Oct. 7, 1930. W. K. SIMPSON 1,777,333

DIFFERENTIAL LOOP FOR HEATING SYSTEMS

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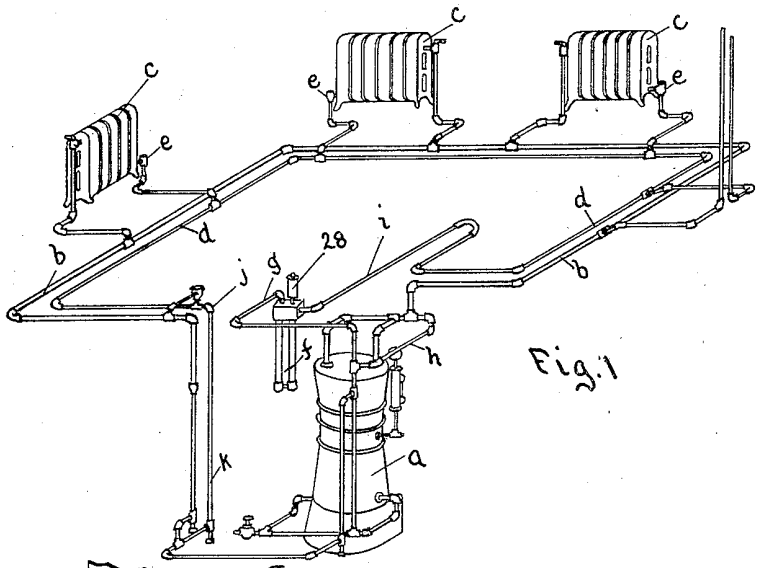

Fig. 1

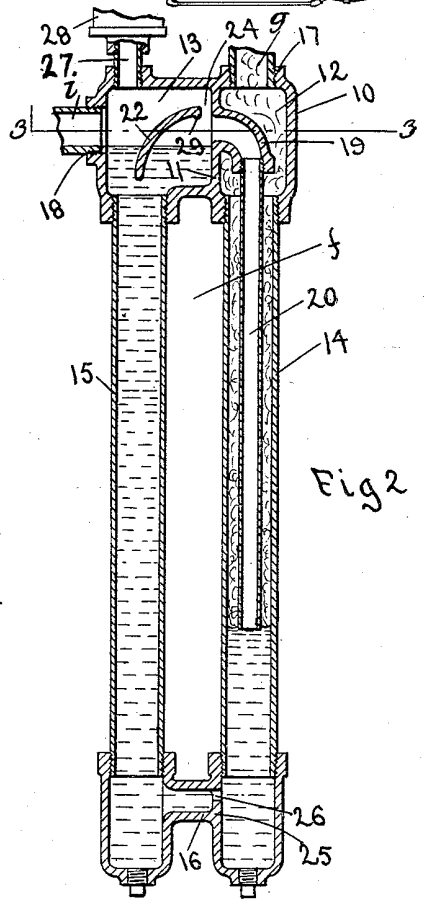

Fig 2

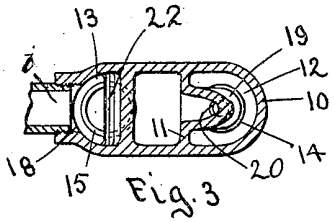

Fig. 3

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UNITED STATES PATENT OFFICE

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DIFFERENTIAL LOOP FOR HEATING SYSTEMS

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The present invention relates to automatic valveless pressure regulators for heating systems, designed and adapted to permit transfer of steam from the steam line, or high pressure side of the system, to the return line, or low pressure side of the system, whenever the pressure in the boiler, or high pressure side, exceeds a predetermined value, while at the same time maintaining a difference of pressure between the two sides of the system.

The object of the invention is to provide a regulator of a construction the parts of which may be simply and accurately made and assembled, and which can be installed readily in any system of the types to which it is applicable.

The invention comprises the device and combination hereinafter particularly described, in the embodiment so described and in all equivalents thereof, within the scope of the appended claims.

Regulators of the type herein disclosed have been given the descriptive name of "differential loop," in commercial practice; and I will use that same name in the following detailed description of my improved regulator.

