Dec. 5, 1961 B. C. FISHER 3,012,084

IGNITION DEVICE

Filed Dec. 17, 1958

Fig. 1.

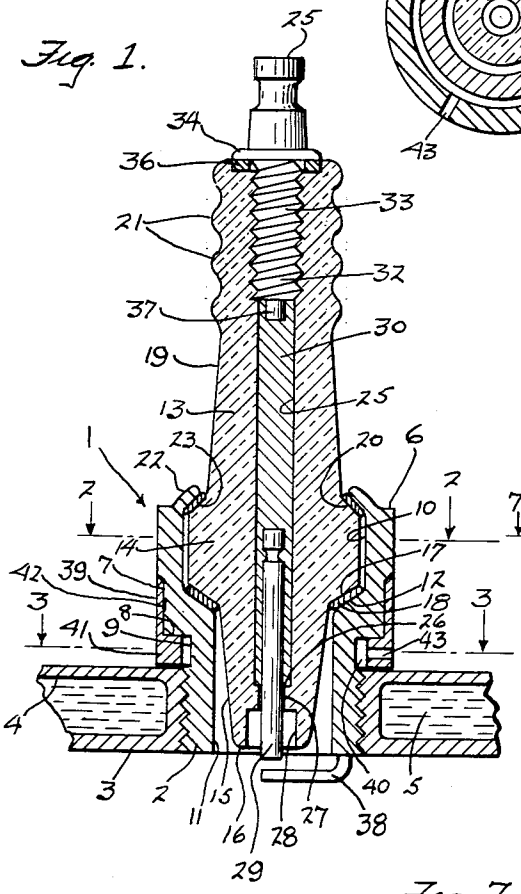


Fig. 3.

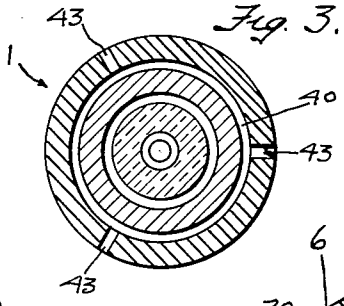
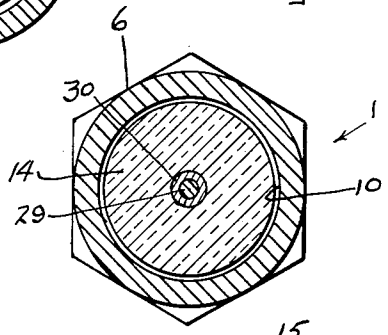


Fig. 2.



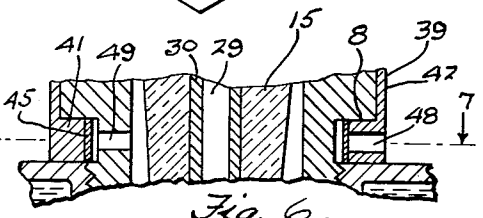


Fig. 6.

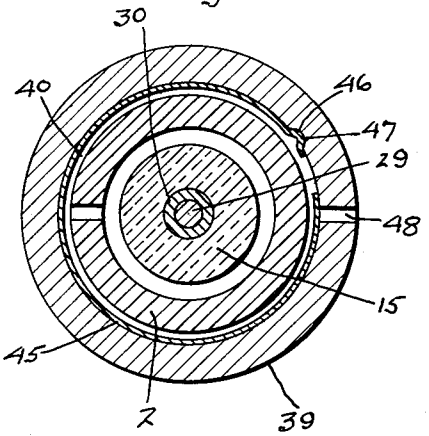
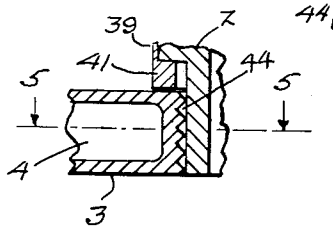


Fig. 7.

Fig. 4.



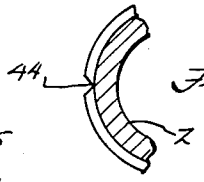


Fig. 5.

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3,012,084
IGNITION DEVICE

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6 Claims. (Cl. 123—169)

This invention relates to ignition devices used especially with internal combustion engines.

One of the causes of detonation in internal combustion engines is the overheating of parts of the spark plugs, causing them to become incandescent and to take over the firing of the explosive mixture, thus causing firing at the wrong time and consequent detonation and loss of power.

One of the objects of this invention is to provide an ignition device which will operate in such a manner that none of the parts will become incandescent in operation or hot enough to ignite the mixture.

