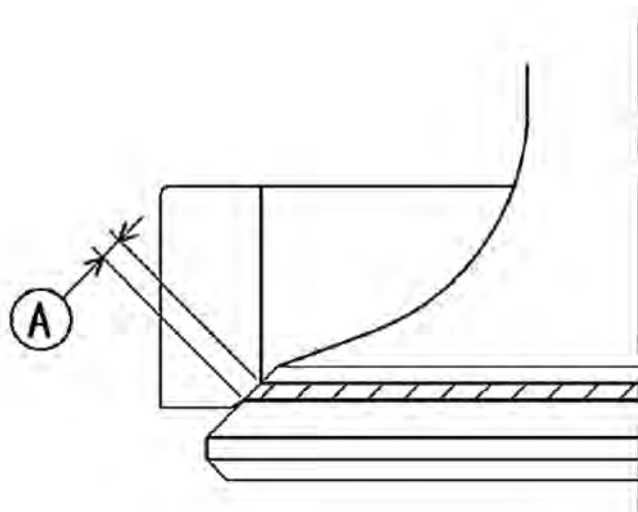


Figure 34 Check for Correct Width

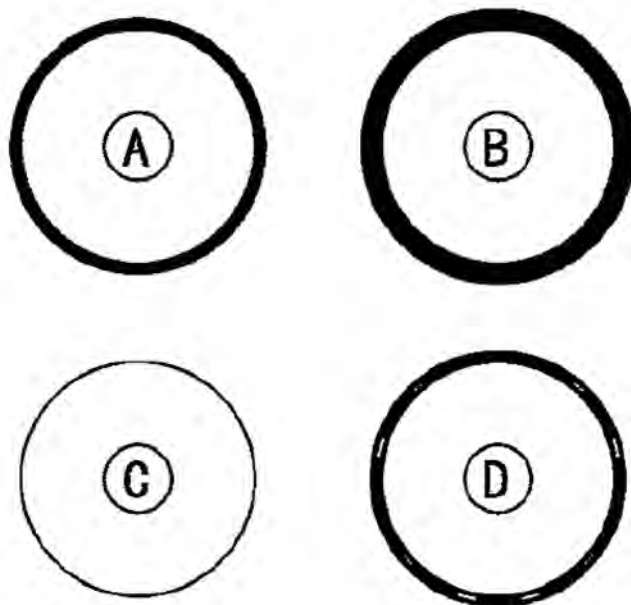


Figure 35 Seating Pattern

## Lubrication System

### Engine Oil Level Inspection

- Place the engine on a level surface.
- Remove the oil filler cap [A] and wipe its dipstick [B] with a clean cloth.
- Insert the dipstick into tube [C] without screwing it in, then check the oil level.
- The oil level should be the operating range (grid area) [D] on the dipstick. If the oil level is “ADD” range [E], add enough engine oil to bring oil level to the operating range.



**Caution:** Do not add more oil above the operating range. Excess oil will cause a smoking condition.

- Use the same type and make of oil that is already in the engine.



**Note:** If the engine oil type and make are unknown, use any brand of the specified oil to top up the level in preference to running the engine with the oil level low. Then at your earliest convenience, change the oil completely.

- If the oil level is “FULL” range [F], drain the excess oil by loosening the quick drain fitting.

### Engine Oil Change

- Change the oil after first 8 hours of operation. Thereafter change oil every 50 hours.
- Start and warm up the engine to drain the oil easily.
- Stop the engine.
- Place the unit on a level surface.
- Use a suitable container to contain drained engine oil.
- Release the drain tube from the clamp.
- Position the drain tube into the container.
- Twist the quick open oil drain fitting approximately 1/4 turn to allow the oil to drain from the engine into the container.
- When all oil has drained, twist the oil drain fitting closed and secure the drain hose.



**Warning:** Be careful of hot oil when draining. It may be hot enough to burn you severely.

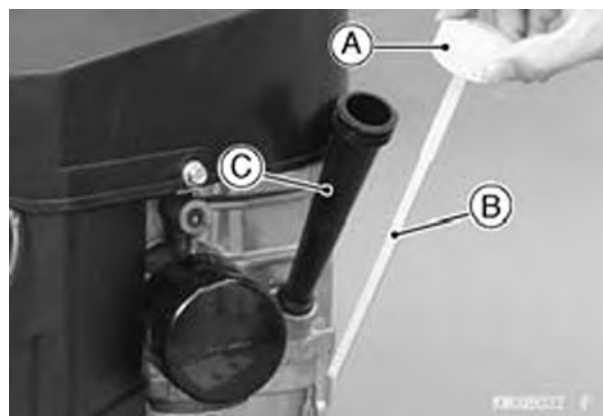


Figure 36 Dipstick

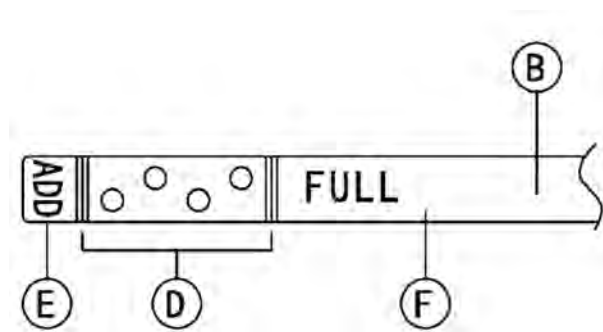


Figure 37 Oil Level on Dipstick

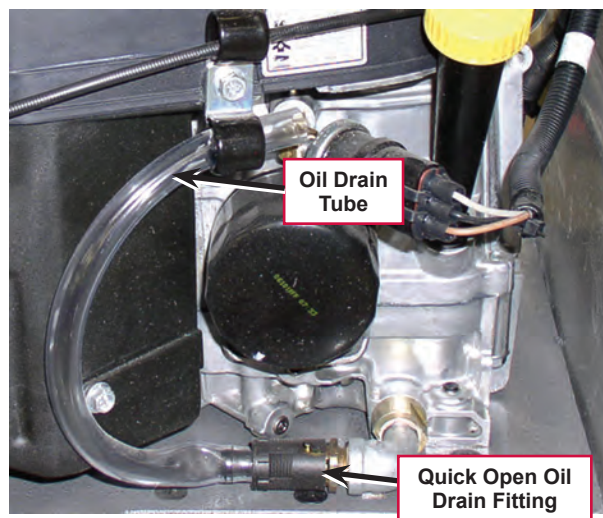


Figure 38 Oil Drain Components



- Remove the oil filler cap and pour in the specified type and the amount of oil.

### Engine Oil:

**Grade:** SJ or higher class

**Viscosity:** SAE40, SAE30, SAE10W-30/  
SAE10W-40, or SAE5W-20

**Capacity:** [When the oil filter is not removed]  
1.5 L (1.6 US qt)  
[When the oil filter is removed]  
1.7 L (1.8 US qt)

- Check the O-ring [A] on the oil filler cap for damage. Replace the oil filler cap assembly if O-ring is damaged.
- When checking the oil level, do not turn oil filler cap on threads.



**Note:** Some increase in oil consumption may be expected when a multi grade engine oil (10W-30/10W-40, 5W-20) is used. Check the oil level more frequently than recommended interval.

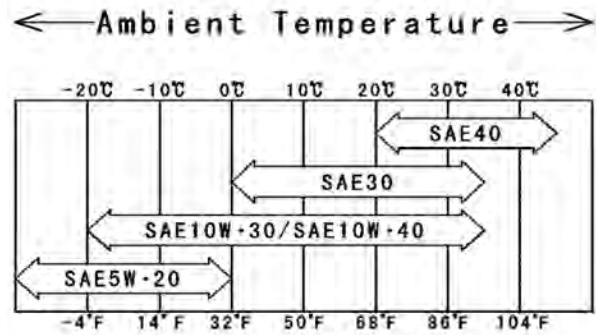


Figure 39 Oil Types and Temperatures

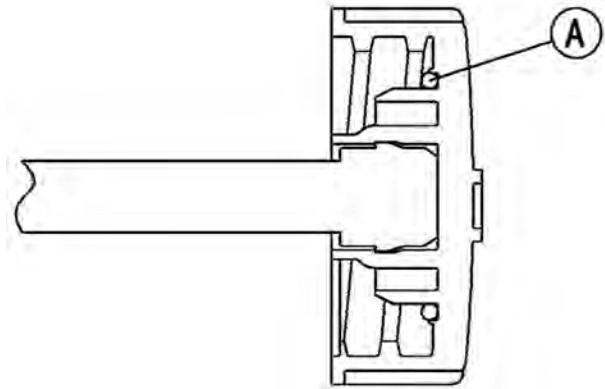


Figure 40 O-Ring

### Oil Filter Replacement

- Drain the engine oil (see Engine Oil Change).
- Using a suitable tool [A], remove the oil filter [B].
- When unscrewing the oil filter, place a suitable container beneath the oil drip tray to receive oil from the oil filter and oil passages in the engine.

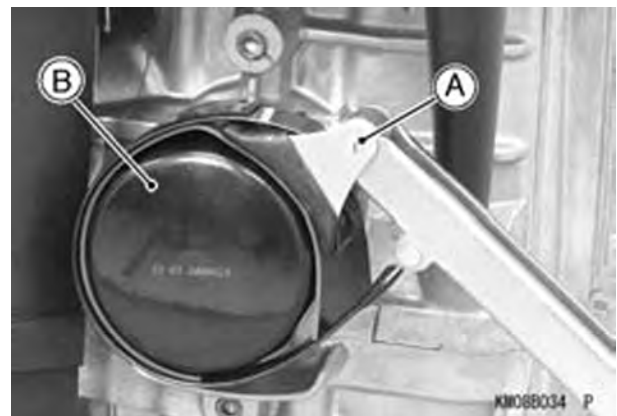


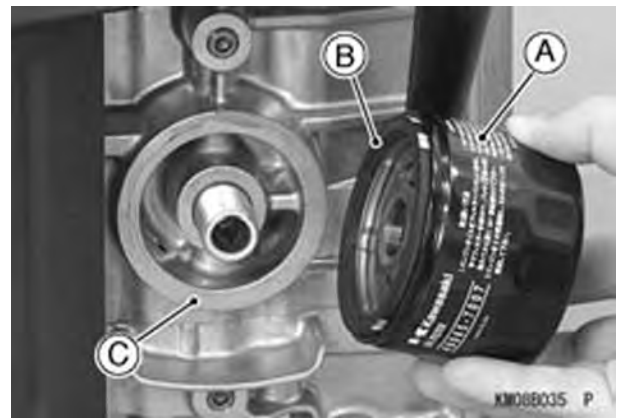
Figure 41 Unscrew Oil Filter



- Replace the oil filter [A] with a new one.
- Apply light film of engine oil to the seal [B].
- Install the oil filter.

