

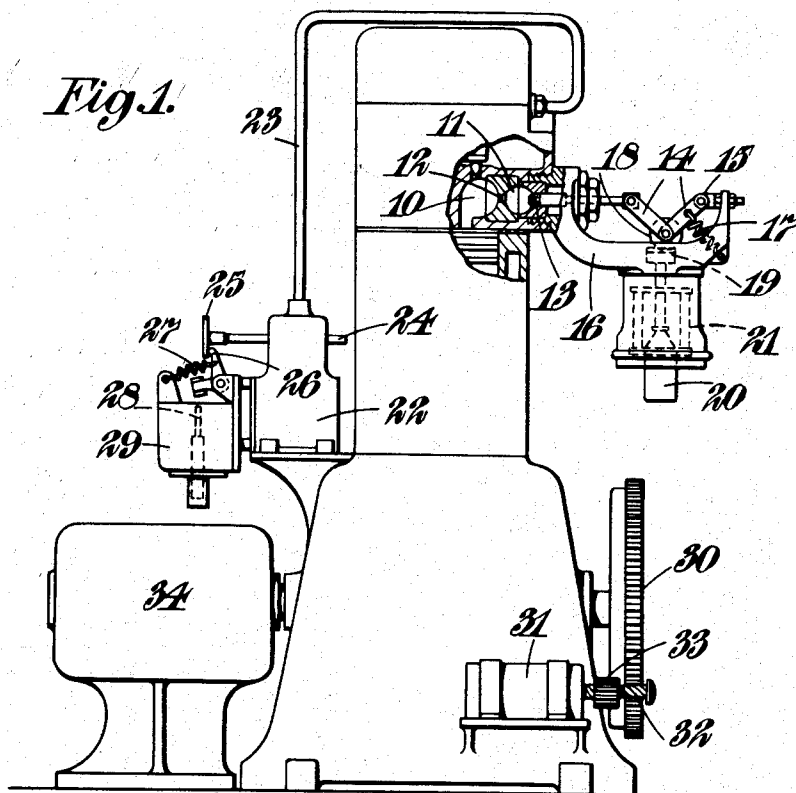
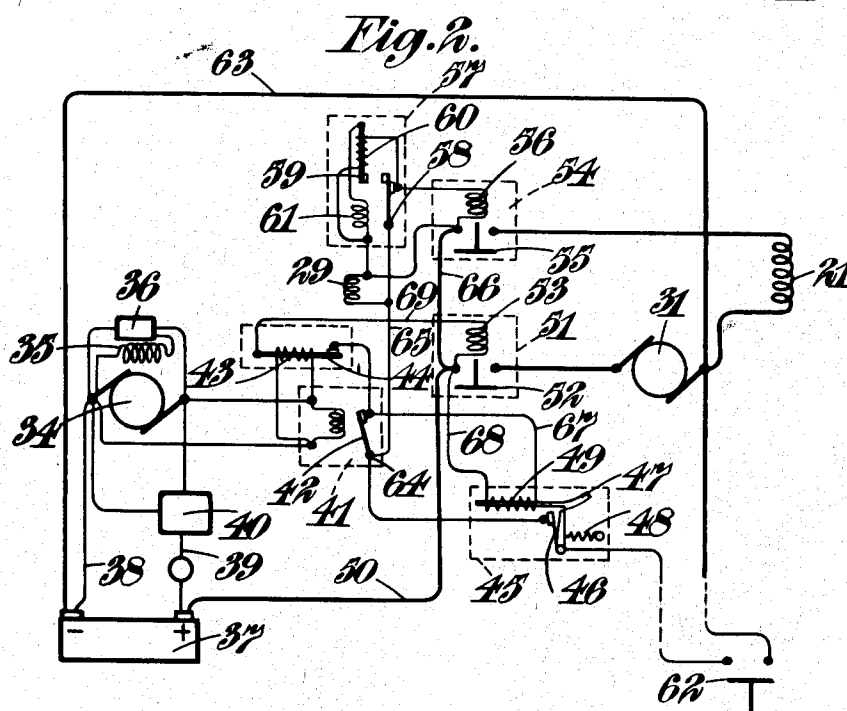
Oct. 10, 1933.

