

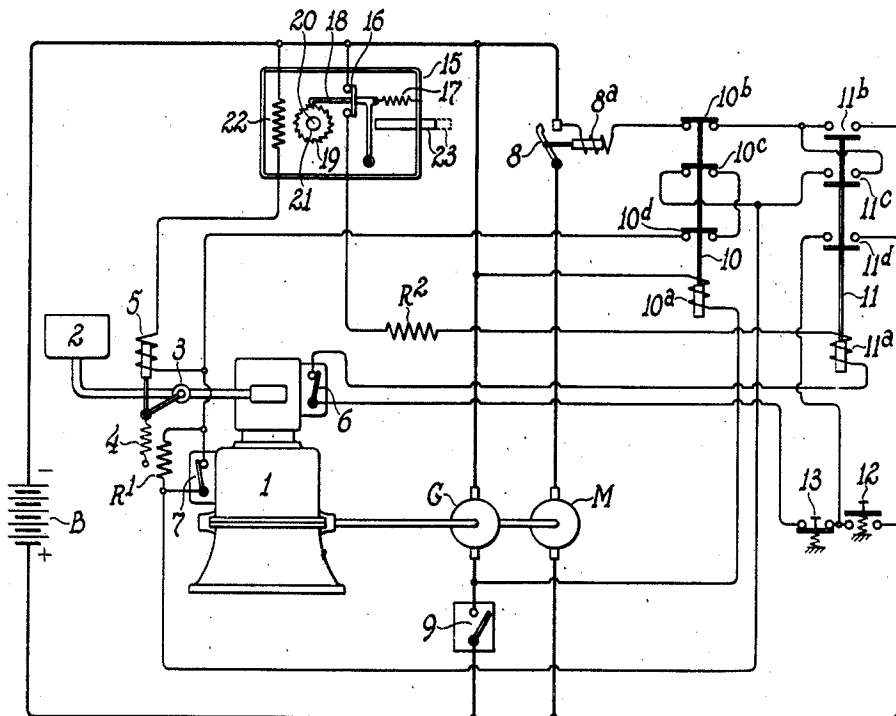
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STARTING SYSTEM FOR INTERNAL COMBUSTION ENGINES

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STARTING SYSTEM FOR INTERNAL COMBUSTION ENGINES

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This invention relates to starting systems for internal combustion engines.

The invention is particularly applicable to systems for automatically starting Diesel engines of the type having a cranking motor to be supplied with current from a storage battery and a generator for charging said battery.

An object of the invention is to provide a starting system for Diesel engines of the aforesaid type having improved means for automatically deenergizing the cranking motor upon starting of the engine or upon failure of the engine to start within a predetermined interval.

Another object is to provide a starting system of the aforesaid character which provides for automatic stopping of the engine upon overheating thereof and also upon failure of pressure in the oil lubricating system of the engine.

Another object is to provide a system of the aforesaid character having improved means for controlling the fuel supply for the engine.

Various other objects and advantages of the invention will hereinafter appear.

The accompanying drawing schematically and diagrammatically illustrates an embodiment of the invention which will now be described, it being understood that the embodiment illustrated is susceptible of modification without departing from the spirit and scope of the appended claims.

Referring to the drawing, the same illustrates a Diesel engine 1 to be supplied with fuel from a tank 2 and having a fuel control device 3 associated therewith which is normally held in closed position by a spring 4 and is movable into a position to admit fuel to the engine by a solenoid 5. The engine is provided with a cranking motor M to be supplied with current from a battery B, a generator G for charging said battery and a pair of normally closed switches 6 and 7, the former switch being thermostatically controlled and being adapted to open when the temperature of the water in the cooling system of the engine rises to a given value and the latter switch being responsive to pressure in the oil lubricating system of the engine.

The cranking motor M is controlled by a normally open electromagnetic starting switch 8 and the generator G has a normally open cutout device 9 associated therewith which is of the type usually employed in battery charging systems for connecting the generator to the battery B when the engine is started and for disconnecting the generator from said battery when the engine is stopped.

Starting switch 8 and also the operating solenoid 5 of fuel control device 3 are controlled by a pair of electromagnetic relays 10 and 11. Relay 10 is provided with an operating winding 10^a which is permanently connected across the terminals of generator G and the same is also provided with three sets of normally closed contacts 10^b, 10^c and 10^d which are connected as hereinafter set forth. Relay 11 is provided with an operating winding 11^a and three sets of normally open contacts 11^b, 11^c and 11^d which are connected as hereinafter set forth and the energizing circuit for said relay is controlled by switch 6 and also by a normally open start push button 12, a normally closed stop push button 13 and a timing relay 15.

