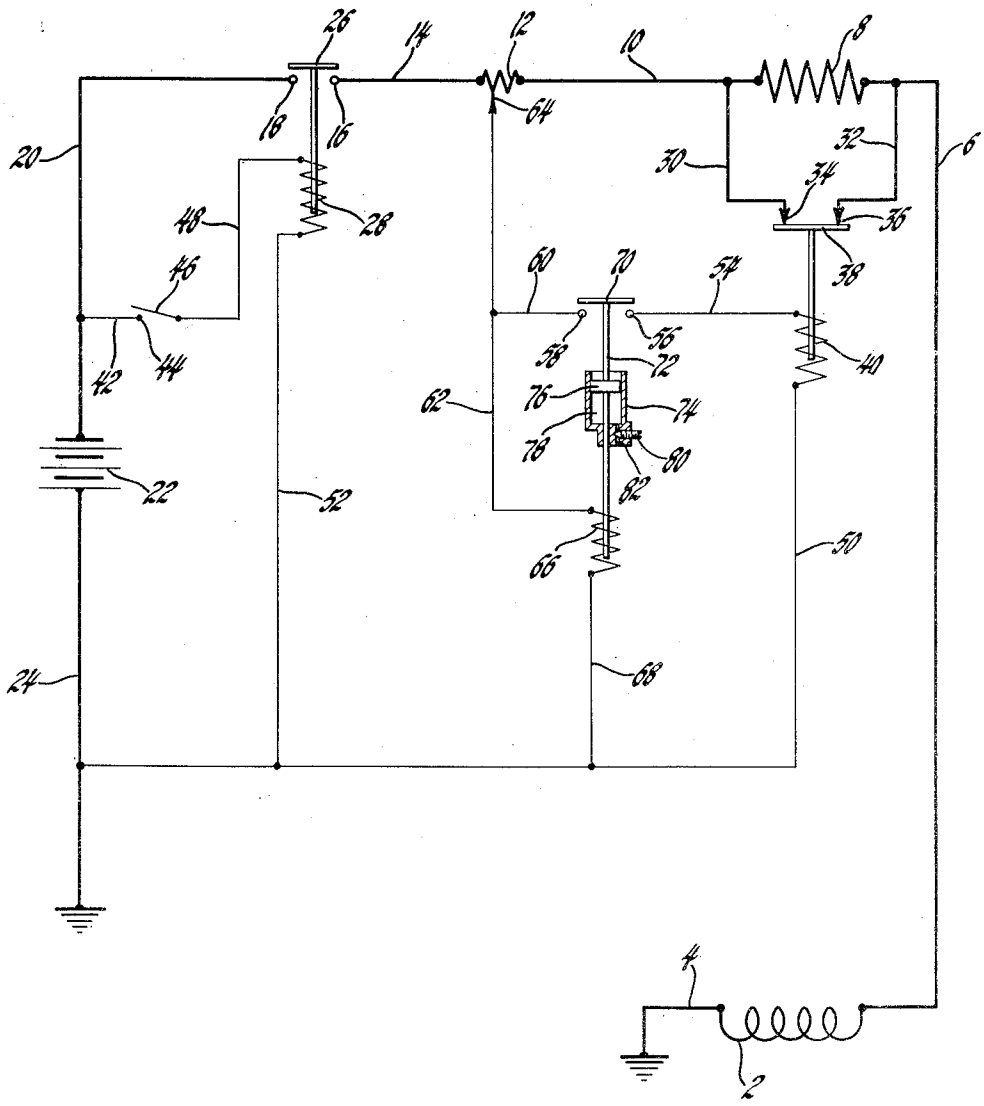
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GLOW PLUG IGNITION SYSTEM

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GLOW PLUG IGNITION SYSTEM

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This application relates to igniting means for internal combustion engines and more particularly to igniting means of the glow or hot-spot type. The majority of means used to ignite internal combustion engines are the so-called spark plugs in which voltage is applied across an open gap of sufficient strength to break down the dielectric and arc across, said open arc thereby igniting the combustible combination in the cylinder. This type of system is provided with timed electrical impulses to the spark plugs so that they will fire at a predetermined instant in the cycle of the piston to apply maximum power from the explosion of the fuel. However, of growing importance has been a second group of igniting means for combustible fuel in any internal combustion engine in which a means which is constantly glowing or incandescent is provided therein which is capable of igniting the fuel after it has been introduced.

