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HEATING SYSTEM

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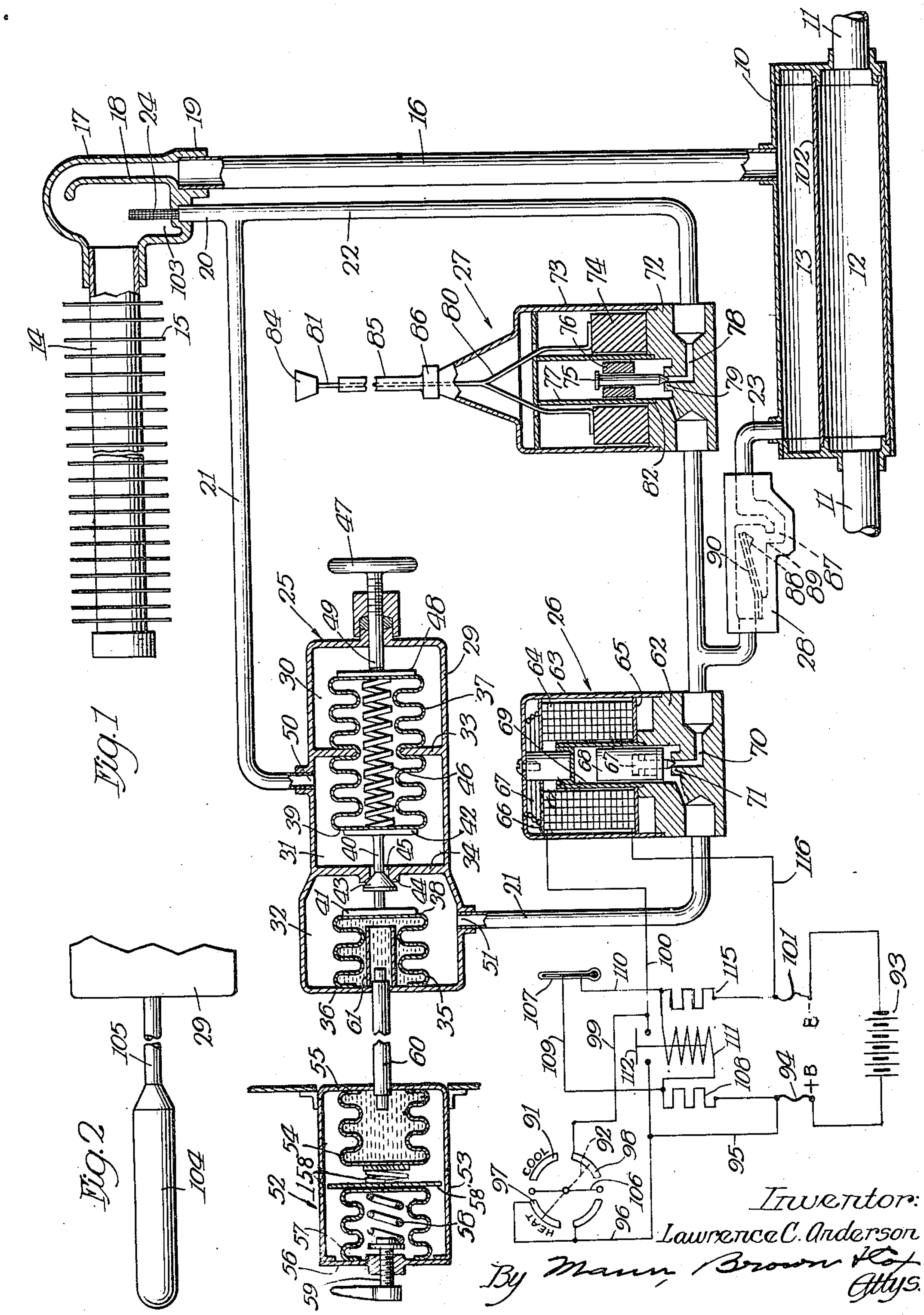

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HEATING SYSTEM

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4 Claims. (Cl. 237—6)

Among the principal objects of the present invention are the following: To provide an entirely automatic sealed modulating heating system capable of maintaining uniform temperatures throughout the space to be heated, and one which will insure against freezing temperatures irrespective of the setting of the individual thermostat controlling the heating system and whether or not the main heating system is in operation; to provide a control valve for such a system which is highly efficient in maintaining uniform temperatures irrespective of atmospheric pressure changes and is simple in construction and operation; and to provide a valve which will operate in a completely sealed system.

