Sept. 20, 1960 E. ENGEL 2,953,720

IGNITION SYSTEMS

Filed Nov. 12, 1958

Fig. 1.

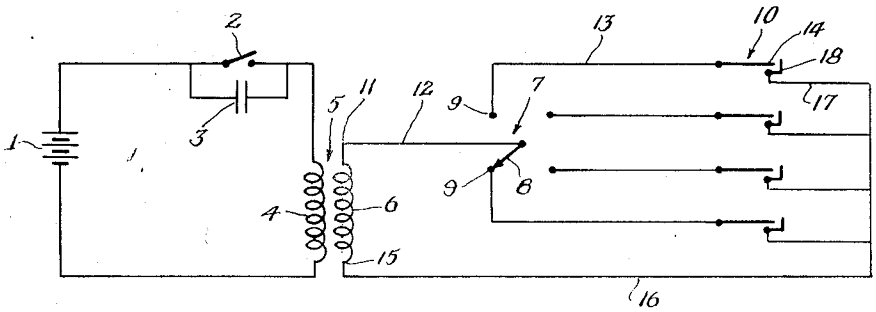


Fig. 2.

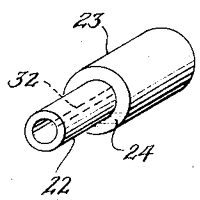


Fig. 3.

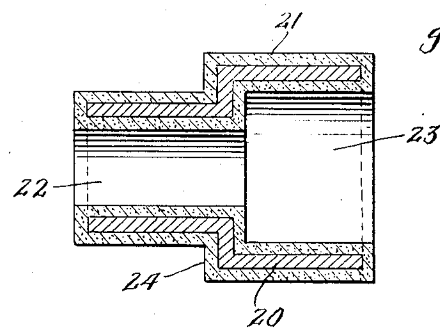


Fig. 4.

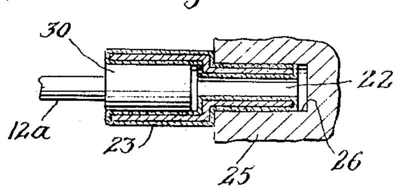


Fig. 5.

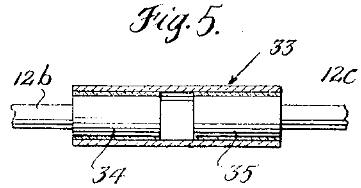
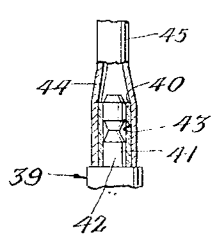


Fig. 6.



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IGNITION SYSTEMS

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1 Claim. (Cl. 315—209)

This invention relates in general to improvements in ignition systems for internal combustion engines.

The principal object of the invention is to provide an element which is a permanent part of or insertable in the high tension side of an ignition system, the element functioning in a manner to obtain sustantial and highly advantageous results in fuel economy, spark plug maintenance and operation, engine power and in engine performance and maintenance.

The invention contemplates in an ignition system that the conducting medium between the high tension side of the ignition coil or transformer and one of the electrodes of the spark plug include a pair of spaced conducting surfaces separated by a dielectric. In the preferred form, this being obtained by means of a tubular piece of aluminum having a dielectric coating or surface of aluminum oxide anodized thereon and being disposed in the distributor cap so as to electrically interconnect the distributor rotor and the high tension cable from the transformer secondary.

My invention provides many dramatic advantages and some of these are generally discussed below.

One of the advantages of my invention is that it increases the torque or horsepower of the engine with which it is used. In other words, through the medium of my invention most of the available energy of the air/fuel mixture in an engine cylinder is utilized to do work, i.e., there is more force moving the piston. This is important from several standpoints; for example, in connection with passenger cars, more power is available when the same is needed, such as in hill climbing and for acceleration in passing. For burden and load-carrying vehicles, it is important because more load can be carried per unit of fuel cost.

