June 4, 1935. C. A. DUNHAM 2,003,585

METHOD AND APPARATUS FOR HEATING WITH STEAM

Original Filed Oct. 18, 1923 2 Sheets-Sheet 1

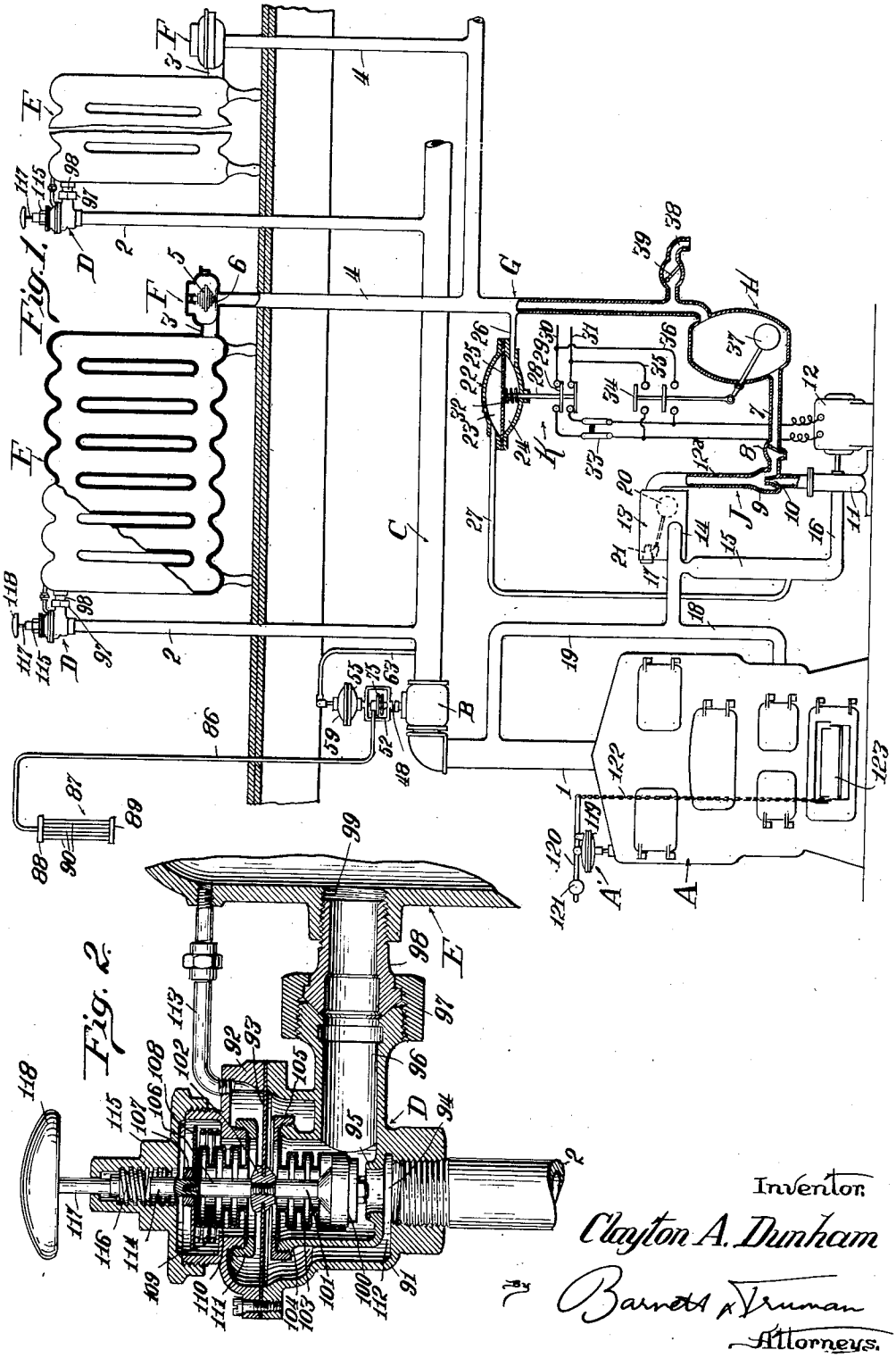


Fig. 1.

Fig. 2.

