May 9, 1933. B. F. RANDEL 1,908,552

METHOD OF HEATING WITH STEAM

Filed May 27, 1929 2 Sheets-Sheet 1

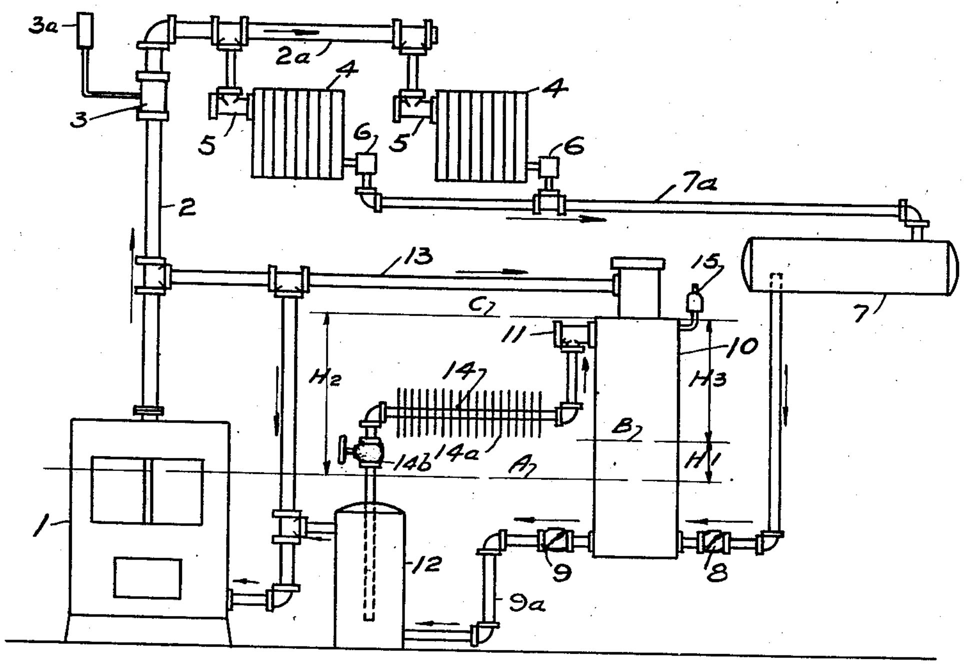

FIG. 1

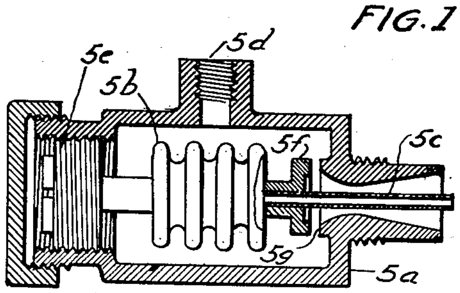

FIG. 2

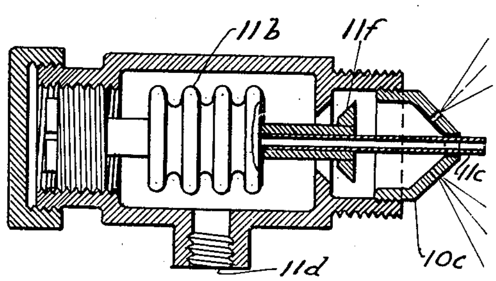

FIG. 3

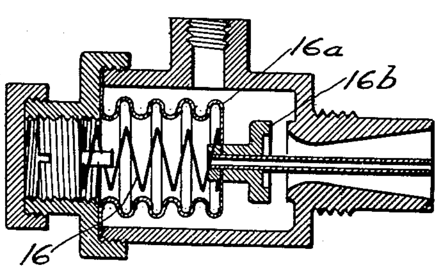

FIG. 4

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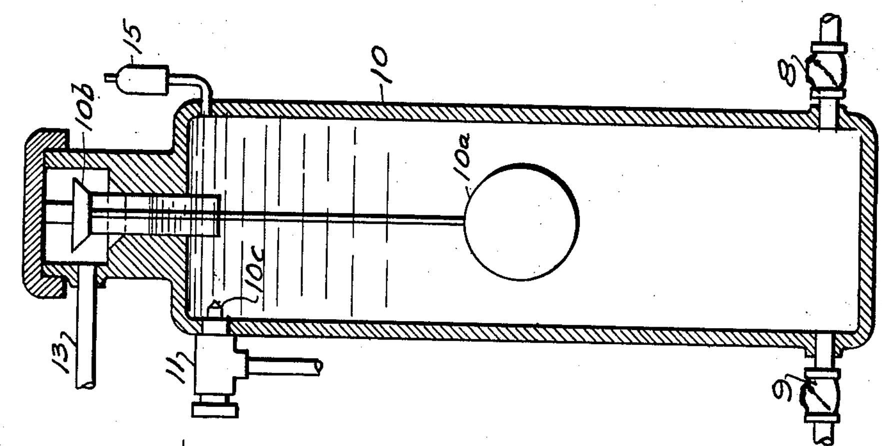

