Nov. 26, 1940. C. S. NADLER ET AL 2,223,151

IGNITION SYSTEM FOR INTERNAL COMBUSTION ENGINES

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Fig. 1.

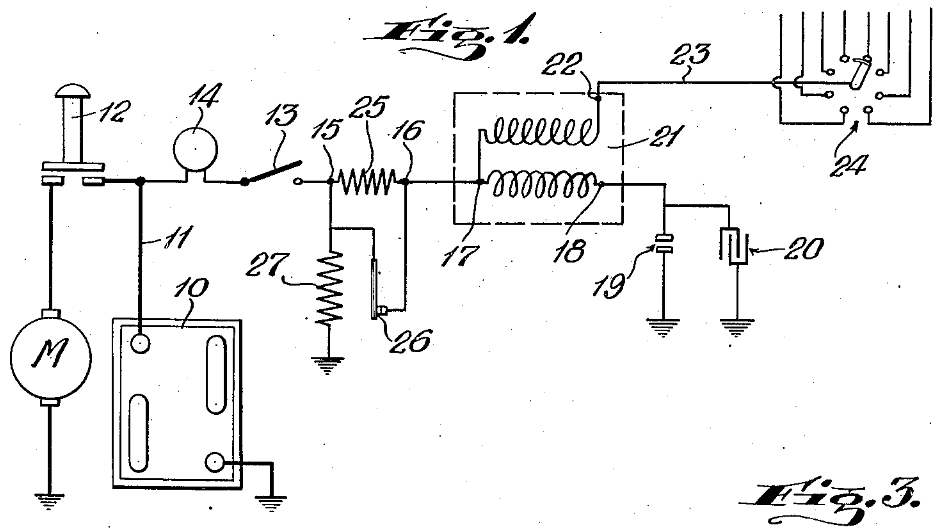


Fig. 2.

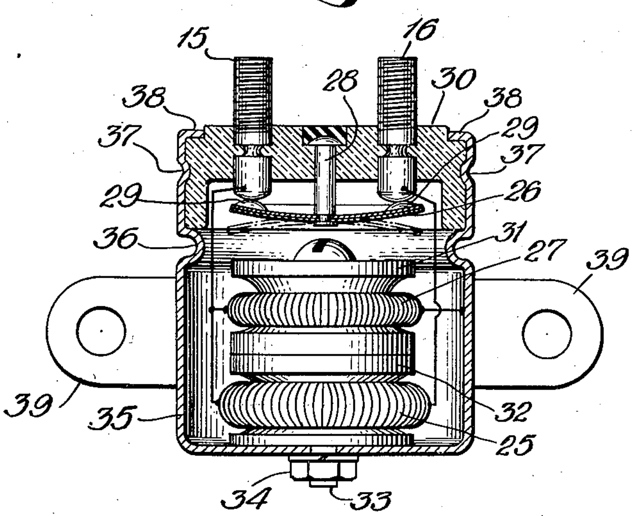
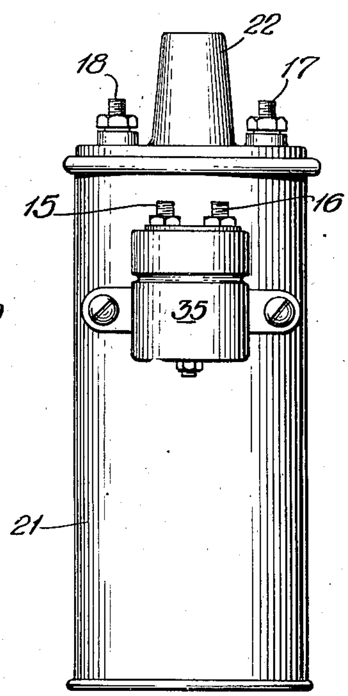


Fig. 3.



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IGNITION SYSTEM FOR INTERNAL COMBUSTION ENGINES

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5 Claims. (Cl. 123—148)

This invention relates to a novel ignition system for internal combustion engines, and the object and purpose of this invention is to provide means for delivering to the engine during the starting operation a spark which is hotter and stronger than the normal running spark, including automatic control means whereby a spark of the intensity of the normal running spark is reestablished a short time after the engine has started and is maintained during the period of engine operation. A further object is to provide a hotter and stronger spark without the use of auxiliary relays, batteries or cells, and by use of a device which is compact, satisfactory for its intended purpose, and inexpensive to manufacture.