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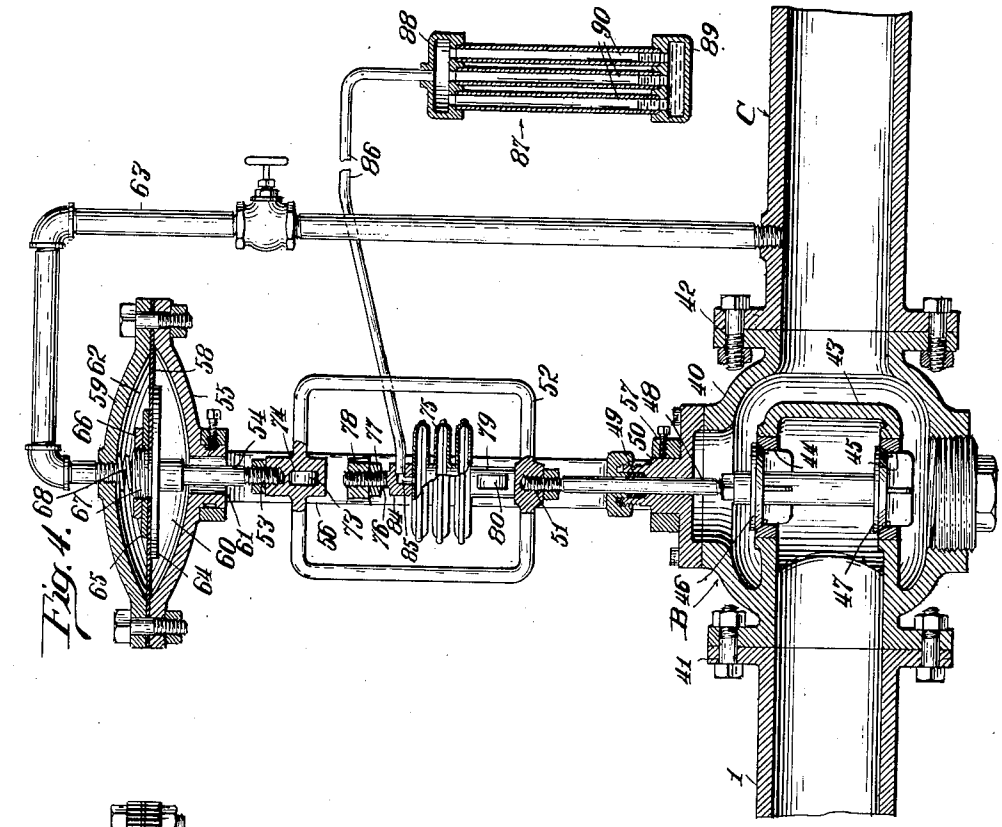


Fig. 4.

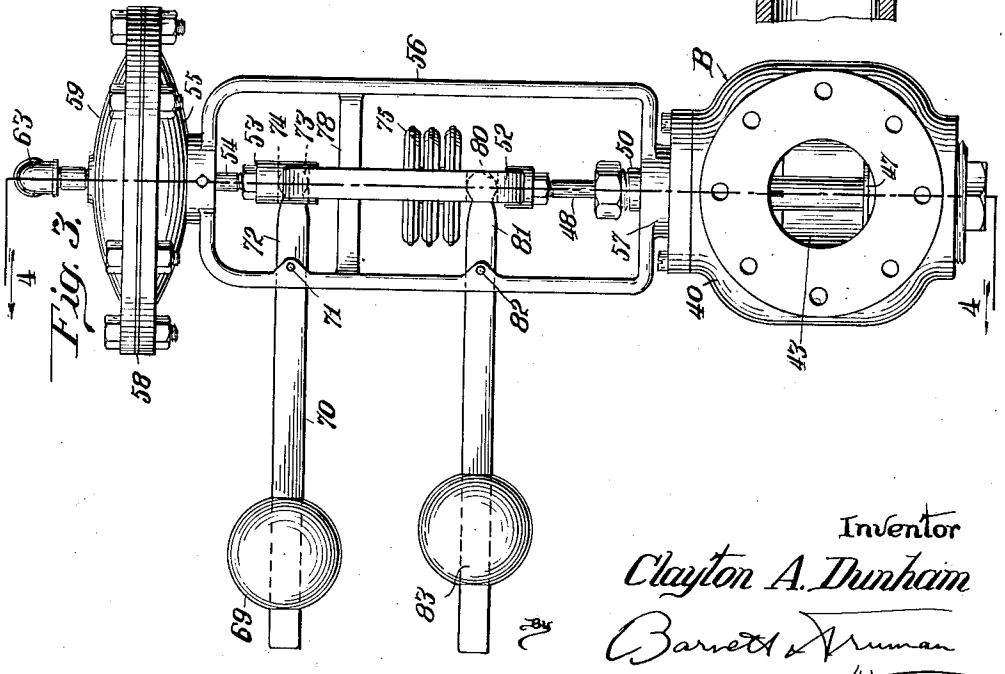


Fig. 3.

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UNITED STATES PATENT OFFICE

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METHOD AND APPARATUS FOR HEATING WITH STEAM

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Original application October 18, 1923, Serial No. 669,363. Divided and this application May 14, 1934, Serial No. 725,476

24 Claims. (Cl. 237—12)

This invention relates to certain new and useful improvements in a method and apparatus for heating with steam, the novel subject matter having first been disclosed in my copending application Serial No. 669,363, filed October 18, 1923, of which this application is a division.

