MTD For A Growing World.™ ®

Professional Shop Manual

Engine Analysis

NOTE: These materials are for use by trained technicians who are experienced in the service and repair of outdoor power equipment of the kind described in this publication, and are not intended for use by untrained or inexperienced individuals. These materials are intended to provide supplemental information to assist the trained technician. Untrained or inexperienced individuals should seek the assistance of an experienced and trained professional. Read, understand, and follow all instructions and use common sense when working on power equipment. This includes the contents of the product's Operators Manual, supplied with the equipment. No liability can be accepted for any inaccuracies or omission in this publication, although care has been taken to make it as complete and accurate as possible at the time of publication. However, due to the variety of outdoor power equipment and continuing product changes that occur over time, updates will be made to these instructions from time to time. Therefore, it may be necessary to obtain the latest materials before servicing or repairing a product. The company reserves the right to make changes at any time to this publication without prior notice and without incurring an obligation to make such changes to previously published versions. Instructions, photographs and illustrations used in this publication are for reference use only and may not depict actual model and component parts.

MTD Products Inc - Product Training and Education Department

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Failure Analysis

1. INTRODUCTION

1.1. **Disclaimer:** This service manual was intended for use by trained technicians. The information contained in this manual is current and accurate at the time of writing, but is subject to change without notice.

1.2. Purpose: To provide a better understanding of the cause and effects of engine failures.

1.3. A technician can thoroughly troubleshoot an engine and successfully find “what” the cause of the failure was. A failure analysis needs to be done to determine “how” the failure happened.

1.4. Determining How the failure happened can make the difference between a warranty being paid or having the consumer pay for the repair.

2. MAINTENANCE

2.1. Specifics are aimed at the MTD engine however the contents can be used for most outdoor power equipment.

2.2. As the saying goes “an ounce of prevention is worth a pound of cure” the same can be said about preventive maintenance on outdoor power equipment. By changing the spark plug, air filter, and oil in annual intervals many failures can be avoided.Sometime just be clearing off yard debris that was collected while in use can make the difference between a properly running piece of equipment or a failure.

2.3. **Spark plug:** used in the MTD engine is a Torch model F7RTC gapped to .024”-.032” (.60-.80 mm). See Figure 2.3.

Figure 2.3

- Champion RN14YC or NGK BPR4ES are physically similar but may not match the F7RTC in heat range.This difference in heat ranges will effect performance and emissions. It is recommended that the torch F7RTC plug be used in service.
- Wear rate will vary somewhat with severity of use. If the edges of the center electrode are rounded-off, or any other apparent wear / damage occurs, replace the spark plug before operating failure (no start) occurs.

2.4. Cleaning the spark plug

- Use of a wire brush may leave metal deposits on the insulator that causes the spark plug to short out and fail to spark.
- Use of abrasive blast for cleaning may leave blast media in recesses in the spark plug. When the media comes loose during engine operation, severe and non-warrantable engine damage may result.

2.5. **Air Filter**: Generally air filters come in two different types, a pleated-paper element, or a foam plastic, sometimes a combination of the two will be used like the one on the MTD engine. See Figure 2.5.

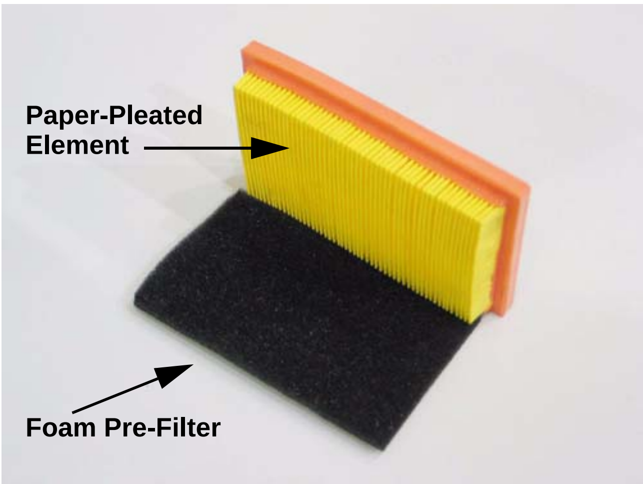

Figure 2.5

2.6. The main function of the air filter is to trap air borne particles before they reach the carburetor that can cause catastrophic internal engine damage.

2.7. Air filters used on the MTD engine are designed to prevent particles larger than 3-5 micron from passing through into the engine.

2.8. The filter should be checked on a regular basis possibly several times in a season. See Figure 2.8.

Figure 2.8

2.9. Typically an air filter should be changed before every season.

2.10. If an air cleaner is dirty and not in to bad of condition it can be cleaned and reused.The paper pleated filters can be shaken or lightly tapped to free the debris from the filter.

2.11. Foam filters can be washer in warm soapy water.

NOTE: When drying a foam filter either squeeze in side of a paper towel or let it air dry DO NOT wring because the filter will tear.

