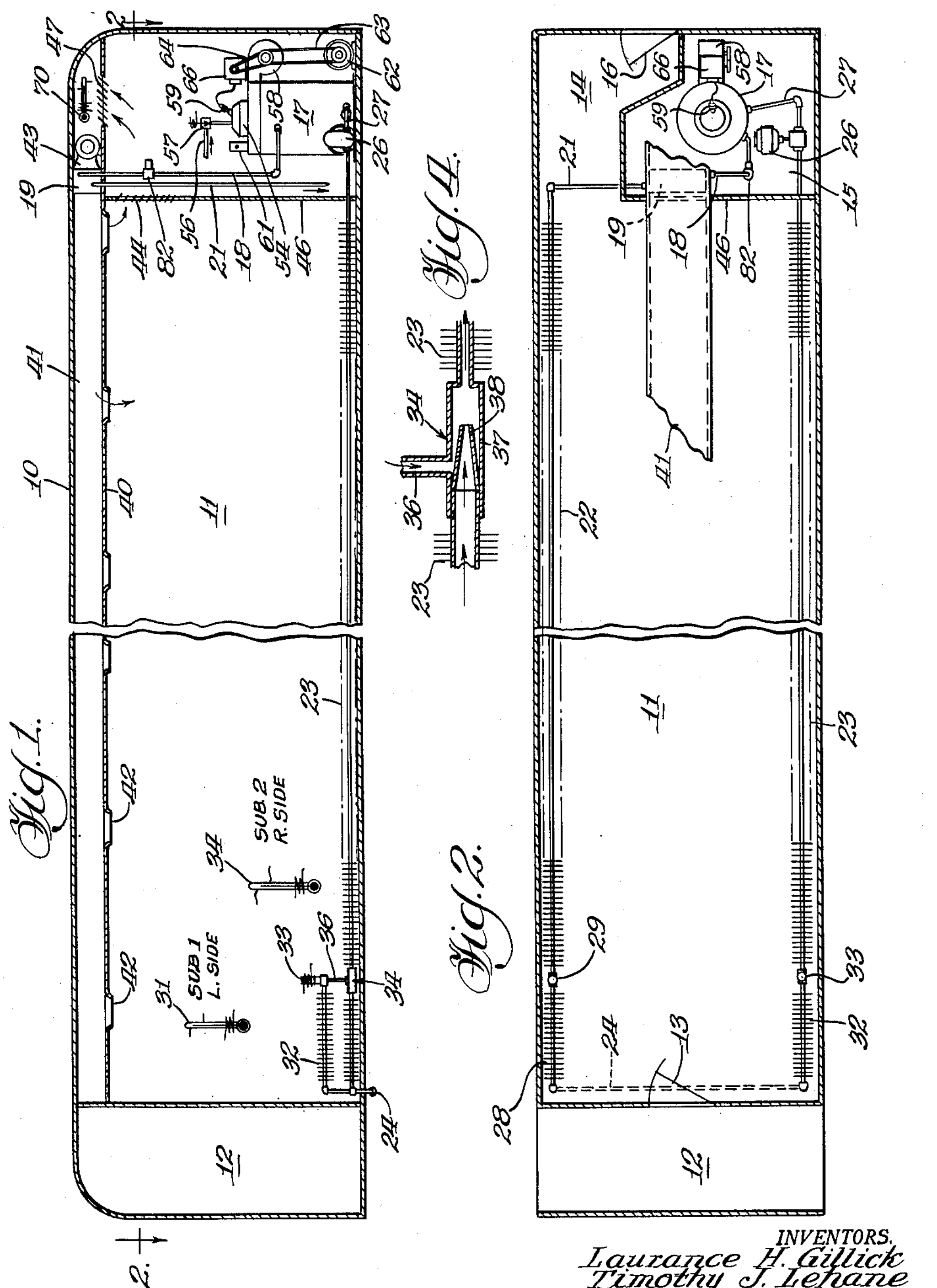
Feb. 24, 1953 L. H. GILLICK ET AL 2,629,554

