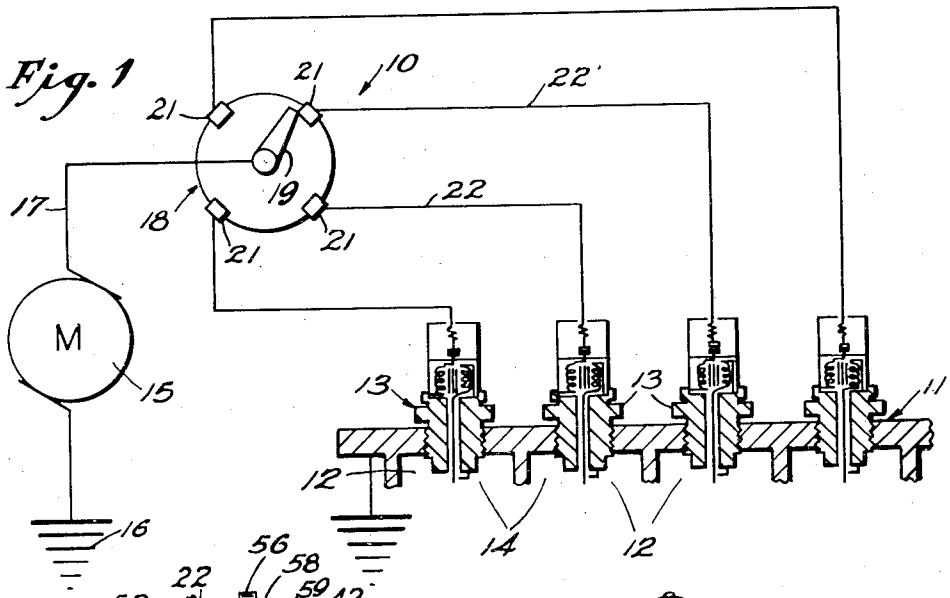
Aug. 10, 1948. H. W. SHERIDAN ET AL 2,446,888

IGNITION SYSTEM

Filed March 22, 1943

Fig. 1



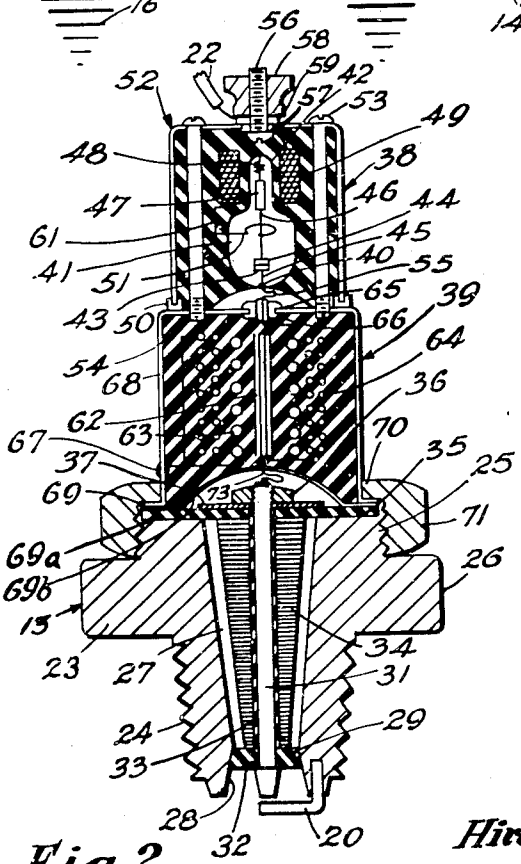


Fig. 2

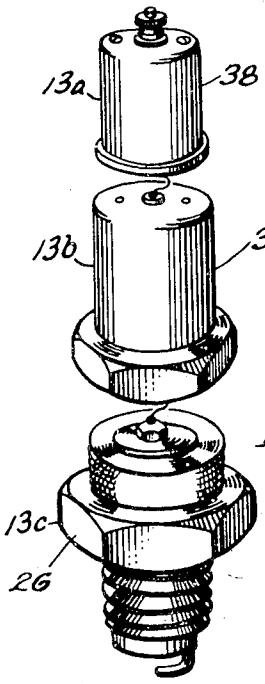


Fig. 3

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IGNITION SYSTEM

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Application March 22, 1943, Serial No. 479,964

1 Claim. (Cl. 175—357)

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This invention relates to ignition mechanism for use in internal combustion engines, and the like.

One of the objects of the invention is the provision of new and improved ignition mechanism that has a maximum of efficiency and that occupies a minimum amount of space.

