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Commercial Equipment Service Training

Small Engine Troubleshooting

(Rev. 6-12)

Program Study Workbook

To The Technician: The following Program Study Workbook is designed to enhance your understanding of small engine operation and troubleshooting.
The format is designed to increase your comprehension of important concepts and material that are addressed in the manual.

This Service Training material should also be utilized as future reference materials to be used one your return back at your workplace.

If you still have questions or want further explanations/clarifications, talk with other attendees here, and/or the Training Instructor for additional explanation or discussion.

Make the most productive use of your time in this program. The clearer the understanding you have of the information provided the more effective you become to your employer.

The Toro Company
8111 Lyndale Ave South
Bloomington, MN 55068 U.S.A.

Printed in the U.S.A.

***Small Engine** Troubleshooting*

Good afternoon and on behalf of the Toro Company, thanks for attending this informational session on Small Engine Troubleshooting.

If through the course of this presentation, you have any questions please feel free to ask.

This session is for you and no one should leave without getting their questions asked.

Small Engine Troubleshooting

- Small Engines are machines that can provide great assistance in performing many tasks.
- They are built very rugged and can last for many years with the proper care.

Small engines are an important component of many of the machines that are needed to maintain turf areas and perform other maintenance jobs.

Small engines are very reliable and with proper care and maintenance will last a long time

Small Engine Troubleshooting

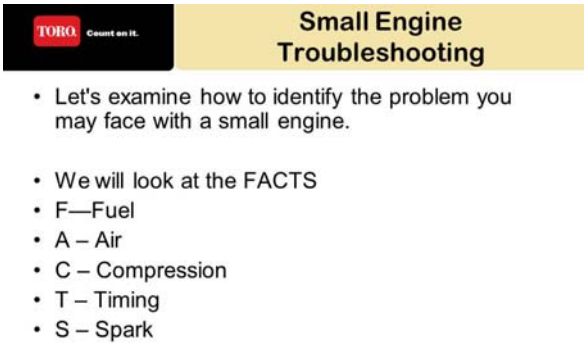
- So if they are so great, then why do they aggravate me so much!!

However, while they are dependable components, when they do not perform as needed, they can be one of the most frustrating devices in our selection of tools and machines.

The most common complaint about small engines is that they "WONT START"

The second most common complaint is that it runs, but runs poorly.

In this program we will discuss what is needed for these engines to start, what is needed from them to run properly and what tests and troubleshooting steps can be used when either of these two situations are encountered.



Let's examine how to identify the problem you may face with a small engine.

If you have a no-start issue or a poor performance issue, there are some Facts that we need to understand when troubleshooting these engines.

We will look at the FACTS

F—Fuel

A – Air

C – Compression

T – Timing

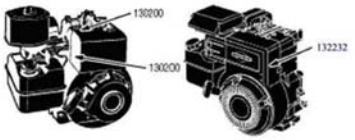
S – Spark

For the engine to run properly we need to have, Fuel, Air, Compression, Timing & Spark.

These will be discussed in more depth later in this program.

Model Number Locations

- The first thing that needs to be identified is what type of engine you have.
- Each engine has an identification number located on the engine.
- Some are on the engine housing, some are on the valve cover, and some are on a side plate.



To begin, we need to identify the engine to get the correct engine specs, testing specs and adjustment information.

The engine will normally have an “Engine Identification” number on the engine.

It may be on the engine housing, on the valve cover or on an engine side plate.

These numbers may include a model, type, and code

Briggs and Stratton for example, provide the following information through their numbering system.

Model provides engine configuration information.

Type list specific parts, paint color, OEM information.

Code provides specific manufacturing date and plant information.

This is an example of a basic Briggs & Stratton engine number.

Model 303447 Type 1234-01 Code 01061201

A **Cubic Inch Displacement**	**B** **Basic Design Series**	**C** **Crankshaft, Carburetor, Governor**	**D** **PTO Bearing, Reduction Gear, Auxiliary Drive, Lubrication**
6	0-9	0 - Horizontal Shaft, Diaphragm Carburetor, Pneumatic Governor	0 - Plain Bearing / DU, Non-Flange Mount
8	A-Z		
9			
10		1 - Horizontal Shaft, Vacu-Jet Carburetor, Pneumatic Governor	1 - Plain Bearing, Flange Mounting
11			
12			
13		2 - Horizontal Shaft, Pulsa-Jet Carburetor, Pneumatic or Mechanical Governor	2 - Sleeve Bearing Flange, Mounting, Splash Lube
16			
17			
18			3 - Ball Bearing, Flange Mounting, Splash Lube
19		3 - Horizontal Shaft, Flo-Jet Carburetor, Pneumatic Governor	
22			
23			4 - Ball Bearing, Flange Mounting, Pressure Lubrication on Horizontal Shaft
24		4 - Horizontal Shaft, Vacu-Jet Carburetor, Mechanical Governor	
25			
26			
28		5 - Vertical Shaft, Vacu-Jet Carburetor, Pneumatic or Mechanical Governor	5 - Plain Bearing, Gear Reduction (6 to 1), CW Rotation, Flange Mounting
29			
30			
32			
35		6 - Vertical Shaft	6 - Plain Bearing, Gear Reduction (6 to 1), CW Rotation, Flange Mounting
40			
42		7 - Vertical Shaft, Flo-Jet Carburetor, Pneumatic or Mechanical Governor	7 - Plain Bearing, Pressure Lubrication on Vertical Shaft
46			
		8 - Vertical Shaft, Flo-Jet Carburetor, Mechanical Governor	8 - Plain Bearing, Auxiliary Drive (PTO) Perpendicular to Crankshaft
		9 - Vertical Shaft, Pulsa-Jet Carburetor, Pneumatic or Mechanical Governor	9 - Plain Bearing, Auxiliary Drive (PTO) Parallel to Crankshaft

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Model 303447 Type 1234-01 Code 01061201

MODEL To identify Model 303447:

30	3	4	4	7
30 Cubic Inch	Design Series 3	Horizontal Crankshaft	Ball Bearing Flange Mounting Pressure Lubrication	Electric Starter 12 Volt Gear Drive With Alternator

TYPE 1234-01, The type number identifies the engines mechanical parts, color of paint, decals, governed speed, and Original Equipment Manufacturer.

CODE 01061201, The code is the manufacturing date and is read as follows:

01	06	12	01
YEAR	MONTH	DAY	ASSEMBLY LINE AND MANUFACTURING PLANT

Using the previous chart, we can see that the 303447 refer to the following engine spec.

30 Cubic Inch, design series 3, horizontal crankshaft, ball bearing, pressure lubricated engine with an electric started and gear drive alternator.

The type number list specification normally related to the OEM options and requirement.

This included the engine paint color, governed speed and OEM information.

The code tells us that this engine was built, June 12, 2001 on line 1, plant 1.

All of this information is needed to properly test, adjust and repair the engine.

Eight (8) Engine Events

Eight (8) events are required for a 2 or 4 cycle engine to operate.

1. Air is drawn into the cylinder
2. The correct amount of fuel is metered into the air
3. The air and fuel are mixed
4. The air fuel mixture is compressed
5. The spark plug fires starting combustion
6. Combustion causes a rapid rise in temperature. The increased temperature causes pressure to increase which produces a force on the piston.
7. The connecting rod and crankshaft converts the linear motion to rotary motion.
8. The burnt gases are expelled from the engine.

Do not confuse these events with the four strokes (events) of a four cycle engine.

For the engine to run there are Eight (8) events are required for a 2 or 4 cycle engine to operate.

