Shop Handbook

Troubleshooting and Failure Analysis of MTD Engines

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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INTRODUCTION

INTRODUCTION

1. SHOP HANDBOOK INTENT

This Handbook is intended to provide service dealers with an introduction to sound and proven troubleshooting and diagnostic procedures.

Disclaimer: This handbook was written using a prototype engine. The information contained in this handbook is correct at the time of writing. Both the product and the information about the product are subject to change without notice.

About the text format:

NOTE: is used to point-out information that is relevant to the procedure, but does not fit as a step in the procedure.

CAUTION: is used to point-out potential danger to the technician, operator, bystanders, or surrounding property.

- Bullet points: indicate sub-steps or points.

Disclaimer: This handbook is intended for use by trained, professional technicians.

- Common sense in operation and safety is assumed.
- In no event shall MTD or Cub Cadet be liable for for poor text interpretation, or poor execution of the procedures described in the text.
- If the person using this handbook is uncomfortable with any procedures they encounter, they should seek the help of a qualified technician.

Fasteners:

- Most of the fasteners used on the engine are sized in metric. Some are fractional inches. For this reason, wrench sizes are frequently identified in the text, and measurements are given in U.S. and metric scales.
- If a fastener has a locking feature that has worn, replace the fastener or apply a small amount of releasable thread locking compound such as Loctite® 242 (blue).
- Some fasteners like cotter pins are single-use items that are not to be reused. Other fasteners such as lock washers, retaining rings, and internal cotter pins (hairpin clips) may be reused if they do not show signs of wear or damage. This manual leaves that decision to the judgement of the technician.

Assembly:

Torque specifications may be noted in the part of the text that covers assembly, they may also be summarized in tables along with special instructions regarding locking or lubrication. Whichever method is more appropriate will be used. In many cases, both will be used so that the manual is handy as a quick-reference guide as well as a step-by-step procedure guide that does not require the user to hunt for information.

The level of assembly instructions provided will be determined by the complexity and of reassembly, and by the potential for unsafe conditions to arise from mistakes made in assembly.

Some instructions may refer to other parts of the manual for subsidiary procedures. This avoids repeating the same procedure two or three times in the manual.

MAINTENANCE

The specifics in this manual are aimed at the MTD engine however the contents can be used for most outdoor power equipment.

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. Sometimes just clearing off yard debris that was collected while in use can make the difference between a properly running piece of equipment or a failure.

Spark plugs

1. The spark plug used in the MTD engine is a Torch model F7RTC gapped to .024”-.032” (.60-.80 mm). See Figure 2.1.

Figure 2.1

NOTE: 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 only the torch F7RTC plug be used in MTD engines.

2. 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.

3. Cleaning the spark plug:

   NOTE: It is not recommended to clean spark plugs. 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 cause damage to ceramic insulator or leave blast media in the recesses of the spark plug. When the media comes loose during engine operation, severe and non-warrantable engine damage may result.

4. Inspection of the spark plug can provide indications of the operating condition of the engine.

- Light tan colored deposits on insulator and electrodes is normal.
- Dry, black deposits on the insulator and electrodes indicate an over-rich fuel / air mixture (too much fuel or not enough air)
- Wet, black deposits on the insulator and electrodes indicate the presence of oil in the combustion chamber.
- Heat damaged (melted electrodes / cracked insulator / metal transfer deposits) may indicate detonation.
- A spark plug that is wet with fuel indicates that fuel is present in the combustion chamber, but it is not being ignited.

Air filters

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 2.2.

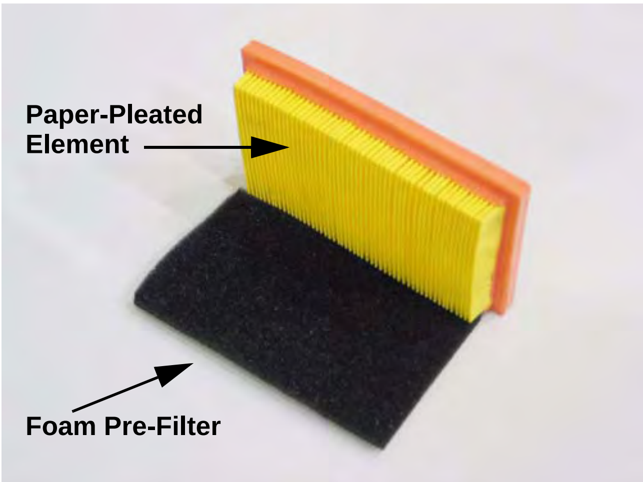


Figure 2.2

1. 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. Air filters used on the MTD engine are designed to prevent particles larger than 3-5 micron from passing through into the engine.
3. The filter should be checked on a regular basis possibly several times in a season. See Figure 2.3.

Figure 2.3

4. Typically an air filter should be changed before every season.
5. 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.

   NOTE: Never use compressed air on a paper air filter. Compressed air will remove the tiny fibers that are used to catch the dirt in the air. Without these fibers the filter is useless.
6. 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.
7. Before installing any foam filter, after it has been washed, it needs to be free of moisture.

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

Oil type and capacity

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 2.4.

Figure 2.4

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

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

  NOTE: It is recommended to use petroleum oil during the break in period to ensure the piston rings actually break in.

- 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.

  NOTE: Some oil additives may cause severe and non warrantable engine damage, constituting a lubrication failure.

Changing the oil

NOTE: If the engine has been running allow the engine to cool before doing any maintenance work.

1. 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 2.5.

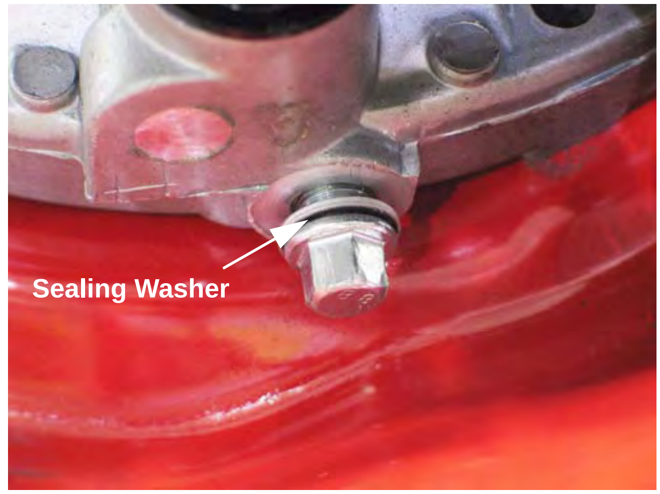


Figure 2.5

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.

2. An alternate (recommended) 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.

   2a. Disconnect the spark plug lead and ground it to the engine block.

2b. Lean the mower to the muffler side of the engine. See Figure 2.6.

Figure 2.6

Fuel

1. Use clean, fresh fuel with a pump octane rating of 87 or greater.

- Stale or out-of-date fuel is the leading cause of hard starting issues.
- Pump octane ratings beyond 87 will not improve engine performance.

Fuel filters

Dirty fuel can clog the carburetor and introduce abrasive materials into the engine. To help prevent that, the MTD engine is equipped with a fuel filter.

1. Some of the early engines were equipped with a fuel filter placed between the fuel tank and the carburetor. See Figure 2.7.

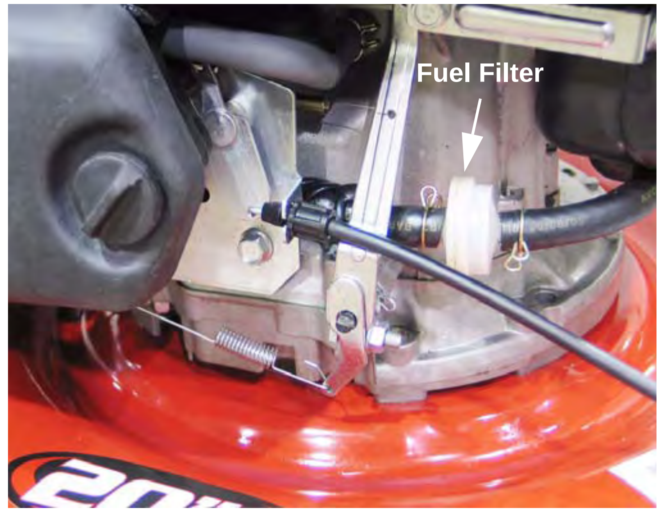


Figure 2.7

2. Currently the engines are being equipped with a fuel filter installed in the fuel tank where the feed line connects. See Figure 2.8.

Figure 2.8

Valve lash

Valve lash can be checked and adjusted using the following steps:

1. If the engine has been run, allow it to cool thoroughly. Position the mower for easy access to the cylinder head.
2. Disconnect the high-tension lead from the spark plug and ground it well away from the spark plug hole.
3. Remove the spark plug using a 13/16" or 21mm wrench. A flexible coupling or "wobbly" extension may help. See Figure 2.9.

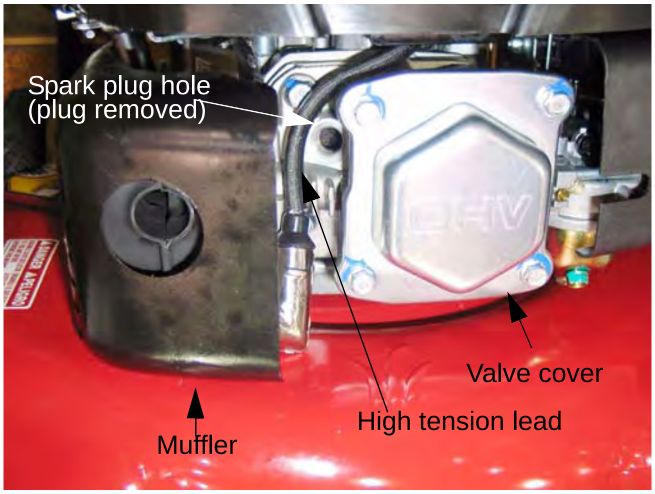


Figure 2.9

4. Remove the four bolts that secure the valve cover using a 10mm wrench, and remove the valve cover from the engine.

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

5. 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. Confirm that the piston is at Top-Dead-Center on the compression stroke. See Figure 2.10.

Figure 2.10

- TDC can be identified using the probe. The keyway in the PTO end of the crankshaft also corresponds with the crank pin (and piston) position.
- 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.

