This booklet has been designed to convey how vitally important the Sparking Plug is in its relation to the successful operation of the engine

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FACTS ABOUT SPARKING PLUGS AND ENGINES

DEPENDABLE

CHAMPION

PLUGS

FACTS ABOUT SPARKING PLUGS AND ENGINES

How Engine Operates

Cycle 1. *The downward stroke* of the piston draws into the cylinder a charge of highly inflammable gas, produced by the proper uniting of petrol and air in the carburettor and intake manifold.

Cycle 2. *The upward stroke* of the piston compresses this gas, and at a point just before the piston reaches the top of its stroke the compressed gas is ignited by a spark at the points of the sparking plug, developed by passing a high tension electric current through the sparking plug at that particular fraction of a second.

Cycle 3. *The ignited gas* burns very rapidly and the more complete the combustion the better the engine operates, the almost instantaneous expansion of the rapidly burning gas driving the piston down and thus developing power.

Cycle 4. *On the next upward stroke* of the piston the exhaust valve opens and the burned gas is expelled from the cylinder, preparatory to the drawing in of another fresh charge as explained in Cycle 1.

These are the four cycles of the ordinary internal combustion engine and are constantly repeated in each cylinder of the engine : (1) Intake of gas ; (2) Compression of gas ; (3) Rapid expansion of burning gas developing power ; and (4) Scavenging of cylinder of burned gas.

The rapidity of the instantaneous ignition and the completeness of the combustion help to determine the efficiency and economy of the engine performance—the aim being to convert the highest possible percentage of the fuel used into power.

The completeness of the combustion at all speeds further determines car performance, the ease with which the car performs at low speeds, the power that it shows under acceleration, the high speed and the power on hills. The spark at the points of each sparking plug must be of full strength at all engine speeds and under all conditions of operation in order to give the maximum initial impetus for the almost instantaneous burning and

expansion of the compressed gas and this is very definitely dependent upon the efficiency of the sparking plugs themselves and upon their operating condition. Otherwise there is a lag to the burning process and a sluggish performance of the whole car as a result.

It is very necessary that the sparking plugs be of the right type for the vehicle in which they are used and that they be well designed and well made—they should be reasonably hot at lower engine speeds to keep free from oil and fouling matter, and at the same time run cool at the top engine speeds. They should perfectly insulate the high tension current at all speeds and at all changes in temperature to which they are subjected throughout the range of engine operation.

If sparking plugs are of the wrong type or are inefficient, the compressed gas does not burn with sufficient rapidity. There is incomplete combustion and only part of the fuel used is converted into power, some going out of the exhaust valves in the form of unburned gas, while some remains as a residue in the cylinder and forms carbon, which further interferes with proper development of power and satisfactory performance.

Many other factors can contribute to incomplete combustion and consequent waste of power and these will be referred to later under specific cases and definite types of trouble and what to look for to eliminate the causes thereof.

The sparking plug is of such great importance in satisfactory engine performance that one should have a detailed understanding of it and of its most necessary functions under all conditions of engine operation.

It is poor economy to use any but the most efficient sparking plugs. This is plainly evident when their importance is realized. The better plug will soon pay for itself by delivering more complete combustion with a maximum development of power from the fuel supply, and by eliminating the waste and annoyance caused by the reduced power delivered by partially unburned fuel.

The whole subject is handled here in a series of questions and answers, presented so as to give the information desired, under the varying conditions encountered in the operation of a motor, as logically and completely as possible.

1. Q. What is a sparking plug ? What is its function ?

A. It is a very important part of an engine, and consists of two wires carefully insulated from each other. The wires are spaced to form a spark gap at the lower end of the plug which projects into the firing chamber.

Its function is to bring the high tension current into the cylinder of the engine and to deliver it in the form of a spark which ignites the combustible gases, thus furnishing the power stroke of each cylinder of the engine.

2. Q. What are the important elements of a sparking plug ?

A. (1) The insulator which must retain its efficiency under all temperatures and pressures in the firing chamber or cylinder of the engine.

(2) The metal parts such as the shell, bushing and gaskets which introduce the insulator into the cylinder without loss of compression.

(3) The centre electrode which conveys the current through the insulator and the side electrode which is brought up adjacent to the inner end of the former to form the gap over which the high tension current passes in the form of a spark.

3. Q. What is the definite function of the insulator ?

A. To prevent the current from flowing in any direction except across the gap formed by the two electrode wires.

4. Q. What are the principal operations in the making of finished sparking plugs

A. (1) The complete and careful manufacture of the metal parts, such as the various shells, bushings, gaskets, terminals, electrode wires, etc.

