(No Model.) 3 Sheets—Sheet 1.

W. E. HALL.

STEAM HEATING SYSTEM.

No. 454,965. Patented June 30, 1891.

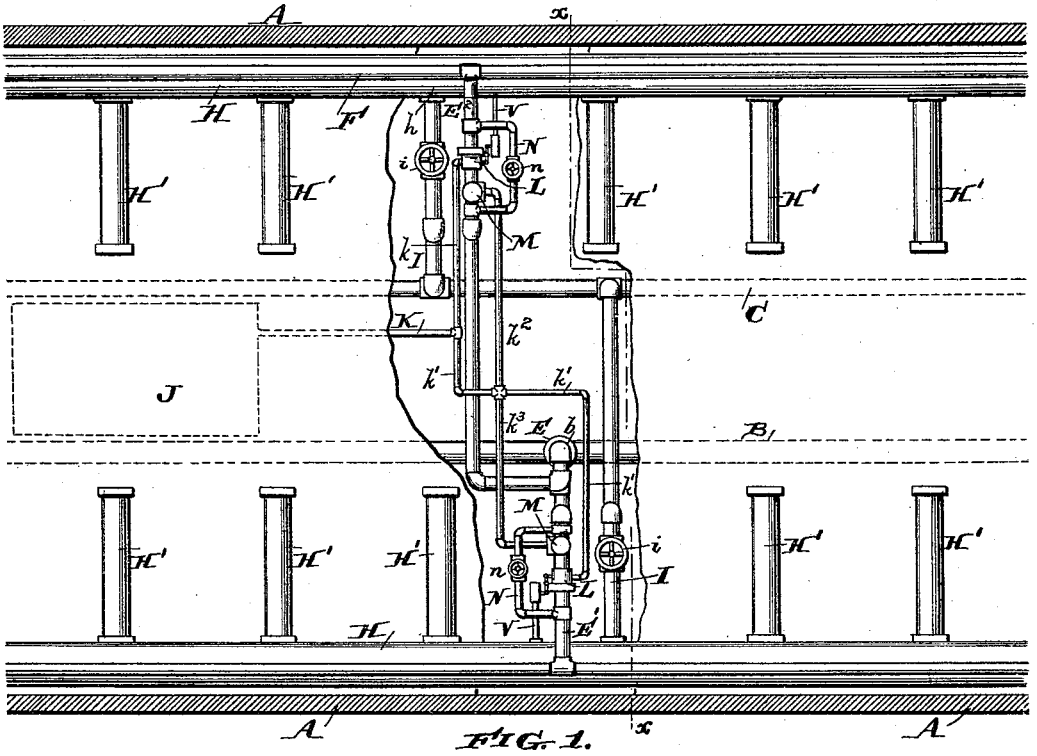

FIG. 1.

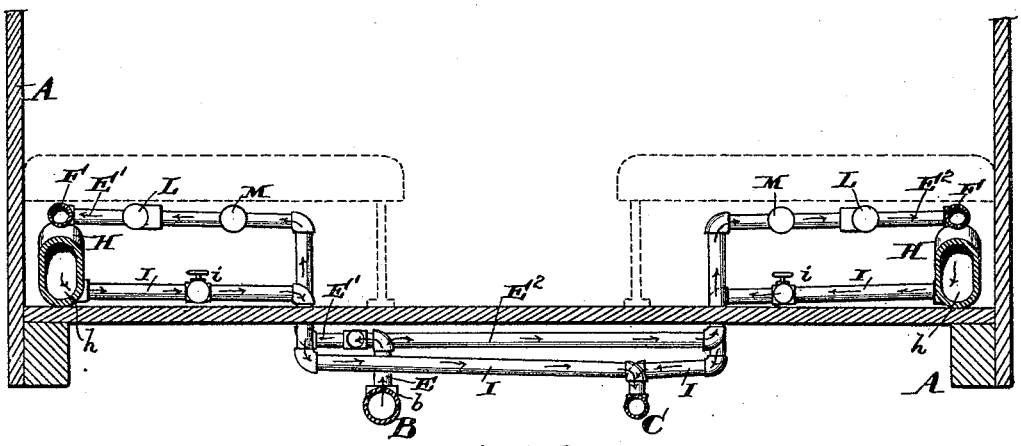

FIG. 2.

Witnesses:
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Jesse Heller

Inventor:
Willis E. Hall
by his attorney
Francis T. Chambers

(No Model.) 3 Sheets—Sheet 2.

W. E. HALL.

STEAM HEATING SYSTEM.

