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INTERNAL COMBUSTION ENGINE

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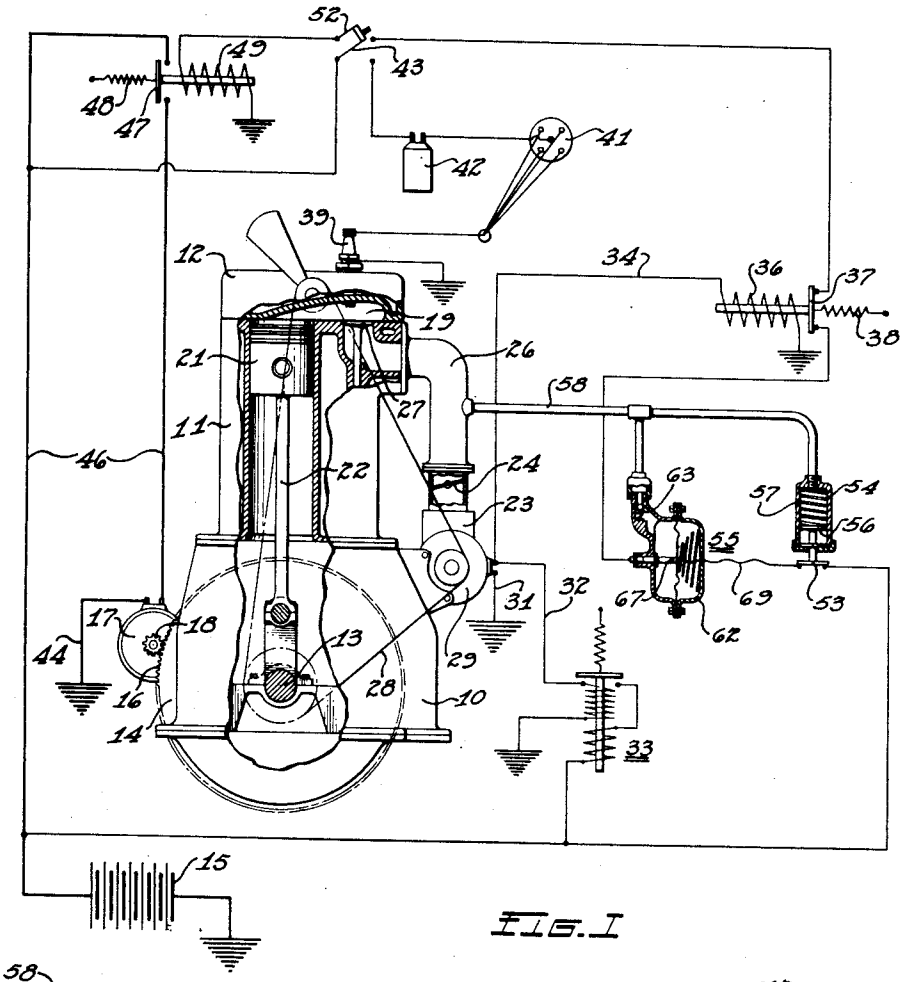


FIG. 1

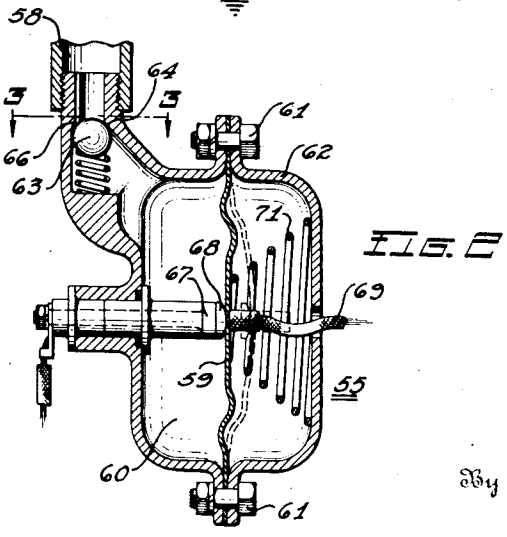


FIG. 2

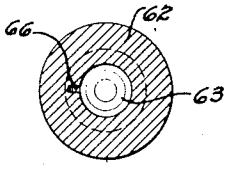


FIG. 3

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INTERNAL COMBUSTION ENGINE

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This invention relates to internal combustion engines and more particularly to engine starting mechanism control.

An internal combustion engine is normally started by connecting to it an outside source of energy which is then disconnected from the engine as soon as it is operating under its own power. There have been proposed several ways of automatically re-making the connection between the source of energy and the engine whenever the engine stops and this invention relates to improvement on such mechanisms.

