April 30, 1940. E. WHITE 2,198,850

GLOW PLUG FOR INTERNAL COMBUSTION ENGINES

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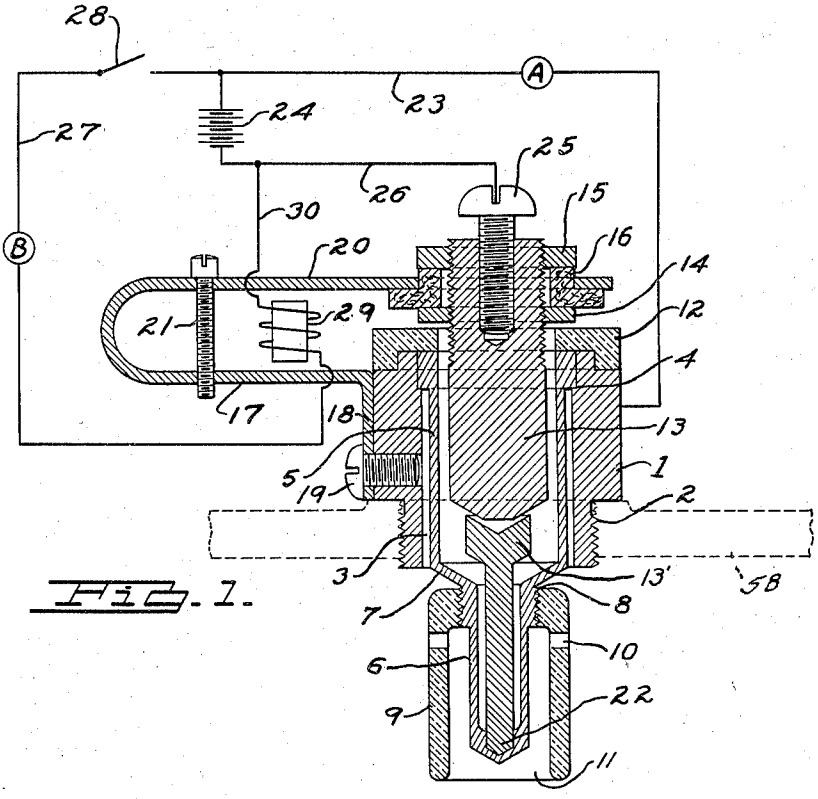
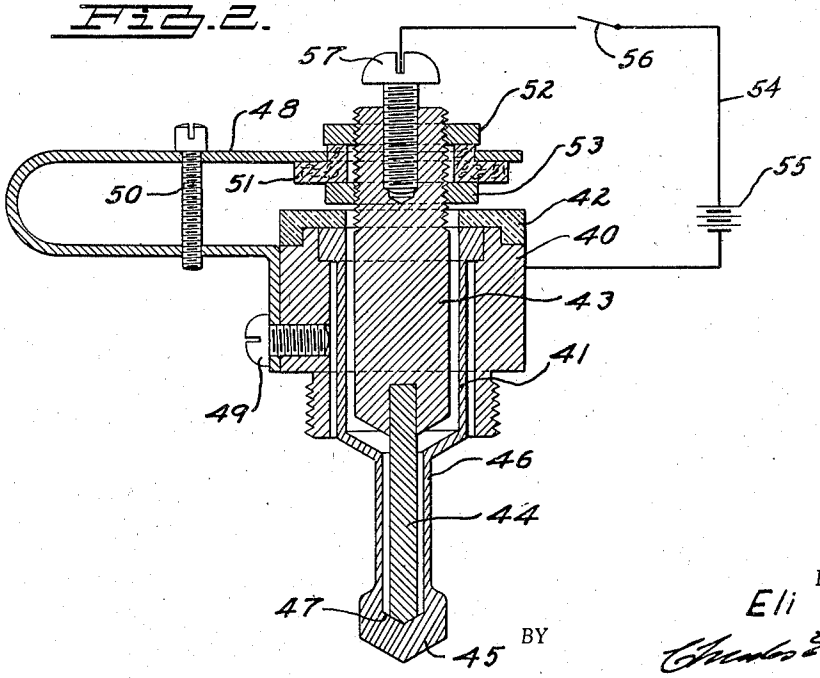


Fig. 1.