HOT-WATER HEATING SYSTEM

Filed Oct. 17, 1950 2 SHEETS--SHEET 1



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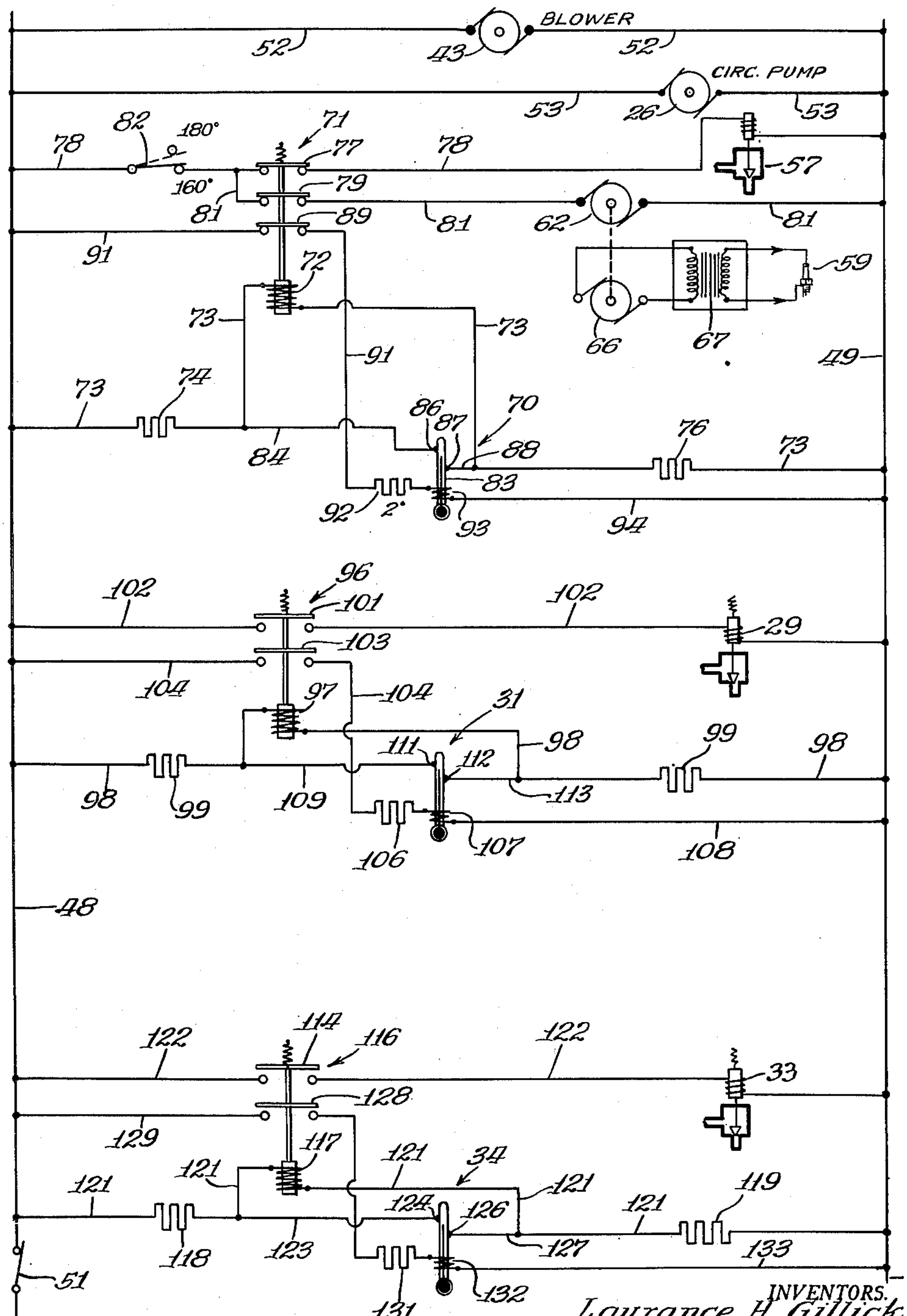

Fig. 3.