Another object of the invention which fulfills the last-mentioned object is to provide an ignition device with a specially constructed heat conducting path leading from the sparking electrode to the air and to the coolant in the engine block with which the device is used.

In my United States Patent No. 2,646,782 I have disclosed an ignition device having a cavity or auxiliary firing space therein in which the compressed fuel mixture is stratified according to its air content when compressed and provides a control of the timing of the spark for varying conditions of speed and load, so as to give the maximum firing efficiency.

It is therefore also one of the objects of the invention to provide an ignition device which combines the control of the firing time by means of the cavity with a greatly increased heat conduction path away from the sparking electrode for extremely rapid cooling of the electrode and adjacent parts.

Another object of the invention is to provide an ignition device which requires no gasket when applied to an internal combustion engine, part of the device itself acting in this capacity.

Still another object of the invention is to provide an ignition device for an internal combustion engine in which a relatively long duct of small cross section is provided leading from the atmosphere to a point near the sparking electrodes which admits air to the combustion chamber during the intake stroke and plays an important part in the cooling of the device.

Still another important object of the invention is to provide an ignition device which will reduce excess pressures in the intake manifold.

Another object of the invention is to provide an ignition device which will act to scavenge and blow exhaust gases and residues out of the combustion areas of the engine.

Another object of the invention is to provide an ignition device which offers an effective relief for extreme pressures, arising during operation, with no appreciable loss in power.

Another object of the invention is to provide an ignition device which will have a minimum of electrical leakage and will substantially eliminate electrical interference with radio equipment or other electrical apparatus.

Other objects and advantages will appear as the description proceeds.

The invention is illustrated in the accompany drawings, in which:

FIGURE 1 is a sectional elevational view of an ignition device embodying the invention;

FIGURE 2 is a sectional plan view of the device taken on the line 2—2 of FIGURE 1;

FIGURE 3 is a sectional plan view of the device taken on the line 3—3 of FIGURE 1;

FIGURE 4 is a fragmentary, sectional elevational view of a modified form of the device;

FIGURE 5 is a sectional plan view of the modified form of the invention, taken on the line 5—5 of FIGURE 4;

FIGURE 6 is an enlarged, fragmentary, sectional view of another modified form of the invention; and

FIGURE 7 is an enlarged, fragmentary, sectional plan view, taken on the line 7—7 of FIGURE 6.

Referring now to the drawings, the ignition device, which I prefer to call a "fuse," comprises a body member 1 which is tubular in form and is preferably made of cold rolled steel. One end 2 is threaded so as to be screwed into a tapped hole in the engine block 3 of an internal combustion engine provided with a cooling chamber 4 filled with a coolant 5. The other end 6 of the body member is enlarged and has a hexagonal surface configuration so that a wrench may be applied thereto in order to screw the fuse into the engine block. A straight cylindrical portion 7 is provided between the threaded end 2 and the enlarged end 6, slightly smaller in diameter than the enlarged end and forming a shoulder 8 between it and the threaded portion. A second straight cylindrical portion 9 between the shoulder 8 and the threaded portion 2 is slightly smaller in diameter than the threaded portion.

The body member is provided with two interconnecting bores 10 and 11 having two different diameters. The bore 10 is in the enlarged portion 6 of the body member and has the larger diameter, while the bore 11 is in the end 2 and has a smaller diameter. The two bores are joined by a tapered surface 12.

An insulator 13 is fitted within the body member 1. It has an enlarged portion 14 of sufficient diameter to fit easily into the bore 10 of the body member and a tapered portion 15 which is small enough in diameter so that its walls are spaced from the walls of the bore 11 into which the portion 15 extends. The end of the insulator is slightly rounded and lies just short of a plane through the end 2 of the body member and forms a skirt 16 which is spaced from the body member and also from the sparking electrode, as will be described later. The two portions of the insulator are joined by a tapered surface 17 having the same taper as the surface 12 in the body member close to which it rests, a sealing gasket 18 being provided between the two surfaces.

A third portion 19 of the insulator extends in the other direction from the enlarged portion 14 at a distance which may be greater than the length of the body portion. This portion is of smaller diameter than the portion 14 and is tapered slightly from the enlarged portion to which it is joined by a tapered surface 20. The outer end of the portion 19 may be provided with circular corrugations 21 for a short distance from the end to increase the possible electrical path over the outside of the insulator and to provide a greater surface for the radiation of heat.

It is important to make the insulator of some ceramic material having a high heat conductivity, and I have found that brown alumina having a coefficient of thermal conductivity of 0.0180 is satisfactory.