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The correct amount of fuel is metered into the air

The air and fuel are mixed

The air fuel mixture is compressed

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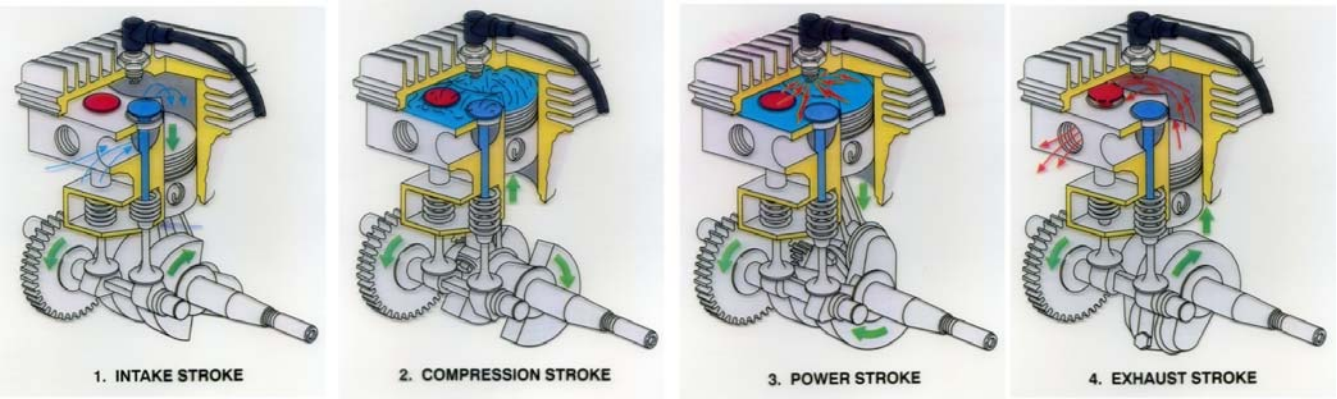
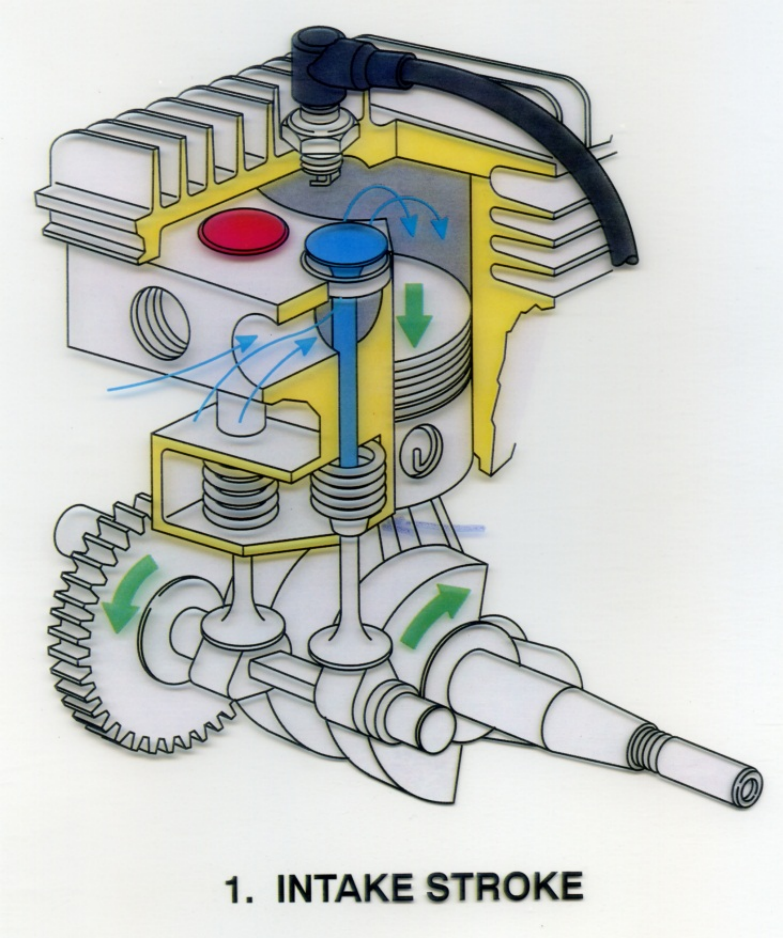


Everyone has heard of the four stroke or four cycle engine.

A four-stroke engine, also known as four-cycle, is an internal combustion engine in which the piston completes four separate strokes—intake, compression, power, and exhaust—during two separate revolutions of the engine's crankshaft, and one single combustion cycle.



INTAKE stroke: on the intake or induction stroke of the piston, the piston descends from the top of the cylinder to the bottom of the cylinder, reducing the pressure inside the cylinder. A mixture of fuel and air, is forced by atmospheric pressure into the cylinder through the intake port. The intake valve(s) then close. The volume of air/fuel mixture that is drawn into the cylinder, relative to the volume of the cylinder is called, the volumetric efficiency of the engine.

Detail

Piston moves from TDC to BDC

Intake valve open

Exhaust valve closed

Piston movement causes an area of low pressure to develop in the combustion chamber.

Higher ambient atmospheric pressure forces air through the intake system.

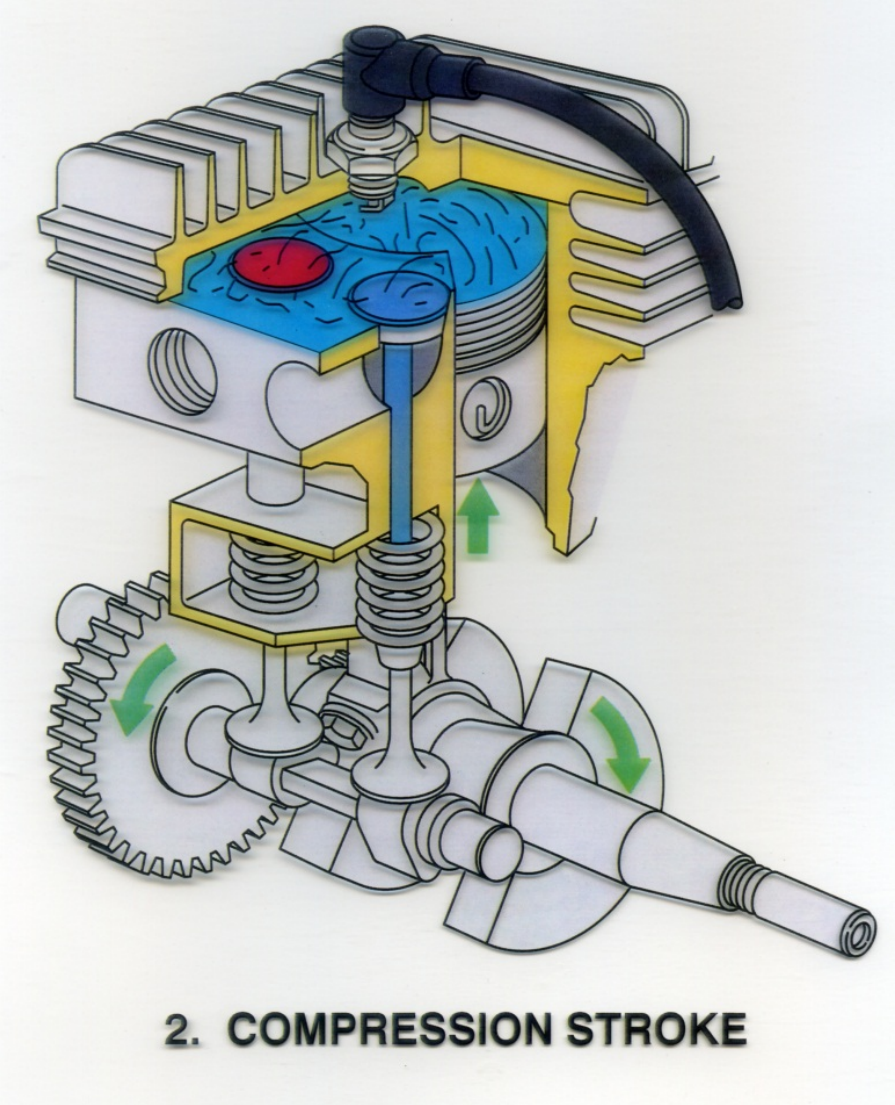
In gas carbureted engine the air picks up the fuel as it passes through the carburetor.

