



# Service Manual



## 2006 MTD Single Cylinder Engine 350/450/650 Series "First Look"

**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.

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**MTD Products Inc - Product Training and Education Department**

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## MTD Engine - Series 350/450/650

### MTD Engine - Series 350/450/650

#### 1. INTRODUCTION:

- 1.1. MTD has chosen to introduce three MTD exclusive engines for walk-behind and self-propelled mowers for the 2006 season. See Figure 1.1.



**Figure 1.1**

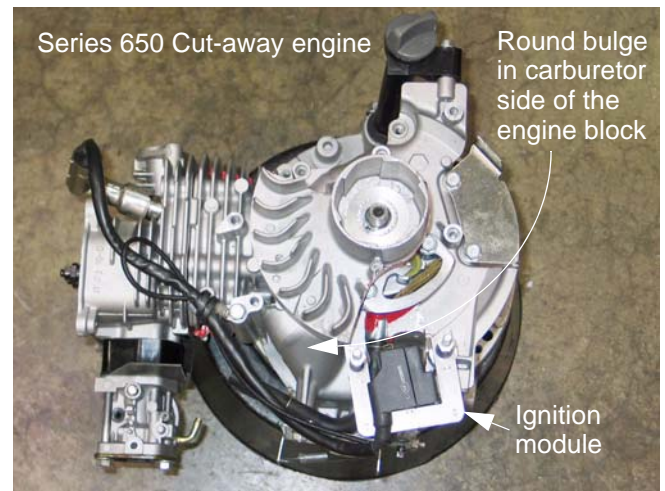
- 1.2. They will be designated with as Series 350, Series 450, and Series 650. The series number does not imply displacement or power out-put.
- 1.3. These nominal designations correspond to factory numbers P61, P65, and P70 series.
- 1.4. The 3rd and 4th digits are the bore in mm.

- 1.5. The Series 350 and Series 450 share some basic parts. See Figure 1.5.



**Figure 1.5**

- 1.6. The major castings and some architecture of the Series 650 differs from the two smaller engines. See Figure 1.6.



**Figure 1.6**

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- The service procedures are similar enough that all three engines will be covered in this manual.
  - Individual differences will be noted in the text and tables where necessary.
  - The most obvious feature that distinguishes the two engine blocks is the location of the ignition module.
  - The module is mounted above the cylinder on the Series 350 and Series 450 engines, off-set slightly to the intake side. See Figure 1.5.
  - The module is mounted about 90 degrees from the cylinder on the Series 650 engine blocks. See Figure 1.6.
- 1.7. The Series 650 engine may have a steel or plastic cam and a very robust compression release mechanism. The Series 350 and 450 use polymer cams
- 1.8. While some components of the MTD engines may be visually similar to those of other manufacturers, none of the proprietary parts are directly interchangeable.

**NOTE:** The procedures detailed in this manual are intended for use by trained technicians who are experienced in the service and repair of outdoor power equipment. Persons who are untrained or inexperienced in this field should seek the assistance of an authorized service dealer.

**NOTE:** This manual was developed using pre-production equipment. Although it is current and correct at the time of writing, it is subject to change without notice.

## 2. SERVICE INTENT

- 2.1. The engines are warranted for two years against defects in materials and workmanship, as described in the warranty that accompanies the mower.
- 2.2. Because MTD is entering a new field, dealers can assume that MTD will be very interested in scrutinizing any failed parts that dealers replace under warranty during the '06 and '07 mowing season.
- 2.3. Major engine failures will be repaired using service engines, short blocks, cylinder head assemblies, or long blocks.
- The repair method will depend on the nature of the damage to the engine. Service engines will most-likely be prevalent.
  - The dealer should do any diagnostic disassembly needed to discern lubrication and abuse failures from defects in material or workmanship, and file a warranty claim for the time allowed.
- 2.4. Realistically, service will be limited primarily to external components.
- It is not anticipated that dealers will be doing machine-work intensive rebuilds because it is not cost effective.
  - Internal specifications that would be relevant to such rebuilding are not included in this manual.

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### 3. MAJOR FAILURES NOT COVERED UNDER WARRANTY

**NOTE:** The following is a list of typical non warrantable scenarios. It is meant to provide illustration of the intended principles of the warranty. Non-warrantable repairs include, but are no limited to the items on this list.

- 3.1. Ingestion of dirt through the intake (air filter/carburetor)
- 3.2. Lubrication failure
- 3.3. Bent crankshaft
- 3.4. Overheated by obstructed cooling system
- 3.5. Corrosion or water damage
- 3.6. Second year carburetor failures.

### 4. MINOR FAILURES NOT COVERED UNDER WARRANTY

**NOTE:** The following is a list of typical non warrantable scenarios. It is meant to provide illustration of the intended principles of the warranty. Non warrantable repairs include, but are no limited to the items in this section.

- 4.1. Sheared flywheel key
- 4.2. Stale, out-of-date, or improper fuel
- 4.3. Damage from improper storage
- 4.4. Damage caused by animals / insects
- 4.5. Impact damage
- 4.6. Normal maintenance or adjustment items.
- 4.7. Recoil starter rope damage that is not the direct result of a defect in materials or workmanship.

### 5. MAINTENANCE AND ADJUSTMENT INFORMATION

- 5.1. **Fasteners:** All threaded fasteners used on the engine are metric, with the following exceptions:

- A 13/16" or 21mm wrench are suitable for spark plug removal.
- Series 350 and Series 450 engines are secured to mower decks using a 3/8" self-tapping screw. Remove them using a 9/16" wrench.
- Series 650 engines are secured to the mower decks using metric nuts and bolts. Remove them using a pair of 14mm wrenches.
- The crankshafts of all engines in this manual are tapped with a 1/2"-20 thread, and the bolts can be removed using a 5/8" wrench.

- 5.2. **Spark plug:** 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.

- 5.3. Cleaning the spark plug:

- 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 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.
- Abrasive blast cleaning with organic media such as walnut shells is acceptable.

- 5.4. 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)



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- 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.
- 5.5. **Idle speed:** If applicable, is 1,800 RPM  $\pm$  160 RPM, set using throttle stop screw. See Figure 5.5.

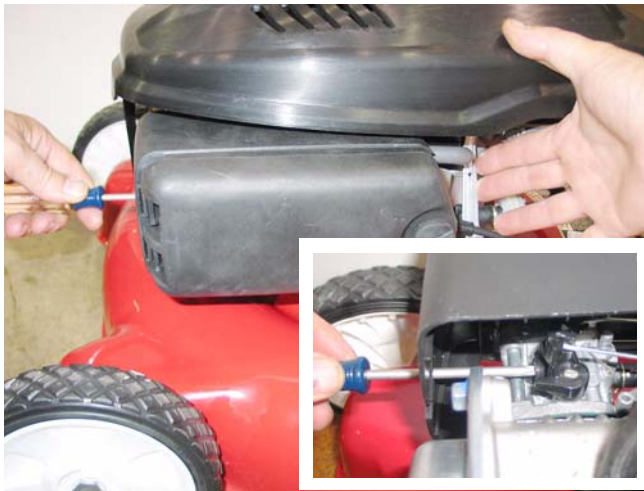


Figure 5.5

- Idle speed is not normally critical in mower applications because the operator is not provided with a throttle control.

- 5.6. **Top no-load speed** varies with blade length per ANSI B71.1-1984 standard of 19,000 feet per minute, allowing 200 RPM for safety margin: See Figure 5.6.



Figure 5.6

- 20" blade models: 3,300 RPM max., all engines.
  - 21" blade models: 3,100 RPM max., all engines.
- 5.7. Top no-load speed may be adjusted slightly to meet this specification by bending the bracket that the governor spring connects to. The bracket is visible under the air filter. See Figure 5.7.

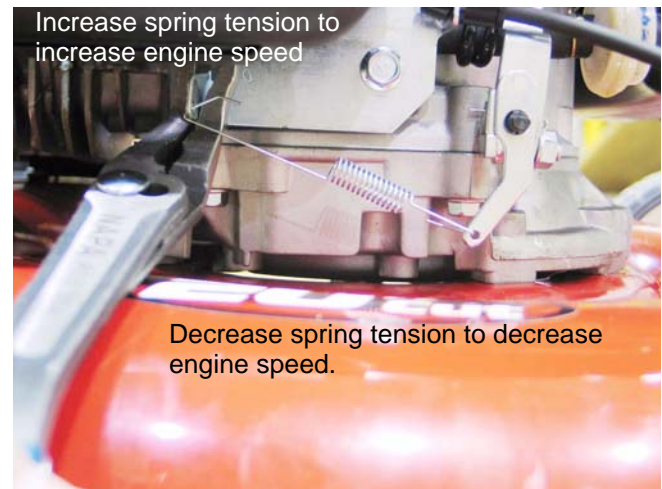


Figure 5.7

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- The regulated blade tip speed is a safety feature. A dealer who puts a mower back into service with a defeated safety feature may be subject to liability if damage or an accident occurs.

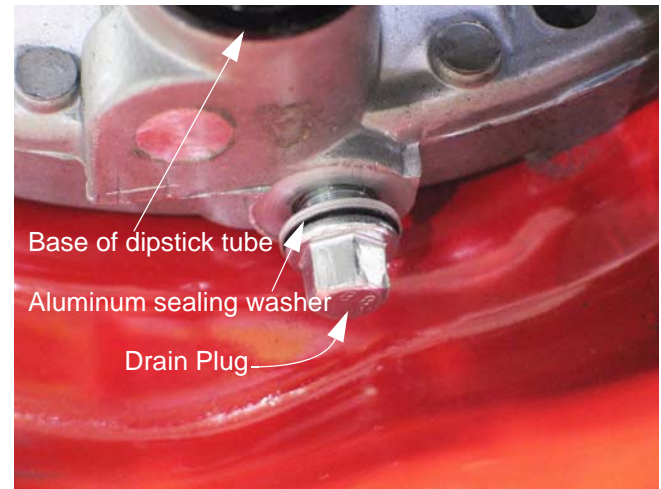
5.8. **Oil type and capacity:** See Figure 5.8.



**Figure 5.8**

- SAE 10W-30 SF/CD API rating for most operating conditions up to 97 deg. F. (36 deg. C.)
  - 17.0 - 20.3 fl.oz. (0.5 - 0.6 liters)
  - Insert but do not thread-in dipstick to check oil level.
  - The oil level is determined by the lowest point on the dipstick that is completely covered with oil.
- 5.9. Special notes on oil:
- Check the oil level more 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 or tall grass.
  - Synthetic oil may be used, but it does not extend service intervals because the engine oil is not filtered.
  - No oil additives or viscosity modifiers are recommended. The performance of oil meeting the SF/CD specification will not be improved by the addition of any commercially available products.
  - Some oil additives may cause severe and non-warrantable engine damage, constituting a lubrication failure.

5.10. 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 5.10.



**Figure 5.10**

- Replace the drain plug sealing washer with a new one to ensure that it does not leak.
  - Tighten the drain plug to a torque of 84 in-lb. (10 Nm) on installation.
- 5.11. Alternatively, the mower may be tipped on its side and the dipstick removed to drain the oil into pre-positioned drain pan. See Figure 5.11.



**Figure 5.11**

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

**NOTE:** If the oil is noticeable thin, or smells of gasoline, carburetor repair will be needed before the engine can be safely run.



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5.12. **Fuel:** 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.
- The gasoline can have a maximum of 10% ethanol or 15% MTBE.
- Do not use E85 in MTD engines.

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

5.14. If the engine has been run, allow it to cool thoroughly. Position the mower for easy access to the cylinder head.

5.15. Disconnect the high-tension lead from the spark plug and ground it well away from the spark plug hole.

5.16. Remove the spark plug using a 13/16" or 21mm wrench. A flexible coupling or "wobbly" extension may help. See Figure 5.16.

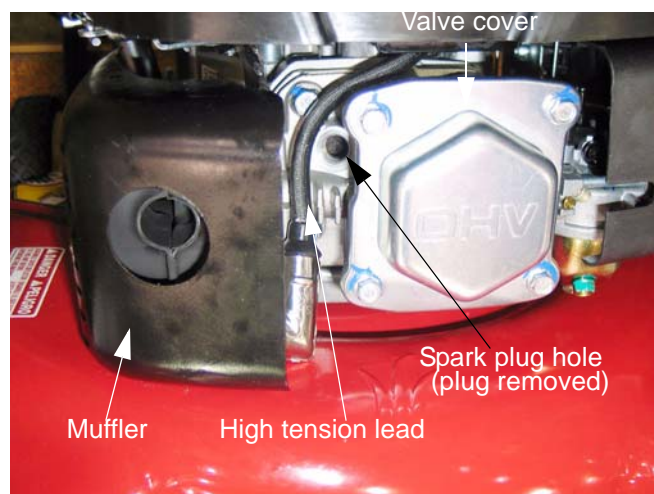


Figure 5.16

5.17. 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.

5.18. 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.

5.19. Confirm that the piston is at Top-Dead-Center on the compression stroke. See Figure 5.19.



Figure 5.19

- 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.

