

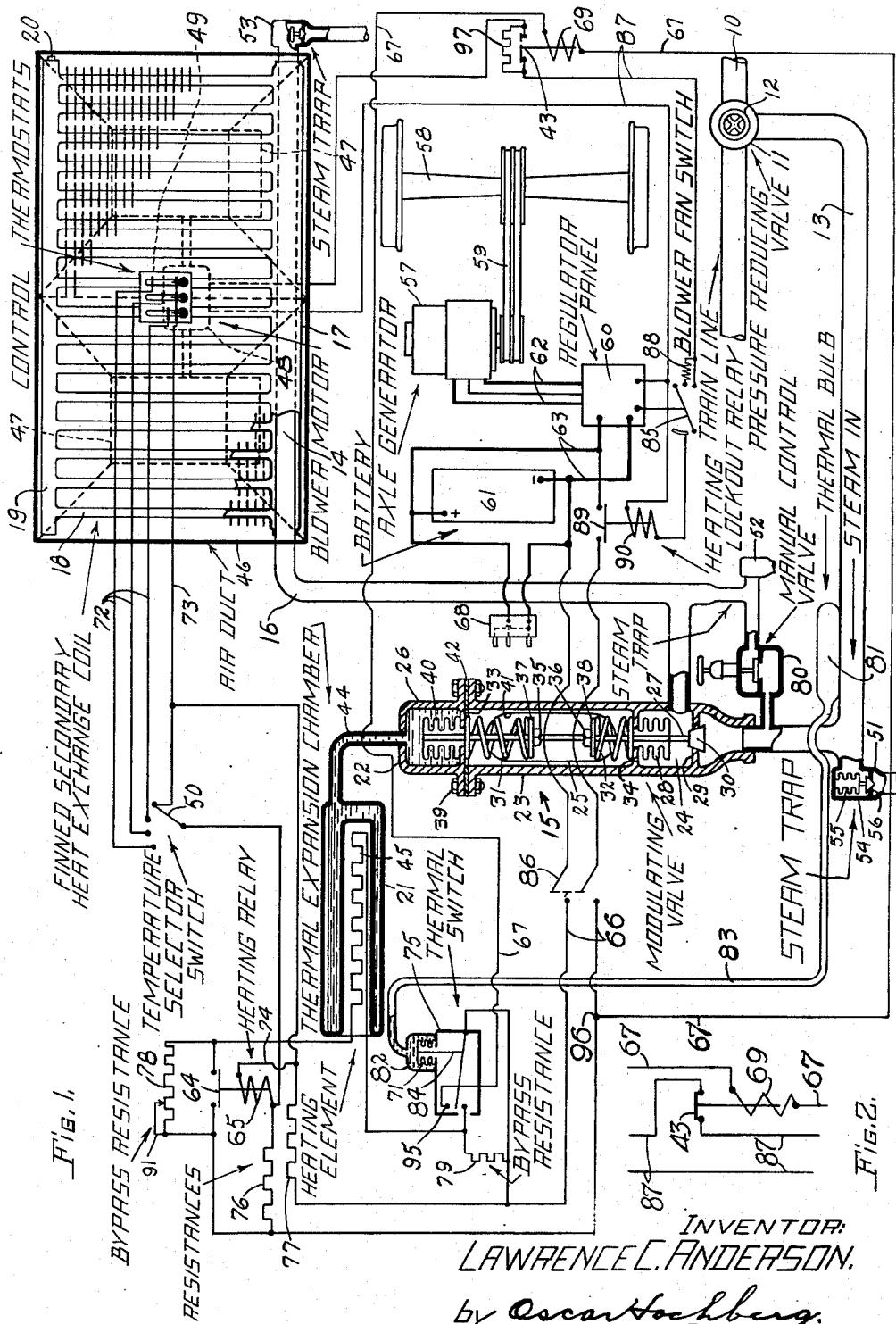
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MODULATING HEATING SYSTEM

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MODULATING HEATING SYSTEM

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The invention relates to air conditioning systems more particularly adapted for use in railway cars, and is primarily concerned with the heating phase of such systems.

5 The principal object of the invention is the attainment of a predetermined constant temperature of the air supplied an enclosure.