In gas fuel injected engines the gas is added to the air through an injector.

In Diesel engines the fuel is injected into the cylinder at the end of the compression stroke.

180 degrees of rotation

Anything that restricts the flow of air will reduce engine performance.



COMPRESSION stroke: with both intake and exhaust valves closed, the piston returns to the top of the cylinder compressing the air, or fuel-air mixture into the combustion chamber of the cylinder head.

Detail

Piston moves from BDC to TDC

Intake valve closed

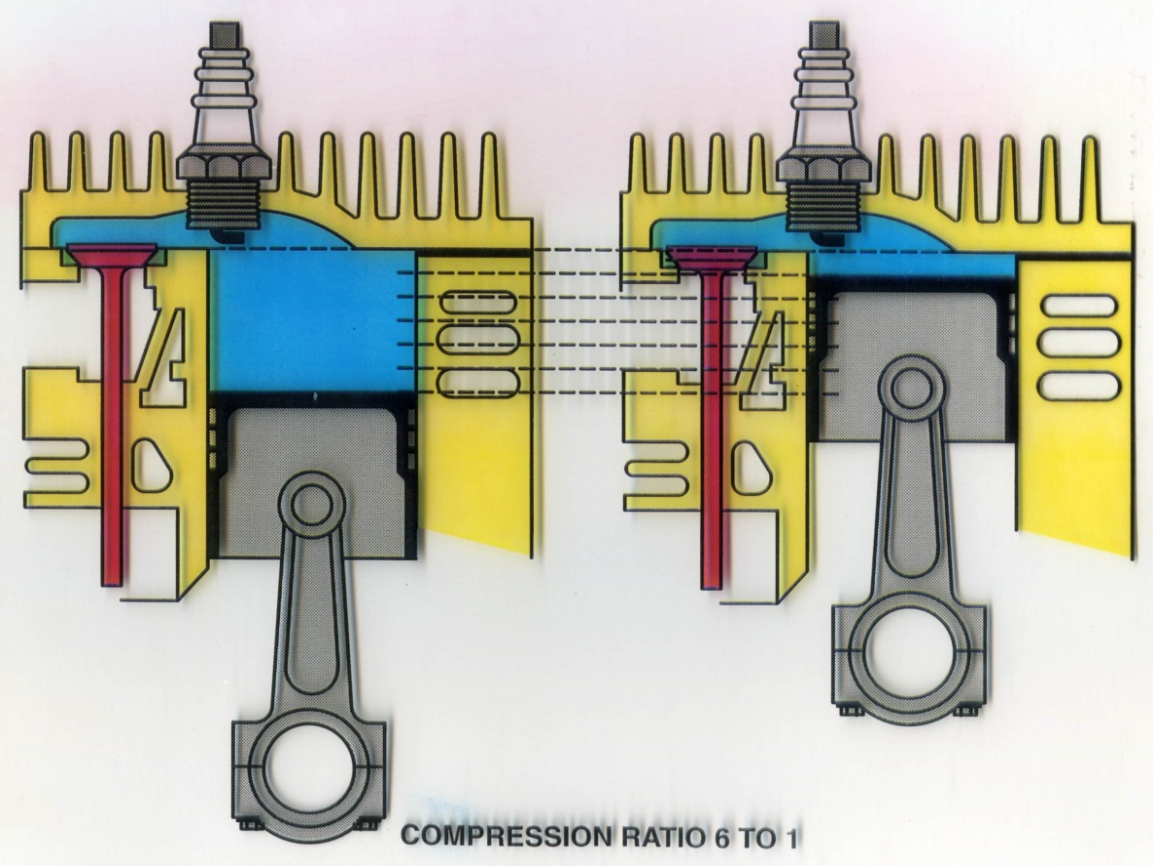
Exhaust valve closed

Piston movement reduces the volume of the combustion chamber--increases pressure.

Pressure of compression = 60 to 80 psi.

Any pressure that escapes reduces the performance of the engine.

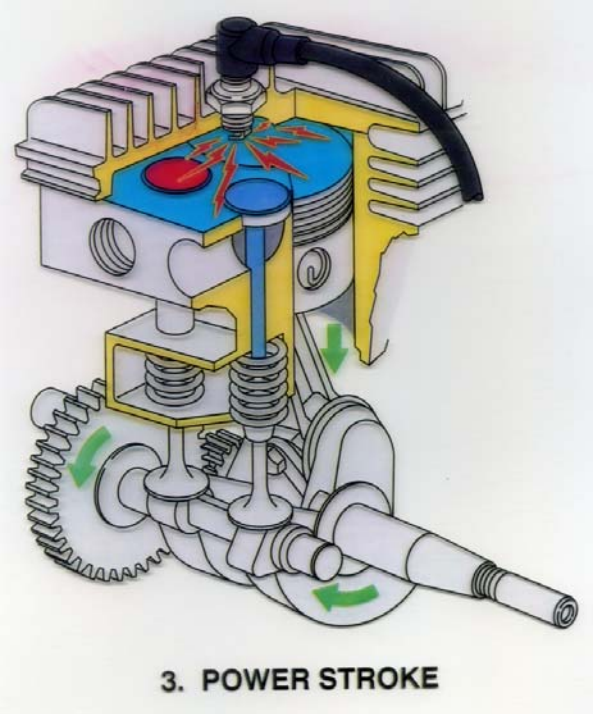
360 degrees of rotation



In order for the engine to run, the air and fuel mixture is compressed in the cylinder. This increases the density of the fuel air mixture and allows for a more efficient combustion process, and higher power output.

Compression ratio is a comparison between the volume of the cylinder at BDC to the volume of the cylinder at TDC.

Ratios of 6 to 8:1 are common for gasoline engines and 18 to 20:1 for Diesel engines.



POWER stroke: this is the start of the second revolution of the engine. While the piston is close to Top Dead Center, the compressed air–fuel mixture in a gasoline engine is ignited, usually by a spark plug, or fuel is injected into the diesel engine, which ignites due to the heat generated in the air during the compression stroke. The resulting massive pressure from the combustion of the compressed fuel-air mixture forces the piston back down toward bottom dead center.

Detail

Piston moves from TDC to BDC

Intake valve closed

Exhaust valve closed

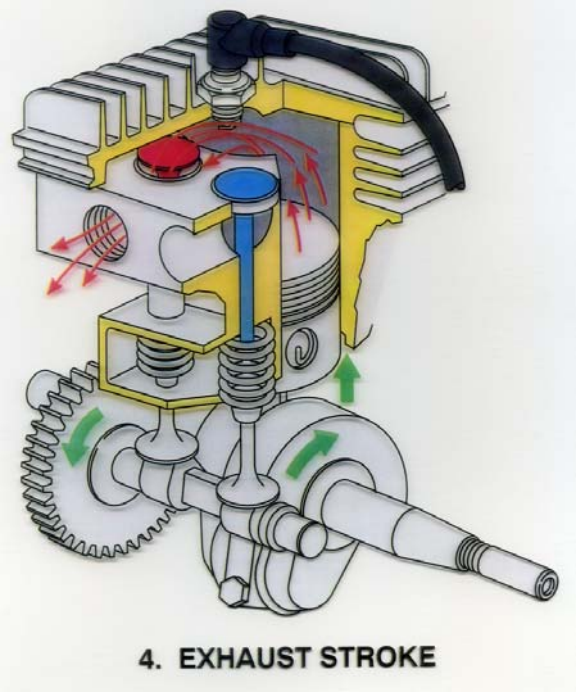
Rapid burning causes rapid rise in temperature.