FIG. 7

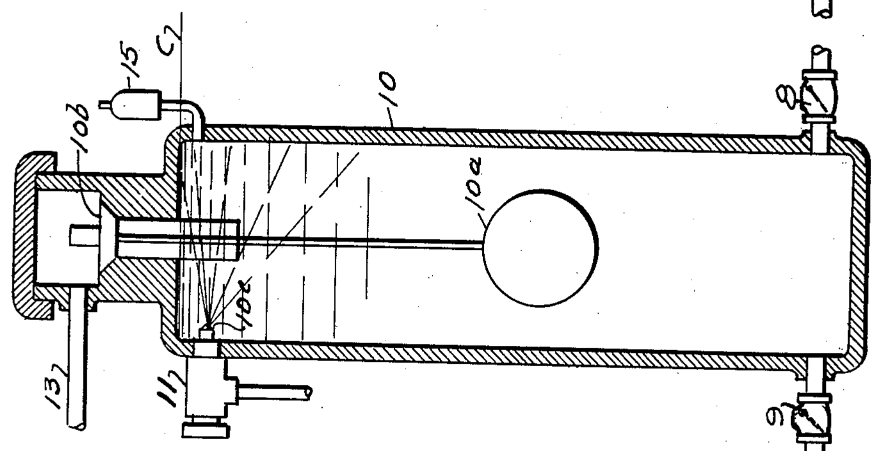

FIG. 6

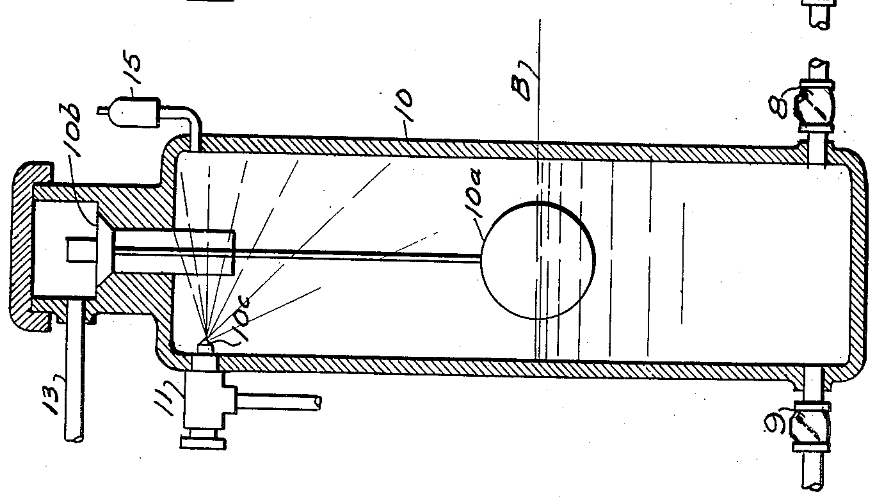

FIG. 5

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Patented May 9, 1933

1,908,552

UNITED STATES PATENT OFFICE

BO FOLKE RANDEL, OF SAN DIEGO, CALIFORNIA

METHOD OF HEATING WITH STEAM

Application filed May 27, 1929. Serial No. 366,113.

My invention relates to the art of heating, and the principal object is to provide a novel method of heating with steam, wherein the steam is distributed under relatively higher pressures than now in common use, then reducing this pressure before reaching the heating elements or at the heating element through a definite pressure drop and then providing flow in the system from a low pressure zone to a high pressure zone by alternately equalizing the low and high pressures in a vessel separating the said low and high pressure sides.

With these and other objects in view as will appear hereinafter, my invention consists of certain novel features of construction, combination and arrangements of parts as will be hereinafter described in detail and particularly set forth in the appended claims, reference being had to the accompanying drawings and to the characters of reference thereon which form a part in this application in which:

Fig. 1 is a detail view of the arrangement of the different parts of the apparatus employed in my heating system. Fig. 2 is a section through my differential pressure valve. Fig. 3 is a section through my low pressure control valve. Figure 4 is a modified form of valve. Figures 5, 6, and 7 are sections through my combination low pressure producer, return trap, and pressure equalizer, the different figures showing this low pressure producer during different phases of the operation.