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HOT-WATER HEATING SYSTEM

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7 Claims. (Cl. 237—8)

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This invention relates to heating systems and more particularly to a hot liquid heating system suitable for use in heating railway cars or other similar enclosures where the demand for heat varies from time to time at different locations in the enclosure.

The present system is designed especially for use in railway cars such as office cars or private cars which may be disconnected from the train for long periods of time. Such cars are ordinarily provided with individual heating systems. The present invention is directed to improvements in heating systems for this general class of car and has for its principal object to simplify such systems, whereby the effective area of radiation may be varied at different locations within the car to compensate for variations in the heat demand or to compensate for variations in the efficiency or heat output of the heating plant.

Specifically, the invention includes an intermittently operated heating unit adapted to maintain the water of the circulating system between a fixed temperature range. Consequently when the water is near the lower limits of its temperature range, the required efficiency of the heating plant may be augmented by increasing the effective area of radiation, particularly in the cooler regions of the car, such as the end portions or the side shaded from the sun. There are many other conditions which tend to affect the interior temperature of the car. For example, it is known that the side of the car to the lee of a cross-wind may be warmer than the opposite side. It is also known that the side of the car exposed to the sun's rays may be warmer than the opposite side, and that the ends of the car near the doors are somewhat cooler than the middle.

It is another object of the invention, therefore, to maintain the temperature of the car at a uniform level irrespective of the variations in the heating load which may result from weather conditions and irrespective of the variations in the temperature of the circulating medium of the system.

According to the present invention an intermittently operated heater is employed to heat a fluid in heat exchange relationship with the conventional floor radiators of a railway car and with an overhead heat radiator and blower. The blower may be operated constantly to force air through the overhead heater and through an overhead duct into the car. A pump is employed to move the fluid through floor and overhead radiators, and thermostatic controls are provided for the control of the intermittently operated heater according to the temperature of the fluid and the average temperature within the enclosed space. Additional thermostats are provided for the control of auxiliary radiators adapted to augment the radiation area by circulating heating fluid in a shunt heating circuit with respect to the main floor radiators. These auxiliary radiators may be located in areas requiring a temperature different from the rest of the car, such as a washroom or other area. The auxiliary radiators may preferably be operated independently of each other and are preferably disposed on opposite sides of the car or at a cool end thereof so as to supplement the heat output.

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Other objects and important features of the invention will be apparent from a study of the within specification taken with the drawings which together illustrate a preferred embodiment of the invention and what is now considered to be the best mode of applying the principles thereof. However, the invention contemplates all other embodiments of the invention as may fall within the purview and scope of the appended claims.

In the drawings:

Figure 1 is a longitudinal cross-section view taken through a railway car on a vertical plane spaced a small distance from the side of the car, showing the improvements according to the present invention embodied therein;

Figure 2 is a longitudinal horizontal section taken through the car of Figure 1 along a plane 2—2 and looking in the direction of the arrows;

Figure 3 is a circuit diagram showing a control circuit for the improved heating system of Figures 1 and 2; and

Figure 4 is a diagrammatic illustration of a flow device for insuring circulation through the auxiliary radiators of the heating system shown in Figures 1 and 2.

Referring now particularly to Figures 1 and 2 of the drawings, there is shown a railway car body 10 which is constructed to have a main section 11. A vestibule 12 is located at one end of the car and an entrance is afforded to the section 11 by a vestibule door 13. A passageway 14 connects the other end of the passenger compartment 11 with an exit door 16 to other cars with which the car 10 may be connected.