7. Check valve lash between each valve stem and rocker arm using a feeler gauge. See Figure 2.11.

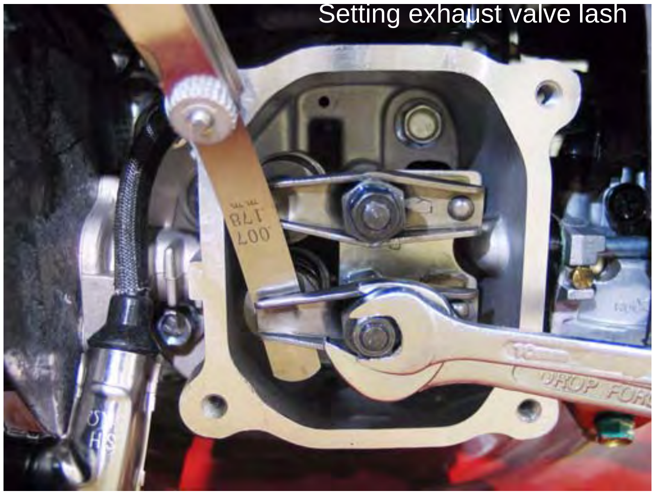
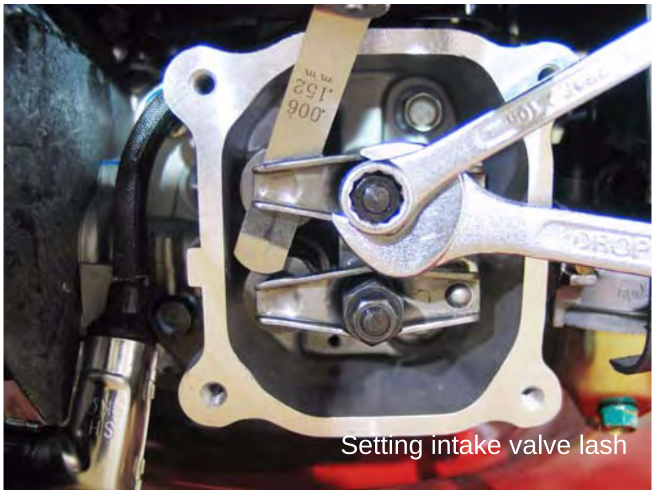


Figure 2.11

8. Intake valve lash (top valve) should be .003”-.005” (.10 ± .02mm).

9. Exhaust valve lash (bottom valve) should be .005-.007” (.15 ± .02mm).

10. Use a 10mm wrench to loosen the jam nut, and a 14mm wrench to adjust the rocker arm fulcrum nut. See Figure 2.12.



Setting intake valve lash

Figure 2.12

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

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

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

13. Rotate the engine through several compression cycles:

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

14. Clean-up any oil around the valve cover opening, clean the valve cover, replace the valve cover gasket if necessary.

15. Install the valve cover, tightening the valve cover screws to a torque of 62 - 80 in-lbs (7-9 Nm).

16. Install the spark plug.

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

Exhaust system

The exhaust system is a frequently overlooked component of an engine. it is important to make sure the muffle is in good condition and free of debris and/or insects.

> **NOTE:** A blocked muffler will result in poor performance. If a muffler is completely blocked the engine may not start.

Cleaning the engine

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

2. It is recommended to use compressed air to blow all of the debris off of the engine.

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

> **NOTE:** Debris can build up under the deck and cause the engine to operate under an unintended load.

Blades

A sharp, balanced, and well secured blade is important.

> **NOTE:** The blade also acts as a counter weight for the engine. An engine should never be started without a balanced blade firmly attached.

1. A **dull blade** will bludgeon the grass rather than cutting it.

- This results in poor cut quality because the grass is torn rather than cut, and the additional drag can pull-down engine RPMs when the mower is near the limits of its capacity.
- A dull blade makes the engine work harder, increasing operating temperature and fuel consumption, while decreasing engine life.
- A dull blade, in combination with other abuse issues may constitute abuse, voiding the warranty.

2. An **imbalanced or bent blade** (sometimes accompanied by a bent crankshaft) creates vibration.

- This vibration makes the mower unpleasant to use and will damage the mower.
- Typical complaints include parts falling-off.
- In extreme cases the engine crankcase or mower deck may crack or separate from each other.

CAUTION: Continued operation with a damaged blade or crankshaft will create safety issues.

CAUTION: Under NO CIRCUMSTANCES should a blade or crankshaft be straightened and re-used. Any dealer or operator who does so is subjecting themselves to extreme risk of injury and liability.

NOTE: Impact damage to the blade and/or crankshaft is not warrantable except as a victim part of a specific failure of the damaged mower. Examples would be a baffle or axle from the damaged mower coming loose and contacting the blade.

NOTE: Secondary vibration damage is not warrantable. A customer who continues to operate a mower with a damaged blade or crankshaft does so at their own risk.

3. Impact damage to the blade or crankshaft is often accompanied by impact damage to the flywheel or key. Flywheel and flywheel key damage are not warrantable, and will be considered abuse unless there is very specific evidence of a defect in material or workmanship on the part of MTD.

4. Use of non-OEM blades, blade adaptors, and hardware is not recommended for MTD mowers.

5. When it is necessary to tilt the mower, tilt it so that the carburetor is up. When tilting to the side, this will place the dipstick toward the ground. The mower may also be positioned on the bench as shown below, if the fuel tank is empty or the fuel cap is sealed. See Figure 2.13.

Figure 2.13

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

6. If the blade is removed for any reason, make a visual inspection of all blade mounting hardware. See Figure 2.14.

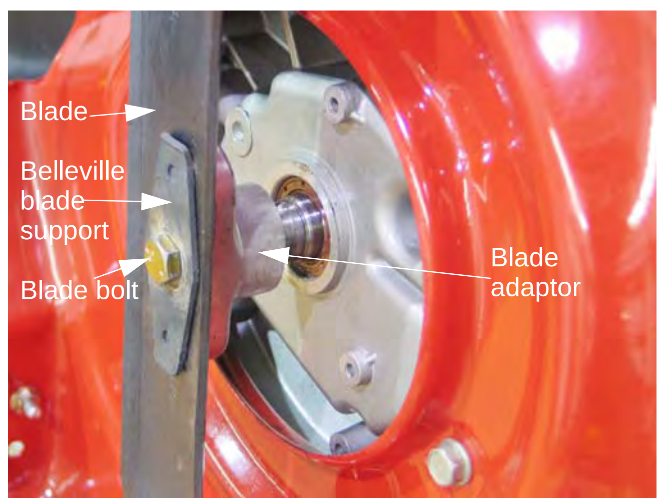


Figure 2.14

CAUTION: At no time should any part of the body be placed in the path that the blade would follow if it were to rotate.

7. When servicing the blade:

   7a. Replace any parts that are damaged or suspect.

   7b. Use a commercially available blade stop tool or a firmly positioned length of dimensional lumber to keep the blade from rotating during removal and installation.

   7c. Tighten the blade bolt to a torque of 450-600 in-lbs. (51-68 Nm).

   7d. Test run the mower in a safe area before returning it to service.

   NOTE: The rotating mass of the blade is important to the smooth operation of the engine.

   CAUTION: The engine will be difficult or impossible to start with the blade removed, and the resulting "kick-back" through the starter rope may cause painful hand injuries. Do not attempt to start the mower without a properly attached blade.

INITIAL TROUBLE SHOOTING

Troubleshooting an engine is an art form that is built upon several factors. First and most importantly is a good understanding of how the engine works. The second is skills that are honed by experience. Finally the use of visual observations and a structured, systematic approach to diagnosing a problem.

When approaching an engine to troubleshoot it, keep your eyes open and keep your mind clear. What does this mean, well if there is a puddle of oil under the engine their is no need to change the filters and spark plug to get it running. address the oil issue first. Also be aware of tunnel vision. Tunnel vision is when the mind is focused on one thing. A narrow focus can find one problem, but maybe there are more than one problem. A narrow focus allows for other problems to be overlook. An example could be focusing on a sheared flywheel key and overlooking the cracked fins on the cylinder. The two are unrelated, but both require attention.

The first step in troubleshooting is to confirm the problem:

- Does it start? Bad fuel, low compression, no spark, etc...
- Is it a hard start? Bad fuel, choke, fouled spark plugs, etc...
- Is the rope hard to pull? Engine seized, broken starter, etc...
- Does the rope jerk back as you pull it? Timing, bent crank shaft, etc...
- Does the engine surge when the engine is running? Carburetor issue, governor, etc...
- Does the engine lack power or running at a low speed? Bad fuel, carburetor, blocked muffler, etc...

Use these questions to narrow down causes of the engine problem.

> **CAUTION:** The first rule in diagnosing is to cause no further harm to the engine and prevent injuries. Always make sure to check the oil for level and condition before starting an engine. Also check blade and/or attachments for damage and make sure they are firmly mounted.

If the engine runs, but runs poorly start by performing the routine maintenance described in chapter 2.

Most gasoline engine diagnosis involves isolating problems in the four critical factors an engine needs to run properly:

- Ignition- sufficient spark to start combustion in the cylinder, occurring at the right time.
- Compression- enough pressure in the cylinder to convert combustion into kinetic motion. It also needs sufficient sealing to generate the vacuum needed to draw in and atomize the next intake charge.
- Fuel- correct type and grade of fresh gasoline; in sufficient quantity, atomized (tiny droplets) and in correct fuel/air proportions.
- Flow- if all of the above conditions are met, but the flow of air is constricted on the inlet or exhaust side it will cause the engine to run poorly or not at all. This also includes the ensuring the valves are timed to open at the proper time.

1. To isolate the ignition system and compression from the fuel system:

   1a. Prime the engine through the carburetor throat using a squirt bottle, filled with clean fresh gasoline.

   NOTE: Inspect the air filter while priming the engine. Look for a dirty or plugged filter that could prevent air flow or a missing filter that would indicate dirt ingestion.

   1b. Pull the safety bail back.

   1c. Attempt to start the engine.

   1d. If the engine starts and runs long enough to burn the prime, the problem is effectively isolated to the fuel system. proceed to the Troubleshooting the Fuel System section of this manual.

   1e. Check ignition system as described in the Troubleshooting the Ignition System section of this manual.

   1f. If the ignition system is working, check the compression.

2. To perform a compression test:

NOTE: Compression should be in the range of 45-95 PSI (3.1-6.5 Bar).

2a. If the engine has been run, allow it to cool thoroughly.

2b. Disconnect the high-tension lead from the spark plug and ground it well away from the spark plug hole. See Figure 3.1.

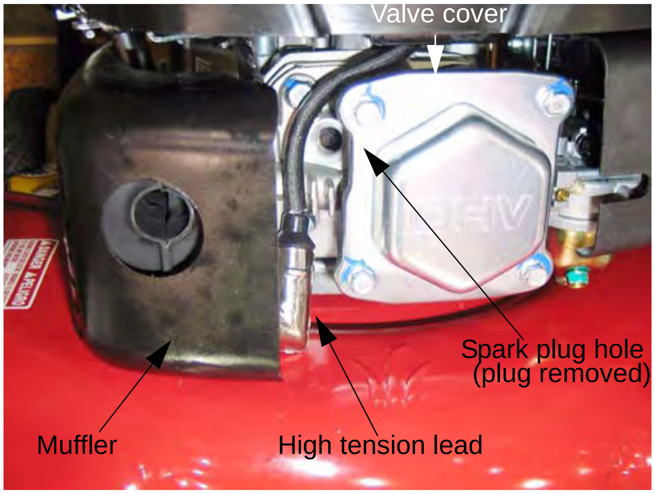


Figure 3.1

2c. Remove the spark plug using a 13/16" or 21mm wrench. A flexible coupling or "wobbly" extension may help.

2d. 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.

2e. Install a compression gauge in the spark plug hole.

2f. 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 to. See Figure 3.2.