5.20. Check valve lash between each valve stem and rocker arm using a feeler gauge. See Figure 5.20.

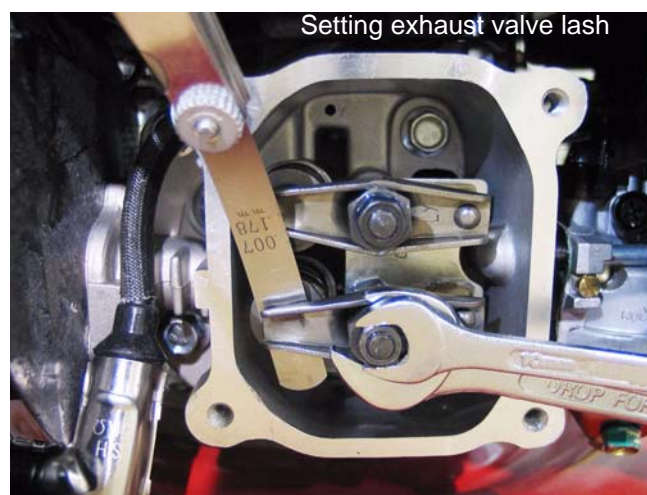


Figure 5.20



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- 5.21. Intake valve lash (top valve) should be .003"-.005" ( $.10 \pm .02\text{mm}$ ).
- 5.22. Exhaust valve lash (bottom valve) should be .005-.007" ( $.15 \pm .02\text{mm}$ ).
- 5.23. Use a 10mm wrench to loosen the jam nut, and a 14mm wrench to adjust the rocker arm fulcrum nut. See Figure 5.23.



Figure 5.23

- 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.
- 5.24. 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.
- 5.25. Double-check the clearance after tightening the jam nut, to confirm that it did not shift. Re-adjust if necessary.
- 5.26. Rotate the engine through several compression cycles:
  - Observe the movement of the valve train.
  - 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.
- 5.27. Clean-up any oil around the valve cover opening, clean the valve cover, replace the valve cover gasket if necessary.
- 5.28. Install the valve cover, tightening the valve cover screws to a torque of 71 in-lb (8 Nm).
- 5.29. Install the spark plug and tighten to a torque of 177-221 in-lbs (20 - 25 Nm).
- 5.30. Release the spring clamp securing the safety bail, start the engine and test run it long enough to confirm correct operation.
- 5.31. **Compression** should be in the range of  $70 \pm 25$  PSI ( $5.2 \pm 1.7$  Bar).
- 5.32. If the engine has been run, allow it to cool thoroughly.
- 5.33. Disconnect the high-tension lead from the spark plug and ground it well away from the spark plug hole. See Figure 5.16.
- 5.34. Remove the spark plug using a 13/16" or 21mm wrench. A flexible coupling or "wobbly" extension may help.
- 5.35. 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.
- 5.36. Install a compression gauge in the spark plug hole.
- 5.37. 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 5.37.

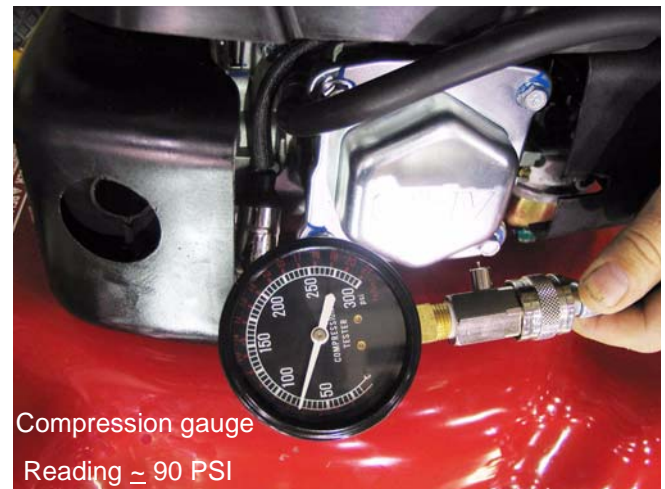


Figure 5.37

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### 5.38. 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.
- Too high compression (>95 PSI [>6.55 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.

5.39. **Stop switch and brake:** The stop switch and brake must be able to stop the blade from rotating within 3.0 seconds after the release of the safety bail, per ANSI B71.1-2003 standard.

5.40. Make sure that the mower conforms to these standards by performing a stop test.

5.41. Check the movement of the cable and brake mechanism. See Figure 5.41.



Figure 5.41

- The cable should not bind. Replace the cable if it is kinked, melted frayed, or damaged in any other way that causes it to bind.
- The brake arm on the engine should not bind.
- Each can be lubricated with light penetrating oil or a dry PTFE-based lubricant such as "Tri-Flow" dry Teflon lubricant.

5.42. To replace the cable: See Figure 5.42.



Figure 5.42

- Squeeze the safety bail ends together to release the bail from the upper handle bar.
  - Releasing the bail from the handle bar will provide enough slack in the cable to unhook the Z-fitting at the top of the cable from the bail.
  - After the bail end of the cable is unhooked, the Z-fitting at the engine end of the cable can be unhooked.
  - Squeeze the barbs together at the engine end of the cable housing to disconnect it completely from the engine.
  - Remove the nut and bolt that secure the cable to the handle bar.
  - Reverse the removal process to install the cable, then test the mower in a safe area before returning it to service.
- 5.43. The brake pad should be replaced when the thickness of the friction material is less than .25" (6.35mm) at the thinnest spot.



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- 5.44. **To replace the brake pad**, remove the flywheel as described in the IGNITION section of this manual. See Figure 5.44.

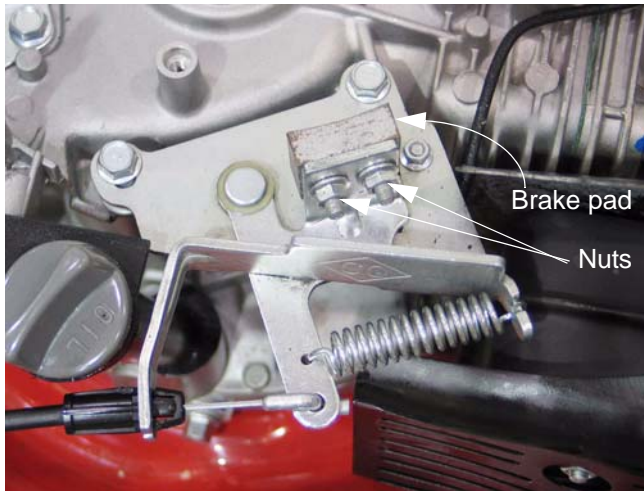


Figure 5.44

- 5.45. Remove the two nuts that hold the brake pad to the brake arm using an 8mm wrench, and remove the pad.
- 5.46. Apply a small amount of thread locking compound such as Loctite 242 (blue) to the threaded studs on the new brake pad, and fasten it to the brake arm using the two nuts previously removed.
- 5.47. Assemble the engine, reversing the disassembly process. Adjust the brake arm if necessary.
- 5.48. **Adjust the brake arm** with the flywheel installed, but the fan shroud, recoil assembly, and engine cover removed.

- 5.49. There are two screws that hold the brake assembly to the engine. They can be loosened using an 10mm wrench. See Figure 5.49.

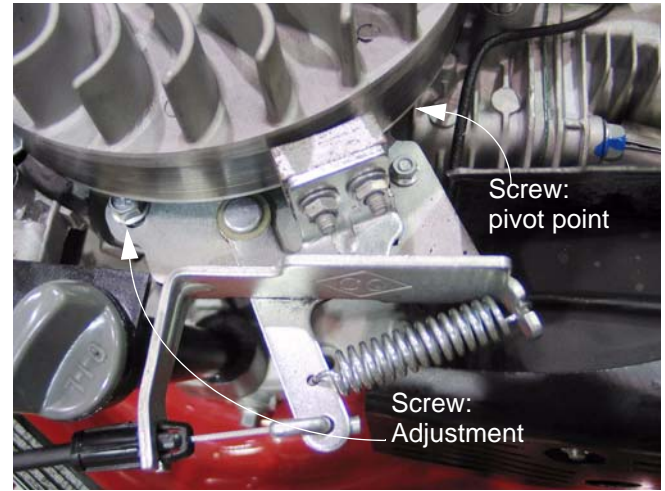


Figure 5.49

- The screw near the base of the cylinder is a pivot point.
  - The screw near the oil fill tube clamps the brake mechanism in place via a slotted hole.
- 5.50. Use a spring clamp to hold the safety bail against the upper handle bar.
- 5.51. Position the brake assembly so that the edge of the brake pad that is nearest the slotted hole is roughly .050" (1.27mm) from the flywheel, then tighten the screws. See Figure 5.51.

**NOTE:** The shank of an unused drill bit may be used as a feeler gauge

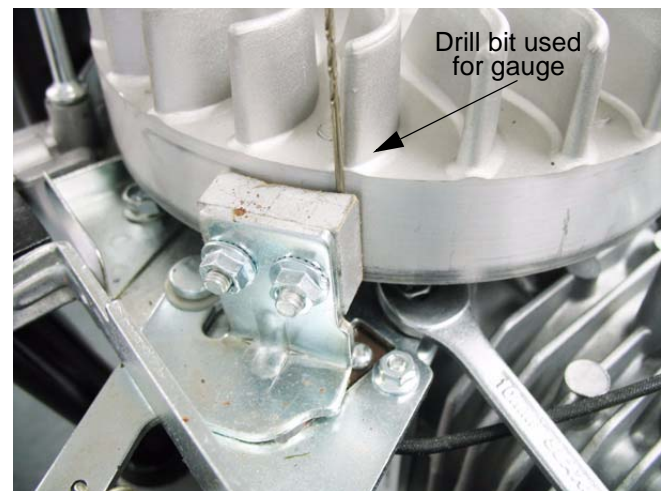


Figure 5.51

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5.52. Run and test the mower in a safe area before returning it to service.

5.53. To **test the stop switch**: locate the terminal that connects the stop switch wire to the primary windings of the ignition module. See Figure 5.53.

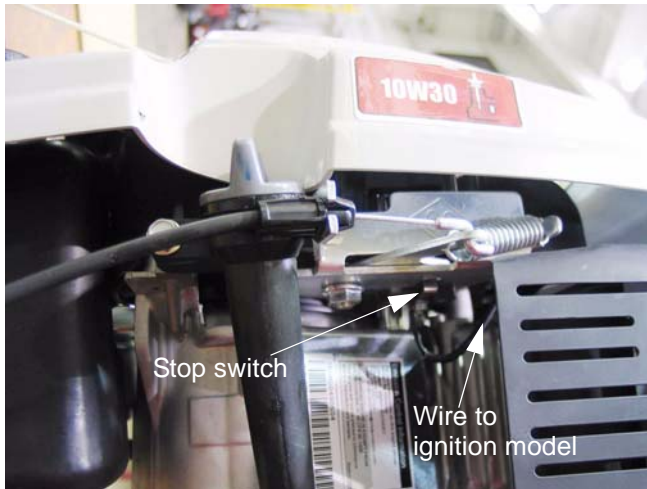


Figure 5.53

5.54. 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 5.54.



Figure 5.54

5.55. The reading should be high when the bail is pulled down, reflecting the resistance in the primary windings of the ignition module. See Figure 5.55.

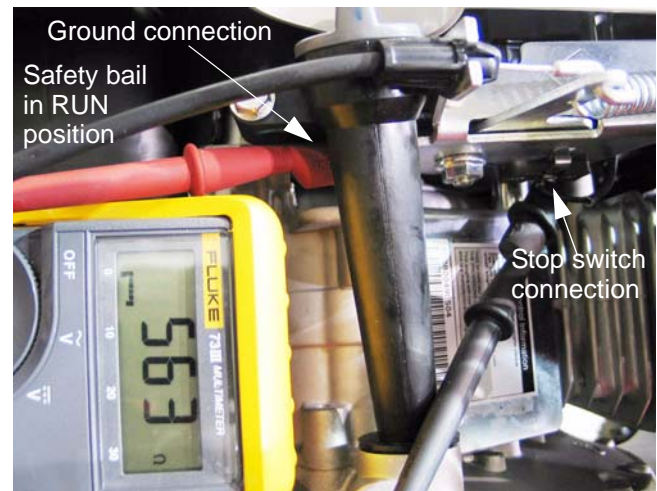


Figure 5.55

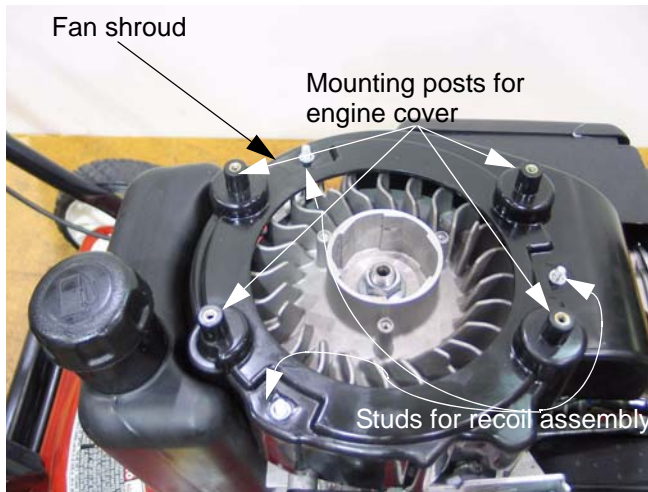
5.56. Alternatively, a jumper wire could be connected to the same locations. Use a commercially available spark checker to see if the ignition is working or not.

- 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.



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5.57. If further investigation is required, remove the recoil assembly, as described in the **STARTER SERVICE** section of this manual. See Figure 5.57.



**Figure 5.57**

- 5.58. Lift the fan shroud off of the studs that locate it.
- 5.59. 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.
- 5.60. 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 approach zero with the bail released. See Figure 5.60.



**Figure 5.60**

5.61. Resistance (Ohms) should be infinite (O.L) with the bail depressed. See Figure 5.61.



**Figure 5.61**

- 5.62. 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.
- 5.63. **Blade:** A sharp, balanced, and well secured blade is important.
- 5.64. 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.

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5.65. An **imbalanced or bent blade** (sometimes in 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.

5.66. 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.

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

5.68. 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 5.68.