The enclosed space 11 is heated by an intermittently operated hot water heater 17 which is positioned in a compartment 15 adjacent the passageway 14 and to one side thereof. The heater 17 is connected in a piping system 18 to supply heat to an overhead radiator 19. The overhead heater 19 is first in line relative to the heater 17 so as to receive the heating medium of higher temperature and is connected by a pipe 21 leading therefrom in series with a fin tube floor radiator 22 which runs the length of the enclosed space 11 along one side thereof and receives the partially cooled heating medium from the overhead radiator 19. The floor radiator 22 is connected to a floor radiator 23 extending along the other side of the enclosed space 11 by an under-floor pipe 24, circulation through the overhead heater 19, the floor radiators 22 and 23 being maintained by a motor and pump unit 26 which returns the fluid to the heater 17 by a return pipe 27.

The floor radiator 22 is connected in parallel with an axially radiator 28, the flow through the auxiliary radiator 28 being controlled by a solenoid actuated valve 29 which is controlled by a thermostat 31. The opposite floor radiator 23 is likewise provided with an auxiliary radiator 32 which is under control of a solenoid actuated valve 33 controlled in its operation by a thermostat 34.

Flow is assisted in each of the auxiliary radiators 28 and 32 upon the operation of their respective solenoid actuated valves 29 and 33 by a Venturi-type flow device 34 as seen more or less schematically in Figure 4, which illustrates the mode of connection of the auxiliary radiator 32 with the floor radiator 23. The flow device 34 is connected by a length of pipe or tubing 36 to one end of the auxiliary radiator 32, and consists of a length of tubing 37 fitted into the main radiator 23. The tubing 37 is formed on the interior with converging walls 38 and the return pipe 36 from the auxiliary radiator 32 is connected to the tubing 37 at a point where the walls 38 begin to converge. As seen in Figure 4, the arrows indicate the direction of flow in the floor radiators 23 and the direction of flow through the flow device 37. The construction in the fluid stream afforded by the convergence of the walls 38 results in decreased pressure at a point where the tube 36 is connected to the tube 37 thereby inducing flow in the auxiliary radiator 32 upon opening of the solenoid valve 33. The auxiliary radiator 28 is likewise provided with a flow-inducing device of the same structure as shown in Figure 4 and is connected in the return end of the auxiliary radiator 28.

Overhead heat is provided for the enclosed space 11 by an overhead duct 41 having openings 42 on the underside 40 thereof. A motor operated blower 43 is positioned to force air through the heater 19 and cause the air to pass into the enclosure 11. The air, or at least a portion thereof, is drawn from the enclosure into the overhead duct 41 past a return air grill 44 mounted in a bulkhead 46 separating the heater compartment 15 from the passageway compartment 11 and an overhead grill 47 in the underside 40 of the return duct 41.

As seen in Figure 3, the overhead blower 43 and the circulating pump 26 are connected across a supply line consisting of a positive lead 48 and a negative lead 49, the flow of current therein being under the control of a main switch 51. As seen in Figure 3, the overhead blower 43 is connected in a lead 52 across the supply leads 48 and 49, and the motor driven circulating pump 26 is connected in a lead 53 across the supply leads 48 and 49. It should be noted that the overhead blower 43 and the circulating pump for the water supplied to the overhead heater 19 and the floor radiators 22 and 23 are adapted to operate constantly as long as the condition of the ambient is such as to require heat within the enclosure 11 and as long as the switch 51 is closed.

The heater 17 is provided with a burner 54 which is supplied with fuel oil by a supply pipe 56, the flow of fuel in the pipe 56 being controlled by a solenoid actuated valve 57. The burner 54 is provided with a blower 58 which supplies a suitable volume of air to the fuel which is ignited by a sparking plug 59. Exhaust gases from the burner 54 are led therefrom by an exhaust flue 61 which is connected to an exhaust stack, not shown. A motor 62 is connected by a belt 63 to drive the blower 58, which is connected by a drive belt 64 to drive a rotary converter 66 for supplying current to a transformer 67 to furnish a high tension spark to the sparking plug 59.