The glow plugs up to the present time have been connected in two general types of control systems; first, one in which a relatively high voltage is applied across the glow plug to bring it quickly to a fairly high incandescent state to ignite the fuel to start the engine, but which, following the starting of said engine, has the voltage supply removed therefrom by opening the circuit, the incandescent portion of the glow plug thereafter being maintained in a glowing condition by the heat generated in the cylinder from the explosion of the gas, and this is sufficient to maintain the engine in operation. The second type of control system has also been used with a glow plug in which a lower initial voltage is applied to the plug which brings the incandescent portion up to its operating temperature more slowly, but which supply of voltage is allowed to continue after the engine has once started so that the glow plug is maintained in incandescent condition, both by voltage supplied thereto and by heat generated within the cylinder.

These two systems have the following objectionable characteristics. If the first system is used, in which the voltage is high in order to obtain an initial incandescent heat, then the voltage must be removed before any prolonged operation, or the heat supplied by the voltage plus that supplied by combustion in the engine would cause the plug to burn out. In idling an engine supplied with this system, the amount of heat supplied to the glow plug from combustion may be reduced to such a point that the incandescent element cools below a temperature which is capable of igniting the gas and the engine will

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stop. On the other hand, if the engine is supplied with a control system of the second type, in which both the voltage and the combustion temperature are continuously supplied to the plug, if this engine is operated at very high output, the temperature from combustion added to the temperature due to supply voltage may cause the plug to burn out, and the engine to stop. Therefore, both systems are open to objections at opposite ends of their operating scales.

It is, therefore, an object of our invention to provide a control system for a glow plug which is capable of supplying different amounts of electrical energy to the plug at different times in the cycle of operation thereof.

It is a further object of our invention to provide a control system for a glow plug for preventing the application of too great voltages under certain conditions of operation, such as rapidly restarting the engine after continued operation.

It is a still further object of our invention to provide a control system for glow plugs in which varying amounts of voltage are applied, dependent upon the conditions of operation of said engine.

With these and other objects in view which will become apparent as the specification proceeds, our invention will be best understood by reference to the following specification and claims and the illustration in the accompanying drawing, in which the figure represents a circuit diagram of a control system for a glow plug embodying our invention.

Referring now more specifically to said figure, there is shown therein at 2 an incandescent portion or coil of a glow plug, one end of which is connected through conductor 4 to ground, such as the combustion chamber housing of an engine when the plug is applied thereto, the opposite end of said glow plug being connected through conductor 6 to one terminal of a resistance 8. A conductor 10 interconnects the opposite terminal of resistor 8 with one side of a smaller resistance 12, the opposite side of which is connected through conductor 14 to a stationary switch contact 16. A second spaced stationary contact 18 is connected through line 20 with the positive side of a battery 22 which may be of the storage type, the negative pole of which is connected through line 24 with ground. A conductive bridging switch element 26 is adapted to be moved to close the circuit between stationary contacts 16 and 18 and is operated by a relay coil 28.

A shunt circuit around resistor 8 is provided

by two conductors 30 and 32, which terminate in stationary contacts 34 and 36 respectively, and are respectively connected to conductors 10 and 6. Stationary contacts 34 and 36 are bridged by a conductive movable armature 38 which is in turn moved into and out of engagement therewith by relay coil 40. Conductors 24, 20, 14, 10 and 6, as well as shunt conductors 30 and 32 are relatively heavy and are adapted to conduct full current from the battery 22 to the glow plug element 2. A lighter control conductor 42 is connected between conductor 20 and stationary contact 44 of a manually operated switch, the movable contact 46 of which is connected through line 48 to one terminal of the relay coil 28. A further light conductor 50 extends from line 24 to one terminal of relay coil 40. Interconnecting line 52 connects the opposite terminal of relay coil 28 with conductor 50.