2.12. Before installing any foam filter, after it has been washed, it needs to be free of moisture and in some cases a small amount of oil is mixed into the filter to act as the particulate trapping agent.

NOTE: Always check with factory specification prior to servicing/replacing any engine components.

2.13. Although using pressurized air to clean an air filter appears to do a thorough job, it also damages the filter by separating the filtering fibers to the point that it would allow harmful abrasive particles to penetrate the filter and enter the carburetor.

NOTE: It is highly recommended **NOT** to use pressurized air to clean a paper pleated air filter.

3. OIL TYPE AND CAPACITY

3.1. When checking the oil twist and remove the dipstick from the engine. Clean the oil off of the tip of the dipstick. Re-insert the dipstick **without** threading it in to get the oil level reading. See Figure 3.1.

Figure 3.1

- SAE 10W-30 SF/CD API rating for most operating conditions up 97° F(36° C.)
- 17.0- 20.3 fl.oz (0.5-0.6 liters)

3.2. The oil level is determined by the lowest point on the dipstick that is completely covered with oil.

3.3. If the oil is noticeable thin, or smells of gasoline, a carburetor repair may be needed before the engine can be safely run.

- Check the oil level frequently and change the oil more frequently in severe operating conditions such as high ambient temperature, dusty conditions, or high load use in exceptionally thick grass.
- Synthetic oil is a suitable alternative, but it does not extend service intervals.
- Synthetic vs. Petroleum based oil: To simply look at synthetic oil and to compare it with Petroleum based oil there is very little difference. However, when you look at the two through a microscope it is easy to see the difference. Synthetic is made up of smaller molecules which allows the oil to get into areas that petroleum based oil cannot.
- No oil additives or viscosity modifiers are recommended. The performance of a good oil meeting the SF/ CD specifications will not be improved by the addition of any oil additives.
- Some oil additives may cause severe and non warrantable engine damage, constituting a lubrication failure.

3.4. Some oil can be drained by removing the drain plug located at the base of the filler tube / dipstick tube, using a 10mm wrench. See Figure 3.4.

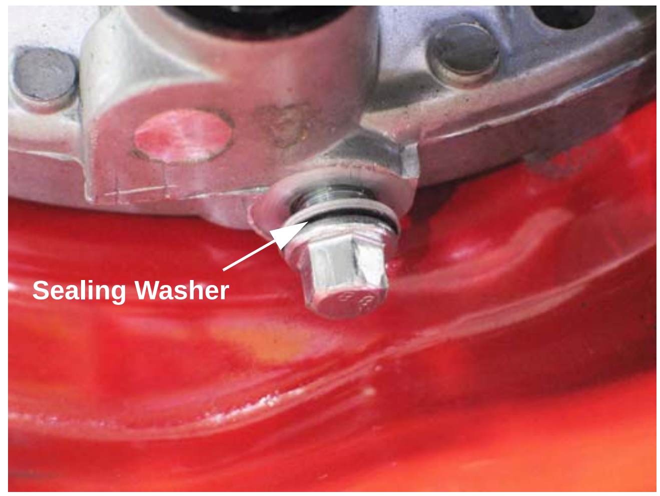

Figure 3.4

NOTE: Replace the drain plug sealing washer with a new one to ensure that it does not leak.

NOTE: Tighten the drain plug to a torque of 84 in. lbs. (10Nm) on installation.

3.5. An alternate method for draining the mower engine oil would be to tip the mower on its side, dipstick tube down and dipstick removed, draining the oil into a waste oil pan.

- Disconnect the spark plug lead and ground it to the engine block.
- Lean the mower to the muffler side of the engine.

- If the engine has been running allow the engine to cool before doing any maintenance work. See Figure 3.5.

Figure 3.5

3.6. Some engines have been equipped with a fuel filter placed between the fuel tank and carburetor. See Figure 3.6.

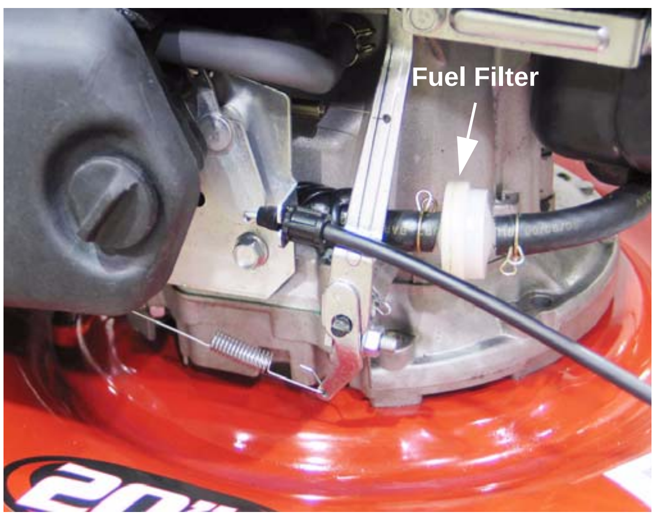

Figure 3.6

3.7. Presently engines are being equipped with a fuel filter installed in the fuel tank were the feed line connects. See Figure 3.7.