Rapid rise in temperature causes increased pressure.

Pressure induces a force on the piston.

Force on piston produces torque on crankshaft.

540 degrees rotation



EXHAUST stroke: during the exhaust stroke, the piston once again returns to top dead center while the exhaust valve is open. This action evacuates the burnt products of combustion from the cylinder by expelling the spent fuel-air mixture out through the exhaust valve(s).

Detail

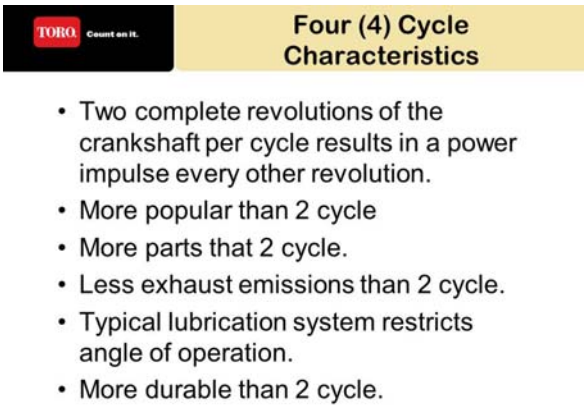
Piston moving from BDC to TDC.

Intake valve closed

Exhaust valve open

Waste gasses are expelled from the cylinder.

720 degrees of rotation



There are some specific characteristics related to a four cycle engine

Two complete revolutions of the crankshaft per cycle results in a power impulse every other revolution.

These engines are more popular than 2 cycle

They do require more parts that 2 cycle.

Less exhaust emissions than 2 cycle.

Typical lubrication system restricts angle of operation due to either splash lube from the sump, or pressure lubricated, pulling oil from the sump.

They are also normally more durable than 2 cycle.

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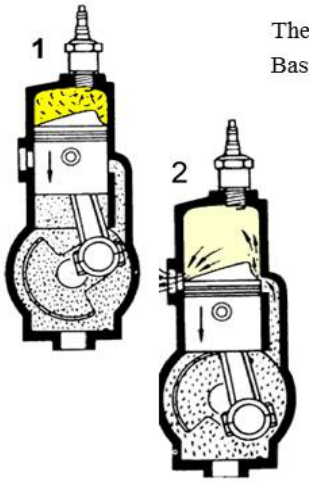
Two (2) Stroke Cycle

In the 2 stroke cycle all eight events occur in two strokes, one revolution of the crankshaft.



There is more variability in 2 stroke engine design than in four.
Basic process:

The spark plug fires and the piston moves away from the cylinder head.
Simultaneously the air-fuel-oil in the crankcase is compressed.

As the piston reaches the bottom of the stroke the exhaust port is exposed.
Cylinder pressure causes gasses to flow out the port.

Further movement of the piston and the intake port is exposed.

Crankcase pressure causes air-fuel-oil to flow into the combustion chamber.

As the piston moves towards the cylinder head the intake and exhaust ports are covered and the air-fuel-oil charge is compressed.
As soon as the intake port is covered, further piston movement causes low pressure in the crankcase and a new charge fills the crankcase.

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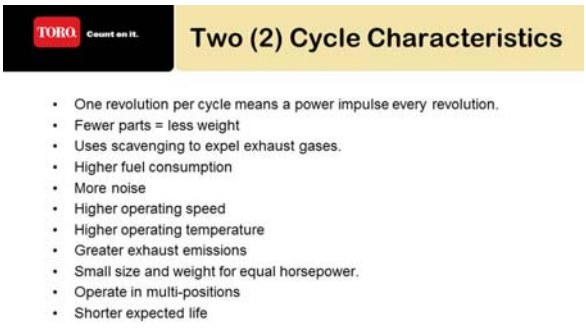


There are some specific characteristics related to a two cycle engine

One revolution per cycle means a power impulse every revolution.

Fewer parts = less weight

Uses scavenging to expel exhaust gases.

Higher fuel consumption

More noise

Higher operating speed

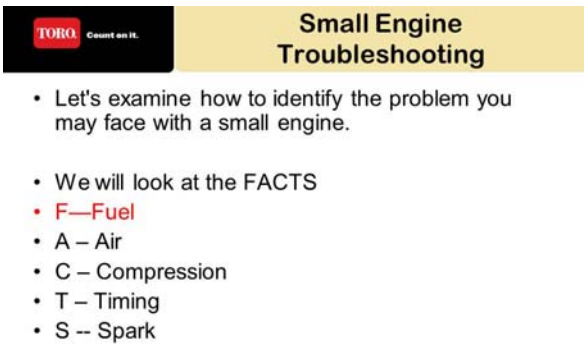
Higher operating temperature

Greater exhaust emissions

Small size and weight for equal horsepower.

Operate in multi-positions

Shorter expected life

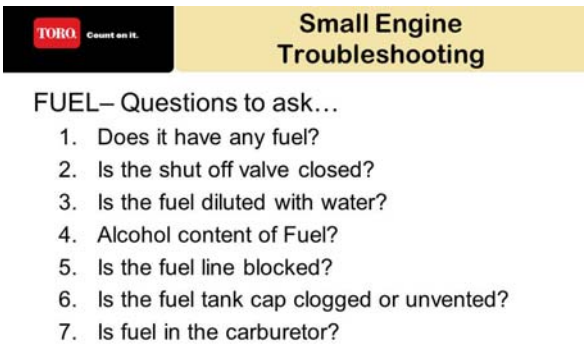


Earlier we mentions the “FACTS” required for engine operation.

Let's examine how to identify the problem you may face with a small engine

This will require a look at the Facts that are needed to make the engine run, and run properly.

Let's begin with Fuel.



When looking at FUEL there are a few questions to ask…

Does it have any fuel?

Is the shut off valve closed?

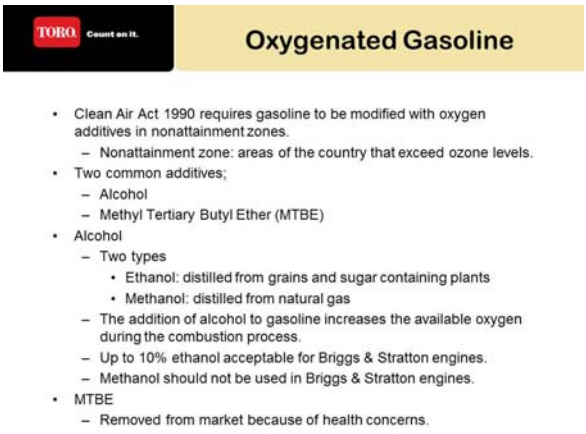
Is the fuel diluted with water?

Alcohol content of Fuel?

Is the fuel line blocked?

Is the fuel tank cap clogged or unvented?

Is fuel in the carburetor?



In recent years, small engines have run into issues due to federally mandated changes in fuel requirements.

This deals with the “Oxygenated” fuel that are becoming more common in the country.

This started back in 1990 with the clean air act.

Clean Air Act 1990 requires gasoline to be modified with oxygen additives in nonattainment zones.

Nonattainment zone: areas of the country that exceed ozone levels.

There are Two common additives;

Alcohol

Methyl Tertiary Butyl Ether (MTBE)

Alcohol

Two types

Ethanol: distilled from grains and sugar containing plants

Methanol: distilled from natural gas

The addition of alcohol to gasoline increases the available oxygen during the combustion process.

Up to 10% ethanol acceptable for most small engines.

Methanol is not normally recommended for small engines.

MTBE

Removed from market because of health concerns.

Fuel/Alcohol Test

- Check alcohol content

Alcohol content can play a major role in performance issues related to small engines.

The blending of alcohol with gasoline can in some areas be inconsistent with alcohol content sometimes being higher than the desired 10%

To check the alcohol contest of fuel, there are a variety of test devices to assist with this.

This kit, available from Kohler allows the user to quickly and effectively test fuel for alcohol content.