Figure 3.2

Interpreting compression readings:

- Near Zero (< 20PSI [1.38 Bar]): most likely a stuck valve or too-tight valve lash, provided starter rope pulls with normal effort.
- Moderately low (20-45 PSI [1.38-3.1Bar]): 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 exhaust on throttle increase tends to indicate piston ring wear. Oil smoke in exhaust on over-run tends to indicate valve guide wear.
- Normal compression (45-95 PSI [3.1-6.5 Bar]) would indicate an ignition issue. Refer to the chapter on ignition systems.
- Too high compression (>95 PSI [>6.5 Bar]) most likely indicates excessive valve lash, negating the automatic compression release. It may also indicate a partial hydraulic lock or severe carbon deposits within the cylinder.

PCV testing

The PCV valve is located under the flywheel and allows the crankcase pressure to escape.

Leakage and blockage are the two failure modes for a PCV system. Either mode will cause crankcase pressure to build-up, though the effects of a blocked PCV are generally more dramatic. Increased case pressure will result in oil entering the combustion chamber.

1. The PCV chamber is vented to the air filter through a molded rubber hose. The rubber hose directs crankcase fumes to a covered duct within the air filter housing. See Figure 3.3.

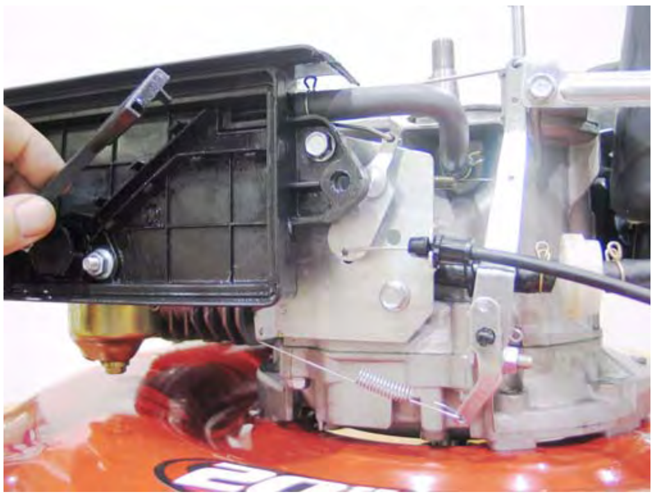


Figure 3.3

2. When functioning properly, the PCV valve (Positive Crankcase Ventilation) works with the inherent pumping action of the piston in the bore to expel extra pressure from the crankcase. See Figure 3.4.

Figure 3.4

- Normally, small engines run with slightly negative case pressure.
- This case pressure can be measured using a slack-tube water manometer, or an electronic version of the same tool.
- Less than (between zero and -1”) (-2.54cm) of water is a typical reading.

  NOTE: An adaptor can easily be made form an old or extra dipstick. See Figure 3.5.

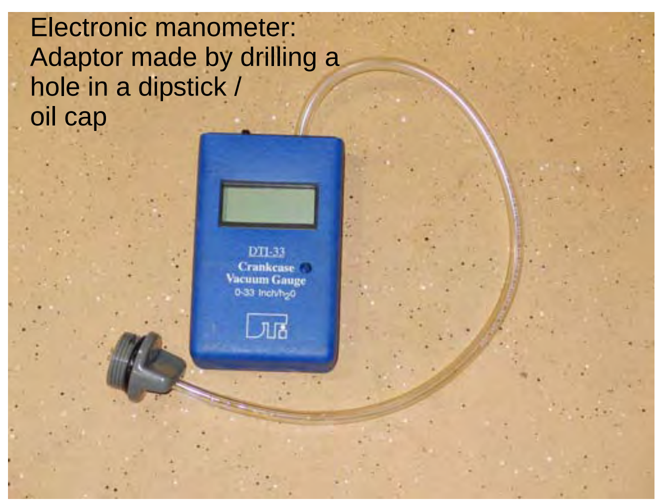


Figure 3.5

3. An engine that fails to purge extra case pressure in a controlled manner will build case pressure. The pressure will find it's own way out of the engine in undesirable ways.

- Oil will be forced by the rings and valve guides, being burnt in the combustion chamber.
- The cause of this oil burning can be mistaken for a worn-out engine, if proper diagnosis (compression, leak-down, and case pressure) is not performed.

4. Experimentation by MTD's Training and Education Department has revealed the following characteristics of MTD engines:

- A leaky PCV system will not build-up substantial case pressure.
- A leaky PCV system will allow the engine to ingest contaminants through the system, accelerating engine wear.
- A blocked PCV system will allow crankcase pressure to build very rapidly. Noticeable oil fumes will be evident in the exhaust within several minutes of normal operation.

5. The PCV chamber is accessible by removing the flywheel, as described in the IGNITION SYSTEM chapter of this manual. See Figure 3.6.

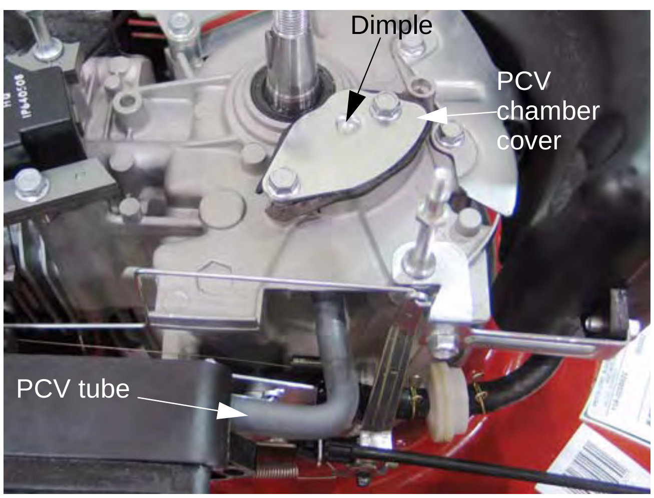


Figure 3.6

6. Remove the two screws that hold the PCV chamber cover to the engine block using a 10mm wrench.

7. The cover and gasket can be separated from the chamber. See Figure 3.7.

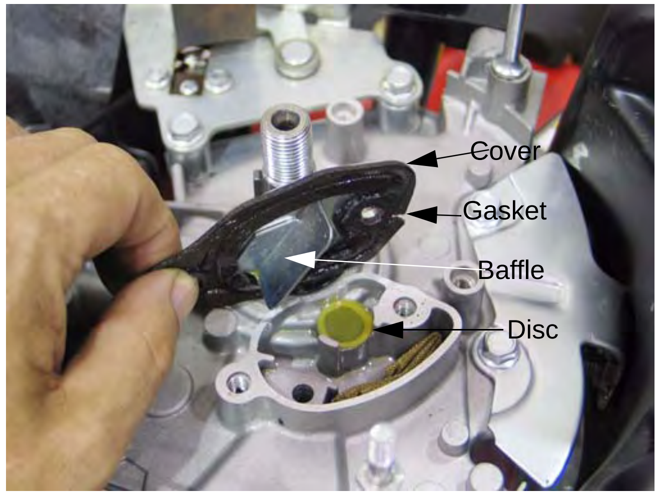


Figure 3.7

NOTE: The dimple in the cover helps locate the fiber disc over the port that leads into the crankcase.

NOTE: the baffle in the cover helps separate the oil from the air in the chamber. It is desirable to allow the air out, but important to keep as much oil as possible in the engine.

8. The disc acts as a check valve: pressure pulses force it off of the port, but it falls back over the port when the pressure drops.

9. The folded wire mesh in the chamber also helps separate the oil from the air. See Figure 3.8.

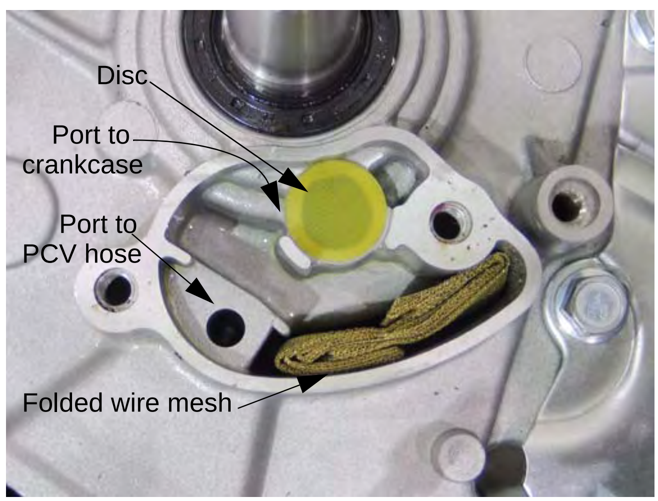


Figure 3.8

10. The port to the PCV hose is near the top of the chamber. The oil tends to settle out of suspension, leaving mostly air to exit the chamber through the PCV hose.

11. The screen accumulates droplets of oil, which eventually drip down to the bottom of the chamber. Beneath the screen is a drain-back port, leading to the crankcase. the size of the port is small enough that significant pressure does not flow through it. See Figure 3.9.

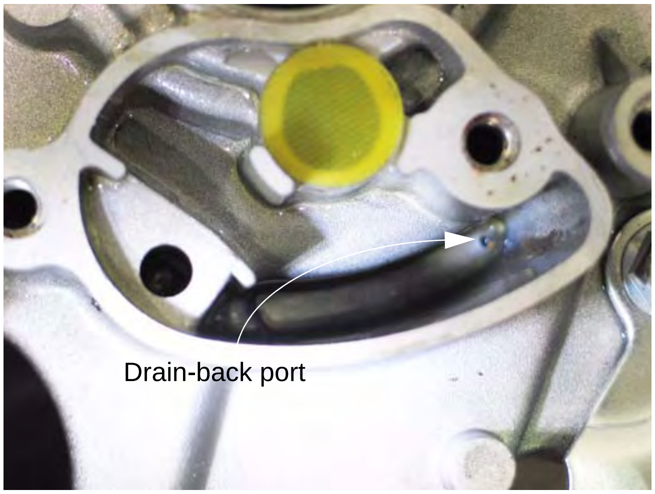


Figure 3.9

12. With the cover re-installed and torqued to 27-35 in-lbs. (3-4 Nm), vigorous pumping with a hand pump vacuum / pressure tester will result in a slight build-up of pressure within the chamber. See Figure 3.10.

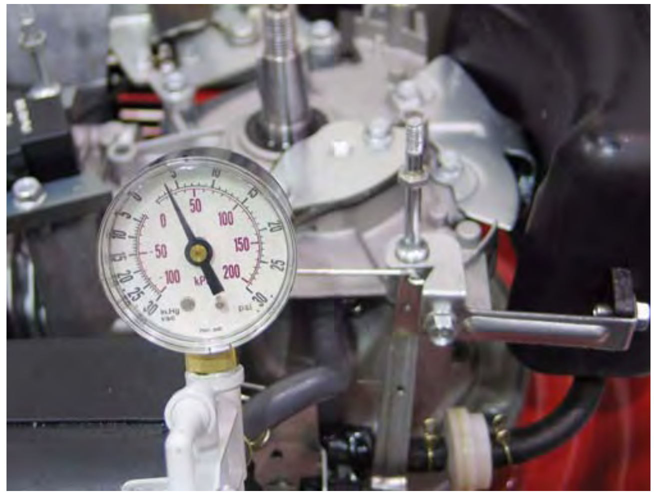


Figure 3.10

- This 2-3 PSI (.14-.20 Bar) build-up will dissipate through the drain-back port over the course of 5-10 seconds.
- No vacuum should accumulate in the chamber unless the drain-back port is blocked and the disc is not moving from over the crankcase port.

