Feb. 22, 1966 J. Q. HOLMES 3,236,220

AUXILIARY AUTOMATIC HEAT EXCHANGE SYSTEM FOR INTERNAL COMBUSTION ENGINES

Filed June 29, 1964 2 Sheets-Sheet 1

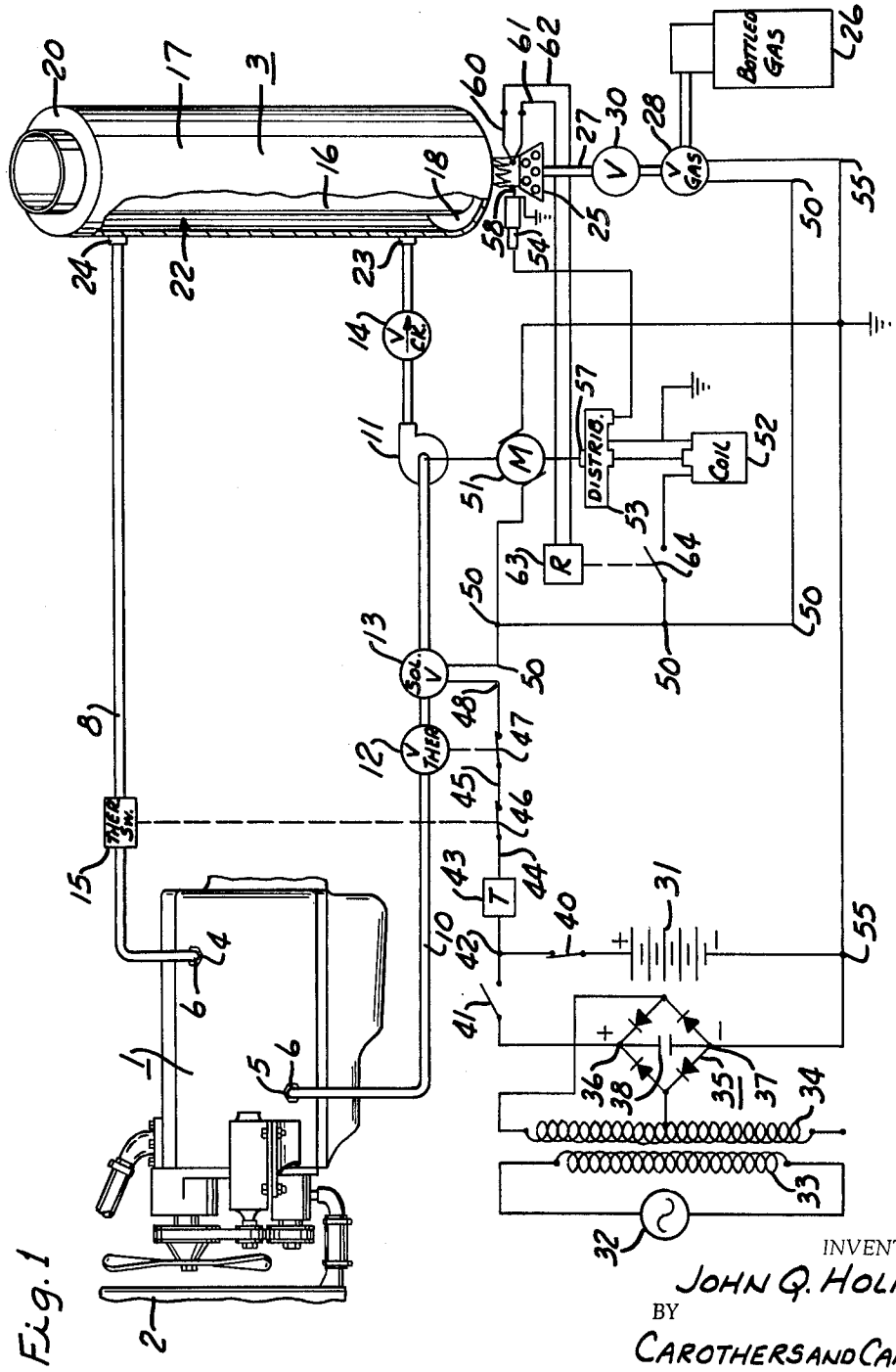


Fig. 1

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Fig. 2

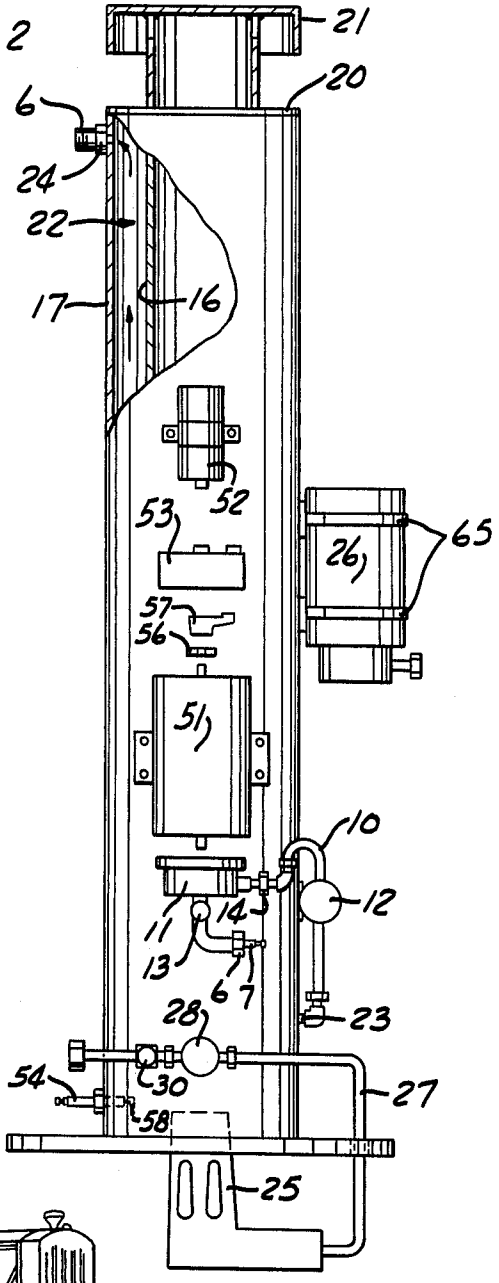
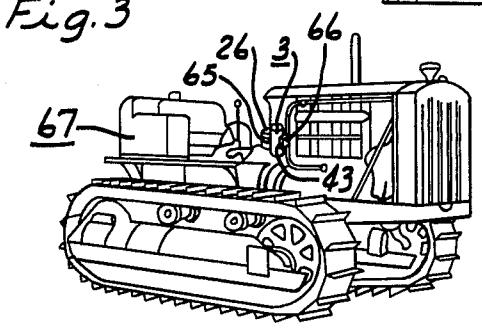


Fig. 3



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United States Patent Office 3,236,220 Patented Feb. 22, 1966

3,236,220

AUXILIARY AUTOMATIC HEAT EXCHANGE SYSTEM FOR INTERNAL COMBUSTION ENGINES

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Filed June 29, 1964, Ser. No. 378,897
8 Claims. (Cl. 123—142.5)

This invention relates generally to a heat exchange system to aid the starting of internal combustion engines and more particularly to a fully automatic control for a heat exchange system to be used in starting internal combustion engines.

The prior art in the field of heat exchange systems for assisting in the starting operation of internal combustion engines is voluminous. Structures are shown in the art that mechanically, through means such as gas or electric power, heat the liquid coolant in the cooling system of the engine and circulate it back into the water jacket of the engine. Circulation of the coolant may be accomplished purely by the thermosiphonic theory or by the more efficient method of using a pump. The piror art has illustrated automatic control for the operation of these heat exchange systems but such controls are not a complete automatic system with necessary safeguards. Furthermore, previous automatic control systems have developed into complex control systems which limit their practicability which need is more frequent than not.

The principal object of this invention is the provision of an independent heat exchange system for any liquid cooled internal combustion engine with fully automatic temperature and circulatory operation and control.

Another object of this invention is the provision of a heat exchange system to aid in the starting of internal combustion engines.

Another object of this invention is the provision of a heat exchange system to minimize the risk of damage to the engine or coolant system due to the solidification of the coolant in colder temperatures. In connection with this point, the automatic control of this invention would eliminate need of freezing preventative in the coolant which would not only eliminate the expense but also the corrosive action on the coolant system caused by many of these preventatives.