Figure 3.7

4. CLEANING

4.1. To maintain a proper operating temperature and to keep the equipment looking good all debris should be removed from the engine.

4.2. A pressure washer may be used to clean outdoor power equipment **but only** after the unit has been allowed to properly cool.

4.3. Debris can build up under the deck and cause the engine to operate under an unintended load.

5. TROUBLE SHOOTING

5.1. Trouble shooting is the art and science of observation and testing.

5.2. By observation and testing finding a failure can be done in a timely and profitably manner.

5.3. Observation is key. By simply looking at the equipment a lot can be said about how well a piece of equipment was taken care of or used.

5.4. By looking at the different components the story will begin to unfold.

Ignition System

5.5. There are two different types of Ingition systems used since the demise of the points ignition. CDI, Capacitor Discharge Ignition and Transistorized Magneto.

5.6. The Ignition system used on the MTD engine is a transistorized magneto.

5.7. The testing procedures each are very similar.

5.8. The magneto is a three leg design. See Figure 5.8.

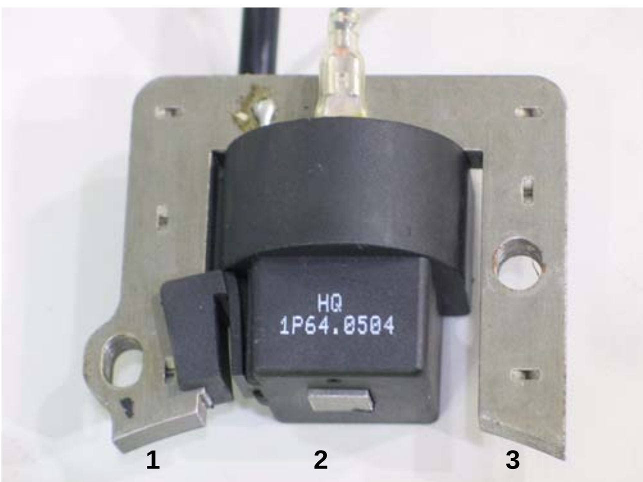

Figure 5.8

5.9. The magneto is energized by the passing of a pair of magnets mounted in the flywheel. See Figure 5.9.

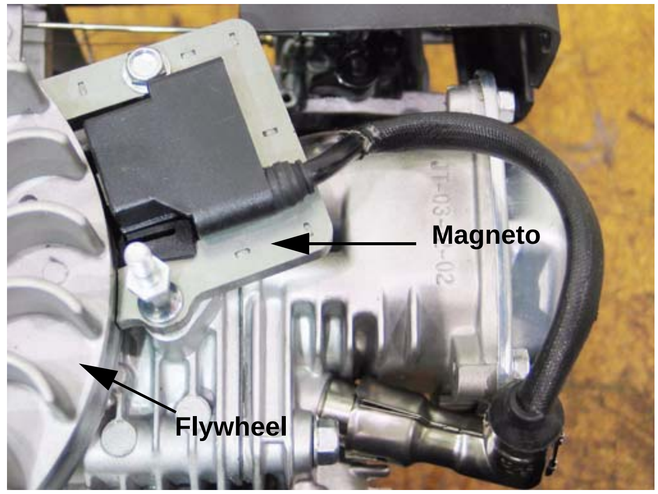

Figure 5.9

NOTE: The air gap should be.008”-.016” (.2-.4mm)

5.10. Ignition timing is set by the location of the flywheel in relation to the crankshaft. Proper timing is maintained by a steel key. See Figure 5.10.

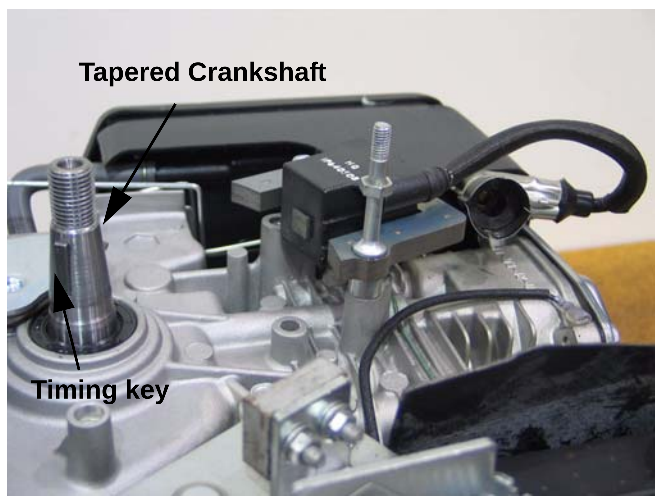

Figure 5.10

Failure Analysis

5.11. When troubleshooting the ignition system start with the spark plug.

5.12. The spark plug is one of the engines biggest tattle tales. and can give you a good starting point for your diagnosis.