Starter rope stops pulling

A hard to pull starter rope is a fairly easy thing to diagnose, but is often misdiagnosed. There are a few reasons why a starter rope is hard to pull, don't assume the engine is seized without troubleshooting it first.

Trouble shooting a hard to pull starter rope.

1. Check for hydraulic lock

   NOTE: Hydraulic lock or hydro-lock as it is more commonly called, it the collection of liquids in the combustion chamber.

   1a. Remove the spark plug and pull the starter rope.

   1b. If the rope can now be pulled, there was a hydro lock in the engine. Start the engine and let it run. It will smoke until all the excess fluids are burned away.

   NOTE: Possible causes of hydro lock include: tipping the engine, overfilling the engine, leaking carburetor or possibly bad piston rings.

   NOTE: If an engine has been submerged, change the fuel, oil and all filters. If the engine will start after that, start it and let it run to burn out the rest of the contaminates. Change the oil every fifteen minutes or so, until all signs of contamination are gone.

2. Turn the blade.

   2a. Check for and remove any material that maybe binding the blade.

   2b. Check for any material that could be trapped in the blade brake that could be binding the flywheel. See Figure 3.11.

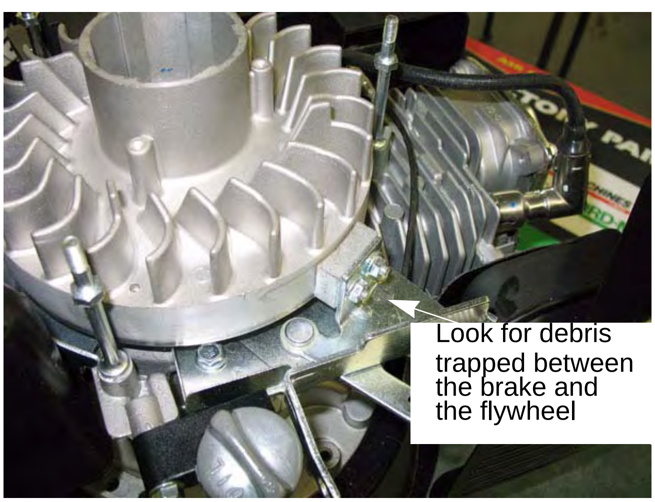


Figure 3.11

   2c. To isolate the starter from the engine, with the spark plug removed turn the blade.

   2d. If the blade turns easily, the starter is the cause of the hard pull.

   2e. If the blade does not turn, there is an internal engine failure. Further examination of the engine will be required.

Starter rope is hard to pull (jerky)

A hard, jerky pull could be a couple of things, timing or compression release.

1. Check the valve lash.

   NOTE: A pull that gets hard then releases could be in the compression releases. In order to make the engine easier to pull start a compression release (ACR) is employed in the MTD engines. The ACR is on the cam shaft and "bumps" the exhaust valve to bleed off compression and automatically releases when the engine starts. If the valve lash is too loose, the exhaust vale will not bleed off compression .

2. Inspect the flywheel.

   NOTE: If the rope is jerked away violently, that generally indicates timing. Inspect the flywheel for a sheared flywheel key.

3. If the two above conditions were ok, then open the engine and look at the ACR on the cam shaft. See Figure 3.12.

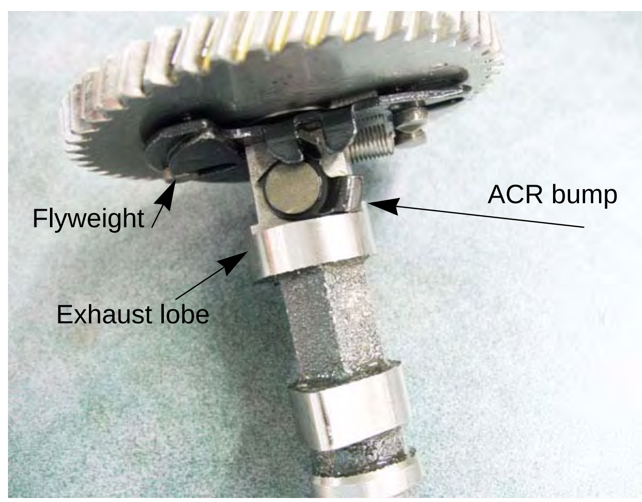


Figure 3.12

   NOTE: If the flyweight is stuck in the out position, there will be no compression release. If the flyweight is stuck in he retracted position, the engine will have no power.

4. Check the cam timing.

   NOTE: There are timing marks on the crank shaft and the cam. when the crank shaft is at TDC, the cam should be at TDC of the compression stroke as noted by having the intake and the exhaust lobes equally away from the tappets. See Figure 3.13.

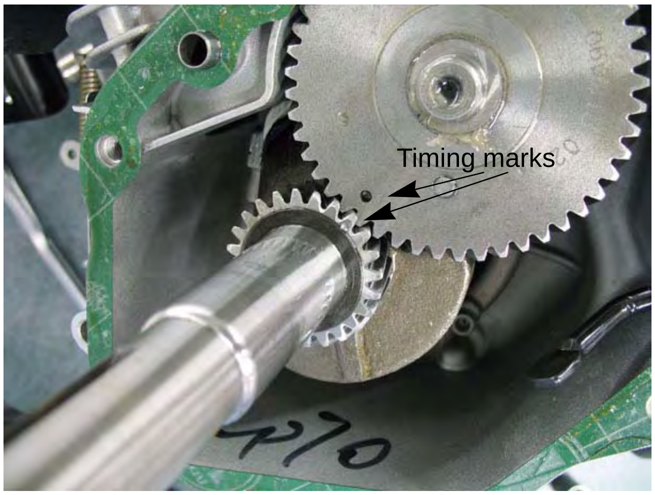


Figure 3.13

NOTE: The cam gear may be a polymer gear. Use the same procedure for both.
See Figure 3.14.

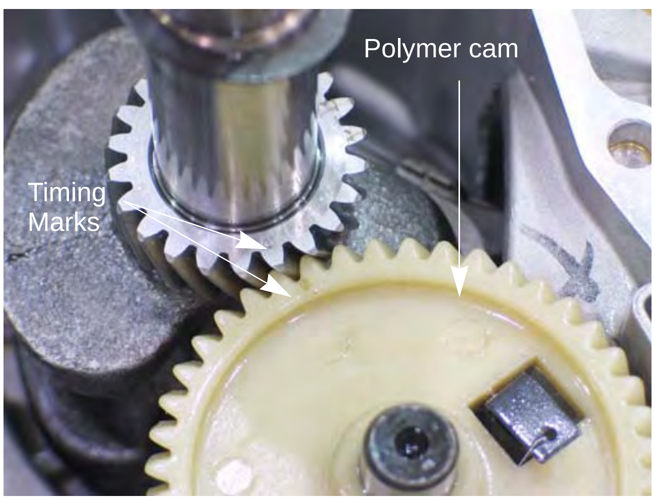


Figure 3.14

TROUBLESHOOTING THE IGNITION SYSTEM

The purpose of the ignition system is to provide a spark in the combustion chamber at the proper time to ignite the fuel/air mixture. The first step in troubleshooting the ignition system is to examine the spark plug(s).

About the spark plug:

- The spark plug is a Torch model F7RTC, gapped to .024"-.032" (.60-.80 mm).
- 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 for 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.

Cleaning the spark plug:

- Cleaning the spark plug is not recommended. If the plug needs to be cleaned, replace it.
- Use of a wire brush may leave metal deposits on the insulator that cause the spark plug to short-out and fail to spark.
- Use of abrasive blast for cleaning may damage the ceramic insulator or leave blast media in the recesses of the spark plug. When the media comes loose during engine operation, severe and non-warrantable engine damage may result.

Inspection of the spark plug

Inspection of the spark plug can provide indications of the operating condition of the engine.

- Light tan colored deposits on insulator and electrodes is normal.
- Dry, black deposits on the insulator and electrodes indicate an over-rich fuel / air mixture (too much fuel or not enough air)
- Wet, black deposits on the insulator and electrodes indicate the presence of oil in the combustion chamber.
- Heat damaged (melted electrodes / cracked insulator / metal transfer deposits) may indicate detonation.
- A spark plug that is wet with fuel indicates that fuel is present in the combustion chamber, but it is not being ignited.

1. Test the ignition system:

After examining the spark plug reinstall it or a new one to ensure a good spark plug is being used. Now the ignition can be tested to verify spark is getting to the spark plug. To test the system:

1a. Disconnect the spark plug wire.

1b. Connect a spark tester to the spark plug wire.

1c. Connect the other end of the spark tester to the engine block. See Figure 4.1.

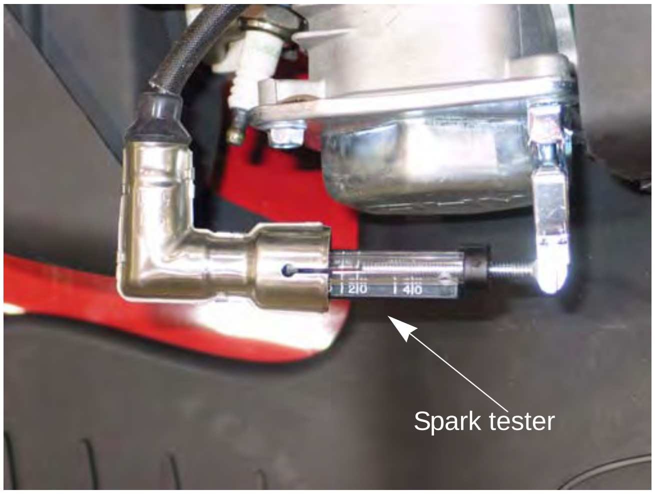


Figure 4.1

CAUTION: Never remove the spark plug and hold it against the cylinder head to test for spark. The fuel/air mix coming out of the spark plug hole will catch on fire.

NOTE: The spark should be a minimum of 10 Kv (10,000 volts) at pull over speed.

1d. Squeeze the safety bail and pull the starter rope. Watch the spark tester. If sparks are seen in the spark tester, the ignition system is working. Replace the spark plug.

1e. If no sparks are seen in the spark tester further testing is required.

2. Test the stop switch:

The stop switch for the MTD engine is located on the engine brake. It is designed to ground out the module when the brake is applied.

To test the stop switch:

2a. locate the terminal that connects the stop switch wire to the primary windings of the ignition module. See Figure 4.2.