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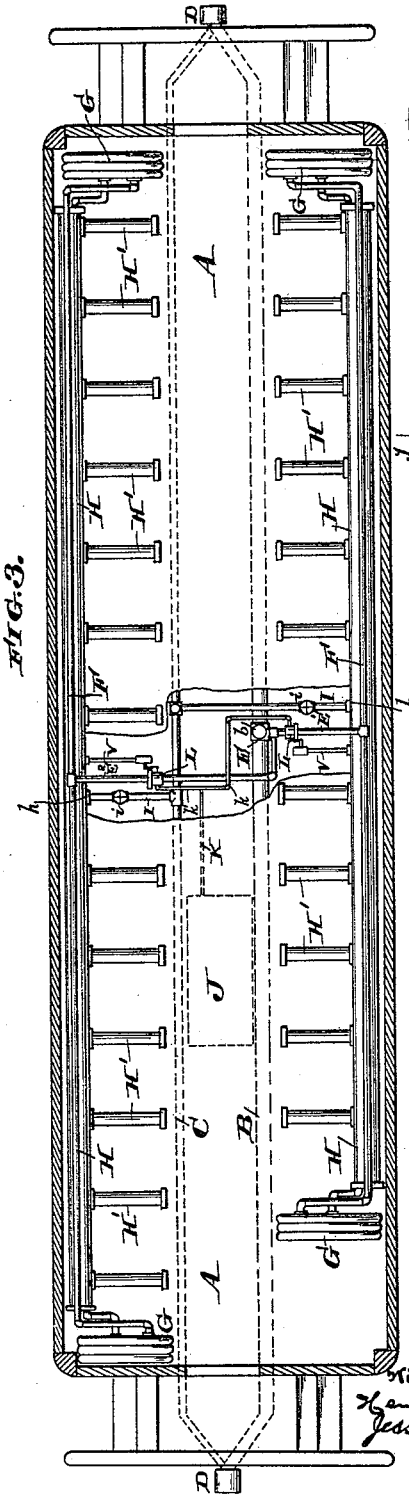

FIG. 3.

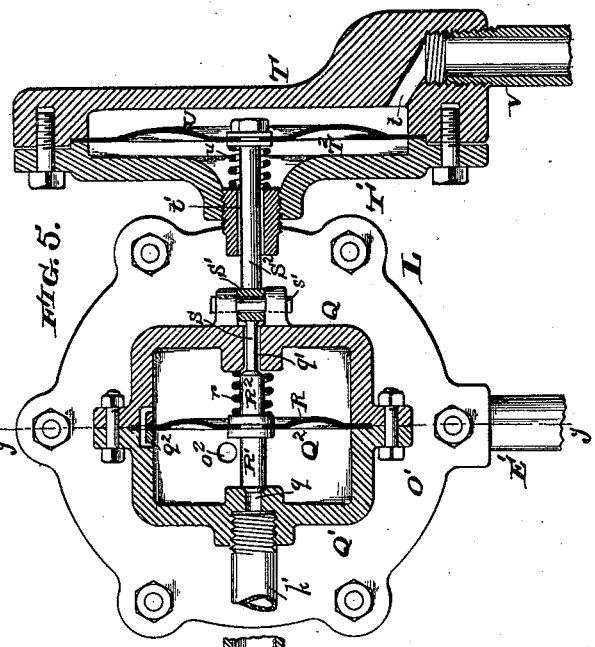

FIG. 5.

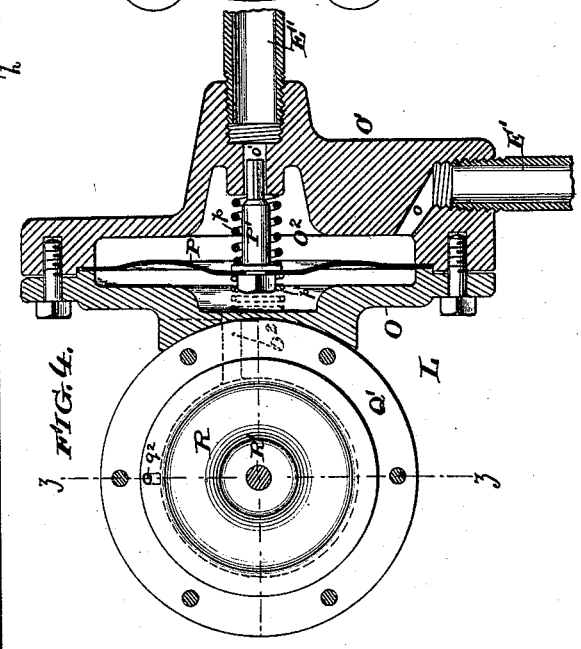

FIG. 4.

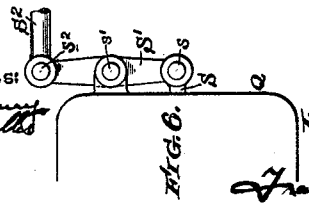

FIG. 6.

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(No Model.) 3 Sheets—Sheet 3.

W. E. HALL.

STEAM HEATING SYSTEM.

No. 454,965. Patented June 30, 1891.

