Student

Electrics

What you will learn

When you have finished this module, you should be able to:

- ❑ Choose the right spark plug for your engine
- ❑ Clean a spark plug and set the gap
- ❑ Check and clean the HT lead and cap

Things you need before you start

Materials

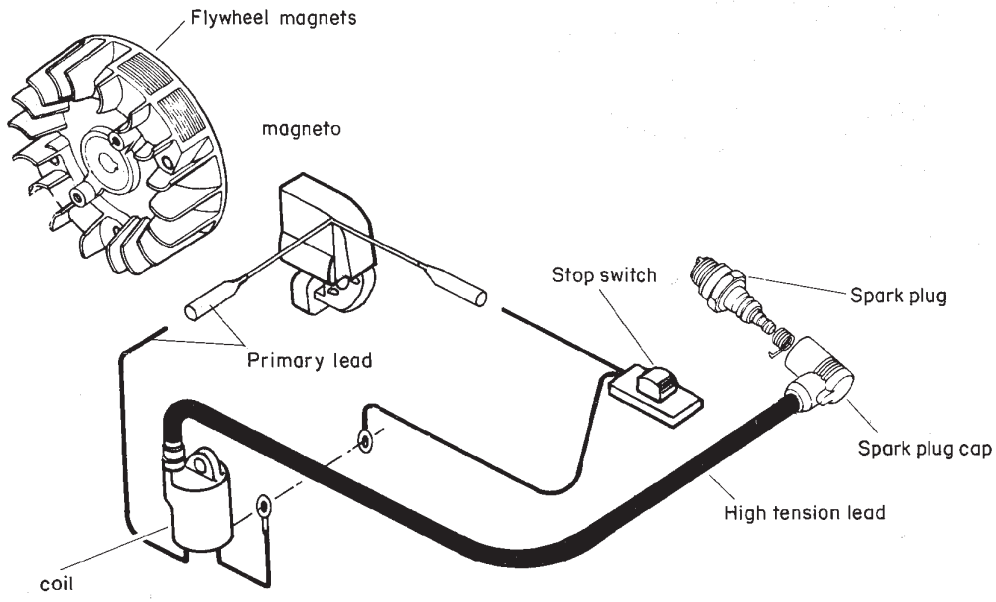
- Spare plug(s) ❑
- Cleaning rag/cloth ❑
- CRC, WD40 or similar ❑

Tools

- Spark plug spanner/wrench ❑
- Feeler gauge or plug gap setting tool ❑
- Wire brush ❑

Introduction

The main part of the electric system on small engines is called the **ignition system** – it ignites the fuel.



The main parts of the ignition system

Petrol engines need a spark of some sort to ignite the fuel inside the cylinders.

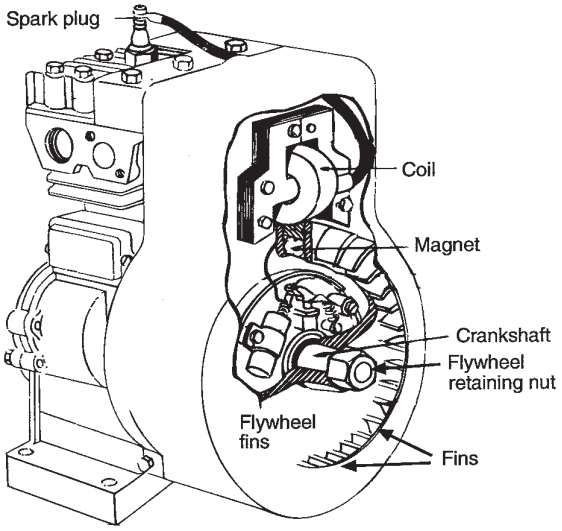
- The spark is made by electricity jumping across the gap of a *spark plug*.
- The electricity is produced by a small generator in the engine called a *magneto*.
- The electricity is high voltage 5,000–20,000 volts so it needs special *cables* and *caps* to stop it sparking to places we don't want.