Other objects and advantages will become apparent as the disclosure proceeds and the description is read in conjunction with the accompanying drawing, in which

Fig. 1 is a diagrammatic view of the complete heating system showing somewhat in detail the valves employed in controlling the system and showing schematically the control circuit;

Fig. 2 is a fragmentary view of a modified form of the thermostatic means for operating the control valve shown in Fig. 1.

The present invention has particular value as a heating system for railway passenger cars and the like, but its use is not limited to such installations. The system itself is shown entirely apart from any particular application of the heating arrangement, and only one embodiment is selected to disclose the invention in compliance with section 4888 of the Revised Statutes.

This is continuation of the co-pending application bearing Serial No. 273,139 filed May 11, 1939.

Referring to the figures, the heating system includes a boiler 10 mounted on a steam pipe line 11 having a primary chamber and a secondary chamber 12 and 13 respectively. In the space to be heated is a radiator 14 having fins 15, and rising from the secondary chamber 13 of the boiler 10 is a vapor riser 16 connected to the radiator 14 by a joint 17. A baffle 18 extends from the mouth 19 of the joint to the upper regions so that any vapor passing through the riser 16 is discharged into the joint 17 adjacent to the top. Extending downwardly from the joint 17 is a return line 20 having two branches 21 and 22, both emptying into the secondary chamber 13 through a common return 23. The return line 20 has an upwardly extending screen 24 which extends well into the joint 17, as shown in Fig. 1. In branch return line 21 is a modulating heat valve 25 and a heat protection valve 26, and in the other branch 22 of the return line is a manually operated control valve 27. A safety valve 28 is placed in the common return line 23, and its purpose is to prevent excessive temperatures or pressures from arising in the heating system.

The modulating heat valve 25 comprises a housing 29 divided into three separate chambers, 30, 31, and 32, by partitions 33 and 34 between chambers 30 and 31, and 31 and 32, respectively. In chamber 32, a bellows 35 is secured to the wall 36 of the housing 29. A second bellows 37 is housed in the chambers 30 and 31 with a portion of the bellows in each chamber. The partitioned wall 33 is sealed against the bellows. Extending between bellows 35 at its free end 38 and bellows 37 at it send 39 is a rod 40 secured to the bellows by means of plate members 41 and 42, respectively. A movable valve member 43 is carried by rod 40, and is adapted to fit into valve seat 44 in the partitioned wall 34, thus closing off passage 45 between chambers 31 and 32. A spring 46 is housed within bellows 37, and a manually operated regulating screw 47 passes through the housing 29 to serve as the stop for the spring 46. A plate 48 is inserted between the shank 49 of screw 47 and the end face of the bellows 37. The branch 21 of the return line enters chamber 31 of the valve 25 at 50, and leaves chamber 32 at 51. Thus the flow of condensate from the radiator passes into chamber 31 at 50, through passage 45 when the movable valve member 43 opens its passage, and then leaves chamber 32 through opening 51.

A thermostatic element generally indicated at 52 is located in the space to be heated and comprises a housing 53 in which is mounted bellows 54, secured to one face 55 of the housing 53. The housing 53 is open at one end and a cover 56 closes this opening. A bellows 57 is fastened to the cover and extends inwardly in the housing 53. An adjusting screw 59 engages the inner face of bellows 57 to regulate its degree of expansion and a compression spring 58 extends between bellows 57 and the end of housing 53. This spring urges the bellows into a contracted position opposing the force exerted by the screw 59 and resisting any tendency for the bellows to expand due to increases in pressure inside bellows 57. A wear plate 58' is inserted between the spring 58 and bellows 57.

Extending between the thermostatic element 52 and the modulating valve 25 is a tube 60 communicating with the interiors of bellows 54 and

35, and a cylindrical tube 61 is positioned inside bellows 35 over the end of tube 60.

Some suitable operating medium such as light oil fills bellows 54 and 35 and tube 60 to impart movement to valve 43 in response to the requirements of the thermostat 52. This medium is preferably a liquid having a low freezing point so that the tube 60 may be placed underneath the car without danger of freezing the liquid in cold weather. Liquid also has the advantage over a gas because there is no expansion or contraction of the medium due to the temperature changes to which it will be exposed under normal operating conditions.

The heat protection thermostat 26 includes a base 62 supporting a housing 63, which is sealed to the base. An electromagnetic coil 64 is mounted in the housing 63 between plate members 65 and 66, and a spring 67 is placed between the plate 66 and the top of the housing 63. When the unit is assembled, this spring holds the electromagnet in place.