As seen in Figure 3, the operation of the heater 17 is controlled by a master thermostat 70 which is positioned in the return end of the overhead duct 41. It will be seen that the master thermostat 70 being arranged in the return duct, measures the average temperature within the enclosure 11. A relay 71 is provided with a winding 72 connected in a lead 73 across the supply leads 48 and 49 and in series with buffer resistors 74 and 76. The relay 71 is provided with a contact 77 connected in a lead 78 and in series with the winding of the solenoid operated fuel valve 57 across the supply leads 48 and 49. The relay 71 has an additional contact 79 connected in a lead 81 branching from the lead 78. As seen in Figure 3, the heater blower motor 62 is connected in the lead 81 and with the contact 79 across the supply leads 48 and 49.

The solenoid operated fuel valve 57 and the heater blower motor 62 are additionally under the control of a temperature responsive switch or Aquastat 82 positioned to measure the temperature of the liquid in the pipe 18, see Figure 1. As seen in Figure 3, the switch 82 is adapted to open with a snap action when the temperature of the circulating liquid reaches 180° and to close with a snap action when the temperature of the circulating liquid has dropped to 160°.

The master thermostat 70 is connected to short circuit winding 72 of the relay 71, and consists of a mercury column 83 which is adapted to close said short circuit, which consists of a lead 84 branching from the lead 72, a contact point 86 on the thermostat 83, the length of the mercury column between the contact point 86 and a lower contact point 87 thereon, the short circuit being completed by a lead 88 and lead 73 to the other side of the supply line. The thermostat 70 is so designed that when the average temperature in the car as measured by the temperature in the return air attains a temperature of 72°, for example, a short circuit, just described, is made thereby deenergizing the winding 72 of the relay 71.

It will thus be noted that if the temperature of the water is 160° or less, and if the temperature in the return end of the duct 41 is less than 72°, the circuits will be completed to operate the solenoid actuated fuel valves 57 to supply fuel to the burner 54, and to operate the heater blower motor 62 so that the blower 58 can supply combustion air to the burner 54. If, however, the temperature in the line 18 of the hot liquid system should reach 180°, the heater blower motor 62 and the solenoid actuated fuel valve 57 will be deenergized to interrupt the operation of the burner 54. It will also be seen that if the temperature in the recirculated air, as determined by thermostat 70, should rise to above a desired value, the winding 72 of the relay 71 will be deenergized by the short circuit attained through the thermostat 70, thereby opening the contacts 77 and 79 to deenergize the solenoid actuated fuel valve 57 and the heater blower motor 62.

The thermostat 70 is of the cycling type and is so constructed as to be furnished with a desired amount of heat, which in the case at hand is of the order of two degrees, to raise the mercury column 83 in the thermostat 70 and cause the short circuit as has been previously described. The relay 71 is provided with a contact 89 which is connected in a line 91 which is in series with a limiting resistor 92 and a heater coil 93 of the thermostat 70, the circuit being completed by a lead 94 to the other side of the supply line. When the winding 72 of the relay 71 is energized as would be occasioned by the temperature in the return end of the overhead duct falling below a desired value, which in the instant case is 72°, the closing of the contact 89 on the relay 71 will cause two degrees of heat to be placed on the thermostat 70 to raise the mercury column 83. If said two degrees of heat is sufficient to cause the mercury column to close on the contact 86, the short circuit will once more be made thereby deenergizing the winding 72 of the relay 71 and opening circuits to the solenoid actuated fuel valve 57 and the heater blower motor 62.

It will thus be seen from the description thus far that the heater 17 is operated only when the average temperature in the car has fallen below a desired minimum and when the temperature of the circulating liquid of the heating system is below a maximum value.