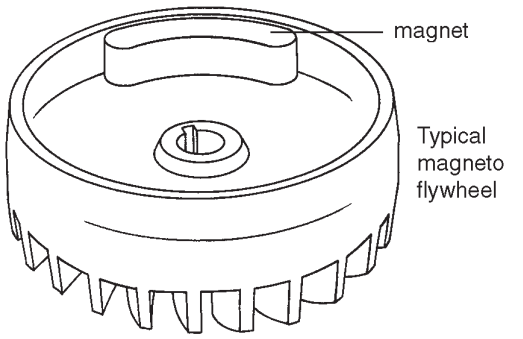
Magneto

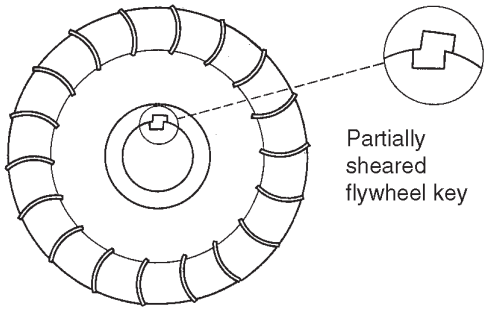
The magneto produces electricity for the engine.

It has magnets that are usually made into the engine flywheel and electric coils that move close to each other

When the engine turns, the magnets spin past the coils that pick up an electric current. The current is controlled by other electronic parts. The electricity then goes to the spark plug(s) along the HT leads.







On most engines, all the magneto parts are behind the flywheel where you cannot see them. On modern engines the magneto does not need any regular maintenance any way.

The flywheel is a very tight fit on the crankshaft and has a special slotted key-way to make sure it stays in exactly the right place.

Note

If the magneto parts do need to be worked on, the fly wheel will need to be pulled off with a special tool by a mechanic. Never hit, lever or heat the fly wheel to try to get it off! You will cause a lot of damage – and you probably still won't get if off!

Spark plugs

Spark plugs are simple pieces of equipment – but they have a very hard life.

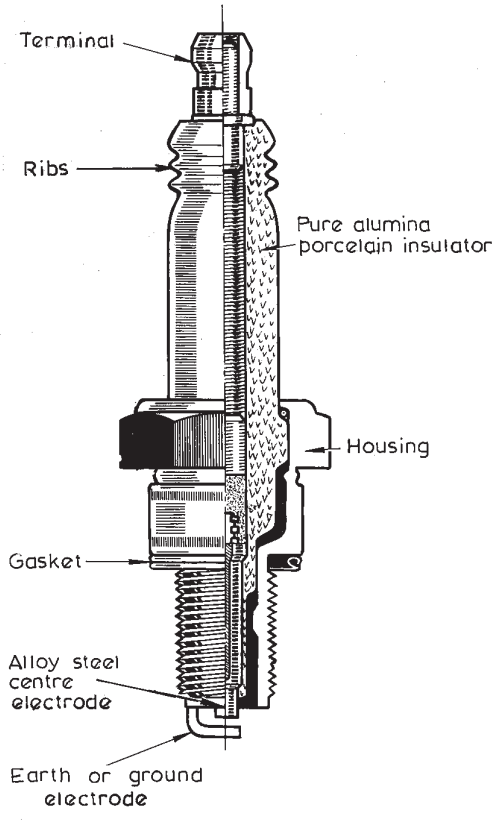
Plugs should last for many hundreds of hours running if they are regularly looked after.

If the plugs are not looked after, the engine will not run – or not run properly.

Here is a spark plug in a typical engine cylinder head.

This picture shows the main parts of a typical spark plug:

The *central electrode* runs all through the plug. It is made of a nickel alloy steel, sometimes with a copper core. At the top it has a *terminal* that connects to the wire lead from the magneto.



The central electrode is surrounded by a *porcelain insulator*. Porcelain is a type of pottery like cups and plates are made of. Electricity cannot pass through it – so it is called an 'insulator'

The bottom of the insulator is held in a *steel housing*. This has a *screw thread*, to screw into the cylinder head, and a *hexagon* (nut) *shape* to fit a spanner.