5.13. If an engine is running correctly there will be little change on the electrode of the spark plug.

5.14. A dry black deposit that wipes off easily is caused by an engine running rich (too much gasoline), commonly caused by:

- Dirty air filter
- Sticking choke
- Air mix adjustment on carburetor
- Float stuck open allowing excessive fuel in to the combustion chamber.

5.15. A wet black deposit caused by oil in the combustion chamber commonly caused by:

- Worn valves
- Scored piston or cylinder wall

5.16. A white colored plug caused from over heating, commonly caused by:

- Low octanes high alcohol content fuels
- Wrong heat range on spark plug
- The flow of cooling air is impeded by debris build up.
- Carburetor set lean (too much air).
- Lack of oil
- Leaking crankshaft seals

5.17. The electrode was pushed back into the spark plug, commonly caused by:

- The spark plug was dropped before it was installed
- The incorrect spark plug was used and the piston made contact with the spark plug.

5.18. The porcelain on the bottom of the spark plug breaking away from excessive detonation, commonly caused by:

- Using fuel with a high octane rating.

5.19. Carbon across the spark plug gap, commonly caused by:

- Carbon that is loose and it lodges between the gap causing the plug to misfire.

5.20. Burned or deteriorated electrode, commonly caused by:

- Incorrect heat range on plug
- Advanced ignition timing
- Lean fuel/air mixture
- Over heating
- Insufficient lubrication

5.21. A spark plug that has worn out will have a rounded center electrode.

5.22. If the rope pulls easily check the spark plug.

- Check to see if the spark plug is wet or dry.
- This will indicate if fuel is making it to the combustion chamber and that there is not a spark to detonated the mixture.

5.23. Simple spark-testers are readily available and inexpensive. Thexton Part # 404 is available from a variety of retailers. See Figure 5.23.

Figure 5.23

CAUTION: Disconnect the high tension lead from the spark plug and ground the lead before doing any work that exposes the blade.

5.24. **Fuel**: Use clean, fresh fuel with a pump octane rating of 90 or greater.

- The engine has a nominal compression rating of 9.0:1
- Stale or out-of-date fuel is the leading cause of hard starting issues.

5.25. Pump octane rating beyond 90 octane will not improve engine performance.

5.26. Try to start the engine in a safe area conducive for operating an internal combustion engine.

5.27. Test the machine. If the consumer states, the engine will not start, it could mean a variety of different causes.

5.28. Check for fuel in the fuel tank, Check for debris or dirt particles, or water in the fuel tank.

5.29. Check and make sure the fuel cap is vented correctly.

6. Valve lash

6.1. The valve lash can be checked and adjusted using the following steps.

- If the engine has been run, allow it to cool thoroughly. Position the mower for easy access to the cylinder head.
- Disconnect the high-tension lead from the spark plug and ground it well away from the spark plug hole.
- Remove the spark plug using a 13/16" or 21mm wrench.
- A flexible coupling or "wobbly" extension may help.
- Remove the four bolts that secure the valve cover using a 10mm wrench, and remove the valve cover from the engine. See Figure 6.1.

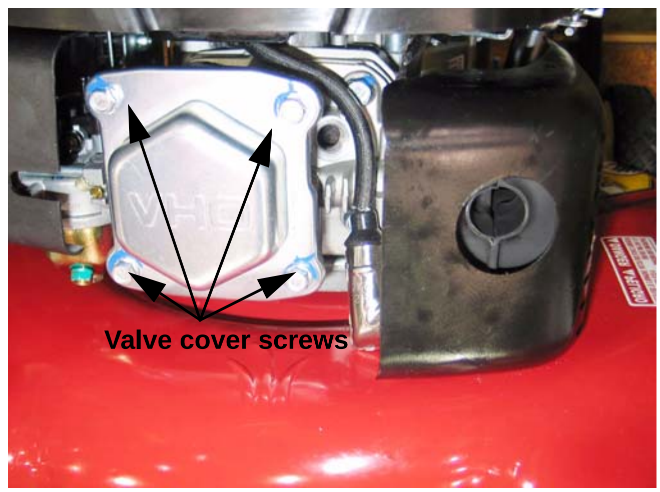

Figure 6.1

NOTE: If care is used not to damage the valve cover gasket, it can be re-used.

6.2. Secure the safety bale with a spring clamp and slowly pull the starter rope until air can be heard being expelled from the spark plug hole.