Another important advantage of the invention is in the substantial economies effected by lower engine maintenance costs and in engine longevity; for example, an engine equipped with my invention can be idled at from between 20–25% lower r.p.m. than the usual manufacturers' recommended setting. Idling comprises a large percentage of engine operating time and with engine parts moving at slower speeds, the wear factor is reduced. Furthermore, an engine equipped with my invention, even the so-called high compression engine will give completely satisfactory operation with non-leaded fuels. Thus, lead fouling such as pitting and the build up of deposits on valves, piston walls, etc., is eliminated. Additionally, the invention promotes a high degree of fuel burning which is important from the standpoint of preventing carbon deposits which are conducive to loss of engine power, sticky valves, poor starting and the like. The pitting and the build up of lead and carbon deposits can only be corrected by expensive engine overhaul and the elimination of the necessity for this is a highly useful and desirable objective.

Another important advantage of the invention is in connection with the performance in operating life of the spark plugs. With my invention the gap spacing in a spark plug can be much greater than the conventional spacing. This is highly desirable because even with wear, there is no deleterious effect on performance. Also, wide gap spacing is desirable because the area of the conduction or discharge between the electrodes is much greater and more energy is available to cause the ignition or burning of the fuel/air mixture.

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A still further and important advantage of my invention is in the substantial savings in operating fuel. First of all, engines equipped with the invention can be operated with regular rather than more expensive high test gasoline and this is the case even for high compression engines. Additionally, the invention permits a much leaner mixture, i.e., less gasoline to air and this permits fuel savings ranging from 18–40% depending upon the type engine, power requirements and the like. Fuel savings are also gained by reason of the lower idling speed mentioned above.

The manner in which the invention is constructed and certain other advantages thereof will be apparent from the following description and drawings wherein:

Figure 1 is a diagrammatic view of a typical ignition circuit;

Figure 2 is a perspective view of a device constructed in accordance with the invention;

Figure 3 is a cross sectional view of the device of Figure 2;

Figure 4 is a fragmentary view partially in section illustrating the manner in which the device of Figures 2 and 3 can be inserted in a distributor cap or coil tower;

Figure 5 is a fragmentary view partially in section showing the manner in which a device of the invention can be inserted in the high tension cable running from the ignition coil to the distributor; and

Figure 6 is a fragmentary view of the top of a spark plug showing how the invention may be applied thereto.

In Figure 1 a typical ignition circuit has a low tension side comprising a battery **1**, an interrupter **2** shunted by a capacitor **3** and the lower voltage coils **4** of a transformer **5**. The high tension side comprises the secondary **6** of the step-up transformer **5**, the distributor **7** having a rotor arm **8** and fixed terminals **9**, together with spark plugs **10**.

The interrupter is actuated by means not shown connected to the engine and, by opening and closing, creates a periodic current in the transformer primary. This induces a high voltage in the secondary of the transformer. This secondary or ignition voltage, or at least a part thereof, is successively applied between the electrodes of the spark plugs by the action of the rotor **8** which is driven by means not shown connected to the engine.

The elements described above are all standard and their construction and operation is well understood by those skilled in the art and need not be described further. For present purposes, it is understood that there are two conducting paths between the secondary **6** and any one of the spark plugs. For example, in connection with the topmost spark plug, a path includes the point **11** on the secondary conductor **12**, rotor **8**, contact **9**, conductor **13** to the center electrode **14**. The conductors **12** and **13** are usually rubber insulated copper cables. The othe path includes the point **15** on the secondary, the conductors **16** and **17** and the other electrode **18**. The conductors **16** and **17** are usually formed by means of the engine block itself.

Other forms of ignition circuits are well known and need not be explained. However, these all incorporate a device to produce a high voltage which can be applied against the electrodes of the spark plugs and have a conducting medium between such mechanism and the electrodes.

It is contemplated that my invention be incorporated in any point in the high tension side of the ignition circuit. As a practical matter, an element constructed in accordance with the invention is inserted in the distributor cap so as to electrically connect the rotor arm **8** and the conductor **12**. One form of invention for accomplishing this is shown in Figures 2 and 3.