A metal *gasket* stops any leaks between the plug and the cylinder head. Some plugs/ cylinder heads have a *tapered seat* to stop leaks instead of a gasket.

An *earth* or *ground electrode* is at the bottom of the housing and crosses over the central electrode.

Electricity jumps across the *gap* between the earth electrode and the bottom of the central electrode to make a spark. You can adjust the size of the gap.

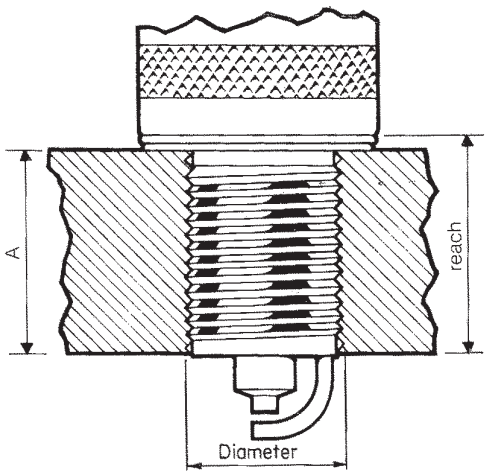
Types of plug

Unfortunately there are hundreds of different plugs designed for different jobs – and you **must** have the correct one or you can seriously damage your engine.

Plugs are described by:

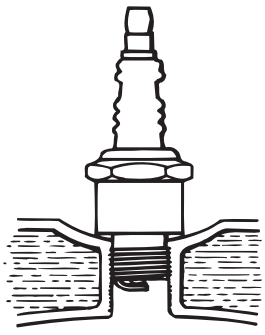
Thread diameter

This is the size across the screw thread on the plug and in your cylinder head. They must be the same or the plug wont fit! The most common size (diameter) is 14 mm, but 12 mm and 18 mm plugs are possible.



Thread reach

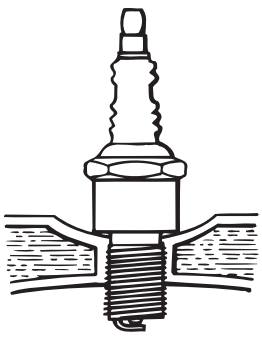
This is the length of thread that screws into the cylinder head. You must have the right length.



Combustion chamber

REACH TOO SHORT

Too short – the spark will be inside the plug-hole and will make a poor explosion. Carbon will also build up inside the plug-hole.



Combustion chamber

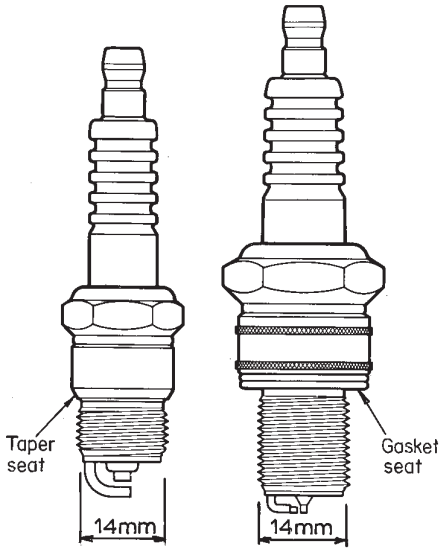
REACH TOO LONG

Too long – the plug might hit the piston (or valves on a 4-stroke). Carbon might also build up on the extra screw thread making if difficult to get the plug out again.

Seating

This is how the plug seals into the cylinder head to prevent leaks.

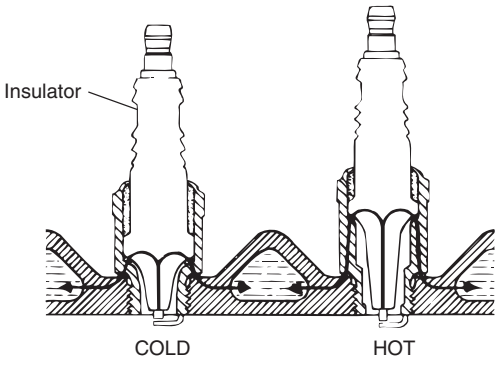
There are *gasket* and *taper-seated* plugs. You must have the right type for your engine.