6.3. Confirm that the piston is at Top-Dead-Center on the compression stroke. See Figure 6.3.

Figure 6.3

- TDC can be identified using a probe in the spark plug hole feeling the piston till it reaches TDC.
- The compression stroke can be distinguished from the overlap stroke by the presence of air pressure at the spark plug hole and the fact that neither of the valves should move significantly on the compression stroke.
- There is an automatic compression release mechanism that “bumps” the exhaust valve as the piston rises on the compression stroke. At TDC, the exhaust valve should be fully closed.

6.4. Check valve lash between each valve stem and rocker arm using a feeler gauge.

6.5. Intake valve lash (top valve) should be .005”-.007” (.15 ±.0.2mm) See Figure 6.5.

Figure 6.5

6.6. Exhaust valve lash (bottom valve) should be .007-.009” (.20 ±.0.2mm). See Figure 6.6.

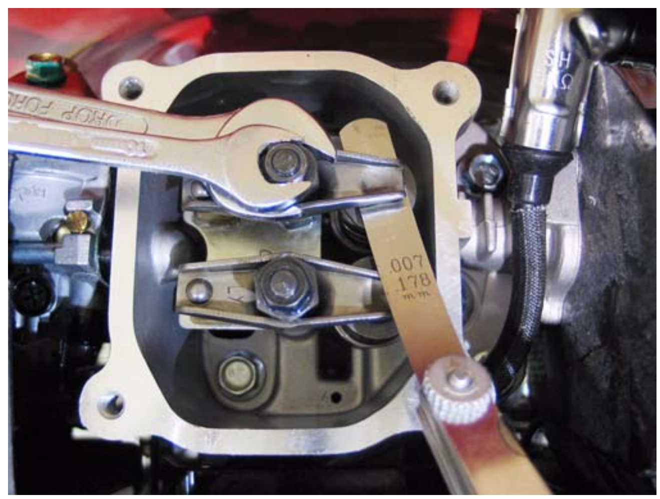

Figure 6.6

6.7. Use a 10 mm wrench to loosen the jam nut and a 14mm wrench to adjust the rocker arm fulcrum nut.

- Tighten the rocker arm fulcrum nut to close-up the clearance between the end of the valve stem and the contact point of the rocker arm.
- Loosen the rocker arm fulcrum nut to open-up the clearance between the end of the valve stem and the contact point on the rocker arm.

6.8. Hold the fulcrum nut with a 14mm wrench, tighten the jam nut to a torque of 88.5 in-lbs. (10Nm) using a 10mm wrench.

6.9. Double-check the clearance after tightening the jam nut, to confirm that it did not change. Re-adjust if necessary.

6.10. Rotate the engine through several compression cycles:

- Return the piston to TDC compression stroke and re-check the valve lash to confirm consistent movement to the valve gear, including the slight bump to the exhaust valve from the automatic compression release.

6.11. Clean-up any oil or debris from around the valve cover gasket.

6.12. Install the valve cover, tighten the valve cover screws to a torque of 88.5 in lbs (10Nm).

6.13. Install the spark plug

6.14. Release the spring clamp securing the safety bail, start the engine and test run it long enough to confirm correct operation.

6.15. **Compression:** If the engine has been running, allow it to cool thoroughly.

6.16. Disconnect the high tension lead from the spark plug and ground it away from the spark plug hole.

6.17. Remove the spark plug using a 13/16” or 21mm wrench. A flexible coupling or “wobbly” extension may help.

6.18. Hold the safety bail and pull the starter rope several times to purge any fuel or oil from the combustion chamber.

NOTE: Air compresses readily, liquid does not. Liquid in the combustion chamber will result in an artificially high compression reading.

6.19. Install a compression gauge in the spark plug hole.

6.20. Confirm that the gauge is “zeroed”, then hold the safety bail and pull the starter rope repeatedly, until the needle on the gauge has risen as far as it is going. See Figure 6.20.