In a heating system of this type, steam is circulated through the radiators or condensing spaces at pressures which are varied according to the amount of heat required for maintaining the room or other space to be heated at the desired temperature. At all times the radiators will be kept free of air and condensate and full of steam, but the pressure and consequently the temperature of the steam in the radiators will be varied in accordance with the amount of heat that must be emitted from the radiators in order to maintain the desired temperature conditions. In mild weather the steam will be maintained at a lower pressure, and consequently at a lower temperature, than in cold weather. By maintaining a high vacuum in certain portions of the system, the pressure in the radiators may be varied over a very considerable range so that it will be possible with the same amount of radiating surface to obtain just the quantity of heat required, and no more, whether the outside temperature be low or high, by maintaining the radiators at a high temperature in cold weather and at a much lower temperature in mild weather.

In brief, the steam is generated at any convenient pressure and is introduced into a distributing main through a reducing valve by means of which the steam pressure in this main is lowered to any desired extent. This reducing valve, which forms one feature of this invention, may be manually adjusted to maintain any desired reduced pressure in the distributing main, and this valve may also be automatically adjusted by a thermostatic device responsive to temperature changes at any predetermined location, either inside or out of the building. Separate branch pipes lead from the distributing main to each of a plurality of radiators. These branch pipes are normally in open communication with the radiators since it is desirable to continuously maintain the radiators filled with steam, but since the several radiators may differ in size or capacity, and be situated at different distances from the source of steam supply, it is desirable to provide means for properly proportioning the flow of steam from the distributing main to each of the radiators so that the maximum quantity of steam that any radiator will receive will be fixed and proportioned to the condensing capacity of that radiator, and no one radiator will receive excess steam at the expense of some other radiator in the system. In the parent application Serial No. 669,363 from which this present application has been divided, orifice plates are positioned between the several branch pipes and radiators, these orifices differing in size in accordance with the capacity and location of the respective radiators. In the form of the invention disclosed and claimed in the present application, differential-pressure controlled inlet valves are provided between the branch pipes and radiators, each valve functioning to maintain the steam pressure within the radiator lower by a predetermined amount than the steam pressure in the branch pipe through which the radiator is supplied. Each of these valves may be adjusted in accordance with the capacity and location of the radiator so as to determine the proper flow of steam to that radiator, and the size of the valve orifice through which the steam flows will be automatically varied in accordance with pressure fluctuations within the radiator and/or the supply pipe 2 so that the desired steam pressure will be constantly maintained within the radiator. These reducing inlet valves also permit the maintenance of a higher pressure in the distributing main and branch pipes than is desired in the radiators, since a pressure reduction is continuously maintained at the inlet to each radiator.

Condensate and non-condensable gases are withdrawn from the radiators through a return pipe system leading to an exhausting apparatus which vents the non-condensable gases and returns the condensate to the steam generator. Thermostatically operated traps are provided at the outlets to the several radiators so as to permit the withdrawal of the condensate and non-condensable gases without permitting the outflow of any appreciable amount of steam. The exhausting mechanism is automatically controlled so as to maintain a sufficiently low pressure in the return pipe so that the gases and condensate will be withdrawn from the radiators no matter how much the steam pressure within the radiators may be lowered.

The principal object of this invention is to provide an improved method and apparatus for heating with steam, such as briefly described hereinabove and disclosed more in detail in the specifications which follow.

Another object is to provide an improved pressure-controlled inlet valve for reducing the pressure of the steam introduced into the radiators.

Other objects and advantages of this invention will be more apparent from the following detailed

description of certain approved forms of apparatus constructed and operated according to the principles of this invention.

In the accompanying drawings:

Fig. 1 is a diagrammatic elevation, partially broken away, showing the complete heating system.

Fig. 2 is a central vertical section through the improved inlet valve.

Fig. 3 is an end elevation of the improved reducing valve.

Fig. 4 is a longitudinal vertical section through this reducing valve, the view being taken substantially on the line 4—4 of Fig. 3.

The apparatus comprises, in general, the steam generator or boiler A, the improved reducing valve B, the distributing main C, the improved reducing inlet valves D, the radiators E (two of which are here shown by way of example, it being understood that any desired number of radiators may be included in the system), the thermostatically-operated steam traps F, the return main G, the collecting receptacle H, the exhausting mechanism J, and the automatic controlling mechanism indicated generally at K.

The generator A may be of any approved type adapted to generate and supply steam at either super-atmospheric or sub-atmospheric pressures. This steam is delivered through pipe 1 and reducing valve B into the distributing main C. The valve B, which will be hereinafter described in detail, may be manually adjusted so that it will automatically function to permit a restricted flow of steam into the distributing main C so that the pressure of the steam in this main will be maintained at any predetermined pressure (lower than the generator pressure) either above or below atmospheric pressure. Usually the pressure in distributing main C will be sub-atmospheric. Reducing valve B is also thermostatically controlled so that the pressure of the steam in distributing main C will be automatically raised or lowered in accordance with temperature changes at some predetermined location, thereby eventually changing the steam pressure and temperature within the radiators as will be hereinafter apparent.