A further object of the invention is the provision of a new and improved ignition mechanism so constructed as to eliminate corona cutting, thereby adding to the effectiveness of the ignition sparks delivered by the spark plugs for igniting the charges in the engine cylinders.

A further object of the invention is the provision of a new and improved spark plug assembly comprising an electric interrupter, and a transformer detachably mounted on a spark plug and so constructed and arranged as to form a unitary structure therewith.

A still further object of the invention is the provision of a new and improved high tension system of ignition for internal combustion engines that is simple in construction, easily assembled, efficient in operation, and that eliminates the necessity for conducting high tension currents over extended conductors.

Other and further objects and advantages of the invention will appear from the following description taken in connection with the accompanying drawings, in which

Fig. 1 is a wiring diagram illustrating one application of the invention into the spark plugs of an internal combustion engine;

Fig. 2 is a vertical section of a spark plug, shown more or less diagrammatically; and

Fig. 3 is an exploded view of the spark plug showing the same in perspective.

A great amount of trouble has been experienced in the operation of airplane engines, especially those that ascend to extremely high altitudes. It has been found that the insulation for the high tension wires rapidly deteriorates, resulting in misfiring of the charges in the cylinders and not infrequently in stoppage of one or more of the engines. This is due to corona cutting of the insulation. There is often considerable loss of electrical energy from high tension wires, and this loss increases as the pressure of air on the insulation decreases. This loss often manifests itself in a halo or corona about the high tension conductors. The escaping energy ionizes the air, and the continued bombardment of the insulation by these ionized particles in time perforates the insulation and renders it ineffective.

The present invention seeks to eliminate this

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difficulty by the use of what will be termed a low tension ignition system. That is, the low voltage will not be transformed to a higher voltage adjacent the source of the current, as is the present practice, but will be transformed into higher voltages adjacent its point of application which, in an ignition system, will be adjacent to the spark plugs. By means of this arrangement the high tension voltages may be well protected, and the high tension conductors will be of minimum length, thus entirely obviating any danger of corona cutting of the insulation. Furthermore, the transformer is so mounted that it is not affected by atmospheric conditions during its use.

Referring now to the drawing, the reference character 10 indicates diagrammatically the system as applied to an internal combustion engine 11, having a plurality of cylinders 12 each provided with a spark plug assembly 13 extending into the combustion chamber 14 of each cylinder. For illustrative purposes the engine is shown with only four cylinders. It is understood that in the use of airplanes, the more expensive automobiles, and the like, a larger number of cylinders are employed, but since the principle is the same it is not thought necessary to complicate the drawing by disclosing additional cylinders.

As is usual in internal combustion engines of the compression type, each cylinder is provided with a spark plug having a spark gap across which an electric spark is caused to jump for igniting the charge at the proper stage of its compression. A suitable source 15 of electric current, such as a magneto or storage battery, is employed for energizing the system. The source 15 may be grounded, as at 16, on the car or plane, and a lead 17 is adapted to conduct the current to a distributor 18, as is usual in such constructions. The distributor 18 is provided with a conductor arm 19, which is adapted to be rotated to bring the same into successive engagement with the contact members 21, which are insulated from each other and which in turn are electrically connected with corresponding spark plugs 13, as by means of the leads 22.

The current passing from the source 15 will explode the charges intermittently in a predetermined order in the cylinders, in the usual manner. The order of firing is not shown in the drawing, because it is not believed necessary to an understanding of the invention, and in order to avoid confusion of lines the exact order of firing is not indicated.

Suitable means are provided for converting the low tension current from the source 15 into a

high tension one before it reaches the firing spark gap on the lower end of the spark plug assembly 13. In the form of invention selected to illustrate one embodiment thereof, an interrupter 13a and transformer 13b are employed for this purpose, and these are closely associated with the central electrode of the spark plug. The spark plug assembly 13 is preferably, though not necessarily, sectional, and comprises the upper section or interrupter 13a, the intermediate section or transformer 13b, and the lower section or spark plug 13c. This lower section or spark plug comprises a metallic shell or metallic member 23, screw-threaded at its lower end, as at 24, for engaging a corresponding threaded opening in the cylinder head. It is screw-threaded at its upper end, as at 25, for engaging a clamping nut, as will presently appear. This plug is provided with integral hexagonal shoulders or sides 26 for receiving a wrench for attaching the plug to the engine cylinder. The interior of the plug has an axial opening 27 which, in the form shown, tapers toward its lower end. The lower end of the plug is apertured to form a truncated cone 28 for receiving a correspondingly shaped insulating plate or plates 29, as will presently appear.

