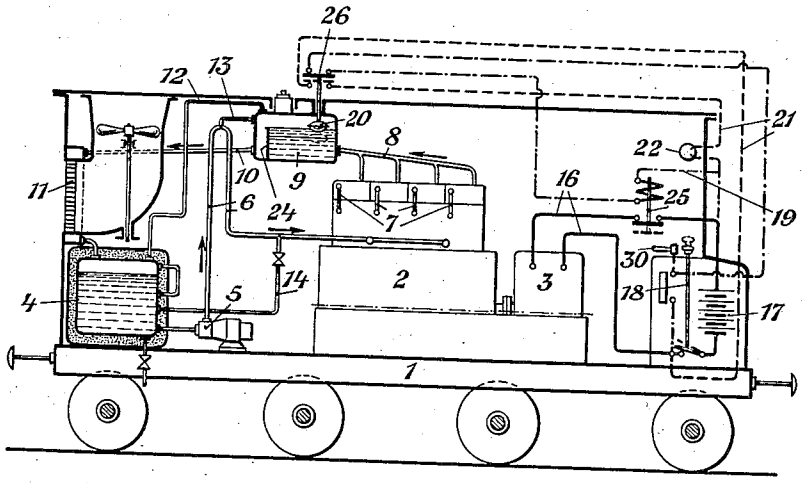
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APPARATUS FOR STARTING INTERNAL COMBUSTION ENGINES

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APPARATUS FOR STARTING INTERNAL COMBUSTION ENGINES

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This invention relates to apparatus for starting internal combustion engines of the liquid cooled type furnished with an electric generator which can be employed as a motor for starting purposes. The invention refers particularly, though not exclusively, to apparatus for starting such engines when employed on vehicles.

It is sometimes desirable, more particularly in the case of internal combustion engines employed on vehicles, to drain off the cooling liquid when the engine is not in use. After the liquid has been drained however there is the risk that the engine may be restarted with empty cooling jackets thereby causing damage to the engine and the present invention has for its object to provide means whereby such restarting will be avoided.

To this end according to the present invention the level of the liquid within the cooling system of the engine is employed to determine whether the starting motor shall be operative or is to be rendered inoperative. Preferably means are provided for indicating when the starting motor is rendered inoperative in this manner.

One construction embodying the invention is illustrated somewhat diagrammatically and by way of example as applied to an internal combustion engine mounted on a rail vehicle, in the accompanying drawing.

In the construction illustrated the vehicle 1 carries an internal combustion engine 2 which drives a generator 3. Cooling medium for the engine 2 is drawn from a heat insulated low level tank 4 by a pump 5 which delivers the medium through a delivery pipe 6 to the cooling jackets of the engine 2.

The cooling medium flows through the pipes 7 and manifold 8 to a high level tank 9 arranged above the level of the cooling jackets as shown, and from which the liquid flows by gravity through a return pipe 10 to a radiator 11 and thence back to the low level tank 4. The air space of the tank 4 communicates through a vent pipe 12 with the air space of the high level tank 9 whilst part of the delivery pipe 6 which is raised up to or above the liquid level within the tank 9, communicates through a vent pipe 13 with the air space of the tank 9. The vent pipes 12 and 13 assure that the pressure in the tanks 4 and 9 and the pipe 6 will be the same at all times.

The arrangement of the cooling system is therefore such that when circulation of the liquid ceases, due, for example, to the pump 5 being stopped the liquid contained in the pipe 10 and radiator 11 will automatically drain to the low level tank 4, whilst the liquid contained in the cylinder jackets will be maintained at the level indicated in the high level tank 9. For the purpose of draining the water jackets however a drain pipe 14 is provided so that the liquid in the tank 9 and water jackets of the engine may also be returned to the low level tank 4. If the liquid is completely drained from the cooling system into the low level tank as above described and the engine thereupon started considerable damage is liable to result, since the cooling jackets of the engine will be empty. In the construction illustrated however and embodying the present invention the generator 3 is provided with a motor operating circuit 16, battery 17 and starting switch 18 so that the generator 3 can be employed as a motor to start the engine 2. A subsidiary circuit 19 is controlled by a device 20 actuated in accordance with the liquid level in the tank 9, the device 20 similarly controlling, as hereinafter described, a second subsidiary circuit 21 which includes a signal lamp 22. In addition to the starting switch 18 a main control switch 30 operated by the driver is adapted to cooperate with contacts included in the circuit 19.

When the liquid has been drained from the cooling system of the engine through the drain pipe 14 the control device 20 will be in its lowermost position, that is to say, with the contact piece 26 in the position shown dotted thereby rendering the circuit 21 operative and the circuit 19 inoperative. If therefore an attempt is made to start the engine by closing the starting switch 18 and actuating the control switch 30, in the first place closing of the starting switch 18 will not result in power being supplied to the motor, since the contacts controlled by the relay 25 are open and, secondly, upon operation of the control switch 30 the signal lamp 22 will be illuminated thereby warning the operator that the liquid within the cooling system of the engine is below the desired minimum level. The pump 5, which may be driven by power derived from the battery 17, will now be started so as to deliver cooling medium to the cooling system of the engine.