Heat range

This is about how hot the tip of plug gets. Too hot and it might get red-hot and ignite the fuel before it should. Too cold and the plug won't burn off carbon and oil deposits.It will gradually foul up and stop sparking.

The right heat range of plug depends on the engine's design, operating speed, load and fuel.



Resistor

Spark plugs can have a built in resistor that stops radio interference they create – that's the 'crackle' or 'buzz' you hear on a radio near the engine. The resistor won't affect the way the plug performs in the engine.

Plug codes

Plug makers print a code number on the plug insulators. They are coded according to the thread, reach, heat range, seating, resistor and manufacturing methods (and lots more things). Most makers have a code of their own!

For example, you may have a code something like:

NGK (maker) code **BPZ8H – N-10** which is a common plug to many Mercury Outboards

The Champion equivalent plug is code number **L78YC**

A Champion **RJ8C** plug fits many small Briggs and Stratton engines.

The NGK code for this is a **BR6S**

The equivalent plugs made by Autolite, Denso, AC, Bosch etc., will all have different codes.

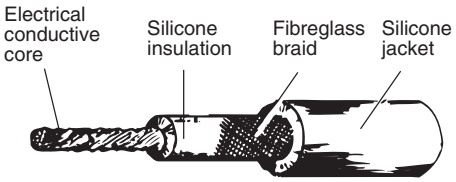
Use the plug recommended by the engine maker (or recommended by the spark plug makers for your exact engine make/model and age).

Plug leads and caps

The cables connecting to the spark plugs are special wires made to carry the high voltage. They are sometimes called '*high tension* leads' or HT leads.

The diagram shows the layers of silicon insulation around the core. If the insulation is damaged, wet or dirty the lead may

- stop working –
- or spark to part of the engine –
- or give you a shock when you touch it.



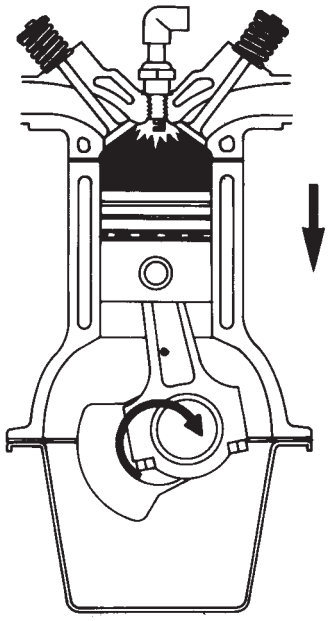
The caps that connect the HT lead to the spark plug terminal are made of plastic or rubber and push onto the spark plug. The caps stop unwanted sparks around the plug and keep out dirt and water.

Keep the cables and caps clean and as dry as possible. Wipe them with a cloth and spray them with CRC Marine or WD40 fluid.

The cables are easily damaged – so when you remove a plug lead, pull on the cap, NOT the cable

Timing the spark

For an engine to start and run properly, the spark plug must ‘spark’ at exactly the right point in the engine’s cycle. In most engines that point is just before top dead centre (b.t.d.c) as the piston reaches the top of its stroke. Most engines automatically change this timing to suit different engine speeds.

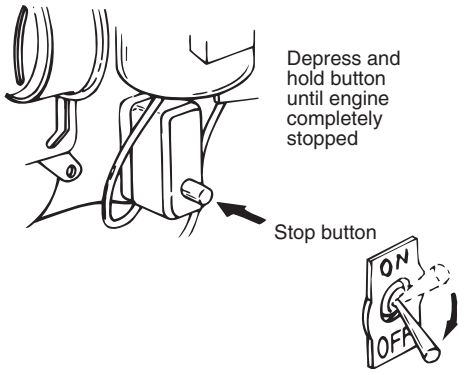


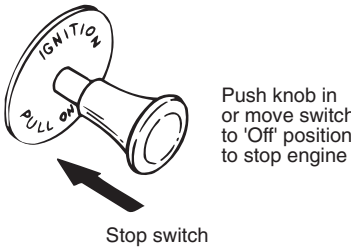
The timing can be checked and adjusted by moving parts of the magneto, but the job needs special equipment and tools. Do not try to make timing adjustments unless you have the equipment and you know what you are doing.