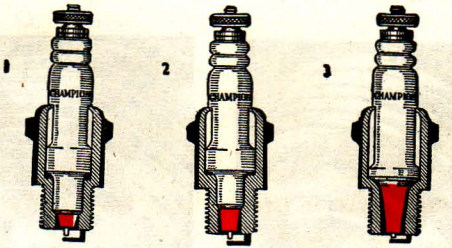
(2) The production of the most satisfactory material for the electrode wire is an art in itself. The next step, which consists of sealing this electrode in the insulator, is one in which much progress has been made in the past few years.

5. Q. Why is the maintenance of gas tightness so important in sparking plugs ?

A. Gas leakage, either between centre electrode and insulator or between insulator and shell, will cause a plug to overheat very rapidly. In fact, what seems to be a very slight leak between centre electrode and insulator will raise the temperature at the tip of the insulator as much as 40 to 45 degrees Fahrenheit.

6. Q. What is the heat range of sparking plugs ?

A. The arrangement of plugs by types according to their ability to transfer heat from the firing end to the cooling water or air.



1. COLD PLUG — Low Insulator seat quickly carries heat from insulator and makes a cold plug.
2. NORMAL PLUG — Intermediate seat permits insulator to retain a normal amount of heat.
3. HOT PLUG — High Insulator seat allows insulator to retain maximum amount of heat, making a hot plug.

7. Q. Why is it necessary in ordinary sparking plugs to have different types with different lengths of insulator projecting into the firing chamber of the plug ?

A. To control the rate of heat flow from the gap of the plug to the cooling medium which is either water or air. The rate of heat flow depends on the length and shape of the cylinder end of the insulator from the tip to the inside gasket.

8. Q. What service should sparking plugs have ?

A. (1) When vehicle is taken in for 300 or 500 mile inspection, gaps should be checked.

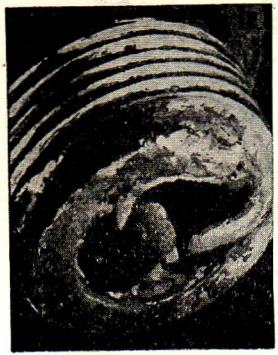
(2) At regular intervals, when changing oil is usually most convenient, plugs should be checked in tester, and if necessary cleaned and gaps reset.

(3) At regular intervals plugs should be replaced.

(4) Whenever vehicle is washed the upper portion of sparking plug core should be cleaned with a damp cloth.

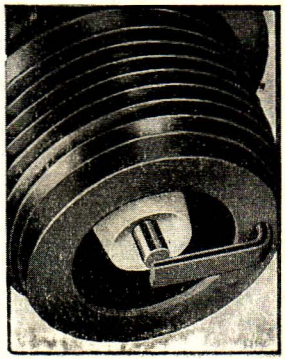
OILY, DIRTY, WORN-OUT SPARKING PLUGS

A sluggish, wasteful engine



NEW, CLEAN, EFFICIENT SPARKING PLUGS

A snappy, responsive engine



9. Q. What is fouling of sparking plugs ?

A. There are two kinds of fouling. (1) Petrol fouling. When an engine is started, cold petrol carbon is deposited on the firing end of the core, and a part of this is burned off the portion of the core which is hot enough to do so, but some remains. Oil vapour present in the combustion chamber deposits carbon on the tip of the core which with the petrol carbon present forms a hard crust. When the deposit formed at the colder end of the core by condensation meets the deposit formed at the hot firing tip, a conducting path is established over which the current will pass, causing failure to spark.

(2) Oil fouling. When excess oil is permitted to pass the pistons and enter the combustion chamber, it is turned to a hard cakey material on insulator and shell, and gradually fills up the space between insulator and shell until the plug is definitely short circuited.

When plugs are petrol fouled, the insulator shows a dull black, fluffy carbon deposit. When they are oil fouled the insulator more often shows a shiny black hard deposit, and in severe cases a filling of the space between insulator and shell with caked carbon.

10. Q. In what manner do sparking plugs wear out ?

A. (1) Gaps are burned open by constant application of spark, heat, pressure and the chemical action of the petrol mixture.

(2) Electrodes become oxidized and corroded, causing increased resistance to the passage of current.

(3) Firing end of insulator becomes crusted with carbon and other deposits, resulting in missing because of loss of current over and through these deposits.

(4) Plugs develop a gas leakage between insulator and shell or between centre electrode and insulator.

11. Q. Why are there many sizes of sparking plugs ?

A. This is a case of evolution, in many cases justifiable and in others not. Sizes at present in use are ½" gas thread, 22 mm, 18 mm, 14 mm, and 10 mm. The smaller sizes will of course reach their levelling off temperature slightly faster, but they will also tend to oil foul much more rapidly than the larger plugs where more clearance can be provided between insulator and shell. The principal justification for smaller plugs is lack of sufficient clearance for the larger sizes.

