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STARTER ARRANGEMENT FOR INTERNAL COMBUSTION ENGINES

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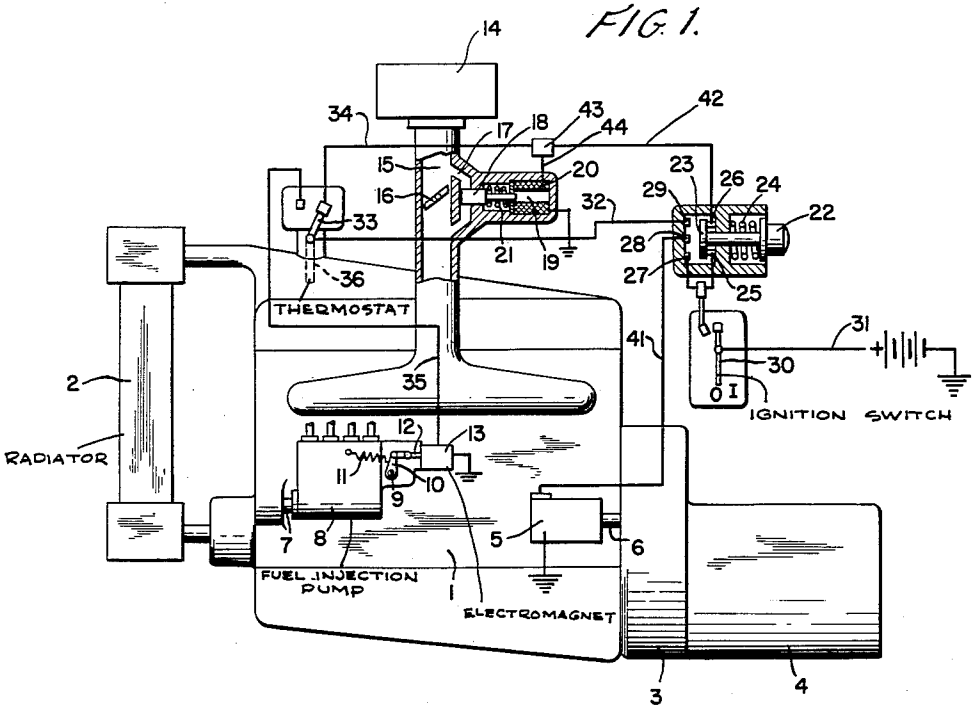
FIG. 1.



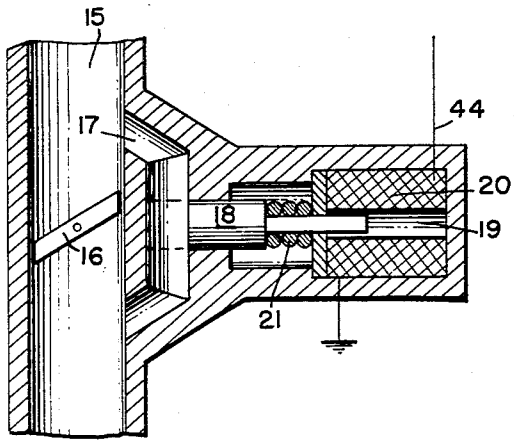


FIG. 2.

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13 Claims. (Cl. 123—179)

The present invention relates to a starting arrangement for internal combustion engines, especially mixture-compressing gas engines provided with fuel injection, and consists essentially in that the supply of combustion air to the cylinders is reduced or lessened to a considerable extent during the actuation of the starter by the use of a temperature responsive member which is controlled in dependence on the temperature condition of a fluid medium such as, for example, of the cooling water, the cooling air or of the lubricant, which are indicative of and proportional to the temperature condition of the engine, when the fluid medium is below a predetermined temperature limit.

In that manner, the preparation of the supplied fuel, i.e., especially the evaporation in the cylinder space of the injected fuel, is enhanced and the condensation thereof at the cold cylinder walls is reduced since a relatively high vacuum occurs in the cylinder during the suction stroke of the piston thereof as a result of cutting-off or interrupting the air supply to the cylinders.