Other objects and advantages will become apparent as the description of the invention is read in conjunction with the accompanying drawing in which

Fig. 1 represents, in a diagrammatic form, the invention as contemplated for use on railway cars.

15 Fig. 2 is a fragmentary illustration of a portion of the electrical circuit controlling the blower and represents a modified form of control.

Ordinarily, railway cars are heated by a coil arranged adjacent the floor line—sometimes supplemented by means for distributing heated air from overhead, and the operation of these systems is such that the coils are maintained at excessively high temperatures for short periods of time, after which they necessarily are allowed to grow cold, thus causing variation in the temperature of the air delivered to the space being heated.

The present invention provides a heating system modulated to provide an equable temperature of any desired or preselected degree and, as shown, is adapted for use in a system utilizing blowers for circulation and distribution of air from an associated system of ducts, although it may well be used in a direct radiation system or an arrangement wherein one supplements the other.

In the embodiment illustrated, a source of heat is provided by the train line 10 supplying high pressure steam from a locomotive or from a boiler provided for that purpose. As a safety measure, only relatively low-pressure steam is admitted to the heating system and, for this purpose, a pressure reducing valve 11 is inserted in the train line which may be manually set or controlled by means of the hand control 12 to supply steam of relatively constant pressure to the lead-in pipe 13 from which it is admitted to the primary heating coil 14 under control of modulating valve 15 through feed pipe 16. The primary heating coil 14 passes through a bottom header 17 of a secondary heat exchange coil comprising finned tubes 18 rising from the header 17, and, if desired, intercommunicating at the top through header 19, although the top header may

be dispensed with merely by closing the upright ends of the heat exchange tubes 18.

The secondary heat exchange coil is maintained under vacuum to provide uniform temperature throughout the surface area of the coil regardless of the temperature necessary to meet heating requirements and thus avoid cold spots in the stream of air passed over the coil. The air is withdrawn therefrom by means of charging valve 20 located in the upper header 19 and a given amount of liquid transfer agent introduced therein through the charging valve which settles about the primary heating coil 14. Due to the fact that the secondary coil is maintained under vacuum, the normal atmospheric boiling point of the transfer agent is lowered to a point approximating normal room temperatures, and when steam is admitted to the primary heating coil passing through the bottom header 17, the liquid about the coil—to all practical purposes—is converted instantaneously into vapor which rises through finned tubes 18 where it is condensed by the transfer of heat units from the vapor to the air passing over the tubes in heat exchange relation therewith, whereupon it returns to the bottom header to be again vaporized and the cycle repeated as long as the operation of heating of the air continues.

Admission of steam to the primary heating coil 14 is regulated by the modulating valve arrangement 15 operatively controlled by thermal expansion chamber 21 which, in practice, may be heavily insulated and may be said to form one part of the modulating valve arrangement. The valve body is composed of two sections 22 and 23 insulated from each other and secured together by means of bolts 39 to provide access for inspection and adjustment, and forming three chambers 24, 25 and 26. Chamber 24 houses the valve 27 and provides a tapered seating surface in the web 29 for the valve head 30 affording controlled communication between the lead-in pipe 13 and the pipe 16 and is sealed from the chamber 25 by a bellows-fold diaphragm 28 to prevent the escape of steam passing through chamber 24. Valve tension adjustment springs 31 and 32 are contained in chamber 25 and are seated against webs 33 and 34 respectively. Adjustment of the springs for determining the opening and closing pressures of the valve is accomplished through an opening 41 in the wall of chamber 25 by adjusting the nuts 35 and 36 on the valve stem 27 with respect to the spring abutment washers 37 and 38 bearing against the respective springs 31 and 32 until the desired tension

is obtained on the springs. Chambers 24 and 25 integrally form one section of the modulating valve and section 26 comprises a separate pressure chamber functioning to open the valve 30 through pressure, generated in a manner herein-after described, applied to the end of valve stem 27 which is disposed in abutting relation to the bellows-fold diaphragm 40 closing the opening in web 33 permitting entrance of the valve stem. The bellows-fold diaphragms 28 and 40 effectively seal the respective chambers 24 and 26 while, at the same time, permitting unobstructed operation of the valve. Insulation 42 is disposed between the adjoining faces of the connection between the two sections of the modulating valve to prevent the transmission of heat from the steam in chamber 24 through the walls of the valve to pressure chamber 26.