**Torque - Oil Filter: 11.8 N·m (1.2 kgf·m, 104 in·lb)**

- Turn the filter until the seal contacts mounting surface [C] of the engine. Then turn the filter BY HAND (S) 3/4 turn.
- Run the engine at slow idle speed 3 minutes.
- While running the engine, check for oil leaks around it.
- Stop the engine and check the oil level (see Engine Oil Level Inspection).

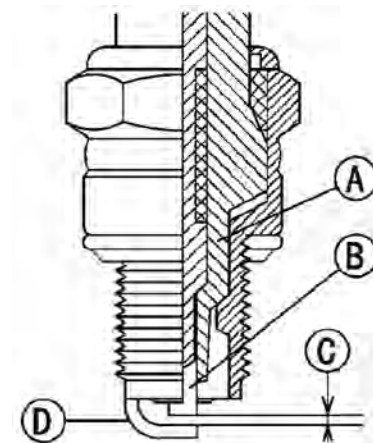


**Figure 42 Install Oil Filter**

## Electrical System

### Spark Plug Cleaning and Inspection

- Carefully pull the plug cap from the spark plug, and remove the spark plug.
- If the plug is oily or has carbon built up on it, clean the plug using a high-flash point solvent and a wire brush or other suitable tools.
- If the spark plug electrodes are corroded or damaged, or if the insulator is cracked replace the plug with a new one. Use the standard spark plug or its equivalent.
  - Insulator [A]
  - Center Electrode [B]
  - Plug Gap [C]
  - Side Electrode [D]



**Figure 43 Spark Plug**

- Spark Plug Gap Inspection
  - Measure the gap with a wire-type thickness gauge.
  - If the gap is not correct, carefully bend the side electrode with a suitable tool to obtain the correct gap.
- Spark Plug Gap Standard: 0.7 ~ 0.8 mm (0.028 ~ 0.031 in.)**

## Air Cleaner

### Element Removal

- Turn the fasteners [A] clockwise.
- Remove the air cleaner cover [B].



Figure 44 Remove Air Cleaner Cover

- Loosen the clamp [A].
- Remove the intake hose [B] together with the element assembly [C].

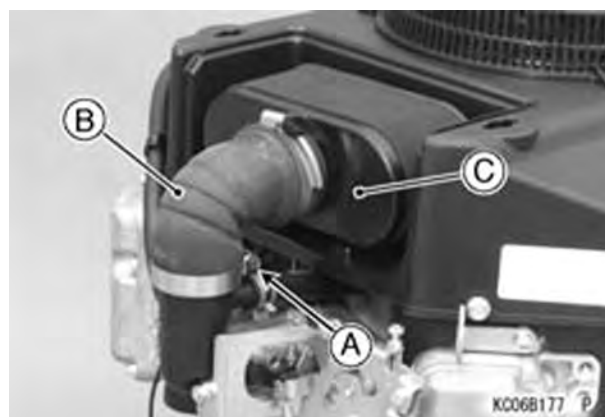


Figure 45 Remove Intake and Element Assy

- Loosen the clamp [A].
- Remove:
  - Intake Hose [B]
  - Foam Element [C]

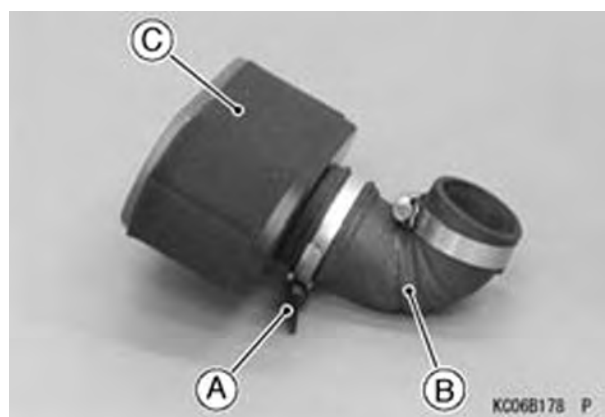


Figure 46 Remove Intake Hose and Foam Element

## Element Installation

- Install the form element [A] to the paper element [B].
- Install the intake hose [A], and tighten the clamp [B].
- Check that the element [C] is horizontally installed.

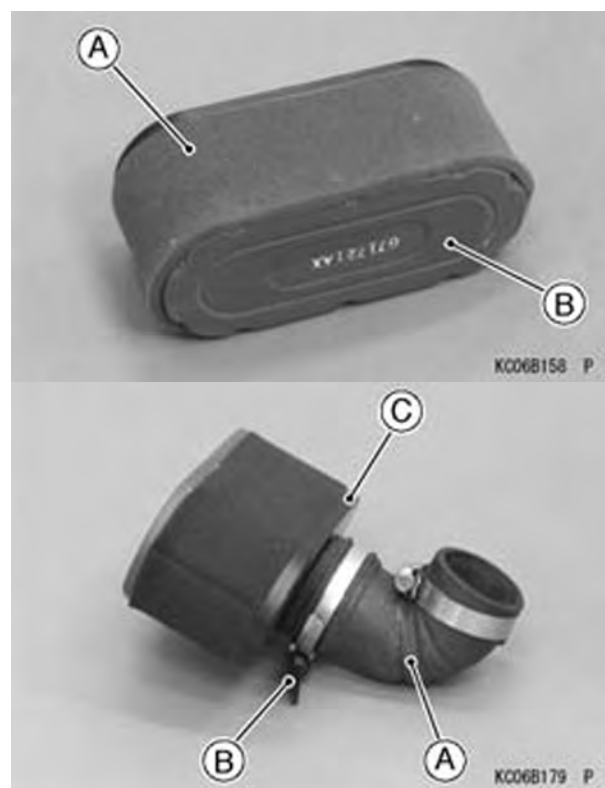


Figure 47 Install Element

- Install the intake hose [A], and tighten the clamp [B].

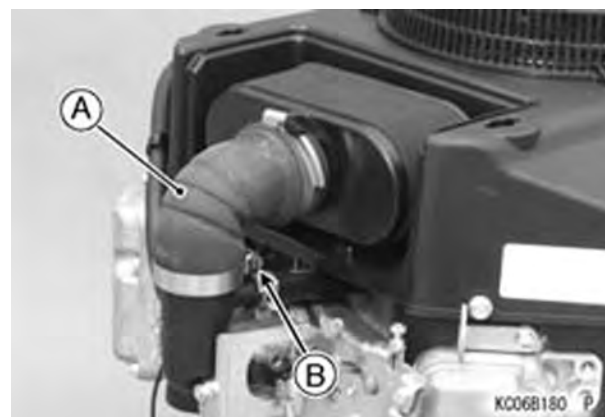


Figure 48 Install Hose, Tighten Clamp

- Install the air cleaner cover [A].
- Turn the fasteners [B] counterclockwise.

## Element Cleaning and Inspection

Cleaning of paper air cleaner elements is not recommended. Each air cleaner element should be replaced with a new air cleaner element according to the maintenance schedule.



Figure 49 Install Cover

## Troubleshooting

Engine turns over but does not start:

1. Check ignition system.
  - a. Check spark at both spark plug wire ends for a minimum of 10 KV.
  - b. Check spark plugs.
2. Check fuel delivery
  - a. Check primary regulator pressure
  - b. Check fuel lock off solenoid
3. Check Mechanical Engine
  - a. Check compression
  - b. Check for plugged exhaust
  - c. Check for plugged intake
  - d. Check oil pressure

Engine shuts down:

- Oil pressure drop
- Fuel lock off solenoid failure
- Oxygen sensor (see Carb Gard)

## Compression Measurement

- Before measuring compression, do the following.
- Be sure the battery is fully charged.
- Thoroughly warm up the engine so that engine oil between the piston and cylinder wall will help sealing the compression as it does during normal running.
- Stop the engine.
- Disconnect the spark plug caps of each cylinder and remove the spark plugs.
- Attach the compression gauge assembly firmly into one plug hole.

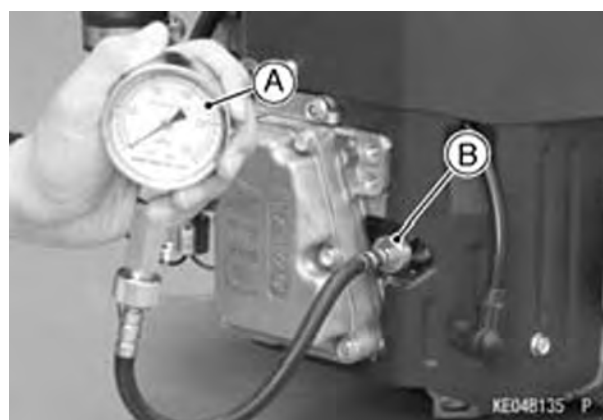


Figure 50 Compression Measurement

- **Special Tools - Compression Gauge, 20 kgf/cm<sup>2</sup> [A]: 57001-221**  
**Compression Gauge Adapter, M14 × 1.25 [B]: 57001-1159**
- Ground the spark plugs to the engine.



**Warning:** To avoid fire, do not ground the spark plugs in proximity to the plug holes. Keep the plugs as far away as possible from the plug holes.



- Open the throttle fully. Crank the engine by turning the engine switch key several times until the compression gauge stops rising. Read the highest compression value.