According to a further feature in accordance with the present invention, it is preferable that the temperature responsive member in internal combustion engines of the injection type described above also provides a control effect during actuation of the starter which provides a larger quantity of injected fuel than in normal operation of the engine.

By the use of such an arrangement, the starting process of the engine is also materially aided on the part of the fuel supply since the fact that with low temperatures a large part of the injected fuel quantity condenses along the cold cylinder walls so as to be ineffective for the combustion is taken into consideration.

In connection with starting arrangements provided with an electrically actuated starter the present invention proposes in particular that a control or throttling member be arranged in the combustion air line which control member is moved by a spring force into the blocking position thereof, yet, may be kept electromagnetically in the open position thereof by overcoming the spring force, whereby the arrangement is such that the electromagnet controlling the throttling member is supplied with current directly over the starter switch with the electrical system of the internal combustion engine switched on and with the starter switch released, while this electromagnet is supplied with current over a line including a thermostatic switch when the starter switch is actuated, and only in case the thermostatic switch is in the position corresponding to that which occurs when a predetermined temperature limit has been surpassed. With a position of this thermostat corresponding to a temperature below the predetermined temperature limit an electromagnet is energized upon actuation of the starter which produces an increase in the injected fuel quantity.

By the use of such a simple arrangement and construction the starting of the internal combustion engine is reliably assured even with relatively low temperatures. In addition thereto, such a construction offers the advantage

that it may also be used to prevent the continued operation of the internal combustion engine due to after-glow ignition after the electric ignition switch has been cut off since upon turning off the electric system the electromagnet controlling the throttling member in the air line is no longer supplied with energizing current and the air line is thereby blocked so that the engine must come to a standstill as a result of lack of adequate combustion air.

A particularly simple construction and arrangement is possible with the present invention in those types of internal combustion engines in which a separate idling-speed air line by-passing the main throttling member of the inlet manifold or suction line is provided if the blocking or throttling member is arranged in the idling speed air line and, as a result thereof, requires only relatively small dimensions.

Accordingly, it is an object of the present invention to provide a starting arrangement and control system for internal gas combustion engines with fuel injection which is relatively simple yet assures starting of the engines even with relatively cold temperatures.

Another object of the present invention resides in the provision of an arrangement of a control system for internal combustion engines of the fuel injection type which greatly facilitates starting of the engine at cold temperatures.

Still another object of the present invention is the provision of a control system for starting a relatively cold internal combustion engine which enhances the preparation of the fuel in the cylinders by cutting off the supply of suction air so as to increase the vacuum during the suction stroke in the cylinders and thereby reduce the danger of condensation of the fuel along the cold cylinder walls.

Still another object of the present invention is the provision of such a starting control arrangement for internal combustion engines which not only controls the amount of combustion air supplied to the engine during starting but also controls the amount of injected fuel dependent on the temperature of a fluid medium which is indicative of or proportional to the temperature of the engine, such as, for example, the cooling water of a water-cooled combustion engine, the cooling air of an air-cooled internal combustion engine or the lubricant of the internal combustion engine.

Still another object of the present invention is the provision of a starting control arrangement for internal combustions which at the same time is provided with such an electric control circuit as to prevent operation of the internal combustion engine due to after-glow in the cylinders after the ignition and therewith the spark plugs are cut off from the source of electric power.

These and other objects, features and advantages of the present invention will become more obvious from the following description when taken in connection with the accompanying drawing which shows, for purposes of illustration only, one preferred embodiment in accordance with the present invention and wherein:

Figure 1 shows schematically a starter arrangement for internal combustion engines according to the present invention, and

Figure 2 shows an enlarged cross-sectional view of the engine throttle valve and idling speed control valve of Figure 1.