The auxiliary radiators 28 and 32 are under the control, as has been explained, of auxiliary thermostats 31 and 34. The auxiliary radiators in the embodiment of the invention as shown herein are intended to heat an end portion of the car, the end portion tending to be cooler than the other portions of the car. The auxiliary radiators 28 and 32 are thus connected to overcome the tendency of the end of the car to become cooler than the other portion of the car. However, it is contemplated that the auxiliary radiators 28 and 32 may be of a suitable length not only to correct the cooling tendency of an end portion of the car, but at the same time to correct the tendency of one side of the car to be cooler than the other, as would be occasioned by the movement and the service conditions hereinabove mentioned.

As seen in Figure 3, a relay 96 having a winding 97 is connected across the supply leads 48 and 49 and in series with a lead 98 having buffer resistors 99 connected in series therein. The relay 96 includes a contact 101 which is connected in a lead 102 containing the winding of the solenoid actuated valve 29 and is adapted to close a circuit through the solenoid actuated valve 29 when the temperature at the forward end of the car on the side where the auxiliary radiator 28 is located is below a desired value, which for purposes of explanation herein may be taken as a temperature below 72°. With the temperature at said position below the value just mentioned, the winding of the solenoid actuated valve 29 will be energized to cause the valve to open and the hot water to move through the auxiliary radiator 28, and past a flow device as shown in Figure 4, to be returned to the system at the juncture of the auxiliary radiator 28 with the cross line 24.

The relay 96 is provided with a contact 103 connected in a line 104 having connected therein a limiting resistor 106 and a heater coil 107, the circuit being completed to the other side of the supply line by a lead 108. The relay 96 which is energized when the temperature is below the desired value thus closes a circuit to the heater coil 102 causing the mercury column therein to rise in a manner similar as with the thermostat 70 to cause a short circuit to be made to deenergize winding 97 of the relay 96, said short circuit includes a lead 109 branching from the lead 98, the length of the mercury column between a contact point 111 and a contact point 112, the short circuit being completed by a lead 113 to the lead 98 to the other side of the supply line. When the short circuit, just described, has been made, the contacts 101 and 103 will open, the opening of contact 101 thereby deenergizing the solenoid winding of the solenoid actuated valve 29, the opening of the contact 103 thereupon removing heat from the heater coil 107, causing the mercury column to open the circuit at the contact 111. It will be apparent that when the circuit is broken at the contact 111, the relay 96 will recycle to repeat the operation just described. Obviously, if the addition of two degrees of heat to the heater coil 107 is insufficient to cause the mercury column to close at the contact 111, the relay will remain in energized condition so that the hot water will move through the auxiliary radiator 28.

The operation of the auxiliary radiator 32 is affected by the energization of the solenoid actuated valve 33, which is adapted to be energized when a contact 114 of a control relay 116 is closed when the winding 117 thereof is energized. The winding 117 is in series with buffer resistors 118 and 119 and is connected across the supply leads 48 and 49 by a lead 121. The winding 117 and the relay 116 remain in energized condition as long as the temperature affecting the thermostat 34 is below a desired value, and the energization of the winding 117 closes a circuit through the contact 114 and the winding of the solenoid actuated valve 33 which are connected in series with a lead 122 across the supply leads 48 and 49.

When the temperature adjacent the thermostat 34 rises to some predetermined value, a short circuit is made deenergizing the winding 117 of the relay 116, and includes a lead 123 branching from the lead 121, the length of the mercury column between contact points 124 and 126 and a lead 127 connected to the lead 121 to the other side of the supply line. When the mercury column rises to close on the contact 124, the winding 117 will be deenergized and the contact 114 will be opened to deenergize the winding of the solenoid actuated valve 33. The thermostat 34 is adapted to be cycled by a contact 128 of the relay 116 which is connected in series with a lead 129, a buffer resistor 131, a heater coil 132 of the relay 34 and a lead 133 to the other side of the supply line. It will be apparent that when the relay 116 is energized, approximately two degrees of heat will be given to the thermostat 34, and if said amount of heat is sufficient to cause the mercury column to close on the contact 124, the short circuit will once more be made to deenergize the winding 117. As with the thermostat 31, the cycling operation will be repeated unless the temperature at the forward end of the car adjacent the auxiliary radiator **32** is low enough so that the addition of two degrees of heat to the thermostat **34** will not cause the short circuit to be made at the contact **124**.