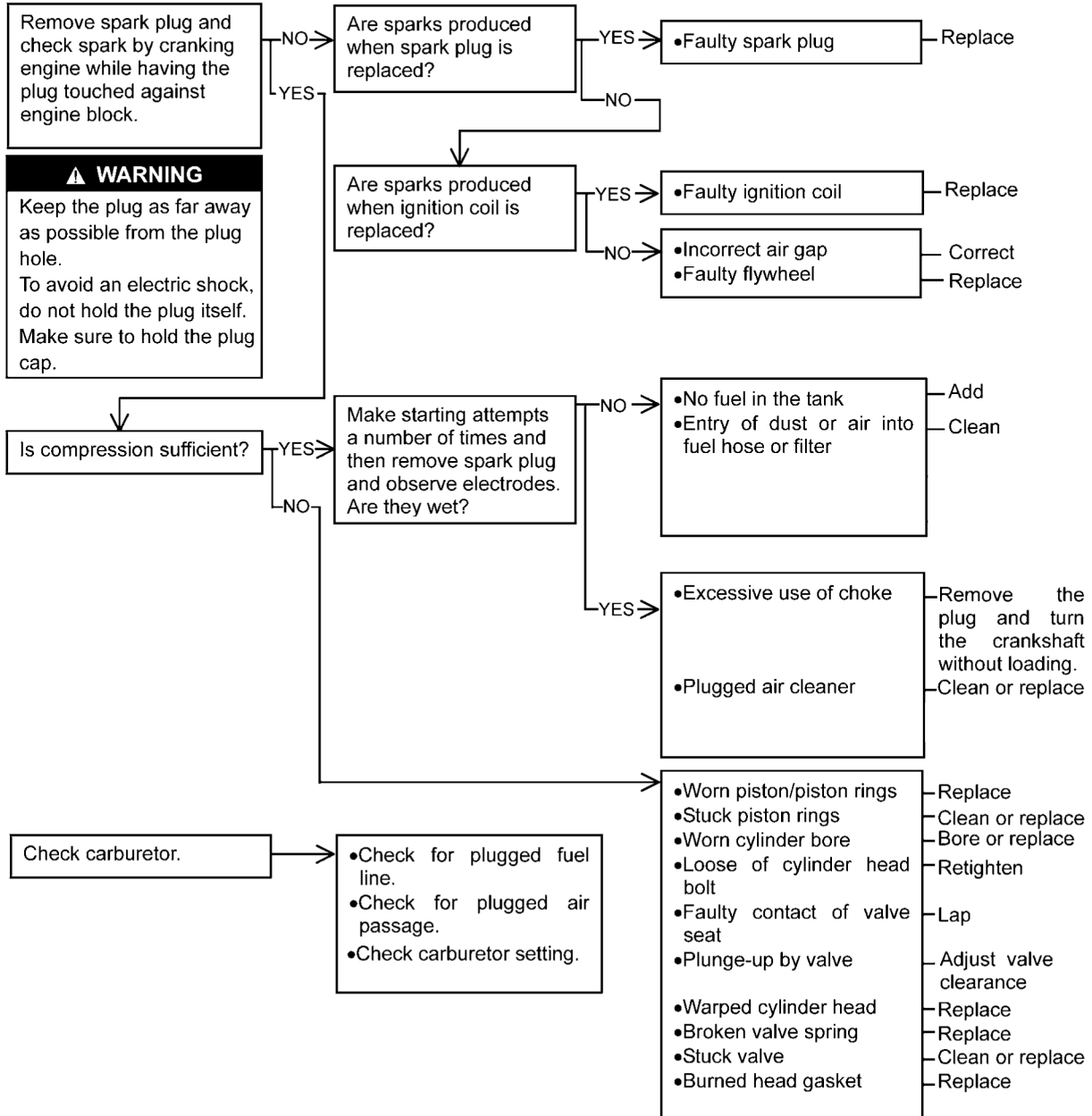
**Cylinder Compression (MIN) 448 kPa (64 psi) @ Engine Oil Temperature 50 ~ 60°C (122 ~ 140°F), Cranking Speed 500 rpm/5 Seconds**

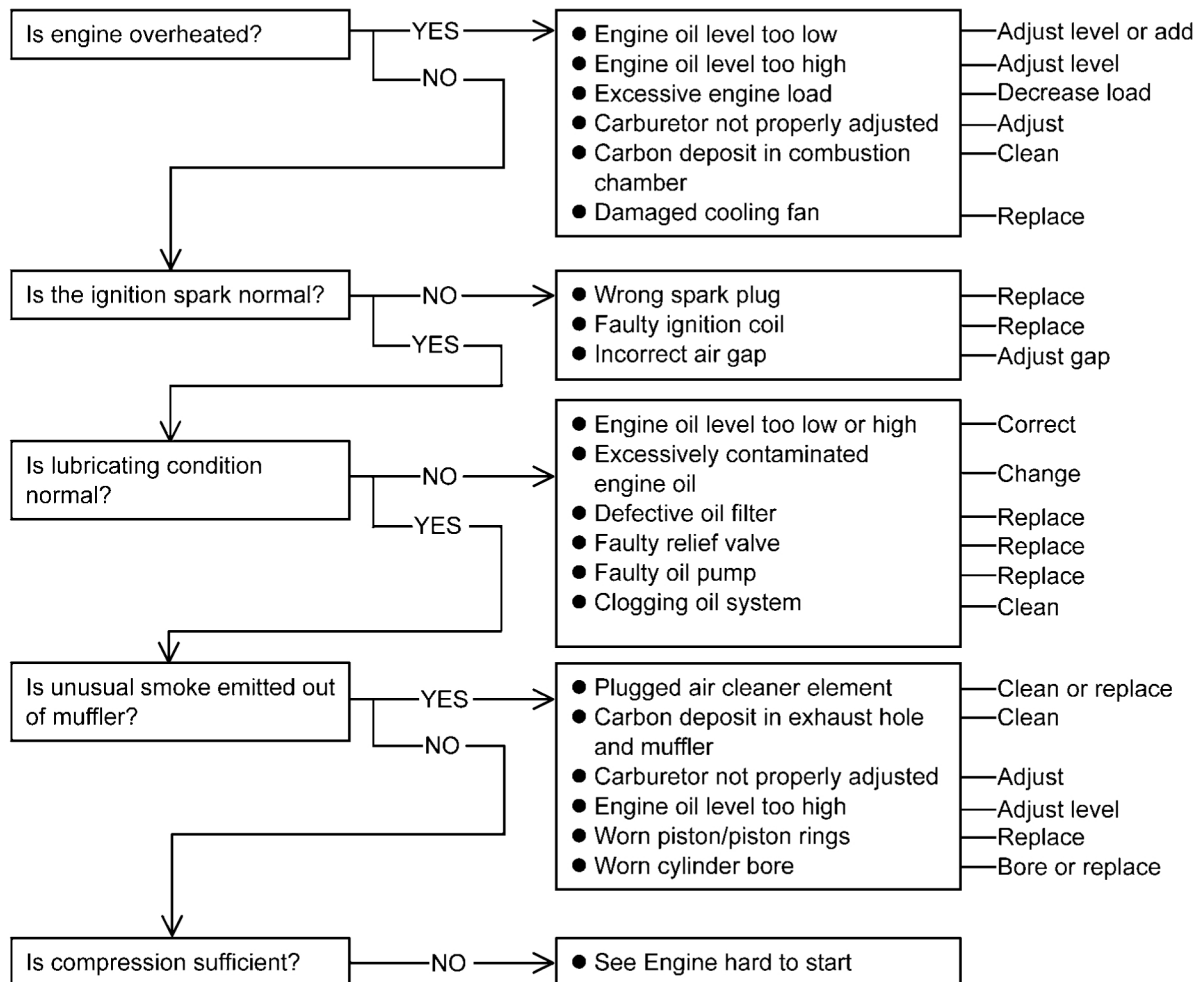
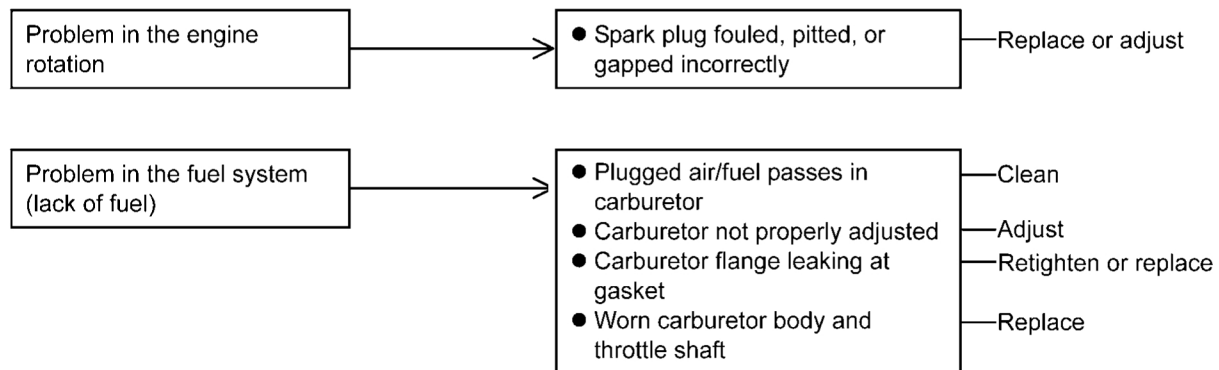
- Repeat the measurement on the other cylinder.
- If the compression is higher than the specified value, the piston rings, cylinder and valves are probably in good condition. If the compression is too high, check the following.
  1. Carbon build-up on the piston crown and cylinder head - clean off any carbon on the piston crown and cylinder head.
  2. Cylinder head gasket - use only the proper gasket. The use of a gasket of incorrect thickness will change the compression.
  3. Valve guides and piston rings - rapid carbon accumulation in the combustion chamber may be caused by worn valve guides and/or worn piston oil rings. This may be indicated by white exhaust smoke.
- If the cylinder compression is lower than the (MIN), check the following.
  1. Gas leakage around the cylinder head - replace the damaged gasket with a new one and check the cylinder head warp.
  2. Condition of the valve seating.
  3. Valve clearance.
  4. Piston/cylinder wear, piston seizure.
  5. Piston ring, piston ring groove.