Pressure chamber 26 is in direct communication with the thermal expansion chamber 21 through connecting tube 44 and is evacuated of air therewith. After extraction of the air from the chambers 21 and 26 for effecting a vacuum, a volatile fluid—preferably having a boiling point above normal room temperatures—is introduced, which serves to transmit pressures developed in the expansion chamber 21 to pressure chamber 26. As pressure is generated by the application of heat to the liquid in chamber 21 by means of heating element 45, vaporization and expansion thereof occurs, and the development of pressure in chamber 26 follows as a natural result. Pressure in chamber 26 causes the bellows-fold diaphragm 40 to collapse, against the pressure of the adjustment springs 31 and 32, to press the tapered valve 30 away from its seat in web 29 to admit steam to primary heating coil 14. The steam transfers the heat units it contains to the intermediate liquid transfer agent in bottom header 17 of the secondary transfer coil and consequently causes a heat exchange action with the air passing over the finned tubes 18, as set out above. When the heating element 45 cools, the liquid in expansion chamber 21 condenses, thereby reducing the pressure in chamber 26, allowing the valve 30 to exert a throttling action and limit the entrance of steam into the primary heating coil 14 whereupon the vaporized intermediate transfer agent in the secondary transfer coil condenses and settles in bottom header 17, and heating of the air passing over the tubes 18 is minimized. Although it is preferable that the fluid introduced in chambers 21 and 26 should have a boiling point above normal room temperatures, a fluid having a boiling point lower than normal room temperature may be utilized for this purpose provided the resultant difference in pressure is compensated for by adjustment of springs 31 and 32. In the actual practice of the invention, the chamber 21 is heavily insulated further to isolate the fluid therein from the effects of the temperature of the surrounding air and resulting in its more accurate response to changing temperatures of the heating element 45.

As shown, the secondary heat exchange coil is located in a duct 46 which may be mounted in the roof zone of a railway car, or otherwise, and adapted to distribute the air passing over the coil to an enclosure to be heated. The coil is disposed in association with blowers 47 driven by a motor 48 whereby the air is positively circulated over the coil to cause a more rapid and efficient heat exchange action and uniform distribution of the heated air. However, where certain prescribed conditions obtain, the secondary heating coil may

be used to advantage in a direct radiation system such as used in the so-called floor heat arrangements of railway cars, wherein heating coils are disposed adjacent the floor line along the side walls, or, if desired, a combination of the two may be utilized—one supplementing the other.

Steam traps 51, 52 and 53 are provided for draining condensation from the lead-in pipe 13 and the lower portion of chamber 24 of the modulating valve, for draining the feed pipe 16 and the upper portion of chamber 24 and for draining the primary heating coil 14, respectively. The steam traps each comprise a housing 54 containing a bellows-type thermostatically operating valve 55 seating within a tapered opening in bottom web 56 and adapted, when the relatively cooler condensate collects around the bellows, to open and drain the condensate, whereupon the steam contacts the bellows and causes the valve again to close.

The heating system above described is rendered operative by the use of suitable means for regulating the operation of the several parts and herein comprising a series of electrically operated controls thermostatically regulated in such manner as to render the entire system automatically responsive to temperature requirements and resulting in a supply of air of minimum variation in temperature and of predetermined degree.

Electrical current for operation of the controls is supplied by a generator 57 driven from a car axle 58 by means of belts 59 which, upon rotation of the axle, delivers current through the switch-board and regulator panel 60 to the battery 61 by means of circuits 62 and 63, respectively. Upon cessation of current from the generator 57, the current stored in battery 61 flows back through the circuit 63—at all times to keep the regulator panel 60 energized so that power is always available for circuits tapped therefrom. A plug-in receptacle 68, which is connected into the circuit 63, is provided for charging the battery and supplying current during stopover periods.

