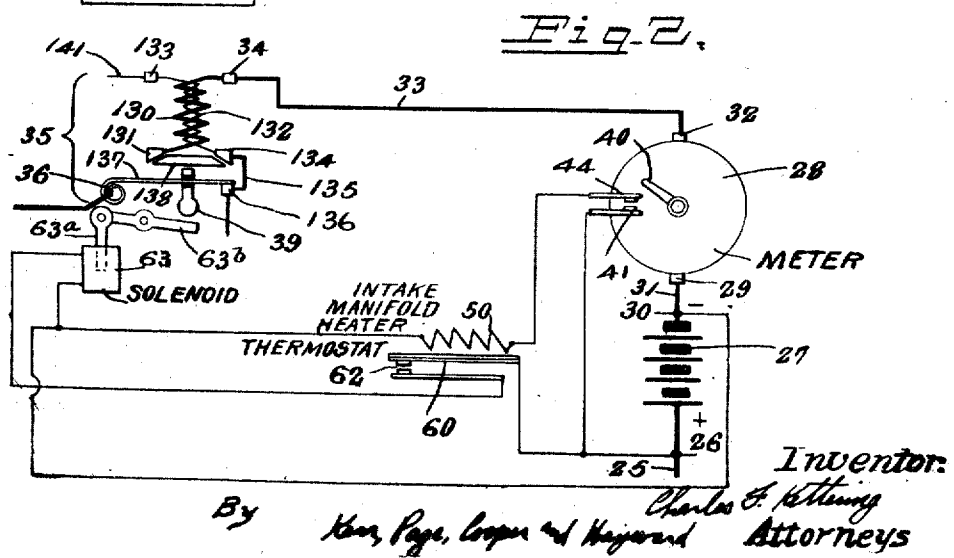
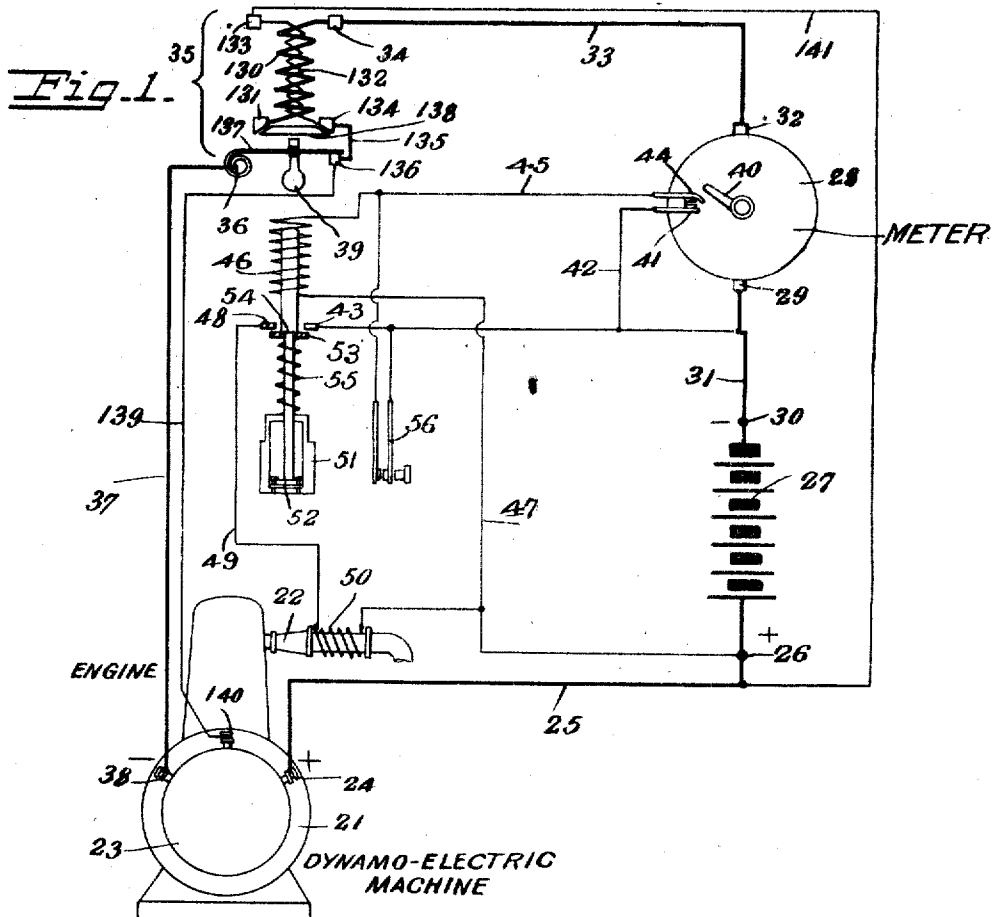


