Feb. 16, 1937. V. E. PLANTE 2,070,615

OPERATING APPARATUS FOR INTERNAL COMBUSTION ENGINES

Filed April 5, 1934 3 Sheets-Sheet 1

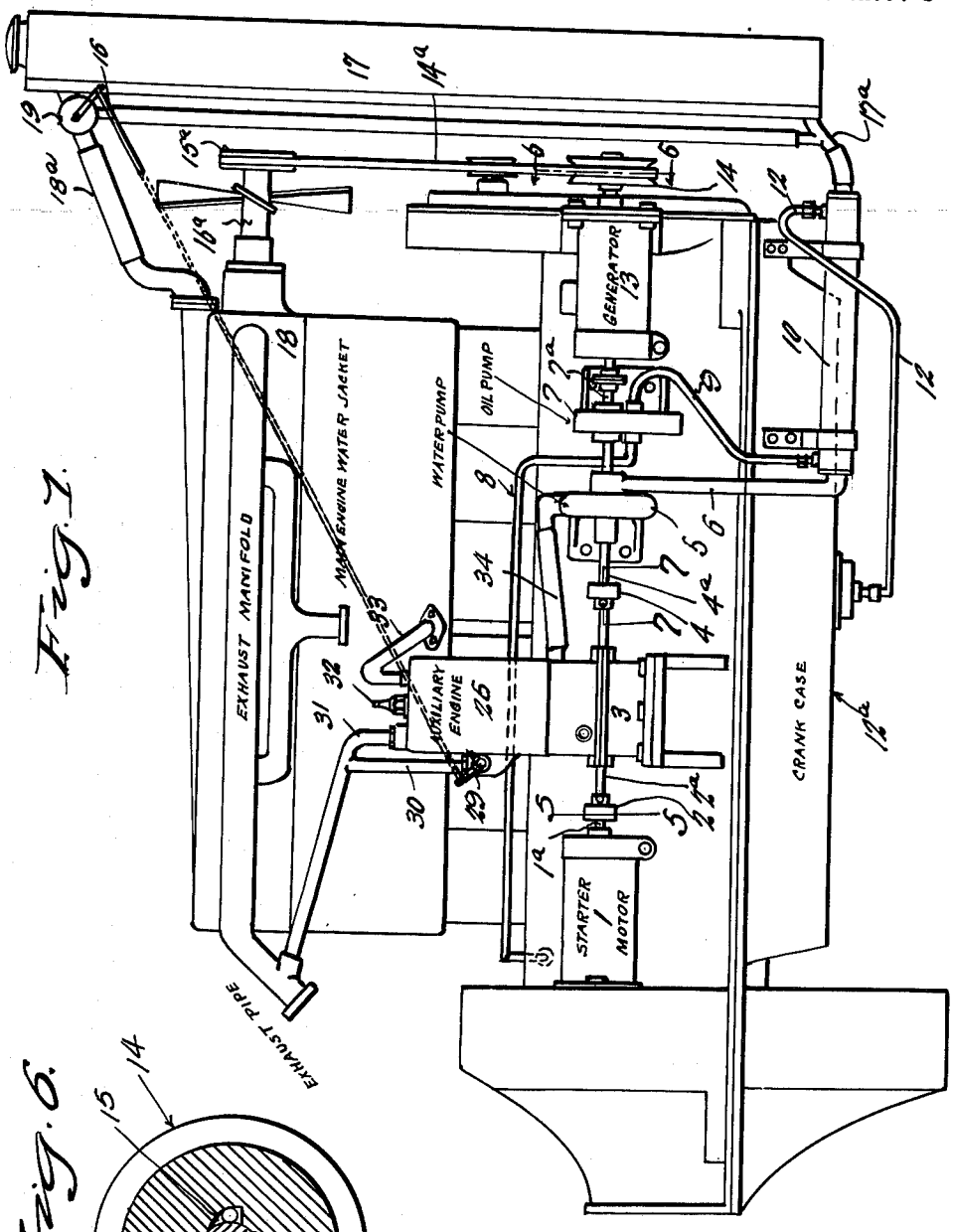


Fig. 1.

Fig. 6.

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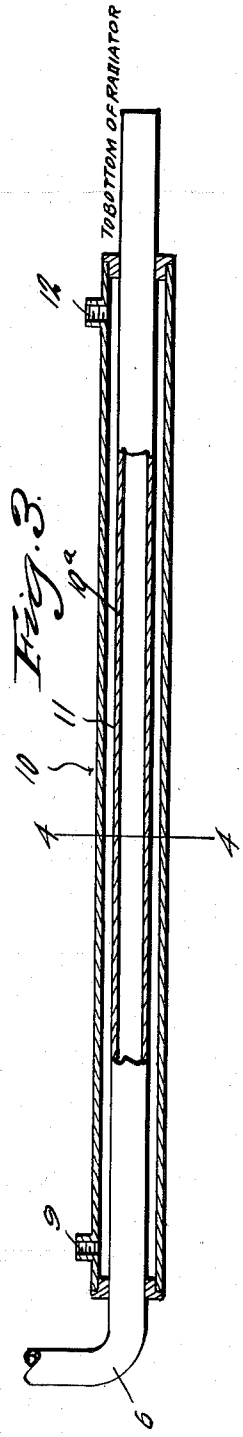


Fig. 3.