Steam flows from the distributing main C through the respective branch supply pipes 2 and improved inlet valves D into the respective radiators E. The inlet valves D, which will also be hereinafter described in detail, are adapted to restrict the flow of steam from the branch pipes into the radiators so that the steam pressures within the respective radiators will be maintained lower by a predetermined amount than the pressures in the supply pipes. While the pressure in the generator A may be relatively high, and need not be constant, the main reducing valve B and the inlet valves D successively reduce the pressure of the steam in such a manner as to continuously maintain the radiators filled with steam at a controlled low pressure which is predetermined in accordance with heating requirements.

A steam trap F is interposed between the outlet 3 of each radiator and a branch return pipe 4 which leads into the main return pipe G. The trap F comprises a thermostatic element 5 adapted to move a valve member into and out of engagement with a valve seat 6 on the inlet to pipe 4. As condensate or cooled non-condensable gases accumulate in the radiator E, the thermostatic element 5 will contract and permit these fluids to be drawn out through pipe 4, but as soon as steam comes in contact with the thermostatic element 5 it will expand and close the valve thus preventing the escape of steam from the radiator.

The condensate and non-condensable gases flow through return main G into the collection device H. This collection device H, the exhausting mechanism J, and the control mechanism K are all disclosed in detail and claimed in the parent application Serial No. 669,363, hereinabove referred to. Since the specific construction of these mechanisms constitute no part of the invention, these elements have here been indicated diagrammatically so as to simplify the disclosure. The devices herein diagrammatically shown are, however, essentially the same as those disclosed more in detail in the parent application.

The fluids collected in receptacle H flow or are drawn through pipe 7 and check valve 8 into the casing 9 of ejector 10. The exhausting mechanism J comprises a hurling circuit for forcing water through the ejector 10 to withdraw fluids into this circuit from collection device H. The pump 11 driven by motor 12 forces water through ejector 10, this liquid stream combining with the fluids withdrawn from the heating system through pipe 7 and passing through tube 12a into the upper portion of the separating device 13. The liquid stream flows from the lower portion of separator 13 through pipe 14, receiver 15 and pipe 16 back to pump 11 thus completing the hurling circuit. This hurling circuit communicates through pipes 17, 18 and 19 with the boiler or generator A. Air or other gases withdrawn by the ejector into this hurling circuit will accumulate in the upper portion of separator 13 and consequently lower the liquid level within this separator until a float 20 opens a vent valve 21 and permits the escape of a portion of these trapped gases. As these gases flow out the float 20 will rise and close valve 21 to prevent the escape of liquid. As excess liquid is accumulated in the hurling circuit it will be forced out through pipe 17 and thence through pipe 18 into the generator.

It will be noted that the exhausting mechanism J functions not only to withdraw condensate and force this water back into the boiler but also, by withdrawing gases through the return pipe G it serves to lower the pressure in this return side of the system. It is essential that a sufficient vacuum or reduced pressure be maintained in return main G so that condensate and non-condensable gases will be drawn out of the radiators E whenever the traps F open. The control mechanism K functions to always maintain the pressure in the return main G lower, by a predetermined differential, than the pressure in the generator or supply side of the system. The differential-pressure controller 22 may be in the form of a closed casing divided into an upper pressure chamber 23 and a lower pressure chamber 24 by the intermediate flexible diaphragm 25. The lower or low pressure chamber 24 is connected through pressure pipe 26 with the return main G, whereas the upper chamber 23 is connected through pipe 27 with any desired portion of the high pressure or supply side of the system. Diaphragm 25 is connected through stem 28 with a double-pole switch 29 adapted to make or break the circuit through wires 30 and 31 for energizing motor 12. The spring 32 tends to move diaphragm 25 and stem 28 in a direction to close the switch, and the pressure differential exerted on diaphragm 25 by the pressure in upper chamber 23 in excess of that in lower chamber 24 tends to open the switch. When this pressure differential reaches a predetermined amount, sufficient to overcome the spring 32, the switch 29

will be opened and the motor 12 will stop. When the pressure differential falls below this predetermined amount, the spring 32 will close the switch and motor 12 will operate the exhausting mechanism J to withdraw fluids from the return main G and lower the pressure in the return side of the system. In this manner the exhausting mechanism J will be operated intermittently so as to maintain a predetermined pressure differential between the supply and return sides of the system, this pressure differential being adjusted so that the vacuum in the return main will be sufficient to keep the radiators E purged of condensate and non-condensable gases.

Under certain conditions it may be desirable to operate the system under substantially atmospheric pressure. At such times the manually controlled switch 33 will be opened to put the differential controller out of service. A second double-hole switch 34 positioned in the shunt circuits 35 and 36 is automatically operated by means of a float 37 within the collection receptacle H so that when a sufficient amount of condensate has collected in this receptacle switch 34 will be closed and the motor 12 energized so as to operate the exhausting mechanism J and withdraw this liquid from receptacle H and force it back into the generator A. When the liquid has been withdrawn from receptacle H, the switch 34 will be automatically opened to stop the motor. At such times gases will be vented from the return main G through outlet 38 provided with the outwardly opening check valve 39. This check valve 39 will remain closed as long as a vacuum is being maintained in the return main G.