When the liquid in the system has risen to the level indicated, that is to say, until the liquid in the high level tank 9 commences to overflow at 24 the contact piece 26 of the device 20 will be in the raised position shown in full lines whereupon the circuit 21 containing the signal lamp 22 will be rendered inoperative and the contacts of the circuit 19 associated with the contact piece 26 will be bridged so that the circuit 19 containing the relay 25 will be operative. When there-

fore the starting switch 18 and control switch 30 are closed by the driver the relay 25 will be energized so as to close the circuit 16 thereby starting the engine.

It will therefore be seen that in starting apparatus according to the invention any risk of the engine being set into operation with the water jackets containing an insufficient qantity of cooling medium will be obviated.

I claim:

1. In combination with an internal combustion engine having a jacket for a cooling liquid, a tank for the cooling liquid located above the level of the cooling jacket, a second tank for the cooling liquid located at a level below the cooling jacket, conduits connecting the cooling jacket with both of said tanks, a passage for liquid from the upper tank to the lower tank, means for causing a cooling liquid to circulate from the lower tank to the cooling jacket, then to the upper tank, and from the upper tank back to the lower tank, the liquid in said passage from the upper tank to the lower tank being free to drain into said lower tank when the liquid-circulating means ceases operation, means for maintaining liquid in the cooling jacket and in the upper tank after said passage has drained, and means for indicating when the liquid in the upper tank reaches a predetermined low level.

2. In combination with an internal combustion engine having a jacket for a cooling liquid, a tank for the cooling liquid located above the level of the cooling jacket, a second tank for the cooling liquid located at a level below the cooling jacket, a radiator, conduits connecting the cooling jacket with both of said tanks, conduits connecting the radiator with both of said tanks, means for causing a cooling liquid to circulate from the lower tank to the cooling jacket, then to the upper tank, from the upper tank to the radiator and then back to the lower tank, the liquid in said radiator being free to drain into said lower tank when the liquid-circulating means ceases operation, means for maintaining liquid in the cooling jacket and in the upper tank after the radiator has drained, and means for indicating when the liquid in the upper tank reaches a predetermined low level.

3. In combination with an internal combustion engine having a jacket for a cooling liquid, a tank for the cooling liquid located above the level of the cooling jacket, a second tank for the cooling liquid located at a level below the cooling jacket, means for maintaining the same pressure in said tanks, a radiator, conduits connecting the cooling jacket with both of said tanks, conduits connecting the radiator with both of said tanks, means for causing a cooling liquid to circulate from the lower tank to the cooling jacket, then to the upper tank, from the upper tank to the radiator, and then back to the lower tank, the liquid in said radiator being free to drain into said lower tank when the liquid-circulating means ceases operation, means for maintaining liquid in the upper tank and the cooling jacket after the radiator has been drained, means whereby the liquid in the cooling jacket may be drained, and means for indicating when the liquid in the upper tank reaches a predetermined low level.

4. In combination with an internal combustion engine having a jacket for a cooling liquid, a motor for starting said engine, a power circuit for said motor, a tank for the cooling liquid located above the level of the cooling jacket, a second tank for the cooling liquid located at a level below the cooling jacket, conduits connecting the cooling jacket with both of said tanks, a passage for liquid from the upper tank to the lower tank, means for causing a cooling liquid to circulate from the lower tank to the cooling jacket, then to the upper tank, and from the upper tank back to the lower tank, the liquid in said passage from the upper tank to the lower tank being free to drain into said lower tank when the liquid-circulating means ceases operation, means for maintaining liquid in the cooling jacket and in the upper tank after said passage has drained, and means for interrupting said power circuit when the liquid in the upper tank reaches a predetermined low level.

5. In combination with an internal combustion engine having a jacket for a cooling liquid, a motor for starting said engine, a power circuit for said motor, a tank for the cooling liquid located above the level of the cooling jacket, a second tank for the cooling liquid located at a level below the cooling jacket, conduits connecting the cooling jacket with both of said tanks, a passage for liquid from the upper tank to the lower tank, means for causing a cooling liquid to circulate from the lower tank to the cooling jacket, then to the upper tank, and from the upper tank back to the lower tank, the liquid in said passage from the upper tank to the lower tank being free to drain into said lower tank when the liquid-circulating means ceases operation, means for maintaining liquid in the cooling jacket and in the upper tank after said passage has drained, an indicator, and means for interrupting said power circuit and actuating said indicator when the liquid in the upper tank reaches a predetermined low level.

6. In combination with an internal combustion engine having a jacket for a cooling liquid, a generator driven by said engine and adapted to act as a motor for starting the engine, a power circuit for said generator, an electrically-controlled switch for opening and closing said power circuit, an operating circuit for said switch, an electrical indicator, an energizing circuit for said indicator, a tank for the cooling liquid located above the level of the cooling jacket, a second tank for the cooling liquid located at a level below the cooling jacket, a radiator, conduits connecting the cooling jacket with both of said tanks, conduits connecting the radiator with both of said tanks, means for causing a cooling liquid to circulate from the lower tank to the cooling jacket, then to the upper tank, from the upper tank to the radiator and then back to the lower tank, the liquid in said radiator being free to drain into said lower tank when the liquid-circulating means ceases operation, means for maintaining liquid in the cooling jacket and in the upper tank after the radiator has drained, and means for altering the operating circuit for the electrically-controlled switch and the energizing circuit for the indicator to render the generator inoperative as a motor to start the engine and to set the electrical indicator into operation when the liquid in the upper tank reaches a predetermined low level.

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