Timing relay 15 includes a switch 16 biased towards open position by a spring 17 and having a latch 18 associated therewith which engages a ratchet wheel 19 to normally hold the same in closed position. Ratchet wheel 19 is secured to a stationary pin 20 by a solder connection 21 and said ratchet wheel has an electric heater 22 associated therewith which is connected in series with the operating solenoid 5 of fuel control device 3. As hereinafter set forth, the heater 22 acts upon failure of the engine to start within a predetermined interval or upon failure of pressure in the oil lubricating system of the engine to fuse the solder connection 21 and thereby release the ratchet wheel 19 from pin 20 for opening of switch 16. Switch 16 when opened is adapted to be reset by a manual operating member 23.

The operation of the aforescribed control system and also the circuit connections therefor will now be more fully described.

To effect starting of the engine, start push button 12 is depressed and circuit is then established from the positive terminal of battery B through said start-push button, through stop push button 13, and temperature responsive switch 6, to and through the operating winding 11^a of relay 11, and through a resistance R² and switch 16 of the timing relay 15 to the negative terminal of battery B. Relay 11 then responds and the contacts 11^d thereof shunt push button 12 to maintain the operating winding 11^a energized upon release of said push button. Switch 8 closes upon response of relay 11, an energizing circuit therefor being established from the positive terminal of battery B through contacts 11^b of relay 11 and contacts 10^b of relay 10, to and through the operating winding 8^a of said starting switch to the negative terminal of the

battery B. Closure of switch 8 connects cranking motor M across the terminals of battery B. Also upon response of relay 11 the fuel control device 3 is energized by a circuit extending from the positive terminal of battery B through contacts 11^b and 11^c of relay 11, through contacts 10^c and 10^d of relay 10, to and through the operating solenoid 5 of said fuel control device and through heater coil 22 of timing relay 15 to the negative terminal of battery B.

Thus upon depression of start push button 12 motor M is energized to crank the engine and fuel control device 3 is energized to admit fuel to the engine. Under normal conditions the engine will then start firing and when the voltage of generator G builds up to a given value operating winding 10^a of relay 10 which is connected across the terminals of said generator will be energized to effect response of said relay. Relay 10 in responding interrupts the aforescribed energizing circuit for starting switch 8 and said switch then drops out to deenergize the cranking motor M. Also when the engine is started the cutout device 9 responds to connect generator G across the terminals of battery B.

Upon starting of the engine, switch 7 opens in response to pressure in the oil lubricating system of the engine and solenoid 5 of fuel control device 3 is maintained energized by a circuit extending from the positive terminal of battery B, through contacts 11^b and 11^c of relay 11, through a resistance R¹ to and through said solenoid and through heater coil 22 to the negative terminal of the battery. Inclusion of resistance R¹ in the energizing circuit of the operating solenoid 5 reduces the current in such circuit to a value which is sufficient to maintain fuel control device 3 in on position. However, the current in heater coil 22 is reduced to such a value that the heat generated in said coil is insufficient to fuse solder connections 21 of timing switch 15. The timing device 15 is thus rendered ineffective upon starting of the engine.

However, if the engine fails to start relay 10 remains in normal position and the current in the aforescribed energizing circuit for solenoid 5 is of sufficient value to cause heater coil 22 to fuse the solder connection 21 of timing device 15 after a predetermined interval. The switch 16 of said timing device then opens to interrupt the aforescribed energizing circuit for relay 11 and said relay in dropping out interrupts the aforescribed energizing circuit for starting switch 8. The cranking operation is thus discontinued upon failure of the engine to start within a predetermined interval and before the engine can be re cranked it is necessary to reset timing device 15.

As hereinbefore set forth, switch 6 is adapted to open when the temperature of the cooling water for the engine rises above a given value and is connected in the energizing circuit of relay 11. Thus switch 6 is adapted to act upon overheating of the engine to deenergize relay 11 and said relay in dropping out interrupts the aforescribed energizing circuit for fuel control device 3 to effect stopping of the engine. Switch 7 which is responsive to pressure in the oil lubricating system of the engine is connected in shunt with resistance R¹ in the aforescribed maintaining circuit for solenoid 5. Thus if the oil pressure falls during operation of the engine, switch 7 closes to shunt resistance R¹ and thereby increases the current in heater coil 22. The heater coil 22 then acts after a predetermined inter-

val to cause switch 16 to open and upon opening of said switch the engine is stopped as hereinbefore set forth.