At the time of starting an internal combustion engine, in the wiring arrangements now in common use, the closing of the starting switch causes a heavy drain on the batteries and consequently a considerable drop in voltage across the battery terminals. This condition continues as long as the starting switch is closed. As a result, during this period, the voltage applied to the ignition system is correspondingly reduced and in consequence the flow of current in the primary winding of the coil is of less intensity and the current induced in the secondary winding of the coil produces a weaker and thinner spark within the cylinder. As is well known, the starting phase is the time at which the strongest spark is required in the cylinder, because of the necessity of igniting raw, cold, and overriched gasoline mixture.

This invention is particularly directed to affording means for maintaining an increased current through the primary winding of the coil at the moment of starting and for such period of time thereafter as to allow for delay in firing and for the length of time which sometimes elapses, particularly when engines are cold, during which they must be cranked by the starter before combustion occurs. Furthermore, according to this invention, the length of time during which the spark of increased intensity is maintained can be established by the design and size and relationship of the parts, so as to permit establishment of any desired length of time within certain outside limits. Further, the invention affords means responsive to the temperature of the surrounding air, whereby the length of this period of intensified spark may be prolonged when the temperature of the surrounding air is low and shortened when the temperature of the surrounding air is high. By this means current intensification is afforded over a longer starting period when the weather is cold, and over a shorter starting period when the weather is warm, the latter saving unnecessary wear and tear on the points and condenser due to the intensified current.

Referring to the drawing which forms a part of this specification:

Fig. 1 shows diagrammatically the standard wiring circuit of the electrical system of a modern automobile, with the invention which is the subject of this application incorporated therein.

Fig. 2 is a vertical section of a device embodying certain elements of this invention.

Fig. 3 is a vertical elevation showing the device of Fig. 2 secured to the outer shell of an ignition coil.

The one terminal of a battery 10 is connected to a relatively heavy cable 11, the other end of which is connected to one of the stationary contacts of a starter switch 12. The other stationary contact of starter switch 12 is connected to one terminal of the motor M, the other terminal of which is connected to the ground. The opposite terminal of the battery is connected to the ground, thus affording a circuit whereby energy is transmitted from the battery through the closed starter switch 12 and through motor M and returned to ground. This circuit is closed when the internal combustion engine is being cranked to induce combustion to begin in the cylinders.

Connected with some convenient point of the cable 11 is an ammeter 14. The opposite terminal of the latter is connected with ignition switch 13 and the opposite terminal of the latter is, in accordance with this invention, connected with terminal 15 of the device hereinafter to be described. The opposite terminal 16 of said device is connected to the terminal 17 of a coil 21, the opposite terminal 18 of which is connected to one terminal of the interrupter 19. The opposite terminal of the interrupter is connected to ground, and a condenser 20 is bridged around the interrupter contacts in the usual well-known manner. Current flows in the circuit just described when the ignition switch 13 is closed and when the contacts of the interrupter 19 are closed.

The coil 21 contains primary and secondary windings, the latter being connected to the primary circuit at one end and at the other end being connected to a terminal 22 from which high tension cable 23 leads to a distributor 24.

In the primary ignition circuit, according to the present invention, there is interposed a device comprising a ballast resistor 25, adapted to be normally connected in series with the other elements of the primary circuit described above, and, in association therewith, a heat-responsive thermostatic switch 26 bridging the terminals 15, 16 and, when closed, arranged to shunt the current through a path of low resistance around the ballast resistor 25, and a heating resistor 27 adapted to be energized when the ignition switch 13 is closed, and spaced in such mechanical relationship (hereinafter more fully described) with switch 26 as to afford a means for causing said switch to open after expiration of a period of time determined by the heat output of heating resistor 27 and the rate of heat transferred from it to switch 26 at the prevailing temperature of the surrounding atmosphere.

Referring to Fig. 2, switch 26 is preferably made of a bimetallic unit comprising two sheets or discs of metal having different coefficients of expansion, secured together and mounted upon a supporting post 28. Terminal members 15, 16 are positioned at either side of post 28, the inner ends of these terminal members being formed as stationary contact elements adapted to engage either with the bimetallic unit or with raised portions 29 secured thereon. Preferably the post 28 and the terminals 15, 16 are secured in fixed relation by being molded into a hardened block 30 of molded insulating material such as, for example, phenolformaldehyde resin. Switch 26 is so arranged and adapted as to close when the temperature in the neighborhood of the bimetallic unit falls below a predetermined temperature, and to open when said temperature rises above a predetermined temperature.