Once set in operation, the system is responsive to the group of thermostats 49, preferably of the mercury type and any one of which may be elected to control the operation of the system by means of the selector switch 50. The thermostats each are of different temperature values and function to control the energization and deenergization of the heating relay 65 which, in turn, controls energization of the thermal expansion chamber heating element 45—resulting in normal operation of the heating system. As shown, the circuit 66, tapped off the main circuit 63 between the battery and regulator panel, comprises the source of current for all of the elements affecting the control of the system after it has been placed in operation. One side of the circuit 66, through a resistance 76, traverses one post of the heating relay 65 and connects with the hinging post of the selector switch 50. From here the current travels through one of the wires 72, depending upon the temperature value of the thermostat desired, to the top contact of the thermostat selected to control actuation of the relay 65. Thus, when the air of the space being heated reaches the temperature required by the controlling thermostat, the mercury rising in the thermostat completes the circuit to the bottom contact wire 73 and, by means of the connection 74 to the other terminal post of the heating relay 65, the relay is short-circuited, causing the contactor 64 to open and break the circuit to the heating element 45 of the thermal expansion chamber 21.

Interposed in the circuit 66 to the thermostats 49 and before the relay 65 are resistances 76 and 77 which limit the current through the mercury column of the thermostat affected to avoid arcing as the circuit makes and breaks, and, further, when the circuit from the top to the bottom contact of the thermostat is not completed by the mercury column, serve to permit the flow of sufficient current to the heating relay 65 to energize the coil thereof to maintain the contactor 64 in closed position until short-circuited by the thermostat. When the hinged selector switch 50 is in the off position as shown, the coil of the heating relay 65 is short-circuited in the same manner as by thermostats 49.

The circuit to the heating element 45 in the thermal expansion chamber is completed from the circuit 66 in such manner as to preclude the possibility of the element 45 being heated when no steam is available in the lead-in pipe 13 for admission to the primary heating coil 14 of the heat exchanger to cause heating of the air passing over tubes 18 and consequent short circuiting of the heating relay 65 as the upper and lower contacts of the controlling thermostat are bridged by the mercury column. A pressure-actuated thermal switch 75 is placed in one side of the circuit to the heating element 45 opposite to that in which the relay 65 is interposed and is normally open and which closes only when steam is in the lead-in pipe 13. The principle of operation of the thermal switch is the same as that of the modulating valve arrangement 15. A thermal bulb 81 is closely associated with the lead-in pipe 13 and communicates directly with the pressure chamber 82 through the intervening pipe 83. The bulb, pipe and pressure chamber 82 contain a liquid, reacting to the temperature of the lead-in pipe, and as the thermal bulb 81 is heated, the pressure thus developed is reflected in the pressure chamber 82 and the bellows-fold diaphragm 71 thereby compressed—closing the switch 75 by means of plunger 84 and completing one side of the circuit to the heating element 45. Closing of the heating relay 65 will not complete the circuit to the heating element 45 unless the thermal switch 75 is closed, and as long as there is steam in the lead-in pipe 13, the thermal switch will remain closed, but when the steam pipe 13 cools, the pressure in chamber 82 is reduced, causing the switch to open to avoid the generation of excessive pressure in the modulating control valve 15.

By-pass resistances 78 and 79 are disposed in the circuit to the heating element 45 bridging the heating relay contacts and the thermal switch, respectively, and provide a low-leak source of current to the heating element at all times while the system is in operation—sufficient to keep the thermal expansion chamber 21 moderately warm to avoid the necessity of raising the temperature of the liquid therein a greater amount than would otherwise be necessary. By keeping the thermal expansion chamber warm, the heat exchange coil is kept at a more nearly constant temperature since the modulating valve 30, with this arrangement, does not close completely or open completely immediately upon demand of the thermostatic controls, but remains more or less open at all times due to the by-pass resistances 78 and 79 providing heating current to the heating element 45 to keep the pressure built up in the expansion chamber, partially energizing the control valve and thus operating more uniformly to supply the steam necessary to

the heat exchanger as required by the thermostats, thereby providing a modulating action not otherwise obtainable. Consequently, the operation of the modulating control valve 15 is rendered of greater sensitivity and the heat exchanger therefore more closely responsive to temperature requirements. The resistance 78 is adjustable for varying the amount of current fed to the heating element 45 and thereby the modulating pressure built up by the expansion chamber 21. The adjustment for the desired pressure is effected by means of sliding contact 91, changing the value of resistance 78 in accordance with the temperature required of the heating element 45 to maintain such pressure as a minimum and thereby regulate the throttling action exerted by valve 30. The by-pass resistances 78 and 79 serve the further purpose of acting as arc dampeners across the contacts of the heating relay 65 and of the thermal switch 75, since the resistances bridge the contacts of those respective elements and provide low-leak sources of current thereacross to avoid the necessity of contactor 64 and the switch 75 closing fully open circuits.