The insulator is held in the body member 1 by spinning over the edge of the body member, as at 22, or by any other suitable means, a gasket 23, similar to the gasket 18, being provided to make a substantially gas-tight joint. In addition, a ceramic cement may be used between the insulator portion 14 and the body member to increase the sealing effect.

The insulator has a bore 25 extending coaxially therethrough from the end of the portion 19 to a point near the end of the portion 15. This bore is considerably larger in diameter than the rod normally extending through the center of a spark plug and terminates near the end of

the portion 15 at a shoulder 26 formed by a restriction 27. Another bore 28 in the end of the insulator portion 15 terminates at the other side of the restriction 27 and is larger in diameter than the bore 25.

A conducting member formed of three parts extends through the insulator. A first part comprises a rod 29 which forms the sparking electrode and extends from a point about even with the end 2 of the body member, through the restriction 27, into the bore 25 to a point within the enlarged insulator portion 14.

A second part comprises a porous conducting cylinder or cartridge 30 which is tightly fitted within the bore 25, abutting the restriction 27, and encompassing the inner end of the rod 29. This porous cylinder is preferably made by rolling a rectangular sheet of fine wire mesh into a cylinder or cartridge and compressing it to a diameter so as to permit ramming tightly into the bore 25. The wires of the mesh are preferably made of copper in ribbon form. Other metal may be used, but the wires should have a high heat conductivity, since it is very important that the cartridge should be a good conductor of heat.

Before the compressing step, a hole may be drilled in the end to receive the inner end of the rod 29 which may be provided with a groove or grooves near the end to insure a tight grip when the material is compressed around the rod.

The conducting cartridge 30, which I call a "Basterite cartridge," has an important effect on the operation of the ignition device. Although it appears to occupy a large portion of the space within the bore 25, it is actually porous because of the interstices between the individual wires and therefore forms part of the cavity or firing space referred to above in connection with my prior patent.

Another way of making the porous cartridge 30 is to compress powdered copper with a binder of water glass and powdered china cement and dry it at about 200° Farenheit for about 40 hours. The cylinder will then have about the same expansion rate as the porcelain insulator. The cartridge of wire mesh has a certain resiliency which will prevent expansion pressures from exerting too great a force on the insulator so as to prevent possible fractures. I prefer the cartridge made of wire mesh.

A third part of the conductive member is a terminal stud 32 which may be made of any suitable conducting metal. This stud comprises a threaded end 33 adapted to be screwed into a tapped hole in the outer end of the bore 25 of the insulator, an enlarged flange 34 adapted to fit over the end of the insulator, and a terminal end 25 adapted for making the electrical connection to the device. A gasket 36 of silicone or other suitable material is provided under the flange 34 to prevent the escape of gases at the top of the device, the end of the insulator being recessed to receive it. The end 33 of the stud has a tip of reduced diameter to form a short stud 37 which fits into a hole provided for it in the porous cartridge 30.

The cartridge 30, after being compressed to a diameter which fits tightly into the bore 25 and with the rod 29 held in the end, is forced into the bore 25, with the rod 29 extending through the restriction 27. Then the terminal stud 32 is screwed tightly into place, compressing the silicone gasket 36 and forming a gas-tight connection.

A ground wire 38 is welded to the end of the screw threaded portion 2 of the body member and extends radially to just beyond the center of the device and is spaced from the end of the rod 29 to form the other sparking electrode.

A sleeve 39 surrounds the body member between the threaded end 2 and the enlarged portion 6. This sleeve is made of a metal having a higher heat conductivity than steel and I prefer aluminum for this purpose. The sleeve has three functions: (1) it conducts heat very rapidly from the body member 1 to the coolant 6 in the cylinder block; (2) it provides a cavity 40 the purpose of which will be later described; and (3) it acts as the gasket normally used between a spark plug and the cylinder block.

The sleeve 39 has a thickened inwardly extending flange 41 at one end. The main portion of the sleeve has an inside diameter just large enough to fit tightly over the straight portion 7 of the body member until the end of the sleeve abuts against the edge of the hexagonal enlargement, and the distance from this end to the flange 41 is just sufficient to permit the flange to abut against the shoulder 8. When the device is screwed into the engine block, the sleeve 39 is squeezed between the enlarged portion of the body member and the engine block to form the gas-tight connection. Thus, it takes the place of the usual copper gasket used with a spark plug and has the advantage of being part of the device, so that it can not be lost, as gaskets often are, when the device is removed from the engine block.

The sleeve 39 is held on the body member 1 by friction, but in order to increase this frictional effect, I knurl the surface 7 of the body member at one or more places, as at 42, to form a roughened band or bands around the circumference. One forced on the body member, the knurling locks the sleeve securely in position.