It will be apparent from the foregoing description that there has been provided a novel and useful system for controlling the temperature of a railway car in such a fashion that the temperature will be maintained nearly uniform irrespective of the condition of the ambient or the movement of the car in said ambient. It will be noted that the overhead blower and the circulating pump are operable at all times to make use of the reservoir of heat contained within the intermittently operated heater and to recirculate the air within the car at all times. By the use of the auxiliary thermostats and the auxiliary relays controlled thereby for the control of the auxiliary radiators on the forward end of the car, it is possible to obtain additional radiation at such points irrespective of whether the intermittent heater is being operated or not, since the auxiliary thermostats **31** and **34** may call for additional heat to be radiated from the radiator system and the heater **17**. It will be noted that the burner **54** and its blowers **62** will be operated only when the water in the system has reached a lower operating level, normally 160°, and when the main thermostat is calling for heat as measured by a fall in temperature measured in the return line of the air duct **41**. It is obvious, therefore, that the auxiliary radiators **28** and **32** may be employed to give additional heat radiation at the forward end of the car when the temperature thereat has fallen below a desired level, which additional radiation would be reflected into the temperature of the recirculated air as measured at the return end of the overhead duct **41**.

From the foregoing it will be seen that by the practice of the invention as disclosed herein it is possible to maintain the temperature of the car at a desired level as determined by the operation of auxiliary radiators which are called upon to operate to correct for low temperatures obtaining at the several points in the car, at the same time making it unnecessary to operate the heater in accordance with the demand as might be made by the several auxiliary radiators.

While the invention has been described in terms of a preferred embodiment thereof, it is not intended that the invention be limited in terms of the embodiment shown nor otherwise than by the claims here appended.

We claim:

1. A heating system for heating an enclosed space comprising a closed circulating system for a heating medium comprising an intermittently operated heater, a plurality of main heat radiators connected in series with each other and with said heater and adapted to deliver heat into said space, means for circulating heating medium through said heater and main radiators, electrically energized means including a thermostat responsive to the temperature of the enclosed space as a whole for controlling the operation of said heater, auxiliary radiators connected in parallel with said main radiators for augmenting the delivery of heat at predetermined locations in said space, and electrical circuit means including a thermostat responsive to the temperature of the area of the space served by said auxiliary heaters for controlling the operation thereof.

2. A heating system for heating an enclosed space comprising a closed circulating system for a heating medium comprising an intermittently operated heater, a plurality of main heat radiators connected in series with each other and with said heater and adapted to deliver heat into the upper and lower regions of said space, means for circulating heating medium through said heater and main radiators, electrically energized means including a thermostat responsive to the temperature of the enclosed space and a device responsive to predetermined lower and upper temperature limits of the heating medium for controlling the operation of said heater, auxiliary radiators connected in parallel with said main radiators for augmenting the delivery of heat at predetermined locations in said space, and electrical circuit means including a separate thermostat for each auxiliary heater responsive to the temperature of the area of the space served by its associated auxiliary heater for controlling the operation thereof.

3. A heating system for heating an enclosed space comprising a closed circulating system for a heating medium comprising an intermittently operated heater, a plurality of main heat radiators connected in series with each other and with said heater and adapted to deliver heat into the upper and lower regions of said space, means for circulating heating medium through said heater and main radiators, electrically energized means including a thermostat responsive to the temperature of the enclosed space and a relay controlled thereby for controlling the operation of the heater in relation to the general temperature of the enclosed space, a circuit making and breaking device interposed in electrical circuits connected through said relay and responsive to predetermined minimum and maximum temperatures of the heating medium for controlling the operation of said heater when the said thermostat remains unsatisfied, at least one auxiliary radiator connected in said closed circulating system in parallel with a main radiator for augmenting the delivery of heat into the lower region of said space at a predetermined location, and electrical circuit means including a thermostat responsive to the temperature of the area of said space served by such auxiliary radiator for controlling the operation thereof.