On/off switch

Most small engines have an **ON / OFF** switch to stop the engine. It may also be called an *ignition switch* or a *kill switch*.

The switch usually grounds-out the magneto electrics so that no spark is produced and the engine stops.





Outboard motors may also have a *lanyard kill switch*. This is a safety cord attached to the boat operator and the kill switch. If the operator falls overboard, the cord pulls the switch to stop the motor.

Check regularly that this safety switch **does** stop your engine.

Maintenance

HT leads and caps

Keep leads and caps clean and as dry as possible. Regularly wipe them with a cloth and spray them with CRC Marine or WD40 fluid to keep out water.

Check the leads for wear and damage such as cracks and cuts. Also look for any signs of melting or burning – this could show where a lead or cap is arcing (sparking) to the outside of the engine.

Some HT leads have the cap moulded onto the end of the cable. If the lead or cap is damaged/not working you have to replace the complete lead. Some older HT leads have caps that screw onto the end of the cable and can be replaced.

Spark plugs

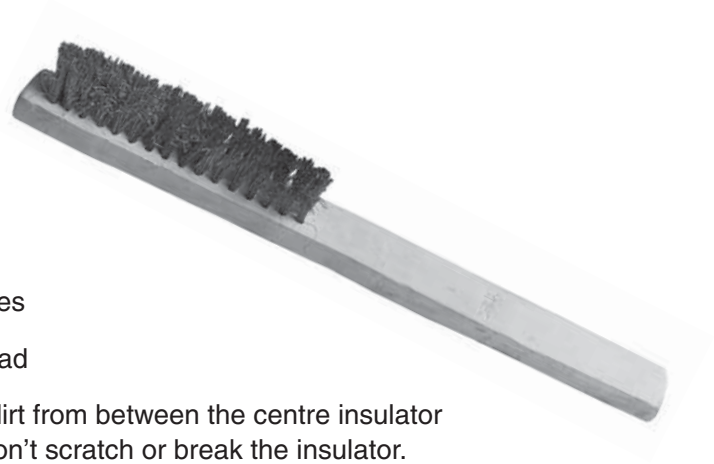
Removing the plug

Don't remove plugs from an engine while it is hot. You might damage the screw threads in the cylinder head.

- Twist and pull on the plug cap – don't pull the HT lead as it is easy to damage it.
- Clean any dirt, sand or water away from around the plug – or it will drop into the engine.
- Use a proper spark plug spanner or socket wrench to unscrew the plug – take care, the insulator is easily cracked or broken if you use normal spanners.
- Remove the plug and check condition.
- Compare your plug condition to the chart at the end of this Electrics module. The chart is supplied by Autolite spark plugs and should give you some idea about the condition of your plug and your engine.

Replace the plug with a new one if:

- the electrodes are damaged or worn away
- the insulator around the centre electrode is broken, cracked or blistered in any way.



Cleaning

Use a wire brush to remove:

- any deposits from the electrodes
- dirt and oil from the screw thread
- Use a pin or a nail to remove dirt from between the centre insulator and the spark plug housing. Don't scratch or break the insulator.

Blow, or use a solvent, to remove dirt and loose deposit around the centre electrode

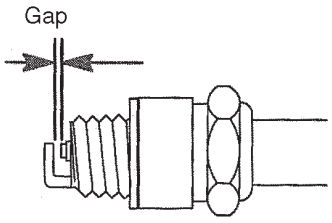
Clean dirt from the body and porcelain insulator with a cloth.