Similar characters of reference refer to similar parts throughout the several views of the drawings. Arrows indicate direction of flow.

Boiler 1, main steam line 2, thermostatically controlled valve 3, radiators 4, differential pressure valves 5, thermostatic return traps 6, low pressure return receiver 7, check valves 8 and 9, combination low pressure producer, return trap and pressure equalizer vessel 10, low pressure control valve 11, high pressure return receiver 12, pressure equalizing pipe 13, return cooler 14, and air relief valve 15 are the principal parts of my heating system.

Many of the parts included in the arrangement of my system are standard articles of commerce and a detail description of same will not be given. Such parts are the following: Boiler 1, thermostatic valve 3, controlled by thermostat 3*a* adjusting the opening of valve as required by room temperature, thermostatic traps 6 adjusted to pass condensate and air but not steam, receivers 7 and 12 which are ordinary receivers suitable to receive liquids and vapors, check valves 8 and 9, which will allow flow in one direction only, air relief valve 15 which will allow air to escape but close against water or steam and also prevent inflow of air to break the vacuum.

The novelty of the invention is first, the arrangement of the different parts to accomplish a specific purpose, second, the differential pressure valves 5, third, the combination low pressure producer, return trap and pressure equalizer 10 and fourth, vacuum control valve 11.

In Fig. 2 I illustrate in detail the construction of differential pressure valves 5. The differential pressure valve consists of valve body 5*a*, enclosed pressure differential the element 5*b*, the inside of which element communicates with the low pressure discharge end of the valve by a tube 5*c*. High pressure inlet is shown at 5*d*. The differential pressure element may be moved by screw 5*e*, changing the position of valve disc 5*f* in relation to valve seat 5*g*.

The differential pressure element being enclosed in the valve body and being surrounded by the fluid under high pressure, with the tube 5*c* connecting the inside of this element with the low pressure outlet, it is seen that variation of differential pressure will effect this element, contracting or expanding same with the increasing or decreasing of this differential, thus opening or closing the valve. It will also be seen, that by moving the entire differential mechanism, with the differential element, tube and valve disc, any predetermined differential pressure may be established. The valve may thus be set for any desired drop of pressure from inlet to outlet. Thus if set for a 15 pound drop, the high pressure may be 15 pounds with the low pressure 0 pounds. If high pressure should increase to 30 pounds, the low pressure will also increase 15 pounds or to 15 pounds, maintaining the drop of 15 pounds.

In Fig. 3 I illustrate in detail my low pressure control valve 11. This valve is of substantially the same construction as my differential pressure valve 5, except the position of valve disc in relation to valve seat. In my low pressure control valve 11 the valve disc 11*f* is in such a position, that increase of pressure on the low pressure discharge end will open the valve. A certain low pressure may therefore be maintained, and any increase of this low pressure will open the valve, by communicating itself through tube 11*c* to inside of differential pressure element 11*b*. The purpose of such a novel valve design will be explained later.

The detail construction of my differential pressure valve 5 and my low pressure control valve 11 may vary, and I may adopt any of the present conventional forms of valve seats, balanced or unbalanced, cone shape, flat disc shape, sleeve or piston type. The differential pressure element may also be of any conventional form, disc style, single or multiple, multiple bellows, piston or spring adjusted diaphragm, etc. and I do not desire to limit myself to any definite form of valve except as to the main form which is an adjustable differential pressure element enclosed in a valve body, surrounded by the high pressure fluid, the inside of said element being in communication with the low pressure outlet of said valve.

In Fig. 4 I therefore illustrate a slightly modified form of valve in which I use an adjustable spring 16 to set the desired differential by increasing or decreasing the tension on bellows 16*a*. Valve disc 16*b* may be in position as shown, in which case the valve will be used as differential pressure valves 5, or the disc may be in position as shown in Fig. 3, in which case the valve will serve as low pressure control valve 11.

In Figures 5, 6 and 7 I illustrate my combination low pressure producer, my return trap and pressure equalizer 10 showing different positions of parts during the cycle of operation. The description of this vessel will be best understood by describing the operation of my entire system.

It is assumed that steam is generated in boiler and distributed under 15 pounds gauge pressure, and that valve 3 is wide open, the conditions being maximum. Also that pressure in radiators under these conditions is approximately atmospheric or 0 pounds gauge.

Differential pressure valves 5 are adjusted to give a 15 pounds drop in pressure, so that any increase of radiator pressure above 0 pounds will close these valves against a high pressure of 15 pounds

It is assumed that practically all air and noncondensable gases have been driven out of the system, so that spaces above water lines are mainly filled with water vapor. It is also assumed that water line in boiler is at level A and water line in combination low pressure producer, return trap and pressure equalizer 10 is at level B. Thus the float 10*a* is in down position and the conditions in trap 10 are as shown in Fig. 5, with valve 10*b* closed, preventing inlet of steam through pressure equalizer pipe 13.