The plug is provided with a suitable central electrode 31, the lower end of which is provided with an annular shoulder 32 on which an insulating plate 29 is adapted to seat. The electrode 31 is also suitably insulated from the metallic portion or shell 23 of the plug, and its lower end cooperates with a terminal 20 on the shell for forming a spark gap for the plug. As shown, a sleeve of mica 33, or other insulating temperature resisting material, is provided which surrounds the electrode, and surrounding the sleeve 33 is a stack of apertured insulating plates 34 of mica or other insulating and heat resisting elements. Extending across the upper end of the column or stack 34 of insulating plates is an enlarged plate 35 of mica or other suitable insulating heat resisting material, which rests on the upper flat face of the spark plug, as shown more clearly in Fig. 2 of the drawing.

The plug or insulating plate 29 is tapered to correspond with the taper 28 of the lower end of the opening through the plug, and the parts are held firmly in assembled relation by a nut 36 threaded on the upper screw-threaded end of the central electrode 31. In order that the parts may be held firmly in position, a metallic plate 37 is placed beneath the nut 36, and the nut is tightened up for bringing the plug 29 firmly into the conical opening 28, thus forming a gas-tight joint at this point. By tapering the plug 29 upwardly the force of the explosion will tend to tighten the plug and thus maintain a gas-tight joint. The plate 37 extends across the opening 27, and its outer edge overlaps the walls of the plug, thus enabling the nut 36 to be firmly screwed down on the terminal for holding the parts in assembled relation.

In order to reduce corona cutting to a minimum, it is desirable that the means for transforming the low tension current from the source 15 into a high tension current be adjacent to the spark plug, so as to reduce the length of the high tension conductors, and in the form of construction shown means are provided whereby it is mounted on and becomes a unitary structure with the plug 13c. It has been found that a more satisfactory spark is obtained if a vacuum tube be employed in the primary circuit, the vacuum tube having therein a gap-forming means com-

prising two terminals or contacts that are normally together but are adapted for separation in response to current flow therefor to break the primary circuit. The voltage developed in a secondary at the moment an interrupter breaks the circuit in a primary will depend on the promptness of the collapse of the magnetic field at the time of the interruption. This in turn is affected by the suddenness or celerity with which the circuit is opened, that is, the time elapsing during the circuit opening operation and the absence of ionized gas enveloping the gap. The use of a solenoid as a circuit breaker is more prompt and sudden in its operation than is possible with a cam-operated interrupter. Furthermore, since there is no gas, or very little, in a vacuum type of interrupter, ionization is not present, and hence the break in the circuit is instantaneous with a consequent sudden collapse of the magnetic field and a resulting tremendously high voltage spark in the spark plug. By using a vacuum interrupter the transformer may be much smaller in size. In fact it may be small enough, in an ignition system, to be mounted on the spark plug and carried thereby, and yet develop a very high tension at the spark plug gap.

In order to facilitate assembly and removal of the parts, the interrupter 38 is built as a complete unit, and the transformer 39 is constructed also as a separate unit; and the parts are so arranged that they may all be assembled with the spark plug as one unitary construction.

The circuit interrupter comprises essentially a container 41, having a reduced upper portion or neck 42, in the form of a closed container having the air evacuated therefrom. This container may be of glass or other suitable material. In the construction shown a glass bulb, somewhat like a light bulb, is employed within which the interrupter mechanism is mounted and the air, or practically all of it, is exhausted. The air is so rare within the bulb that the space will, for convenience of description, be referred to herein as a vacuum. A circuit breaker is provided within this vacuum container, and this circuit breaker is automatically electromagnetically operated. The switch comprises a pair of terminals 43 and 44. The lower terminal 43 is fixed on a suitable support 45, which also is a conductor, as will presently appear. The upper terminal 44 is carried by a rod 46, the upper end of which constitutes the movable member 47 of a solenoid.

The solenoid 47 is held normally in lowered position by a light compression spring 48, operating between the solenoid and the upper wall of the reduced portion or neck 42 of the container 41. An electromagnet 49 surrounds the neck 42, and, when energized, causes the solenoid 47 to be elevated, thus breaking the circuit between the contact members 43 and 44. The rod 46 is positioned within the container 41 by means of one or more C-shaped spring rod members 51, which are extremely light and resilient.