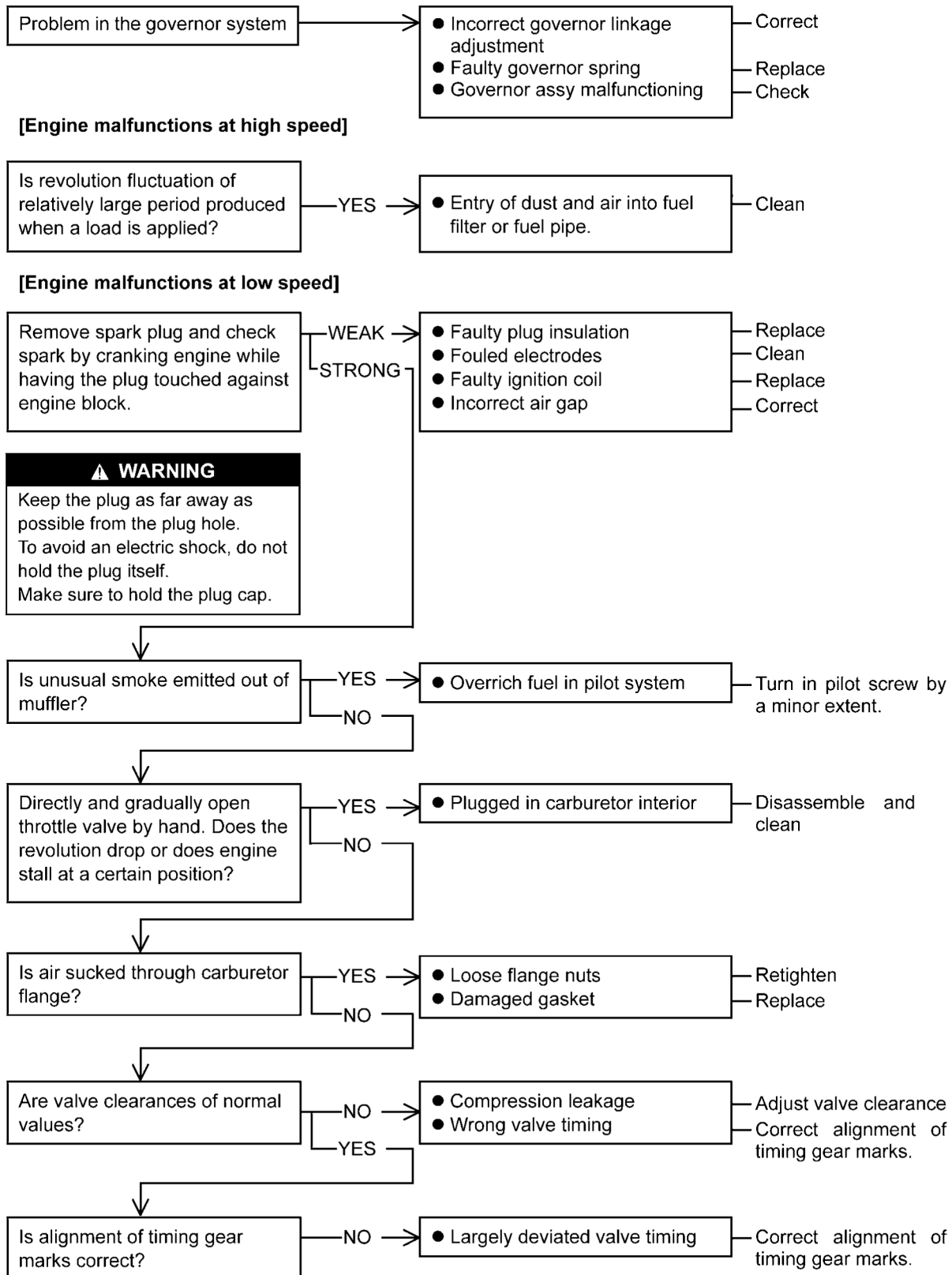
## Engine Troubleshooting Guide

This chart describes typical troubleshooting procedures (from engine manual).

### [Engine hard to start]



**[Engine power loss]****[Engine runs erratically]**





**[Fuel consumption is excessive]**

Is compression sufficient?

YES



- High idling RPM
- Choke partially closed

Adjust  
Open choke.

NO



- Worn piston/piston rings
- Stuck piston
- Worn cylinder bore
- Loose of cylinder head bolt
- Faulty valve seat contact
- Plunge-up of valve
- Wrong valve timing
- Broken valve spring
- Stuck valve

Replace  
Clean or replace  
Bore or replace  
Retighten  
Lap  
Adjust valve clearance  
Adjust  
Replace  
Clean or replace

**[Oil consumption is excessive]**

Is compression sufficient?

YES



- Plugged oil ring groove
- High oil level
- Worn valve stem and valve guide
- Oil leakage along governor shaft
- Oil leakage from oil seal
- Oil leakage from mounting surface
- Oil leakage from drain bolt
- Clogged breather valve
- Drain-back hole in breather chamber plugged
- Incorrect oil viscosity

Clean  
Adjust  
Replace  
Replace  
Replace  
Replace gasket  
Retighten or replace gasket  
Clean  
Clean  
Correct

NO



- Worn piston rings
- Stuck piston rings
- Worn cylinder bore
- Broken piston ring

Replace  
Clean or replace  
Bore or replace  
Replace

**[Engine backfires]**

- Loose carburetor or intake manifold
- Loose cylinder head bolt or leaking head gasket
- Burned or sticking inlet valve
- Faulty ignition coil
- Carburetor not properly adjusted

Retighten  
Tighten  
Replace  
Replace  
Adjust

**[Engine knocks]**

- Excessive carbon deposit in engine
- Excessive engine load
- Engine overheating
- Faulty ignition coil

Clean  
Adjust  
See Engine power loss  
Replace

## Starter Motor Troubleshooting Guide

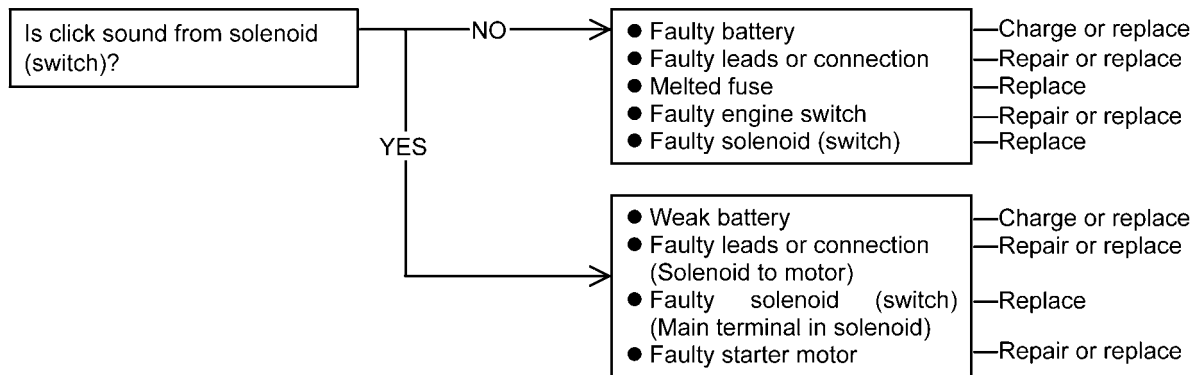
1. Disconnect spark plug caps from the spark plugs.
2. Turn engine switch to “START” position and check condition.



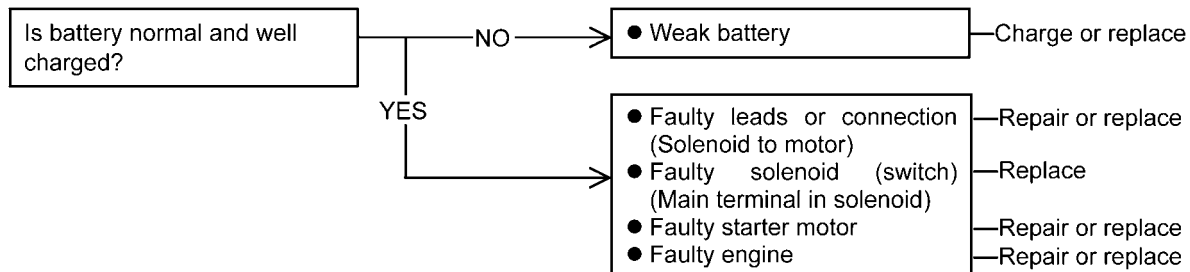
**Warning:** Engine may be cranked in this test. Do not touch any rotating parts of engine and equipment during test.

**Caution:** If starter does not stop by engine switch OFF, disconnect negative (–) cable from battery as soon as possible.