A movable valve member 67 operates inside the coil 64 and an armature 68 is secured to the valve member 67. A sleeve 69 of non-magnetic material is inserted between the armature 68 and the magnetic coil 64. Extending through the base 62 of the valve 26 is a passage 70, and the movable valve member 67 moves in and out of the valve seat 71 to close and open the passage through the base 62.

Manually controlled valve 27 includes a base 72, to which is secured a housing 73. A permanent magnet 74 operates in the housing 73, and is in the form of a ring in the center of which a movable valve member 75 operates. An armature 76 of magnetic material is positioned in the field of the magnet 74, and a sleeve 77 of non-magnetic material is positioned between the magnet 74 and the armature 76.

The movable valve member 75 closes and opens the passage 78 through the base 72 by moving in and out of the valve seat 79 in response to the position of the permanent magnet 74. A magnet supporting arm 80 extends upwardly from the magnet 74, to the end of which is secured a rod or cable 81. The sleeve member 77 is closed across the top and is sealed to the base 72 at 82 so that the movable valve member 75 is entirely sealed from the atmosphere, thus avoiding the danger of dirt collecting on the valve seat. At the free end of the rod or cable 81 is a knob 84 for the manipulation of the manually controlled valve. A casing 85 surrounds the rod or cable 81 and is secured to the top of the housing 73, as indicated at 86.

The safety valve 28 has a passage 87 extending therethrough, and a movable valve member 88 is adapted to enter the valve seat 89 to close this passage when excessive temperatures cause a bimetallic strip 90, carrying the valve member 88, to bend toward the valve seat 89.

The thermostatic element 52 per se does not constitute any part of the present invention. There are many forms of adjustable thermostats which would be suitable in applicant's device, but the one shown is simple and serves to illustrate one type.

In the operation of the system, the thermostatic element 52 is manually adjusted to operate at predetermined temperature, say, for example, 74°. This is done by manipulation of the adjustment screw 59, which expands or contracts bellows 57 to compress the gas more or less within the housing 53, which, in turn, initially sets the position of bellows 54. A spring 158 may be required between bellows 57 and bellows 54 to effect the adjustment of bellows 54 by movement of bellows 57. The entire system from the thermostatic element 52 to the shank 49 of screw 47 is placed under initial compression so that the spring 46 forces plate 48 firmly against the end of shank 49 on screw 47. This initial compression is sufficient to overcome normal atmospheric pressure changes in the chamber 30. These changes in atmospheric pressure applied against the plate 48 merely vary the distribution of the reactive forces on this plate, which opposes the force of spring 46. During normal operation of the system when heating up to 74° is required, a temperature selector switch 91 is turned to the "heat" position, indicated in dotted lines at 92, thereby closing the circuit from battery 93 through the fuse 94, conductors 95 and 96, contact plate 97, arm 92, contact plate 98, conductors 99 and 100, electromagnetic coil 64 of the heat protection valve 26, and then back to the battery through conductor 116 and fuse 101. The electromagnetic coil 64 is thereby energized to raise the movable valve member 67 and hold it in this raised position as long as the temperature selector switch 91 is calling for heat. Thus, the heating system is under the operation of modulating heat valve 25, which functions in the following manner: As the temperature in the space to be heated drops below 74°, the gas in housing 53 of the thermostatic element 52 contracts, thereby allowing bellows 54 to expand. A light oil is contained within the bellows 54, tube 60, and bellows 35, so that, as the bellows 54 expands, the pressure on this oil is lowered, thereby permitting the force of spring 46 in the modulating heat valve 25 to force valve member 43 away from the valve seat 44 to open the passage between chambers 31 and 32, allowing the volatile liquid to flow from branch line 21 of the return line back to the secondary chamber 13 of the boiler. Steam is passing through steam line 11 and primary chamber 12 of the boiler so that the volatile liquid in the secondary chamber 13 contacts the heat exchange surface 102 between primary and secondary chambers 12 and 13, respectively, causing vaporization of the volatile liquid. The vapor ascends riser 16 and passes into the radiator 14 through joint 17; and, on being cooled in the radiator, condenses. The condensate flows through screen 24 in the return line 20, and the cycle is repeated. Under the initial setting of the modulating heat valve 25, the initial adjustment of that valve and the thermostatic element 52 is such that the oil pressure within bellows 54, tube 60, and bellows 35 balances the pressure of spring 46; and, when the oil pressure within bellows 54 is varied due to changes in gas pressure within housing 53, the movable valve member 43 is moved with respect to valve seat 44 until the system is again placed in a state of equilibrium. Consequently, the valve opening may be entirely closed or opened to any degree, depending upon pressure conditions within the housing 53 of the thermostatic element 52. Thus, the action of the modulating heat valve 25 is a throttling action and not a mere open-and-close action. When the temperature of the space to be heated reaches 74°, gas pressure within housing 53 increases to contract bellows 54, thereby closing the passage between chambers 31 and 32 of the modulating heat valve 25.