Figure 5.68

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

5.69. If the blade is removed for any reason, make a visual inspection of all blade mounting hardware. See Figure 5.69.

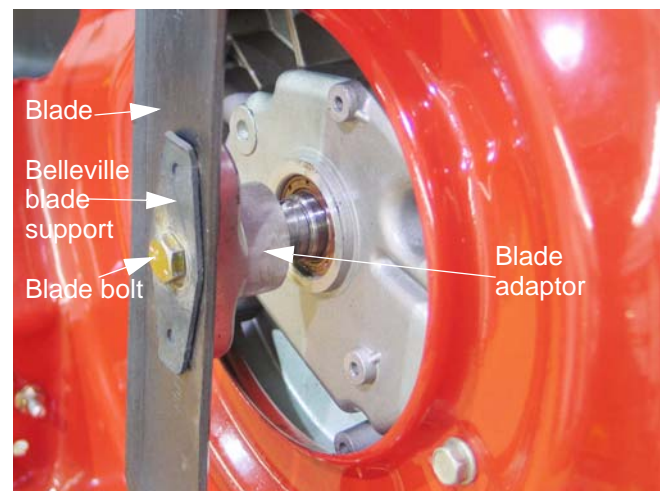


Figure 5.69

**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.

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### 5.70. When servicing the blade:

- Replace any parts that are damaged or suspect.
- 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.
- Tighten the blade bolt to a torque of 450-600 in-lbs. (51-68 Nm).
- 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.

### 6. STARTER SERVICE

- 6.1. To Remove recoil assembly from the mower, remove the fuel cap.

**CAUTION:** Use common sense when working around fuel: No sources of sparks or open flame should be near enough to cause ignition.

- 6.2. Loosen the wingnut that secures the starter rope eyelet to the handlebars to provide clearance for removing / installing starter rope.
- 6.3. Remove the four screws that hold the engine cover to the engine. See Figure 6.3.



Figure 6.3

- 6.4. Remove the engine cover and replace the fuel cap.
- 6.5. Remove the three nuts that secure the recoil assembly and fan shroud to the engine using a 10mm wrench. See Figure 6.5.

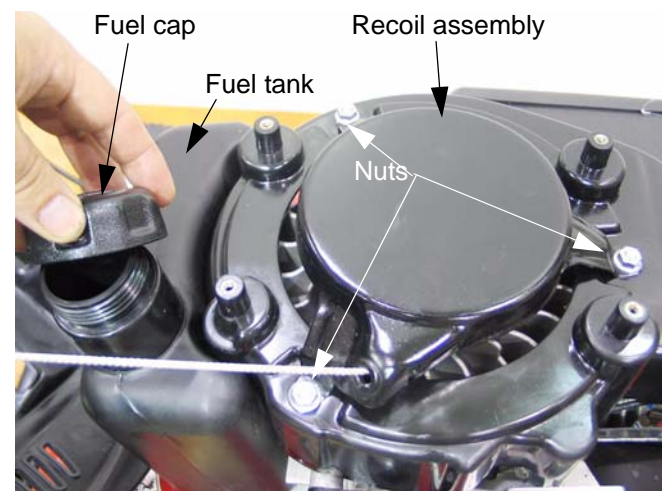


Figure 6.5



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- 6.6. Lift the recoil assembly off of the engine, and place it on a convenient work surface.
- 6.7. Inspect the inside of the starter cup portion of the flywheel casting. See Figure 6.7.

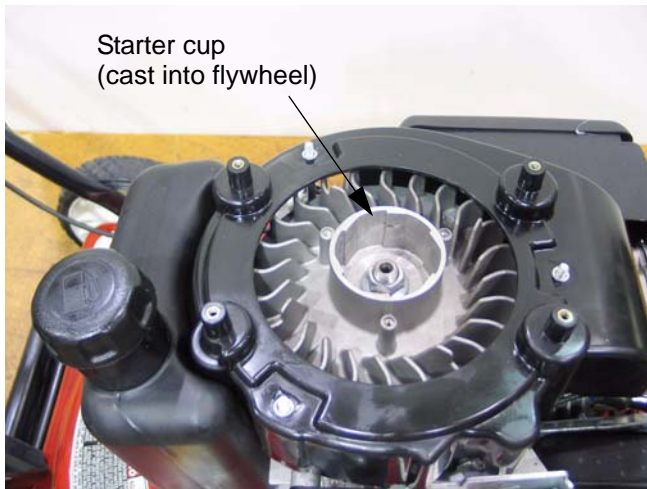


Figure 6.7

- 6.8. If the starter was failing to engage the flywheel, and the edges of the teeth inside the cup are rounded, replace the flywheel.
- If the flywheel is replaced, the stator pawls or the complete starter should be replaced as well, to prevent a repeat failure.
- 6.9. The most common failure mode for most recoil assemblies is a broken rope. See Figure 6.9.



Figure 6.9

- If the spring was not damaged when the recoil sprung back, it is possible to simply remove the remnants of the old rope.

- Replace the rope with 83" (2.1 meters) of #4 recoil rope, with ends heat-sealed to prevent fraying, and wound 6 turns counter-clockwise for tension.
- 6.10. If further damage is suspected, the recoil may be disassembled by removing the shoulder screw and pressure plate using a 10 mm wrench. See Figure 6.10.

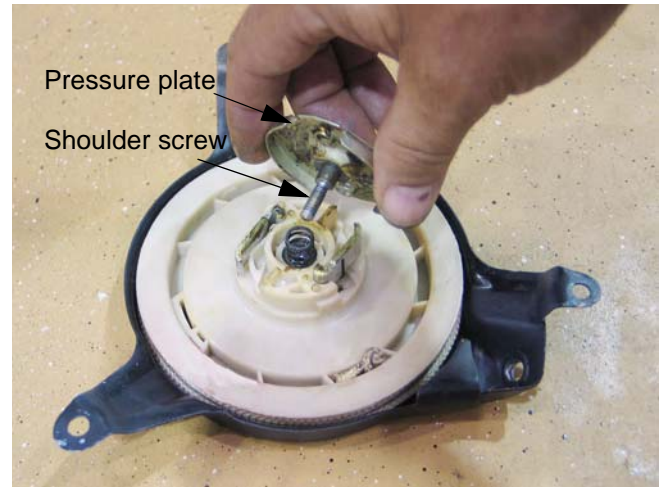


Figure 6.10

- 6.11. Beneath the pressure plate is a compression spring, and two starter pawls that are held in the disengaged position by two torsion springs.
- 6.12. Inspect the pawls and torsion springs for wear and damage. See Figure 6.12.

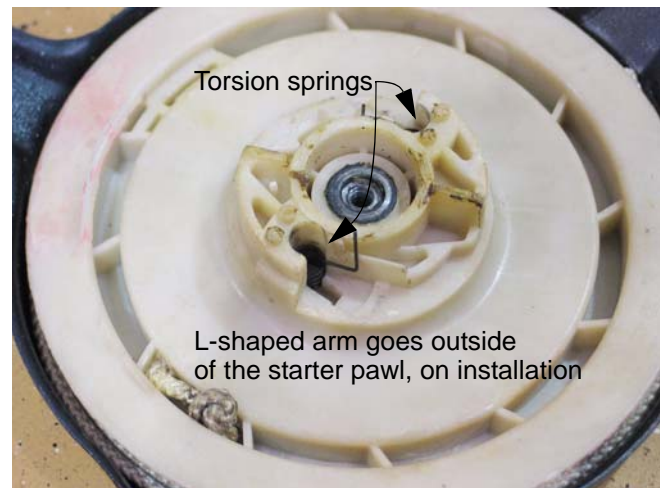


Figure 6.12

**CAUTION:** Eye protection should be worn if the starter pulley is to be removed.



## MTD Engine - Series 350/450/650

- 6.13. Carefully lift the spring and pulley out of the recoil housing. See Figure 6.13.

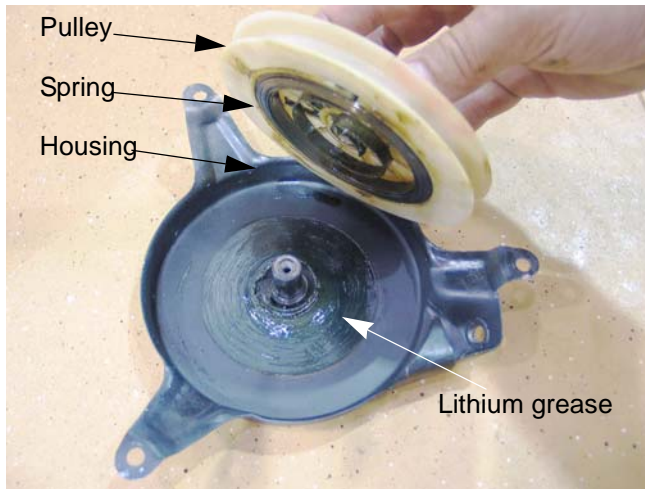


Figure 6.13

**NOTE:** The spring is nested within the starter pulley. Service intent is to supply both parts assembled under a single part number.

**NOTE:** If the spring is undamaged, but has been removed from the pulley, the spring may be re-wound. Engage the hook in the end of the spring with the slot in the outer lip of the recess that the spring fits in, and wind the spring into the recess in a counter-clockwise direction.

- 6.14. Evaluate the damage, including parts prices and local labor rates. In some parts of the country, it makes economic sense to replace the complete assembly, in other areas labor rates favor repair.
- 6.15. On assembly, apply a small amount of lithium-based chassis grease to the surface of the recoil housing that contacts the spring.
- 6.16. Carefully position the pulley and spring in the recoil housing. Rotate the pulley gently counter-clockwise until the spring seats, allowing the pulley to fall into position.

- 6.17. Install the torsion springs and pawls so that the long arm of the spring reaches outside of the pawl, and draws it toward the center of the assembly. See Figure 6.17.

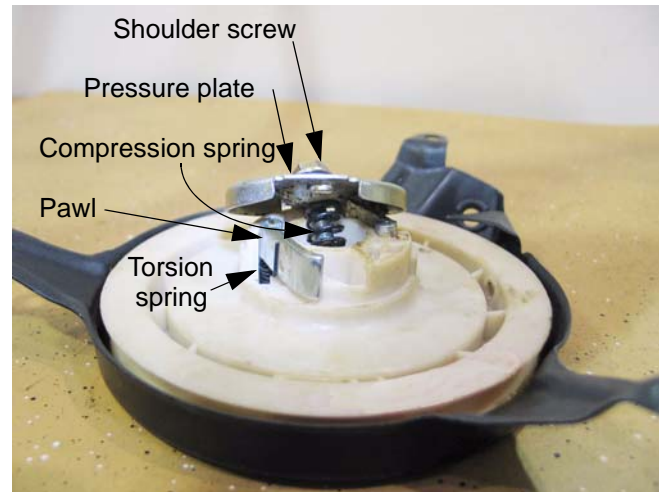
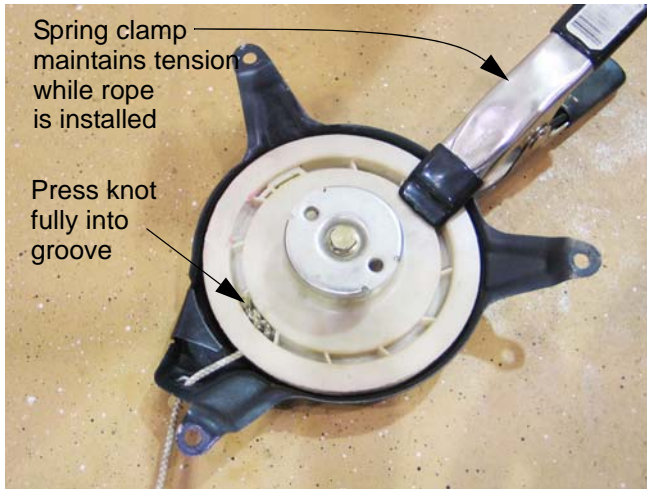


Figure 6.17

- 6.18. The rolled end of the pawl fits in the recess in the starter pulley. The hooked end engages the starter cup. Both the roll and the hook face inward.
- 6.19. The extrusions on the pressure plate should fall inside of the pawls as the starter is assembled.
- NOTE:** Drag on the pressure plate, from the friction between the compression spring and the head of the shoulder screw causes these extrusions to force the pawls outward, engaging the starter cup.
- 6.20. Apply a small amount of thread locking compound such as Loctite 242 (blue) to the threads of the shoulder screw, and install the screw. Tighten it to a torque of 71 - 88.5 in-lb. (8 - 10 Nm).
- 6.21. Wind the pulley 6 turns in the counter-clockwise direction, to tension the spring. Align the rope hole in the pulley with the rope eyelet in the recoil housing, and secure it with a spring clamp.

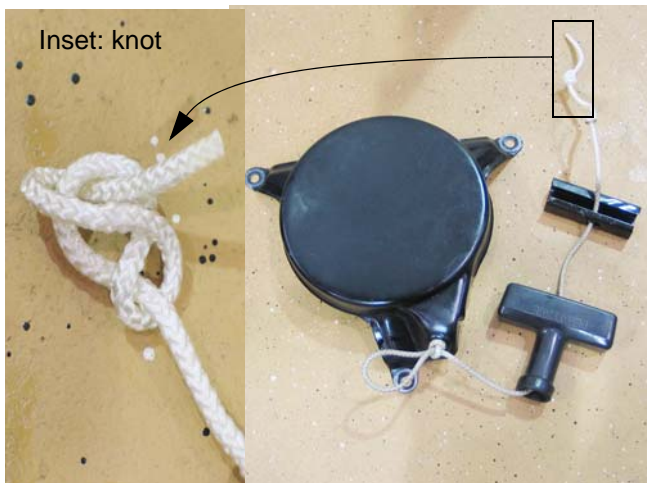
## MTD Engine - Series 350/450/650

- 6.22. Heat fuse the ends of a 9' (3 meter) length of #4 starter rope, and tie a double half-hitch in one end.
- 6.23. The rope may be easily installed from the inside-out. Pull the rope tight to seat the knot firmly in the recess in the back of the pulley. See Figure 6.23.