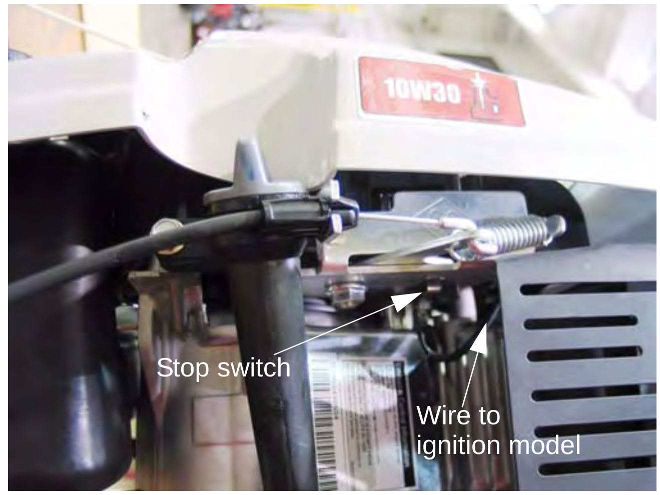


Figure 4.2

2b. Connect an Ohm meter between the terminal and a ground point. The reading should approach zero when the bail is released, closing the contacts. See Figure 4.3.

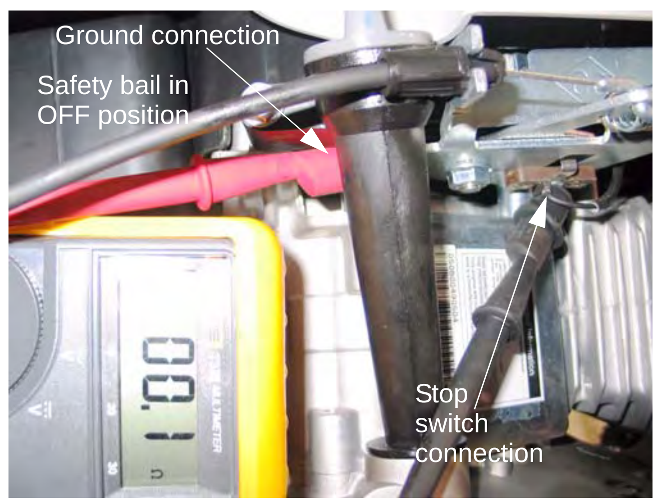


Figure 4.3

NOTE: If the reading is high, the contacts may be burnt or there is a bad ground to the switch. This could prevent the engine from shutting down rapidly.

2c. The reading should be high when the bail is pulled down, reflecting the resistance in the primary windings of the ignition module. See Figure 4.4.

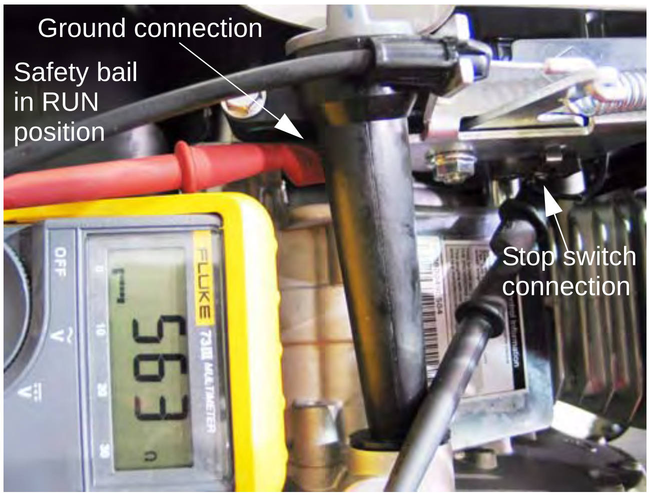


Figure 4.4

NOTE: If the reading is low, the module is shorted to ground and may not produce a spark. The wire will need to be traced back to the module to find the short.

2d. Alternatively, a jumper wire could be connected to the same locations. Use a commercially available spark checker to see if the ignition is working or not.

- If the jumper disables the ignition, but releasing the bail does not, the problem lies in the switch.
- If the jumper does not disable the ignition, then the wire that connects the switch to the ignition may have a fault, or the ignition module itself may be faulty. Further investigation is required.
- If the problem is a lack of spark when the bail is pressed against the upper handlebar, disconnect the wire from the switch using a 7mm wrench. Isolate the wire from incidental contact with ground, and test the ignition. If it fails to spark, the wire may be shorted or the ignition may be at fault. Further investigation is required.

2e. If further investigation is required, remove the recoil assembly. See Figure 4.5.

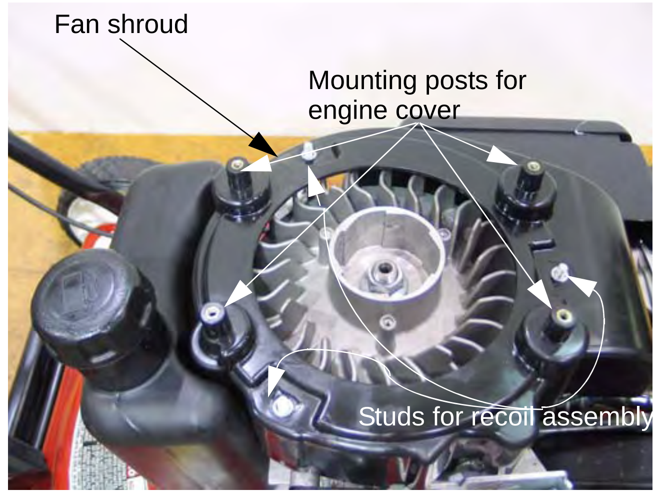


Figure 4.5

2f. Lift the fan shroud off of the studs that locate it.

2g. Visually trace the wire from the stop switch to the spade terminal on the module, and inspect the wire for any damaged insulation or potential contact with ground.

2h. Unplug the wire from the spade terminal on the module, and check continuity to ground from the female spade terminal on the wire. Resistance (Ohms) should be zero with the bail released. See Figure 4.6.

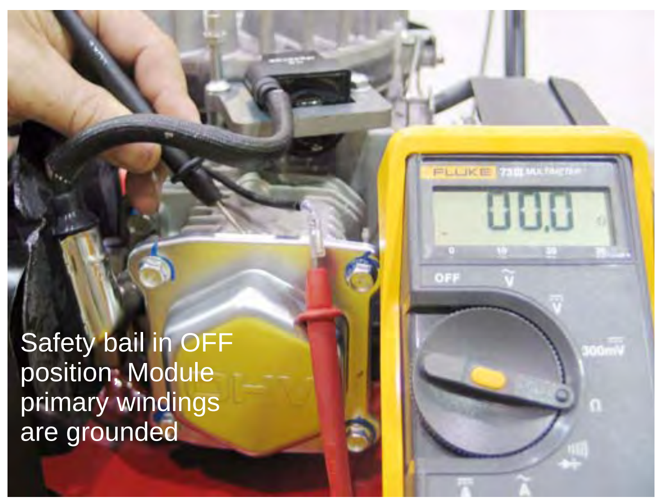


Figure 4.6

2i. Resistance (Ohms) should be infinite (O.L) with the bail released. See Figure 4.7.

Figure 4.7

2j. If the switch and wire work properly, and the connection is good at the spade terminal, but releasing the bail fails to stop the engine, then the problem lies within the module.

3. The module

The ignition system is a capacitive discharge magneto, contained in a single module.

- The magneto is a three leg design.
- The magneto is energized by the passing of a pair of magnets mounted in the flywheel.
- Ignition timing is set by the location of the fly-wheel in relation to the crankshaft. Proper timing is maintained by a steel key.

3a. Normal performance of the coil is to produce at least 10,000 volts at starter-rope pull-through speed. See Figure 4.8.

Figure 4.8

3b. Presence or absence of strong spark, with the stop switch and wire known to be good, is generally enough to identify the ignition coil as good or bad. Resistance readings may help confirm the source of the failure, but are generally unnecessary.

NOTE: Presence of a weak spark maybe the result of an improper air gap. The air gap should be .008”-.016” (.2-.4mm).

3c. It is possible for the transistorized portion of the module to fail, yet resistance tests will show the windings to be good. A simple spark-gap tester is will give an adequate indication of the ignition system’s condition.

3d. Simple spark-testers are readily available and inexpensive. Thexton Part # 404 is available form a variety of retailers, and similar units are available form other manufacturers. See Figure 4.9.

Figure 4.9

3e. At operating speed, the ignition should produce voltage approaching 12,000. See Figure 4.10.

Figure 4.10

3f. At pull-over speed (~ 600 RPM), voltage should be at least 10,000V. See Figure 4.11.

Figure 4.11

NOTE: Flash-over voltage will vary with spark plug condition and gap.

NOTE: Pull-over speed may vary from operator to operator.

3g. Resistance in the primary windings of the ignition module, measured between the spade terminal and the laminations, was observed to be in the 550-650 Ω range. See Figure 4.12.

Figure 4.12

3h. Resistance in the secondary windings of the ignition module, measured between the spark plug terminal and the laminations, was observed to be in the 8K-9KΩ range. See Figure 4.13.

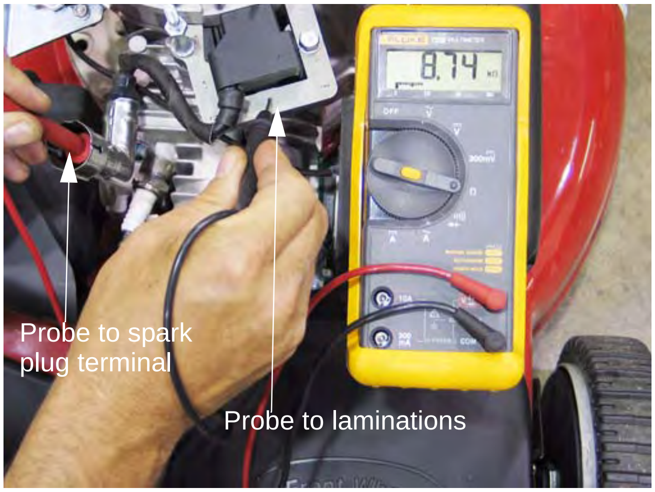


Figure 4.13

NOTE: There may be slight variation in specification due to production variation and other factors such as temperature.

- Resistance figures that are vastly lower may indicate a short in the windings being tested.
- Resistance figures that are vastly higher (or O.L) may indicate a fault in the windings being tested.

NOTE: Intermittent failure requires tests for voltage and resistance to be made when the engine is cold, and again when it is hot. Typical customer complaint: “It stops after I mow for 10 minutes and I can’t get it to re-start”.

- To confirm that the problem is ignition-based, it is necessary to “catch it in the act”.
- Resistance normally increases slightly as temperature increases.

NOTE: Failure of the magnets in the flywheel is exceedingly rare. To test the magnets, simply hold an item made of ferrous metal roughly 1/4” (.635cm) away from the magnets in the flywheel. It should be drawn to the flywheel. A wrench or screwdriver is suitable for this test.

NOTE: An inexpensive compass or bar magnet can be used to confirm opposite polarity of the flywheel magnets. See Figure 4.14.