Fig. 2.



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GLOW PLUG FOR INTERNAL COMBUSTION ENGINES

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13 Claims. (Cl. 123—145)

This invention relates to glow plugs for use in the ignition of a combustible mixture or for use in ignition of the fuel charges of internal combustion engines particularly of the fuel injection type commonly referred to as Diesel engines.

The object of the invention is to provide a new and improved means for igniting a combustible mixture by a heated element, the initial heat of which is produced by an electric current and including means for automatically breaking the circuit subsequent to an initial heating period.

More specifically an object and feature of the invention is to provide a means for initially heating the plug prior to operation of the engine by a manually closable circuit of a comparatively high amperage so that the plug may be brought to a glowing condition for ignition of the fuel charge in operation of the engine.

In the form of plug shown in my previous application for patent for Glow plugs, Serial No. 234,639, the means for maintaining the conductor in contact with the portion of the plug utilized for ignition purposes when the parts are cold, included an internal spring element and therefore in a position to become ineffective due to deterioration by heat. In the improved structure herein disclosed the spring element is positioned externally of the plug and subject to the cooling effect of atmosphere. Thus the arrangement is of longer life period than is the structure shown in said former application.

A further structural difference involved in the device hereinafter more fully disclosed resides in the fact that the spring maintains the contact elements of the plug in normally slightly spaced relation providing a break in an otherwise closed electric circuit, means (preferably electrical) being provided to close the contact elements to initially heat the plug and to insure its attaining the proper temperature for ignition of the fuel charge and to thereafter break the circuit as the burning fuel charge maintains the glow portion of the plug heated and the circuit broken.

A further object of the invention is to provide a glow plug having a metallic portion subject to expansion and elongation under heat and a cylindrical shield thereabout formed of a material such as an unglazed porcelain or graphite providing a poor conductor of heat but capable of absorbing and storing the heat energy radiated from the metallic plug to thereby develop a higher temperature more particularly on the inner surface of the shield than is developed on the surface of the heated glow plug.

These and other objects and novel features of the invention are hereinafter more fully described and claimed and the preferred form of construction of a glow plug embodying my invention is shown in the accompanying drawing in which—

Fig. 1 is a vertical section showing my improved glow plug and circuit for the initial heating thereof.

Fig. 2 is a vertical section of an alternative form of the device.

In the form of invention shown in Fig. 1 the glow plug comprises a metallic body 1 the exterior surface of which may have a hexagonal form in cross section adapting it for use by a wrench to screw the threaded end 2 into the threaded aperture at the head of the engine cylinder indicated by dotted lines 58 or other apparatus, not here shown. This body 1 has a hollow interior 3 formed with a shoulder 4 at the upper end thereof to receive the shank or base 5 externally of the glow plug which is shouldered to seat on the shoulder 4. This base 5 and the internal recess is preferably cylindrical in form and the lower end 6 of the plug is of less diameter than the base portion 5 and is connected therewith by a tapered cone like wall 7. At the junction of the portions 6 and 7, the tube is threaded at 8 and a porcelain or like cylindrical shield 9 is threaded thereonto. The body of the shield is spaced from the portion 6 of the glow plug and is provided with apertures 10 adjacent the threaded end thereof permitting free flow of gases in the combustion chamber of the engine into the shield and about the plug end 6, the shield being open at the lower end 11. During the combustion of gases in the cylinder, the portion 6 of the tube is maintained at ignition temperature and the shield 9 being a poor conductor of heat, such as unglazed porcelain or graphite, becomes highly heated by the radiant energy from the glow plug. By such means, when the glow plug is heated to practically incandescence, radiant energy is transferred outwardly from the plug and heats the shield. Subsequent to the heating of the glow plug by the electric current and starting the operation of the engine the heated gases in combustion maintain the shield and plug practically incandescent.