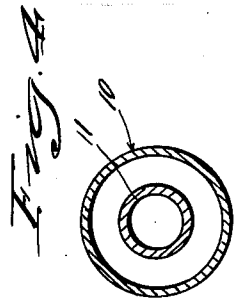


Fig. 4.



Fig. 5.

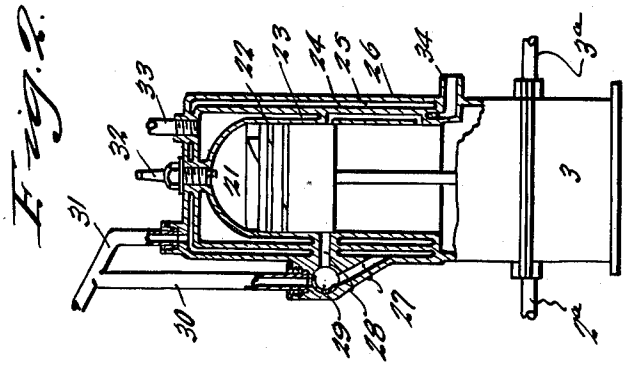


Fig. 2.

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OPERATING APPARATUS FOR INTERNAL COMBUSTION ENGINES

Filed April 5, 1934 3 Sheets-Sheet 3

Fig. 9.

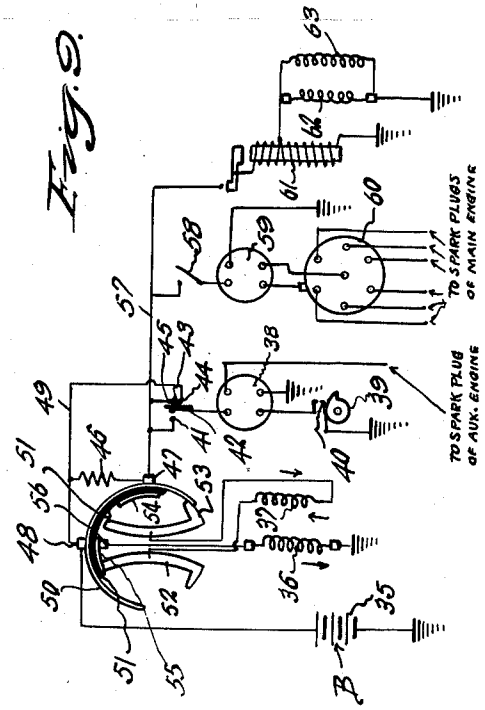


Fig. 11.

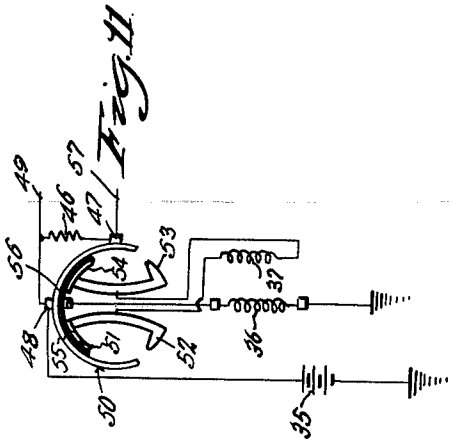


Fig. 7.

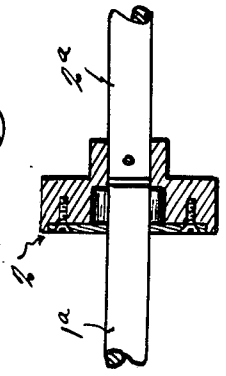


Fig. 8.

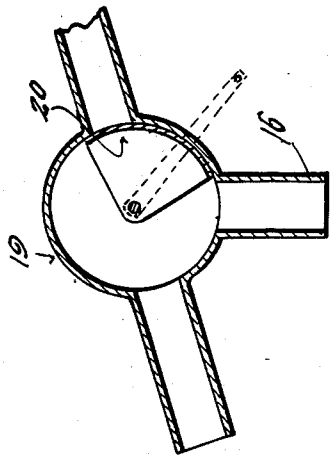
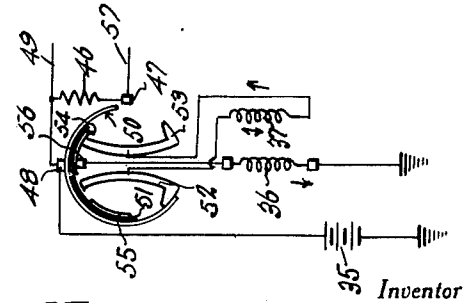


Fig. 10.



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Patented Feb. 16, 1937

2,070,615

UNITED STATES PATENT OFFICE

2,070,615

OPERATING APPARATUS FOR INTERNAL COMBUSTION ENGINES

Victor E. Plante, Milwaukee, Wis.

Application April 5, 1934, Serial No. 719,221

26 Claims. (Cl. 290—4)

This invention relates to an internal combustion engine including means for starting the engine and aiding the functioning of the lubricating system thereof under conditions which would ordinarily render the starting and proper lubrication of the engine difficult, if not impossible.