As shown in Fig. 1, the thermostatic element 52 has a manual adjustment feature for regulating the temperature of operation of the thermostat. The adjusting screw 47 is merely for adjusting the valve to initially set the system for proper operation, and for later adjusting purposes. It may be desirable, however, to use a reservoir 104 as the thermostatic element housing a volatile liquid for operating the bellows 35. In this case, a tube 105 connects the reservoir 104 with the interior of bellows 35 in the same manner as indicated in Fig. 1. Variations in temperature conditions of the space surrounding reservoir 104 changes the volume of the gas in the reservoir to alter the pressure within the bellows 35; and, in this manner, the modulating heat valve 25 is controlled. The adjusting screw 47 is used in this instance to vary the temperature of operation of the thermostatic element 104.

It has been found that changes in atmospheric pressures can have a very decided effect on the operation of valves, and this is particularly true in railway car installations where cars may be operating at sea level or a mile or more above sea level. These variations in atmospheric pressures can affect the temperature of operation of the systems as much as four degrees, which in most instances is the difference between comfortable and uncomfortable temperature conditions. The present invention, however, entirely overcomes this difficulty because the valve 43 is sealed from the atmosphere and spring 46 cooperates with the adjusting screw 47 to overcome any pressure changes in chamber 30 while the thermostatic chamber 53 is sealed from the atmosphere by bellows 54 and 57. Spring 58 cooperates with adjusting screw 59 to overcome any pressure changes in bellows 57. Spring 46 is sealed in bellows 37 with the air exhausted from the bellows interior so that temperature changes in chambers 30 and 31 in no way effect the operation of valve 43. Thus, the movable valve member 43 is a floating member moving between a constant force on the one hand—namely, the spring—and a varying force on the other side—namely, a gas or oil pressure; and this gas or oil pressure varies directly with the change in temperatures surrounding the thermostatic element, whether it be of the type shown in Fig. 1 or a reservoir 104, as shown in Fig. 2. Atmospheric pressures cannot affect the forces on either side of the movable valve member 43. Consequently, the action of the heating system is the same, irrespective of the atmospheric pressure changes.

When it is no longer desired to have heating, the temperature selector switch 91 is turned off; that is, it is turned to the solid line position shown at 106. Immediately the circuit to the electromagnet 64 is broken, so that the movable valve member 67 in the heat protection valve 26 drops to close the passage 70 and prevent the flow of volatile liquid into the boiler. A heat protection thermostat 107 is initially set at, say, 60° or any other temperature desired as a minimum in the space to be heated. Resistors 108 and 115 are employed in the circuit from battery 93 to the thermostat 107 so that, when the temperature is above 60°, only a very small amount of current is flowing, part of which is flowing from the positive terminal +B of the battery through the resistor 108, where this current splits and flows partly through conductor 109, thermostat 107, conductor 110, resistor 115, and then back to the negative terminal of the battery. The remainder flows from the resistor 108 through a relay 111, and then back to the negative terminal through resistor 115. As long as this current is divided as described, the relay 111 is too weak to close a relay switch 112; but, when the temperature drops below 60°, the circuit through thermostat 107 is opened so that all of the current from the battery passes through relay 111, thereby closing the relay switch 112. The current now passes from the positive terminal +B of the battery through conductor 95, relay switch 112, conductor 100, electromagnet 64, and then back to the negative terminal —B of the battery through conductor 116. Thus the valve 67 is lifted to permit the volatile liquid to pass to the boiler, thereby placing the heating system into operation. Of course, when the temperature of the space is below 60°, the modulating heat valve 25 is open, so that the heating system is entirely under the control of the heat protection valve 26, which in turn, responds to the heat protection thermostat 107. In this manner, temperatures above freezing are always assured irrespective of whether the temperature selector switch is calling for heat.

When the temperature selector switch is calling for heat and the thermostatic element 52 is set for, say 74°, a very constant temperature can be maintained; but, if the room occupant should for any reason desire a temperature higher than 74°, he may bypass the volatile liquid through return line 22 by opening the manually controlled valve 27, thereby placing the heating system in manual operation.