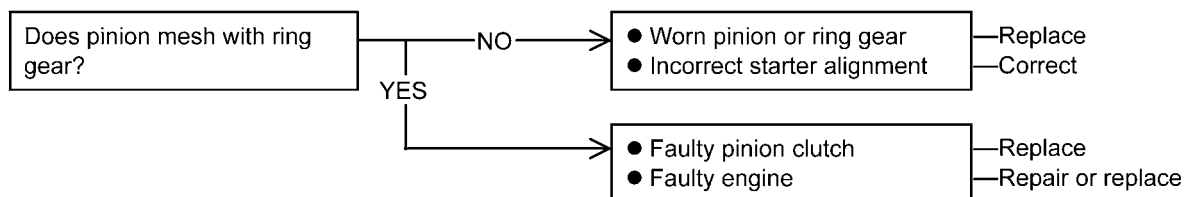
### [Starter does not rotate]



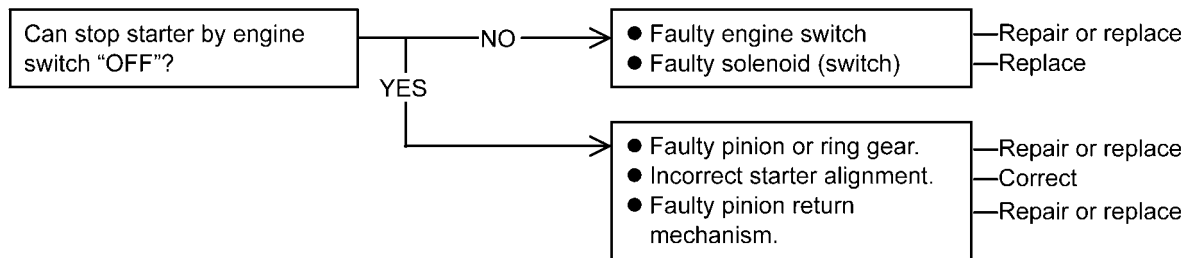
### [Starter rotates but slow]



### [Starter rotates but engine can not crank]



### [Starter does not stop in engine switch “OFF”]



## Removal and Installation

### Ignition Coil Removal

- Remove the fan housing (see Flywheel and Stator Coil Removal).
- Cut off the band [A].
- Remove:
  - Spark Plug Cap [B]
  - Bolts [C]
  - Stop Switch Lead Connector [D]
  - Ignition Coil #1 [E]
  - Ignition Coil #2 [F]

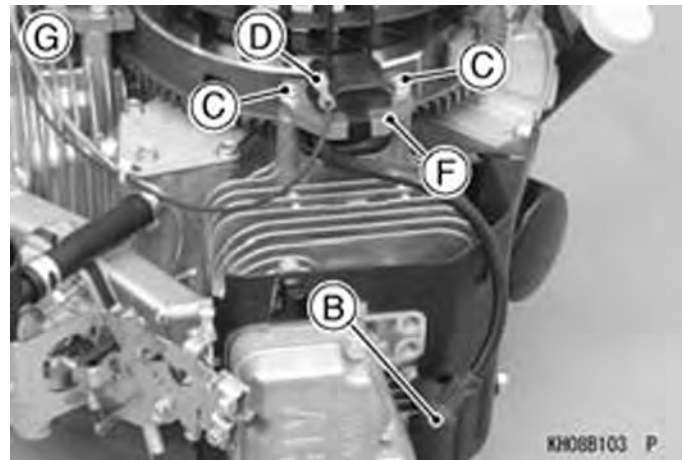
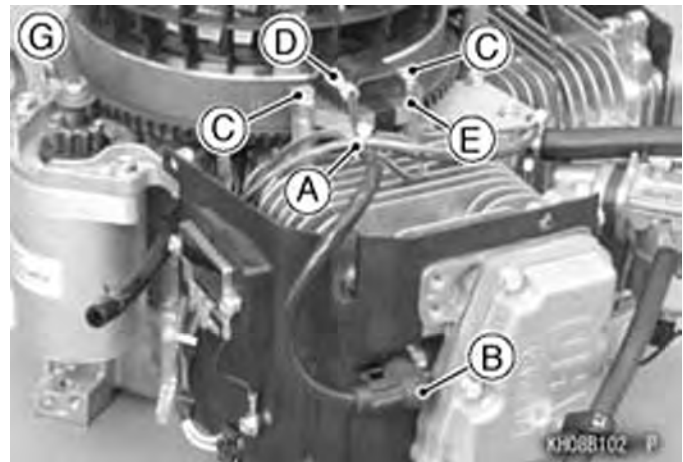


Figure 51 Component Removal

### Ignition Coil Installation

- Install the ignition coil on the crankcase so that the stop switch lead connector [A] face the upward, and tighten bolt [B] first, then tighten bolt [C]. While tightening bolts, adjust the air gaps to specified gap value as shown.
  - [D]: between left leg of ignition coil and left pole-plate of magnet
  - [E]: between center of ignition coil and right pole-plate of magnet

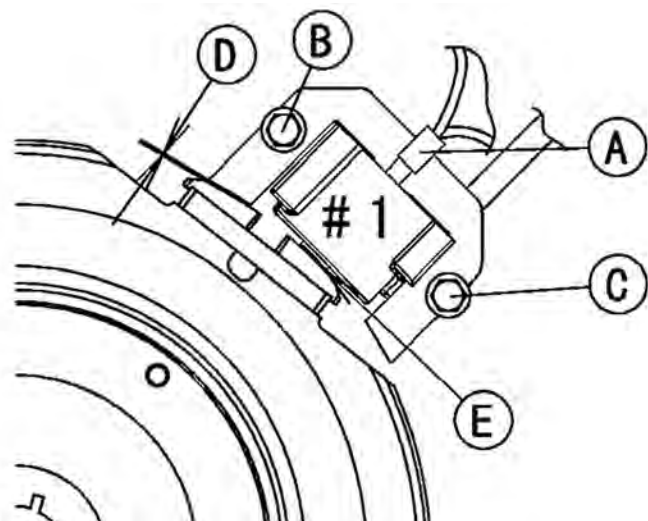


Figure 52 Coil Installation

**Ignition Coil Air Gap Standard: 0.2 ~ 0.4 mm (0.008 ~ 0.016 in.)** Torque - Ignition Coil Bolts: 5.9 N·m (0.60 kgf·m, 52 in·lb)



**Note:** Use the above procedure to insure proper coil air gap.

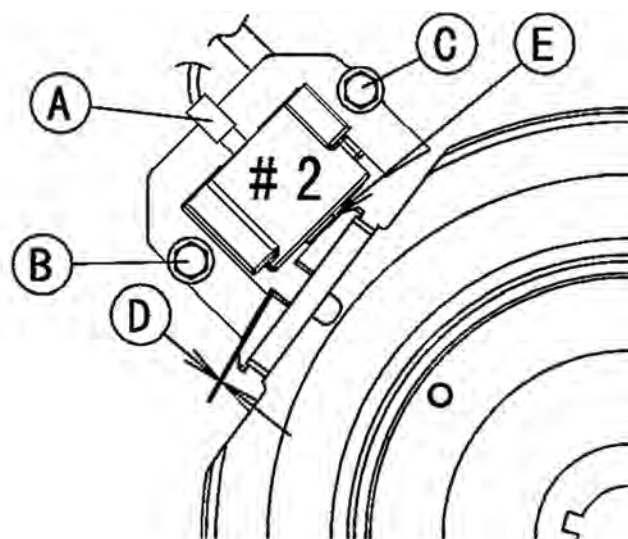


Figure 53 Air Gap

- Fit the ignition coil leads [A] to the each engine shroud groove [B].
- Install the spark plug cap [C].

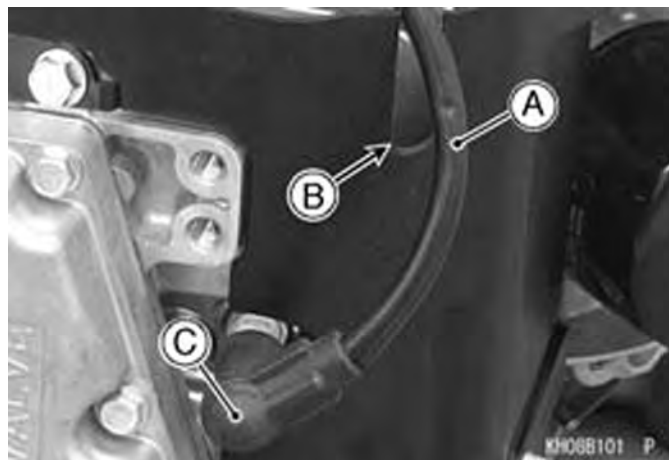


Figure 54 Fit Leads, Install Cap

- Attach the solenoid valve connector lead [A] and stop switch lead [B] to the ignition coil lead [C] with the band [D].

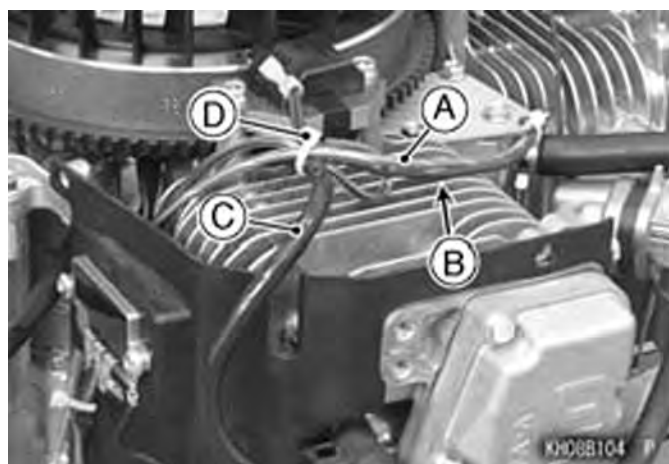


Figure 55 Attach Leads



### ***Spark Plug Removal***

- Carefully pull the plug caps from the spark plugs.
- Remove the spark plugs using a suitable plug wrench.

### ***Spark Plug Installation***

- Insert the spark plug vertically into the plug hole with the plug installed in the plug wrench.
- Tighten the plugs. **Torque - Spark Plugs: 22 N·m (2.2 kgf·m, 16 ft·lb)**
- Fit the plug caps securely.
- Pull up the spark plug caps lightly to make sure of the installation of the spark plug caps.

### ***Spark Plug Cleaning and Inspection***

- Refer to the Maintenance schedule

### ***Spark Plug Gap Inspection***

- Refer to the Maintenance schedule

## LP Regulator Replacement Before Serial Number 3000083761

After replacing the regulator, the idle mixture “regulator screw” must be adjusted and capped off. Correct adjustment requires the use of an exhaust analyzer.

Tools required:

- Pulse tachometer
- Phillips screwdriver
- Exhaust gas analyzer
- 3/32 and 3/16 inch Allen wrench
- Hammer
- Punch - large

1. Set the butterfly valve adjustment screw on the carburetor (mixer).

Using a Phillips screwdriver, turn the butterfly valve adjustment screw clockwise until resistance is felt. Then turn the screw counterclockwise 1 1/4 turns.