To check alcohol content, add water to the tester, up to the water line.

Then add gasoline up to the neck of the tester.

Put on the cap and shake.

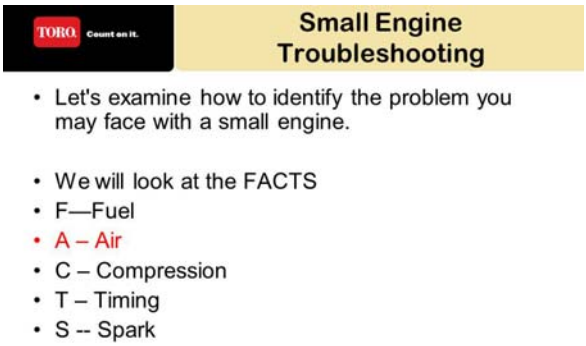
The water will mix with the alcohol while the gas and the water will remain separated.

Set aside for a couple minutes and then note where the water/fuel separation line is.

Compare that separation line to the line on the tester.

This will indicate the percentage of alcohol in the fuel.

Ideally this should be 10%.



Next, let's look at AIR

Air is required to provide the oxygen needed for combustion, and the engine also needs a sufficient amount of air, for compression to be adequate.

In small engines there are only two area that can restrict the flow of air into the engine.

First is the throttle plate in the carburetor or intake manifold in fuel injected engines.

The other location is the air filter. This can be an air restriction point if not properly maintained.

The primary function of an air filter is to deliver both high airflow and dirt protection.

Both air flow and dirt protection are critical to engine performance.

The basic types of air filters are.

Oiled-foam, this is a foam type material which is oiled to capture dirt particles and keeps them from entering the engine.

These types of filters are normally cleaned and re-oiled as a maintenance procedure

Paper type filters used a pleated paper element with holes of a specific size designed to capture dirt particles also of a specific size.

These can also be cleaned as a maintenance procedure.

Dual-element filters are a combination of both types. They consist of a paper element covered by an oiled-foam element.

Small Engine Troubleshooting

- **Air Cleaner Service** –
  - Air filters should be cleaned per manufactures recommendations
  - Oiled-Foam type elements can be cleaned using soap and water. Add a small amount of oil and squeeze to saturate the element.
  - Paper type elements can be cleaned by tapping gently on a flat surface or by using compressed air.

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Clean with Low Pressure Air

Some engine manufactures may not recommend using compressed air when cleaning filters. If you choose to you compressed air to clean a paper element filter, it is recommended that the filter be cleaned with low pressure air.

This reduces the likelihood that the paper element is damaged during the cleaning process.

A recommendation is to attach an air pressure regulator to the hose that is used for filter cleaning.

Setting the regulator for 10-20 PSI will normally do a sufficient job of cleaning without risking damage to the element.

Small Engine Troubleshooting

- Let's examine how to identify the problem you may face with a small engine.

- We will look at the FACTS
- F—Fuel
- A – Air
- C – Compression
- T – Timing
- S -- Spark

The next item to look at is Compression.

Small Engine Troubleshooting

- **COMPRESSION** -- This is necessary for the engine to reach its maximum efficiency.
- Loss can be due to a leak occurring from the valves, rings or cylinder head.
- This can be checked by spinning the flywheel counter-clockwise. If the compression is adequate the flywheel should rebound sharply.
- Or perform a compression test

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Compression Test

A compression test checks the air pressure built up in the cylinder as the piston comes up, and the air is compressed.

This test will gauge the condition of the intake and exhaust valves, piston rings and cylinder walls, and head gaskets or other sealing components,

Compression Testing

- Preparing the unit for the test
  - Remove all the Sparkplug(s).
  - Connect Battery Charger (If equipped with electric start)
  - On single cylinder engine, with compression release, engine may need to be rotated backwards. Refer to the engine manufactures documentations.
- Crank engine a consistent number of compression strokes.
  - On multiple cylinder engines, the actual compression reading is not as important at the relationship between all cylinders.
- NOTE: There are too many factors that can result in all cylinders reading low.

Preparing the unit for the test

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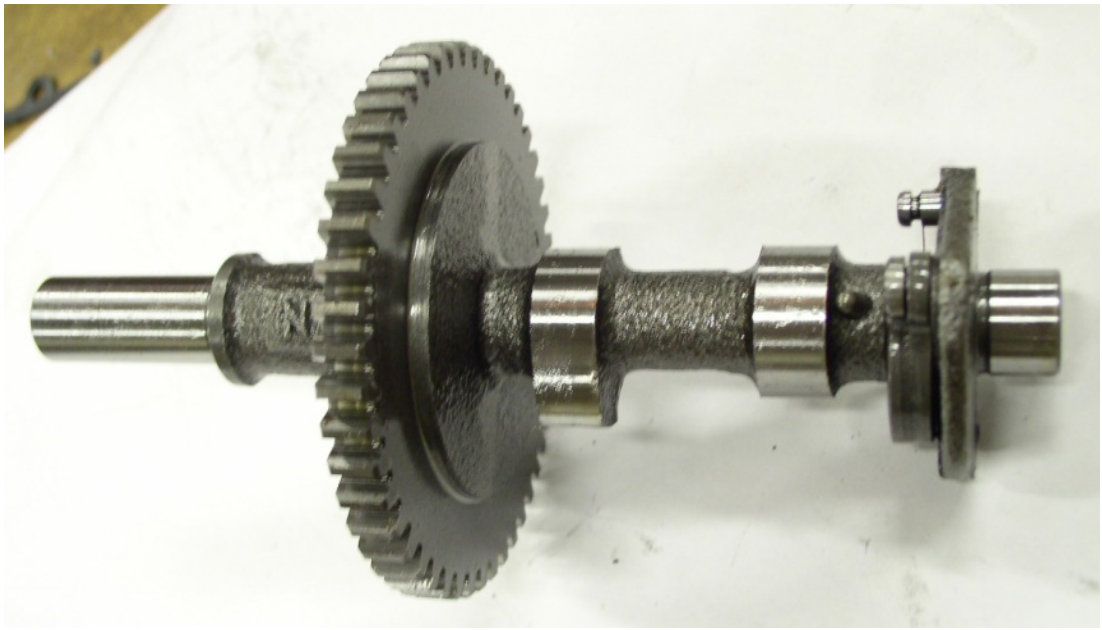


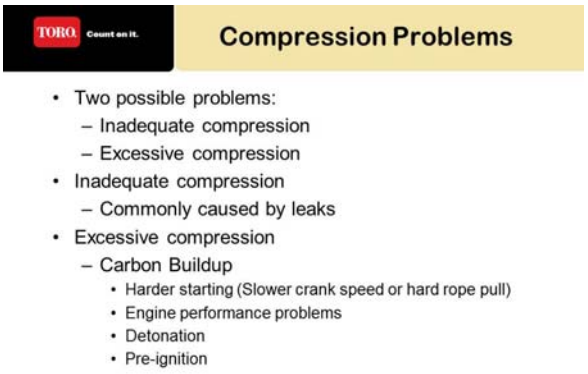
Compression release systems are used to decrease effort required to start engine.

Holds the exhaust or intake valve slightly open during starting, and then allows it to fully close once engine starts.

May be designed into camshaft and hold the valve open for a short period of time on every compression stoke.

May be mechanical. Engages during starting and disengages after the engine reaches operating speed.

Compression release will affect the results from a compression test



There are some problems related to compression in gas engines.

Two possible problems:

Inadequate compression

Excessive compression

Inadequate compression

Commonly caused by leaks

Excessive compression

Carbon Buildup

Harder starting (Slower crank speed or hard rope pull)

Engine performance problems

Detonation

Pre-ignition

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Detonation

- An undesirable engine condition in which pockets of fuel start to burn at about the same time as the spark plug fires.
- Multiple pressure fronts collide
- Sometimes called knocking, spark knock or pinging.
- Causes large pressure differentials in the combustion chamber.
- Can cause engine damage.