Because of the presence of a volatile liquid in the system, it is possible for extremely high pressures to arise, and consequently the safety valve 26 is provided. As shown, this valve is responsive to the temperature of the volatile liquid, but it may be equally effective if it responds to pressures, in which case some suitable pressure valve may be employed.

Before the closed circulating system is charged with a volatile liquid, it is first exhausted of air to a very high degree of vacuum; and then some suitable liquid, such as ethyl alcohol, is inserted and the system is sealed.

Although the present invention has a very wide range of applications, it is particularly well adapted to railway car installations because of its high degree of flexibility in operation and the uniformity of temperature which it maintains. Also, when a car is not in operation but is in the yards, it is not necessary to have temperatures of 72° or more; but it is very important to have some means of preventing freezing of the water pipes, etc., within the car. A system of this kind assures against freezing of the car.

One complete system is shown in Fig. 1 capable of heating a single zone. In the event that the heating system is applied to a plurality of zones such as a number of rooms in a railroad car, a separate complete system controlled by its own thermostatic element 52 would be placed in each room. Separate boilers may be used or one boiler with a plurality of lines branching off may be employed.

The heating system is continuous as long as any one of the operating valves permits passage of the condensate and in normal operation the amount of condensate passing through the modulating heat valve depends on heating requirements.

The spring 46 in the valve 25 must be strong enough to overcome any atmospheric pressure encountered because chamber 30 is not sealed and changes in atmospheric pressures in this chamber should not affect the bellows 37.

The entire heating system is completely sealed from the atmosphere, and the valve **25** is particularly well suited for such a system.

I claim:

1. A heating system including a boiler having primary and secondary chambers in heat exchange relationship with each other, a closed circulating system including the secondary chamber, a radiator, a vapor line, and a return line, a volatile liquid in the closed system, a modulating heat valve and a heat protection valve in the return line means for maintaining the heat protection valve normally open, thermostatic means responsive to temperature conditions in the room to be heated connected directly to the modulating heat valve so that the valve positively responds to the thermostatic means, a temperature selector switch associated with the heat protection valve to hold the said valve normally open at one setting of the said switch and to close the valve at another setting of the switch for placing the heating system in or out of operation, and a control circuit associated with the selector switch for operating the heat protection valve, said circuit maintaining the last named valve in open position at all times when the temperature selector switch is set for heating.

2. A heating system including a boiler having primary and secondary chambers in heat exchange relationship with each other, a closed circulating system including the secondary chamber, a radiator, a vapor line, and a return line, a volatile liquid in the closed system, an internally balanced modulating heat valve having a throttling action in the return line for controlling the flow of the volatile liquid, said valve being adapted to respond directly to temperature conditions in the space to be heated, a secondary control valve in the return line, means for alternatively maintaining said secondary valve in open position and allowing said valve to close, and thermostatic means responsive to room temperatures operatively connected to the secondary control valve, said last named thermostatic means responding to an operating temperature lower than that for the first thermostat.

3. A heating system including a boiler having primary and secondary chambers in heat exchange relationship with each other, a closed circulating system including the secondary chamber, a radiator, a vapor line, and a return line, a volatile liquid in the closed system, a primary control valve and a secondary control valve in the return line, means for maintaining the secondary control valve normally open to permit passage of the volatile liquid through said valve, thermostatic means responsive to temperature conditions in the room to be heated operatively connected to the primary control valve, the primary valve responding to said thermostat to control the flow of volatile liquid through the return line, a temperature selector switch associated with the secondary valve to maintain said valve open at one setting of said switch and to allow said secondary valve to close at another setting of the switch, and a second thermostat operatively connected to the secondary valve for controlling same, said second thermostat responding to temperatures in said room.

4. A heating system including a boiler having primary and secondary chambers in heat exchange relationship with each other, a closed circulating system including the secondary chamber, a radiator, a vapor line, and a return line, a volatile liquid in the closed system, a primary control valve in the return line, thermostatic means responsive to temperatures in the room to be heated operatively connected to the primary valve, said valve being balanced so that it responds to slight changes in room temperatures, a secondary control valve in the return line, a thermostatic control circuit for the secondary control valve, the secondary thermostatic control circuit functioning at an operating temperature lower han that of the primary thermostat, and a temperature selector switch associated with the secondary control valve to maintain said secondary valve open at one setting of said switch and to allow said secondary valve to close at another setting of the switch.

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