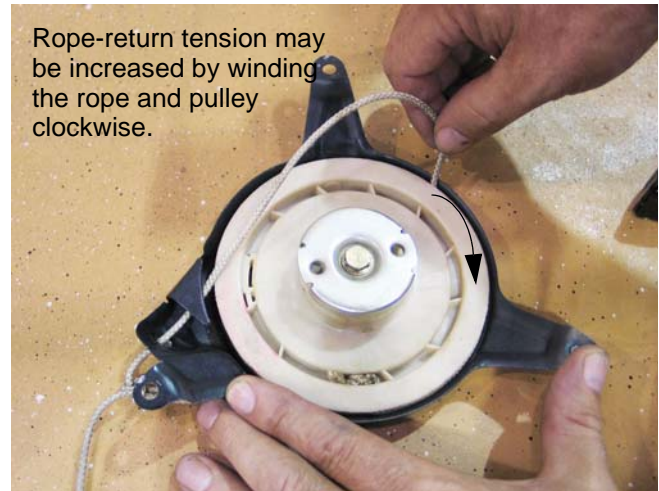
**Figure 6.23**

- 6.24. Install the handle and handle insert on the loose end of the rope, again using a double half-hitch. See Figure 6.24.



**Figure 6.24**

- 6.25. If starter rope tension needs to be adjusted, there is room between the recoil housing and the pulley to wind-on more tension. See Figure 6.25.



**Figure 6.25**

- 6.26. Install the starter and tighten to a torque of 80 - 106 in-lbs. (9 - 12 Nm).



## MTD Engine - Series 350/450/650

### 7. IGNITION SYSTEM

- 7.1. The ignition system is a transistorized 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 flywheel in relation to the crankshaft. Proper timing is maintained by a steel key.
- 7.2. Remove the recoil assembly as described in the STARTER SERVICE section of this manual.
- 7.3. Lift the fan shroud off of the three studs that locate it. See Figure 7.3.

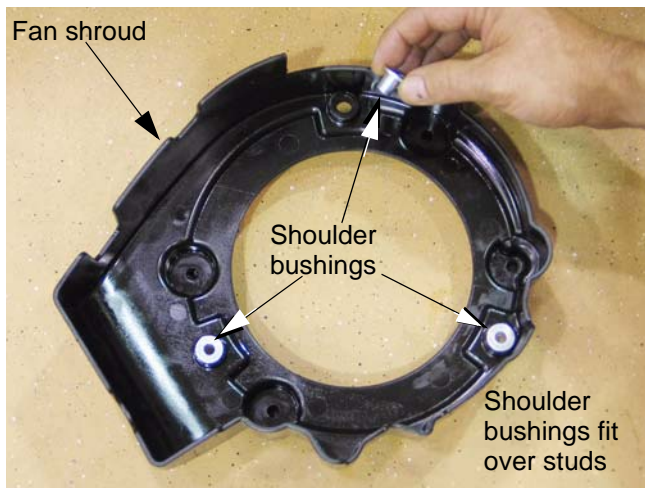


Figure 7.3

- 7.4. To remove the flywheel, remove the flywheel nut using a 19mm wrench. See Figure 7.4.



Figure 7.4

- 7.5. 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.

- 7.6. Inspect the key, keyway, and tapered mating surfaces of the flywheel and crankshaft. See Figure 7.6.

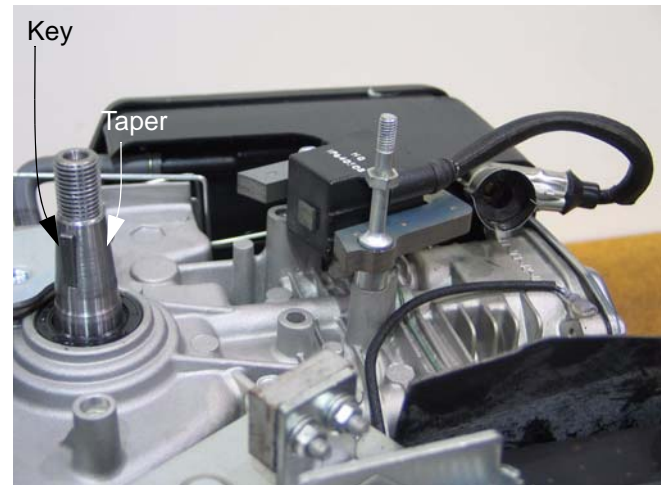


Figure 7.6

- 7.7. The ignition module for the Series 350 and Series 450 engines is mounted to the cylinder. See Figure 7.7.

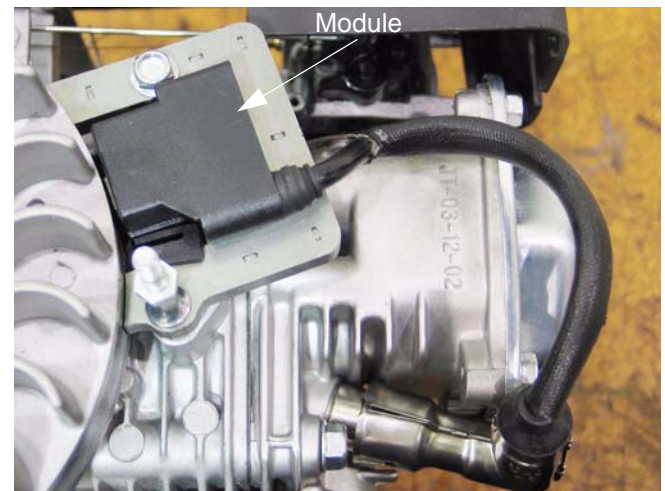
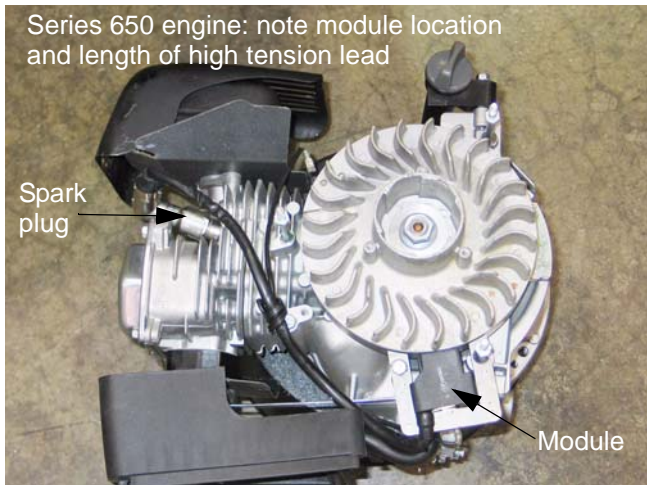


Figure 7.7

## MTD Engine - Series 350/450/650

- 7.8. The ignition module for the Series 650 engines is mounted off-set from the cylinder. See Figure 7.8.



**Figure 7.8**

- 7.9. The ignition modules differ between the two basic engine designs, because of the longer distance from the module to the plug on the Series 650 engines. The high tension lead from the module to the spark plug is longer on these engines than on the smaller ones.
- 7.10. The flywheels are interchangeable between the two engine designs. Even though the module is mounted in different locations, the relationship between the key-way and the magnets is the same. The keyways in the crankshafts are indexed differently to suit the module location.
- 7.11. 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.
- 7.12. Install the flywheel nut to a torque of 41-48 ft-lbs. (55-65 Nm).
- 7.13. Use a 10mm wrench to remove the ignition module or adjust the air gap between the module and the flywheel.
- The air gap should be .016"-.024" (.4-.6mm).
  - The module is attached with the high-tension lead facing up.

- One leg of the module is secured by a stud that also supports the fan shroud, the second leg is secured by a screw.
  - On Series 350 and Series 450 engines, there is a spacer between the cylinder and the module at both mounting points.
  - On the Series 650 engines, there is a spacer between the module and the crankcase on the stud only.
  - On module installation, set the air gap, tighten the stud and screw to a torque of 84 in-lb (10 Nm), then re-check the air gap.
- 7.14. Diagnosis: refer to steps 5.53 through 5.62 of the MAINTENANCE AND ADJUSTMENT INFORMATION section of this manual to isolate the ignition coil from the stop switch.
- 7.15. Normal performance of the coil is to produce at least 10,000 volts at starter-rope pull-through speed. See Figure 7.15.



**Figure 7.15**

- 7.16. 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.
- 7.17. 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 will give an adequate indication of the ignition system's condition.



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- 7.18. Simple spark-testers are readily available and inexpensive. Thexton Part # 404 is available from a variety of retailers, and similar units are available from other manufacturers. See Figure 7.18.



Figure 7.18

- 7.19. At operating speed, the ignition should produce voltage approaching 12,000. See Figure 7.19.



Figure 7.19

- 7.20. At pull-over speed ( $\approx 600$  RPM), voltage should be at least 8,000. See Figure 7.20.



Figure 7.20

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

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

- 7.21. 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  $\Omega$  range. See Figure 7.21.

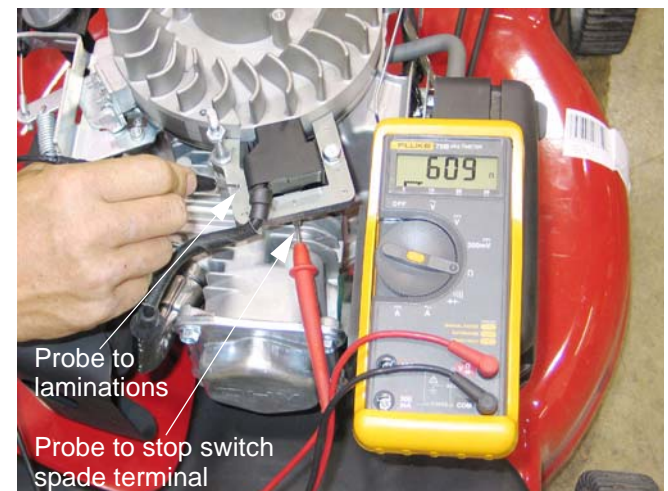


Figure 7.21

## MTD Engine - Series 350/450/650

7.22. 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-9K $\Omega$  range. See Figure 7.22.

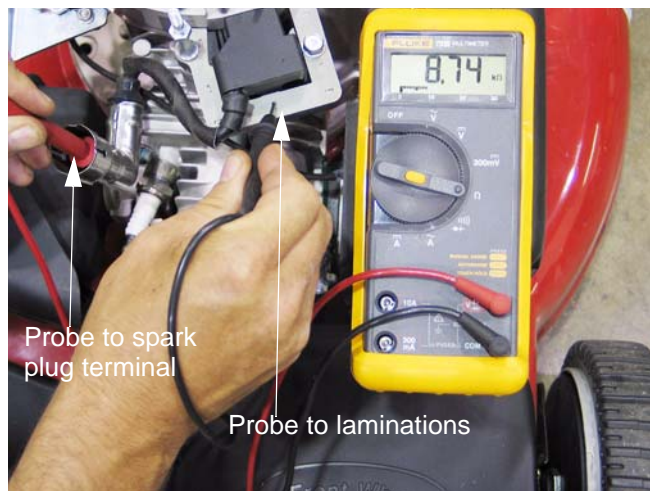


Figure 7.22

7.23. 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.

7.24. An inexpensive compass or bar magnet can be used to confirm opposite polarity of the flywheel magnets. See Figure 7.24.

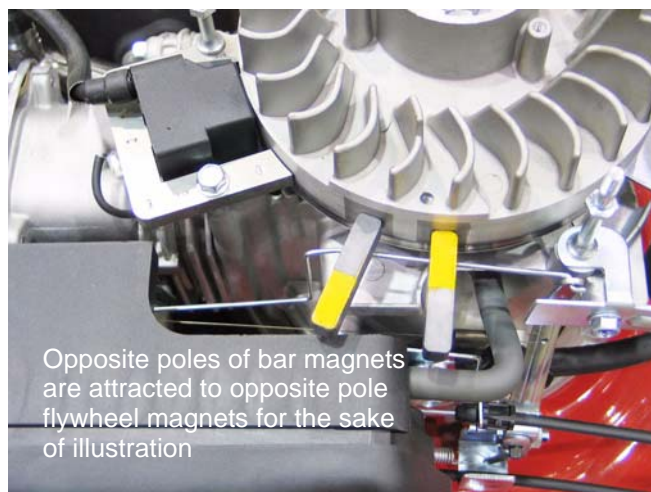


Figure 7.24

7.25. Spark plug: refer to steps 5.2 through 5.4 in the MAINTENANCE AND ADJUSTMENT INFORMATION section of this manual.

**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 rises as temperature increases.



## MTD Engine - Series 350/450/650

### 8. FUEL SYSTEM

**CAUTION:** When working around the fuel system, do not bring any sources of heat, spark, or open flame close enough to the work area to pose a fire hazard.

- Drain the fuel tank or clamp the fuel line before starting work to prevent spillage.
  - Dispose of drained fuel in a safe and responsible manner.
- 8.1. The fuel tank is secured to a bracket on the back of the engine by a screw and fender washer, removable with a 12mm wrench, and a second bolt, removable with a 10mm wrench. See Figure 8.1.

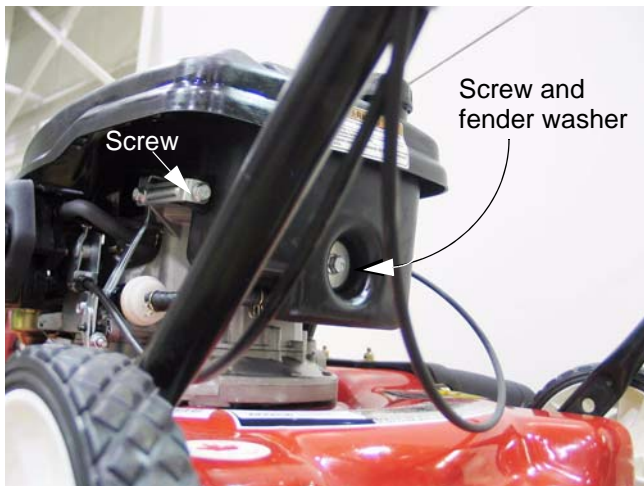


Figure 8.1

- 8.2. To remove the fuel tank:
- Drain the tank.
  - Disconnect the fuel line from the tank.
  - Remove the fuel cap.
  - Unbolt, and remove the tank.