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1,930,200

AUTOMATIC CONTROL OF INTERNAL COMBUSTION ENGINES

Filed April 4, 1933



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UNITED STATES PATENT OFFICE

1,930,200

AUTOMATIC CONTROL OF INTERNAL COMBUSTION ENGINES

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Application April 4, 1933, Serial No. 664,393, and in Great Britain April 2, 1932

3 Claims. (Cl. 290—36)

This invention relates to the automatic control of electrically-started internal-combustion engines, particularly fuel-injection compression-ignition engines, its main object being to provide improved controlling means which will avoid draining the starting battery of current if the engine should be short of fuel or out of order in some other respect. It should be understood that the engine has an electric starting motor, an electric battery, a main control switch for effecting the electrical connection of the motor to the battery for starting the engine, and an electric generator mechanically connected to be driven by the engine.

According to the invention, a cut-out relay is electrically connected to the generator and arranged to operate, when the engine is running sufficiently to drive the generator at a predetermined speed, to effect the opening of the circuit through the starting motor. In the case of a fuel-injection engine where the clearance volume can be reduced to increase the compression ratio with a view to facilitating compression-ignition when starting, this reduction of clearance volume is preferably effected by an electro-magnetic device, as described in British Specification No. 352,591, which is energized on the closure of the main control switch and automatically de-energized after a predetermined time lag.

In the accompanying drawing illustrating one method of carrying out the present invention:—

Figure 1 is a somewhat diagrammatic elevation of a fuel-injection compression-ignition engine; and

Figure 2 is a diagram of the electrical connections therefor.

The drawing shows an engine with a clearance volume in the form of two spaced cavities 10, 11, interconnected by a narrow passage 12 which can be closed by the valve 13 leaving only the cavity 10 in communication with the interior of the cylinder. The outer end of the valve is connected by the toggle links 14, 14 which are hinged at 15 to a supporting bracket 16 and biased by the spring 17 to the position shown in which the passage 12 is not closed. The common pivot of the toggle carries a roller 18 disposed above the stem 19 of an armature 20 associated with the solenoid coil 21 such that on energization of this coil the armature will be raised, the toggle links straightened against the spring bias, and the passage 12 closed by the valve 13. With its clearance volume thus reduced its starting by compression-ignition becomes an easy matter.

The fuel injection is effected from the pump

22 along the pipe line 23 and is controlled in any convenient manner, preferably as described in British specification No. 384,360, by the slidable rod 24. This has a head 25 engaged by one arm of a bell crank 26 which is biased anti-clockwise by the spring 27 to cut the fuel supply off. Associated with the other arm of the bell crank is the movable element 28 of a solenoid winding 29 such that when the winding is energized the bell crank will be rocked clockwise against the spring bias, allowing the rod 24 to be operated (manually or by a governor) to control the fuel supply.

The drawing also shows a toothed ring 30 on the flywheel and positioned adjacent thereto is an electric starting motor 31 the shaft of which is formed with a quick thread 32 on which is mounted a pinion 33 adapted to be flung along the shaft into engagement with the toothed ring when the starting motor is energized.

The other end of the crankshaft is mechanically connected to an electric generator 34. This latter has a field winding 35 and a charge rate regulator 36 of known form, and it is electrically connected across the terminals of the starter battery 37 by the leads 38, 39, the usual battery cut-out 40 being connected in this circuit as shown.

In addition, the cut-out relay 41 has its winding connected across the generator terminals, the relay being designed so that its normally-closed contact member 42 will not open until the generator voltage reaches a predetermined value such as will not be reached until the engine is firing fairly regularly and running under its own power. Furthermore, the winding 43 around the normally closed bi-metallic contact strip 44 of a time-delay switch is also connected across the generator terminals.

45 is a thermal circuit breaker the contact member 46 of which is adapted to be held closed by the thermostatic latch 47, being biased to the open position by the spring 48. The winding 49 around the thermostatic latch is connected to the contact member 42 when closed and to the positive terminal of the battery by the lead 50.

51 is the starter motor relay having a contact member 52 and a winding 53.

54 is the starter valve relay having a contact member 55 and a winding 56. 57 is the starter valve delay switch and cut-out, including a normally-closed contact member 58, a bi-metallic contact strip 59 which is spaced from the contact 58 until sufficiently heated by the coil 60. Upon engaging it a circuit is completed for the coil 61

which, when energized, attracts the contact member 58 to break the circuit of the winding 56.

In operation, on closure of the main control switch 62 by manual or automatic means, a circuit is completed from the negative terminal of the battery by the lead 63 through the switch 62, through the contact member 46, to the terminal 64; and from there through four windings in parallel to the positive terminal of the battery by the lead 50. One course is through the fuel cut-off coil 29 by the lead 65 and the lead 66. Another circuit from the terminal 64 is by the lead 65, through the contact member 58, through the winding 56 of the starter valve relay, and to the lead 66. Another circuit is through the contact member 42 to the winding 49 by the lead 67, and thence by the lead 68. The fourth circuit is through the contact member 42, the contact member 44 and thence by the lead 69 to the coil 53 of the starter motor relay.