An important object of my invention is to provide means for preheating the main internal combustion engine to facilitate starting particularly under such adverse starting conditions as those which obtain at low temperatures, by utilizing the heat generated by the combustion in an auxiliary internal combustion engine to preheat the cooling medium in the main engine and in any other parts desired, such as the carburetor fuel pump, etc.

Another important object of my invention is to provide means to preheat and circulate the lubricating oil under greater than normal pressure to the various bearings, thereby assuring thorough lubrication, prior to, during, and after starting the main engine, as well as promoting easy starting.

Another important object of this invention is to provide simple and efficient means for charging the storage battery of the main internal combustion engine at any time or place without resorting to any outside source of supply of electrical energy.

Another important object of the invention is to provide means for supplying additional energy other than that from the storage battery for starting purposes, by operating the auxiliary internal combustion engine to drive the electric generator of the main engine as a motor-generator set to assist the said storage battery in supplying electric energy to the electric starter motor and ignition coils during the starting period.

Another important object of the invention is to provide means for supplying a higher voltage, for ignition purposes, than is obtainable from the storage battery during the starting period, by inserting resistance means in the circuit between the generator and the junction of the battery and starter motor circuit, and by connecting the primary of the main engine ignition coil between the aforesaid resistor and electric generator.

Another important object of the invention is to provide means for driving the oil pump, by means of the electric starter, to supply oil to the main engine bearings, etc., prior to starting the main engine. When it is not desired to operate the auxiliary engine to circulate the oil prior to starting the main engine, the oil pump may be operated, without the functioning of the auxiliary engine, merely by operating the electric starter in the reverse direction just long enough to establish oil pressure, prior to operating the electric starter in the normal or forward direction to start the main engine. This feature is very desirable in warm weather and particularly when the main engine has been standing overnight after having been operated at fairly high temperature, in which case the bearings are quite dry, because the oil which was thinned at high temperature has drained from the bearings. While, under such conditions, the starting conditions are not severe enough to require operation of the auxiliary engine, it will greatly prolong the life of the bearings if the oil pressure in the bearings is established by merely spinning the oil pump, by operating the electric starter in the reverse direction, for a moment, prior to starting the engine.

A still further important object of my invention is to provide means to preheat the storage battery, by operating the electric generator by means of the auxiliary engine, prior to starting the main engine. Aside from the chemical energy which will be stored in the battery, during operation of the generator, some of the generated electrical energy, in overcoming the electrical resistance of the battery, will be transformed into heat energy which will raise the temperature of the battery. While it is not generally known, it is a proven fact that with a given resistance load, as for example, the starter windings, the output of a battery, during cold weather, will be greatly increased if preheated. Hence, it follows that the preheated battery will supply the electric starter and ignition coils with an appreciably greater amount of electrical energy.

In addition to facilitating starting of the main engine the auxiliary engine may be used to circulate the medium used in car heaters for heating the interior of the vehicle particularly when the main engine is not in operation. While such a car heater for the interior of the vehicle is not shown, it may be of any type and may be connected to any desired point in the system whether it be of the cooling-water or hot-air type.

Further, the auxiliary engine may be operated to drive the water pump, oil pump, and generator at a higher speed than that corresponding to the main engine speed to increase the circulation of the cooling medium, the pressure of the oil and hence the supply to the bearings, and the amount of current to provide sufficient circulation of cooling medium, oil supply, and electric current.

The accompanying figures together with the

description of the construction and operation of the apparatus embodying my invention are to be understood to be illustrative only and for the purpose of making clear the nature and manner of employing the invention, and that the invention is not to be regarded as limited to the precise mechanism illustrated nor to any detail thereof. Voltage and current regulators of any kind may be employed depending upon the electrical apparatus used and the operating characteristics desired.

The exhaust gas may be utilized to heat any part of the main engine and any method, other than employing an exhaust gas chamber surrounding the auxiliary engine water jacket, may be used to transfer the heat of the exhaust gas to the cooling medium of the main engine.

In the drawings:—

Figure 1 is a side elevational view showing an embodiment of the invention in an automobile internal combustion engine.

Figure 2 is a vertical longitudinal sectional view through the auxiliary internal combustion engine.

Figure 3 is a longitudinal vertical sectional view taken through the oil heater or cooler.

Figure 4 is a transverse vertical sectional view taken through Figure 3 approximately on the line 4—4.

Figure 5 is a transverse vertical sectional view taken through Figure 1 approximately on the line 5—5.

Figure 6 is a vertical transverse sectional view taken approximately on the line 6—6 of Figure 1 and looking in the direction of the arrows.

Figure 7 is a longitudinal vertical sectional view taken approximately on the line 7—7 of Figure 1.

Figure 8 is a longitudinal vertical sectional view through the thermostatic valve.

Figure 9 is a diagrammatic view of the starter switch and the main parts of the electrical circuits, illustrating the operation of the starter switch and showing it positioned to start the auxiliary engine, provided that the engine switch 42 is positioned to close the contacts 41, the resistor 46 being shorted by the starter switch member 50 in this position.