12. Q. What is the proper way of setting gaps ?

A. Gaps should always be adjusted by bending the shell electrode and never by bending the centre electrode. The correct setting will be found in the instruction book or manual.

13. Q. If one or more cylinders tend to foul sparking plugs, what is most likely the reason ?

A. (1) Compression may be weak in the cylinders in question. It should be checked with the crank to determine which cylinders are weak. Difficulty may be either in pistons or rings, out of round cylinders, or in the valves. A valve stem may be struck, the seat damaged or the valve tappets may not allow the valves to close.

(2) The cable leading from the distributor to the sparking plug may be faulty or broken.

(3) Petrol distribution may not be uniform.

(4) There may be dirt or paint on the upper end of the plug, causing arcing from the brass cap to the bushing.

(5) The gaps of the plugs may not be correctly set, usually found too close.

14. Q. Why do new engines often tend to foul all sparking plugs ?

A. (1) Use of wrong grades of oil in petrol to help " running in " the engine.

(2) Oil poured on top of pistons at factory to seal pistons and guard against rusting and seizing.

(3) Long idling run to warm up engine.

(4) Poor carburettor adjustment.

(5) Choke used too much.

(6) Dirt found occasionally in engines.

(7) Car driven too slowly in " running in."

(8) Distributor points defective or not properly set.

(9) Weak coil or condenser.

(10) Gaps incorrectly set.

15. Q. What causes an occasional miss at high speed ?

A. (1) Breaker points incorrectly set or point surfaces may be glazed over.

(2) Weak coil or condenser.

(3) Carburation incorrect.

(4) One or more valve tappets need adjusting.

(5) Gap set too wide.

16. Q. What causes a miss on a hard pull up-hill or through sand ?

A. (1) Weak coil.

(2) Spark too far advanced.

(3) Carburation incorrect.

(4) Poor compression in one or more cylinders.

(5) A partial " surface short " of the plug, that is, sufficient carbon deposit on the insulator so that part of the current will go across the carbon surface on a hard pull instead of across the gap.

(6) Gaps incorrectly set.

17. Q. When engine will not idle, what may be the cause ?

A. (1) Carburettor adjustment.
(2) Leaking carburettor gasket or intake.
(3) Distributor points.
(4) Weak coil or condenser.
(5) Lack of compression.
(6) Valve tappets.
(7) Improper valve timing.
(8) Sticking valve stems.
(9) Gaps set too close.

18. Q. What is the cause when sparking plugs run satisfactorily until high speed is reached ; then after short time the car slows down and there is a tendency to spit back in the carburettor ?

A. This is clear evidence of pre-ignition caused by some item in the combustion chamber becoming sufficiently hot to ignite the mixture before the spark occurs at the sparking plug gap. This hot spot may be carbon, a valve holding open, or a hot sparking plug. If the sparking plug used is the one normally recommended for the engine, it is essential that the following items be checked before coming to the conclusion that a colder sparking plug should be used.

The cause of the extreme heat may be :

(1) A lean mixture or a stoppage in the petrol pipe, such as a dirty filter or dirt in the line.

(2) The vacuum tank or petrol pump may be too low capacity for the speed desired, causing a period of starving in which the lean mixture will cause overheating.

(3) Lack of cooling, due to the water being too low in the radiator.

(4) A stoppage in the water system—a defective pump—a broken or slipping fan belt.

19. Q. What causes the engine to knock or "pink" when accelerating or at high speed ?

A. Petrol not sufficiently high test is usually the answer.

To meet the condition of the high compression engine for operation without knocking or pinking, it is often necessary to use a special anti-knock petrol. Examples of anti-knock petrol are those blended with benzol or leaded fuel.

Another reason for detonation or pinking is having the spark too far advanced.

Detonation is caused by the uneven burning of the gases in the combustion chamber. Sparking plugs are not ordinarily a factor in detonation.

Examination of plugs used with leaded petrol after a considerable period of operation, shows a heavy deposit of yellowish, glassy substance which leads many people to believe that the plugs have been injured. Numerous tests have definitely proved that this deposit is not injurious, and that the plugs will be entirely satisfactory in operation.

It is not advisable to attempt to scrape this deposit; utilise instead a compressed air cleaner.

20. Q. What may cause the engine to give unsatisfactory performance with the plugs being used ?

A. Before concluding that different plugs are needed, the engine should be checked for the following items :

(1) Compression.
(2) Distributor points.
(3) Spark timing.
(4) Valves—action, timing, tappets.
(5) Grade of petrol used.
(6) Gap setting.