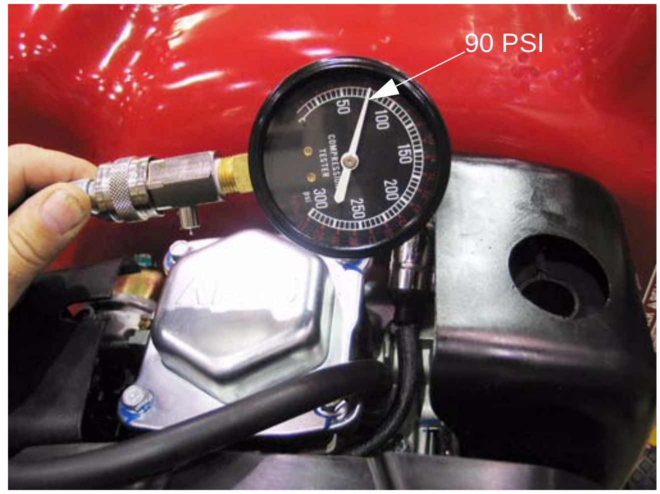

Figure 6.20

6.21. Interpreting the compression readings:

- Compression reading should be in the range of 75-85 PSI (5.2-5.9 Bar)
- Near Zero (20PSI [1.33Bar]): Most likely a stuck valve or too-tight valve lash, provided starter rope pulls with normal effort.
- Moderately Low (20-75 PSI [1.33-5.2 Bar]): Valve seat damage or piston ring wear. Leak-down test or compressed air test will help confirm if damage is isolated to valves or piston rings.
- Oil smoke in the exhaust on throttle increase tends to indicate piston ring wear.
- Oil smoke in the exhaust on over-run tends to indicate valve guide wear.
- Too high compression(85 PSI [5.9 Bar]) most likely indicates excessive valve lash, negating the automatic compression release. It may also indicate a partial hydraulic lock or severe carbon deposits on the piston or cylinder head.

7. FAILURE ANALYSIS

7.1. There are generally five different failure types:

- Abrasive Ingestion
- Insufficient Lubrication
- Over Heating
- Over Speeding
- Breakage / wear
- Combination (two or more failures)

7.2. Abrasive Ingestion

7.3. Abrasive Ingestion is when hard particles are introduced into the engine. Particles can be introduced into the engine by leaks in the air intake system or through a dirty oil fill plug. Particles may also be introduced through worn or improperly installed seals or gaskets.

7.4. Abrasive particles can be sand or dirt that has entered the engine either by normal air passages or compromises in seals. See Figure 7.4.

Figure 7.4

7.5. It's not unusual to have debris collected on the outside of the air filter. However, the carburetor should always remain clean and debris free. See Figure 7.5.

Figure 7.5

7.6. Dirt will work through the filter if the filter is not maintained regularly. See Figure 7.6.

Figure 7.6

NOTE: Air travels in through the carburetor at approximately 30-35 MPH. The particles entering the air filter housing are entering like tiny meteorites.

NOTE: Failing to follow recommended maintenance intervals can cause irreversible engine damage.

7.7. If the debris penetrates the filter the particles can collect on the carburetor choke and throttle shafts that can hinder the movement of the choke and throttle plates.

7.8. The particles can pass through the carburetor venturi and follow the fuel passages to the valves and valve seats.

7.9. When particles enter the combustion chamber the up and down motion of the piston grinds the particles into the side of the cylinder walls and damages the piston and piston rings.

7.10. This can be identified by the scoring along the vertical axis of the piston and cylinder wall or the cross hatch on the cylinder wall being worn off.

7.11. To help in the lubrication of the cylinder walls, and piston ring seating, a diamond cross hatch is honed into the cylinder wall.

7.12. Debris entering the cylinder will polish the cross hatch off of the cylinder wall and destroy the piston and piston rings. See Figure 7.12.

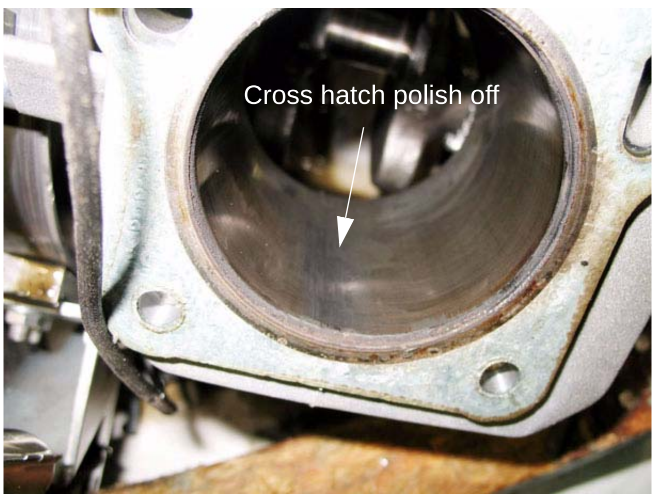

Figure 7.12

7.13. Carbon can build up on the top side of the piston through use and heat the carbon can work itself loose a create an abrasive environment.

7.14. The engine needs to be cleaned prior to checking or adding oil.

7.15. As the piston rings wear and the cylinder wears a positive pressure causing engine oil consumption and ultimately engine failure.
See Figure 7.15.

Figure 7.15

7.16. When abrasive material enters the oil the oil begins to thicken like adding flour to gravy. The gravy that an engine makes is in the form of sludge. See Figure 7.16.