Causes

1. Increased compression
2. High temperatures
3. Lean fuel/air mixture
4. Advanced ignition timing
5. Lower octane fuels

Prevention

Remove any cause

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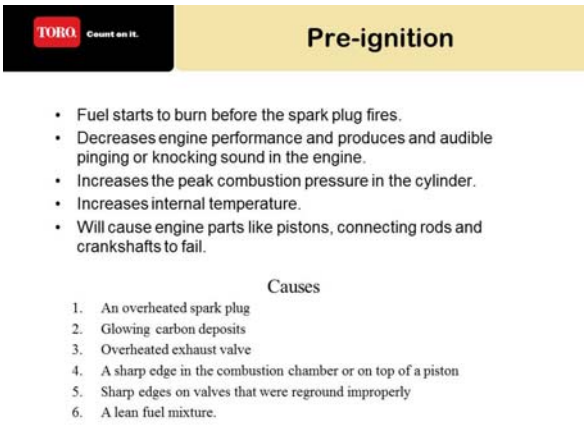


Pre-ignition

Fuel starts to burn before the spark plug fires.

Decreases engine performance and produces and audible pinging or knocking sound in the engine.

Increases the peak combustion pressure in the cylinder.

Increases internal temperature.

Will cause engine parts like pistons, connecting rods and crankshafts to fail.

Causes

An overheated spark plug

Glowing carbon deposits

Overheated exhaust valve

A sharp edge in the combustion chamber or on top of a piston

Sharp edges on valves that were reground improperly

A lean fuel mixture.

There is another test that can be performed to evaluate the condition of the engine cylinder

Additional Cylinder Condition Test

Cylinder Leakage Test

Another test to perform is a Cylinder leakage test.

When performing a cylinder leakage test, a defined amount of air is pumped into the cylinder.

My measuring how much pressure can be created in the cylinder, the amount of leakage can also be determined.

Think of this as Air in vs. Air out indicates leakage in the cylinder.

Cylinder Leakage Test

- Identifies cylinder which has the problem.
- Also will provide information on where the problem is.
  - Air leaking out of the exhaust indicates a leaking exhaust valve.
  - Air leaking from the air filter indicates a leaking intake valve.
  - Air leaking from the crankcase indicates leaking compression rings or head gasket.
    - NOTE: There will always be air leaking for the crankcase. If this is the gauge shows excessive leakage and the only place you hear air escaping is from the crankcase, then the excessive leakage is past the rings.

Identifies cylinder which has the problem.

Also will provide information on where the problem is.

Air leaking out of the exhaust indicates a leaking exhaust valve.

Air leaking from the air filter indicates a leaking intake valve.

Air leaking from the crankcase indicates leaking compression rings or head gasket.

NOTE: There will always be air leaking for the crankcase. If this is the gauge shows excessive leakage and the only place you hear air escaping is from the crankcase, then the excessive leakage is past the rings.

Areas to examine

For Compression Issues

When an engine displays compression reading that are not within the normal specs, there are several areas to inspect.

The first area is the intake and exhaust valves.

Types

One piece

A one piece valve is forged from on single type of material.

Two piece

A two piece valve is manufactured from two different materials. The valve face material may have better heat ratings, while the valve stem material would have better wear characteristics.

Projection Welded Tip

For a complete valve manufactured in stainless steel for example, a small piece of is welded on the stem end. Then this tip is quenched to improve its mechanical properties.

This helps to tolerate high impact and wear resistance of the stem end.

Valve hard facing

Changes or modifies wear and heat characteristics of the valve face.

Valve stem surface treatments

Changes or modifies wear characteristics of the valve stem.

Valve head design

Interference interface angle

Valve seat angle and the valve seat angle are slightly different. Prevents carbon build-up between sealing surfaces.

Face can be resurfaced

Valve dynamics

Most valves rotate slightly each time they open and close.

Rotation improves temperature distribution

Rotation helps clean valve interface.

Rotation can be enhanced through use of valve rotators

Valve Guides

Controls the position of the valves

Subject to fluctuations in temperature, chemical corrosion, ingestion of foreign material and for the exhaust valve, high temperatures.

Must provide a predictable and consistent clearance between itself and the valve stem.

Can be aluminum, brass or sintered iron.

Valve Seats

Mate with valve face to seal combustion chamber.

Metal to metal seal

Usually insert but not always

Can be resurfaced

Pistons

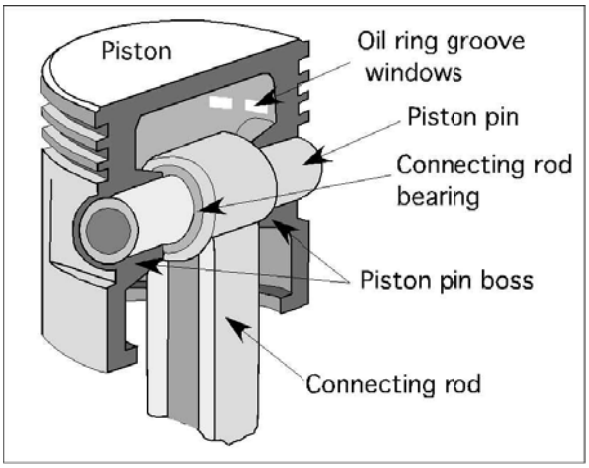
Acts as moveable end of the combustion chamber and must withstand pressure fluctuations, thermal stress, and mechanical loads

May use elliptical shape

Elliptical when cold

Diameter at piston pin bore expands more that thin edge of piston.

Round when hot



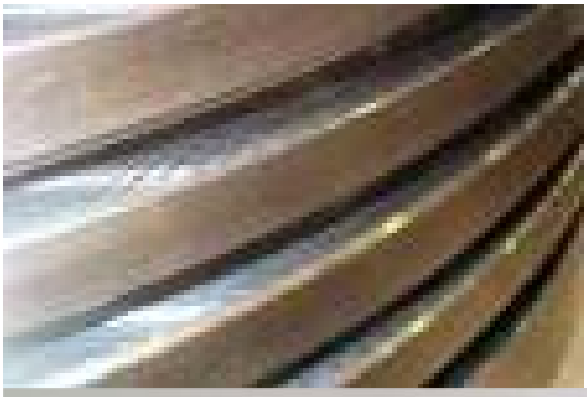
Pistons - cont.

Piston Pins

Some piston pins are offset

Piston must be orientated correctly in bore.

Windows are used in oil ring groove to allow excess oil to return to crankcase.



Ring Grooves.

Ring grooves are machined grooves in the piston designed to hold the rings.

Ring lands are the areas of the piston between the ring grooves.

The clearance between the rings and the ring lands is critical.

During overhaul the grooves should be cleaned with a ring groove cleaner.

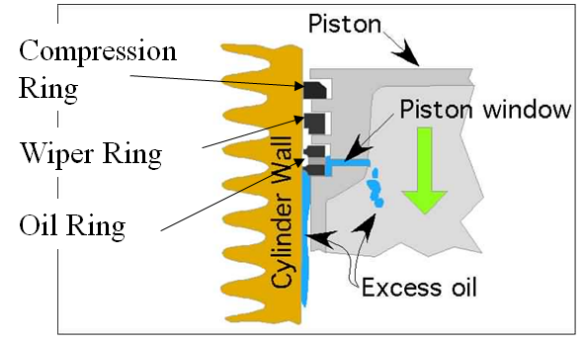
Piston Rings

The job of the rings is to fill the space between the piston and the cylinder walls.

The combustion chamber is sealed by a thin film of oil between the rings and the piston and between the rings and the cylinder wall.

Usually constructed of cast iron.

The total number of rings per piston can vary, but there are three types of rings on each piston.