Antoher object of this invention is the provision of less complex heat exchange system for starting internal combustion engines yet is fully automatic needing no human or outside system after once initially set and is portable and capable of use on machinery which, during nonuse, is either housed within a building or is left outside or at the place where the machinery is being employed.

Other objects and advantages appear hereinafter in the following descriptions and claims.

The accompanying drawings show for the purpose of exemplification without limiting the invention or claims thereto, certain practical embodiments illustrating the principles of this invention wherein:

FIG. 1 shows a schematic view of heat exchange system and automatic control for the same comprising this invention.

FIG. 2 is a side elevation of the heat exchange system showing arrangement of the components thereof.

FIG. 3 is a perspective view showing the application of a portable arrangement of the heat exchange system of this invention to a crawler-type tractor.

Referring to FIG. 1, the illustration therein made is to demonstrate in a simple form the features comprising this invention. This has been illustrated exclusive of any attempt to show a practical and logical arrangement of the mechanical and electrical components of the system and control. FIGS. 2 and 3 clearly illustrate the practical and

logical application of the invention and component arrangement.

Engine **1** represents an internal combustion engine having a coolant system including radiator **2**. The heat exchange tank **3** may be connected to the inlet **4** and outlet **5** of the engine coolant jacket of the engine **1**. The coolant flows through the couplings **6**. The male portion **7** of the coupling **6** is illustrated in FIG. 2. It should be noted as a practical matter the couplings **6** in the circulatory system of FIG. 1 would not be used as such but would be located on the engine block **1**. Thus, the female valve portions (not shown) of the coupling **6** would be on the engine block **1** and the valve would open upon coupling with the male portion **7**. The male portion **7** would be on the tank **3**. The heat exchange tank **3** may be connected directly to the engine **1** or connected through the hose members **8** and **10**. The use of so-called "quick" couplers provide easy maintenance of a fleet of internal combustion engines. The valve type couplings may also be provided on the tank **3** so as to retain any coolant in the tank upon disconnection of the tank from engine **1**.

The pump **11**, usually the centrifugal type, will pump the coolant from the engine coolant jacket at outlet **5** through supply line **10** to the lower portion of the heat exchange tank **3**.

A thermostat-solenoid control **12** is provided in line **10**. Line **10** may also be provided with a solenoid valve **13** and a check valve **14**.

Return line **8** returns the heated coolant to the engine block **1** at inlet **4**. A thermolimit switch **15** may be provided in line **8** as a safety feature to be explained below. Thus, a complete enclosed, but independent, coolant circulatory system is provided between the engine **1** and the heat exchange tank **3**.

It should be noted that check valve **14** and pump **11** permit flow only in one direction and thus the fluid coolant circulated is permitted only to enter at **4** and exit at **5** of the engine **1**. This flow will be opposite to the coolant flow when the engine **1** is in actual operation, in the case of most internal combustion engines. However, coolant flow may be reversed from that shown in FIG. 1 by interchanging the coupling connections **6** and the same results will be obtained as far as transferring heat to and exchanging heat within the engine block **1**. The advantage of the arrangement as shown in FIG. 1 resides in the fact that sufficient coolant is readily obtainable from the radiator **2** as well as the engine block **1**. However, the disadvantage resides in a much longer period of time to heat the coolant and subsequently the engine block. With the connections reversed only the coolant in the engine block **1** will circulate, thus providing the most rapid method of heating the engine block **1**.

The heat exchange tank **3** may be of any construction well known in the art. A simple construction is that shown in the drawings wherein an inner cylindrical wall **16** is placed within an outer cylindrical wall **17**. The space between the walls **16** and **17** is sealed at both ends thereof. These ends form a bottom **18** and top **20**. The interior of the cylinder **16** is open at both ends and a diffuser **21**, such as shown in FIG. 2, may be placed upon the upper end of the cylinder **16**. Thus, the two cylindrical walls **16** and **17** together with the bottom **18** and top **20** form a cylindrical enclosure **22** for the coolant which enters the tank **3** at the inlet **23** near the bottom **18** and departs at the outlet **24** near the top **20**. The coolant may circulate throughout the chamber or enclosure **22** and receive heat energy from the wall **16** and finally flow from the outlet **24** back to the engine **1** for circulation.