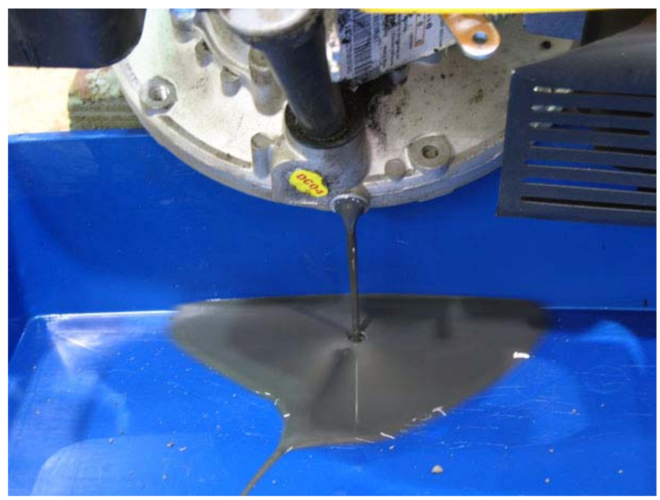

Figure 7.16

7.17. The engine components that are immersed in oil will show definite signs of abrasive ingestion around the connecting rod and main bearing journals. See Figure 7.17.

Figure 7.17

7.18. Severe engine damage will occur when the oil is contaminated with too much debris.

8. INSUFFICIENT LUBRICATION

8.1. Insufficient lubrication is caused by the absence, loss, or degradation of the engine oil.

8.2. The engine failed due to the oil lubricating qualities breaking down and allowed engine metal to metal contact.

8.3. Oil is Oil --right? - ah no!

8.4. Motor oil is tailored for different applications. For example, the viscosity rating will be different for two different engine used in different ambient temperatures.

8.5. Ambient temperatures (the temperature the equipment is used in) play a role in selecting the correct oil formulation. a lawn mower is use in temperatures in excess of 100 degrees or a snow thrower could be used in temperatues as low as -30 degrees.

8.6. The crankshaft journal and connecting rod will show the first signs of insufficient lubrication. See Figure 8.6.

Figure 8.6

8.7. The friction that is created from the connecting rod and the crank shaft journal causes metal transfer and a galling in the journal and connecting rod. See Figure 8.7.

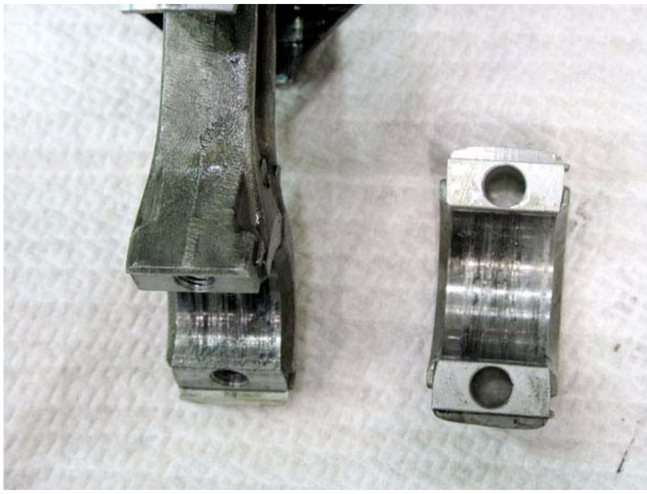

Figure 8.7

9. OVER HEATING

9.1. Overheating occurs from a lean air mixture, use of improper fuels, build up of debris in the cooling fins, damaged to the cooling system, obstruction inside the engine shrouds.

9.2. A continuous air flow needs to be maintained across the cooling fins.

9.3. If the air flow is impeded in anyway the engine will not operate at a desired temperature.

9.4. The engine block and head are constructed of aluminum.

9.5. Aluminum is softer and lighter than steel and can dissipate heat easier as long as a good supply of air flows across the engine. See Figure 9.5.

Figure 9.5

9.6. A good supply of air and lubrication is needed to prevent the aluminum from reaching a breakdown/melting point.

9.7. When the engine block begins to heat up beyond its intended temperature the engine head can warp causing a leak in the head gasket. See Figure 9.7.

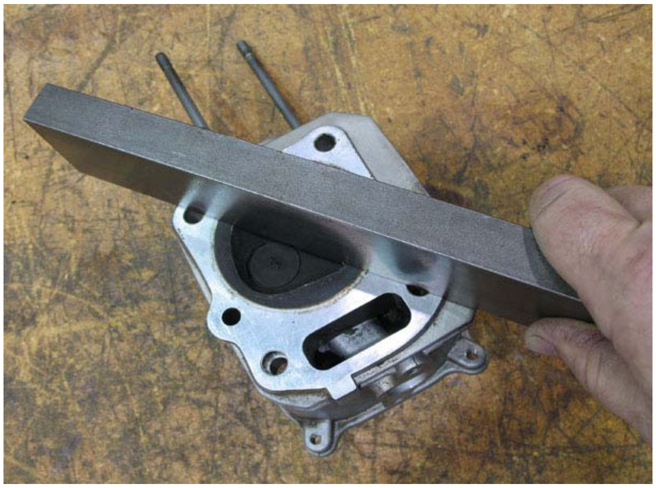

Figure 9.7

9.8. If the engine reaches a high enough temperature the valve seats have been known to loosen.

9.9. If it continues to operate with a over heating condition a tell tale sign will be the color of the steel wrist pins, crank shaft journal. which will change to a blueish color due to the heat. See Figure 9.9.