Compression

Subject to the greatest amount of chemical corrosion and highest temperatures.

Transfers 70% of combustion heat from piston to cylinder walls.

Wiper ring

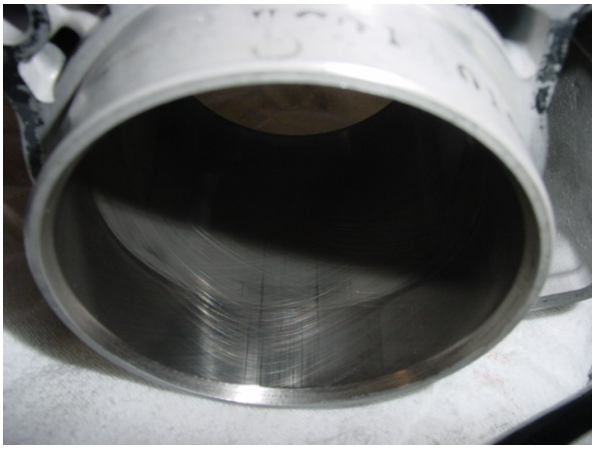
Meters oil film on cylinder walls

Must be installed correctly.

Oil ring

Constructed of two thin rails with holes or slots cut in between.

Has the highest pressure against the cylinder wall of the three rings.



Cylinder Bore

Three types

Cast aluminum

Cast aluminum with cast iron sleeve

Cast iron

Usually use a cross-hatch finish to improves ring lubrication

Small Engine Troubleshooting

- Let's examine how to identify the problem you may face with a small engine.

- We will look at the FACTS
- F - Fuel
- A - Air
- C - Compression
- T - Timing
- S - Spark

After Fuel, Air and Compression, the next item to look at is Timing and the Spartk.

Small Engine Troubleshooting

- **TIMING** – The spark must occur at the correct point in the engine cycle for the engine to operate properly.
- Most often this is affected by a bad flywheel key.

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- **Spark** -- Most often affected by a bad spark plug.
- Remove the spark plug and check for deposits. These can be cleaned with a wire brush.
- The gap of the spark plug can also be a factor. The gap should be set as recommended by the manufacture".
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Small Engine Troubleshooting

- **Spark (Cont.)**
- The spark can be checked using a spark tester.
- Simply connect the spark plug lead to the tester and ground the clamp to the engine.
- Pull the rewind starter or engage the starter and check for spark output in the window.

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Ignition System

- The ignition system provides a high voltage spark in the combustion chamber at the proper time.
- Two types of ignition systems
  - Battery
  - Magneto
- Battery
  - Battery systems transforms the battery voltage and fires the spark plug at the correct time.
- Magneto
  - Magneto systems must produce the current, transform the voltage and time the spark plug.
  - Most small engines use the magneto system
- Two types of magneto systems:
  - Breaker point ignition
  - Solid state (electronic) ignition

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Two types of magneto systems:

Breaker point ignition

Solid state (electronic) ignition

Ignition System-cont.

- Breaker point ignition
  - Older system. Most manufacturers have replaced them with solid state.
  - Uses a set of points to break the primary circuit.
- Solid state ignition
  - Uses a transistor to break the primary circuit.

Breaker point ignition

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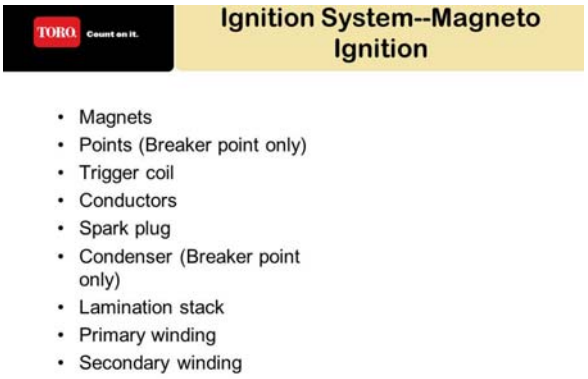
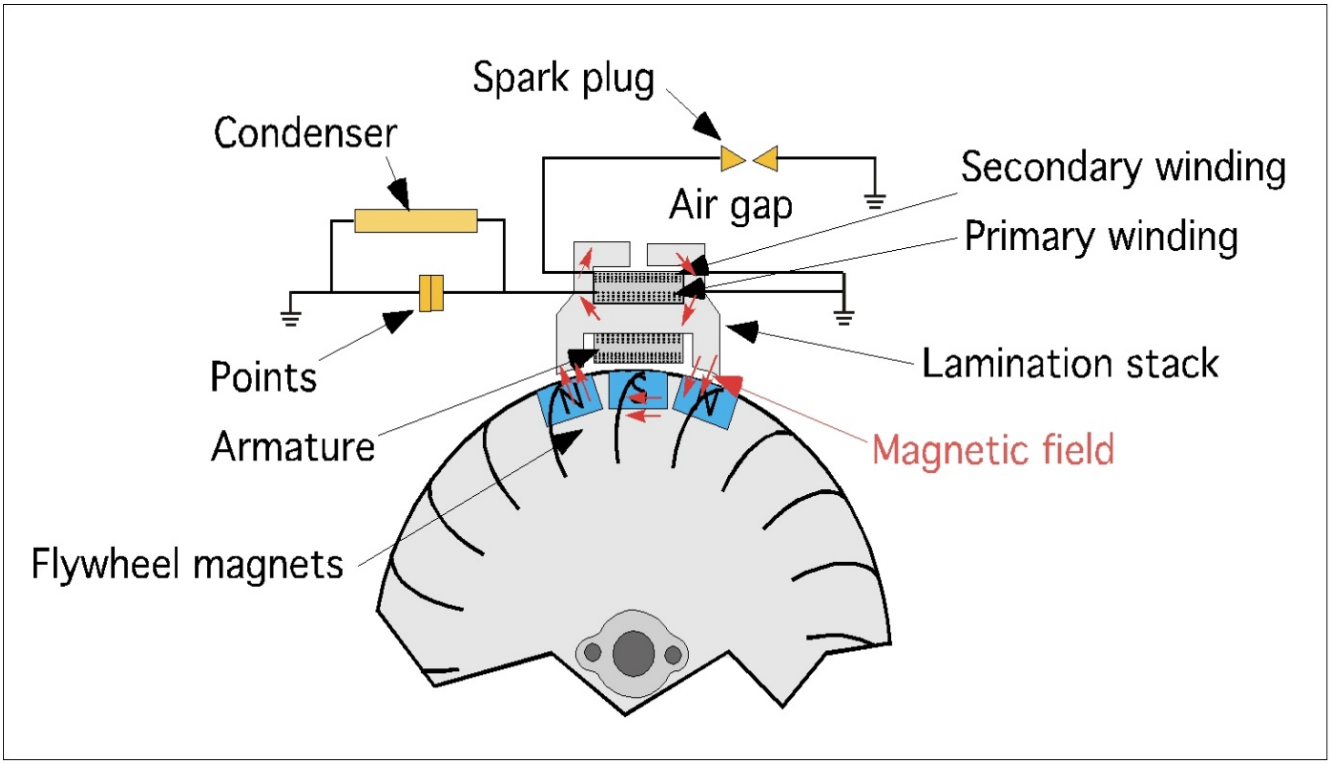
Solid state ignition

Uses a transistor to break the primary circuit.