The inner surface of the flange 41 is spaced from the body member, forming the annular cavity 40, as shown in FIGURES 1 and 3. This cavity provides an important function in the efficient operation of the device, as will be explained.

The cavity 40 forms part of a passageway between the atmosphere and the combustion space of the engine. To this end I provide a plurality of ducts 43 diametrically through the flange 41, thus leading from the cavity 40 to the atmosphere. I preferably provide three of these ducts spaced at angles of 120°. Between the cavity 40 and the combustion space of the engine the passageway comprises the spiral leakage path along the threads of the threaded end 2 of the body member 1.

When the members are screwed together with a standard uniform thread, one surface of one thread is in contact with one surface of the thread on the other part and there is a slight clearance between the other surfaces of the threads and between the tips of one thread and the valleys of the other. This clearance provides just the right cross section for my purpose. Of course the length of the passageway, thus formed, is an important factor in the amount of gases which will pass through. I have found that good results are obtained in an ordinary automobile engine if the threaded portion of the end 2 is ⅜ of an inch long and threaded with standard 14 and/or 18 millimeter thread with a so-called No. 2 fit having a tolerance of plus or minus 0.002 inch. Different thread dimensions will of course be necessary for different size devices to be used in different sized engines.

The ignition device, when constructed as described above, performs with astonishing efficiency in an internal combustion engine. In the first place, the bore 25 of the insulator with its porous cartridge 30 and the space between the skirt of the insulator and the body portion combine to form the cavity referred to in my above mentioned United States Patent No. 2,646,782, which has the effect of causing stratification of the air and gas mixture during the compression stroke, producing the "blow torch" effect when the spark occurs and controlling the timing of this effect with variations of speed and load.

In the second place, there is a heat conducting path from the rod 29 which is far more effective than that of any spark plug heretofore used. The cartridge 30 draws the heat rapidly from the rod into its much larger mass from which the heat passes through the portion 19 of the insulator to the air and through the portion 14 to the body member 1. The sleeve 39, being of aluminum is a better conductor of heat than the body member and draws the heat rapidly away from the body member, and, because of its contact with the engine block, delivers it to the coolant 5.

In the third place, the air drawn into the cavity **40** at high velocity during the intake stroke and through the spiral path along the threads from the cavity **40** into the combustion chamber has a very great cooling effect on the sleeve **39** as well as all the parts of the device adjacent the sparking electrodes. This air is trapped under pressure during the compression stroke and during the explosion stroke and passes through the spiral path around the threads with great velocity during the exhaust stroke and swirls around the space adjacent the sparking electrodes, sweeping all burned gases before it and thoroughly cleaning the sparking electrodes and the insulator skirt and producing a cooling effect on these parts. Any loss through this path during the compression or explosion strokes is negligible.

As a result of these effects, the fuse operates relatively cool and neither the end of the insulator nor the sparking electrodes can ever become incandescent and the firing is always under control of the spark regardless of speed or load conditions.

Although I prefer to have the air from the cavity **40** enter the combustion chamber around the spiral path of the threads, I may, in some instances, provide an additional shorter path for the air. Thus, in FIGURES 4 and 5 I have shown a modification of my invention in which I provide a groove **44** transverse to the threads on the end of the body member **1** and thus leading from the cavity **40** to the combustion chamber of the engine. This groove provides an additional passage to permit freer entrance of the air into the combustion chamber from the cavity **40**.

In FIGURES 1 to 5 I have shown an arrangement in which the passageway between the combustion chamber of the engine and the atmosphere is unobstructed except by the tortuous path around the screw threads between the device and the engine block. However, in some instances I may wish to control this passageway by means of a valve. In FIGURES 6 and 7 I have shown an arrangement in which a valve is provided in the cavity **40**. To this end a resilient ribbon **45** of spring metal, having a length a little shorter than the circumference of the inner surface of the flange **41**, is bent into a circular form and placed in the cavity **40**. The spring valve, thus constructed, normally has a diameter larger than the inner diameter of the flange **41**, so that it has to be compressed to be inserted within the flange. It thus hugs the inside of the flange by virtue of its own resiliency. Adjacent one end, the spring **45** is provided with an outwardly extending deformation or kink **46** which fits into a notch or groove **47** provided in the flange to receive it. With the kink **46** lying in the notch **47**, the spring is prevented from shifting circumferentially in the cavity.

The spring may be made of any resilient metal which will maintain its resiliency at 500° Fahrenheit, and I prefer to use berylium for this purpose. A spring ⅛ inch wide and 0.015 inch thick has been found to give good results.