Figure 10 is a diagrammatic view of the starter switch and its electrical circuits illustrating the position of the starter switch for starting the main engine, the field of the starter being reversed with respect to Figure 9.

Figure 11 is a diagrammatic view of the starter switch and its circuits showing the starter switch in neutral position, in which either of the engines or both may be operating or not operating.

Referring in detail to the drawings, the numeral 1 refers generally to a conventional starter motor wound so as to be capable of being operated in reverse and forward directions. In the forward or normal direction the starter drive engages the flywheel of the main engine to start the same, and in the reverse direction the starter motor acts to start the auxiliary engine through the cooperation of the over-running clutch 2 connected to the auxiliary engine shaft 2a. This overrunning clutch engages only when the starter motor is operated in the reverse direction. The numeral 3 refers to the crank case of the auxiliary engine, and the numeral 4 refers to another oppositely placed over-running clutch which connects the opposite end of the auxiliary engine shaft 2a to the water pump shaft 4a, the water pump being designated by the numeral 5. The clutch 4 engages only when the auxiliary engine is running faster than the shaft of the water pump 5, the oil pump 7, and the generator 13. I desire to include within the scope of the invention any other manner of connection of these members which will permit similar action, whereby the generator, cooling medium pump, or oil pump, or more than one of these elements, can be driven faster than at corresponding main engine speed or while the main engine is not running.

The numeral 6 refers generally to the intake pipe of the cooling medium pump which is jacketed by a casing 10 to form an annular chamber heated by the cooling medium or cooled by the cooling medium in the pipe 6 for heating or cooling the oil which is led thereinto by the pipe 12 from the main engine crank case 12a, and discharged by means of the pipe 9 which is connected to the intake of the oil pump 7. The oil pump outlet pipe 8 carries the oil to lubricate the main engine and auxiliary engine if desired. The oil pump shaft 7a is directly coupled to the shaft of the generator 13. It will be observed that in the oil cooling or heating chamber 11 which is defined by the jacket 10 and the pipe 6, the oil may be cooled when too hot, and warmed when the engine is cold to facilitate starting.

The numeral 14 refers to an over-running pulley which is mounted on the generator shaft and connected to the fan assembly 16a by the belt 14a trained over the pulley 14 and the fan assembly pulley 15a, whereby the generator, the oil pump, and the cooling medium pump, are normally driven by the main engine as it is operating under normal circumstances. Of course, where the generator drive is through gears or through a belt other than that which drives the fan, a suitable overrunning arrangement of the connection to the generator may be provided for, without invention. The overrunning pulley 14 engages the shaft of the generator only when the generator is being driven by the main engine.

The numeral 16 designates a by-pass pipe between the radiator outlet 17a and the radiator inlet pipe 18a, the outlet pipe 17a being directly connected to the cooling medium pump intake 6, and the radiator inlet pipe 18a being directly connected to the by-pass thermostatically operated valve 19 at the top of the radiator 17. The numeral 18 designates generally the cooling medium jacket and head of the main engine.

Referring in particular to Figure 2, the numeral 21 generally designates the combustion chamber of the auxiliary engine, the numeral 22 the cylinder wall, the numeral 23 the cooling medium chamber which connects with the cooling medium pump through the pipe 34, and the numeral 24 designates the outer wall of the cooling chamber which serves as the inner wall of the exhaust gas heating chamber. The exhaust gas heating chamber is generally designated 25 and has the outer wall 26. The passage 27 connects the exhaust port 28 to the exhaust gas chamber 25.

The numeral 29 designates a valve which is arcuate in form and rotatable and is capable of being positioned to permit the exhaust gas from the exhaust port 28 to flow directly to the exhaust pipe 30 or instead through the passage 27 to the exhaust gas chamber 25 and thence to the exhaust pipe 31. The exhaust pipe 30 connects directly with the exhaust port 28 when the valve 29 is in such a position that it closes the passage 27. The exhaust pipe 31 connects both the exhaust pipe 30 and the exhaust gas chamber 25

to the main engine exhaust manifold or to any other desired point.

The numeral 32 generally designates the spark plug of the auxiliary engine.

The pipe 33 connects the auxiliary engine cooling chamber with the cooling chamber or cooling medium water jacket of the main engine, directly or indirectly, depending upon whether or not the cooling medium is to be employed for warming or cooling elements additional to those shown, such as fuel pumps, carburetor, or a heater for the interior of the automobile, and the like. The pipe 34 connects the cooling medium pump 5 to the auxiliary engine cooling chamber 23. While an auxiliary engine of the two-stroke-cycle type is shown, I desire to include within the scope of the invention an auxiliary internal combustion engine of any type and construction.

Referring to Figures 9 through 11, the storage battery is designated 35, the numeral 36 designates the armature winding of the starter motor, and the numeral 37 the series wound field of the starter motor. The numeral 38 designates the ignition coil of the auxiliary engine, the numeral 39 the contact breaker of the auxiliary engine primary ignition circuit, the numeral 40 the contact points of the auxiliary engine primary circuit, the numeral 41 the contact points of the ignition switch of the auxiliary engine, and the numeral 42 the movable element of the auxiliary engine ignition switch.