A burner **25** is provided at the bottom **18** of the tank **3** which provides the necessary heat to the cylinder **16** and tank **3** in order that the coolant fluid will be heated

a sufficient degree during its upward circulation in the chamber 22.

The burner 25 may be supplied with any convenient combustible gas such as propane. Bottled gas 26 is provided for storage of the gas in order to give the heat exchange system as much portability as possible. The supply line 27 to the burner 25 may be provided with an electric gas valve 28 as a safety precaution and also prevent any passage of gas to the burner 25 when the heat exchange system and control is not in operation. A valve 30 may also be provided in supply line 27 in order to adjust the flow of gas to the burner 25.

FIG. 1 shows the electrical circuit for the control of the heat exchange system. The electrical power to the circuit may be provided either by battery 31 or from any convenient electrical A.C. outlet or A.C. power source 32. In order to provide the necessary direct current for the circuit control, a D.C. converter may be employed between the circuit and A.C. source. Such converters are well known in the art and consist of a tap transformer 33 wherein a reduced voltage is taken from the secondary 34 of the transformer and supplied to the full wave rectifier 35. A direct current is taken from the output 36—37. The current may be made of constant or smooth generation by supplying the capacitor 38 of predetermined value at the output.

By arranging the circuit to operate from a low voltage source such as 12 volts, the system may be operated from the battery supply of the vehicle or machinery itself. This battery supply is represented by 31. On the other hand, switch 40 may be opened and the power may be supplied to the circuit from the D.C. converter upon closing of switch 41.

From either switch 40 or 41, the power is supplied through line 42 to the timer 43 marked T. Thus, the circuit will not operate unless the timer is set to permit passage of the current. The timer 43 is set for a predetermined time so that the heat exchange system will only begin to operate when necessary.

From the timer 43, line 44 is connected to line 45 through the contact 46 of the thermolimit switch 15. Switch 15 is in the return line 8 of the heat exchange system and operates to open its contact when the coolant flowing through return line 8 reaches a high predetermined temperature. Thus, for a water type coolant system, the return supply of coolant should not exceed the boiling point of water. The thermoswitch 15 is set to operate at 200° F. and its normally closed contact 46 will remain closed until the temperature of 200° F. is reached whereupon the switch will operate, opening its contact 46. The temperature is not expected to reach such a high value, but if the thermostat 12 is not operating properly within its set limits, the thermolimit switch 15 will act as a safety precautionary feature and prevent the coolant from being circulated at an unnecessary high temperature which may be detrimental to the engine as well as the heat exchange system. The thermolimit switch 15 is provided with a manual reset.

Line 45 is connected to the contact 47 of the thermostat or thermoswitch 12 which in turn is connected by line 48 to the solenoid valve 13. The thermostat 12 is set within a predetermined temperature range. Thus, in the case of diesel engines, for efficient starting the engine temperature should be above the freezing point. A thermostat set within the range of 49° F. to 62° F. will cause the contact 47 to open if the coolant from the engine 1 has reached at least 62° F. If either the coolant fluid temperature in supply line 10 or the atmospheric temperature is below 49° F., the contact 47 will be made to close so that the control circuit of the heat exchange system will go into operation. Thus, thermostat 12 is the very heart of the control circuit operating, if the timer 43 is set to operate also, to heat the coolant fluid in the engine 1 if its temperature has dropped below a predetermined value.

The fluid solenoid valve 13 is not an essential component of the system but will not permit passage of fluid coolant to the tank 3 unless the thermostat 12 is in operation closing its contact 47. Solenoid valve 13 though not essential is important to prevent any back pressure from forcing the coolant in the lines back through the pump 11 after the system is shut off. Any possibility of seal rupture in the pump is eliminated.