In connection with the foregoing it should be noted that with the aforescribed cranking control system it is only necessary to momentarily depress the start push button 12 to effect starting of the engine and to momentarily depress the stop push button 13 to insure stopping thereof. On the other hand, it should be noted that if the heater coil 22 of timing device 15 burns out or if the energizing circuit for the operating solenoid 5 of fuel control device 3 becomes defective for any reason said fuel control device will remain in off position to prevent starting of the engine.

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

1. The combination with an internal combustion engine having a cranking motor and an electromagnetically operated fuel control device associated therewith, said fuel control device being normally held in a given off position and being responsive when energized to admit fuel to said engine, of means for simultaneously energizing said cranking motor and said fuel control device to effect starting of said engine and for automatically deenergizing said cranking motor and maintaining said fuel control device energized when said engine becomes self-operative and means associated with said former means for deenergizing said cranking motor and said fuel control device upon energization of said cranking motor for a predetermined interval, said latter means including an electro-thermal timing device connected in series in the energizing circuit for said fuel control device.

2. The combination with an internal combustion engine having a cranking motor and an electromagnetically operated fuel control device associated therewith, said fuel control device being normally held in a given off position and being responsive when energized to admit fuel to said engine, of an electromagnetic relay responsive to establish an energizing circuit for said cranking motor and said fuel control device to effect starting of said engine, a second electromagnetic relay responsive to interrupt the energizing circuit for said cranking motor when said engine becomes self-operative, and a timing relay for controlling said first mentioned relay to deenergize said cranking motor and said fuel control device upon energization of said cranking motor for a predetermined interval, said timing relay being rendered ineffective upon response of said second mentioned relay.

3. The combination with an internal combustion engine having a cranking motor and an electromagnetically operated fuel control device associated therewith, said fuel control device being normally held in off position and being responsive to admit fuel to said engine, of means for energizing said cranking motor and said fuel control device to effect starting of said engine and for automatically deenergizing said cranking motor and maintaining said fuel control device energized when said engine becomes self-operative, a thermal relay responsive to control said means to effect deenergization of said cranking motor and said fuel control device upon failure of said engine to become self-operative within a predetermined interval upon cranking thereof, and a heater coil connected in the energizing circuit of said fuel control device for controlling said relay.

4. The combination with an internal combustion engine having a cranking motor and an

electromagnetically operated fuel control device associated therewith, said fuel control device being normally held in off position and being responsive to admit fuel to said engine, of control means for energizing said cranking motor and said fuel control device to effect starting of said engine, an electro-thermal relay associated with said control means and responsive to deenergize said cranking motor and said fuel control device upon failure of said engine to become self-operative within a predetermined interval, said relay being subjected to control by current in the energizing circuit of said fuel control device and means responsive when said engine becomes self-operative to deenergize said cranking motor and to reduce the current in the energizing circuit of said fuel control device to a value sufficient to hold said fuel control device in fuel admitting position and to also render said relay unresponsive.

5. The combination with a water cooled internal combustion engine having a cranking motor and an electromagnetically operated fuel control device associated therewith, said fuel control device being normally held in off position and being responsive to admit fuel to said engine, of control means for energizing said cranking motor and said fuel control device to effect starting of said engine, an electro-thermal relay associated with said control means and responsive to deenergize said cranking motor and said fuel control device upon failure of said engine to become self-operative within a predetermined interval, said relay being subjected to control by current in the energizing circuit of said fuel control device, means

responsive when said engine becomes self-operative to deenergize said cranking motor and to reduce the current in the energizing circuit of said fuel control device to a value sufficient to hold said fuel control device in fuel admitting position and to also render said relay unresponsive and means responsive to the temperature of the water in the cooling system of said engine for deenergizing said fuel control device upon overheating of said engine.

6. The combination with a water cooled internal combustion engine having a pressure oiling system associated therewith, of a cranking motor and an electromagnetically operated fuel control device for said engine, said fuel control device being normally held in a given off position and being responsive when energized to admit fuel to said engine, of means for simultaneously energizing said cranking motor and said fuel control device to effect starting of said engine and for automatically deenergizing said cranking motor and maintaining said fuel control device energized when said engine becomes self-operative, means associated with said former means for deenergizing said cranking motor and said fuel control device upon energization of said cranking motor for a predetermined interval, and means associated with said former means and responsive to a given temperature of the water in the cooling system of said engine and also upon failure of pressure in the oiling system of said engine for deenergizing said fuel control device.

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