The body 1 is of metallic character and has a centrally apertured cap 12 formed of an insulating material. The upper end of the conductor 13 is threaded and a nut 14 is threaded thereon and a second nut 15 is also threaded thereon and between the two there is a shouldered spacing ring 16 preferably of insulating material. A U shaped spring 17 has an out-turned base portion 18 for attachment to the body 1 as by a screw 19 and the

other arm 20 of the spring is apertured to engage over the reduced diameter portion of the shouldered spacing ring 16. A screw 21 is inserted through an aperture in the arm 20 and is threaded in the arm 17 of the spring and, by turning the screw in or out of the threaded aperture, the spacing between the contact elements 13 and 13' may be varied. The contact element 13' has its lower end 22 fixed in the terminal end 6 of the glow tube. Due to the glow tube 6 being formed of metallic alloy, as for instance a chromium alloy, it will become highly heated due to its resistance to flow of electric current through the conductors 13 and 13' when in contact, as will be hereinafter described. The spring 20 normally spaces the nut 14 from the insulating member 12 and this likewise, to a less degree, spaces the conductor elements 13 and 13' under which condition no current may pass therethrough the glow tube.

To initially heat the glow tube I provide a two-part electric circuit one part being indicated at A consisting of the wire 23 leading from a source of current supply 24 and connected with the metallic body 1 within which the upper end of the glow tube is in electrical contact and thus current passes through the glow tube, the conductor elements 13' and 13 and through the fastening screw 25 and thence through line 26 to the battery, it being understood that the circuit is normally open by reason of the spacing of the elements 13 and 13'.

The second circuit indicated at B consists of the wire 27 connected to the battery 24 when the switch 28 is closed and this wire 27 leads to an electro-magnet 29 and thence by a line 30 and line 26 to the opposite side of the battery. Thus by closing the switch 28 the electro-magnet tends to draw the arm 20 of the spring toward the magnet and placing the members 13 and 13' in contact and closing the circuit A thereby heating the tube 6. As this tube elongates longitudinally due to heating the spring arm 20 will continue to move toward the magnet until the nut 14 engages the upper surface of the insulating cap 12 for the casing 1. This arrangement is provided to prevent the breaking of the circuit prior to the tube 6 attaining incandescence and by adjustment of the nuts 14 and 15 the gap between the member 14 and the cap 12 may be varied to provide for a greater or less period of time of electrical contact between the two parts 13 and 13'.

By holding the switch 28 closed, current will pass through the conductors and the tube portions 5 and 6 but, as the tube ends 6 become sufficiently elongated by heating, the circuit through the conductor elements 13 and 13' will be automatically broken and the tube 6 maintained in practically incandescent condition by the heat developed by the combustion of gases.

The apparatus will function efficiently without the shield 9 but by use of the shield 9, of a refractory material and a poor conductor of heat, it becomes highly heated and the efficiency of the glow plug is increased somewhat due to the greater surface area thereof in contact with the gases and due to the higher temperature thereof and to the fact that gases may pass into the interior of the shield as well as to contact with the exterior thereof. It is for this latter purpose that the apertures 10 are provided which permit flow of gases therethrough during the compression stroke of the engine and thus the chamber between the glow plug 6 and inner wall of the member 9 does not become filled with burned gases.

While I have described the parts 13 and 13' being normally slightly spaced apart, as shown, the apparatus will function if these two parts of the conductor are normally in contact and thus the adjusting screw 21 may be set to normally hold these members 13 and 13' in contact or in a spaced relation.

In either case the spacing between the nut 14 and cap 12 should be sufficient to permit the arm 20 to move downwardly under influence of the magnet 29 during the initial heating of the glow tube and the part 14 contacting the cap 12 limiting the inward movement of the member 13 and thus providing that further expansion of the tube 6 will cause separation of the member 13' from the companion element 13.

While I have described the use of an electro-magnet and circuit therefor as a means of moving the arm 20 to force the contact element 13 downwardly in the position of the parts here shown to contact with the conductor element 13' other means for such purpose may be utilized without departing from the spirit and scope of this invention as defined by the appended claims. The electric circuit for the initial heating of the glow plug is an essential characteristic and considered the most desirable means for the initial heating of the plug.

In the form of the invention shown in Fig. 2 the body 40 is practically identical in form to the body 1 of Fig. 1 and the upper end of the glow tube 41 is shouldered to seat in the upper end of the body 40 which has a cap 42 of insulating material. Within this body is a conductor formed of two parts 43 and 44 secured together or made of an integral piece with the end portion 44 of less diameter than the portion 43. The inner end of the blow tube is enlarged as indicated at 45 to provide a relatively large mass of metal connected with the main body of the tube by the thin walled, small diameter portion 46.