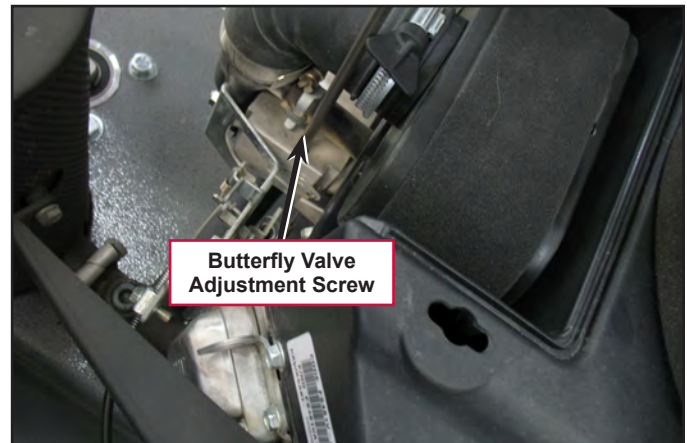


Figure 56 Butterfly Valve Adjustment Screw

2. Use a 3/32 inch Allen tool to adjust the top of regulator adjustment screw to a depth of 1/4 inch below the top of housing. (Use a caliper or tools on hand to measure depth).

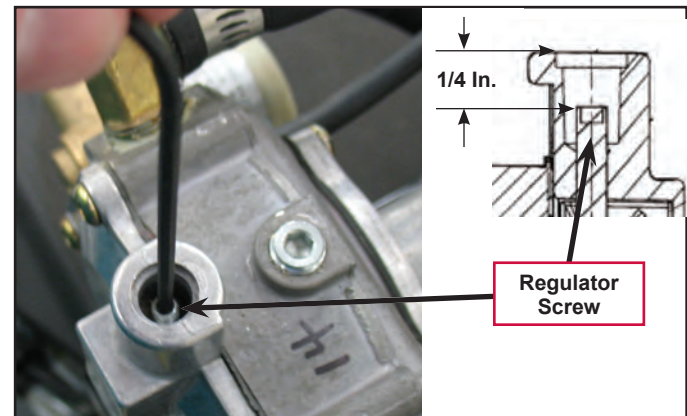


Figure 57 Regulator Adjustment Screw

3. The throttle cable must move freely and not restrict throttle movement over the full range of low to high speed. If necessary, loosen the cable housing clamp screw and reposition the cable housing to allow unrestricted throttle movement.

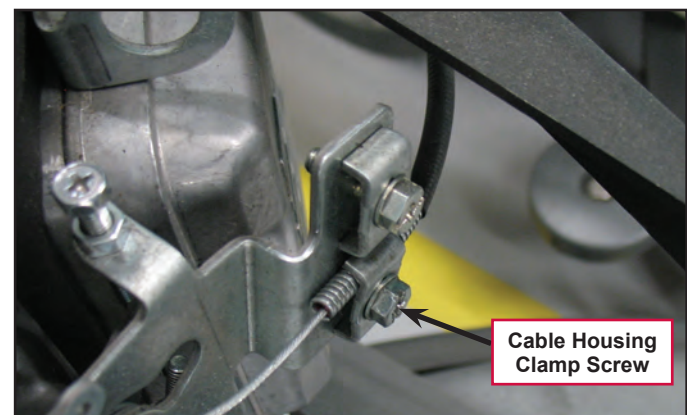
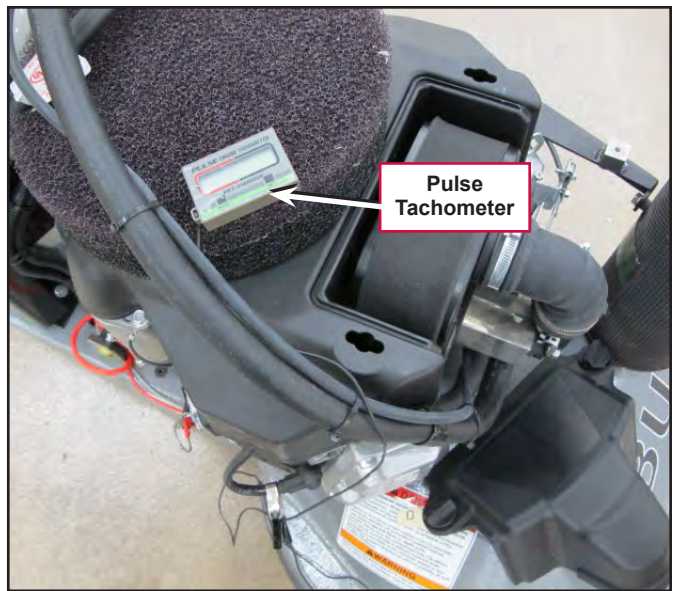


Figure 58 Throttle Cable Housing Clamp Screws

4. Connect a tachometer to a spark plug lead.
5. Start and warm up the engine. Run at full throttle for a minimum of five minutes.

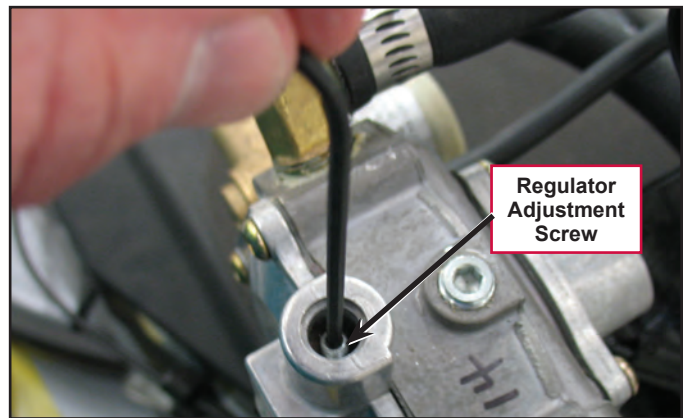


**Figure 59 Connect Pulse Tachometer**

6. Return to idle.

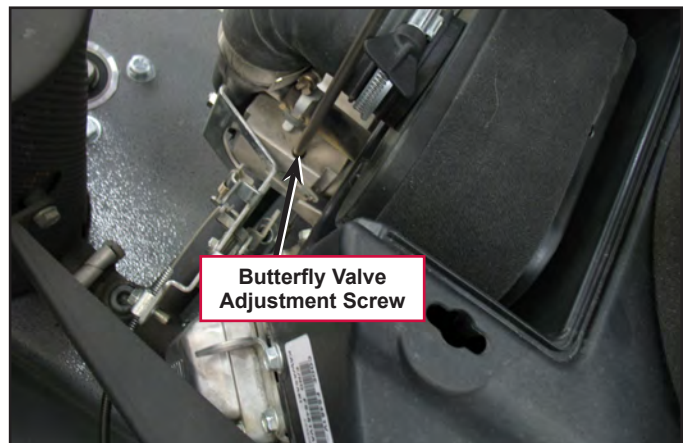
While referring to the tachometer, use a 3/32 inch Allen wrench to turn the regulator adjustment screw to achieve the highest engine RPM at idle.

7. After achieving the highest engine RPM, turn the regulator adjustment screw counterclockwise two full turns.



**Figure 60 Regulator Adjustment Screw**

8. Using a Phillips screwdriver and the tachometer, turn the butterfly valve adjustment screw to achieve an engine idle RPM of approximately 1600 to 1700.
9. Repeat steps 6, 7 and 8 above to verify regulator adjustments.



**Figure 61 Butterfly Adjustment Screw**



10. Advance the throttle.

- a. Models without a clutch: advance the throttle lever fully (lever locks into detent) to achieve the highest possible engine RPM.
- b. Models with a clutch: pull the throttle lever up (against handle) to achieve the highest possible engine RPM.

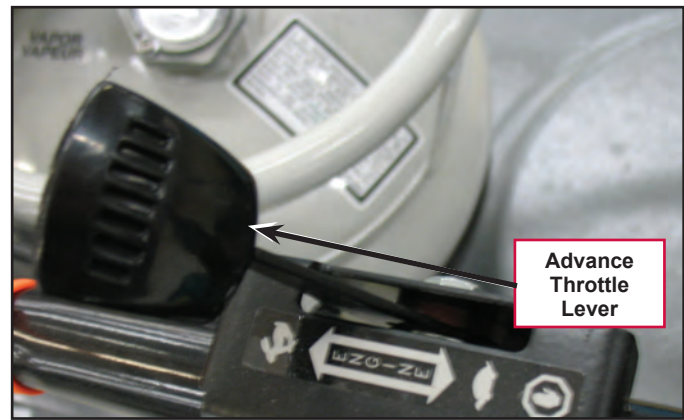


Figure 62 Throttle Lever, Models without Clutch

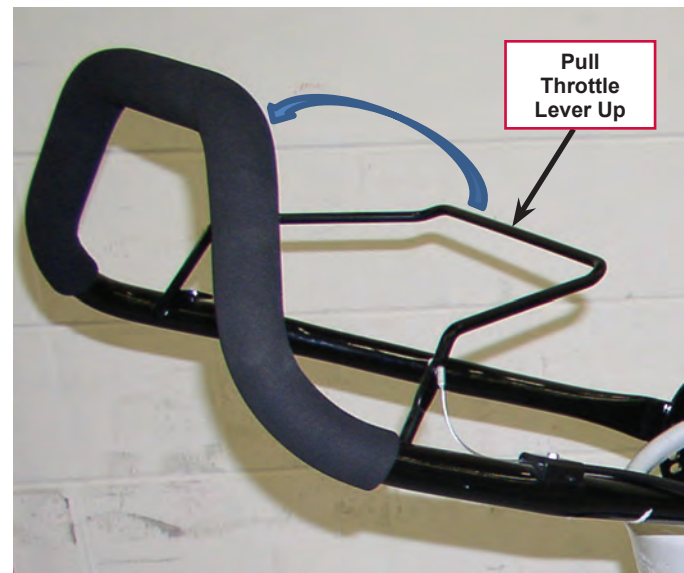


Figure 63 Throttle Lever, Models with Clutch

11. Loosen the jam nut that secures the high speed throttle set screw.

Using the tachometer, adjust the high speed throttle set screw so that the engine runs at 3500 to 3600 RPM when the throttle lever is fully advanced. Tighten the jam nut to secure the high speed throttle set screw at this position.