In actual practice in a railway car equipped with an air conditioning system for cooling as well as heating, the temperature selector switch 50 would be combined with a master temperature selector switch for controlling both the cooling and heating phases, and the contacts leading to the thermostats 49, here shown, would comprise only one side thereof, and by turning the selector switch to either one side or the other, the cooling or heating phase would automatically be cut out for seasonal operation, but, for the simplification of the illustration of the present disclosure, a switch 86 is interposed in the circuit 66 by means of which the heating system may be completely cut out when not required.

The heating system cannot be operated until the blowers 47 are placed in operation to provide a draft of air over the heat exchanger tubes 18 and control thermostats 49. The blowers are driven directly from motor 48 which is energized off the regulator panel 60 through a circuit 87 and, by means of the switch 85 and through suitable resistances 88, is adapted for multi-speed operation. Energization of the circuit 87 by closing the switch 85 also energizes a circuit to relay 90, closing a contactor 89 bridging a gap in one side of the circuit 66 and therefore controlling energization of that circuit so that none of the electrical controls for starting and regulating the operation of the heating system, other than a contactor 43 hereinafter described, are operable until the blower fan switch 85 is closed, whereby overheating of the secondary heat exchange coil is prevented. The circuit to the blowers is designed so that should a car equipped with this heating system be cut out of a train and allowed to remain without steam for any length of time, the blowers will automatically be slowed down—or, stopped—to avoid the blast of cold air that would occur were the blowers allowed to continue operating at full speed without heat. The thermal switch 75 performs this function in addition to that of breaking the circuit to the heating element 45. A circuit 67 from the main circuit 66 to a relay coil 69 is made through the thermal switch 75 by means of a contact 95 provided therein on the opposite side of the contact arm from that leading to the heating element 45 and affording, when the thermal switch 75 is open

from lack of steam in the pipe 13, a direct connection to one side of the circuit 66, the other side being joined as at 96, and serving to energize relay 69 to open the contactor 43 in one side of the circuit 87 to the blower motor 48 whereby, when steam is not available, a direct circuit to the relay coil 69 is provided energizing it to open, leaving a gap in the circuit 87 as shown in Fig. 2. The contactor 43 is normally closed, and so long as the thermal switch 75 remains closed in response to energization of the bulb 81, or when the switch 86 is opened, cutting out the entire circuit, will remain closed for normal operation of the blowers 47 in response to the setting of the multi-speed switch 85. The gap in the circuit 87 may be bridged by a resistance 97 if desired as in Fig. 1 so that when the contactor 43 is open the blowers 47 will run at reduced speed to provide circulation without a pronounced drop in temperature instead of cutting out completely. Thus it will be seen that when the thermal switch 75 opens from lack of steam in the pipe 13, the circuit to relay coil 69 will be energized as that to the heating element 45 is broken, causing the contactor 43 to open and the blowers 47 to run at reduced speed through the resistance 97, or, if the resistance is omitted, to stop, as preferred.

Assuming that a railway car equipped with this system is connected to a locomotive, or steam otherwise made available in the lead-in pipe 13, and it is desired to operate the heating system, the attendant, by means of the temperature selector switch 50, will select a thermostat of the group 49 of a temperature value desired to control operation of the system and set the blower fan switch 85 for the speed at which it is desired to operate the blowers 47. Closing of the blower fan switch energizes the heating lockout relay 90, closing the contactor 89 to energize the circuit 66. The switch 86 is normally closed and, steam being in the lead-in pipe 13, the thermal switch 75 also will be closed. The car being cold, the mercury column in the selected thermostat will not have reached the top contact thereof, and the heating relay 65 therefore will be energized to close the contactor 64—completing a direct circuit to the heating element 45 in the thermal expansion chamber. Heating of the liquid in the thermal chamber will cause expansion of the liquid and consequent pressure in the chamber 26 to open the valve 30 and admit steam to the primary heating coil 14 whereupon the intermediate transfer liquid therein is vaporized and enters the finned tubes 18 to heat the air passing thereover. As the air reaches the temperature required by the control thermostat, the mercury column therein reaches the top contact and short-circuits the relay 65, dropping the contactor 64 and partially de-energizing the heating element 45. The pressure in chamber 26 is thereby reduced and the valve 30 throttles the supply of steam to the secondary heat exchanger until again called for by the thermostat. When the contactor 64 opens the direct circuit to the heating element 45, the resistances 78 and 79 will still allow sufficient current to by-pass either the contactor 64 or both the contactor and the thermal switch 75 to keep the heating element moderately warm, and, when the car is out of service, even this minimum current may be cut out by opening the switch 86.