An internal combustion engine usually requires a high torque in starting and in order that the source of energy may be small, the connection between the source and the engine, which may be either mechanical, electrical, or both, is usually mechanically geared to the engine at a rather high ratio.

A connection which has been commonly used is a direct or a geared drive of the type shown in Patent 1,116,370, to Vincent Bendix, dated November 10, 1914. A characteristic of this type of starting mechanism is that rotation of the engine in a forward direction at a speed higher than the speed of the starter will cause disengagement of the starter gear from the fly-wheel or other engine gear. Rotation of the fly-wheel gear in the reverse direction, such as sometimes occurs when the engine is backfiring, will have no such disengaging tendency, and if the fly-wheel gear is rotating backwards and an attempt is made to mesh the starter gear with the fly-wheel gear, damage is apt to be caused to the starter gear.

If the engine is equipped with an automatic starter operating mechanism adapted to energize the starter and connect it to the engine as soon as forward engine rotation ceases, the starter gear will usually begin rotating before such engagement, and if the fly-wheel gear teeth are rotating in a backward direction, the load on the starter gear at the instant of engagement will be greatly increased, and damage may result to the starter gear or whatever means of communication there may be between the outside source of energy and the engine.

Accordingly, a starter control mechanism of the type which automatically causes starter engagement upon the cessation of forward engine rotation must be delayed in its action whenever forward engine rotation is to be followed by backward rotation.

Mechanical means have heretofore been proposed for automatically rendering the automatic starter operating mechanism inoperative when a back fire occurs, but such mechanical means have not been adapted to cause automatic starter engagement after the back-firing is completed and the engine has finally come to rest. One type of such mechanical means with which I am familiar necessitates, after a back-fire, the lifting of the engine hood and the pushing of a control knob in order again to render the operation of the starter operating mechanism automatic.

It is one of the objects of this invention to provide an automatically operating device to render such lifting of the hood, or other manual operations, entirely unnecessary.

Another object of the invention is to provide a starter control mechanism which will be entirely automatic in its action and which will cause starter operation upon the cessation of forward engine rotation except when such forward rotation is followed by reverse rotation, at which time automatic operation of the starter will be automatically prevented, the means for accomplishing such prevention being rendered automatically ineffective as soon thereafter as the motor shall come to a complete stop.

Another object of the invention is to prevent damage to the parts of the starting system upon the occurrence of a back-fire in a motor equipped with an automatic starter operating mechanism, without, at the same time, making the starting operating mechanism any less automatic in any of its functions.

Other objects of the invention will appear from the following description taken in connection with the drawing, which forms a part of this specification, and in which:

Fig. 1 is a diagrammatic representation of an internal combustion engine equipped with an automatic starter operating mechanism in accordance with my invention.

Fig. 2 is an enlarged view of a portion of Fig. 1, showing a portion of my automatic starter operating mechanism, and

Fig. 3 is an enlarged section on the line 3—3 of Fig. 2.

Referring to the drawing, 10 illustrates a motor crankcase to which is attached a cylinder block 11 having a cylinder head 12. Mounted in the crankcase is a crankshaft 13, attached to which is the fly-wheel 14 having a gear 16 thereon. An outside source of energy, such as a storage battery 15, is connectable with a starting motor 17 having a gear 18 associated therewith which is adapted to be engaged with the fly-wheel gear 16 when the starter is operating.

The connection between the starter and the gear may be of the resilient inertia controlled type described in Patent 1,116,370 to Vincent Bendix dated November 10, 1914. The control of the starter will be later described.

The crankshaft 13 is adapted to be driven in the conventional manner by the explosion of a combustible mixture occurring in the combustion chamber 19 and exerting pressure on a piston 21 and connecting rod 22 attached to the crankshaft.

The mixture, which in the engine shown is of the carbureted type, is sucked into the cylinder by the piston through a carburetor 23 which forms the mixture, past a throttle valve 24, through an intake manifold 26, and past an intake valve 27 which controls the communication of suction between the cylinder and the intake manifold. Thus, when the engine is running, a vacuum exists in the intake manifold between the intake valve and the throttle valve. This vacuum is used to control the automatic starting operating mechanism in a manner to be later described.

A belt 28, or other suitable driving means connects a motor-mounted generator 29 to the crankshaft in driving relation. The electrical circuit for the generator comprises a ground lead 31 and a battery charging lead 32 controlled by a reverse current relay 33 of conventional type. A further lead 34 leads from the generator to a high resistance solenoid 36 and thence to the ground.

Thus, the generator, as soon as the motor is operating fast enough to generate sufficient voltage, will energize the solenoid 36 and open the switch 37 against a spring 38. This switch is one of those used to control the starter operating mechanism and its purpose will be later more fully described.