The improved reducing valve B will now be described, referring more particularly to Figs. 3 and 4. This pressure-reducer comprises the valve casing 40 which is connected between the supply pipe 1 and distributing main C as indicated at 41 and 42, and which has an interior web 43 provided with two ports 44 and 45 adapted to be closed by the valves 46 and 47 respectively, mounted on a stem 48 which passes out and is slidable through a stuffing box 49 in the bonnet 50 of the valve casing. The valve stem 48 is secured at 51 to the lower side of a yoke 52, the upper end of which is secured at 53 to a second stem 54 which projects upward through the lower half of a diaphragm casing 55 carried by yoke structure 56 which is supported at its lower end at 57 on the bonnet 50. A flexible diaphragm 58 is clamped between the lower half 55 and upper half 59 of the diaphragm casing so as to divide this casing into a lower chamber 60 open to the atmosphere at 61, and an upper chamber 62 which is connected through pipe 63 with the reduced pressure distributing main C. The central portion of flexible diaphragm 58 is clamped between a plate 64 on the upper end of stem 54 and a follower plate 65 secured in place by nut 66 threaded on the boss 67 which projects through the diaphragm. The spring 68 is interposed between the diaphragm and the upper section 59 of the diaphragm casing. A weight 69 is adjustably mounted on the outer arm 70 of a lever intermediately pivoted at 71 in the supporting yoke structure 56. The inner arm 72 of this lever is provided with a circular projection 73 which enters a slot 74 formed in the upper end portion of yoke 52. The weight 69 is positioned to determine the pressure which it is desired to maintain in the distributing main C. It will be noted that the weight 69 plus atmospheric pressure exerted on the bottom of diaphragm 58 tends to open the valves 46 and 47 and admit more steam from supply pipe 1 into the distributing main C. The spring 68 plus the pressure exerted through pipe 63 on the upper face of diaphragm 58 tends to close the valves and cut off the further flow of steam into the distributing main C. By providing a spring 58 of proper strength, and properly positioning the weight 69, any desired pressure, either super-atmospheric or sub-atmospheric may be continuously maintained in the distributing main C, providing steam at a somewhat higher pressure is supplied through pipe 1. When the desired pressure is reached in the distributing main the valves will be closed to cut off the further flow of steam through the valves. When the pressure in the distributing main falls below this desired standard, the weight 69 will overcome the established balance and cause the valves to open to admit more steam into the main. Ordinarily a balance will be established with the valves in partially open position, so as to permit a flow of steam through the valve just sufficient to maintain the desired pressure in the distributing main.

A flexible corrugated vessel 75 is supported by means of an upstanding threaded stem 76 provided with lock nut 77 to a cross piece 78 formed in the yoke structure 56. The expansible vessel 75 is provided on its under side with a boss 79 adapted to bear against the lower portion of yoke 52 and provided with a slot to receive the circular projection 80 on the inner end of lever 81 intermediately pivoted at 82 in the yoke structure 56 and carrying on its outer arm an adjustable weight 83. Interposed between the threaded stem 76 and the flexible portion of vesel 75 is a boss 84 provided with a passage 85 leading to the interior of the vessel, this passage being connected by a tube 86 with the thermostat 87 which, in the form shown, consists of upper and lower headers 88 and 89 connected by a plurality of tubes 90. This thermostat 87 contains a fluid which expands and contracts with fluctuations in temperature. This thermostat 87 may be positioned at any desired location, either inside or outside of the building. On rise of temperature to the point at which the thermostat is designed to act, the pressure of the fluid in the thermostat 87, pipe 86 and expansible vessel 75 will cause the corrugated vessel 75 to expand and overcome the force exerted by weight 83 (which force will depend upon the position to which weight 83 has been adjusted on lever 81), and move the valves 46 and 47 toward their seats to shut off or throttle the flow of steam into the distributing main C. It will be observed that the arrangement is such that even though the pressure in the distributing main is at this time insufficient to deflect diaphragm 58 downwardly to close or throttle the ports of the pressure reducer, if the temperature at the location of thermostat 87 rises to the point at which this thermostat is set to operate, the thermostat will act to throttle or close the valves.