The numeral 43 designates a contact mounted on but insulated from the auxiliary engine ignition switch, the numeral 44 a contact connected to the electrical conductor 49, the numeral 45 a contact connected to the conductor 57, and the numeral 46 a resistor connecting the starting switch contacts 47 and 48. The numeral 47 designates the contact on the stationary contact on the starter switch, the numeral 48 another stationary contact on the starter switch, and the numeral 49 the conductor which short circuits the resistor 46 when the auxiliary engine ignition switch 42 is open, thereby causing contact 43 to short circuit contacts 44 and 45.

The numeral 50 generally designates the movable contact member of the starter switch, the numeral 51 the insulator between the contact 50 and the contacts 54 and 55. The numeral 52 designates a stationary contact to which one end of the field winding of the starter motor is connected, and the numeral 53 another stationary contact similar to the stationary contact 52, the former being connected to the opposite end of the field winding of the starter motor. The numeral 54 designates a contact which short connects the contacts 53 and 56 when the starter switch is in the position shown in Figure 10, for starting the main engine.

The numeral 55 designates a contact which is adapted to connect the contacts 52 and 56 when the starter switch is in the position shown in Figure 9 for starting the auxiliary engine. The numeral 56 designates a contact which is connected to one of the brushes of the starter motor, the remaining brush, which is of opposite polarity being grounded as shown. The numeral 57 is a conductor connecting the breaker point of the element 61 with the contact 47.

The numeral 58 generally designates the main engine ignition switch, the numeral 59 the main engine ignition coil, and the numeral 60 the main engine distributor.

The numeral 61 generally designates the generator cut-out of the main engine, the numeral 62 the armature winding of the generator, and the numeral 63 the shunt wound field of the generator.

With the starter switch in the position shown in Figure 9, to start the auxiliary engine, the direction of rotation of the starter motor is the reverse of the direction of rotation normally obtaining. When the starter switch is in the position shown in Figure 10 to start the main engine, only the battery terminal voltage will be available for energizing the primary of the main engine ignition coil during the starting, if the auxiliary engine ignition switch 42 is in the position shown in Figure 9. It will be readily seen that with the auxiliary engine ignition switch open as shown in Figure 9 the insulated contact 43 short circuits the contacts 44 and 45, thereby short circuiting the resistor 46. This permits the battery terminal voltage to be impressed across the primary of the main engine ignition coil during the starting. However, if the auxiliary engine is operating while the main engine is being started it will be seen that the switch 42 is in such a position that contacts 41 are closed and the contacts 44 and 45 are open, thereby inserting the resistor 46 in the electrical circuit. This resistor, while permitting the generator to supply some current to the starter motor thereby assisting the storage battery, will permit a higher voltage to be available for the primary of the main engine ignition coil than would be available ordinarily from the battery. This facilitates starting, particularly in cold weather. The resistor 46, however, may be omitted where the generator or the regulator or both are properly designed to warrant its omission.

It will be obvious from the foregoing that the auxiliary engine may be operated while the main engine is running, to pump a greater amount of cooling medium through the cooling system, a greater amount of oil or of oil under greater pressure, and that this arrangement may also be utilized for causing the generator 13 to turn at a higher rate than it is ordinarily turned by the fan belt or gear connection with the main engine, for charging the battery of the automobile at a greater rate than would ordinarily be the case at the speed at which the main engine is running. When the main engine is cold and it is desired to start the same, the cooling medium will be heated by the auxiliary engine being put into operation before starting the main engine, and this cooling medium which is being heated by the auxiliary engine will be circulated by the cooling medium pump 5 through the cooling system of the main engine and any other parts to be heated by said cooling medium, and at the same time the oil may be pumped from the crankcase of the main engine through the oil heating chamber 11 and under a greater than normal pressure to insure its circulation in the main engine before, during and after starting of said main engine, and similarly the generator may be operated to assist the battery to supply a greater than ordinary amount of current to the starter motor, thereby assisting the turning over of a stiff engine, and to furnish a greater than ordinary amount of current for ignition purposes for the starting of the main engine. As soon as the main engine starts, which is effected by the usual adjustments of the throttle spark and choke, by operating the starter motor in the normal direction, the starter switch is released, thus allowing the starter motor drive to disconnect from the main engine. Once the main engine has started and has begun to run at a greater relative speed than the auxiliary engine, the over-running

pulley 14 will connect the elements with which it is operatively associated to the main engine, and this condition will remain until the auxiliary engine be operated at such a speed as to be turning over relatively faster than the main engine, in which case the over-running pulley 14 will overrun and the over-running clutch 4 will come into action to pump the cooling medium and the oil at the desired rate, as well as drive the generator at an increased rate. By reason of these arrangements, driving the automobile on which the main engine is mounted at low speed may be facilitated by a relatively greater circulation of the cooling medium and of the lubricating medium, and this may be supplemented by a relatively greater current supply to meet the greater demands of low speed driving.