Connected across the supply source through line 50 is the motor 51 which operates the pump 11. Also connected across the supply source is the coil 52 which supplies periodically stored potential to the distributor 53 which in turn distributes this at intervals to the spark plug 54. The electric gas valve 28 is also connected across the supply source. The motor 51 and electric gas valve 28 are connected through return line 55 to the negative side of the power source which is grounded. The distributor-coil combination is of the type commonly found on ignition systems of vehicles and is only shown here as a means to supply the necessary ignition to the gas escaping from the burner 25. A high voltage is obtained from the coil 52 which, through a cam 56, contact points and rotor 57 of the distributor 53, is distributed frequently to the air gap 58 of the spark plug 54. This developed high A. C. frequency produces a succession of sparks at the air gap 58 which will ignite the gas from the burner 25. The spark ignition system used in electric furnace control is also available to supply an ignition system for the heat exchanger of this invention.

Another type of ignition system to ignite the gas escaping from the burner 25 is the piezoelectric ignition system which utilizes the principle of producing an electrical charge due to change of stress within the crystalline material. The crystalline materials capable of producing the piezoelectric effect are ceramic materials such as lead-zirconate-titanite ceramics. Thus by applying a force to such a ceramic material, causing the material to be placed under stress due to compression by an outside force, a spark gap connected to the two ends of the same ceramic will produce a spark upon such compression. This type of generator or commonly called spark pump may be operated from the shaft of the electric motor 51 which operates the pump 11. The shaft may employ a cam means which upon rotation by the electric motor 51 would come in contact with the actuating lever of the spark pump. The actuating lever would in turn compress the ceramic element, causing a spark at the air gap 58. If the force created by the motor 51 on the actuating lever of the spark pump is not of sufficient magnitude, a force multiplication system may be incorporated in the spark pump, which system is now known in this particular art.

A thermocouple 60 may be provided with its contact end in the flame of the burner 25. The heat energy will cause a small electron flow or current in the lines 61 and 62 which will energize the low voltage sensitive relay 63 causing it to open its contact 64 which is in line 50. Thus, after the flame appears at burner 25 upon ignition by the plug 54, the relay 63 will discontinue the supply of current to the coil 52 and eliminate continued sparking at the air gap 58. Such a control is not necessary but reduces the power necessary to be supplied to the control circuit after once in operation. On the other hand, the thermocouple-relay combination is a constant spark ignition. It is therefore a safety feature in that if the gas flame would ever extinguish during operation of the heat exchanger, the thermocouple 60 would permit the relay 63 to close its contact 64 upon sufficient cooling of the former, thus permitting the ignition system to again ignite the gas escaping from the burner 25.

FIG. 2 shows suggestively, the arrangement of circuit components on the heat exchange tank 3 thus giving the complete assembled system acceptable portability. The gas supply 26 may be removably secured to the tank 3 as indicated at 65.

The thermostatic control 12 may be placed on either side of the pump 11 and check valve 14. In FIG. 1, the thermostat control 12 is before the pump 11. In FIG. 2, the thermostatic control is placed in supply line 10 between the check valve 14 and the heat exchange tank 3. In the former position, the control 12 will be sensitive to coolant fluid temperature change as well as atmospheric temperature change. In the latter explained position shown in FIG. 2, the control 12 will be only sensitive to atmospheric temperature change since the solenoid valve 13 will not permit fluid passage until the circuit is activated by the timer 43 and the control 12 itself.

FIG. 3 illustrates that upon reduction of the size and capacity of the heat exchange tank 3 and necessary gas supply tank 26, the unit comprising this invention along with the electrical control placed within a box 66 with fluid lines 8 and 10 intercepting circuit elements as shown in FIG. 1 may be secured to the side of the tractor 67 by any convenient clamping method. Thus, the unit may remain with the vehicle upon which it is to operate for an indefinite period of time. The operator, after the daily work is completed, need only set the timer 43 upon leaving the tractor 67. The power supply 31 may be the battery of the tractor 67. If upon actuation of the circuit by the timer 43, the thermostat 12 has closed its contact 47 due to an atmospheric temperature below the predetermined setting, the heat exchange system will begin to operate by opening the solenoid valves 13 and 28 and by operation of the pump 11 and coil-distributor system through motor 51. As the coolant is circulated from engine 1 to heat exchange tank 3 and back, the coolant fluid will be heated sending warmth to all parts of the engine block 1 heating toe block to a sufficient degree rendering the starting operation easier. This is especially true in the case of diesel engines which will not start easily in sub-freezing weather due to the character of their combustible operation. When the coolant fluid returning to the heat exchange tank reaches the higher of the two predetermined temperature settings in the thermostat 12, the contact 47 is opened and the operation of the system is extinguished until the atmospheric temperature reduces the coolant fluid to a temperature below the lower of the two predetermined temperature settings in the thermostat 12, whereupon the cycle of operation begins operation again.