The mass of metal 45 has a cone shaped recess 47 and a contact element 44 has a similar formed end portion normally seating in the coned recess. To maintain the conductor with the end of the portion 44 in contact with the enlarged end 45 of the glow tube, under normal condition, I provide a U spring 48 having one leg attached to the body portion by the screw 49 and the two arms of the spring are held in adjusted position by the screw 50 which passes through an aperture in the upper arm of the spring and into a threaded aperture in the lower arm of the spring. The upper arm of the spring engages a shouldered element 51 positioned between the two adjusting nuts 52 and 53 threaded on the upper threaded end of the conductor body 43. The spring is tensioned to normally provide pressure between the end 44 of the conductor and the surface 47 of the glow tube 46 and with the nut 53 normally spaced from the cap 42 and the spacing may be varied by threading the nuts 52 and 53 inwardly or outwardly on the conductor body 43. There is an electric circuit 54 having a source of current supply, as a battery 55, and a switch element 56 therein utilized to make or break the circuit. Said circuit has one end connected with the body 40 and the other end connected with a screw 57 at the end of the conductor body. By closing the switch 56 current passes from the battery to the body 40 into the glow tube and thence through the conductors 44 and 43 back to the battery.

The glow tube, particularly the portion 46, is formed of chromium alloy or other electrically resistant element whereby it becomes heated and tends to elongate. Due to the spring 48 being tensioned to maintain the parts 44 and 45 in electric contact, said contact will be maintained for the period required for the nut 53 to move to contact with the face of the insulator member 42. Continued heating of the tube 46 and consequent further elongation thereof will move the coned face 47 of the end 45 of the tube out of contact with the conductor element 44. Thus, on the assumption that the switch 56 remains closed (which is the normal condition in initially heating the glow tube) the circuit will be broken by separation of the elements 44 and 45 and the tube will be maintained in heated condition due to the heat of the gases in combustion and continue to automatically ignite the fuel charges when in contact therewith, whether the glow tube be used in an internal combustion engine or other apparatus supplied with combustible fuel at intervals.

By use of the mass of metal 45 at the end of the glow tube 46 and breaking the circuit at the end of the glow tube rather than within the body of the apparatus, as shown in Fig. 1, less heat is developed within the body of the plug. The apparatus of Fig. 2 further differs from that shown in Fig. 1 in that in Fig. 1 the spring is electrically actuated to move the part 13 downwardly to produce initial contact with the conductor element 13'.

But in either case, on the initial heating of the plug by means of an electric circuit, the circuit is maintained closed for a predetermined period limited by the spacing of the nuts 14 or 53 relative to the cap 12 or 42 in the respective forms. Both structures function alike in the initial heating of the plug in which the respective conductors are formed of metal of low electrical resistance and the glow tube is a metal of high electrical resistance elongating under influence of temperature and thus functions to break an established electrical circuit through the conductor after a predetermined period of heating.

From the foregoing description it is believed evident that the various features and objects of the invention are attained by the construction described and that the parts may be varied in structure and form without departing from the spirit of the invention as set forth in the appended claims.

Having thus fully described my invention, its utility and mode of operation, what I claim and desire to secure by Letters Patent of the United States is—

1. In a glow plug for ignition of a combustible mixture, a tube formed of a metal of high electrical resistance, a conductor centrally disposed within the tube having an end fixed to the end of the tube, a second conductor in longitudinal alignment with the first conductor, a spring normally supporting the second conductor with an end in spaced relation with the end of the first conductor opposite the fixed end, an electrical circuit, the said conductors and tube forming a part of the circuit, and means for moving the second conductor to contact with the first conductor to close the circuit through the said conductors and tube.