In the drawings,—

Figure 1 is a diagrammatic view showing a heating system equipped with my differential loop.

Figure 2 is a vertical section of the loop apart from the system and shown on a larger scale.

Figure 3 is a cross section of the loop on line 3—3 of Figure 2.

Referring first to Figure 1 in explanation of the utility of the invention and the environment in which it is used, the letter *a* designates a steam boiler, the letter *b* designates the steam supply pipe of a heating system, *c*, *c* designate radiators, and *d* represents the return pipe. *e* represents thermostatic return valves connected to the radiators and through which water of condensation and entrapped air are allowed to flow freely to the return pipe or line but which close automatically to prevent live steam so flowing.

f represents my differential loop. It is connected by means of suitably arranged pipes *g* and *h* with the steam pipe or line, and thereby with the steam space of the boiler, and by means of a pipe *i* with the return line. The steam line and steam space of the boiler constitute the high pressure side of the heating system, while the return line constitutes the low pressure side of the system.

As here shown, the return line runs from a high point near the boiler, on a gradual downward inclination in a circuit of the building in which the heating system is installed, and at a level wholly above the boiler water level, as far as a point *j*, also near the boiler. This part of the return line normally is practically empty of water, containing only the condensate returning to the boiler, which never fills it, and is called the "dry" return. A descending pipe *k*, connected to the dry return line at *j* and constituting what is called the "wet" return line, carries the accumulated water of condensation to the boiler, and water normally rises therein to a height which will balance the boiler pressure. The loop is preferably connected to the high end of the return line. This layout of the return line, and the idea of connecting the loop to the high end of such line are the invention of Ralph R. Emerson of Brooklyn, N. Y., patented by him August 16, 1927, No. 1,639,084 and I do not claim them herein; but I have shown them as representing the best mode known to me of installing the loop, in which my invention resides, in a heating system.

Referring now to Figures 2 and 3, which show the preferred structure of the loop in detail, such structure comprises a box or casing 10 having a partition 11 which divides it into two chambers 12 and 13; upright pipes 14 and 15 secured to the casing in communication with openings in the bottoms of the chambers 12 and 13 respectively, and a coupling 16 joining the lower ends of said pipes. Generically, the loop as a whole is a U-tube, of which the pipes 14 and 15 are the legs, the coupling or fitting 16 is the bottom, and the chambers 12 and 13 are the heads of the legs. The members or fittings thus designated as the casing 10 and coupling 16 may be made

as castings of iron or other suitable metal, and the pipes 14 and 15 may be cast or drawn tubes threaded and screwed into the openings provided, substantially as shown, in the fittings 10 and 16. The steam connection *g* is screwed into an entrance opening 17 in the top of the chamber 12, and the return line connection *i* is screwed into an opening 18 in the side of the chamber 13.

There is formed integral with the partition 11 an elbow conduit 19 which terminates within the chamber 12 in an orifice in substantially axial alinement with the bottom opening which receives the pipe 14, and to this elbow conduit there is attached, by being screwed into it, an interior pipe 20 which extends downwardly in pipe 14 part way to the lower end of the latter. This pipe and the elbow fitting 19 constitute an equalizing pipe, so called because it is adapted to perform an equalizing function as presently described.

In the chamber 13 and opposite to the upper orifice of the elbow connection 19 is a curved baffle 22 which extends entirely across the chamber from side to side and lies on an inclination between the connection 19 and the return line connection 18. Its purpose and effect is to deflect water issuing from the connection 19 toward the pipe 15 and to prevent outflow of such water through the return line connection 18. Adjacent to the upper end of the baffle 22 is an opening 24 so arranged that steam flowing through the elbow connection may pass readily over the baffle to the return line connection 18.

It will be noted that the coupling or connection 16 between the lower ends of the pipes is partly blocked by a wall 25, and that there is a restricted passage 26 through said wall.