CAUTION: use of gloves is recommended.

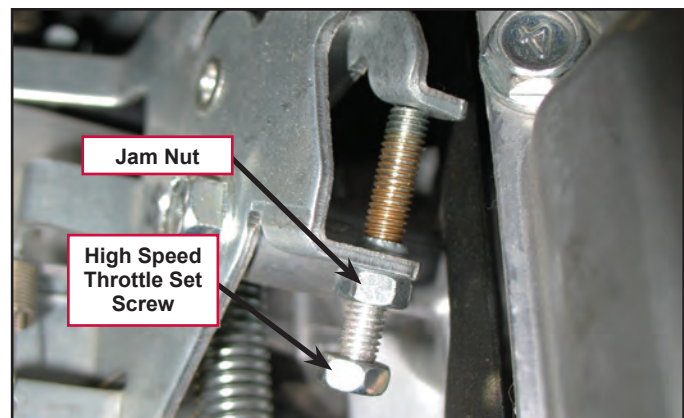
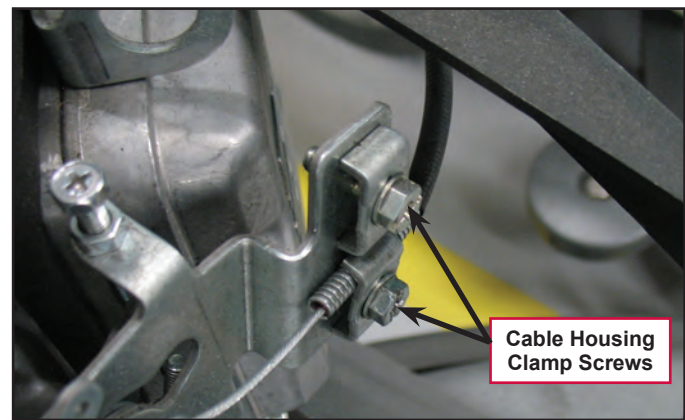


Figure 64 High Speed Throttle Screw

12. Check the tightness of the throttle cable clamp. If necessary, tighten the throttle cable housing clamp screws to firmly secure the throttle cable housing. Do not over-tighten. The throttle lever must be able to freely advance or retract the throttle cable.

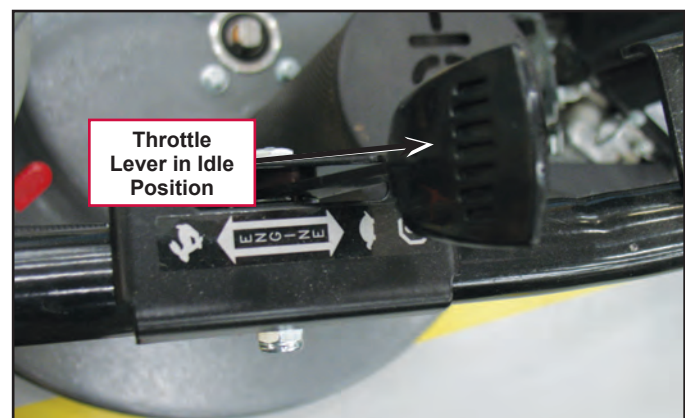


**Figure 65 Throttle Cable Housing Clamp Screws**

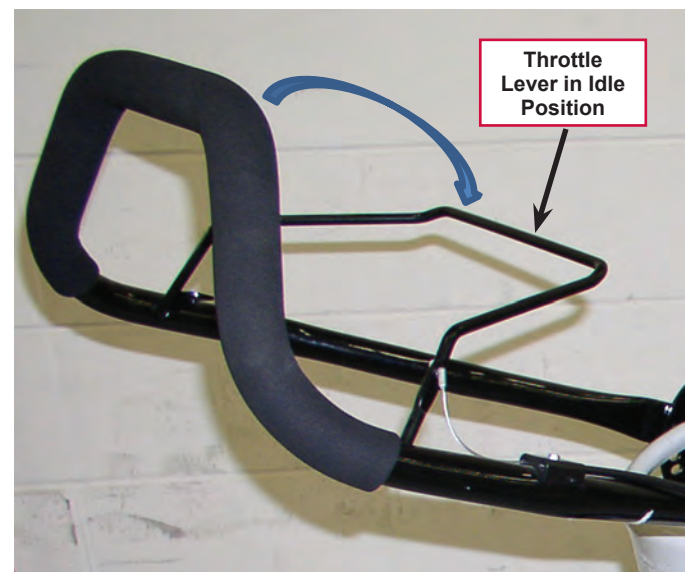
13. Move throttle lever to idle position.

Advance the throttle lever fully.  
Verify high speed engine RPM is 3500 to 3600.

Move throttle lever to idle position.  
Verify low speed engine RPM is 1600 to 1700.



**Figure 66 Throttle Lever in Idle Position, Models without Clutch**



**Figure 67 Throttle Lever in Idle Position, Models with Clutch**



14. The idle speed throttle set screw must not push on the plate beneath it. Loosen the jam nut that secures the idle speed throttle set screw.

Adjust the idle speed throttle set screw so that it does not make contact with the plate. Tighten the jam nut to secure the idle speed throttle set screw at this position.

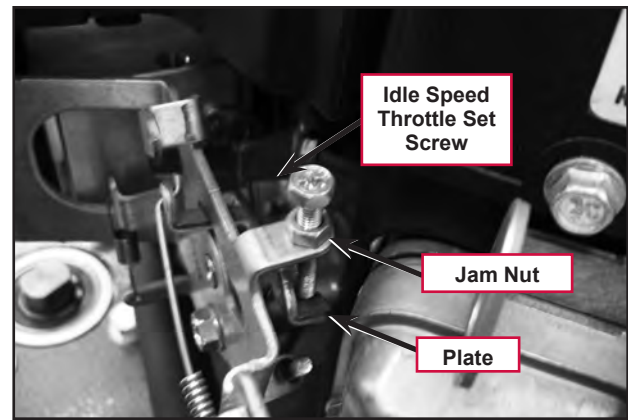


Figure 68 Idle Speed Set Screw

15. Measure the exhaust Carbon Monoxide content. An exhaust analyzer is required for this test measurement.

Acceptable test measurement results:

<u>PBU with Muffler version:</u>	<u>Catalyst Muffler version:</u>
RPM Range (1600-1700)	RPM Range (1600-1700)
Target CO = 0.14%	Target CO = 0.007%
Max. CO = 0.2%	Max. CO = 0.02%
Target HC = 168 ppm	
Max. HC = 500 ppm	Max. HC = 50 ppm
NOx = Less than 80 ppm	NOx = Less than 60 ppm



Figure 69 Exhaust Analyzer

If the test results are unacceptable, repeat the procedure above, beginning at Step 2.

16. Place a small amount of 242 Loctite at the edge of the opening over the regulator adjustment screw. Using a wide punch and hammer to compress the cap (found taped to the side of the regulator) into the opening.

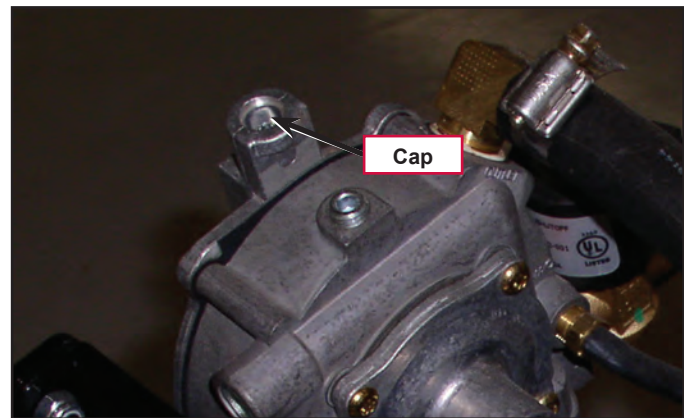


Figure 70 Cap Compressed Into Opening

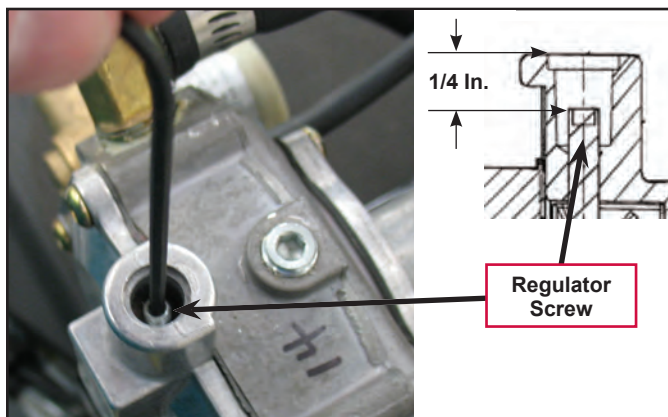
## LP Regulator Replacement - After Serial Number 3000083760

After replacing the regulator, the idle mixture “regulator screw” must be adjusted and capped off. Correct adjustment requires the use of an exhaust analyzer.

Tools required:

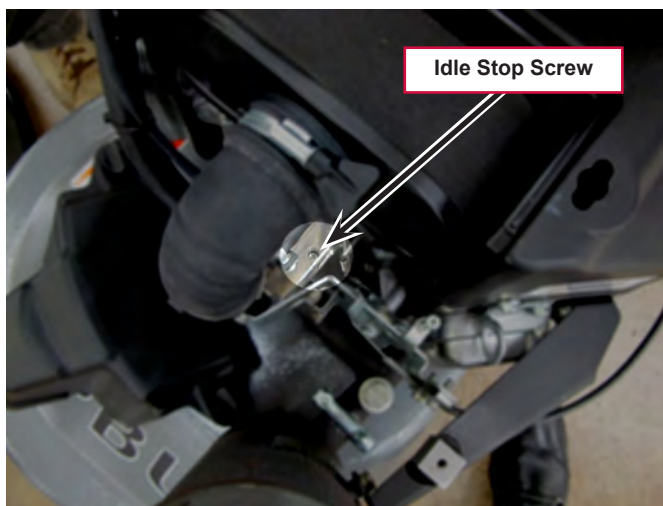
- Pulse tachometer
- Phillips screwdriver
- Exhaust gas analyzer
- 3/32 and 3/16 inch Allen wrench
- Hammer
- Punch - large

1. Set the idle mixture “regulator screw” to the base setting of 1/4” (6.4 mm) from the top of the regulator housing to the top of the screw head as shown.