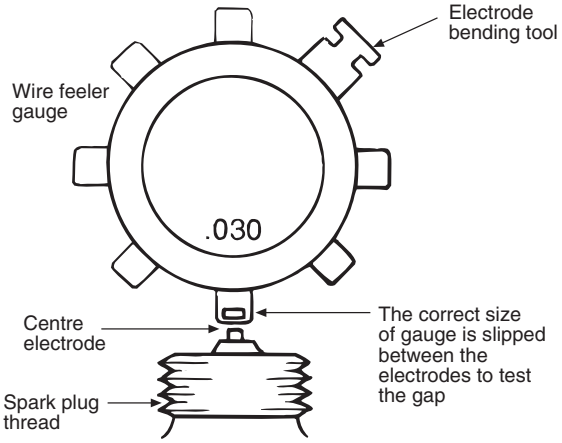
Gap setting

The gap must be the correct size for the plug to work properly.

Check the gap on new plugs as well.

- Clean or scrape any deposits from the electrodes. Take care not to damage the centre insulator.
- Check the gap. Use feeler gauges or a plug wire-gap gauge like the one in the picture below. The gauge should be a light sliding fit in the gap. The correct size will be in your engine manufactures booklet and may be written on a sticker on the engine. It will be given in thousands of an inch (thou) or in mm. A typical gap size is .035 inch (35 thou) or 1.1 mm.





- To open the gap, gently bend the side/earth electrode outwards. Use pliers or the electrode bending tool on the wire gauge if you have one. Take care not to touch the porcelain insulator or the centre electrode as they can be easily damaged. Check for the correct gap size.
- To close the gap, tap the earth electrode gently on a hard surface and then open the gap to the size you need.

Refit the spark plugs

Before putting a plug back into the cylinder head, clean off any dirt around the spark plug seat in the cylinder head.

Screw-in the plug until it is finger-tight, then tighten no more than a quarter turn with the correct plug spanner. You will damage the cylinder head if you tighten too much.

Push the plug lead/cap onto the plug terminal. If you have a multi-cylinder engine, make sure you connect the right lead to each plug!

Activity - electrics

Find out and write down

What type of spark plug does your engine have?

Code number?

Where can you buy new plugs?

When should you check the plug(s)?

When should you fit new plug(s)?

Things to do

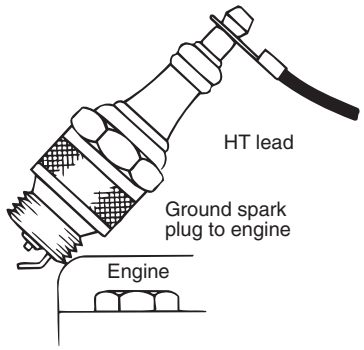
Spark plugs

- ✔ Take out your spark plug(s)
- ✔ Clean them
- ✔ Check and set the gap
- ✔ Refit them
- ✔ Check and clean the HT lead and plug cap

Fault finding – spark plugs

Checking for a spark

- Take out the spark plug.
- Fit the plug to the HT lead
- Hold the plug to touch the engine of metal casing as in the picture (keep your hands away from metal parts and the plug)
- Make sure the **Kill** or **On / Off** switch is “ON”
- Pull the starter cord



- The plug should spark as the engine turns.

If there is no spark

- Check switch is “ON”
- Try another plug. If this one sparks, the first one is faulty.

If still no spark, check for damage to the HT lead and plug cap and/or replace with another one.

If still no spark, the fault must be in the magneto or ignition wiring.

Autolite® Technical Information

1. NORMAL

2. NORMAL WITH RED COATING

3. FUEL FOULED

4. DETONATION

5. WORN OUT

6. GLAZING

7. CARBON FOULED

8. SUSTAINED PREIGNITION

9. ASH DEPOSITS

10. OIL FOULED

11. MECHANICAL DAMAGE

12. LEAD FOULED

PLUG TIPS TELL THE STORY.

Looking at spark plug firing tips can tell you if your engine has a problem that needs correcting. They reflect the performance of a well-tuned engine or a poorly maintained engine.

Even though spark plugs are easily replaced, inexpensive and immediately improve engine performance, they are often ignored until they cause serious performance problems. Bad plugs can cause overheating, rough running, power loss and even engine failure. Check your spark plugs regularly, and use this chart as a guide to spot performance problems.