A control conductor 54 connects the opposite terminal of relay 40 with a stationary switch contact 56. A second spaced stationary contact 58 is connected by control line 60 with a second control line 62 extending between a variable tap 64 on resistance 12 and one terminal of the control relay coil 66, the opposite terminal of which is connected through control line 68 with line 50. A movable conductive contact 70 is adapted to bridge the stationary contacts 58—56 and is moved into position by relay coil 66. Mounted on shaft 72, which supports conductive contact 70, is a time delay dash pot 74 having a plunger 76 secured to the shaft 72, which operates within the dash pot to cause a delaying action in the closure of said switch 58—56 when current is applied to relay coil 66, as it is necessary to force the fluid within the cavity 78 up around the plunger or leak out the exhaust port before the same can be moved downwardly. The amount of fluid pressure under the piston 76 can be varied by adjusting set screw 80 which controls fluid flow through a small exhaust port 82, which allows fluid to escape from chamber 78, and thus varies the resistive effect of the fluid in preventing switch 58—56 from closing for a certain predetermined period.

The switches are all shown in their normal inoperative position and in the operation of the device manual switch 44—46 is first closed. This places relay coil 28 directly across the battery source 22 and it, therefore, is energized to attract its armature and close the conductive member 26 across contacts 16—18. This completes a circuit through the glow plug coil as follows: from battery 22, through conductor 20, switch 16—26—16, conductor 14, resistor 12, conductor 10, shunt circuit through conductor 30, contact 34, armature 38, contact 36, conductor 32, conductor 6, glow plug coil 2, conductor 4, to ground, through the ground to conductor 24 and back to the battery 22. This places the glow plug 2 directly in series with the battery 22 and the small resistance 12, thus applying a relatively high voltage to the coil and a rapid ascent to high incandescence will result.

At the same time a variable amount of voltage will be applied to relay coil 66 depending upon the position of the movable tap 64 on resistance 12. This energization of 66 will cause that coil to attempt to draw its armature downwardly to close switch 56—70—58. The motion, however, will be resisted by the dash pot 74 and the value of this mechanical damping can be varied by the position of screw 80. After a certain time delay period which is dependent both upon the position of screw 80 and the position of variable tap 64 on resistance 12, switch 56—70—58 will close, which now completes an obvious energizing circuit through relay coil 40 to energize the same, which energization will cause it to attract its armature and it will move downward, opening switch 34—36, breaking the shunt circuit around resistance 8, and inserting that resistance in series with the glow plug coil 2, thus reducing the voltage across the glow plug and, therefore, reducing the incandescence thereof. The value of the resistance 8 is so selected that with this resistance in series, the glow plug will have a sufficient voltage still applied to retain normal operation of the engine, but its insertion will remove the high voltage which is necessary to provide a quick start and thus avoid burning out the plug.

When the plug or the engine is cold, the coil 2 has a relatively low resistance and will, therefore, draw a heavy current through that part of the circuit first identified, which is shown in heavier lines. This current flows through only one other element besides the conductors and that is the resistor 12 which causes a voltage drop across said resistor and thus provides a less-than-normal voltage in the circuit of the relay coil 66. This relay, which is very sensitive to the voltage supply, does not operate as fast, due to this reduced voltage and, therefore, permits feeding of the approximately full 24 volts to the glow plug for some little time. If, however, the glow plug were hot or the engine had been operated for some time and had been turned off and then turned on again after a short interval, the resistance of the plug element would be much higher, in some instances nearly double, and if the full 24 volts were now to be reapplied, the element could not stand this full voltage for as long a time and might overheat and burn out. However, due to the higher resistance of the plug, it will draw a smaller amount of current and if the resistance is twice what it was when cold, would, therefore, draw only about half as much current, which causes a smaller voltage drop across resistor 12, which allows a higher voltage from the stable source to be applied to the relay coil 66.