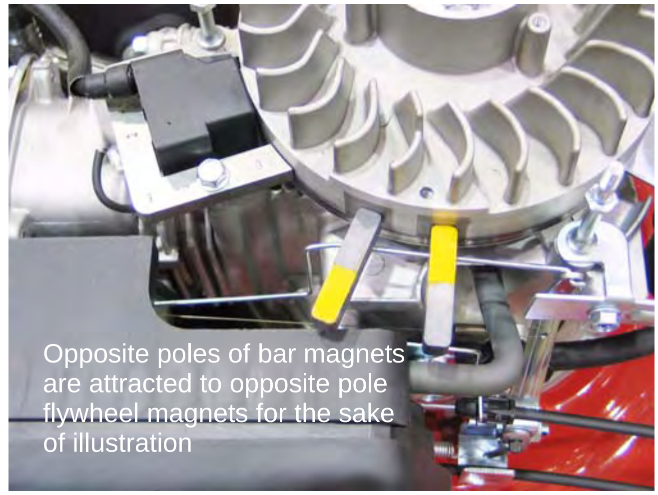


Figure 4.14

4. Inspect the flywheel.

The flywheel is a frequently forgotten component of the ignition system. It holds the magnets that induce a field in the module which in turn produces a spark. But it also controls the timing of the ignition system by controlling when the magnets are introduced to the module.

A sheared flywheel key will throw off the ignition timing. To inspect the flywheel and key:

4a. Remove the recoil assembly.

4b. Lift the fan shroud off of the three studs that locate it. See Figure 4.15.

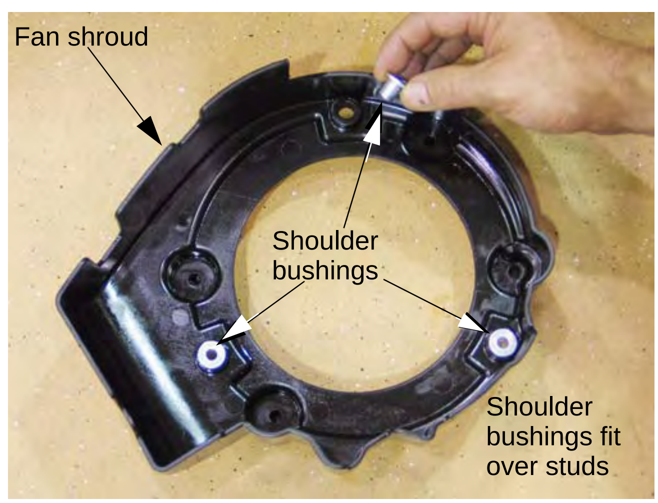


Figure 4.15

4c. To remove the flywheel, remove the flywheel nut using a 19mm wrench. See Figure 4.16.

Figure 4.16

4d. Hold the safety bail down using a spring clamp, and remove the flywheel using an appropriate puller.

CAUTION: If the flywheel shows any signs of physical damage such as cracks, broken vanes, or damaged key-way, replace it. A damaged flywheel poses a threat of burst failure. Burst failures are extremely hazardous to surrounding people and property.

4e. Inspect the key, keyway, and tapered mating surfaces of the flywheel and crankshaft. See Figure 4.17.

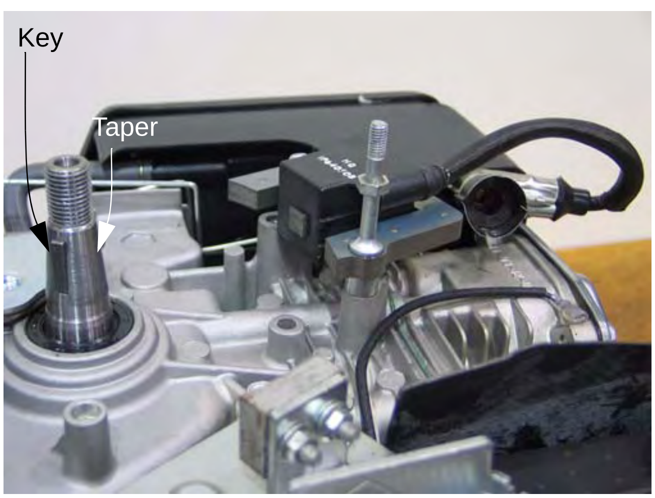


Figure 4.17

4f. On installation, confirm that the key is properly seated in the key-way, and that the tapers are fully seated. Key or keyway failure may result from improper seating.

IMPORTANT: The flywheel and the tapper on the crank shaft must be clean and dry. The flywheel is held in place by the friction fit between the flywheel and the crank shaft, not the key. The key is only to guide the flywheel to the proper position until it is torqued down.

4g. Install the flywheel nut to a torque of 47-52 ft-lbs. (64-70 Nm).

4h. Use a 10mm wrench to adjust the air gap between the module and the flywheel.

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

TROUBLESHOOTING THE FUEL SYSTEM

The function of the fuel system is to store, mix the fuel with air and deliver it to the combustion chamber. The fuel system consists of the following components:

- Fuel tank
- Fuel lines
- Fuel filter
- Carburetor

Inspecting the fuel:

NOTE: The fuel is the maintenance item most often overlooked by consumers. A lot of fuel systems problems are caused by bad gas. When inspecting the fuel:

- Look for water.
- Look for dirt.
- Look for discoloration.
- Sniff carefully to see if it smells like varnish or kerosene.
- Save the fuel to show to customer.
- Look for oil in the fuel.
- Test the fuel for alcohol content if there is a reason to suspect it.

NOTE: Save a sample of the fuel collected to show the customer.

NOTE: Customers pouring engine oil into the fuel tank seems to be a growing problem.

1. Get a plain piece of paper.
2. Divide it into four sections and label them:

- Plain gas
- Gas/oil mix
- Gas from carburetor
- Straight oil

3. Get a sample of fuel from the carburetor and pour it on the section of the paper labeled sample from carburetor. See Figure 5.1.

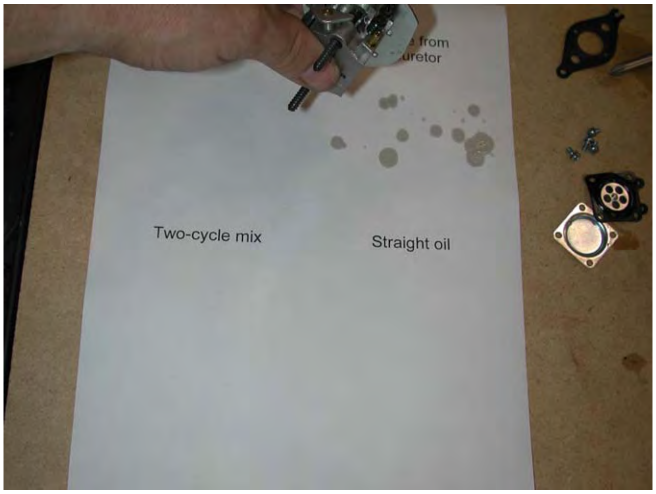


Figure 5.1

4. Place a sample of gas/oil mix where it says gas/oil mix, straight gas with straight gas and straight oil with straight oil. See Figure 5.2.

Figure 5.2

5. Match the sample from the carburetor to the other three samples. This will show if there is oil in the fuel or not. See Figure 5.3.

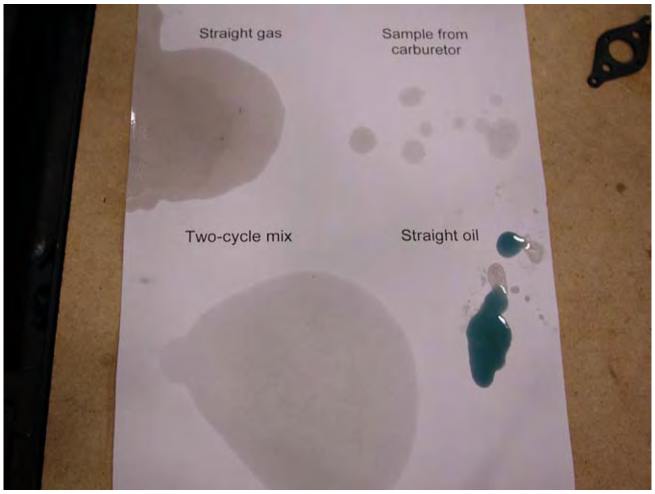


Figure 5.3

Test fuel for alcohol:

Gasolines, currently on the market are not pure gas. Today's fuels have alcohol and other additives in them to reduce emissions. The fuel make up can vary seasonally and geographically. It is hard to find a good quality fuel and unfortunately the fuel has to be purchased before the quality is known.

Alcohol in fuel creates a lot of problems for gasoline engines. The biggest problem is that alcohol attracts and holds water. This corrodes the metal components of the fuel system, especially the carburetor. Alcohol also does not produce as much heat as gasoline when burnt. This results in less power for the engine.

A 10% alcohol mix or a 15% of MTBE is acceptable for MTD engines. Anything higher than that will result in performance issues.

> **NOTE:** E85 fuels are not to be used in any MTD engines.

There are several alcohol test kit available commercially. See Figure 5.4.

Figure 5.4

Generally these kits involve mixing a measured amount of water and gas together and seeing were the boundary layer is. See Figure 5.5.

Figure 5.5

The test kit should come with a chart to compare the boundary layer height to alcohol percentage.

Fuel tank vent

The fuel tank vent preforms the important task of allowing air into the fuel tank as fuel is being used. As fuel is being used by the engine, the fuel level in the tank drops. The dropping fuel level then creates a vacuum in the tank. If the fuel tank could not suck air through the vent, the vacuum would prevent the fuel from getting to the carburetor.

The tank is vented through the cap. See Figure 5.6.

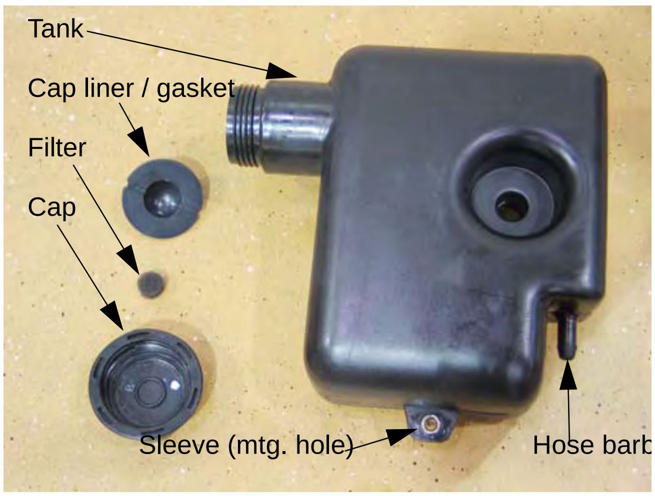


Figure 5.6

To test the cap vent

1. A hand-pumped vacuum / pressure tester may be connected to the fuel barb (after draining). See Figure 5.7.

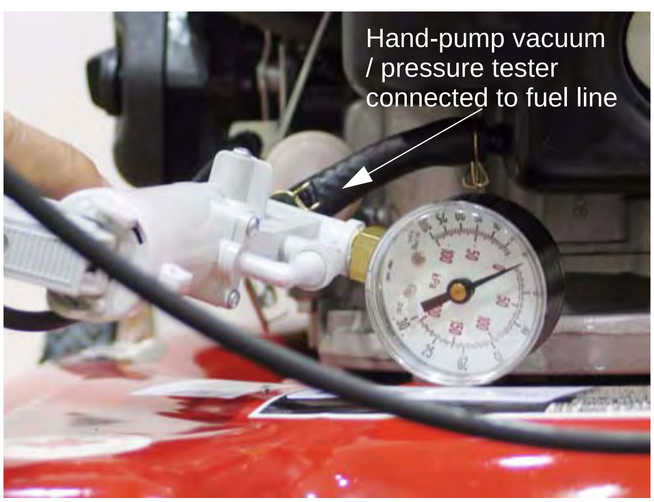


Figure 5.7

2. The tank should not hold any pressure nor any vacuum.

- Replace the cap if either pressure or vacuum builds using the hand-pump tester.
- A cap that maintains pressure will cause the engine to run rich as the fuel in the tank heats and expands, forcing it's way past the float valve in the carburetor.
- A cap that maintains vacuum will cause the engine to run lean as the fuel is depleted and no air comes in to replace it.
- The two conditions may both be present, but the symptoms vary with fuel, fuel level, and operating conditions.
- Usually presents as a "Runs and quits" scenario.