In order to bring the heating resistance 27 into suitable relationship with thermostatic switch 26, it is preferable to mount resistor 27 upon a spool-shaped member 31, preferably of porcelain. For convenience, the ballast resistor 25 may be similarly mounted upon a spool-shaped member 32, and both spools 31, 32 may be supported upon a headed bolt 33 secured by a nut 34 to the bottom of a container 35.

The casing 35 may be made of sheet aluminum or other material having heat conducting properties suited to the purpose. It is initially formed with a closed bottom and an open top. In the assembly thereof, bolt 33, with spools 31, 32 thereon, is first secured through a central opening in the bottom of the casing by means of the nut 34, and suitable electrical connections are provided for the resistors. Preferably connecting means are provided from terminal 15 to one end of each of resistors 25 and 27; the opposite end of resistor 25 is connected to terminal 16 and the opposite end of resistor 27 is connected to the casing 35 which is grounded to the car chassis.

Casing 35 may be formed with a circular indentation 36 serving as a seat or rest for block 30, so arranged and positioned as to afford the exact desired spacing of switch 26 from heating resistor 27.

After spools 31, 32 have been secured in position in the bottom of casing 35, block 30, including the assembled switch members, is then inserted within the open upper end of the casing, and is pressed down until its lower edge rests upon the indentation 36. Preferably indentations 37 are then made, mating with appropriate indentations formed in the sides of the block to secure the latter in desired position to prevent it from turning. To further secure the block in position, and to render the assembly watertight, the upper edges 38 of the casing are then swaged over to assure a tight and permanent fit of the parts. A suitable mounting bracket 39 may be provided.

The result of the above construction is to form a small airtight chamber within casing 35 in which there is imprisoned a small body of air. The temperature of this air is responsive to heat produced in the heating resistor 27, as modified by greater or less loss of heat by conduction through the walls 35. For example, if the thermostatic switch 26 should be arranged to remain closed so long as the temperature of the air around it is below 100° F. and to open when the said temperature exceeds 100° F., then in cold weather the heat produced in heating resistor 27 would bring about a closing of switch 26 after a greater length of time than it would in warm weather.

Preferably, the parts are so arranged and related that at mean temperature the switch 26 will open approximately 20 seconds after ignition switch 13 has been closed, and that the length of this period of time will be increased as the weather is colder and decreased as the weather is warmer than the mean temperature.

In the operation of the device, it will be understood that the driver of the automobile, in order to start his engine, normally first closes the ignition switch 13 and then closes the starting switch 12. In the use of this invention, the closing of ignition switch 13 directs current through the primary ignition circuit, including the primary winding of the coil and across the interrupter contacts, and at the same time through the heating resistor 27 which is in parallel with the portions of the primary ignition circuit mentioned. Assuming heating resistance 27 to be cold at the time switch 13 is closed, thermostatic switch 26 is therefore closed, and the initial current directed through the primary ignition circuit will pass from terminal 15 through switch 26 to terminal 16, thus being shunted around the ballast resistor 25. Accordingly, the full available voltage of the battery is impressed across the primary winding of coil 21, and this full available voltage is maintained until thermostatic switch 26 opens.

Upon the closing of ignition switch 13, current flows through heating resistor 27. Because of the mechanical arrangement of the parts already described, and shown particularly in Fig. 2, the heat produced by resistor 27 is communicated to the imprisoned body of air within casing 35 and this body of air rises in temperature at a rate governed to a substantial degree by the rate of heat-loss through the walls of the casing—i. e., by the temperature of the surrounding atmosphere. When the imprisoned body of air in the neighborhood of the bimetallic unit reaches the critical temperature, switch 26 opens and thereby inserts ballast resistor 25 into the circuit passing through the primary winding of coil 21. When the ballast resistor 25 is so inserted in the ignition circuit, a portion of the IR drop takes place within ballast resistor 25, thereby reducing the voltage applied across the terminals of the primary winding within the coil. As long as the ballast resistor 25 remains in circuit, the voltage within the coil is reduced.