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1,501,852

C. F. KETTERING
ENGINE STARTING SYSTEM

Filed Nov. 2, 1918



UNITED STATES PATENT OFFICE.

CHARLES F. KETTERING, OF DAYTON, OHIO, ASSIGNOR, BY MESNE ASSIGNMENTS, TO
DELCO-LIGHT COMPANY, OF DAYTON, OHIO, A CORPORATION OF DELAWARE.

ENGINE-STARTING SYSTEM.

Application filed November 2, 1918. Serial No. 280,777.

To all whom it may concern:

Be it known that I, CHARLES F. KETTERING, a citizen of the United States of America, residing at Dayton, county of Montgomery, State of Ohio, have invented certain new and useful Improvements in Engine-Starting Systems, of which the following is a full, clear, and exact description.

This invention relates to starting systems for internal-combustion engines, and more particularly to systems for use in connection with internal-combustion engines using heavy hydrocarbons, such as kerosene, for fuel.

The principal objection to kerosene as a fuel has arisen from its difficulty of vaporization when cold, or at normal temperatures, and especially from the apparent impossibility of obtaining sufficient vaporization of such cold fuel to permit starting of the engine. Many devices have been tried for producing ready vaporization of this fuel, and a number of these work successfully after the engine has been started upon a high-grade fuel and operated until hot, but no successful means for starting an engine on kerosene alone has been heretofore devised.

The object of the present invention, therefore, is to provide means for subjecting such a heavy hydrocarbon fuel to treatment preliminary to operating the starting mechanism, which will induce a sufficiently ready vaporization to insure starting of the engine without the use of any supplementary high gravity fuel whatsoever, and to automatically delay functioning of the starting apparatus until such time as the preliminary treatment of the fuel has been completed.

This invention has been especially devised for use in connection with a lighting system, in which a kerosene engine drives an electric machine to charge a storage battery, and it is therefore described and illustrated in such connection. It is to be understood, however, that my invention is by no means limited in its applicability, but that it may be used in connection with any type of internal-combustion engine regardless of the character of the fuel used or the purpose to which such engine is put.

In the drawing, in which like characters of reference designate like parts throughout the various views, Fig. 1 is a diagrammatic

view of a complete starting system comprising my invention and Fig. 2 is a modified form of circuit closing apparatus.

In the drawing, 21 is an internal-combustion engine having an inlet manifold 22 for supplying the necessary fuel thereto. Driven by this engine is an electric machine 23, having its positive terminal 24 connected by means of the conductor 25 to the positive pole 26 of the storage battery 27 and adapted upon operation to charge this battery. This electric machine is also adapted to act as a motor for starting purposes, the operation being such that when it is desired to start the engine, current from the battery 27 is supplied to the field magnets and armature thereof, causing a rotation of the armature which is operatively connected to the driving shaft or flywheel of the engine. Such rotation of the armature during the passage of current through the field magnets will start the engine. Operation of the engine will in turn rotate the armature, and, as soon as the speed of rotation thereof is sufficient, the current generated will start charging the battery. It is quite obvious that any other form of electric starter for the engine can be used, if desired, inasmuch as the precise form of starter is immaterial so far as concerns this particular invention.