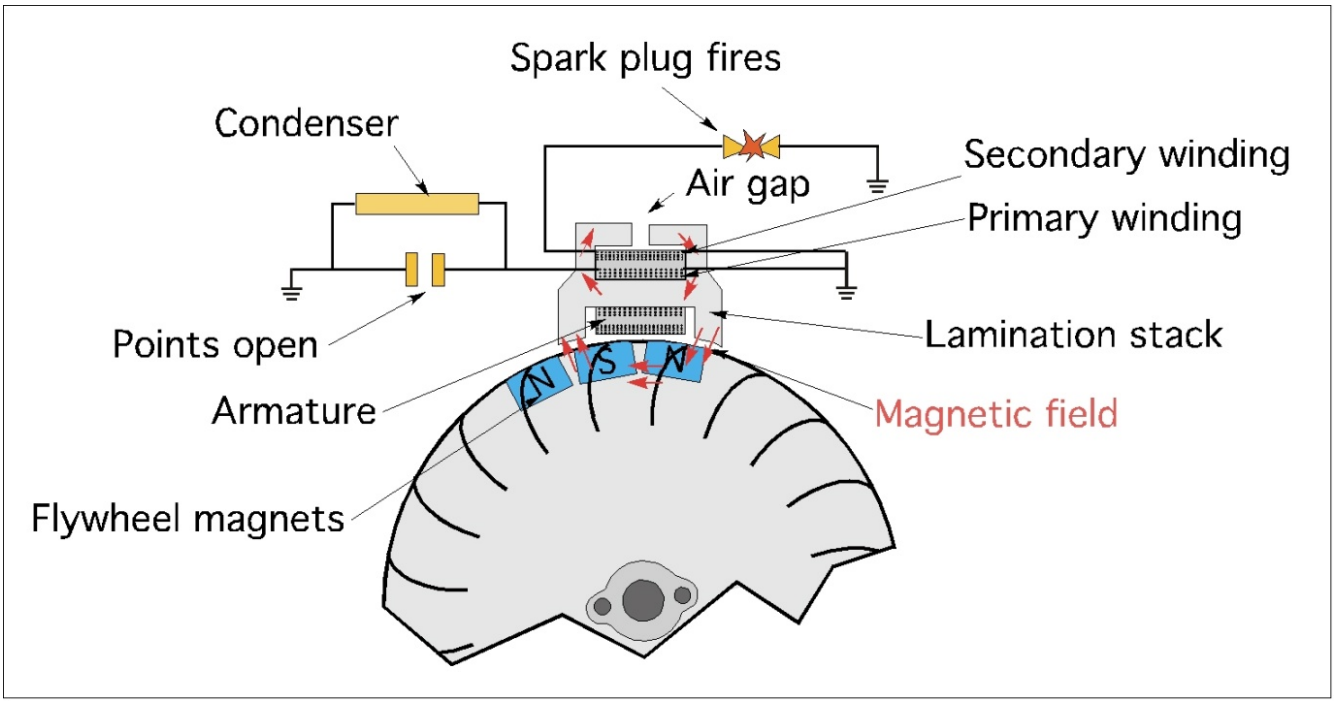
Ignition System--Magneto Ignition

Magnets
Points (Breaker point only)
Trigger coil
Conductors
Spark plug
Condenser (Breaker point only)
Lamination stack
Primary winding
Secondary winding



Magneto Ignition System

As magnets in flywheel rotate past the magneto, the points close.
The magnetic flux of the magnets in the flywheel induces a current in the primary coil.
With current flowing in the primary circuit, a magnetic field develops around the primary coil.
This magnetic field also surrounds the secondary coil.
As the flywheel continues to rotate the breaker points open.

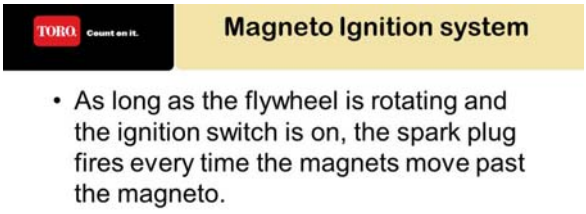


Magneto Ignition System-Firing Spark Plug

When the breaker points open the magnetic field produced by the current in the primary winding collapses.

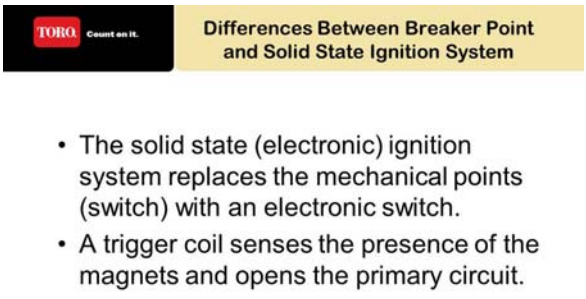
The collapsing magnetic field flows across the secondary coil which induces a current in the secondary coil.

Because there is a 60:1 ratio of windings in the two coils, the voltage is transformed to the 10,000 and 15,000 volts needed to fire the spark plug.



Magneto Ignition system

As long as the flywheel is rotating and the ignition switch is on, the spark plug fires every time the magnets move past the magneto.

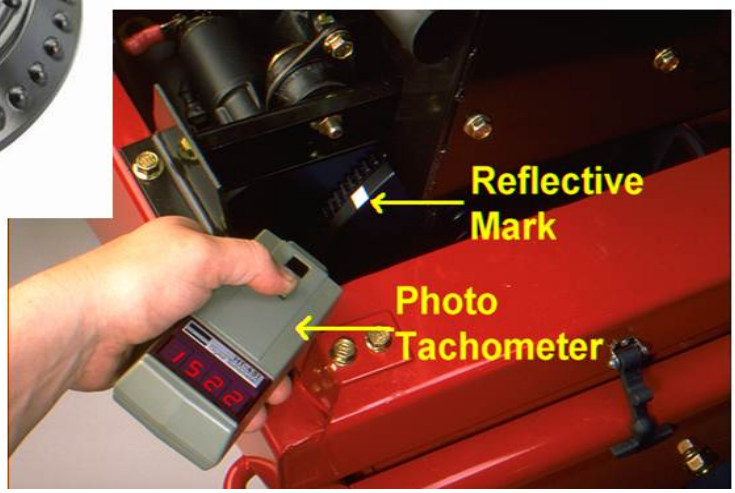


Differences Between Breaker Point and Solid State Ignition System

The solid state (electronic) ignition system replaces the mechanical points (switch) with an electronic switch.

A trigger coil senses the presence of the magnets and opens the primary circuit.

Additional Available Tests



Checking Engine RPM

Another overlooked test is to check engine RPM.

Setting high and low idle by ear is not an accurate way to do it.

One method is to use a Vibra-Tach.

Another is to use a Photo Tach.

The key is that RPM, both Low and High is properly set.

When working with multiple cylinder engines, sometime the performance problem may be related to only one cylinder.

To determine which cylinder is at fault, perform a Cylinder Cancel Test

Cylinder Cancel Test

Used to determine which cylinder has a problem.

The cylinder that does not affect the speed or sound of the engine is probably not doing its share of the work.

If the engine has a knock and the knock goes away, that is the cylinder causing the knock.

If the knock doesn't go away then it could be a mechanical problem. (ie. Piston hitting the head).

Crankcase Breather

Another component to look at is the Crankcase Breather

Maintains pressure in the crankcase at less than ambient pressure to assist in the control of oil consumption.

Excessive engine blowby renders the breather useless.

Old engines vent to the atmosphere.

New engines vent to the carburetor.

Routine Maintenance (Default to Manufactures Recommendation)

Every 25 hours – Check, clean the air filter.

Every 50 hours – Change engine oil, Replace in-line fuel filter.

Every 100 hours – Replace Spark Plug

End-of-season Maintenance

1. Drain the gasoline, or add a fuel stabilizer.
    1. This is especially important on engines running oxygenated fuels.

2. Change the engine oil.

3. Seal the fuel cap.– cover with aluminum foil and seal with rubber band.

4. Fog the engine.
5. Clean and re-gap the spark plug.

End-of-season Maintenance (Cont)

6. Service the air cleaner.

7. Seal the combustion chamber.

Pull rewind rope until the piston reaches top of the cylinder on the compression stroke. (you can tell by the increased tension on the rope)

8. Remove dirt and debris and cover the engine.

Questions?