The arrangement is, therefore, adapted to check excessive voltage in the primary winding of the coil, and hence at the interrupter points and in the condenser, after a short period at starting which may be longer in cold weather than in warm weather; and to provide means whereby an intensified current is passed through the primary winding of the coil and through the interrupter contacts, during this short period at starting. For practical purposes and at average temperatures, we have found that it is desirable that such intensification of the current should be maintained for approximately twenty seconds after the ignition switch has been closed. The mechanical arrangement of parts shown herein is conveniently adapted to procure response of the thermostatic switch after approximately that length of time. The arrangement is such that in cold weather, due to rapid conduction of heat from the body of air within casing **35** to the outside atmosphere, the period of response of thermostatic switch **26** is lengthened, thereby resulting in a prolongation in cold weather of the period during which the ignition current is intensified.

While there is described herein one convenient form of device embodying this invention, and the one which is at present believed to be the best form, it is our intention that this invention shall be deemed to cover and include all forms and shapes and sizes of device, whether the same be located within or without the coil casing, as fall within the terms of the annexed claims.

We claim:

1. For use in an ignition system which includes an ignition switch a coil having a primary winding and a source of electrical current, the combination of a current-limiting resistor adapted to be connected in series with the primary winding of said coil and to limit the flow of current through said winding when so connected, a thermo-responsive switch adapted to open when the temperature of the atmosphere in which said switch is positioned increases above a predetermined temperature and arranged, when closed, to conduct current to the primary winding of said coil through a path having less resistance than is provided by said current-limiting resistor, and an electrical heating resistance adapted to be connected in parallel with the primary winding of said coil and to be energized when said ignition switch is closed, said heating resistance being adapted to supply heat tending to raise the temperature of the atmosphere in which said thermo-responsive switch is positioned.

2. For use in an ignition system which includes a resistor, the combination of a closed casing whose walls consist at least in part of heat conducting material, a confined body of fluid enclosed within said casing and in contact with the walls thereof, a stationary switch contact member, a thermo-responsive movable switch contact element positioned within said body of fluid and adapted to move relatively to said stationary contact member to separate said switch contact members in response to increase in the temperature of the fluid in contact with said movable element above a predetermined temperature, and an electrical heating resistance positioned within said body of fluid and adapted when energized to be connected in parallel with said first-mentioned resistor and to dissipate heat into said fluid at a predetermined and substantially fixed rate, whereby actuation of said movable switch member will be delayed for a length of time after energization of said resistance dependent upon the rate of dissipation of heat from said fluid through the casing walls to the surrounding atmosphere.

3. For use in an ignition circuit which includes a source of electrical current, an ignition switch, and the primary winding of a coil, the combination of a closed casing whose walls consist at least in part of heat-conducting material, a current-limiting resistor adapted to be connected in said circuit in series with said primary winding when the ignition switch is closed, a thermo-responsive switch positioned within said casing and connected in parallel with said resistor and adapted to be connected in series with said primary winding, and a heating resistance positioned within said casing in thermal relationship with said last-mentioned switch, said heating resistance being adapted to be connected across the source of current in parallel with said current-limiting resistor and the primary winding of said coil when the ignition switch is closed.

4. For use in an ignition circuit which includes a source of electrical current, an ignition switch, and the primary winding of a coil, the combination of a closed casing whose walls consist at least in part of heat-conducting material, a current-limiting resistor adapted to be connected in said circuit in series with said primary winding when the ignition switch is closed, a thermo-responsive switch positioned within said casing and connected in parallel with said resistor and adapted to be connected in series with said primary winding, said current-limiting resistor being positioned within said casing in thermal relationship with said last-mentioned switch, and a heating resistance positioned within said casing in thermal relationship with said switch, said heating resistance being adapted to be connected across the source of current in parallel with said current-limiting resistor and the primary winding of said coil when the ignition switch is closed.

5. For use in an ignition circuit which includes a source of electrical current, an ignition switch, and the primary winding of a coil, the combination of a closed casing, a current-limiting resistor adapted to be connected in said circuit in series with said primary winding when the ignition switch is closed, a thermo-responsive switch positioned within said casing and connected in parallel with said resistor and adapted to be connected in series with said primary winding, and a heating resistance positioned within said casing in thermal relationship with said last-mentioned switch, said heating resistance being adapted to be connected across the source of current in parallel with the primary winding of said coil when the ignition switch is closed.

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