The improved inlet valve D will now be described, referring more particularly to Fig. 2. The valve casing comprises lower and upper sections 91 and 92 respectively between which is clamped a flexible diaphragm 93. The main lower portion 91 of the valve casing communicates with the branch supply pipe 2 below the inlet port 94 above which is positioned the valve seat 95. The outlet passage 96 is connected by a fitting 97 with a nipple 98 which is secured into the inlet port 99 of radiator E. The movable valve member 100 which cooperates with valve seat 95 to cut off or

throttle the flow of steam through the valve, is provided with a stem 101 secured to the button 102 mounted in the central portion of flexible diaphragm 93. The flexible corrugated sealing diaphragm 103 is secured at its lower end to the movable valve member 100 and at its upper end to the fixed web 104 by means of cap 105. A second stem 106 is mounted in button 102 above the diaphragm 93 and projects upwardly, a portion of this stem member being threaded to receive the adjustable nut 107 which has a disk-like projection 108. A spring 109 is positioned between the disk or plate 108 and some adjacent portion of the fixed casing. The spring may be positioned either above or below the plate 108 and may be in either tension or compression so as to balance the desired pressure differential acting on the flexible diaphragm 93. A second flexible sealing diaphragm 110 is secured at one end to the stem structure 106 and at the other end to a fixed web in the casing by means of cap 111. Steam from the branch supply pipe 2 can by-pass the valve seat 95 through duct 112 so as to reach the space below flexible diaphragm 93. The chamber above this diaphragm is connected with the interior of the radiator E through pipe 113. The upper end portion 114 of stem 106 projects into a bonnet 115 mounted on the valve casing. This bonnet is internally threaded to receive the lower threaded portion 116 of an operating stem 117 which projects upwardly through the bonnet and is provided with a hand grip 118. The movable valve member 100 may be manually seated on valve seat 95 at any time by turning the hand grip 118, but when the valve is not seated in this positive manner its position with respect to the valve seat will depend upon the balance of steam pressures on opposite sides of the flexible diaphragm 93 and upon the pressure exerted by the adjustable spring 109. By properly adjusting the nut 107, and thereby the force exerted by spring 109, the desired differential to be established between the supply pressure in pipe 2 and the steam pressure within the radiator may be established. When the pressure builds up in the radiator to a certain point, diaphragm 93 will be deflected downwardly so as to throttle or close the inlet port, and when the pressure falls in the radiator the diaphragm will be raised so as to increase the effective size of the inlet port and admit more steam to the radiator. In this manner the steam pressure within the radiator may be maintained lower, by a predetermined amount, than the pressure in the supply pipe 2.

It should be noted that these inlet valves D will function not only to maintain a substantially predetermined drop in pressure between the supply pressure and distributing main C and branch pipes 2 and the pressure within the radiators, but the respective valves D may also be individually adjusted (by means of the spring tension nut 107) so as to determine the effective size of the normal inlet orifice between valve 100 and its seat and thus govern the normal flow of steam into each radiator in accordance with the radiator capacity and the more or less favorable location of that radiator with respect to the supply piping of the heating system.

The generator A may be provided with a device A' for automatically determining and controlling the pressure of the steam generated and supplied to the system through pipe 1. As here shown a diaphragm subject to boiler pressure and positioned in casing 119 is adapted to operate on one arm of a lever 120, carrying an adjustable weight 121, the other arm of this lever being connected by a chain 122 to a damper 123 of the generator. Any other suitable form of automatic generator controller may be used.

Briefly summarizing the operation of the system as a whole, steam is generated at any desired pressure in the boiler A (this pressure being determined by the controller A'), and then by means of reducing valve B the rate of steam flow into the distributing main C is determined so as to maintain a desired, substantially constant, working steam pressure in the distributing main C. This working pressure may be sub-atmospheric, and this pressure may be determined and adjusted, in accordance with prevailing temperature conditions, by properly positioning the adjustable weight 69 of the reducing valve. The weight 83 will be so adjusted that when some predetermined maximum temperature is reached in the space where thermostat 87 is located, the reducing valve B will be throttled or closed so as to cut down the rate of flow of steam into distributing main C and thereby further lower the pressure of the steam in the radiators and cut down the heat output.

The several inlet valves D will effect a further drop in pressure between the distributing pipes and the interior of the radiators so that the steam within the radiators may be maintained at a quite low pressure and temperature without necessitating the maintenance of such a low pressure in the distributing main 3 and branch pipe 2. Furthermore these valves D may be individually adjusted so as to enforce a proper distribution of the steam among the several radiators, in accordance with the capacity and location of these radiators. At all times the mechanisms H, J and K will automatically function to withdraw condensate and return it to the generator A, to withdraw and vent non-condensable gases so that the radiators may be maintained full of steam, and to maintain a sufficiently low pressure in the return pipe system so that these fluids may be exhausted from the radiators whenever the traps F open, these traps automatically closing to prevent the loss of steam from the radiators.

I claim:

1. The method of heating with steam which comprises supplying steam under pressure to a distributing main, introducing a restricted flow of steam from the main into a condensing and heat radiating space so as to maintain a pressure in the space lower by a predetermined amount than the pressure in the main, and withdrawing condensate and non-condensable gases from said space without permitting the escape of steam.

2. The method of heating with steam which comprises supplying steam under pressure to a distributing main, reducing the pressure of the steam in the main by a selected amount, introducing a restricted flow of steam from the main into a condensing and heat radiating space so as to maintain a pressure in the space lower by a predetermined amount than the pressure in the main, and withdrawing condensate and non-condensable gases from said space without permitting the escape of steam.