The solenoid 47, springs 48, 51, and contact member 44 are all very light, so that they have but little inertia. These parts are assembled in the container 41, the air exhausted, and the container sealed. The interrupter may be, and preferably is, assembled in a suitable casing 52 of metal or plastic material, which is adapted to be detachably secured to the transformer 39 by suitable bolts 53 extending through the casing and threaded into suitable internally threaded sockets 54 secured in the upper wall of the housing for the transformer, as will presently appear. A gas-

ket 58 may be inserted between the casing 52 and the top wall of the transformer housing for sealing the casing 52, if desired. The conductor 45 of the lower contact member 43 extends to the exterior of the casing 41, and terminates in a button 40. A conductor 55 is adapted to be connected to the conductor 45 or button 40, as by being welded thereto in any suitable manner.

The casing 52 may be in the form of an inverted cup, as shown in Fig. 1, and this cup, after the interrupter is assembled therein, is adapted to be filled with some suitable insulating material which is plastic at very high temperature only, but will not be seriously affected by the temperatures to which the interrupter is subjected. This material may be of any of the commercial types of heat resisting compositions that is plastic at high temperatures, such as the compositions which have ground mica as a base with a temperature resisting binder, such as the resins of high melting points. The container 52 has an axial opening in its top wall through which a terminal 56 extends. This terminal is insulated from the container wall by a suitable insulation, such as the eyelet 57, which is sealed in position. A binding nut 58 is provided for attaching the outer end of the conductor 22 thereto. One end of the winding for the electromagnet 49 is attached to the terminal post 56, as at 59, and the other end 61 of this winding is connected to the spring member 51 which constitutes a conductor for the circuit of the low tension system.

The transformer unit 39 may be, and preferably is, located between the spark plug 26 and interrupter 38, and is mounted on the spark plug. The transformer comprises a core 62, a primary winding about the core, 63, and a secondary winding 64 which extends about the primary winding. The turns of the transformer are merely indicated, there being many more than here shown. The number of turns are such that the voltage of the sparking current may be that desired, which is usually several thousand volts. The transformer is enclosed in an inverted cup-like container 68, of metal or other material impervious to air, having an axial opening 65 in its upper wall in which an eyelet 66 is secured, and through which the lead 55, connected with one end of the primary winding, extends. This lead is sealed against the passage of air.

The container 68 is preferably of metal and the primary is grounded thereon, as at 67. The lower end of the cup-shaped member or housing 68 is flanged outwardly, as shown at 69, and is adapted to seat on the outer edge of the insulator block 35. A closure plate 69a, having a concave central portion 69b, is welded to the flange 69 to form an air-tight transformer unit. The flange 69 is held firmly against the block by the flange 70 of a flanged nut 71, which engages the threads 25 on the upper end of the spark plug for clamping the parts firmly in position. The housing 68 may be, and preferably is, filled with a suitable insulating material, such as the commercial insulating composition of ground mica and a binder of resin of high melting point, which has high heat resistant properties for holding the windings insulated from each other and from the cup, and will also hold the parts in fixed position within the container.

By means of this arrangement the transformer will not be subjected to differences in air pressure to which the plug may be subjected, as when

it is used on airplanes and the like. It will thus be seen that when the parts are assembled a plug is provided that is not affected by air pressure at any altitude, and that since the transformer is in close proximity to the plug there is no likelihood of stoppage of the engine caused by corona cutting and variation in atmospheric pressure on the various parts. One end of the secondary is grounded on the casing 68, as at 67, and the other end is extended to form a lead 73 which is secured to the central electrode 31 of the plug, as by being welded thereto.

Should the spark plug become disarranged or broken, or fail for any reason, all that is necessary is to release the nut 71, break the connection between the lead 73 and the electrode 31, reconnect the lead with the electrode of the new spark plug, and tighten the nut 71 of the new plug. Likewise, either the interrupter unit 38 or the transformer unit 39 may be replaced, if necessary.

It is thought from the foregoing, taken in connection with the accompanying drawings, that the construction and operation of my device will be apparent to those skilled in the art, and that changes in size, shape, proportion or detail may be made without departing from the spirit and scope of the appended claim.

We claim as our invention:

In a device of the class described, a transformer unit for a spark plug comprising a container, a primary and a secondary coil sealed within said container, said container being filled with an insulating composition for insulating the turns of said coils from one another, means for mounting said transformer unit on said spark plug and an interrupter unit mounted on said transformer unit, said interrupter unit including a vacuum chamber, a conductor extending through said chamber, and electrically operated means within said chamber for opening and closing a circuit through said conductor, said conductor being in circuit with said primary.

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