The explosion of the combustible mixture in the engine is caused by a spark plug 39 connected to a distributor 41 and a high voltage coil 42. A manually operated ignition switch 43 will energize the low voltage side of the coil from the battery in the conventional manner.

I have thus described an engine manifolding, generator, and ignition system which uses manifold vacuum and generator current to control a starter operated circuit.

The starter circuit includes a starter ground wire 44 and a lead 46 to the battery 15. At a convenient point in this circuit is a switch 47 to which is attached a spring 48 tending to maintain the starter circuit in open position. A solenoid coil 49 is arranged to oppose the action of the spring thereby closing the circuit connecting the source of energy, in this case the battery 15, to the motor through the starter pinion 18 and the fly-wheel ring gear 16.

Manually and automatically controlled means have been provided to regulate the action of the starting motor switch. This means consists of a manually controlled switch 52 closed by the act of turning on the ignition switch 43, and an automatically operating means designed to open or deenergize the circuit to the solenoid 49 when the engine begins to operate under its own power, and to close the circuit whenever the motor stops. The automatic starter control mechanism may consist of the generator current regulated switch 37, or a motor vacuum control switch 53, or if desired, both of these could be used simultaneously.

The generator current regulated switch has been previously described. The vacuum controlled switch consists of a cylinder 54 within which is a piston 56 urged by a spring 57 into switch closed position. A conduit 58 connects the cylinder 54 to the intake manifold and thus when the engine is running, the partial vacuum occurring in the manifold will draw the piston 56 into the cylinder 54 and break the circuit switch 53. Stopping of the engine is accompanied by a loss of vacuum and the spring then urges the piston 56 into switch closed position.

With an automatic starting control system of the above described type, the starter will be energized whenever the motor stops rotating in a forward direction. If such rotation is to be followed by rotation in the opposite direction, such as occurs when a back-fire takes place, it is desirable to render the automatic mechanism inoperative. It is not enough automatically to render the automatic starting mechanism inoperative when a back-fire is about to occur, but it is also desirable automatically to render it operative again when the engine finally comes to a stop after a back-fire. This is one of the objects of my invention and the mechanism for accomplishing it will now be described.

As is clearly evident, reverse rotation of a throttled internal combustion engine will be accompanied by a pressure in the intake manifold. I have provided intake manifold pressure controlled means 55 for rendering the automatic starter control mechanism inoperative. This means is shown in detail in Figs. 2 and 3 in which 59 is a diaphragm held by bolts 61 in a casing 62. The chamber formed in the casing on one side of the diaphragm is open to atmospheric pressure and the chamber 60 on the other side is closed to the atmosphere and in communication, through the conduit 58, with the intake manifold vacuum. Within the conduit is a ball check valve 63, the seat 64 of which has a slight groove 66 therein.

Suitably mounted in a pressure-tight manner in the wall of the air-tight chamber 60 is an insulating bushing within which is a lead 67 from the circuit controlling the starting switch solenoid 49. This lead abuts at its inner end a contact 68 passing through the diaphragm 59 in an air-tight manner and connected as by a wire 69 to the circuit controlling the starting motor switch solenoid. A spring 71 normally urges the diaphragm contact 68 against the lead 67 and thus the circuit through the switch shown in Fig. 2 is normally closed.

When an engine back-fire occurs, however, there is a pressure rise in the intake manifold and this is communicated through the conduit 58 to the ball check valve 63. This pressure opens the valve and is communicated to the diaphragm 59 which is moved to the right against the spring 71. When the motor stops back-firing, the ball check valve 63 will close and prevent an immediate loss of pressure in the air-tight chamber 60. This will hold the contact 68 away from the lead 67 and thus the starting motor switch solenoid 49 cannot be energized no matter what happens at the generator control switch 37, or the vacuum control switch 53. These latter switches are thus rendered ineffective and the entire automatic starter operating mechanism is thus automatically made inoperative.

The groove 66 in the valve seat 64 will, however, permit a slow leak of pressure from the air-tight chamber 60 back into the intake manifold and the spring 71 normally pushing the diaphragm to the left, will urge the excess gas out of the air-tight chamber. The size of the groove

66 will determine the length of time during which the automatic starting motor operating mechanism will be rendered inoperative. I have found by experiment that it is desirable to have the contact points 67 and 68 separated for a period as high as 20 seconds, although, of course, this figure will vary for various types of engines. This relatively long time is necessitated by the fact that a back-fire may, in reality, consist of a series of back-fires accompanied by forward engine rotation between-whiles. The switch which I have just described will automatically render the starting motor operating mechanism inoperative and will automatically render it operative again when a sufficient time has elapsed for the motor to come to a complete stop.