Referring now more particularly to the drawing, reference numeral 1 designates the internal combustion engine of the fuel injection type. The engine 1 is connected with the radiator 2 through which the cooling water of the cooling system for the engine flows, a clutch and flywheel housing 3 as well as a transmission 4. The electric starter 5 of suitable construction drives over a shaft 6 the flywheel which is located within the housing

3. Another shaft 7 drives the fuel injection pump 8. A shaft or pivot pin 9 is supported in the injection pump 8 and is connected within the injection pump 8 with the fuel adjusting rod or rack (not shown) thereof and on the outside thereof with a lever 10. The lever 10 is constantly urged toward the left by a spring 11 which thereby adjusts the lever 10 so as to produce a reduction in the amount of fuel injected. In other words, counterclockwise rotation of the lever 10 produces a decrease in the injected fuel quantity and vice versa. The lever 10 is also connected with the core 12 of an electromagnet 13.

The combustion air reaches the main inlet manifold or suction line 15 over an air filter 14. The suction line 15 is provided with a main throttle valve 16. An idling speed air channel 17 by-passes the main throttling valve 16. The idling speed air channel 17 may be blocked or cut off by a slide valve member 18. The slide valve member 18 is connected with the core 19 of an electromagnet 20 and is normally urged into the blocking or cut-off position thereof by the spring 21. The starter button 22 of any suitable construction is connected with an electrically conducting contact piece 23 which is normally urged against two contacts 25 and 26 by the spring 24 when the actuator button 22 is not actuated, i.e., when released. However, upon depressing or actuation of the starter button 22 the contact piece 23 is moved toward the left and thereby bridges the three contacts 27, 28 and 29 which are thereby electrically interconnected with each other. The ignition switch 30 of any suitable construction electrically connects in the position I thereof a cable or wire 31 with both the contacts 25 and 27 so as to supply current from one terminal of the battery (not illustrated) to the contacts 25 and 27, the other terminal of the battery may be suitably grounded.

Contact 28 is connected with the starter 5 over the wire 41, while contact 26 is connected with the electromagnet 20 over wire 42, junction box 43 and wire 44. Furthermore, cable or wire 32 provides an electric connection of the contact member 29 with the contact lever or switch arm 33 which in turn establishes an electric connection, in one position thereof over the cable or wire 34, junction box 43 and wire 44 which the electromagnet 20 or, in the other position thereof, over a cable 35 with the electromagnet 13 at the fuel injection pump 8. The contact lever 33 is actuated by a thermostat 36 of suitable construction which is exposed, for example, to the cooling water of the cooling system of the internal combustion engine and has only two possible positions, namely:

(*a*) Below a predetermined temperature limit of, for example, 65 degrees C. of the cooling water temperature the contact lever 33 establishes an electric connection between the cable 32 and the cable 35, and

(*b*) Above this predetermined temperature limit, the contact lever or switch arm 33 connects the cables 32 and 34 with each other, as shown in the drawing.

The electric circuits and arrangements thereof have been indicated only schematically for sake of clarity. However, it is understood that in actual construction relays of conventional construction may be used, as is well known in connection with such arrangement.

OPERATION

The operation of the control arrangement in accordance with the present invention is as follows:

With a cold engine

If the engine is relatively cold, i.e., if the cooling water temperature, for example, is below 65 degrees C., the contact lever 33 is in the left position, i.e., in the position not illustrated in the drawing, to establish an electric connection between wires 32 and 35.

Upon turning on the ignition switch 30, the contacts 25 and 27 are connected with the positive terminal of the battery. As long as the starter button 22 is pushed toward the left, i.e., as long as the starter button 22 is actuated by depressing, both contacts 28 and 29 are connected by the connecting piece 23 with the contact 27, and are thereby also connected with the positive terminal of the battery. Consequently, current is supplied to line 41 over contact 27 and the starter 5 is energized, on the one hand, while the electromagnet 13 is energized over contact 29 and cables 32 and 35, on the other. As a result of energization of the electromagnet 13 the core thereof is attracted toward the right, as viewed in the drawing, so that the lever 10 rotates the shaft 9 in the clockwise direction, i.e., in the direction of a large increase of the injected fuel quantity. The engine is thereby set into rotation, whereby, as a result of the blocking of the inlet line 15 by the idling-speed adjustment of the throttling member 16, on the one hand, and the position assumed by the slide valve member 18, on the other, a relatively high vacuum occurs in the cylinders which greatly facilitates starting of the engine. Simultaneously therewith, a correspondingly large amount of fuel is injected. After the starter button 22 is released, the electromagnet 13 is no longer energized, whereby the strong enrichment of the mixture is discontinued due to de-energization of electromagnet 13. Simultaneously, the contact piece 23 returns to its normal position and bridges again the contacts 25 and 26 to thereby provide an electric circuit over the contacts 25 and 26 with the electromagnet 20 which is now energized so that the core 19 and therewith the slide valve member 18 are attracted toward the right as viewed in the drawing. The idling speed air line 17, as a result thereof, is rendered free so that the engine receives a sufficient amount of combustion air during the idling-speed operation thereof when the throttle valve 16 is essentially closed.