4. A heating system for heating an enclosed space comprising a closed circulating system for a heating medium comprising an intermittently operated heater, a plurality of main heat radiators connected in series with each other and with said heater and adapted to deliver heat into the upper and lower regions of said space, means for circulating heating medium through said heater and main radiators, electrically energized means including a thermostat responsive to the temperature of the enclosed space and a relay controlled thereby for controlling the operation of the heater in relation to the general temperature of the enclosed space, a circuit making and breaking device interposed in electrical circuits connected through said relay and responsive to predetermined minimum and maximum temperatures of the heating medium for controlling the operation of said heater when the said thermostat remains unsatisfied, a plurality of auxiliary radiators connected in said closed circulating system in parallel with the main radiators for augmenting the delivery of heat into the lower region of the space at predetermined locations, and electrical circuit means including separate

thermostats responsive to the temperatures of the separate areas of said space served by the auxiliary radiators associated therewith for controlling the operation of said auxiliary radiator.

5. A heating system for heating an enclosed space comprising a closed circulating system for a heating medium comprising an intermittently operated heater, a plurality of main heat radiators connected in series with each other and with said heater and adapted to deliver heat into the upper and lower regions of said space, means for circulating heating medium through said heater and main raditors, an air duct and blower associated with a radiator positioned first in line to receive the heating medium from said heater, whereby the medium of maximum heat is utilized to heat re-circulated air delivered into the upper region of the enclosed space, electrically energized means including a thermostat responsive to the temperature of the air returned to said duct for controlling the operation of said air heater, and auxiliary radiators connected in parallel with other main radiators for augmenting the delivery of heat into the lower region and at predetermined locations within said enclosed space, and electrically energized means for the auxiliary radiators responsive to the temperature of the space in the region of such auxiliary radiators for making them effective and ineffective in the heating system.

6. A heating system for heating an enclosed space comrising a closed circulating system for a heating medium comprising an intermittently operated heater, a plurality of main heat radiators connected in series with each other and with said heater and adapted to deliver heat into the upper and lower regions of said space, means for circulating heating medium through said heater and main radiators, an air duct and blower associated with a radiator positioned first in line to receive the heating medium from said heater, whereby the medium of maximum heat is utilized to heat re-circulated air delivered into the upper region of the enclosed space, electrically energized means including a thermostat and a relay controlled thereby and responsive to the temperature of the air returned to said duct for controlling the operation of said heater, a circuit making and breaking device interposed in control circuits connected through said relay and responsive to a predetermined minimum temperature of the heating medium to cooperate with said relay to close an energizing circuit for said heater and adapted to open the last mentioned circuit in response to a predetermined maximum temperature of the heating medium, and auxiliary radiators connected in parallel with said main radiators for augmenting the delivery of heat at predetermined locations within said enclosed space, and electrically energized means for the auxiliary radiators responsive to the temperature of the space in the region of such auxiliary radiators for making them effective and ineffective in the heating system.

7. In a heating control system for an enclosed space such as a railway car or the like having main radiators connected in a closed circuit for supplying heat to said enclosed space, a pair of auxiliary radiators connected in said closed circuit, said auxiliary radiators being located one on either side of said enclosed space adjacent one end thereof, means for circulating heating fluid in said radiators, a duct for recirculating air which has been heated by said radiators, a heater for said fluid including an intermittently operated burner, circuit means including a thermostat connected in said circuit means and positioned at a point remote from said auxiliary radiators and operable in response to the temperature of the returned air to said duct for controlling the operation of said intermittently operated burner.

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