I have thus provided an automatic starting operating mechanism which will automatically energize the starter whenever the motor comes to a complete stop and which will automatically delay the energizing of the starter whenever the motor back-fires. This will thus prevent damage to the starter gear and over-loading of the teeth thereof.

While I have herein described in some detail a specific embodiment of my invention, which I deem to be new and advantageous and may specifically claim, I do not desire it to be understood that my invention is limited to the exact details of the construction, as it will be apparent that changes may be made therein without departing from the spirit or scope of my invention.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. In combination with an engine rotatable in opposite directions but operable in only one direction, a starter and automatic mechanism interconnecting said starter and engine tending to actuate said starter upon the cessation of operation of said engine, of means associated with said mechanism to render it inoperative while said engine is rotating in a reverse direction, and automatic means associated with said mechanism to render the mechanism ineffective upon the cessation of reverse engine rotation.

2. In combination, an engine, a starter, and an automatic starter actuating system operative, upon stalling of the engine, to actuate the starter, means associated with said system tending to render it inoperative during back-firing of the engine, and automatic means associated with said system tending to render it operative upon final stopping of the engine.

3. In an engine, the combination with an engine starting system including a starter device having automatic energizing control means associated therewith effective upon stopping of the engine, of fluid pressure means associated with said system automatically to render said control means inoperative when the engine back-fires and automatically to render said control means operative when the engine stops after back-firing.

4. In an engine having a starter, a starter control system automatically operative upon stopping of the motor to energize the starter, pressure controlled mechanism associated with said system automatically to render said system inoperative upon the occurrence of a back-fire, and automatic means associated with said mechanism to render the same ineffective when the engine stops after back-firing.

5. In an engine having a throttled intake and a starter, starter control mechanism, including a pressure controlled device, adapted automatically to energize the starter upon stopping of the engine and to de-energize the starter upon starting of the engine, pressure controlled means actuated by a back-fire to render said mechanism inoperative, and automatic pressure controlled means associated with the engine to render said pressure controlled means ineffective when the engine finally comes to rest.

6. In an engine having a starter, a starter actuating system, control mechanism associated with said system, said mechanism including an engine controlled device tending to actuate said system upon the cessation of forward engine rotation, and fluid pressure means associated with part of said mechanism tending to render said mechanism inoperative when stopping of the engine is preceded by a back-fire, said means thereafter becoming ineffective against said mechanism.

7. In an internal combustion engine having a throttled intake, a starter, intake pressure controlled means associated to energize the starter upon stopping of the engine, a second intake pressure controlled means tending to render said first named pressure control means inoperative upon the occurrence of a back-fire in said intake, automatic means associated with said second named pressure control means to render the same inoperative when said engine comes to rest after back-firing.

8. In an internal combustion engine having a starter and a generator, generator controlled means tending to energize the starter upon stopping of the engine, engine controlled means tending to render said generator controlled means inoperative upon the occurrence of a back-fire, and automatic means associated with said engine tending to render said engine controlled means ineffective when said engine comes to rest after back-firing.

9. In a motor, a starter, means providing mechanical energy, means providing electrical energy, means regulated by said electrical energy means tending to render said starter operative upon stopping of said motor, means regulated by said mechanical energy means tending to render said electrically energized means ineffective upon the occurrence of a back-fire, and a second mechanically controlled means tending to render said first mechanically controlled means ineffective when said engine comes to rest after back-firing.

10. In an engine having a manifold and starter operating mechanism, means, including an engine controlled element associated with the manifold, operative, when the pressure in the manifold varies in one direction from atmospheric, to render the starter operating mechanism operative, and movable means operative, to render the starter operating mechanism inoperative for a limited period of time after the manifold pressure has changed to the opposite of that hereinbefore mentioned.

11. Starting mechanism for internal combustion engines including a magnetically operated starting switch, a control circuit for said starting switch including a pair of contacts, means responsive to backward rotation of the engine for opening said contacts, and means for delaying closure of the contacts for a time interval after being opened.

12. Starting mechanism for internal combustion engines including a magnetically operated starting switch, a control circuit for said starting switch including a pair of contacts, means re-

sponsive to backward rotation of the engine for opening said contacts, and means for delaying closure of the contacts for a time interval after the backward rotation of the engine ceases.

13. An automatic controller for internal combustion engine starters comprising with an internal combustion engine, an ignition circuit therefor, comprising a switch, a starting motor, means including a switch having an actuating coil in circuit with the first switch for controlling the operation of the motor, means for breaking the coil circuit when vacuum exists in the intake manifold and means for maintaining the coil circuit open when pressure exists in the engine manifold.

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