2. In a glow plug for ignition of a combustible mixture, an element formed of a metal having a high electrical resistance, a hollow body, said electrically resistant element projecting from the body to expose the surface thereof to the combustible mixture, a two-part conductor within the body, the parts being in longitudinal alignment and one of the conductor parts having an end secured to the high resistant element whereby, through the elongation of the elements due to heat, the said conductor part attached thereto is moved relative to the other conductor part, means for adjusting the said other conductor element relative to the first to longitudinally space the same therefrom, an electric circuit including the said conductors and electrically resistant element, means under manual control for moving the second conductor to contact with the first conductor to close the circuit through the said conductors and element of high electrical resistance, and means limiting the extent of movement of the second conductor part by said manually controlled means.

3. In a glow plug for ignition of a combustible mixture in the combustion chamber of an internal combustion engine, a casing having a threaded end portion for assembly in an engine cylinder, having a threaded aperture therefor, a tubular electrically resistant element having one end secured to the casing, and the opposite end projecting into the end of the cylinder for contact with the combustible mixture therein, a two-part conductor, one of the said parts projecting from the casing and movable longitudinally within the tube, the other of said parts having an inner end attached to the inner end of the tubular element and the opposite end in normally spaced relation with the inner end of the first conductor part, a spring externally of the casing, and means for adjusting the spring to hold the said conductor parts in normally spaced relation, an electric circuit including the said normally spaced conductor parts, and means for moving the spring and the conductor parts attached thereto to bring the said two conductor parts in contact to close the electric circuit, and means limiting the movement of the first conductor part whereby as the electrical resistance element is elongated under heat it is moved from contact with the said movable conductor element to automatically break the circuit.

4. In a glow plug for ignition of a combustible mixture in the combustion chamber of an internal combustion engine having a threaded aperture open to the chamber, a hollow body having a threaded open end for threading in the said aperture, a hollow electrically resistant element having an open end secured within the said body and a small diameter closed end projecting therefrom, a pair of electrically conductive elements, the first of the said elements projecting through the open end of the body casing, and the other being longitudinally aligned therewith with an end thereof in normally spaced relation with the contiguous end of the first element, the inner end of the second element being secured to the projecting end of the tube, means yieldably supporting the conductor parts in spaced relation, an electric circuit including the said tube and conductor parts normally open by reason of the spacing of the conductor parts, and means under manual control for moving the said movable conductor part to close the circuit through the tube and the conductor parts, and means for adjusting the extent of movement of the movable conductor element whereby as the tubular element of electrical resistant metal elongates under heat the said conductor element attached

to the tube is moved from contact with the other conductor element and breaks the circuit.

5. In a glow plug for igniting a combustible mixture, a metal body, a tube carried thereby formed of a metal of high electrical resistance and closed at the end in contact with the combustible mixture, a centrally disposed electrical conductor within the tube and contacting the same only at the closed end, a second conductor providing a contact member, a spring adjustable to normally provide an air gap between the conductor element and the contact member, an electric circuit normally closed except for the said air gap, and an auxiliary circuit including an electro-magnet functioning when the circuit is closed to move the conductor to close the air gap to thereby establish an electric circuit through the tube, contact member and conductor to thereby heat the tube and consequently expand the same longitudinally, and means limiting the movement of the contact member by the spring to less than the length of the air gap produced by elongation of the tube under influence of the heat of combustion.

6. In a glow plug for igniting a combustible mixture, a metal body, a tube carried thereby formed of a metal of high electrical resistance and closed at the end in contact with the combustible mixture, a centrally disposed electrical conductor within the tube and contacting the same only at the closed end, a second conductor providing a contact member, a spring adjustable to normally provide an air gap between the conductor element and the contact member, said spring being mounted on the body externally thereof, an electric circuit normally closed except for the said air gap, and an auxiliary circuit including an electro-magnet functioning when the circuit is closed to move the conductor to close the air gap to thereby establish an electric circuit through the tube, contact member and conductor to thereby heat the tube and consequently expand the same longitudinally, and means limiting movement of the contact member by the spring to less than the length of the air gap produced by elongation of the tube under influence of the heat of combustion.