Chokes

All MTD engine are equipped with a manual choke to help start the engine. The choke must be closed to start the engine and opened when the engine starts. This can be a source of starting issues with customers who are not familiar with manual chokes.

The choke is operated by a pull knob on the handle bar. If the choke plate fails to close fully when the knob is pulled, the mower will be difficult or impossible to start when cold.

NOTE: The rod connecting the choke lever to the choke arm on the carburetor can be bent slightly to facilitate adjustment. See Figure 5.8.

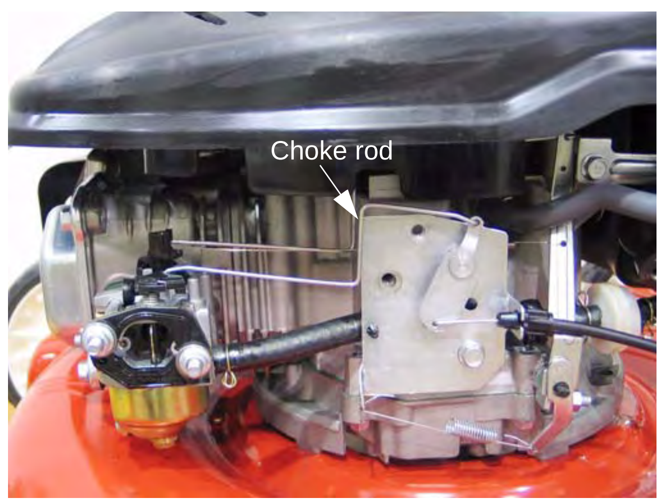


Figure 5.8

TROUBLESHOOTING THE FUEL SYSTEM

Inspect the fuel filter:

The fuel filter is located in the fuel tank. It can be removed and cleaned with a can of carb cleaner or replaced. See Figure 5.9.

Figure 5.9

Inspect the fuel lines:

- Are they cracked?
- Are they clogged?
- Are they brittle?

  NOTE: If the answer to any of the above is yes, replace the fuel lines.

Carburetors

Troubleshooting the carburetor is a process of elimination. If everything else on the engine checks out, the carburetor is probably bad.

> **NOTE:** It is important to perform a compression test before condemning a carburetor. An engine can have a borderline compression reading and not create enough of a vacuum to draw in a sufficient fuel/air charge.

> **NOTE:** If the engine has border-line compression, a quick test to see if that is the problem is to remove the spark plug. Squirt a little bit of oil into the combustion chamber to seal the rings. Reinstall the spark plug. If the engine starts and runs ok, the that was the problem. If it does not start, move on to the carburetor.

Inspecting the carburetor:

1. Remove the float bowl and check for dirt and/or varnish.
2. Inspect the needle valve and needle valve seat for dirt and/or damage.
3. Inspect the gaskets and O-rings for damage.
4. Inspect the vents and orifices, verify that they are free of debris.
5. Check the height of the float, adjust as necessary.

   NOTE: If a little cleaning and new gaskets will fix the carburetor, do it. If the carburetor requires extensive cleaning it is better to replace the carburetor.

   IMPORTANT: Never try to mechanically clean orifices. That will damage them and ruin the carburetor.

FAILURE ANALYSIS

A properly maintained engine will provide years of service. Occasionally an engine will fail. An important part of working on engines is finding out why they failed. Was it something the customer did? Was it a manufacturing defect? Did the engine just wear out? All of these questions need to be answered when a failed engine is found.

Engines can fail in a variety of ways but most failures can be classified in the following categories:

- Abrasive ingestion
- Insufficient lubrication
- Over heating
- Over speed
- Mechanical breakage/ wear

  NOTE: There may be a combination of failures.

Finding the cause of an engine failure requires the complete disassembly of an engine and careful examination of the parts.

With a good understanding of how the engine works, close examination of the parts and experience, an understanding of why the engine failed can be reached.

Abrasive Ingestion

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, through a dirty oil fill plug or by particles of metal that wore off of a part, especially during the break in cycle. Particles may also be introduced through worn or improperly installed seals or gaskets.

1. Abrasive particles that enter the engine through the intake system can be sand or dirt. See Figure 6.1.

Figure 6.1

2. An abrasive particle can enter the engine by bypassing an improperly installed air filter or through leaks in the intake system. Usually there will be tracking marks were the particles enter the system. Use these marks to find the source of the abrasives.

   NOTE: Dirt can also work its way through a poorly maintained air filter. See Figure 6.2.

Figure 6.2

3. Particles that enter the intake system travel at great speed and act like sand blasting media inside the engine. This causes wear to the parts affected.

   NOTE: Choke and throttle shafts are very vulnerable to this wear. If an air filter becomes clogged, the vacuum produced by the engine will try to draw air in by any means possible. This usually happens around the throttle and choke shafts. Because the throttle shaft moves more than the choke, it will wear faster.

4. The particles can pass through the intake system to the valves and valve seats.

5. 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 cylinder wall, piston and piston rings

6. 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.

   NOTE: To help in the lubrication of the cylinder walls, and help with the seating of the piston rings, a diamond cross hatch is honed into the cylinder wall. Debris entering the cylinder will polish the cross hatch off of the cylinder wall. See Figure 6.3.

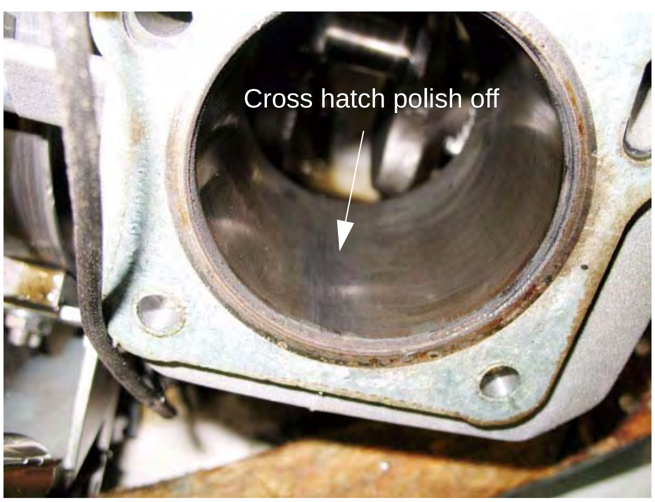


Figure 6.3

NOTE: Abrasives that enter the engine through the intake system will cause the upper portion of the combustion chamber to wear more than the lower portion. Measurements of the cylinder bore at the top and bottom will show this.

Other sources of abrasives that get into the engine includes carbon that builds up on the top side of the piston, metal shavings from the wear of engine parts or dirt entering through the oil fill port. leaking gaskets and seals also have the potential of allowing debris to enter the engine.

A symptom of abrasive ingestion is smoky exhaust. As the cylinder walls wear pressure from the combustion chamber blows by the piston and pressurizes the engine sump. This pushes oil past the piston rings and into the combustion chamber where it is burnt. See Figure 6.4.

Figure 6.4

7. Abrasive materials that enter the engine get absorbed by the oil and thickens it. See Figure 6.5.

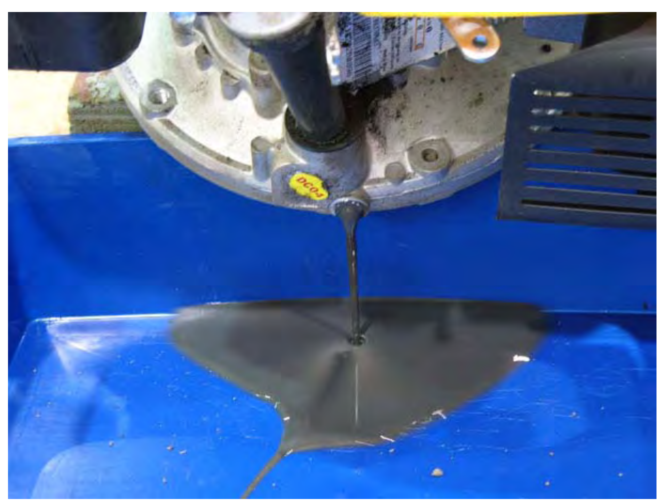


Figure 6.5

8. Because the oil absorbs the abrasive particles, the engine components that are immersed in oil will show definite signs of abrasive ingestion especially around the connecting rod and main bearing journals. See Figure 6.6.

Figure 6.6

NOTE: Abrasives that are trapped in the oil will cause the lower portion of the combustion chamber to wearing more than the upper portion.

NOTE: Wear of only one bearing surface on a new engine could be a sign of a manufacturing defect.

NOTE: Abrasive particles can also be imbedded into materials that are softer than the abrasive. This will cause the affected part to act like a piece of sand paper or a grinding wheel. See Figure 6.7.

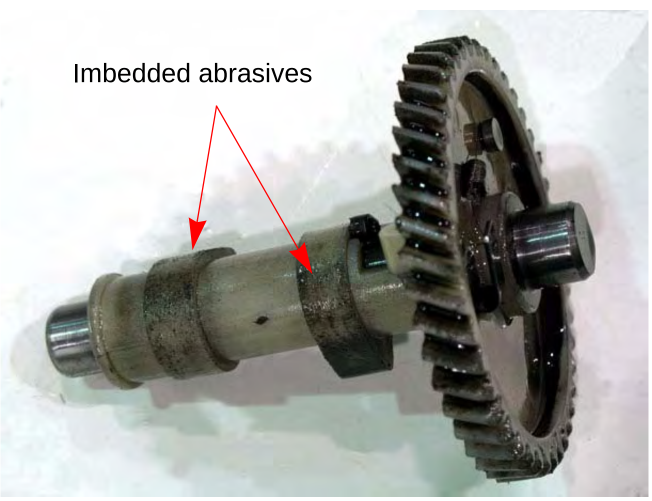


Figure 6.7

Insufficient lubrication

The bearing surfaces in an engine are not smooth. As a result of the machining processes to make the engine parts, there are little peaks and valleys that are only visible on a microscopic scale. These peaks are called asperities. As the engine breaks in, the asperities break off leaving plateaus that become the bearing surface. The valleys become reservoirs for the lubricant.