It will be obvious that the valve 29 which may be of any suitable type for the purpose indicated may be operated to automatically close the pipe 30 while the cooling medium is cold and close the passage 27 to the exhaust gas heating chamber 25 when the cooling medium is hot. The valve 29 may be operated automatically by connecting it operatively by means of the rod 29', to the arm 20' of the thermostatic valve 20, or to a pressure valve, (not shown) connected at some point in the pipe 16, the said pressure valve being actuated by the pressure within the pipe 16.

Although I have shown and described herein a preferred embodiment of my invention, it is to be definitely understood that I do not desire to limit the application of the invention thereto, and any change or changes may be made in material and structure and arrangement of parts, within the spirit of the invention and the scope of the subjoined claims.

What is claimed is:—

1. The combination with an internal combustion engine having a starter motor, of an auxiliary internal combustion engine, said starter motor, and said auxiliary engine, being operatively connected for operation in one direction and disconnected for operation in the opposite direction, said auxiliary engine being arranged to be operated in one direction only.

2. In combination, a main internal combustion engine having a group consisting of a starter, a cooling medium pump, an oil pump, and a generator, all connected together to operate in one direction, means connected with the main engine and with one of said group for normally operating some of them from the main engine; an auxiliary internal combustion engine coupled in over-running manner to at least one of said group and arranged to be operated so as to operate one or more of said group at a greater than main engine speed while said main engine is running, and at certain speeds while the main engine is idle.

3. Starting apparatus for an internal combustion engine, said engine including a cooling system, a cooling medium pump, an oil pump, an electric generator, all operatively connected, and an electric starter operatively connected to said engine, said apparatus including means operatively connecting said starter to said cooling medium pump, oil pump, and generator, said apparatus further including an auxiliary internal combustion engine operatively connected to said cooling medium pump, oil pump, and generator and operatively engageable by said starter, said auxiliary engine being operable independently of said main engine to drive said cooling medium pump to circulate the cooling medium, said oil pump to circulate the oil, and said generator to supply electric current to facilitate starting of and subsequent operation of said main engine.

4. Starting apparatus for an internal combustion engine, said engine including a cooling system, a cooling medium pump, an oil pump, an electric generator, all operatively connected, and an electric starter operatively connected to said engine, said apparatus including means operatively connecting said starter to said cooling medium pump, oil pump, and generator, said apparatus further including an auxiliary internal combustion engine operatively connected to said cooling medium pump, oil pump, and generator and operatively engageable by said starter, said auxiliary engine being operable independently of said main engine to drive said cooling medium pump to circulate the cooling medium, said oil pump to circulate the oil, and said generator to supply electric current to facilitate starting of and subsequent operation of said main engine, said auxiliary engine including a cooling system in communication with the cooling system of said main engine and with said water pump whereby cooling medium preheated in said auxiliary engine is circulated in said main engine to warm the same.

5. Starting apparatus for an internal combustion engine, said engine including a cooling system, a cooling medium pump, an oil pump, an electric generator, all operatively connected, and an electric starter operatively connected to said engine, said apparatus including means operatively connecting said starter to said cooling medium pump, oil pump, and generator, said apparatus further including an auxiliary internal combustion engine operatively connected to said cooling medium pump, oil pump, and generator and operatively engageable by said starter, said auxiliary engine being operable independently of said main engine to drive said cooling medium pump to circulate the cooling medium, said oil pump to circulate the oil, and said generator to supply electric current to facilitate starting of and subsequent operation of said main engine, said auxiliary engine including a cooling system in communication with the cooling system of said main engine and with said cooling medium pump whereby cooling medium preheated in said auxiliary engine is circulated in said main engine to warm the same, the cooling system of the main engine having means connecting the same to said cooling medium pump and containing an extension from said oil pump whereby the oil is preheated as the same is circulated by said oil pump.

6. Starting apparatus for an internal combustion engine, said apparatus comprising independent means for turning over said engine, said means including cooling medium and oil preheating means, and electric means for increasing the available electric supply of said engine for starting purposes.

7. Internal combustion engine assisting apparatus for an internal combustion engine including a water pump, an oil pump, and a generator, said apparatus comprising auxiliary motor means operatively connected to said water pump, oil pump and generator for simultaneously and controllably increasing the rate of circulation of the cooling medium and of the lubricating oil therein and increasing the supply of electric current to the engine.

8. In combination, a main internal combustion engine, an auxiliary internal combustion engine, a reversible electric starter, overrunning coupling means operatively connecting said engines, said

coupling and said starter being arranged to be operated in its normal direction for cranking said main engine and in the reverse direction for cranking said auxiliary engine.

9. The combination with a main internal combustion engine having a starter motor, of an auxiliary internal combustion engine, said engines being arranged to be operated independently or simultaneously, said starter motor being arranged to be operated in its normal direction to start said main engine and in its reverse direction to start said auxiliary engine, said starter motor being arranged to start either engine while the other engine is running or not running.

10. The combination with a main internal combustion engine having an electric starter motor, an electric storage battery and an electric generator, of an auxiliary internal combustion engine, said engines being arranged to be operated independently or simultaneously, said starter motor being arranged to be operated in its normal direction to start said main engine and in its reverse direction to start said auxiliary engine, said starter motor being arranged to start either engine while the other engine is running or not running, overrunning coupling means for operation of said generator from said main engine independently of said auxiliary engine to supply electric energy to the electric system, and overrunning coupling means for operation of said generator from said auxiliary engine independently of said main engine to supply electric energy to the electric system, said generator being arranged to assist the storage battery in supplying electric energy to said starter motor while said generator is being operated by said auxiliary engine and while, at the same time, said starter motor is being operated to start said main engine.