With warm engine

As the engine warms up gradually, the temperature of the cooling water also increases gradually, and as it surpasses a predetermined temperature of, for example, 65 degrees C., the contact lever 33 is so adjusted by the thermostat 36 as to assume the right position thereof, i.e., the position indicated in the drawing.

As a result thereof, the contact lever 33 connects lines 32 and 34 with each other. If, under these conditions the ignition switch 30 is turned on and the starter button 22 is depressed, as in the previous case, the starter 5 is again energized over wire 41. Furthermore, the electromagnet 20 is also energized immediately at that time over the contact 29, line or wire 32, switch 33, line 34, junction box 43 and wire 44 so that the slide valve member 18 in that case does not block or interrupt the idling speed air line 17. However, with relatively high temperatures, it is not required that the idling speed air line 17 be blocked and might even be harmful as in that case so much fuel evaporates immediately as is necessary for purposes of starting and continued operation of the engine, and this amount of fuel also requires a corresponding amount of combustion air. After releasing the starting button 22, the magnet 20 is kept energized over contact 25, connecting piece 23, and contact 26 so that even during subsequent continued operation of the engine the idling speed air line 17 is kept open.

In all cases, regardless of the position assumed by the contact lever 33 which is controlled by the thermostat 36, the entire electric system is cut off from the battery and thereby de-energized if the ignition switch 30 is turned to the position O thereof so that the spring 21 again forces the slide member 18 toward the left into the blocking position thereof whereby continued operation of the engine, for example, as a result of after-glow ignitions, due to, for instance, hot spots, is rendered impossible because of lack of sufficient combustion air.

While I have shown and described one preferred em-

bodiment in accordance with the present invention, it is understood that the same is not limited thereto but is susceptible of many changes and modifications within the spirit of the present invention, and I intend to cover all such changes and modifications except as defined by the appended claims.

I claim:

1. A starting control arrangement with fuel injection, comprising cranking means, a starter switch means for actuating said cranking means, conduit means with adjustable control means including an adjustable control member and spring means for normally urging said adjustable control member into one end position thereof, temperature-responsive means controlled by a fluid medium proportional to the engine temperature, means operatively connecting said temperature-responsive means to said adjustable control means and said starter switch means for enabling said spring means to maintain said adjustable control member in said end position thereof in which it virtually stops the supply of suction air to said engine when said fluid medium is below a predetermined temperature and only during the time of actuation of said starter switch means, said connecting means including an electric circuit with switch means actuated by said temperature-responsive means, said control means including an electromagnet directly connected to said switch means and operatively connnected with said adjustable control member, said electromagnet being energized only when said switch means is in a position for responding to the condition of said temperature-responsive means when said fluid medium is above a predetermined temperature to thereby move said control member into a position of increased suction air supply to the engine.

2. A starting control arrangement according to claim 1, wherein said fluid medium is the cooling water of a water-cooled internal combustion engine.

3. A starting control arrangement according to claim 1, wherein said fluid medium is the cooling air of an air-cooled internal combustion engine.

4. A starting control arrangement according to claim 1, wherein said fluid medium is the lubricant of said internal combustion engine.