7. In a glow plug for igniting a combustible mixture, a metal body, a tube carried thereby formed of a metal of high electrical resistance and closed at the end in contact with the combustible mixture, a centrally disposed electrical conductor within the tube and contacting the same only at the closed end, a second conductor providing a contact member, a spring of U form having one end attached to the body and the other end engaging the second conductor, means for adjusting the last named end of the spring to normally provide an air gap between the conductor element and the contact member, an electric circuit normally closed except for the said air gap, and an auxiliary circuit including an electro-magnet functioning when the auxiliary circuit is closed to move the conductor to close the air gap to thereby establish an electric circuit through the tube, contact member and conductor to thereby heat the tube and consequently expand the same longitudinally, and means limiting the movement of the contact member by the spring to less than the length of the air gap produced by elongation of the tube under influence of the heat of combustion.

8. In a glow plug for igniting a combustible mixture, a body, an electric circuit, an electrical conductor carried by the body and forming part of the electric circuit, said conductor being formed of two parts, one of low electrical resistance and the other of high electrical resistance, said conductor parts being normally spaced, means under manual control for moving the low resistance part to contact with the other to close the circuit to thereby heat the part of high electrical resistance and cause an elongation thereof, means limiting the movement of said low resistance part to a distance less than movement of the said high resistance part by elongation whereby said conductor parts are separated and the circuit automatically broken.

9. In a glow plug for the ignition of a combustible mixture, a hollow body, an electrical conductor carried by the body formed of two separable parts one of low electrical resistance movable relative to the other, and the other being of a high electrical resistance, said parts being in a normally spaced relation, an electric circuit including the said conductor parts, a second electric circuit including an electro-magnet functioning when the second circuit is closed to move the said movable part of the conductor to contact with the high resistance part to thereby close the first circuit through the conductor parts and cause an expansion of the high resistance element by current flow therethrough, means adjustable to limit the extent of movement of the lower resistance part whereby as the high resistance part elongates by expansion under heat the first said circuit is automatically broken.

10. A device for the ignition of a combustible mixture in an internal combustion engine having a combustion chamber, comprising a hollow body having a threaded end engaging in a threaded aperture provided in the wall of the combustion chamber of the engine, a glow plug carried by the body and projecting therefrom into the combustion chamber for contact with the combustible gases intermittently supplied thereto, a hollow shield of refractory material of low heat conduction supported at one end on the body of the glow plug and in which the glow plug is centrally disposed, the opposite end of the shield being open and the wall thereof adjacent the attached end having apertures providing for flow of combustible gases through the shield and about the plug, the plug being a metal of high electrical resistance and forming part of the electric circuit, means whereby the expansion of the plug breaks the electric circuit, the continued heating of the plug by burning of the combustible mixture maintaining the same in expanded condition.

11. A device for the ignition of a combustible mixture in an internal combustion engine, comprising a body, a glow plug extending therefrom at one end, said body being a metal of low electrical resistance and the plug being of a metal of a high electrical resistance, a shield having one end thereof secured to the plug at a distance from the end of the plug, and the opposite end of the shield being open, said shield having apertures adjacent its attached end providing for comparatively free flow of gases through the shield and about the plug, an electric circuit part of which is formed by the said body and plug whereby the plug may be initially heated and expanded by electric current passing therethrough and the shield heated by conduction and radiation, and means whereby the expansion of the plug breaks the electric circuit and continued heating thereof by the combustible mixture maintains the plug in expanded condition.

12. In an ignition device for internal combustion engines, an element of high electrical resistance projecting into the combustion chamber of the engine and adapted to be heated by the gases in combustion therein, an electric circuit for an initial heating element, a hollow shield of a refractory material having one end attached to the said element, the opposite open end of the shield being adjacent the end of the element, said shield being of a character to become highly heated by the heating of the plug and combustion of gases in contact therewith, an electric circuit for initially heating the element, and means actuated by the heating and consequent expansion of the element to break the electrical circuit, the said shield and element being maintained at high temperature by the gases in combustion.

13. A device for ignition of a combustible mixture comprising a hollow body, a glow plug carried thereby and projecting therefrom into the combustible mixture, a hollow shield of a refractory material of low heat conduction into which the plug extends, the glow end of the plug being spaced from the inner surface of the shield, and an electric circuit for initially heating the plug to ignite the combustible mixture, the plug being of a metal of a high electrical resistance and forming part of the electric circuit, and means whereby the expansion of the plug breaks the electric circuit and the continued heating thereof by the burning of the combustible mixture maintaining the same in expanded condition.

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