The chamber 13 has a connection 27 in its upper wall on which is mounted a combination valve 28 containing a thermostatic outlet valve constructed to permit outflow of air, but having a thermostat which closes the valve to prevent outflow of steam, a float which closes the valve to prevent outflow of water and a vacuum valve which closes to prevent inflow of air when the pressure in the heating system drops below the atmospheric pressure.

When the loop is connected in a heating system as described, it contains water to a height at least sufficient to seal the lower end of the pipe 20. The water for this purpose may be poured into the loop before installation or it may be allowed to collect by condensation of steam in the connection *g* and in the loop itself. At any rate while the system is in operation a sufficient supply of water will be maintained by condensation to seal the pipe 20.

When the pressure in the boiler is higher than the return line pressure, the water level in the pipe 14 will be depressed and water will be transferred into the pipe 15 until the difference of levels balances the excess boiler pressure.

If, by reason of rising pressure in the boiler, the water level in pipe 14 should be depressed below the lower end of pipe 20, steam will pass through this pipe and the chamber 13 into the return line and create a pressure there which is equal to the difference between the boiler pressure and the pressure head of the water leg in pipe 15 above the lower end of pipe 20. The absolute value of this pressure difference is determined by the vertical distance to which the pipe 20 descends below the level of the return line connection 18. No matter how high the boiler pressure may rise, the transfer of steam to the return line, which is permitted by the loop, causes the return line pressure to undergo a parallel rise, but the pressure head of the water column in pipe 15 always maintains a pressure difference between the boiler and the return line.

Upon subsidence of the boiler pressure the combined action of the return line pressure and the pressure head in pipe 15 causes the water to rise in pipe 14 and seal the pipe 20 so that steam can no longer pass through the loop until either the boiler pressure rises again or the return line pressure is diminished by condensation of steam therein.

Ordinarily it is intended that the systems in which the loop is used shall be operated with a boiler pressure not exceeding the water head capable of being created in the loop, such water head being the prescribed maximum differential between the boiler and the return line pressures; and when the system is thus operated, no steam will pass through the loop, but the water levels in the two legs thereof will assume positions such that the excess head in leg 15 balances the boiler pressure. Only when abnormally high pressures occur in the boiler, or abnormally low pressures occur in the return line, will the loop allow steam to pass. The pressure then developed in the return line by such transfer of steam prevents any danger of water backing up into the return line and so leaving the boiler.

The thermostatic valve 28, being directly contiguous to the chamber 13 which is filled with steam as soon as steam begins to flow through the loop, is instantly closed by the steam then flowing, so that the pressure in the return line begins at once to rise. But when air in the return line reaches the thermostatic valve, or when the steam in the return line condenses, this valve is opened, while the associated vacuum valve will be opened if there is air in the return line at a pressure higher than atmospheric, or remain closed if there is a vacuum in the return line.

The loop having the construction and characteristics above described, or the equivalent thereof, has the following features of advantage among others. The baffle 22 pre-

vents water from leaving the loop when steam flows through it. When the water in the pipe 14 is forced below the pipe 20 and steam enters the latter the steam has a strong tendency to pick up and carry water with it through the pipe 20, and it does thus carry a substantial quantity of water. But the water thus entrained, when discharged from the connection 19, strikes the baffle 22 and is thereby deflected toward the pipe 15. At the same time the steam is allowed to pass through the opening 24, so that there is practically a complete separation between steam and water at this point. Such separation is assisted by a narrow ledge 29 at the entrance to the steam passage 24. Steam, therefore, passes readily through the loop, but substantially all of the water is retained and preserved except that which, as a result of long accumulation, may pass by overflow through the return line connection. The important fact in connection with the baffle is, however, that it prevents water from being taken out of the loop by entrainment with steam, and so prevents the loop from becoming inoperative by loss of water.

The restriction 26 in the lower part of the loop retards the return flow of water from the leg 15 into the leg 14. The volume of flow through this restricted orifice is less than the volume of water which can be carried by entrainment with steam through the pipe 20. Thus immediately after the flow of steam begins through pipe 20 the water level in the leg 14 is lowered to a point at which there is a minimum of entrainment, and it is maintained at such a low point until the increasing back pressure on the water column in pipe 15, acting in conjunction with the diminished flow of steam, causes the water in leg 14 to rise and again seal the pipe 20. In short, the restriction prevents the steam flow from setting up a circulation of water through the loop and diminishes the quantity of water required to be separated by the baffle.