- 8.3. The tank is vented through the cap. See Figure 8.3.

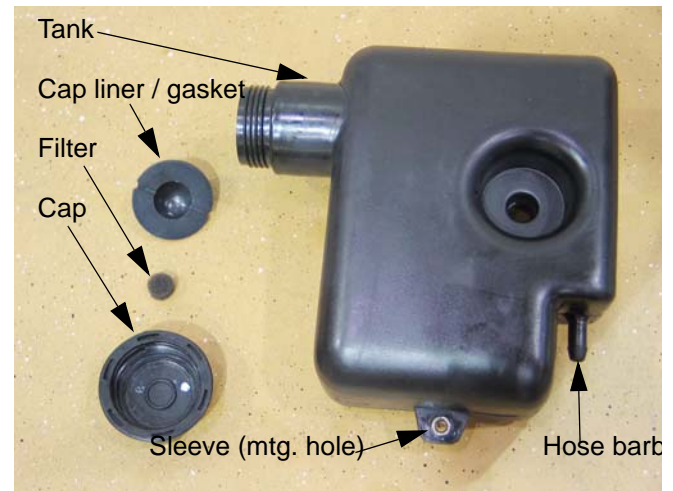


Figure 8.3

- 8.4. To test the cap vent, a hand-pumped vacuum / pressure tester may be connected to the fuel barb (after draining). See Figure 8.4.

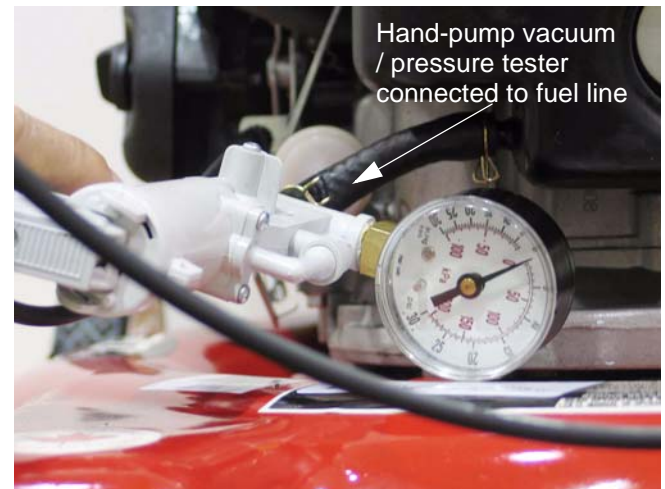


Figure 8.4

## MTD Engine - Series 350/450/650

- 8.5. 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, but 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.
- 8.6. All models are equipped with a manual choke, operated by a pull-knob on the handlebar. See Figure 8.6.

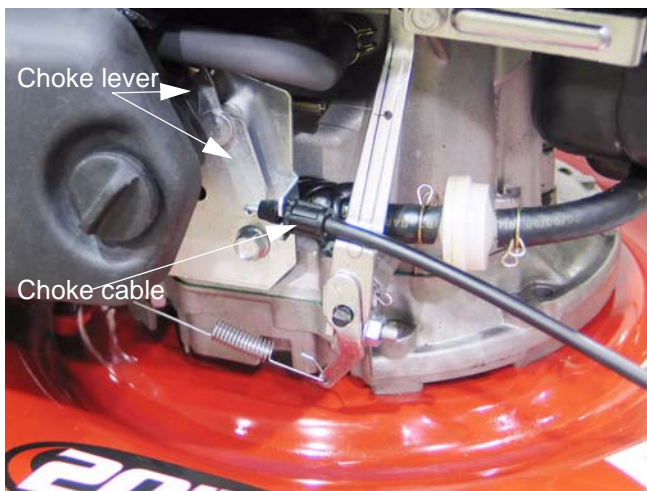


Figure 8.6

- 8.7. If the choke plate fails to close fully when the knob is pulled, the mower will be difficult or impossible to start when cold.
- 8.8. The rod connecting the choke lever to the choke arm on the carburetor can be bent slightly to facilitate adjustment. See Figure 8.8.

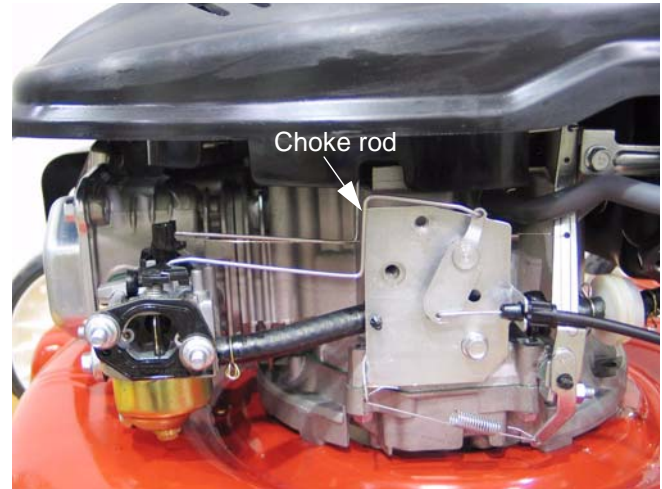


Figure 8.8

**NOTE:** Stale, contaminated, or out-dated fuel is a leading cause of no-start situations. If the fuel in the tank, lines, or carburetor is suspect, it may be easily drained.

- 8.9. Make provisions to safely catch and dispose of drained fuel before draining it.



## MTD Engine - Series 350/450/650

- 8.10. Remove the drain bolt from the carburetor float bowl using a 10mm wrench, and let the fuel flow out of the system. See Figure 8.10.



Figure 8.10

- The bowl drain may also be used to prevent fuel spillage during carburetor removal.
- NOTE:** There is a gasket between the head of the drain bolt and the bowl.
- NOTE:** the torque for the drain bolt is 80 - 106 in-lbs. (9 - 12 Nm).
- 8.11. The air filter and pre-filter are easily accessible behind the air filter cover. See Figure 8.11.

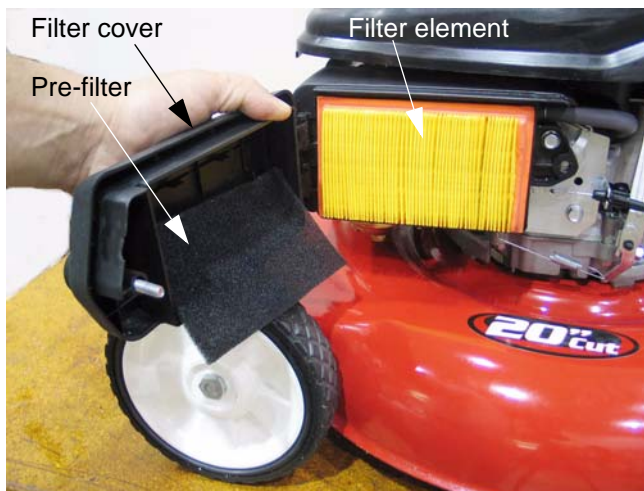


Figure 8.11

- 8.12. The air filter assembly is easily removable using a 10mm wrench. See Figure 8.12.

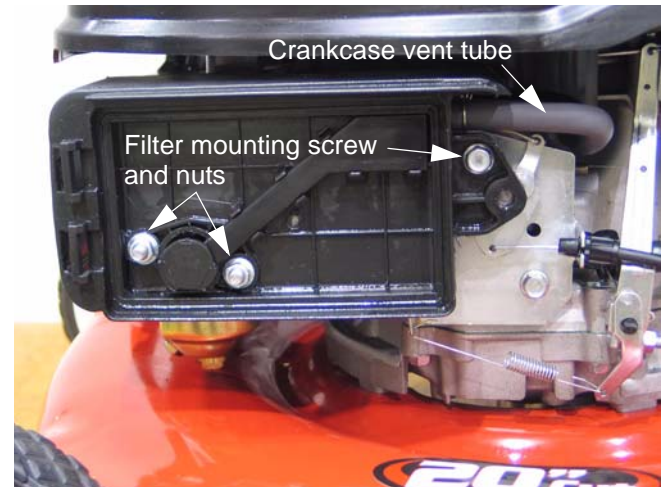


Figure 8.12

- Disconnect the crankcase vent tube.
  - Remove the screw that holds the air filter housing to the control bracket.
  - Remove the two nuts that hold the air filter body to the carburetor mounting studs.
  - Lift away the filter housing.
- 8.13. Behind the filter housing is a steel plate with formed rubber gaskets vulcanized to each surface. See Figure 8.13.

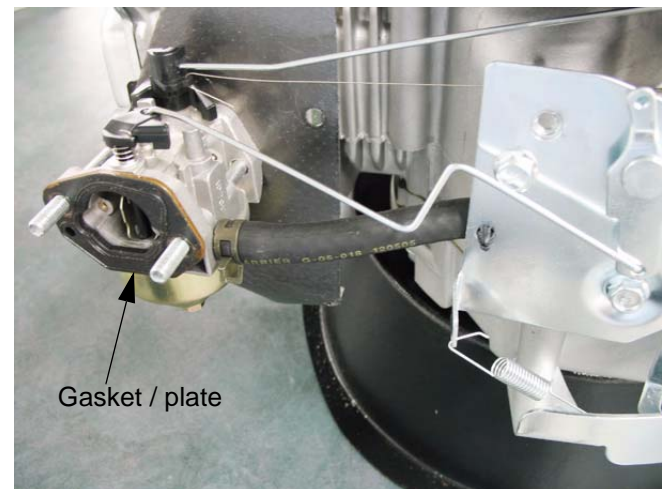


Figure 8.13

## MTD Engine - Series 350/450/650

8.14. Note or mark the orientation of the plate. Notches in the plate allow air to reach emulsion ports: one for the main jet and one for the pilot jet. Channels in the rubber provide air passage to the choke-side bowl vent.

**CAUTION:** When working around the fuel system, do not bring any sources of heat, spark, or open flame close enough to the work area to pose a fire hazard.

- Drain the fuel tank or clamp the fuel line before starting work to prevent spillage.
- Dispose of drained fuel in a safe and responsible manner.

8.15. To remove the carburetor, disconnect the fuel line.

8.16. Double-nut the studs for removal, with a washer between the nuts serrated faces of the nuts. See Figure 8.16.

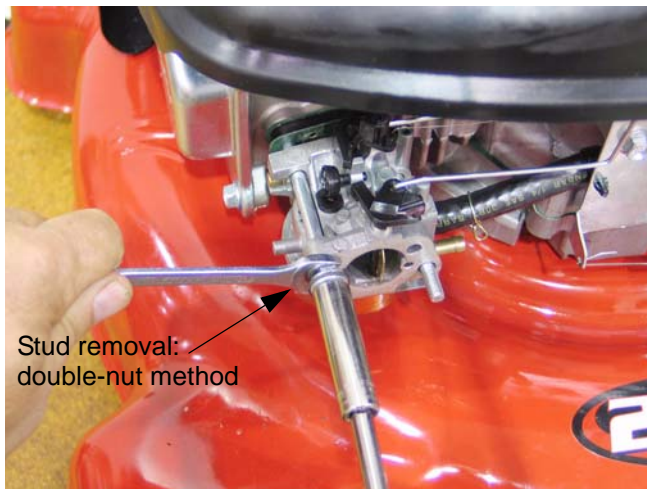


Figure 8.16

**NOTE:** There are differences between the linkages on the Series 650 carburetor, and those shared by the Series 350 and Series 450. Removal technique is similar.

8.17. After the second stud is removed, the carburetor can be maneuvered to disconnect the linkages. See Figure 8.17.

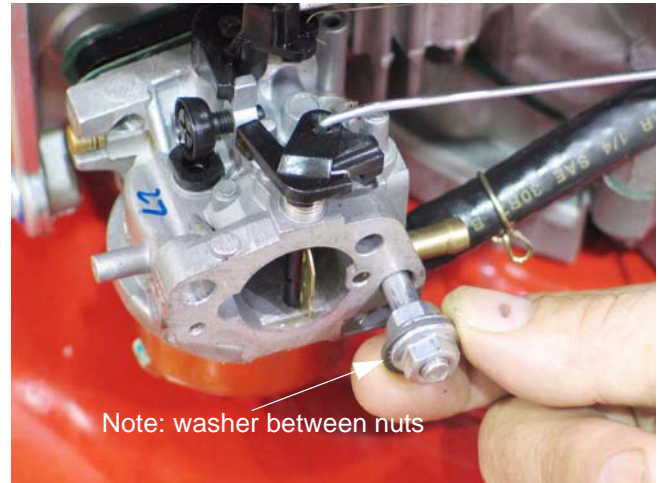


Figure 8.17

8.18. Rotate the throttle arm until it meets the idle speed screw, then pivot the carburetor slightly to disengage the 90 degree bend at the end of the governor rod. See Figure 8.18.