3. The method of heating with steam which comprises supplying steam under pressure to a distributing main, reducing the pressure of the steam in the main an amount determined by temperature changes at a certain location, introducing a restricted flow of steam from the main into a condensing and heat radiating space so as

to maintain a pressure in the space lower by a predetermined amount than the pressure in the main, and withdrawing condensate and non-condensable gases from said space without permitting the escape of steam.

4. The method of heating with steam which comprises generating steam under pressure, restricting the flow of this steam into a distributing main so as to reduce the pressure of the steam in the main a selected amount, introducing a restricted flow of steam from the main into a condensing and heat radiating space so as to maintain a pressure in the space lower by a predetermined amount than the pressure in the main, and withdrawing condensate and non-condensable gases from the space without permitting the escape of steam.

5. The method of heating with steam which comprises generating steam under pressure, restricting the flow of this steam into a distributing main so as to reduce the pressure of the steam in the main an amount determined by temperature changes at a certain location, introducing a restricted flow of steam from the main into a condensing and heat radiating space so as to maintain a pressure in the space lower by a predetermined amount than the pressure in the main, and withdrawing condensate and non-condensable gases from the space without permitting the escape of steam.

6. The method of heating with steam which comprises generating steam under pressure, restricting the flow of this steam into a distributing main so as to reduce the pressure of the steam in the main a selected amount, introducing a restricted flow of steam from the main into a condensing and heat radiating space so as to maintain a pressure in the space lower by a predetermined amount than the pressure in the main, withdrawing condensate and non-condensable gases from the space without permitting the escape of steam, and returning the condensate to the generating process.

7. The method of heating with steam which comprises supplying steam under pressure to a distributing main, separately introducing a restricted flow of steam from the main into each of a plurality of heat radiating and condensing spaces so as to separately maintain a pressure in each space lower by a predetermined amount than the pressure in the main, and withdrawing condensate and non-condensable gases from said spaces without permitting the escape of steam.

8. The method of heating with steam which comprises supplying steam under pressure to a distributing main, reducing the pressure of the steam in the main by a selected amount, separately introducing a restricted flow of steam from the main into each of a plurality of heat radiating and condensing spaces so as to separately maintain a pressure in each space lower by a predetermined amount than the pressure in the main, and withdrawing condensate and non-condensable gases from said spaces without permitting the escape of steam.

9. The method of heating with steam which comprises supplying steam under pressure to a distributing main, reducing the pressure of the steam in the main an amount determined by temperature changes at a certain location, separately introducing a restricted flow of steam from the main into each of a plurality of heat radiating and condensing spaces so as to separately maintain a pressure in each space lower by a predetermined amount than the pressure in the main, and withdrawing condensate and non-condensable gases from said spaces without permitting the escape of steam.

10. The method of heating with steam which comprises generating steam under pressure, restricting the flow of this steam into a distributing main so as to reduce the pressure of the steam in the main a selected amount, separately introducing a restricted flow of steam from the main into each of a plurality of heat radiating and condensing spaces so as to separately maintain a pressure in each space lower by a predetermined amount than the pressure in the main, and withdrawing condensate and non-condensable gases from said spaces without permitting the escape of steam.

11. The method of heating with steam which comprises generating steam under pressure, restricting the flow of this steam into a distributing main so as to reduce the pressure of the steam in the main a selected amount, separately introducing a restricted flow of steam from the main into each of a plurality of heat radiating and condensing spaces so as to separately maintain a pressure in each space lower by a predetermined amount than the pressure in the main, withdrawing condensate and non-condensable gases from said spaces without permitting the escape of steam, and returning the condensate to the generating process.

12. The method of heating with steam which comprises generating steam under pressure, restricting the flow of this steam into a distributing main so as to reduce the pressure of the steam in the main an amount determined by temperature changes at a certain location, separately introducing a restricted flow of steam from the main into each of a plurality of heat radiating and condensing spaces so as to separately maintain a pressure in each space lower by a predetermined amount than the pressure in the main, and withdrawing condensate and non-condensable gases from said spaces without permitting the escape of steam.

13. In a steam heating apparatus, in combination with a radiator and a supply pipe, an inlet valve interposed between the pipe and radiator, said valve comprising a movable valve member adapted to restrict the flow of steam into the radiator, a movable member connected with the valve member and adapted to move the valve toward open or closed positions, a pair of pressure chambers one at each side of the movable member, and conduits connecting the chambers respectively with the pipe and the interior of the radiator.

14. In a steam heating apparatus, in combination with a radiator and a supply pipe, an inlet valve interposed between the pipe and radiator, said valve comprising a movable valve member adapted to restrict the flow of steam into the radiator, a flexible diaphragm connected with the movable valve member and adapted to move the valve member toward open or closed positions, a pair of pressure chambers which are separated by the diaphragm, and conduits connecting the chambers respectively with the pipe and the interior of the radiator.