Located in any convenient place is a meter 28, one terminal 29 of which is connected to the negative pole 30 of the battery 27, by means of the conductor 31. This meter 28 may be an ampere hour meter operable in both directions to indicate the state of charge of the battery. The other terminal 32 of this meter is connected through the conductor 33 with one terminal 34 of the controller 35. Another terminal 36 of the controller is connected through the conductor 37 with the negative terminal 38 of the electric machine 23. The controller 35 is preferably similar in structure to that one illustrated and described in the co-pending application of Charles F. Kettering and William A. Chryst, filed September 14, 1916, Serial No. 120,098. Controller 35 includes a magnet coil 130 connected between terminal 34 and contact 131 and magnet coil 132 of relatively fine wire connected with terminal 133 and contact 134. Wire 135 connects contact 134 with contact 136 which is connected normally by a resilient contact 137 with terminal 36. Contact 137 may be moved by

handle 39 but is insulated therefrom. Contact 138 is normally out of engagement with contacts 131 and 134 but may be moved into engagement therewith by handle 39. Terminal 133 is connected by wire 141 with the positive side of the charging circuit. Contact 136 is connected by wire 139 with terminal 140 of the electric machine 23.

The actuator will now be described: Carried by the meter 28 and movable across the face thereof for indicating purposes is a hand 40. Rigidly attached to the face of the meter is a contact element 41 connected by means of the conductor 42 to the terminal 43 of a switch operated by the actuator solenoid 46. Movably attached to the face of the meter 28 is a contact element 44 connected by means of the conductor 45 to the solenoid 46, which is in turn connected through the conductor 47 with the positive pole 26 of the battery 27. As the battery discharges or charges, the indicating hand 40 will move to or from the contact 44. If the battery discharges a sufficient amount, this hand will move in contact with the contact element 44 and force that element itself into contact with the fixed element 41, thus closing the circuit from the battery through the actuator solenoid 46 to energize the same.

Positioned adjacent the terminal 43 is a corresponding terminal 48, connected by means of the conductor 49 and the heating coil 50 to the conductor 47, and through that conductor to the positive pole 26 of the battery 27. Located below the terminals 43 and 48 is the actuator dash-pot 51 having therein a plunger 52, the upper end of which is extended sufficiently to pass into the solenoid 46. Slidably surrounding this plunger 52 is a ring contact 53, normally held against the shoulder 54 of plunger 52 by means of the spring 55. This ring 53 is so positioned that normally it is held from contact with the terminals 43 and 48. If, however, the contact elements 44 and 41 are moved into contact to thus close the circuit through the solenoid 46 and energize that solenoid, the plunger 52 will be drawn upwardly and the ring 53, acting under the influence of the spring 55, will be moved into contact with the terminals 43 and 48, thus causing a current to flow there-across and through the heating coil 50. Because of the dash-pot 51, the upward movement of the plunger 52, under the action of the solenoid 46, will be gradual, the speed of movement being, of course, entirely dependent upon the strength of the solenoid and the rate of leakage into the dash-pot below the plunger 52. As soon as the ring 53 closes the circuit through the heating coil 50, across the contacts 43 and 48, the said coil 50 will begin to heat up, and inasmuch as it surrounds the intake pipe through which fuel flows to the cylinder of

the engine 21, it is evident that such pipe will be also heated, so that any fuel flowing therethrough will be more easily vaporized. It has been found from experience that if such a heavy hydrocarbon as kerosene is passed over or through a heating coil of practicable dimensions as soon as current is passed therethrough, the heat of the coil will be dissipated by the fuel as quickly as generated and will be insufficient in amount to vaporize the comparatively large quantities of fuel passing to the engine. It is necessary, therefore, to delay the passage of fuel through the manifold until such time as the coil has had an opportunity to heat the entire body of the manifold adjacent thereto, so that ample heat will be stored up to cause vaporization of the fuel before undue cooling of the manifold and heating coil can ensue. Otherwise starting cannot be secured by the use of a heavy fuel alone.