The element is generally tubular in form and includes a metal part **20** preferably made of aluminum and having thereon coating or surface **21** of aluminum oxide obtained by sulfuric acid anodizing. As will be seen, the left-hand part **22** is of smaller diameter than the right-hand part **23**. The two parts are joined by a shoulder **24**. The difference in diameter is principally for ease in applying the unit to the distributor. In the drawings this difference in diameter and the thicknesses of the part **20** and coating **21** are somewhat exaggerated for purposes of clarity.

In Figure 4 I have shown how the element of Figures 2 and 3 is inserted in a distributor cap. The cap includes a fixed conductor **25** formed with an aperture **26**, the conductor being arranged so as to be in electrical contact with the rotor arm but permitting rotation of the latter. Ordinarily, the aperture **26** receives the cylindrically-shaped terminal **30** of the high tension cable **12*a*** going to the transformer. By removing the terminal **30** from the aperture **26** the part **22** of my device can be inserted as shown with the terminal **30** received in the part **23**. It should be noted that the oxide or dielectric coating on the outside of part **22** is in firm contact engagement with the conducting surface of the aperture **26** to form a tubular-shaped contact area and the oxide coating on the inside part of **23** is in firm contact engagement with the conducting surface of the terminal **30** to form a tubular-shaped contact area spaced from first mentioned contact area.

For purposes of insuring firm engagement, the device may be slotted as indicated by the dotted lines **32** in Figure 2 and the dimensions of the device are arranged so that when the part **22** is inserted in the aperture **26**, it is contacted and, therefore, tends to expand and exerts a force against the surface of the aperture.

In Figure 5 I have shown a typical means for using the invention by inserting the same in the high tension cable itself. In Figure 5 the unit **33** is constructed the same as in Figures 2 and 3, except that a uniform diameter is used. The high tension cable is split into two parts **12*b*** and **12*c*** having respective terminals **34** and **35**. Both of these terminals are inserted on the inside of the device **33** so that their conducting surfaces are in firm electrical contact with the dielectric coating.

It will be apparent to those skilled in the art that other forms of the unit may be devised for inserting in other parts of the high tension side of the ignition circuit. For example, in Figure 6 I have shown the top part of a spark plug **39** having a dielectric **40** disposed between the conducting surface **41** of the center electrode **42** and the conducting surface **43** of the terminal **44** connected to cable **45** running to the distributor not shown. Preferably, the terminal **44** is made of aluminum and the dielectric **40** is anodized thereon.

The surface **21** is a dielectric or insulator and is disposed between two conducting surfaces or plates; for example, in Figure 4 the conducting surface of the aperture **26** and the conducting surface of the terminal **30**; or, in Figure 6, the dielectric is disposed between the conducting surfaces **41** and **43**. In its broadest nature, therefore, my invention contemplates a capacitor in the high tension side of the ignition circuit. The embodiment of this preferably takes the forms as described above. For utilizing the invention, the material which follows considers the construction of the dielectric and of the tubular piece **20**.

With regard to the piece **20**, I have indicated above that the same is preferably made of aluminum. Several grades of aluminum and its alloys are available, the types 2–S, 3–S, 52–S and 61–S being preferred. Alloys of aluminum having copper or zinc are not too satisfactory because the copper and zinc restrict the thickness of the coating that can be obtained by anodizing. While aluminum is preferred, other metals capable of having an oxide of their own metal formed thereon may be used, for example, titanium, silicon and magnesium. The tubular metal part **20** may be made from tube stock or by machining from a solid block. The exact dimensions of the piece will vary with the manner in which the device is used in the high tension side of the ignition circuit and with certain other factors mentioned below.

Dielectric coatings or surfaces may be applied to the tubular piece by methods other than anodizing, for example, spraying, brushing, dipping and the like. However, using a tubular element and anodizing the dielectric thereto is preferred because of the simplicity and ruggedness of the unit. Further, the dielectric may be formed as a separate unit and then fitting the same between two conducting surfaces. For example, in Figure 6 the dielectric **40** may be formed and then fitted over the terminal **41**.