11. The combination as set forth in claim 9, including a group consisting of a cooling medium pump, an oil pump and an electric generator, overrunning coupling means connected with the main engine and with one or more of said group for normally operating some or all of them from the main engine, said auxiliary internal combustion engine being coupled in overrunning manner to at least one of said group and arranged to be operated so as to operate one or more of said group at a speed greater than the corresponding main engine speed while said main engine is running, and at certain speeds while said main engine is idle.

12. The combination with a cooling jacket equipped main internal combustion engine having an electric starter motor, an electric storage battery, a heat radiator and a group consisting of a cooling medium pump, an oil pump and an electric generator, of a cooling jacket equipped auxiliary internal combustion engine, said engines being arranged to be operated independently or simultaneously, said starter motor being arranged to be operated in its normal direction to start said main engine and in its reverse direction to start said auxiliary engine, said starter motor being arranged to start either engine while the other engine is running or not running, overrunning coupling means for operation of one or more of said group from said main engine independently of said auxiliary engine, and overrunning coupling means for operation of one or more of said group from said auxiliary engine independently of said main engine, said cooling jackets, radiator and cooling medium pump being in communication.

13. The combination with a cooling jacket equipped main internal combustion engine having an electric starter motor, an electric storage battery, a heat radiator and a group consisting of a cooling medium pump, an oil pump and an electric generator, of a cooling jacket equipped auxiliary internal combustion engine, said engines being arranged to be operated independently or simultaneously, said starter motor being arranged to be operated in its normal direction to start said main engine and in its reverse direction to start said auxiliary engine, said starter motor being arranged to start either engine while the other engine is running or not running, overrunning coupling means for operation of one or more of said group from said main engine independently of said auxiliary engine, and overrunning coupling means for operation of one or more of said group from said auxiliary engine independently of said main engine, said cooling jackets, radiator and cooling medium pump being in communication, said generator being arranged to assist the storage battery in supplying electric energy to said starter motor while said generator is being operated by said auxiliary engine and while, at the same time, said starter motor is being operated to start said main engine.

14. The combination as set forth in claim 12 including cooling medium passage means for passing the cooling medium in heat exchange relation to some part of the lubricating system for heating the lubricant.

15. The combination as set forth in claim 12, including cooling medium passage means for passing the cooling medium in heat exchange relation to some part of the fuel system for heating the fuel.

16. The combination as set forth in claim 12, said generator being arranged to assist the storage battery in supplying electric energy to said starter motor while said generator is being operated by said auxiliary engine and while, at the same time, said starter motor is being operated to start said main engine, and cooling medium passage means for passing the cooling medium in heat exchange relation to some part of the lubricating system for heating the lubricant.

17. The combination as set forth in claim 12, said generator being arranged to assist the storage battery in supplying electric energy to said starter motor while said generator is being operated by said auxiliary engine and while, at the same time, said starter motor is being operated to start said main engine, and cooling medium passage means for passing the cooling medium in heat exchange relation to some part of the fuel system for heating the fuel.

18. The combination as set forth in claim 12, said generator being arranged to assist the storage battery in supplying electric energy to said starter motor while said generator is being operated by said auxiliary engine and while, at the same time, said starter motor is being operated to start said main engine, and cooling medium passage means for passing the cooling medium in heat exchange relation to some part of the lubricating system for heating the lubricant, and cooling medium passage means for passing the cooling medium in heat exchange relation to some part of the fuel system for heating the fuel.

19. The combination as set forth in claim 12, including passage means for passing the exhaust gas of said auxiliary engine in heat exchange relation to the cooling medium, said cooling medium pump being operable to circulate said cool-

ing medium through the cooling jacket of said main engine to warm the latter.

20. The combination as set forth in claim 13, including passage means for passing the exhaust gas of said auxiliary engine in heat exchange relation to the cooling medium, said cooling medium pump being operable to circulate said cooling medium through the cooling jacket of said main engine to warm the latter.

21. The combination with a cooling jacket equipped main internal combustion engine having an electric starter motor, an electric storage battery, a heat radiator and a group consisting of a cooling medium pump, an oil pump and an electric generator, of a cooling jacket equipped auxiliary internal combustion engine, said engines being arranged to be operated independently or simultaneously, said starter motor being arranged to be operated in its normal direction to start said main engine and in its reverse direction to start said auxiliary engine, said starter motor being arranged to start either engine while the other engine is running or not running, overrunning coupling means for operation of one or more of said group from said main engine independently of said auxiliary engine, and overrunning coupling means for operation of one or more of said group from said auxiliary engine independently of said main engine, said cooling jackets, radiator and cooling medium pump being in communication, and cooling medium passage means for passing the cooling medium in heat exchange relation to some part of the lubricating system for heating the lubricant, and further including passage means for passing the exhaust gas from said auxiliary engine in heat exchange relation to the cooling medium, said cooling medium pump being operable to circulate said cooling medium through the cooling jacket of said main engine to warm the latter.