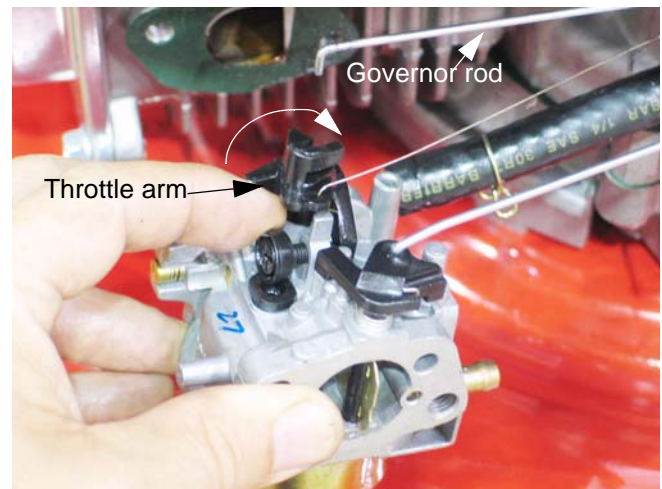
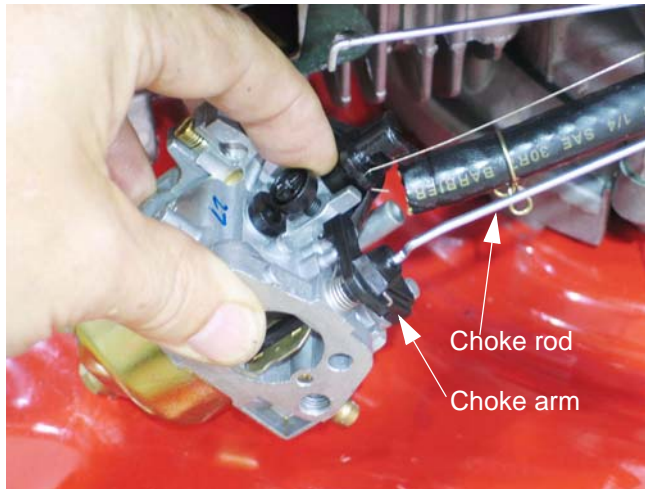


Figure 8.18



## MTD Engine - Series 350/450/650

- 8.19. Pivot the carburetor to disengage the Z-fitting on the end of the choke rod. See Figure 8.19.



**Figure 8.19**

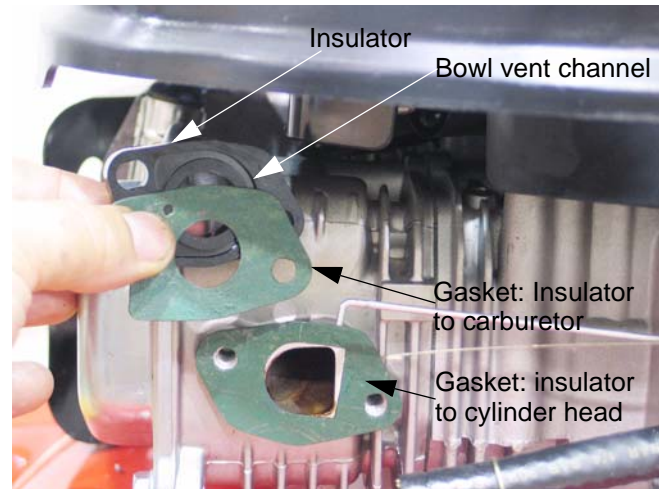
- 8.20. Unhook the stabilizer spring that takes-up the play between the governor arm, the governor rod, and the throttle arm on the carburetor.

**NOTE:** The carburetors used on all three engines are similar in design, but differ in calibration.

**NOTE:** The jet markings may be used for identification purposes, but the technician should not attempt to infer orifice sizes from the identification numbers.

**NOTE:** Installing the wrong main jet, or a carburetor with the wrong main jet will produce performance and emissions issues.

- 8.21. Between the carburetor and the cylinder head is an insulator, sandwiched between two gaskets. See Figure 8.21.



**Figure 8.21**

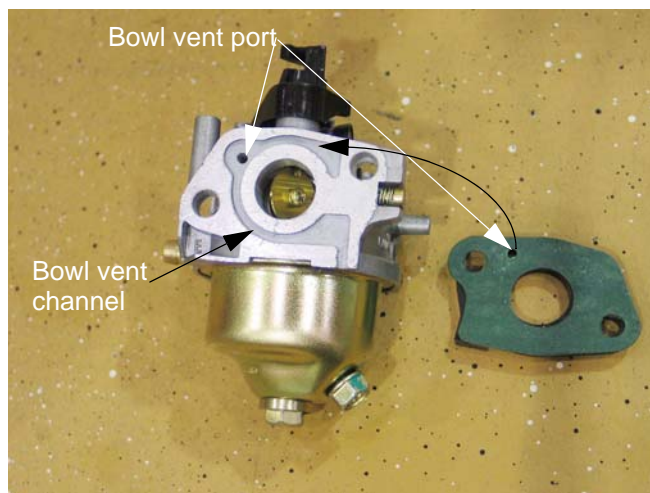
**NOTE:** The gaskets are different, and there is an orientation to the insulator.

- The gasket with the "D" shaped opening goes between the insulator and the cylinder head, matching the shape of the gasket to the shape of the intake port.
- The bowl vent channel in the insulator faces the carburetor, with the exit toward the bottom.
- There is a small hole in the insulator to carburetor gasket. The hole should be aligned to allow passage of air through the bowl vent channel to the throttle side bowl vent in the carburetor body.



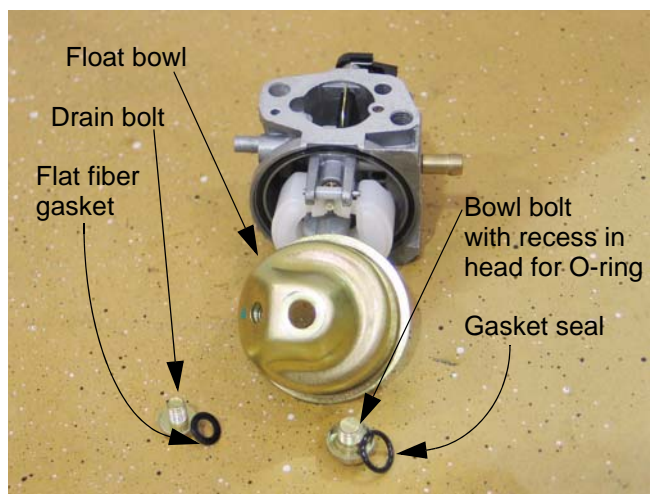
## MTD Engine - Series 350/450/650

8.22. There is a corresponding passage recessed into the mating surface where the throttle end of the carburetor housing meets the gasket. See Figure 8.22.



**Figure 8.22**

8.23. Bowl removal is a logical place to begin carburetor disassembly. Remove the bowl bolt using a 10mm wrench. See Figure 8.23.

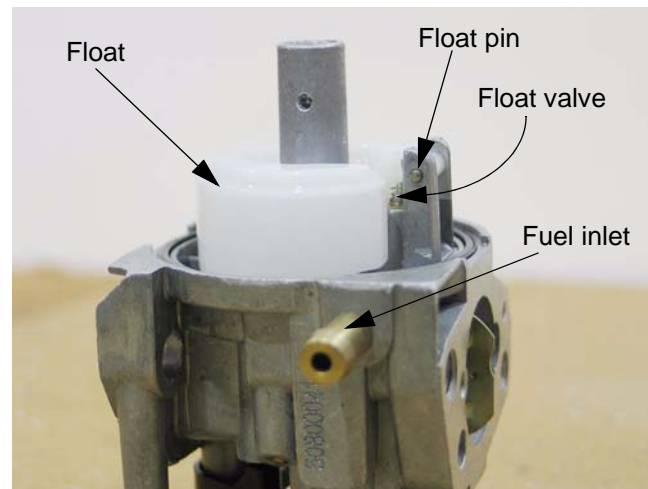


**Figure 8.23**

8.24. From this point an assessment can be made about the viability of rebuilding the carburetor.

- If extensive corrosion is evident, replace the carburetor.
- If varnish build-up is too extensive to clean, replace the carburetor.

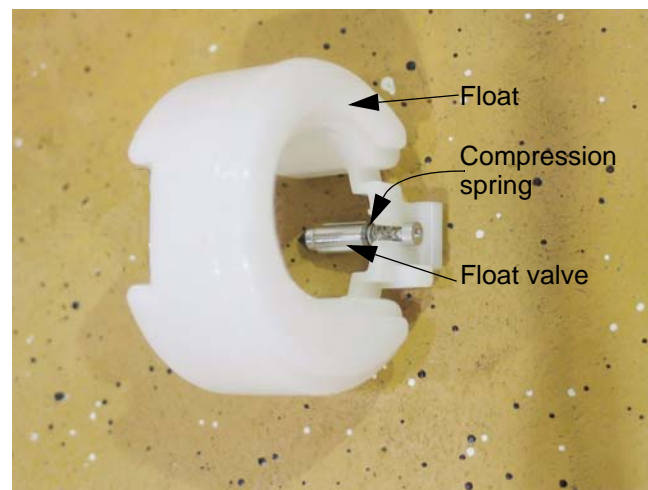
8.25. When inverted, the float should rest in a level position. See Figure 8.25.



**Figure 8.25**

8.26. Remove the pin that the float hinges on to remove the float.

8.27. The float is not adjustable. Spring tension against the float valve begins to build from the horizontal position, putting progressively more pressure between the tip of the valve and the seat. See Figure 8.27.



**Figure 8.27**

8.28. Because the float valve is crucial to the functioning of the carburetor, and the viton tip of the valve is subject to wear, it is suggested that technicians replace the valve and spring any time the carburetor is disassembled for cleaning.

## MTD Engine - Series 350/450/650

- 8.29. A square cross-section gasket seals the bowl to the body of the carburetor.
- 8.30. A narrow-shank straight blade screwdriver can be used to remove the main jet. See Figure 8.30.

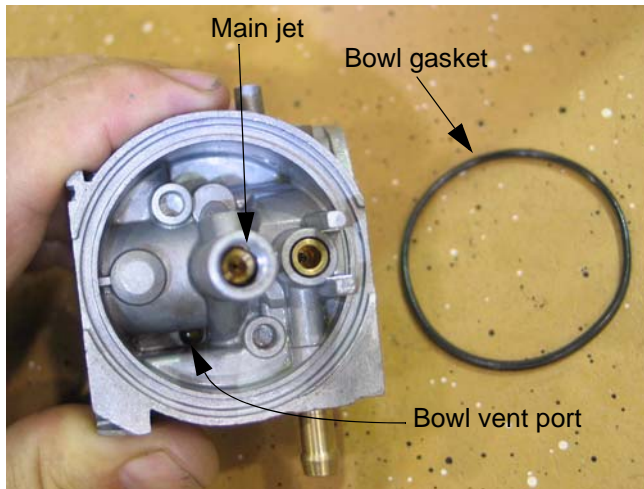


Figure 8.30

**NOTE:** Fuel enters the central column through a port about 1/2" (1cm) from the bottom, to help prevent the ingress of any residue in the bottom of the bowl.

**NOTE:** The orifice in the main jet meters fuel into the central column.

**NOTE:** Air from the main jet emulsion port enters the central column near the top, then gets bubbled through the emulsion tube into the metered fuel flow to promote atomization.

- 8.31. The main jet secures the emulsion tube in the central column of the carburetor. See Figure 8.31.

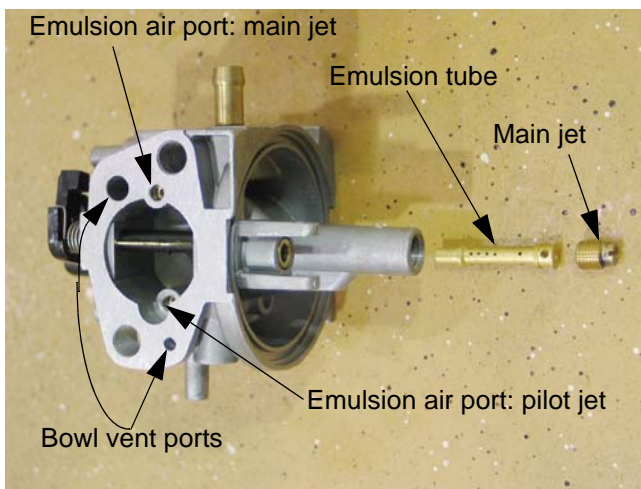


Figure 8.31

- 8.32. The throttle stop screw has a large pliable lip around the head of the screw. That lip secures a metering plug for the pilot and transition ports. Remove the screw to remove reach the plug. See Figure 8.32.

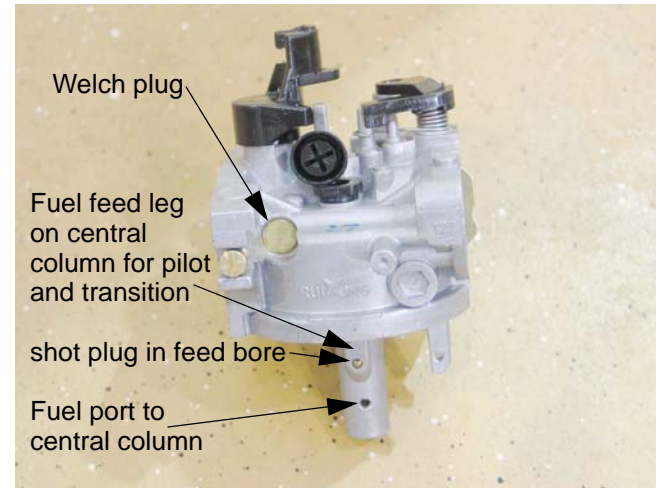


Figure 8.32

- 8.33. The metering plug can be carefully pried out using a small screwdriver. See Figure 8.33.