CLEANING PLUGS

If a plug soots or fouls, it is necessary to clean it, and the best method is—having first removed the sparking plug—to fill the sparking plug between the insulator and the shell or body with petrol and then set fire to it, letting the petrol burn off the excess of carbon or oil that has become deposited on the insulator. Alternatively, set fire to a piece of oily rag and burn the sparking plug clean ; on the larger plugs it is possible to push a piece of cloth around the insulators and remove the carbon in this way.

Having done this, be certain to push something between the points of the plug and remove any carbon that may be on them, adjust the gap to the correct gap setting—and this is very important—replace the sparking plug, not in the hole that it came out of, ***but into a cylinder where the plug is already firing O.K.*** By this means we give the sparking plug that may be a little on the weak side a chance in a good dry cylinder, and we are putting into the oily cylinder a dry sparking plug which has been functioning perfectly in one of the other cylinders. This changing around of the sparking plugs often prevents recurrence of the oiling or sooting up.

Compressed air unit for cleaning and testing Plugs

If the engine is a 6-cylinder and it is necessary to find which sparking plug is missing, it is always much easier to use a tool and "short out" two cylinders, that is, connect our tool, say a hammer-head, against any two sparking plug terminals and cut these out entirely. One then has the equivalent of a 4-cylinder engine, and by shorting each of the remaining plugs in turn it is much easier to locate the plug that is missing than in attempting to short one cylinder at a time in a 6-cylinder engine. When a 4-cylinder engine runs on three cylinders it is much more noticeable than when a 6-cylinder engine is running on five cylinders.

It is also advisable, when examining plugs and cleaning them, TO WIPE THE TOP OF THE INSULATOR, as grease and dirt which gets blown against the insulator from the fan will often cause the spark to flash over or, in other words, jump from the brass terminal to the body of the sparking plug, especially when the vehicle has been standing in a damp atmosphere. If the sparking plugs are of the detachable type, that is, a plug that can be dismantled for cleaning purposes, always be careful when replacing the insulator to see that the copper seating washer is down square, before attempting to tighten the gland nut. It is advisable to obtain new washers, as once a copper washer has been tightened hard to make a joint, the softness and elasticity has gone, and plugs of the detachable variety often leak after re-assembly. GAS LEAKAGE, as mentioned previously, will cause RAPID OVERHEATING of the sparking plug.

Another important point is the copper washer which goes on the outside of the plug between the plug and the cylinder head. This should be renewed from time to time, as it is this copper washer which is to a great extent responsible for transferring the heat from the plug body to the cylinder head and then to the cooling medium. When a plug has been screwed down a number of times on to the copper washer, the washer becomes very hard and consequently does not transfer the heat from the plug body as it was intended to, and slight overheating of the plug takes place.

HINTS FOR EASY STARTING

When you remove Ceramic sparking plugs for examination you will find the appearance of the insulator either ASHY WHITE, a DULL BLACK or a LIGHT BROWN shade. If the insulator is ashy white it is a sure sign that the plug is overheating, and this may be caused by numerous reasons—for example, wrong type plug, improper installation of plug, shortage of water or shortage of oil, poor quality oil, ignition too much retarded, and a weak mixture in particular will cause the engine to overheat. If the insulator is a dull black colour, this is a sign that the plug is running too cold or, in other words, the insulator is not getting hot enough to burn the carbon that gets deposited on the insulator, with the result that this carbon builds up on the insulator until the plug begins to miss and ultimately completely cuts out. This condition can be brought about by the engine idling for long periods, or EXCESSIVE USE OF THE CHOKE and, of course, the wrong type of sparking plug. If the insulator appears a brownish shade, this is a sign that the plug is running at its correct self-cleaning temperature, and the carburettor mixture is correct.

CONCLUSION

Although it should be understood that many factors besides sparking plugs may cause improper operation of engines, it must not be forgotten that the best of sparking plugs do not wear for ever. The intense stresses and strains imposed, especially in the up-to-date higher compression engines, often under conditions which are not of the best because of defection of some item in the engine other than sparking plugs, are so terrific that there is gradual deterioration of the sparking plug.

Almost any of the many items mentioned as having a bearing on engine operation may bring about a condition where it is impossible for the sparking plug to operate at its highest efficiency.

Inefficient functioning of the sparking plug means incomplete combustion in the engine cylinder. Incomplete combustion means unburned gas going out of the exhaust. In this case the full heat value of the fuel is not used and as a result power is lost and petrol is wasted

Additional copies of this leaflet may be obtained upon application. Those desiring more detailed information on the ignition system of the modern Automobile engine, should write for booklet :—

"SPARKING PLUG SERVICE INFORMATION."