When the parts are at rest, they push the lubricant or oil away resting on the bearing surfaces. As the parts rotate, they climb over the oil, pulling the oil between the bearing and the part, riding on a film of oil.

When there is insufficient lubrication, the parts make contact with the bearing surfaces while in motion. This creates friction which creates heat. That will lead to the asperities welding to the moving part, which leads to more friction and starts all over again. As more asperities weld to the moving part, they remove material from the bearing, which looks like gouging or galling.

Insufficient lubrication can be a result of several factors: not enough oil in the engine, contaminates in the oil, wrong oil viscosity, oil break down from age, breakdown of the additives in the oil or oil breakdown from heat.

When examining an engine, metal to metal transfer is a sure sign of insufficient lubrication. Metal to metal transfer only occurs when there is a lack of lubrication. See Figure 6.8.

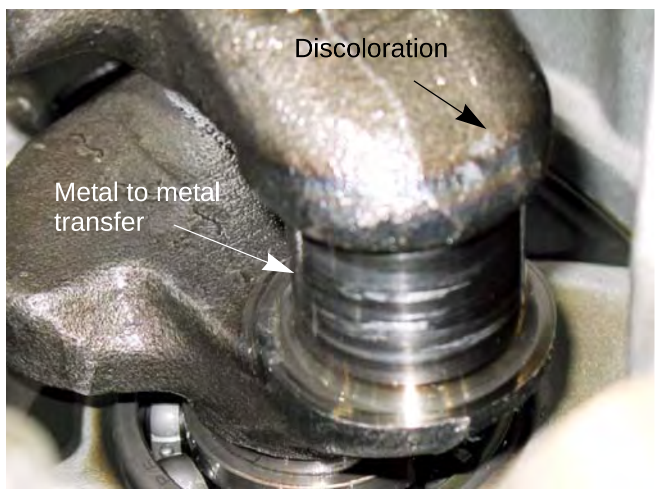


Figure 6.8

An important thing to note is that just because there are signs of insufficient lubrication, that does not mean that was the cause of the failure. It may only be a symptom of the real cause of the failure.

Larger size abrasive particles can render the lubricants ineffective, leading to an engine failure. An overheated engine can cause the oil to break down leading to a failure. In an engine overspeed, the oil is pushed away from the bearing surface leading to a failure.

In all three of the above cases, the signs of insufficient lubrication are symptoms not the cause. There will also be signs of heat or discoloration around the parts affected by the lack of lubrication. See Figure 6.9.

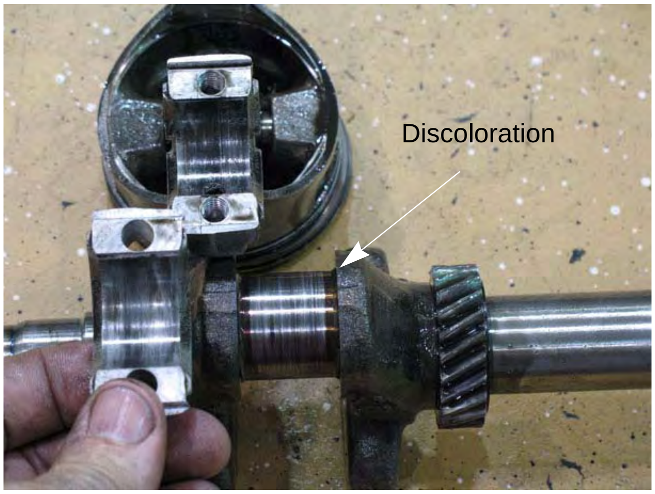


Figure 6.9

Engine Overspeed

The MTD engine is designed for a maximum speed of 3300 rpm. When the governor is unable to control the engine rpm the engine can accelerate past the safe maximum speed.

When an engine runs beyond its designed speed a couple of things happen. The first is vibrations develop. All engines have vibrations and are designed to handle those vibrations, but in overspeed the vibrations change resonance. Parts that can not handle the new resonance will crack. This may result in parts flying off of the engine which is an unsafe condition.

The vibration can also lead to fasteners loosing up. Evidence of this could be elongated mounting holes. The area around the mounting holes may be polished due to the two surfaces rubbing against each other. See Figure 6.10.

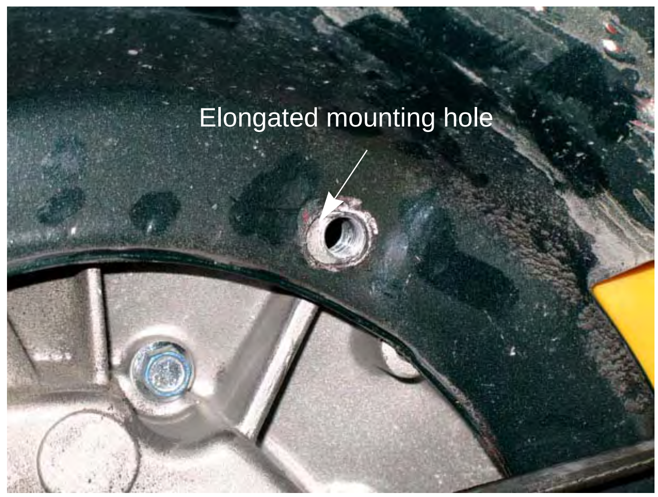


Figure 6.10

The other part of an overspeed condition is the internal failures. Overspeed failure can be challenging to figure out due to the multiple failures involved.

When an engine overspeeds, the oil on the bearing surfaces is flung away allowing metal to metal contact. This will show signs of inadequate lubrication.

Another sign of an oversped engine is a broken connecting rod. As the piston moves up and down in the cylinder it builds momentum. The higher the rpm's the more momentum produced by the pistons. As the momentum builds, the connecting rods will start to stretch. When the connecting rods stretch, they get weaker. Generally speaking this is at the narrowest part of the connecting rods. On most engine that would be about an inch below the wrist pin, but on the MTD engine it is at the wrist pin.

The force on the connecting rod is greatest when the piston transitions from the upward stroke to the downward stroke. Because of this, most overspeed connecting rod failures will occur with the piston at top dead center.

When a connecting rod fails, the piston stops moving but the crankshaft is still moving. This will allow the broken connecting rod to get knocked around in the cylinder causing more damage to it. Usually the connecting rod will be in several pieces after it breaks making it hard to find where the first failure was.

When trying to diagnose an overspeed failure, look at all the pieces. Individually the lack of lubrication, piston position and condition of the connection rod will usually indicate separate failures. Collectively they would indicate an overspeed failure.

Overheated

The MTD engines are air cooled engines. Because of this cleanliness of the engine is very important to the life of the engine. Dirt, grass and sludge all form an insulating layer on the engine. This will trap the heat in the engine and cause it to over heat.

A sign of an overheated engine is discoloration. The discoloration is usually due to material being baked into the metal. On the outside of the engine that could be dirt or grass. As the metal heats up it cooks down the debris on the engine and the pores of the metal open up. this allows the cooked down material to soak into the metal discoloring it.

Inside the engine the metal will soak up some of the oil, turning the metal parts a dark color. See Figure 6.11.

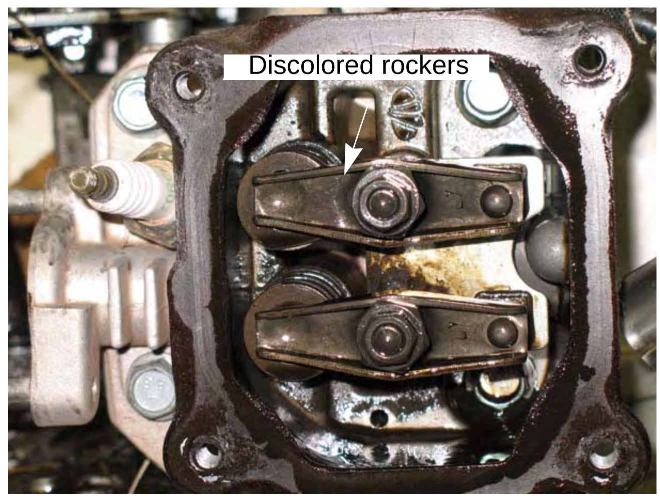


Figure 6.11

Another sign of an overheat failure is warped parts. As metal parts heat up, they expand. In an engine a certain amount of expansion is expected. Engines are built so that when parts are at operating temperature, the parts will expand to be within the tolerances needed for the engine to run. A problem occurs when the parts are over heated. They expand more than they were designed to. Some parts are mounted firmly, like cylinder heads (the hottest part of the engine). As they try to expand, they fight against the head bolts. The head bolts will not move to allow the expansion so the head warps to allow the expansion.

This warping of the head allows the head gasket to leak. A leaking head gasket allows the compressed gases in the engine to escape, lowering the compression in the engine and hurting engine performance. As the cylinder head cools, it shrinks back down to its normal size, but there will still be some warpage of the head. See Figure 6.12.

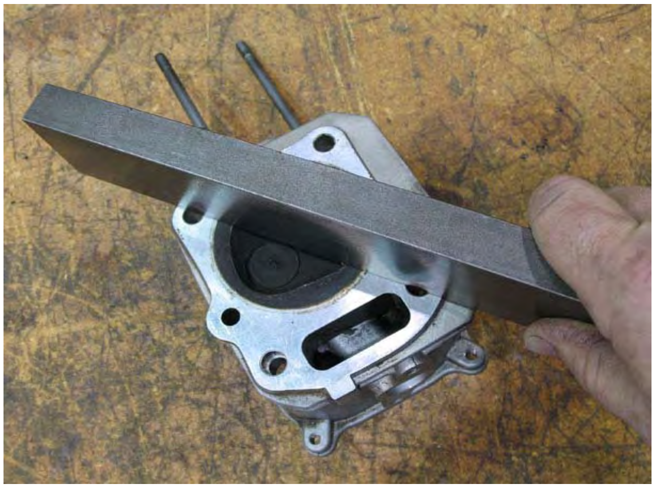


Figure 6.12

Mechanical Breakage/ Wear

Sometimes an engine fails because a part breaks. There are generally three causes of a broken part, outside of the previously discussed engine failures. They are abuse, wear, and manufacturing defects.

A very common way to abuse an engine is a bent crank shaft. Crank shafts bend when they, or something bolted to them hits something. A prime example of this is when a mower blade hits a rock. See Figure 6.13.

Figure 6.13

As the engine runs, there is friction between the moving parts. This friction wears down the parts. Lubrication slows the process, but wear can not be prevented. Over time the parts wear to the point they break or fail in some way. Car tires are a good example of wear. A tire will only last for so many miles before all the rubber is worn off and the tire goes flat. Bushings are another example, they are designed to wear so that the wear of other parts will be minimized.

Manufacturing defects are wrongly blamed for alot of failed parts. A manufacturing defect is when a part is made wrong. It could be a porous casting, parts assembled wrong, the wrong parts used or so on. A manufacturing defect will generally show up within the first couple of hours of use.