If, for any reason, the valve 30 should fail automatically to open, steam may be admitted to the primary heating coil 14 by hand and in controllable quantity by means of the manual

control valve 80 interposed between the lead-in pipe 13 and connecting pipe 16 to by-pass the modulating valve.

The present invention possesses the advantage over heating systems heretofore used in the provision of means for operating a heat exchange element at a relatively lower effective temperature. Ordinarily, in heating systems utilizing high-pressure steam, the heat exchanger is maintained at temperatures of 212° F. and higher and operate only intermittently, thus causing, when the steam is off, an abrupt drop in temperature and, in a thermostatically controlled system, resulting in sluggish response of the control thermostats due to the excessive drop in temperature before the heated air from the heat exchanger can become effective to cause the thermostats to function when the steam is again turned on, whereas, in this system, it is possible to operate the heat exchange element at a temperature of probably 100° F. more or less constantly, whereby sudden temperature changes are avoided and the thermostats consequently rendered more closely responsive and temperature requirements more accurately controlled.

From the foregoing, it will be seen that there has been provided a heating system well adapted to the peculiar requirements of present-day railway service which is so modulated as to supply conditioned air of substantially constant temperature in an economical and efficient manner.

What is claimed is.

1. In a railway car, a heating system comprising a heat exchanger having primary and secondary coils, a vaporizable liquid in the secondary coil, means for heating the primary coil, a pressure-actuated control valve to regulate heating of the primary coil, a thermal expansion chamber having a heating element for causing the generation of pressure to open the control valve, relay means for energizing the heating element from an electrical circuit, thermostatic means in the air stream passing over the secondary coil controlling operation of said relay, means for automatically opening the circuit to said heating element when no heat is available for vaporizing the fluid in said secondary coil and means in the electrical circuit for by-passing said last named means when open for supplying current in reduced volume to said heating element.

2. In a railway car, a heating system comprising a heat exchanger having primary and secondary coils, a vaporizable liquid in the secondary coil, means for heating the primary coil to vaporize the fluid contained in the secondary coil, a pressure-actuated control valve to regulate the heating of the primary coil, a thermal expansion chamber having a heating element for causing the generation of pressure to open the control valve, relay means for energizing the heating element from an electrical circuit, thermostatic means in the air stream passing over the secondary coil controlling operation of said relay, means for opening the circuit to said heating element when no heat is available for vaporizing the fluid in said secondary coil, and means in the electrical circuit for by-passing said last named means and the relay when either one or both of said elements are open for supplying a reduced amount of current to the heating element.

3. In a railway car, a heating system comprising a heat exchanger having primary and secondary coils, a vaporizable liquid in the secondary coil, means for heating the primary coil to vaporize the fluid contained in the secondary coil, a

pressure-actuated control valve to regulate the heating of the primary coil, a thermal expansion chamber having a heating element for causing generation of pressure to open the control valve, relay means for energizing the heating element from an electrical circuit, blower means for circulating air over the secondary coil, a switch in the electrical circuit for energizing the blower means, thermostatic means in the air stream passing over the secondary coil for controlling operation of said relay, and means for preventing the energization of said electrical circuit unless said blower means is in operation, comprising a contactor in the electrical circuit operated by a relay energized upon operation of the blower switch.

4. In a railway car, a heating system comprising a heat exchanger controlled by a pressure-actuated valve to regulate heating thereof, a thermal expansion chamber having a heating element for causing the generation of pressure to actuate the control valve, relay means for energizing the heating element from an electrical circuit, blower means for circulating air over the heat exchanger, thermostatic means in the air stream passing over the heat exchanger controlling operation of said relay, means for opening the circuit to said heating element when no heat is available for the heat exchanger, means in the electrical circuit for by-passing said last named means and the relay when either one or both of said elements are open for supplying a reduced amount of current to the heating element, and means for preventing the energization of said electrical circuit unless said blower means is in operation.