It is to give this opportunity for heating of the manifold that the dash-pot 51 is used. As is clearly shown in the drawing, the plunger 52, when raised sufficiently by the action of the solenoid 46, will contact with the handle 39 of the controller 35 to cause the separation of contacts 136 and 137 and to cause contact 138 to move into engagement with contacts 131 and 134, thereby permitting the passage of current from the battery 27 to the electric machine 23 through the following circuit: wire 25, electric machine 23, terminal 140, wire 139, contact 136, wire 135, contact 134, contact 138, contact 131, magnet coil 130, terminal 34, wire 33, meter 28 and wire 31. The electric machine is thus operated as a starting motor, which, having a series field winding, has strong starting characteristics. By using the dashpot 51, the upward movement of the plunger to move the handle 39 is delayed sufficiently to permit of a proper heating of the manifold 22. Consequently, when the handle 39 is moved to start the engine, the manifold is heated to such a temperature that the first kerosene drawn therethrough is so vaporized as to permit immediate starting of the engine.

As described above, the starting of the engine is completely automatic and the apparatus is so arranged that such starting will take place before the battery has discharged sufficiently to cause any injury thereto. It is quite obvious, however, that manual starting of the engine may be desirable, as for instance, where the battery is not discharged sufficiently to cause an automatic starting, but where, nevertheless, it is desired to renew the charge of the battery. In order to permit of manual starting of the engine, a hand-operated switch 56 is provided, which is adapted to close the circuit from the negative pole of the battery 30, through the actuator solenoid 46,

with the same ensuing operations as are present where the starting is automatic. It is evident that to start the engine manually, it is merely necessary to hold such switch closed until the engine is started. This will result in the passage of a current through the solenoid 46 to move the ring 53 into contact with the terminals 43 and 48, with a resulting passage of current through the heating coil 50. This will also, in due time, cause the plunger 52 to move the handle 39, and thus start the engine. Starting of the engine, therefore, either automatically or manually, involves a definite sequence of operations; in other words, closing of the circuit through the solenoid 46, either manually or automatically, results in the passage of a current through the heating coil 50, and, after a predetermined length of time, in closing of the circuit supplying current to the starter 23, to bring about starting of the engine.

As soon as the engine attains a sufficient speed of operation, the electric-machine 23 will begin to charge the battery 27. This will result in a movement of the hand 40 away from the movable contact 44 to thus break that contact and break the current flowing through the solenoid 46. This will in turn result in a return of the plunger 52 to the bottom of the dash-pot 51 to break the contact between the ring 53 and the terminals 43 and 48, and to also permit of a return movement of the controller handle 39 and the resilient contact 137, which latter, by engaging with contact 136, will short-circuit the series field winding during the generating operation of the electric machine. The controller handle 39 having returned to its original position, the controller will then be free to operate as a circuit breaker to automatically break the charging circuit across the terminals 34 and 36.

As described in the copending application referred to, the contact 138 is maintained magnetically in engagement with contacts 131 and 134 during the normal generating operation of dynamo 23. But, if for any reason, the generator voltage should decrease below battery voltage, a reversal of current in magnet coil 130 will cause coils 130 and 132 to act differentially with the result that the contact 138, will drop away from the contacts 131 and 134 and the circuit between the battery and the generator will be broken. Thus it is apparent that the return of the plunger 52 to the bottom of the dash pot permits of the automatic breaking of the charging circuit in the manner described.

Fig. 2 shows a modification of the actuating mechanism for the heating and starting apparatus. Contact of the terminals 41 and 41 causes a passage of current through

the heating coil 50. This coil is adapted not only to heat the manifold with which it is associated, but, also, to heat the thermostatic strip 60 and cause sufficient deformation of that strip to close the switch 62, which allows the passage of current through the solenoid 63 and thus causes a closing of the circuit through the starting mechanism. The solenoid 63 may operate handle 39 of controller 35 in any suitable manner, for example by drawing down a plunger 63^a which moves a lever 63^b upwardly into engagement with handle 39.