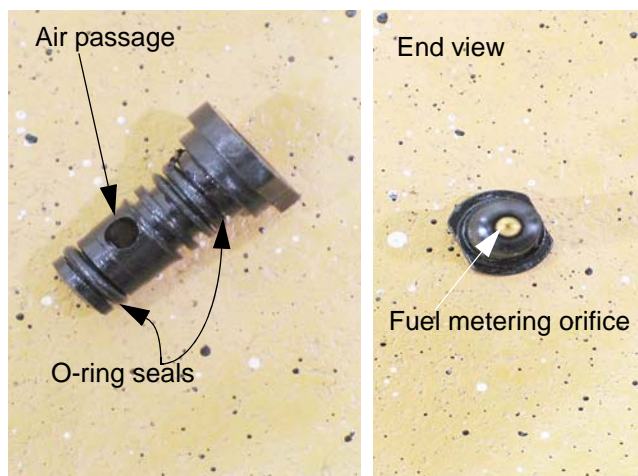


Figure 8.33



## MTD Engine - Series 350/450/650

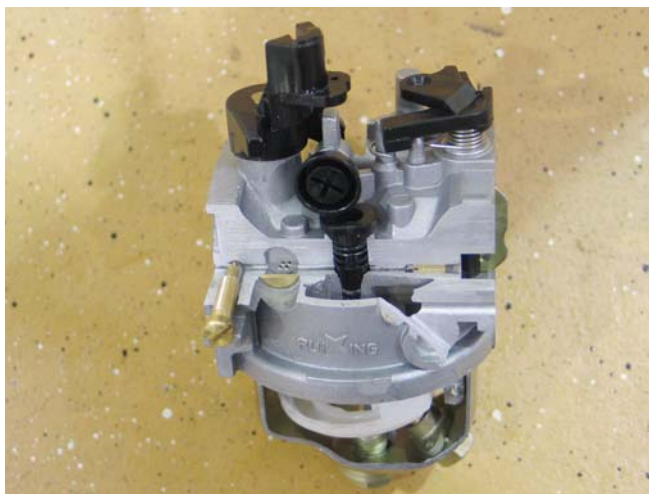
8.34. Examining the metering plug: See Figure 8.34.



**Figure 8.34**

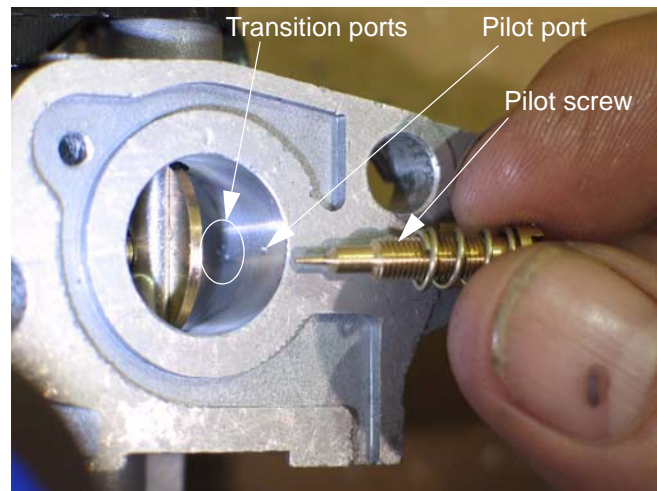
- Fuel, drawn from the central column via the long fuel feed leg, is metered by the brass orifice in the tip of the metering plug.
- Air, drawn from the emulsion air port, is metered by the size of the brass orifice at the entrance to the port.
- The fuel and air that feed the pilot and transition ports are mixed at the metering plug.
- The metering plug creates a small venturi. The pressure drop of the air passing through the metering plug draws the fuel into the passage to the pilot and transition ports, in an emulsified mixture.

8.35. In cut-away view, the passage by the metering port is visible. See Figure 8.35.



**Figure 8.35**

8.36. The pilot screw regulates how much of this pre-mixed fuel/air emulsion is allowed to enter the throat of the carburetor, to atomize down-stream of the throttle plate. See Figure 8.36.



**Figure 8.36**

8.37. The transition ports are fixed. They are drilled into the throat of the carburetor, down-stream of the venturi. They lie behind the brass welch plug near the pilot screw.

8.38. Adjustment on installation:

- Gently turn the pilot screw in all the way, then back it out 3/4 turn (270 degrees).
- Tighten the idle speed screw until 1/8" (3 mm) of the screw is visible on the throttle arm side of the housing.
- After installation, adjust the speed screw as indicated in step 5.5 of the MAINTENANCE AND ADJUSTMENT INFORMATION section of this manual to achieve a 1,800 RPM idle,  $\pm$  160 RPM.



## MTD Engine - Series 350/450/650

### 9. EXHAUST

- 9.1. The muffler and muffler cover are secured to the cylinder head by nuts on studs. They may be removed using a 10mm wrench. See Figure 9.1.



Figure 9.1

**NOTE:** The studs that hold the carburetor and the studs that hold the muffler are interchangeable.

- 9.2. The muffler and cover may be slipped off of the studs as a unit, or separately. See Figure 9.2.



Figure 9.2

- 9.3. The muffler gasket extends well beyond the port, to act as a heat shield and cooling air guide between the muffler and the cylinder. See Figure 9.3.

**NOTE:** The exhaust gasket is a one time use only gasket. Replace every time the muffler is removed.

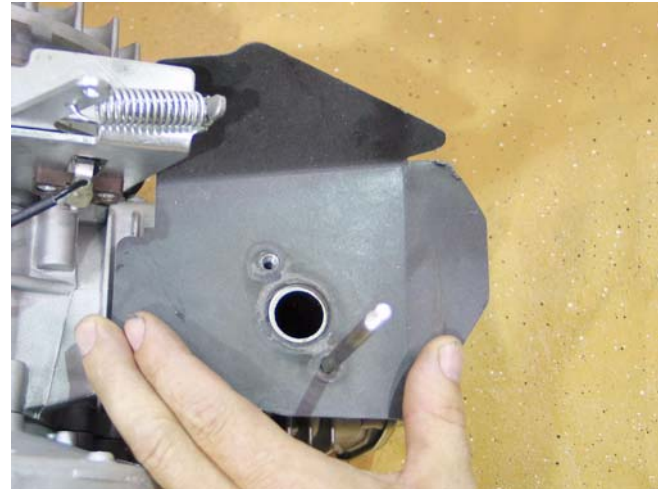


Figure 9.3

## MTD Engine - Series 350/450/650

### 10. GOVERNOR

10.1. The engine speed is controlled by a balance between the force applied by a spring (pulling the throttle open) and a flyweight mechanism within the engine applying force to the governor arm (pushing the throttle closed). See Figure 10.1.

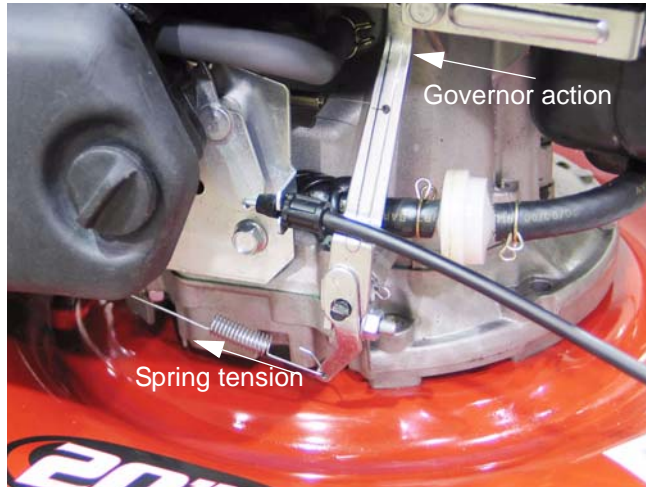


Figure 10.1

10.2. While the mechanism is simple and robust, it is important to pay attention when working on parts near the governor. Binding caused by interference with mis-routed lines or cables may make the governor unresponsive.

10.3. The governor arm may be removed from the governor shaft using a 10mm wrench. See Figure 10.3.

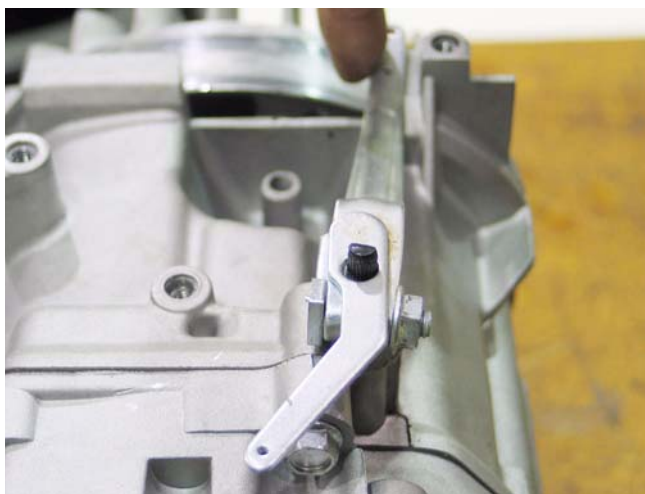


Figure 10.3

10.4. The governor shaft is splined. If it is necessary to remove the governor arm, make an index mark to orient the shaft to the arm on installation.

10.5. If the governor arm is being installed without benefit of index marks:

- Rotate the governor shaft clockwise as far as it will go.
- Position the top of the arm about 3/16" (.476cm) from the boss on the casting that provides a mounting point for the fuel tank bracket.
- Slide the arm onto the shaft. The flat on the top of the shaft should be roughly perpendicular to the shaft.
- Tighten the nut on the clamp bolt to secure the arm.

10.6. Adjust the governor to maintain top no-load speed as described in the MAINTENANCE AND ADJUSTMENT section of this manual, Instruction number 5.6 and 5.7.

**NOTE:** When a governed engine "hunts", it is generally an indication of a lean fuel/air mixture, rather than a problem with the governor.

## MTD Engine - Series 350/450/650

### 11. CRANKCASE VENTILATION

11.1. 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 11.1.



Figure 11.1

11.2. 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 11.2.



Figure 11.2

- 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.

11.3. An adaptor can easily be made form an old or extra dipstick. See Figure 11.3.



Figure 11.3

- 11.4. 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.
- 11.5. Experimentation by MTD's Training and Education department has revealed the following characteristics:
- 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.



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11.6. The PCV chamber is accessible by removing the flywheel, as described in steps 7.2 through 7.6 of the IGNITION SYSTEM section of this manual. See Figure 11.6.

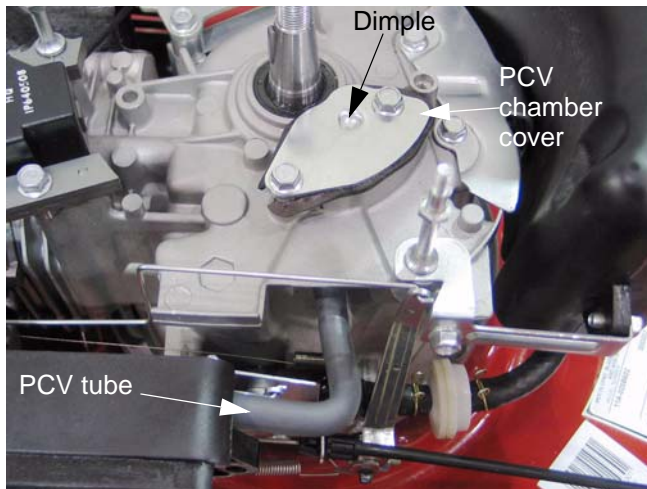


Figure 11.6

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

11.8. The cover and gasket can be separated from the chamber. See Figure 11.8.

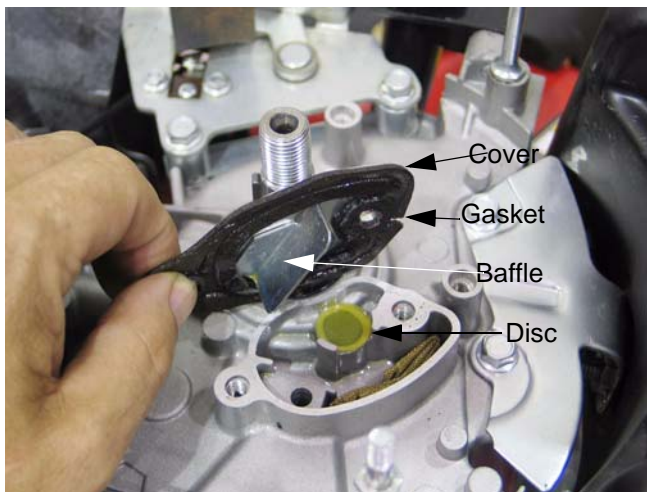


Figure 11.8

**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.

11.9. 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.

11.10. The folded wire mesh in the chamber also helps separate the oil from the air. See Figure 11.10.

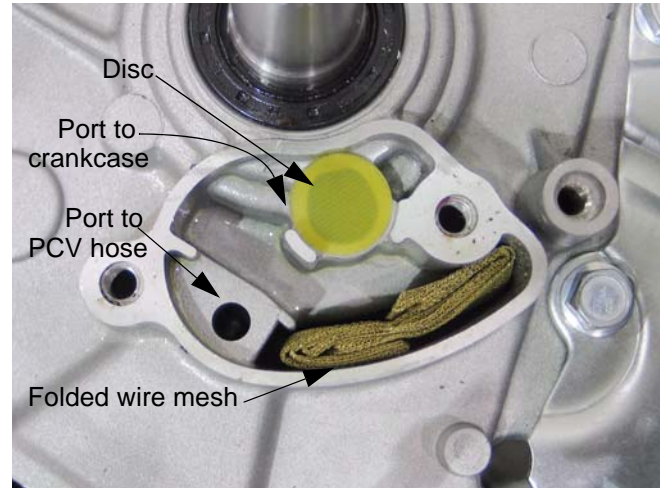


Figure 11.10

11.11. 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.

11.12. 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 11.12.