Thus, the starter valve relay 54 and starter motor relay 51 are energized to close circuits for the starter valve solenoid coil 21 and the starter motor 31 which will be easily traced; the fuel cut-off coil 29 is energized to allow of the fuel pump operating; and current flows through the heating coil 49. The thermostatic latch 47, however, remains in latching position for quite a material time, the temperature rise necessary to operate the latch only occurring when it is quite safe to assume that the engine is without fuel or that some other defect has occurred by which it will be unable to start. If, however, for some reason the engine cannot start, when the thermostatic latch 47 has been sufficiently heated it releases the spring-pressed contact 46 allowing this to open the above-traced circuits.

When the engine begins to fire and to run under its own power the voltage of the generator 34 reaches a value at which the starter relay cut-out 41 responds, the contact member 42 opening the circuit through the heating coil 49 and also the circuit through the winding 53 of the starter motor relay 51, thus causing the contact member 52 to open to effect the de-energization of the starter motor.

The fuel cut-off coil 29, however, remains energized, as does also the winding 56 of the starter valve relay, for it is advisable that the starter valve 13 should remain closed for a predetermined period after the engine has started to run under its own power until it is warmed up sufficiently. This is particularly useful in those cases where the ambient temperature may be very low.

Meanwhile, current has been flowing through the winding 60 to cause the gradual heating of the thermostatic strip 59, and after a predetermined period (subsequent to the opening of the cut-out relay contact member 42) the thermostatic strip 59 will engage the contact member 58 and thus complete a circuit for the cut-out winding 61, whereupon the contact member 58 is moved to break the circuit through the winding 56 of the starter valve relay 54, thus to break the circuit through the starter valve solenoid winding 21. The circuit through the heating coil 60 is also broken, and the circuit through the cut-out winding 61 is maintained closed until the main control switch is opened.

The engine is then running normally and it may carry out any pumping or other operation for which it is designed. The generator will supply current to the battery 37 for charging purposes.

The heating effect of the winding 43 will cause

flexing of the thermostatic member 44 and thus break the circuit for the winding 53 of the starter motor relay 51. This circuit, however, has been previously broken by the contact member 42; but, in the event of the engine running out of fuel or some part breaking and the engine stopping, the contact member 42 would close, and if it were not for the circuit being additionally opened by the contact member 44 an attempt would be made to restart the engine. This, however, is prevented until the thermostatic strip 44 has cooled. By that time the thermostatic latch will have lifted to release the contact 46.

On opening of the main control switch 62 the fuel cut-off coil 29 is de-energized and the engine therefore ceases to operate until such time as the main control switch is again closed.

It will be seen that the invention provides in a very simple manner for the automatic control of a fuel-injection compression-ignition engine.

What I claim as my invention and desire to secure by Letters Patent of the United States is:—

1. The combination with an internal-combustion engine, an electric starting motor therefor, a battery, and a switch for effecting the connection of the battery to the motor, of an electric generator connected to be driven by the engine, a cut-out relay connected to the generator and arranged to operate, when the engine is running sufficiently to drive the generator at a predetermined speed, to effect the opening of the circuit through the starting motor, and a time-lag device for opening the circuit through the starting motor in the event of the engine stopping after the operation of the cut-out relay, the time-lag device having an energizing winding connected to the generator.

2. The combination with an internal-combustion engine, an electric starting motor therefor, a battery, and a switch for effecting the connection of the battery to the motor, of an electric generator connected to be driven by the engine, a cut-out relay connected to the generator and arranged to operate, when the engine is running sufficiently to drive the generator at a predetermined speed, to effect the opening of the circuit through the starting motor, and a time-lag device for opening the circuit through the starting motor in the event of the engine stopping after the operation of the cut-out relay, the time-lag device having an energizing winding connected to the generator, the windings of the cut-out relay and time-lag device being connected in parallel and their contacts in series.

3. The combination with a compression-ignition engine having a starting valve, electro-magnetic means for closing the starting valve, an electric starting motor for the engine, a battery, and a main control switch for effecting the connection of the battery to the motor and to the electro-magnetic means, of an electric generator connected to be driven by the engine, a cut-out relay energized from the generator and operable at a predetermined generator voltage to effect the opening of the circuit through the starting motor, and a time-lag device operable to disconnect the electro-magnetic means subsequent to the operation (when the engine starts normally) of the cut-out relay.

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