It is also assumed that pressures in boiler and return trap are nearly equalized, so that pressure in trap is 15 pounds, minus pressure due to height of liquid H1. Also that low pressure control valve 11 has been set to close at 5 pounds absolute on low side or approximately 20 inches vacuum. Under the conditions as described above and shown in Fig. 5 this valve 11 will therefore be in open position and remain so open until pressure drops to 20 inches of vacuum inside trap 10.

Now if we assume that temperature of condensate in this trap 10 is approximately 160 degrees and with space above level B filled with steam which at this phase of the cycle is momentarily at approximately 15 pounds pressure, condensation of this steam will occur. Trap 10 may also be fitted with cooling fins so as to assist in this condensation of the steam. With this condensation a drop of pressure will occur, sufficient to overcome liquid column H3 and the pressure of 15 pounds in boiler will force condensate from receiver 12 up through condensate cooler 14, and valve 11 into trap 10, spraying same into the vapor through spray 10*c*.

Check valve 9 will prevent flow through pipe 9*a* to trap 10. Also the closed valve 10*b* will prevent flow through pipe 13 to trap 10. Cooler 14 will be placed in a position so as to cool the condensate passing through to say 90 degrees. Cooler 14 may also be equipped with fins 14*a* to assist in this cooling, or may be built in any conventional way suitable to cool a liquid passing through it.

Now it is seen, that when the cool condensate sprays into the vapor filled space above level B in trap 10 a further lowering of pressure will occur to correspond with the temperature of the liquid, or in this case to approximately 28 inches of vacuum. Before this low pressure is reached however, valve 11 will close, being set to do so when 20 inches of vacuum is reached, thus stopping any further inflow of cooling water from receiver 12. There is also a valve 14*b* in pipe from receiver 12 to trap 10, which valve will be adjusted to allow just a sufficient flow of cooling water to cause condensation of vapors without raising pressure in trap 10, which would be possible if the flow of this cooling water was not restrained.

With a low pressure in trap 10 of 20 inches vacuum or more, check valve 8 will open and allow condensate to flow into trap from receiver 7, and through repeated actions in trap 10 a low pressure of 20 inches vacuum or more will finally be established in this receiver and in the entire return system 7*a*.

Condensate will gradually fill trap 10 up to level C, and when this point is reached conditions in this trap 10 will be as shown in Fig. 6. Float will still be in down position due to the 15 pound pressure against valve 10*b*, said float having been adjusted to open this valve only when pressures on each side are nearly equalized.

With conditions as shown in Fig. 6 and with the entire space in trap 10 nearly filled with condensate, thus stopping any further condensing of steam the pressure in the entire return system will slightly increase above the established 20 inches vacuum. As soon as this occurs, valve 11 will reopen and allow a further increase of pressure in trap 10, which increase however can not communicate itself to low pressure receiver 7, the check valve 8 preventing flow in this direction.

As soon as valve 11 opens, pressure will increase sufficient to allow float 10*a* to rise and open valve 10*b*. With valve 10*b* open, complete equalization of pressures between trap 10 and boiler 1 will allow flow by gravity of condensate in trap to boiler through receiver 12. The condition in trap 10 is now as shown in Fig. 7.

Condensate in trap 10 will flow back to boiler 1 until lever B is reached, at the same time steam from equalizing pipe 13 will be filling space above this level. When level B is reached, float will again close valve 10*b*, bringing condition in trap 10 back to conditions as shown in Fig. 5, thus completing the cycle.

Air relief valve 15 will allow air and noncondensable gases to escape from the system when pressure in trap 10 is above atmospheric pressure. Once the air and non-condensable gases are driven out, the entire system may be sealed. The advantages of a heating system under such sealed condition will be: first, no further need of make up water and consequent less corrosion of piping; second, with fire banked in boiler and the entire system cooled, a vacuum in the entire system will occur, which will materially assist in establishing circulation when again starting up.

It is seen from the above description, that I accomplish the following in my heating system: First, maintain a 15 pound pressure on boiler and steam main (or more if desired); second, maintain atmospheric pressure on radiators by maintaining a definite pressure drop through a novel radiator valve; third, maintain a vacuum on return system without mechanically driven pump and fourth, cause a flow from the low pressure side of the system to the high pressure side, by alternately equalizing the low and high pressures in a vessel separating the two sides of the system.