It is obvious that this will cause relay coil 66 to operate in a much shorter time and, therefore, will cause operation of relay 40 more quickly and the removal of the shunt circuit around resistor 8, to cause its insertion in series with the glow plug 2, which will now be inserted in approximately half the time which was originally required, and prevent the glow plug 2 from burning out. This, therefore, provides a safety feature in that if the glow plug has not entirely cooled, the time of operation of the time delay relay 66 will vary proportionally, due to the residual heat remaining in the glow plug, and will operate in such proportional time, dependent upon said heat, to again be able to apply the same incandescence to the glow plug 2 as it would receive in the first instance, but not permit it to remain on any longer than necessary.

We have thus provided in the above a control circuit for a glow plug which provides a very quick and short intense heating period to start the engine, but which then maintains a lower voltage so that the plug will not burn out, but will provide current thereto for normal operation, and which has the added safety factor that it applies intense starting voltage to the glow plug for a varying period, dependent upon the

temperature condition of the plug when the switch is turned on.

We claim:

1. In an ignition system, an igniting plug including a conductive coil capable of incandescence, a source of power, conductive means connecting said source with said conductive coil, resistance means in said conductive connection, a shunt circuit around said resistance means, a switch in said shunt circuit to open and close the same, relay means connected to said source for operating said switch means, and time delay means connected between said relay and said source to control the operating periods of said relay so that the resistance may be inserted in series with the conductive coil and the source of power during a portion of the operation of the system and be shunted out during other conditions of operation, said time delay means being variable as a function of a condition in said coil.

2. In an ignition system, a glow plug having a coil capable of incandescence, a source of direct current, resistance means connected between said source and said glow plug, a shunt circuit around said resistance, switching means in said shunt circuit, relay means to actuate the switching means, a time delay relay connected to the source and to the first-named relay to control the periods of operation of said first-named relay and determine the operative periods during which the resistance is in series with the glow plug and those during which it is shunted out, and means for varying the operation of said time delay relay automatically as a function of a condition in said coil.

3. In an ignition system, a glow plug, a source of direct current, a plurality of resistor means serially connected between said source and said plug, a shunt circuit around one of the resistor means, a switch in said shunt circuit, relay means for operating said switch, a variable tap on another of said resistor means, and time delay relay means connected to the tap and to the first-named relay means for controlling the operation of the first-named relay means to control the shunting of the first-named resistor means.

4. In an ignition system, a glow plug having an incandescent element therein whose electrical resistance changes with temperature, a source of power, a first adjustably tapped resistor, a second resistor, means for connecting said incandescent element, source of power and resistors all in series relation, a shunt circuit around said second resistor, relay switching means in said shunt circuit, and time delay relay switching means connected to control the first-named relay switching means and itself connected to the adjustable tap on the first resistor so that the operating voltage applied to the time delay relay will vary with the change in resistance of the incandescent element in series with the tapped resistor.

5. In an ignition system, a glow plug having a coil, a source of power, circuit means interconnecting said source and said coil including resistance means to adjust the current flowing, means for varying the amount of resistance effective in said circuit, and time delay means connected to and controlling said resistance varying means, said time delay means automatically varying in time of operation dependent upon the temperature of the coil.

6. In an ignition system, a glow plug having a heating coil, a source of power, a plurality of resistors, circuit means connecting the resistors in series with the source of power and the heating coil, a shunt circuit for a first one of the resistors, first switch means in said shunt circuit, and time delay relay switching means for controlling said first switch means, said relay switching means being connected across a portion of another of said resistors to control the insertion or removal of said first resistor in the main circuit means.

7. In an ignition system, a glow plug having a heating coil with a positive temperature-resistance coefficient, a source of power, a first variable tapped resistor, a second resistor, circuit means interconnecting said resistors in series relation with the source of power and coil, a shunt circuit around the second resistor, relay switching means in said shunt circuit, time delay relay switching means connected to the variable tap on the first resistor and to the first mentioned relay means to control the latter and actuated by the voltage across a portion of the first resistor so that the speed of actuation of the time delay relay is a function of the temperature and therefore the resistance of the heating coil.

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