Near the position of the other end of the spring I provide a radial duct **48** through the flange leading directly to the atmosphere. The inner end of this duct is covered by the end of the spring, as will be seen in FIGURE 7. A second duct **49**, diametrically opposite the duct **48**, is provided through the body member **1** leading from the cavity **40** to the space between the skirt **16** of the insulator and the body member. If the pressure within the cavity is equal to or greater than that of the atmosphere, the duct **48** will be closed by the spring. However, when the pressure inside the cavity becomes sufficiently less than that of the atmosphere to overcome the tension of the spring, the end of the spring will move away from the inner end of the flange and air will enter the cavity through the duct **48**. When this happens, the bend of the spring will be distributed over almost the entire length of the spring, so that deterioration of the spring from this bending effect is practically negligible.

In the embodiment of the invention shown in FIGURES 1 to 3, the following measurements of the important elements have been found to give good results:

Inside diameter of end **2** of body member	inches	0.415
Length of end **2** of body member to gasket	inches	0.687
Diameter of end **2** of body member between threads and shoulder **8**	inches	0.558
Overall length of insulator **13**	do	2.34
Diameter of cartridge **30**	do	0.150
Length of cartridge **30**	do	2.062
Diameter of rod **29**	do	0.093
Inner diameter of skirt of insulator **13**	do	0.1875
Outer taper of skirt		6°
Outer diameter of insulator portion **15** adjacent enlarged portion **14**	inches	0.370
Axial length of flange **41**	do	0.125
Inner diameter of flange **41**	do	0.608
Diameter of duct **43**	do	0.030
Diameter of duct **48**	do	0.052
Diameter of duct **49**	do	0.052
Length of sleeve **39**	do	0.651

Modifications may be made in the parts of the device as shown and described and I do not wish to limit the invention except as limited by the appended claims.

What I desire to claim and secure by Letters Patent is:

1. An ignition device comprising a body member, means at one end of said body member for attaching said device to an internal combustion engine, said attaching means comprising threads on the one end of the body member, said body member having a cavity within the wall thereof with an opening communicating with the groove of said threads, and a duct leading from said cavity to the atmosphere, whereby said threads cooperate with the threads on the engine block to form a tortuous path of very small cross section from said cavity to the combustion chamber of the engine.

2. An ignition device, as defined in claim 1, in which the cavity in the body member is annular and coaxial with the body member and the opening communicating with the threads is continuous around said body member.

3. An ignition device, as defined in claim 1, in which the body member is formed of first and second parts, the first part housing the insulator and having at one end the means for attaching to an internal combustion engine and having an enlarged portion at the other end forming a shoulder between it and said attaching means, and the second part of said body member comprising a sleeve press-fitted over said one end of said first part and lying against said shoulder, said sleeve having an internal groove forming said cavity, the duct leading to the atmosphere extending through said sleeve.

4. An ignition device, as defined in claim 3, in which the sleeve is made of metal having a high heat conductivity and acts as the sealing gasket except for the duct and the tortuous path between the device and the engine.

5. An ignition device comprising a tubular body member formed of inner and outer parts, an insulator extending through said inner part, a conductor extending through said insulator, said inner part being threaded at one end to permit attaching to the block of an internal combustion engine and having an enlarged portion at the other end forming a shoulder between it and the threaded end, said outer part of said body member comprising a sleeve press-fitted over said one end of said inner part and lying against said shoulder, the internal diameter of said sleeve being enlarged adjacent the threaded end of said inner part to form an annular cavity between said parts open in the direction of the threads of said threaded end, whereby, when said device is screwed into an engine block, the end of said sleeve will be forced against said block and said cavity will have access to the clearance space around said threads, said sleeve having a duct leading from said cavity to the atmosphere.

6. An ignition device comprising a tubular metallic body member having threads at one end for attaching said device to an internal combustion engine, an insulator having a central bore within said body member and having one end substantially aligned with said one end of said member and the other end protruding out of the other end of said member, said insulator being tapered at said one end to form a space between said insulator and the interior walls of said body member, said one end of said insulator forming a skirt, conducting means extending through said bore and comprising a sparking electrode extending slightly beyond the edge of said skirt, said body member having an annular cavity within the wall thereof coaxial with said body member and having an opening communicating with said threads continuously around said body member, whereby said threads cooperate with the threads on the engine block to form a tortuous path of very small cross section from said annular cavity to the combustion chamber of the engine and a duct leading from said annular cavity through the wall of said body member to the atmosphere, part of said body member acting as a gasket for making a gas-tight seal between said device and the engine block.

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