It is preferred in my system of heating to control temperature of rooms from one central control valve, by varying the pressures in the radiator supply line. This I do by thermostatically controlled valve 3. As the room temperature rises, this valve will lower pressure in supply line 2*a* supplying radiators. As pressure in radiators is at all times 15 pounds less than pressure in supply main, due to the adjustment of differential pressure valve 5, lowering of the pressure in supply main 2*a* will cause a corresponding drop of pressure in radiators, and with such a drop of pressure also a drop or reduction of temperature in same.

It is seen that the pressure in return line is at all times approximately 20 inches vacuum. Pressure in radiators, however is determined by the pressure in supply main and the adjusted drop in differential pressure valve 5. It is not possible for the pressure in radiators to fall below pressure in supply main minus this adjusted drop, in the case in question 15 pounds, as when this occurs valve 5 will open, admitting more steam, and thermostatic trap 6 will close for steam, allowing condensate and air only to pass into return main.

It is therefore seen that I may vary the pressure in radiators from a maximum of atmospheric with 15 pounds on supply mains to a minimum of 20 inches vacuum (5 pounds abs.) with a 5 pound pressure on supply mains. By adjusting valve 11 this minimum may be still lower as desired. In the case mentioned I may therefore vary temperature of radiators from a maximum of 212 degrees to a minimum of 160 degrees.

Now therefore, by adjusting thermostatic control valve 3 to maintain a 15 pound pressure in supply main during maximum conditions and a 5 pound pressure during minimum conditions, the temperature in radiators is varied from 212 degrees to 160 degrees. I do this while at all times generating and distributing steam at pressures above atmospheric pressure, and maintaining a substantially even vacuum condition on return main. Attention is called to this fact, that steam is distributed under above-atmospheric pressure conditions in order to differentiate my system from other heating systems where steam is distributed under subatmospheric conditions. It is possible in my system to effect a great saving in installation cost due to smaller pipes needed.

It must be understood that the figures given are given as examples, and I may vary the conditions at will by adjustment of valves and pressures to suit any desired effect. I may also eliminate my combination low-pressure producer, return trap and pressure equalizer 10 and install in its place a conventional mechanically driven pump, or I may install in radiators ordinary radiator valves as desired, or make any combination of my different parts as desired, and I do not limit myself to the arrangement as described and illustrated, but include in my invention any combination of my different parts to accomplish a desired object.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A method of heating with steam which comprises, supplying steam under pressure to a distributing main, expanding the steam by reducing its pressure a constant and predetermined amount, introducing the expanded steam into a condensing and heat-radiating space, maintaining the pressure in said space below that in said main and withdrawing condensate as formed from said space.

2. A method of heating with steam which comprises, supplying steam under pressure to a distributing main, said pressure being varied according to heating need, expanding the steam by reducing its pressure a constant and predetermined amount, introducing the expanded steam into a condensing and heat radiating space, maintaining the pressure in said space below that in said main and withdrawing condensate as formed from said space.

3. A method of heating with steam which comprises, generating steam, supplying said steam to a distributing main, expanding said steam by reducing its pressure a constant and predetermined amount, introducing the expanded steam into a condensing and heat radiating space, maintaining the pressure in said space below that in said main and withdrawing condensate as formed from said space.

4. A method of heating with steam which comprises, generating steam, supplying said steam to a distributing main, expanding said steam by reducing its pressure a constant and predetermined amount, introducing the expanded steam into a condensing and heat radiating space, maintaining the pressure in said space below that in said main, withdrawing condensate as formed from said space and returning said condensate to the point of steam generation.

5. A method of heating with steam which comprises, generating steam, supplying steam under pressure to a distributing main, said pressure being varied according to heating need, expanding said steam by reducing its pressure a constant and predetermined amount, introducing the expanded steam into a condensing and heat radiating space, maintaining the pressure in said space below that in said main, withdrawing condensate as formed from said space and returning said condensate to the point of steam generation.

6. A method of heating with steam which comprises, generating steam, expanding said steam by reducing its pressure a constant and predetermined amount, introducing the expanded steam into a condensing and heat radiating space, maintaining the pressure in said space below that at the point of steam generation and withdrawing condensate as formed from said space.

7. A method of heating with steam which comprises, generating steam, expanding said steam by reducing its pressure a constant and predetermined amount, introducing the expanded steam into a condensing and heat radiating space, maintaining the pressure in said space below that at the point of steam generation, withdrawing condensate as formed from said space and returning said condensate to the point of steam generation.

In testimony whereof, I have hereunto set my hand at San Diego, California this 22nd day of May 1929.

BO FOLKE RANDEL.