5. A starting control arrangement for internal combustion engines with fuel injection, comprising cranking means, a starter switch means for actuating said cranking means and a fuel injection mechanism with fuel adjusting means for adjusting the amount of injection fuel comprising conduit means with adjustable control means including spring means for virtually stopping the supply of suction air to the engine to thereby establish a high vacuum, temperature responsive means controlled by a fluid medium representative of the engine temperature, and means operatively connecting said starter switch means and said temperature responsive means with said fuel adjusting means and said adjustable control means to adjust said fuel injection mechanism by said fuel adjusting means for larger quantities of injected fuel and to enable said spring means to maintain said adjustable control means in a position thereof to virtually stop said supply of suction air to said engine when said fluid medium is below a predetermined temperature and only during the time of actuation of said starter switch means.

6. A starting control arrangement according to claim 5, further comprising means to restore the normal supply of suction to said engine upon release of said starter means.

7. A starting control arrangement according to claim 6, wherein said fuel adjusting means and said adjustable control means each comprise an electromagnetically actuated control member, wherein said temperature responsive means includes switch means and said starter means includes a starter button, and wherein said connecting means includes electric circuits for the respective electromagnets of said control members which are controlled by said starter button and by said switch means actuated by said temperature responsive means.

8. A starting control arrangement according to claim 7, wherein said conduit means includes an idling-speed bypass line with an electromagnetically controlled valve member forming said adjustable control means to vary the flow cross section thereof.

9. A starting arrangement for internal combustion engines, especially mixture-compressing gas engines with fuel injection, comprising cranking means, starter switch means for actuating said cranking means and conduit means with an adjustable control member including spring means acting thereon for virtually stopping the supply of suction air to said engine to thereby establish a high vacuum, temperature responsive means in said engine and controlled by a fluid medium proportional to the temperature of the engine, and means operatively connnecting said starter switch means and said temperature responsive means to said adjustable control means to enable said spring means to maintain said adjustable control member in a position thereof to virtually stop the supply of suction air to said engine during the time of actuation of said starter switch means with said fluid medium below a predetermined temperature, and a fuel adjusting mechanism for adjusting the quantity of the injected fuel, said last-mentioned means also including means for adjusting said fuel adjusting mechanism to provide a larger quantity of injected fuel during actuation of said starter switch means with said temperature responsive means below said predetermined temperature.

10. A starting control arrangement for internal combustion engines, especially mixture-compressing gasoline engines with fuel injection, comprising cranking means, starter switch means for actuating said cranking means and conduit means provided with an adjustable control member for virtually stopping the supply of suction air to said engine to thereby establish a high vacuum, spring means for normally urging said adjustable control member to a position thereof in which said supply of suction air is virtually stopped, electromagnetic means operatively connected with said adjustable control member to move the same into a position of increased suction air supply by overcoming the force of said spring means, thermostatic means controlled by a fluid medium indicative of the temperature of the engine, an electric system including a source of electric power, a starter button, switch means controlled by said thermostatic means, and means interconnecting said source of electric power, said starter button, said switch means and said electromagnetic means to energize said electromagnetic means from said source, over said starter button, upon depressing the latter, only with said switch means in a position corresponding to the condition of said thermostatic means when said fluid medium is above a predetermined temperature.

11. A starting control arrangement according to claim 10, further comprising an ignition switch in said electric system, said connecting means also interconnecting said source of electric power, said starter butter and said electromagnetic means to energize the latter upon closure of said ignition switch with said starter button released regardless of the position of said switch means controlled by said thermostatic means.

12. A starting control arrangement according to claim 11, further comprising a fuel adjusting mechanism to vary the amount of injected fuel, electromagnetic means for actuating said fuel adjusting mechanism to increase the amount of fuel injected upon energization thereof, and means connecting said switch means to said last-mentioned electromagnetic means to energize the latter upon closing said ignition switch and depressing said starter button and with said switch means in a position corresponding to the condition of said thermostatic means below said predetermined temperature.

13. A starting control arrangement according to claim 12, wherein said conduit means includes a main suction

line with a main control valve, and an idling speed bypass line bypassing said main control valve, said adjustable control member being arranged in said bypass line.

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