What I claim and desire to secure by Letters Patent is:

1. A loop as and for the purposes set forth comprising a U-tube, a head having two chambers each connected with one of the legs of said tube, a steam connection to one of said chambers, an outlet connection from the other of said chambers, and an equalizing pipe extending within the upper part of that leg which is connected to the chamber having the steam connection, said equalizing pipe being connected to discharge laterally into the other chamber.

2. A loop as and for the purposes set forth comprising a U-tube, a head having two chambers each separately connected with one of the legs of said tube, a steam connection to one of said chambers, an outlet connection from the other of said chambers, an equalizing pipe extending within the upper part of that leg which is connected to the chamber having the steam connection, said equalizing pipe being connected to discharge laterally into the other chamber, and a baffle in the last-named chamber between the outlet of said equalizing pipe and the outlet from said chamber, to deflect water issuing from the equalizing pipe toward the leg which is connected to said last-named chamber.

3. A loop as and for the purposes set forth comprising a head having an internal partition dividing it into two chambers, legs forming a U-tube connected respectively to the bottom parts of said chambers, one of said chambers having a steam connection and the other having an outlet connection, an equalizing pipe located in one of said legs and opening into the chamber which has said outlet connection, and a baffle in the latter chamber between said equalizing pipe outlet and said outlet connection, with a steam passage between the highest part of the baffle and the equalizing pipe outlet, and a water space beneath the baffle open to the leg which is connected to said last-named chamber.

4. A differential loop comprising a head, legs leading downward from said head, said head being internally divided into two chambers, one of which has a steam inlet and the other an outlet, an equalizing pipe leading from a relatively low point in that leg which is connected to the chamber having the steam inlet and arranged to discharge into the other chamber, and a loop bottom connecting the lower ends of the legs and having a restricted flow passage of less capacity than the water conducting capacity of said equalizing pipe.

5. A differential loop comprising legs connected together adjacent to their lower ends, a steam connection to the head of one of said legs, a steam and water outlet connection to the head of the other leg, and an equalizing pipe opening at a low point in the leg first above specified and leading thence to the head of the other leg, the connection between said legs having a flow capacity less than that of the equalizing pipe.

6. A differential loop comprising a leg adapted to be connected at its upper end with a steam source, a second leg having an outlet at its upper end, an equalizing pipe leading from the upper end of the second leg into the first leg and having an opening within said first leg at a level below said outlet, and a connection between the legs below the opening of the equalizing pipe having a flow capacity substantially less than that of the said pipe.

7. A differential loop comprising a leg adapted to be connected at its upper end with a steam source, a second leg having an

outlet at its upper end, and equalizing pipe leading from the upper end of the second leg into the first leg and having an opening within said first leg at a level below said outlet, a baffle in the second leg between said outlet and the point where the equalizing pipe opens into the leg arranged to separate water from steam issuing from the equalizing pipe, and a connection between the two legs at a point below the opening of the equalizing pipe in the first leg having a flow capacity less than that of the equalizing pipe.

8. A differential loop comprising an upright U-tube, a steam inlet to the head of one of the legs of said U-tube, a steam and water outlet from the head of the other leg of said U-tube, an equalizing pipe leading from a low point in the first leg into the head of the other leg, and means for separating water from steam issuing into the second leg from the equalizing pipe.

9. A differential loop comprising a head having an intermediate upright partition dividing it into two chambers, legs connected with and extending downwardly from the bottom of the respective chambers and connected to each other near their lower ends, a conduit opening from one of said chambers and leading through the other chamber downwardly into the leg connected thereto and opening into such leg, and a baffle crossing the first named chamber from a point adjacent to but separated from and above the orifice of said conduit on a downward and outward inclination therefrom toward the bottom of the chamber; said first chamber having an outlet and the second mentioned chamber having an inlet.

In testimony whereof I have affixed my signature.

WILLIAM K. SIMPSON.