An example of operation is as follows: During the colder months of the year where diesel vehicles must be left outside without protection from atmospheric conditions present during that time of year, the timer 43 may be set for operation at 5:00 a.m. where the operator must operate the vehicle the next morning at about 5:30 a.m. The atmospheric temperature is —8° F. during the night. Thus, at 5:00 a.m. the timer 43 actuates permitting current supply to the circuit. The thermostat 12 is set within an operation range of 49° F. to 62° F. Since the temperature is below 49° F., the contact 47 is closed and, as explained above, circulation is started by pump 11. The solenoid valves 13 and 28 are opened and the ignition system ignites the burner 25. As soon as the circulating liquid reaches 62° F., the thermo-contact points in thermostat 12 open the contact 47. Since the circuit is open, the heat exchange system will not operate until the temperature of the thermostat 12 is brought back down to at least 49° F. through the natural heat exchange of the coolant and engine block with the atmosphere. In the meantime, the diesel engine 1 is sufficiently warmed up to commence immediate operation by the operator at 5:30 a.m.

As a safety feature, if the coolant fluid returning to the engine block 1 in line 8 should in some way become heated to a greater degree than necessary through a malfunction in the circuit, such as the sticking of the thermostat 12 or stalling of the motor 51, thermoswitch 15 will open its contact 46 and thus completely shut off the heat exchanger and control until the switch 15 is manually reset. The heat exchange system is protected from damage due to overheating.

I claim:

1. In a heat exchange system for heating the coolant fluid in the cooling system of an internal combustion engine comprising a heat exchange tank means having an inlet and an outlet, a supply line from said engine cooling system to the inlet of said tank means, a return line from the outlet of said tank means to said engine cooling system, a combustible gas burner at the bottom of said tank means and having a combustible gas supply, pump means in said supply line to circulate the coolant fluid of said cooling system through said lines and said tank means, an electrical control circuit to operate said heat exchange system having a power source, said electrical control circuit including a thermostatic control in said supply line having a front contact connected in series in said circuit and normally open between a maximum temperature limit and a minimum temperature limit when the coolant fluid temperature is first raised to said minimum temperature limit, a solenoid operated valve connected between said gas supply and said burner and electrically connected across said power source to open the valve upon energizing the solenoid to permit passage of combustible gas to said burner, a motor means connected across said power source to operate said pump means in said supply line, and an electrical ingnition system connected across said power source to ignite the combustible gas escaping from said burner.

2. The heat exchange system of claim 1 characterized by a timer connected in series in said electrical control circuit to permit operation of said heat-exchange system at a predetermined time.

3. The heat exchange system of claim 1 characterized by a solenoid operated valve connected in at least one of said lines and electrically connected in series in said control circuit to permit passage of the coolant to or from said engine cooling system and said tank means when said electrical control circuit is in operation.

4. The heat exchange system of claim 1 characterized by a thermolimit switch in said return line and having a front contact connected in series in said circuit to open when the coolant fluid reaches a high predetermined temperature.

5. The heat exchange system of claim 1 characterized in that said electrical ignition system comprises a high frequency generator to produce a high voltage, a distributor means connected to said generator, a spark gap positioned at said gas burner and electrically connected to said generator and said distributor means to cause a spark within said gap to ignite the combustible gas escaping from said burner.

6. The heat exchange system of claim 5 characterized in that said distributor means is operated by said motor means.

7. The heat exchange system of claim 1 characterized by a low voltage relay having a front contact connected in series with said electrical ignition system, thermocouple means positioned to be within the flame caused by ignition of the combustible gas escaping from said burner, said thermocouple means electrically connected across said relay, said front contact of said relay to open upon energization of said relay caused by an electrical current generated from heat on said thermocouple.

8. The heat exchange system of claim 1 characterized in that said thermostatic control in said supply line having a front contact connected in series in said circuit is normally open between a maximum temperature limit and a minimum temperature limit when the coolant fluid temperature is first raised to said maximum temperature limit.

No references cited.

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