RECOMMENDATIONS

1. NORMAL
Recommendation: Correct heat range of spark plug is being used. Replace with the equivalent Autolite spark plug at the proper interval.

2. NORMAL WITH RED COATING
Recommendation: Normal - coloration is from the use of additives in unleaded fuel.

3. FUEL FOULED
Recommendation: Indicates the cylinder from which the spark plug came is not using all the fuel supplied to it. Check for faulty or sticking choke, overly rich fuel mixture, ignition problems, leaking fuel injectors, or spark plug heat range is too cold.

4. DETONATION
Recommendation: Caused by low octane fuel or over advanced timing. Can be noticed as engine knock. Check for faulty EGR system, detonation sensor, and correct spark plug heat range.

5. WORN OUT
Recommendation: Spark plug used beyond its intended life. Replace with a new set of Autolite spark plugs.

6. GLAZING
Recommendation: Spark plug is operating too hot at high speeds. Replace with a colder heat range of Autolite spark plug.

7. CARBON FOULED
Recommendation: Spark plug heat range is too cold and/or caused by extensive low-speed, short distance driving. Replace with the correct heat range of Autolite spark plug. Also caused by weak ignition system and/or rich fuel mixture. Fuel injection engines would produce carbon fouling from clogged fuel injectors, vacuum leaks, and/or problem with carbon canister/purge valve operation. Carburetor equipped engines cause carbon fouling from improperly adjusted or malfunctioning choke.

8. SUSTAINED PREIGNITION
Recommendation: Check for correct application of spark plug (heat range too hot, wrong spark plug for engine), cross firing of ignition cables, over advanced timing, lean fuel mixture, defective EGR valve, accumulation of combustion chamber deposits, hot spots in the combustion chamber due to poor heat dissipation, improper installation torque applied to spark plug, and/or head gasket protrusion into the combustion chamber.

9. ASH DEPOSITS
Recommendation: Caused by the use of leaded fuel, fuel additives, and/or oil additives. Check for worn piston rings and/or valve guides. Misfiring may occur due to the deposits on the electrodes.

10. OIL FOULED
Recommendation: Caused by presence of oil in the combustion chamber. Check for worn rings, worn valve guides, and/or worn valve seals.

11. MECHANICAL DAMAGE (New Catalog Addition)
Recommendation: Locate and remove foreign object from inside of cylinder. Check catalog for proper spark plug application. Improper spark plug thread reach can protrude into cylinder and sustain damage.

12. LEAD FOULED
Recommendation: Occurrence is from use of leaded fuel or fuel additives containing lead which become conductive over the firing tip. Install new spark plugs.

APPEARANCE

1. Appearance: Grayish-tan to white color

2. Appearance: Pinkish-red color on the ceramic insulator tip, the center electrode, and the ground electrode.

3. Appearance: Firing tip is damp with gasoline, usually the odor of fuel is present on the spark plug. The insulator is often tinted the color of charcoal.

4. Appearance: Insulator is usually cracked, chipped, or broken. Ground electrode can also exhibit damage.

5. Appearance: Center and ground electrodes are eroded, have rounded edges, and are excessively worn away. Difficulty starting engine and misfiring during acceleration may occur.

6. Appearance: Ceramic insulator tip appears to have a melted, glazed coating.

7. Appearance: Black, sooty coating on firing end.

8. Appearance: Melted center and ground electrodes and damaged ceramic insulator tip. Initial and sustained preignition are two extremes of the same engine problem.

9. Appearance: Center electrode, ground electrode, and/or ceramic insulator tip are coated with tan colored deposits.

10. Appearance: Center electrode, ground electrode, and/or ceramic insulator tip are coated with a black, oily substance.

11. Appearance: Center electrode and ground electrode are bent out of position, down or to one side of the spark plug. Ceramic tip is broken and missing from the firing tip.

12. Appearance: Ceramic insulator tip is coated with a brownish-yellow glazed coating.

May 2003