5. In a railway car, a heating system comprising a heat exchanger having a primary coil and an evacuated secondary coil, a vaporizable liquid in the secondary coil, means for heating the primary coil to vaporize the fluid contained in the secondary coil, a pressure-actuated valve for regulating heating of the primary coil, a thermal expansion chamber having a heating element effecting the generation of pressure to open the control valve, relay means for energizing the heating element from an electrical circuit, blower means energized from said circuit for circulating air over the secondary coil, thermostatic means in the air stream passing over the secondary coil controlling operation of said relay, and means for automatically opening the circuits to said heating element and to said blower means when no heat is available for vaporizing the fluid in said secondary coil.

6. In a railway car, a heating system comprising a heat exchanger having primary and secondary coils, a vaporizable liquid in the second coil, means for heating the primary coil to vaporize the fluid contained in the secondary coil, a pressure-actuated valve for regulating heating of the primary coil, a thermal expansion chamber having a heating element effecting the generation of pressure to actuate the control valve, relay means for energizing the heating element from an electrical circuit, blower means energized from said circuit for circulating air over the secondary coil, a switch in the electrical circuit for energizing the blower means, thermostatic means in the air stream passing over the secondary coil controlling operation of said relay, means for automatically opening the circuits to said heating element and to said blower means when no heat is available for vaporizing the fluid in said secondary coil, and means for

preventing energization of said electrical circuit when said blower means is not in operation, comprising a contactor in the electrical circuit operated by a relay energized upon operation of the blower switch.

7. In a railway car, a heating system comprising a heat exchanger having a primary coil and an evacuated secondary coil, a vaporizable liquid in the secondary coil, means for heating the primary coil to vaporize the fluid contained in the secondary coil, a pressure-actuated valve for regulating heating of the primary coil, a thermal expansion chamber having a heating element effecting the generation of pressure to open the control valve, relay means for energizing the heating element from an electrical circuit, blower means energized from said circuit for circulating air over the secondary coil, thermostatic means in the air stream passing over the secondary coil controlling operation of said relay, and means for automatically opening the circuit to said heating element and reducing the speed of said blower means when no heat is available for vaporizing the fluid in said secondary coil.

8. In a railway car, a heating system comprising a heat exchanger having a primary coil and an evacuated secondary coil, a vaporizable liquid in the secondary coil, means for heating the primary coil to vaporize the fluid contained in the secondary coil, a pressure-actuated valve for regulating heating of the primary coil, a thermal expansion chamber having a heating element effecting the generation of pressure to open the control valve, relay means for energizing the heating element from an electrical circuit, blower means energized from said circuit for circulating air over the secondary coil, a switch in the electrical circuit for energizing the blower means, thermostatic means in the air stream passing over the secondary coil controlling operation of said relay, means for automatically opening the circuit to said heating element and reducing the speed of said blower means when no heat is available for vaporizing the fluid in said secondary coil, and means for preventing energization of said electrical circuit unless said blower means is in operation, comprising a contactor in the electrical circuit operated by a relay energized upon operation of the blower switch.

9. In a railway car, a heating system comprising a heat exchanger having primary and secondary coils, a vaporizable liquid in the secondary coil, means for heating the primary coil to vaporize a fluid contained in the secondary coil, a pressure-actuated control valve for regulating heating of the primary coil, a thermal expansion chamber having a heating element for causing the generation of pressure to open the control valve, relay means for energizing the heating element from an electrical circuit, blower means for circulating air over the secondary coil, thermostatic means in the air stream passing over the secondary coil controlling operation of said relay, means for opening the circuit to said heating element when no heat is available for vaporizing the fluid in said secondary coil, means in the electrical circuit for by-passing said last named means and the relay when either one or both of said elements are open for supplying a reduced amount of current to the heating element, and means for preventing the energization of said electrical circuit unless said blower means is in operation.

10. A heating system comprising a heat exchanger controlled by a pressure-actuated valve

to regulate heating thereof, a thermal expansion chamber provided with a heating element causing the generation of pressure for actuating the control valve, relay means for energizing the heating element from an electrical circuit, blower means for circulating air over the heat exchanger, thermostatic means in the air stream passing over the heat exchanger controlling operation of said relay, means for opening the circuit to said heating element when no heat is available for the heat exchanger, and means in the electrical circuit by-passing said last named means and the relay when either one or both of said elements are open for supplying current in reduced volume to the heating element.