22. The combination with a cooling jacket equipped main internal combustion engine having an electric starter motor, an electric storage battery, a heat radiator and a group consisting of a cooling medium pump, an oil pump and an electric generator, of a cooling jacket equipped auxiliary internal combustion engine, said engines being arranged to be operated independently or simultaneously, said starter motor being arranged to be operated in its normal direction to start said main engine and in its reverse direction to start said auxiliary engine, said starter motor being arranged to start either engine while the other engine is running or not running, overrunning coupling means for operation of one or more of said group from said main engine independently of said auxiliary engine, and overrunning coupling means for operation of one or more of said group from said auxiliary engine independently of said main engine, said cooling jackets, radiator and cooling medium pump being in communication, and cooling medium passage means for passing the cooling medium in heat exchange relation to some part of the fuel system for heating the fuel, and further including passage means for passing the exhaust gas of said auxiliary engine in heat exchange relation to the cooling medium, said cooling medium pump being operable to circulate said cooling medium through the water jacket and said main engine to warm the latter.

23. The combination with a cooling jacket equipped main internal combustion engine having an electric starter motor, an electric storage battery, a heat radiator and a group consisting of a cooling medium pump, an oil pump and an electric generator, of a cooling jacket equipped auxiliary internal combustion engine, said engines being arranged to be operated independently or simultaneously, said starter motor being arranged to be operated in its normal direction to start said main engine and in its reverse direction to start said auxiliary engine, said starter motor being arranged to start either engine while the other engine is running or not running, overrunning coupling means for operation of one or more of said group from said main engine independently of said auxiliary engine, and overrunning coupling means for operation of one or more of said group from said auxiliary engine independently of said main engine, said cooling jackets, radiator and cooling medium pump being in communication, said generator being arranged to assist the storage battery in supplying electric energy to said starter motor while said generator is being operated by said auxiliary engine and while, at the same time, said starter motor is being operated to start said main engine, and cooling medium passage means for passing the cooling medium in heat exchange relation to some part of the lubricating system for heating the lubricant, and further including passage means for passing the exhaust gas of said auxiliary engine in heat exchange relation to the cooling medium, said cooling medium pump being operable to circulate said cooling medium through the cooling jacket of said main engine to warm the latter.

24. The combination with a cooling jacket equipped main internal combustion engine having an electric starter motor, an electric storage battery, a heat radiator and a group consisting of a cooling medium pump, an oil pump and an electric generator, of a cooling jacket equipped auxiliary internal combustion engine, said engines being arranged to be operated independently or simultaneously, said starter motor being arranged to be operated in its normal direction to start said main engine and in its reverse direction to start said auxiliary engine, said starter motor being arranged to start either engine while the other engine is running or not running, overrunning coupling means for operation of one or more of said group from said main engine independently of said auxiliary engine, and overrunning coupling means for operation of one or more of said group from said auxiliary engine independently of said main engine, said cooling jackets, radiator and cooling medium pump being in communication, said generator being arranged to assist the storage battery in supplying electric energy to said starter motor while said generator is being operated by said auxiliary engine and while, at the same time, said starter motor is being operated to start said main engine, and cooling medium passage means for passing the cooling medium in heat exchange relation to some part of the fuel system for heating the fuel, and further including passage means for passing the exhaust gas of said auxiliary engine in heat exchange relation to the cooling medium, said cooling medium pump being operable to circulate said cooling medium through the cooling jacket of said main engine to warm the latter.

25. The combination with a cooling jacket equipped main internal combustion engine having an electric starter motor, an electric storage battery, a heat radiator and a group consisting of a cooling medium pump, an oil pump and an electric generator, of a cooling jacket equipped

auxiliary internal combustion engine, said engines being arranged to be operated independently or simultaneously, said starter motor being arranged to be operated in its normal direction to start said main engine and in its reverse direction to start said auxiliary engine, said starter motor being arranged to start either engine while the other engine is running or not running, overrunning coupling means for operation of one or more of said group from said main engine independently of said auxiliary engine, and overrunning coupling means for operation of one or more of said group from said auxiliary engine independently of said main engine, said cooling jackets, radiator and cooling medium pump being in communication, said generator being arranged to assist the storage battery in supplying electric energy to said starter motor while said generator is being operated by said auxiliary engine and while, at the same time, said starter motor is being operated to start said main engine, and cooling medium passage means for passing the cooling medium in heat exchange relation to some part of the lubricating system for heating the lubricant, and cooling medium passage means for passing the cooling medium in heat exchange relation to some part of the fuel system for heating the fuel, and further including passage means for passing the exhaust gas of said auxiliary engine in heat exchange relation to the cooling medium, said cooling medium pump being operable to circulate said cooling medium through the cooling jacket of said main engine to warm the latter.

26. In combination, an internal combustion engine, a reversible electric starter, an oil pump, overrunning coupling means operatively connecting said starter to said engine when said starter is operated in its normal direction, and overrunning coupling means operatively connecting said starter to said oil pump when said starter is operated in its reverse direction.

VICTOR E. PLANTE.