2. Connect a tachometer. Start the engine and warm it up. (3100 rpm maximum for 4 minutes)

3. Push throttle back to idle speed. The idle speed should be 1,600 –1,700 RPM. If not correct adjust the idle stop screw on the carburetor.



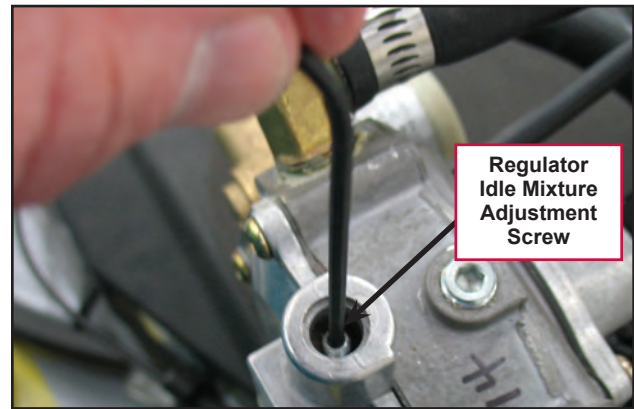
4. Using an exhaust analyzer to measure the engine exhaust, adjust the idle mixture screw in the regulator to obtain:

- a. Muffler **with** Catalyst at 1600-1700 RPM:

CO < 0.02% [goal .007], HC < 50ppm, NOx < 60ppm

- b. Muffler **without** Catalyst at 1600-1700 RPM:

CO < 0.2%, HC < 500ppm, NOx < 80ppm



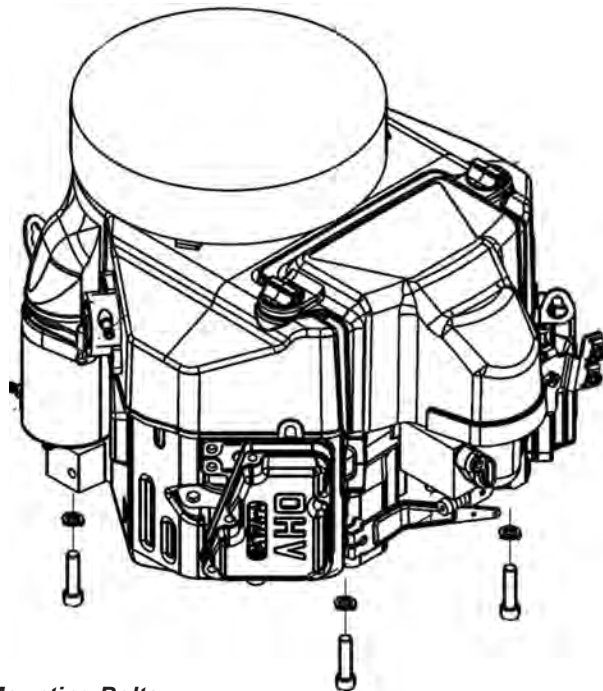
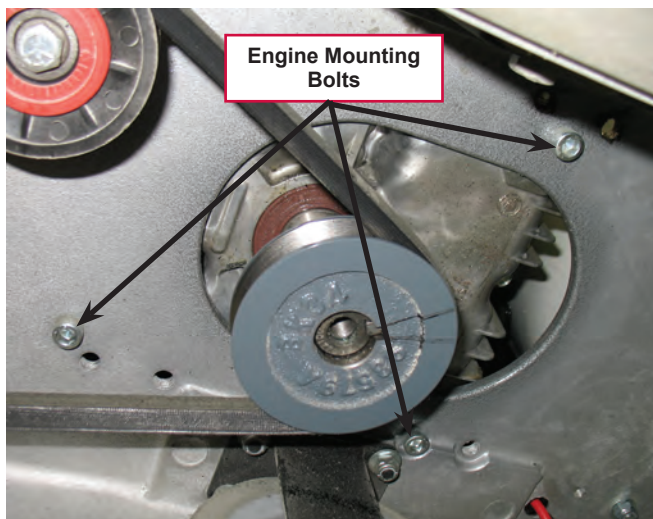
5. Push the throttle to high speed and run for 15 seconds. Move throttle back to idle and recheck idle speed and mixture. If not correct repeat steps 3-5. If okay, go on to step 6.

6. Place a small amount of 242 Loctite at the edge of the opening over the regulator adjustment screw. Using a wide punch and hammer to compress the cap (found taped to the side of the regulator) into the opening.



## Replace Engine

The engine is secured to the unit frame by three bolts.



*Figure 71 Engine Mounting Bolts*

When replacing the engine, apply 242 Loctite to the three engine mounting bolts and **torque to 31 ft-lb.**

## Specifications

### Engine Specifications

Item	Specification
Type of Engine	Forced air-cooled, vertical shaft, OHV, 4-stroke gasoline engine
Cylinder Layout	90 V-Twin
Bore × Stroke	73 mm × 72 mm (2.87 in. × 2.84 in.)
Piston Displacement	603 cm <sup>3</sup> (36.8 cu in.)
Direction of Rotation	Counterclockwise facing the PTO shaft
Compression Release	Automatic compression release
Low Idle Speed	1600 - 1700 RPM
High Idle Speed - Before Serial Number 3000083761	3600 RPM
High Idle Speed - After Serial Number 3000083760	3000 - 3100 RPM
Ignition System	Transistorized-flywheel magneto
RFI	Per Canada and U.S.A. requirements
Starting System	Electric starter
Charging System	12 V - 15 amps with regulator
Spark Plug	NGK BPR4ES
Carburetor	Float type, fixed main jet, internally vented, single barrel
Fuel Pump	Diaphragm type pulse pump
Air Cleaner	Dual stage element, dry type
Governor	Flyweight all speed governor
Lubrication System	Pressure feed by positive displacement pump
Oil Type	30HD or 10W30, API rating SJ or higher
Oil Filter	Cartridge type full flow filter
Oil Capacity (when engine is completely dry)	2.0 L (2.1 US qt)
Cooling System	Forced air cooling by fan
Dimensions (L × W × H )	486 mm × 429 mm × 362 mm (19.1 in. × 16.9 in. × 14.3 in.)
Dry Weight (without muffler)	36.7 kg (80.9 lb)
Specifications are subject to change without notice.	

Item	Service Limit
<b>Cylinder Head:</b>	
Cylinder Compression (MIN)	448 kPa (64 psi) @ Engine Oil Temperature 50 ~ 60°C (122 ~ 144°F), Cranking Speed 500 rpm/5 Seconds
Cylinder Head Warp	0.05 mm (0.002 in.)
<b>Valves:</b>	
Valve Head Thickness: Intake, Exhaust	0.35 mm (0.0138 in.)



Item	Service Limit
Valve Stem Runout: Intake, Exhaust	TIR 0.05 mm (0.002 in.)
Valve Stem Diameter	
Intake	5.95 mm (0.234 in.)
Exhaust	5.93 mm (0.233 in.)
Valve Guide Inside Diameter:	
Intake, Exhaust	6.08 mm (0.239 in.)
Valve Spring Free Length:	
Intake, Exhaust	31.0 mm (1.22 in.)
Rocker Arm Push Rod Runout:	
Intake, Exhaust	TIR 0.5 mm (0.02 in.)
Rocker Shaft Outside Diameter:	
Intake, Exhaust	10.91 mm (0.430 in.)
Rocker Arm Inside Diameter:	
Intake, Exhaust	11.13 mm (0.438 in.)
<b>Cylinder, Piston:</b>	
Piston Diameter	72.79 mm (2.866 in.)
Piston Ring/Groove Clearance:	
Top	0.12 mm (0.0047 in.)
Second	0.12 mm (0.0047 in.)
Piston Ring Thickness:	
Top	1.1 mm (0.043 in.)
Second	1.1 mm (0.043 in.)
Piston Ring End Gap:	
Top	0.7 mm (0.028 in.)
Second	0.9 mm (0.035 in.)
Oil	1.05 mm (0.041 in.)
Piston Pin Outside Diameter	15.96 mm (0.628 in.)
Piston Pin Hole Inside Diameter	16.08 mm (0.633 in.)
Connecting Rod Small End Inside Diameter	16.05 mm (0.632 in.)
Cylinder Inside Diameter:	
Standard Cylinder	73.10 mm (2.878 in.)
0.50 mm Oversize Cylinder	73.60 mm (2.898 in.)
Cylinder Inside Diameter Out Round:	0.05 mm (0.002 in.)
Valve Clearance:	
Intake, Exhaust	0.10 ~ 0.15 mm (0.0039 ~ 0.059 in.)
Valve Seating Surface Angle:	
Intake, Exhaust	45°
Valve Seating Surface Width:	
Intake	0.8 ~ 1.4 mm (0.031 ~ 0.055 in.)
Exhaust	0.8 ~ 1.4 mm (0.031 ~ 0.055 in.)

Item	Service Limit
Valves Guide Inside Diameter:	
Intake, Exhaust	6.000 ~ 6.012 mm (0.2362 ~ 0.2367 in.)
Cylinder Inside Diameter:	
Standard Cylinder	72.98 ~ 73.00 mm (2.873 ~ 2.874 in.)
0.50 mm Oversize Cylinder	73.48 ~ 73.50 mm (2.893 ~ 2.894 in.)

### Ignition Coil Specifications

- Measure the ignition coil winding resistance as shown in the table.

Ignition Coil Winding Resistance:

	+	A	B	C
-				
A	-	-	3 ~ 13 kΩ	10 ~ 20 kΩ
B	∞	∞	-	∞
C	10 ~ 20 kΩ	18 ~ 28 kΩ	-	-



Figure 72 Ignition Coil Inspection

### Special Tools

Exhaust Gas Analyzer