As to the dimensions of the dielectric: I have found that units as described above having capacitance of between 560 and 13,600 mmf. give highly satisfactory results. The capacity may be calculated from the formula

$$C=\frac{A}{L}\times\frac{k}{\pi}$$

where: A is the area of one of the conducting surfaces surrounding the oxide coating, the areas of the conducting surfaces being preferably substantially equal; L is the thickness of the dielectric; and k is the dielectric constant which, for aluminum oxide, is about 7. I have used dielectrics formed by anodizing having a thickness of from .0025″ to .006″ and have found that thicknesses in the range of .002″ to .004″ are preferable.

In the description above it was indicated that the coating was applied to all parts of the metal piece. However, I have found that the coating may be applied as follows: In Figure 4, the dielectric or coating can be applied only to the inside of the part **23** or to the outside only of the part **26**. In the foregoing, it will be apparent that the capacity is less than where the metal piece is completely coated. In Figure 5 the dielectric can be applied only to the inside of the device **33**.

An ignition circuit having my invention incorporated therein functions in a manner so that the energy ouptut of the spark or electrode gap is at least doubled. This is brought about as follows. When the ignition voltage is applied across the secondary of the transformer, parts of this voltage appear both across the spark gap and across my device. My device immediately starts to charge and, for this purpose, there is a flow of current around the secondary circuit. The ignition voltage increases to a point until the gap breaks down and there is a discharge or large flow of current between the electrodes which starts to ignite the fuel/air mixture. At this time my device is then charged to substantially the same voltage as appeared across the transformer secondary. When the ignition voltage across the secondary is removed and starts to drop off, the voltage across my device then appears across the spark gap. The gap breaks down and conduction or discharge takes place. The energy of this discharge then is available to sustain the ignition of or further ignite the fuel/air mixture.

The foregoing happens so fast that for all practical purposes there are two discharges across the electrode spark gaps in the time that the ignition voltage is applied. This, of course, is actually double the number of discharges across the gap than when my invention is not incorporated in the high tension side and only the voltage across the transformer is available to break down the gap.

In connection with the foregoing it is pointed out that I do not completely understand the function played by the tubular metal part **20**, at least from the electrical standpoint, i.e., what part this element plays in making more energy available in the spark gap to effect the combustion or ignition of the fuel/air mixture, although from my observations and tests, it appears to have some influence.

Also, in utilizing the invention, it is preferred particularly in some instances, that the timing of the engine be advanced; although I have found that where the capacitance in the secondary circuit is high, some engines do not require an advance in timing over the usual manufacturers' recommended setting. However, where timing is to be advanced, the following should be observed. With the ordinary spark plugs, the timing is set at about 2°–5° BTDC and the gap setting is usually 0.030" to 0.035". Where my invention is used, with the ordinary plugs and the timing is advanced, the same may be set to about 7°–10° BTDC. Also, the spacing between the electrodes can be increased to about 0.060", although the spacing can be left unchanged if desired. With the so-called resistance type plugs the timing is set at about 4° BTDC and the gap spacing is about 0.033". Where my invention is utilized, with such plugs, the timing may be set at about 9°–11° BTDC and the gap may be increased to about 0.065" or left unchanged.

I claim:

In an ignition circuit having a spark plug and mechanism to produce a voltage to cause current to flow between the spark plug electrodes, electrical conductor means interconnecting said mechanism and one of said electrodes comprising: metal conductor means having two coaxial cylindrically-shaped conducting surfaces spaced from one another and an elongated, tubular piece of aluminum coaxial with and extending between said surfaces and having thereon an anodized surface of aluminum oxide, the oxide surface being in contact engagement with said conducting surfaces to form a pair of spaced, tubular-shaped areas of contact.

References Cited in the file of this patent

UNITED STATES PATENTS

1,531,696	Fay	Mar. 31, 1925
1,994,128	Foust	Mar. 12, 1935
2,376,362	Kasarjian	May 22, 1945
2,427,247	Wilkinson et al.	Sept. 9, 1947
2,587,847	Hofmann	Mar. 4, 1952
2,745,075	Simpkins et al.	May 8, 1956
1,531,696	Fay	Mar. 31, 1925

FOREIGN PATENTS

668,882	France	July 23, 1929