15. In a steam heating apparatus, in combination with a radiator and a supply pipe, an inlet valve interposed between the pipe and radiator, said valve comprising a movable valve member adapted to restrict the flow of steam into the radiator, a movable member connected with the valve member and adapted to move the valve

toward open or closed positions, a pair of pressure chambers one at each side of the movable member, conduits connecting the chambers respectively with the pipe and the interior of the radiator, and means for manually forcing the valve member to closed position.

16. In combination, a source of steam under pressure, a distributing main, means for regulating the pressure of the steam in the main, a radiator, a branch pipe for conducting steam from the main into the radiator, an automatically controlled valve between the branch pipe and radiator for restricting the flow of steam into the radiator so as to maintain the steam pressure within the radiator lower by a predetermined amount than the pressure in the branch pipe, a steam trap at the outlet of the radiator, a return pipe leading from the trap, and exhausting means communicating with the return pipe for withdrawing condensate and non-condensable gases from the radiator.

17. In combination, a source of steam under pressure, a distributing main, a reducing valve in the main, means automatically responsive to temperature changes at a remote location for operating the reducing valve, a radiator, a branch pipe for conducting steam from the main into the radiator, an automatically controlled valve between the branch pipe and radiator for restricting the flow of steam into the radiator so as to maintain the steam pressure within the radiator lower by a predetermined amount than the pressure in the branch pipe, a steam trap at the outlet of the radiator, a return pipe leading from the trap, and exhausting means communicating with the return pipe for withdrawing condensate and non-condensable gases from the radiator.

18. In combination, a source of steam under pressure, a distributing main, means for regulating the pressure of the steam in the main, a radiator, a branch pipe for conducting steam from the main into the radiator, a valve in the branch pipe for restricting the flow of steam into the radiator, means for moving this valve toward open and closed positions comprising a movable member subject on one side to the steam pressure within the pipe and on the other side to the steam pressure within the radiator, so as to maintain the steam pressure within the radiator lower by a predtermined amount than the pressure in the main, a steam trap at the outlet of the radiator, a return pipe leading from the trap, and exhausting means communicating with the return pipe for withdrawing condensate and non-condensable gases from the radiator.

19. In combination, a source of steam under pressure, a distributing main, means for regulating the pressure of the steam in the main, a plurality of radiators, a plurality of branch pipes, one for each radiator for conducting steam from the main into the respective radiator, an automatically controlled valve between each branch pipe and its radiator for restricting the flow of steam into that radiator so as to maintain the steam pressure in the radiator lower by a predetermined amount than the pressure in the branch pipe, a steam trap at the outlet of each radiator, a return pipe leading from the several traps, and exhausting means communicating with the return pipe for withdrawing condensate and non-condensable gases from the radiators.

20. In combination, a source of steam under pressure, a distributing main, a reducing valve in the main, means automatically responsive to temperature changes at a remote location for operating the reducing valve, a plurality of radiators, a plurality of branch pipes, one for each radiator for conducting steam from the main into the respective radiator, an automatically controlled valve between each branch pipe and its radiator for restricting the flow of steam into that radiator so as to maintain the steam pressure in the radiator lower by a predetermined amount than the pressure in the branch pipe, a steam trap at the outlet of each radiator, a return pipe leading from the several traps, and exhausting means communicating with the return pipe for withdrawing condensate and non-condensable gases from the radiators.

21. The method of heating with steam which comprises generating steam at a rate that will maintain a controlled pressure in the steam supply, regulating the rate of flow of this steam into a distributing main so as to maintain a selected pressure in the distributing main, and distributing the steam from this main into each of a plurality of condensing spaces at a rate that will maintain a predetermined difference in pressure between the pressure in the distributing main and a lower pressure in each condensing space.

22. The method of heating with steam which comprises generating steam at a rate that will maintain a controlled pressure in the steam supply, regulating the rate of flow of this steam into a distributing main in response to temperature changes at a certain location so as to maintain a selected pressure in the distributing main, and distributing the steam from this main into each of a plurality of condensing spaces at a rate that will maintain a predetermined difference in pressure between the pressure in the distributing main and a lower pressure in each condensing space.

23. The method of heating with steam which comprises regulating the rate of flow of steam from a source of supply into a distributing main so as to maintain a selected pressure in the distributing main, and distributing the steam from this main into each of a plurality of condensing spaces at a rate that will maintain a predetermined difference in pressure between the pressure in the distributing main and a lower pressure in each condensing space.

24. The method of heating with steam which comprises regulating the rate of flow of steam from a source of supply into a distributing main in response to temperature changes at a certain location so as to maintain a selected pressure in the distributing meain, and distributing the steam from this main into each of a plurality of condensing spaces at a rate that will maintain a predetermined difference in pressure between the pressure in the distributing main and a lower pressure in each condensing space.

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