After the engine has been started and the battery charging operation continues, the hand 40 moves away from contacts 44, 41 permitting them to separate and to break the circuit to the intake manifold heater 50. Then thermostatic strip 60 will unbend and interrupt the circuit between the battery 27 and solenoid 63. Thereupon controller handle 39 may return to normal position, and thereafter the contact 138 may drop away from contacts 131 and 134 when the controller 35 operates automatically to break the circuit between the dynamo and battery.

While the forms of mechanisms herein shown and described constitute preferred embodiments of one form of the invention, it is to be understood that other forms might be adopted, and various changes and alterations made in the shape, size, and proportion of the elements therein without departing from the spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent is:

1. In a starting system, the combination with an internal-combustion engine and a dynamo electric machine driven thereby as a generator, but operable as a motor to start the engine; of a battery; a controller for connecting the dynamo with the battery; an electric fuel vaporizer; an electrically operated actuator for connecting said vaporizer with the battery and then, after a predetermined period, for rendering the controller operative, said actuator having an electromagnet and a movable member controlling the vaporizer during the first part of its movement and then the starter controller during a predetermined later part of its movement, said actuator having means to retard the movement of said movable member toward the magnet; and means for connecting said magnet with the battery.

2. In a starting system, the combination with an internal-combustion engine and a dynamo electric machine driven thereby as a generator, but operable as a motor to start the engine; of a battery; a controller for connecting the dynamo with the battery; an electric fuel vaporizer; an electrically operated actuator for connecting said vaporizer

with the battery and then, after a predetermined period, for rendering the controller operative; said actuator having an electromagnet and a movable member controlling the vaporizer during the first part of its movement and then the starter controller during a predetermined latter part of its movement, said actuator having a dash-pot to retard the movement of said movable member toward the magnet; and means for connecting said magnet with the battery.

3. In a starting system, the combination with an internal-combustion engine and a starting device therefor; of a fuel vaporizer; a current source; an actuator having an electromagnet and a movable member for rendering the fuel vaporizer operative during the first part of its movement, and then for rendering the starter operative during a predetermined later part of its movement, said actuator having dash-pot provisions to retard the movement of said movable member; and means for connecting the magnet with the current source.

4. In a starting system, the combination with an internal-combustion engine and a dynamo electric machine driven thereby and operable as a generator or as a motor to start the engine; of a battery; a controller for connecting the battery and dynamo together to operate the latter as a motor, said controller having provisions for maintaining said connections between the battery and dynamo during the generating operation of the latter, said provisions automatically breaking said connections when the battery tends to discharge through the dynamo; a fuel vaporizer; an actuator operable to render the fuel vaporizer operative and then, after a predetermined period to render the controller operative; and means for controlling said actuator, the release of said means permitting the said automatic operation of said controller.

5. In a starting system, the combination with an internal-combustion engine and a dynamo electric machine driven thereby and operable as a generator or as a motor to

start the engine; of a battery; a controller for connecting the battery and dynamo together to operate the latter as a motor, said controller having provisions for maintaining said connections between the battery and dynamo during the generating operation of the latter, said provisions automatically breaking said connections when the battery tends to discharge through the dynamo; a fuel vaporizer; and means for rendering the vaporizer operative and then, after a predetermined period for rendering the controller operative, said means being dependent on the state of battery charge, the release of said means permitting the said automatic operation of said controller.

6. In a starting system, the combination with an internal-combustion engine and a dynamo electric machine driven thereby and operable as a generator or as a motor to start the engine; of a battery; a controller for connecting the battery and dynamo together to operate the latter as a motor, said controller having provisions for maintaining said connections between the battery and dynamo during the generating operation of the latter, said provisions automatically breaking said connections when the battery tends to discharge through the dynamo; an electrical fuel vaporizer; an electrical actuator operable to render the fuel vaporizer operative and then, after a predetermined period to render the controller operative; and a meter connected with the battery and adapted at a predetermined battery discharge to connect the actuator with the battery, said meter operating after a subsequent certain battery charge to disconnect said actuator from the battery, whereby to release said actuator to permit the said automatic operation of the controller.

In testimony whereof I affix my signature.

CHARLES F. KETTERING.

Witnesses:

J. W. McDONALD,
M. A. PEARE.