11. A heating system comprising a heat exchanger controlled by a pressure-actuated valve to regulate heating thereof, a thermal expansion chamber provided with a heating element causing the generation of pressure for actuating the control valve, relay means for energizing the heating element from an electrical circuit, blower means for circulating air over the heat exchanger, thermostatic means in the air stream passing over the heat exchanger controlling operation of said relay, and means in the electrical circuit by-passing the relay when open for supplying current in reduced volume to the heating element.

12. A heating system comprising a heat exchanger controlled by a pressure-actuated valve to regulate heating thereof, a thermal expansion chamber provided with a heating element causing the generation of pressure for actuating the control valve, relay means for energizing the heating element from an electrical circuit, thermostatic means responsive to the temperature of the heat exchanger controlling operation of said relay, and means in the electrical circuit by-passing the relay when open for supplying current in reduced volume to the heating element.

13. A heating system comprising a heat exchanger controlled by a pressure-actuated valve to regulate heating thereof, a thermal expansion chamber provided with a heating element causing the generation of pressure for actuating the control valve, relay means for energizing the heating element from an electric circuit, thermostatic means responsive to the temperature of the heat exchanger controlling operation of said relay, means in the electrical circuit by-passing the relay when open for supplying current in reduced volume to the heating element, and means to adjust said by-pass means for regulating the volume of current supplied said heating element.

14. A heating system comprising a heat exchanger controlled by a valve for regulating heating thereof, electrically energized means effecting operation of said valve, relay means effecting energization of said means from an electrical circuit, thermostatic means responsive to the temperature of the heat exchanger controlling operation of said relay, and means in the electrical circuit by-passing the relay when open for supplying current in reduced volume to said electrically energized means.

15. In a railway car, a heating system comprising a heat exchanger having a primary coil and a secondary coil evacuated of air, a vapor-

izable liquid in the secondary coil, means for admitting steam to the primary coil to vaporize the fluid in the secondary coil comprising a pressure-actuated control valve, a thermal expansion chamber in communication with said valve and having a heating element for causing generation of pressure to open the valve, an electrical circuit, relay means for intermittently heating said element from said electrical circuit, and a thermostat responsive to temperatures of the secondary coil controlling said relay means.

16. In a railway car having a main steam line, a heating system comprising a heat exchanger having a primary coil and a secondary coil evacuated of air, a vaporizable liquid in the secondary coil, means for admitting steam to the primary coil from said steam line to vaporize the fluid in the secondary coil comprising a pressure-actuated control valve, a thermal expansion chamber in communication with said valve and having a heating element for causing generation of pressure to open the valve, relay means for intermittently heating said element from an electrical circuit, and a thermostat responsive to temperatures of the secondary coil controlling said relay means.

17. In a railway car heating system the combination comprising a heat exchanger having a primary coil and a secondary coil evacuated of air, a vaporizable liquid in the secondary coil, means for heating the primary coil to vaporize the fluid in the secondary coil, a control valve for regulating the heating of the primary coil, and means automatically effecting actuation of said valve in accordance with temperature demands including relay means for opening and closing an electrical circuit to the valve actuating mechanism and a thermostat responsive to temperatures of the secondary coil to control said relay, said valve-actuating mechanism comprising fluid pressure means energized by said electrical circuit.

18. A heating system including a heat exchanger, a valve for regulating heating of said exchanger, means effecting the operation of said valve including a relay energized from an electrical circuit, blower means energized from said circuit for circulating air over the heat exchanger, thermostatic means in the air stream passing over the heat exchanger controlling operation of said relay, and means in parallel electrical circuit relationship with the relay for effecting the operation of said valve independently of said relay.

19. In a railway car, a heating system comprising a heat exchanger having a primary heating element and a secondary heated element, heat transfer means in the secondary element responsive to said primary element, means for heating the primary element to cause said heat transfer means to heat said secondary element, control means effecting the operation of said last-named means, means responsive to heating of said secondary element affecting operation of said control means, and means independent of the control means affecting the action thereof independently of said secondary-responsive means.

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