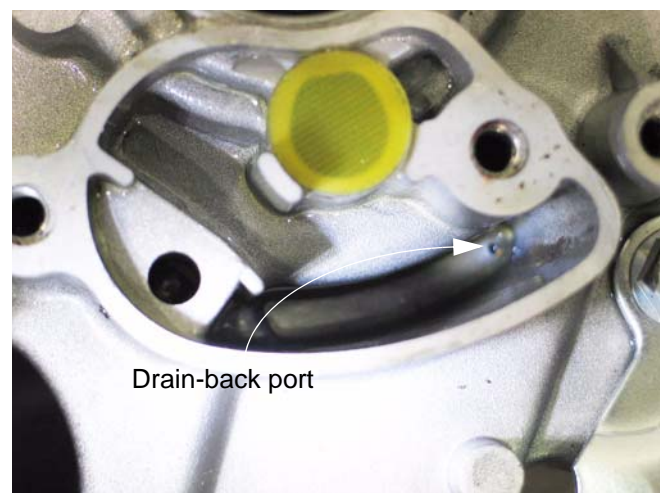


Figure 11.12

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11.13. Vigorous pumping with a hand pump vacuum / pressure tester will result in a slight build-up of pressure within the chamber. See Figure 11.13.



**Figure 11.13**

- 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.

## 12. CYLINDER HEAD REMOVAL

12.1. It is recommended that the mower be positioned on the bench vertically for cylinder head removal. See Figure 12.1.



**Figure 12.1**

**NOTE:** This position provide easy access to most service points, yet prevents undue oil spillage.

**NOTE:** It is not absolutely essential to remove the fan shroud, but taking the engine cover off will ease access to some components.

12.2. Disconnect and ground the spark plug high tension lead, and remove the spark plug using a 13/16" or 21mm wrench. See Figure 12.2.



**Figure 12.2**



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- 12.3. Remove the four screws securing the valve cover using a 10mm wrench. See Figure 12.3.



Figure 12.3

- 12.4. Loosen the jam nuts and fulcrum nuts that secure the rocker arms using a 10mm wrench and a 14mm wrench.

- 12.5. Pivot the rocker arms aside, or remove them completely, and remove the push rods.

**NOTE:** Once broken-in, the rocker arm should be kept with its corresponding valve.

**NOTE:** The intake and exhaust push rods are identical and interchangeable. It is preferable, but not absolutely necessary to return the same push rods to their original locations on engine with substantial ( $\geq 100$  hours) operating time.

- 12.6. Remove the muffler, as described in the EXHAUST section of this manual. See Figure 12.6.



Figure 12.6

- 12.7. Double-nut and remove the exhaust studs, similar to the method used to remove the carburetor studs in the FUEL SYSTEM section of this manual.

- 12.8. Remove the carburetor as described in the FUEL SYSTEM section of this manual. See Figure 12.8.

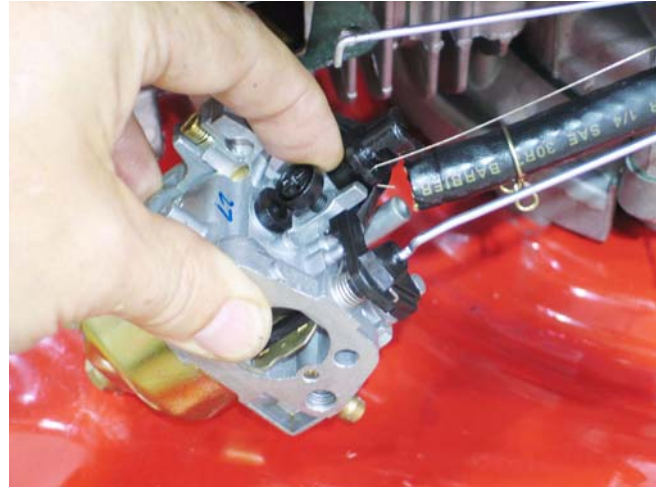


Figure 12.8

- 12.9. Remove the cylinder head bolts using a 14mm wrench. See Figure 12.9.

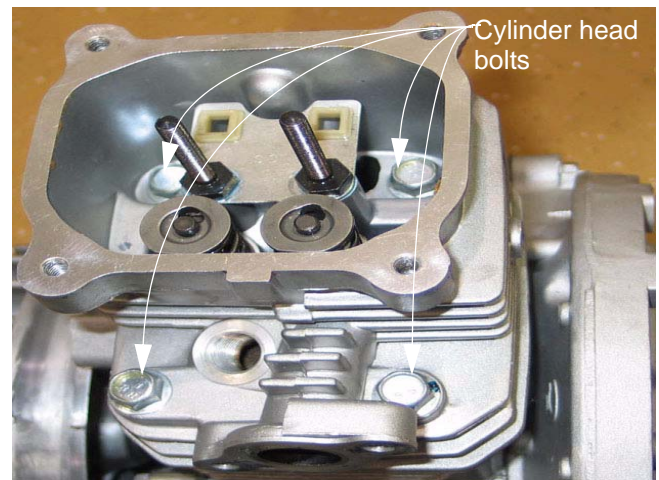


Figure 12.9

- 12.10. Lift the cylinder head off of the mower.

**NOTE:** The alignment dowels fit in two of the head bolt holes.

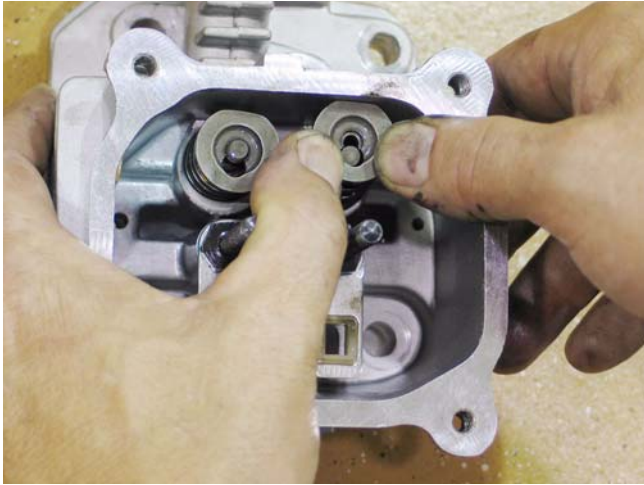
- 12.11. Carefully clean all sealing surfaces of all gasket residue. Do not scratch the sealing surfaces.

- 12.12. Make a visual inspection of the valves and cylinder bore to confirm the initial diagnosis.



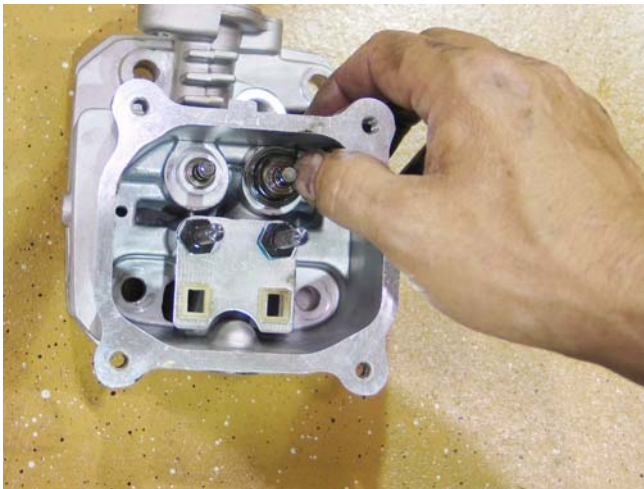
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12.13. For inspection purposes, the valve retainers can be removed with light finger pressure. See Figure 12.13.



**Figure 12.13**

12.14. Only the intake valve has a valve guide seal. See Figure 12.14.

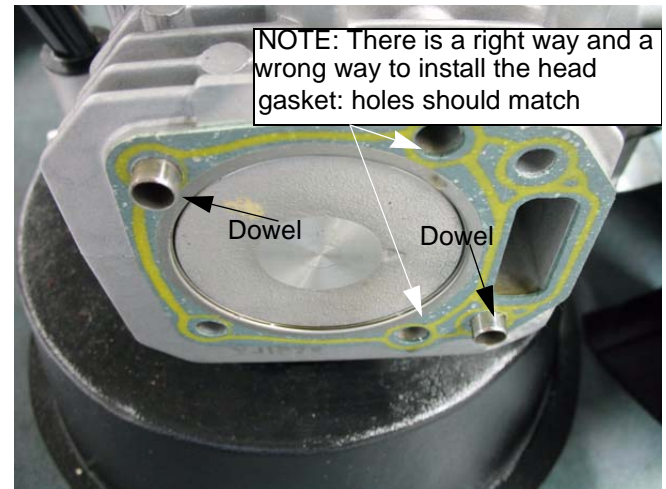


**Figure 12.14**

**NOTE:** Outside of warranty, the dealer may choose to recondition a cylinder head.

- Replacement valve guides are not presently available.
- Valve spring free length should be at least 1.22" (28.5mm). Original length is 1.44" (36.6mm).
- Valve seats are 45 degrees, with a 15 degree topping cut and a 75 degree narrowing cut.
- Seat width should be .043"-.050" (1.1-1.3mm) with a margin of .024" (.6mm) on the exhaust valve and .027" (7mm) on the intake valve.

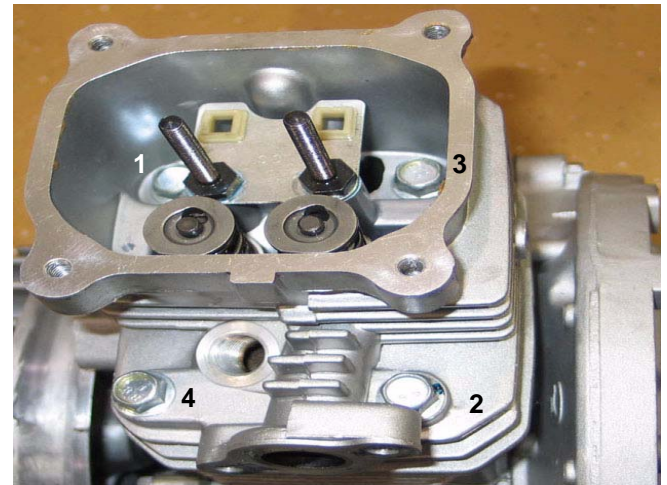
12.15. Position new cylinder head gasket and dowels on engine block. See Figure 12.15.



**Figure 12.15**

12.16. Position the cylinder head on the engine block.

12.17. Install the 4 head bolts, and tighten them to a step torque of 212 in-lb. (24 Nm) in an alternating diagonal pattern. See Figure 12.17.



**Figure 12.17**

12.18. Insert the push rods.

12.19. Install and adjust the rocker arms as described in steps 5.13 through 5.29 of the MAINTENANCE AND ADJUSTMENT section of this manual.

12.20. Install the fuel and exhaust systems, using new gaskets, as described in the FUEL SYSTEM and EXHAUST SYSTEM sections of this manual.

12.21. Test run the mower in a safe area before returning it to service. Check all safety features.

**MTD Engine - Series 350/450/650****13. TORQUE SPECIFICATIONS**

<b>Fastener Torque Table</b>		
<b>Fastener</b>	<b>Torque, SAE</b>	<b>Torque, metric</b>
Nuts, muffler	84 in-lb	10 Nm
Nuts, carburetor	84 in-lb	10 Nm
Screw, dipstick tube	84 in-lb	10 Nm
Nuts, recoil housing	84 in-lb	10 Nm
Screws, brackets	84 in-lb	10 Nm
Screws, PCV cover	84 in-lb	10 Nm
Studs, recoil mounting and ignition module	84 in-lb	10 Nm
Nut, flywheel	41-48 ft-lb	55-65 Nm
Bolt, blade	450-600 in-lb	51-68 Nm
Spark plug	175-220 in-lb	19.1-24.8 Nm
Screws, valve cover	71 in-lb	8 Nm
Jam nuts, rocker arm	84 in-lb	10 Nm
Studs, rocker arm	212 in-lb	24 Nm
Screws, cylinder head	212 in-lb	24 Nm
Screws, sump to block	84 in-lb	10 Nm

**14. MAINTENANCE INTERVALS**

<b>Maintenance item</b>	<b>Each use</b>	<b>Each 25 hrs. use</b>	<b>Each 50 hrs. use</b>
Check oil	*		
Check air filter	*		
Note on air filter	Dirt may be shaken or tapped out of the air filter, but compressed air is not to be used for cleaning. Do not wash or oil paper filter element.		
Note on pre-filter	Foam pre-filter may be washed in water and mild detergent, and re-used. Do not oil.		
Check blade condition	*		
Check & gap spark plug	Replace if worn.		*
Check cooling fins	After prolonged storage		
Change oil			*
Note on oil:	Change oil after first 5 hrs. of use, and before prolonged storage.		
Change air filter		*	
Note on air filter	Air filter and pre-filter life vary dramatically with operating conditions.		
Drain or preserve fuel	Before prolonged storage		
Fog or lube cylinder	Before prolonged storage		
Rotate engine to TDC	Before prolonged storage		

**MTD Engine - Series 350/450/650****15. MAINTENANCE SPECIFICATIONS**

<b>Item</b>	<b>Specification</b>	<b>Setting, SAE</b>	<b>Setting, Metric</b>
Ignition module	air gap	.008"-.016"	.2-.4mm
Spark plug	gap	.024"-.032"	.6mm-.8mm
Spark plug	type	Torch F7TC	
Oil type	SAE 30 SF/CD	32 to 104 deg. F.	0 to 40 deg. C.
Oil type	SAE 10W30 SF/CD	neg. 4 to 97 deg. F.	neg. 20 to 36 deg. C.
Oil	volume	17.0-20.3 fl.oz.	0.5-0.6 L
Fuel	Octane	90 octane pump rating	
Pilot mix screw	setting	Turn-out 180-270 degrees	
Idle speed	RPM	1,600 $\pm$ 160 RPM	
Top no-load	RPM 20" mower	3,400 RPM	
Top no-load	RPM 21" mower	3,250 RPM	
Valve lash	Intake	.005"-.007"	0.15 $\pm$ .02mm
Valve lash	Exhaust	.007"-.009"	0.20 $\pm$ .02mm