Figure 9.9

10. OVERSPEEDING

10.1. When an engine is over speeding, the material that the engine was made of is being pushed beyond its limitations.This could cause metal fatigue making the metal either break or stretch

10.2. Generally small engines are set to run at 3600 RPM. Typically the first thing to happen is a connecting rod failure at the narrowest point of the rod.

10.3. The difference from an overspeeding failure compared to a breakage failure is an over speeding failure is secondary to excessive momentum shifts.A breakage failure is secondary to an impact or wear.

10.4. **Breakage:** When a component of an engine fails from a fractured part / parts.

10.5. Many of these failures are secondary to an impact or loose fasteners.

10.6. The most common breakage failure is when an end user is operating the mower and hits a root or something hard in the lawn. See Figure 10.6.

Figure 10.6

10.7. The initial impact isn't necessarily when the failure is noticed.

10.8. Either the blade, crankshaft or both could get slightly bent and cause an intense vibration that the consumer cant feel right away.

10.9. Vibration is transferred from the bent blade/ crack shaft throughout the entire machine and compromises the integrity of the steel and torque of the fasteners. See Figure 10.9.

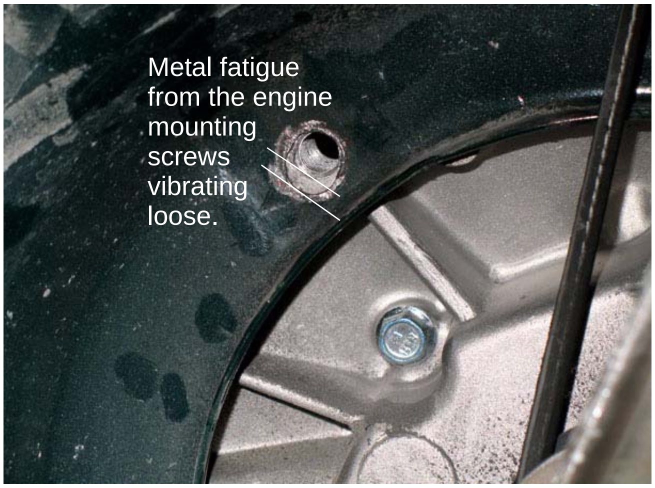

Figure 10.9

10.10. Breakage can also be caused by improper use of the equipment. It is intended to cut grass not to allow the user to reach high places. See Figure 10.10.

Figure 10.10

10.11. Impacts can be caused from improper use or from being dropped. Injuries can occur damages is not detected prior to putting back into service.

10.12. Flywheels are spinning at a rapid speed and if the integrity of the part is compromised in any-way (by using the incorrect tools or dropping) the flywheel could potentially break apart and create a hazardous condition. Use rope in the spark plug hole to prevent the piston from moving. See Figure 10.12.

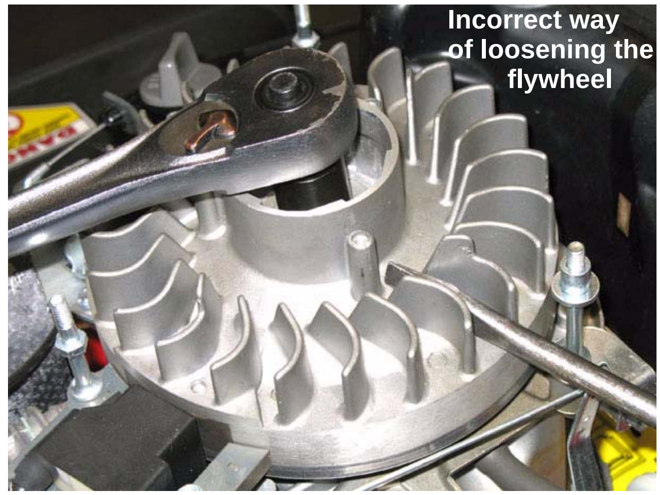

Figure 10.12

NOTE: Never use a screw driver to prevent the fly wheel from turning the aluminium fins are to soft to stand up to the torque

10.13. If there is any sign of wear or facture on a fly-wheel **DO NOT** reuse the flywheel it will need to be replaced. See Figure 10.13.

Figure 10.13

11. COMBINATION

11.1. A combination engine failure is when several conditions exist that caused the failure.

11.2. What came first the chicken or the egg?

11.3. When diagnosing a failure there may be signs of abrasive ingestion along with signs of insufficient lubrication or possible insufficient lubrication may show signs of over heating.

11.4. Determining what happened first would start with simply looking at the machine. An experienced technician can look and get a good ideal what may have been the first issue to start the chain of events to the final failure.