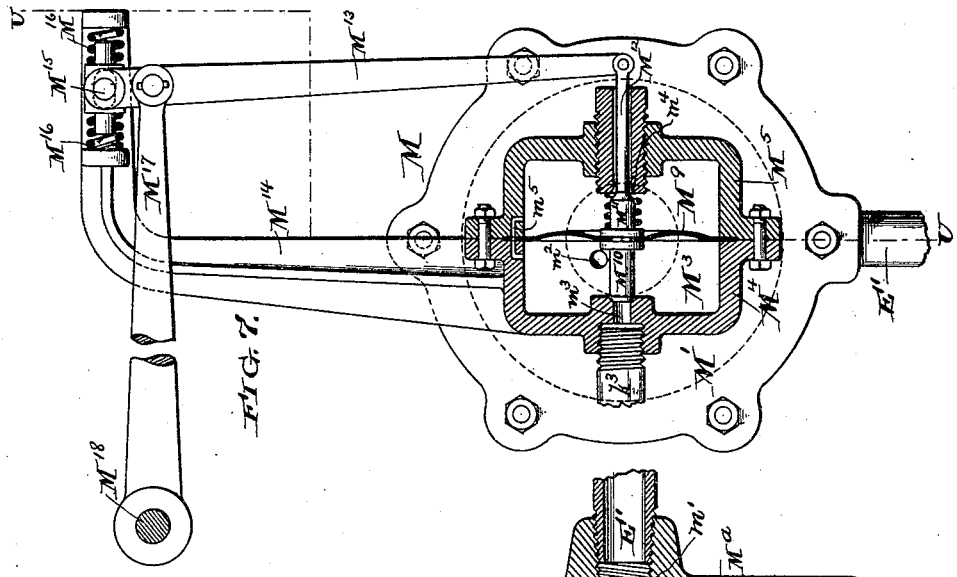

FIG. 7.

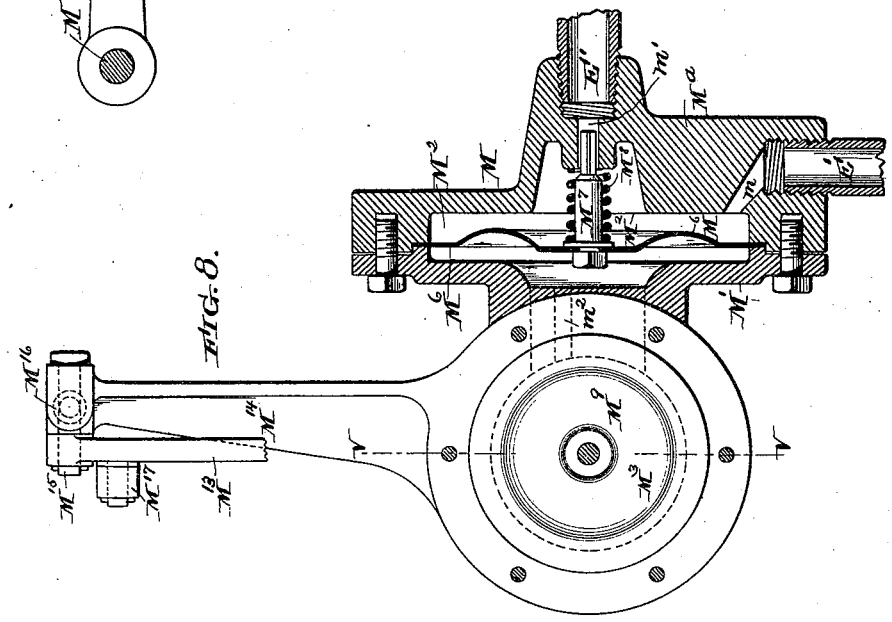

FIG. 8.

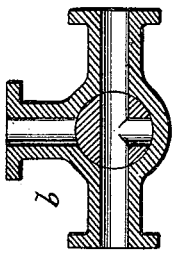

FIG. 9.

Witnesses:
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UNITED STATES PATENT OFFICE.

WILLIS E. HALL, OF ALTOONA, PENNSYLVANIA.

STEAM-HEATING SYSTEM.

SPECIFICATION forming part of Letters Patent No. 454,965, dated June 30, 1891.

Application filed May 22, 1890. Serial No. 352,772. (No model.)

To all whom it may concern:

Be it known that I, WILLIS E. HALL, of Altoona, county of Blair, State of Pennsylvania, have invented a certain new and useful Improvement in Steam-Heating Systems, of which the following is a true and accurate description, reference being had to the drawings, which form a part of this specification.

My invention relates to steam-heating apparatus, and particularly to steam-heating apparatus used in connection with railway-cars, and by which the cars are heated by steam from the engine and the exhaust-steam drawn out by a pump or other apparatus, so as to practically suck or draw the steam through the radiating system in the cars instead of depending on the pressure of the steam-supply to force it through. It is very desirable both for economy in the use of steam and for the efficient working of the apparatus that the steam supplied to the radiating system of each car should be automatically regulated by the temperature of the car and that the pressure of the steam in the radiating system should not exceed a determined amount. The importance of this to the operation of the system is owing to the fact that its sufficiency depends on there being always a suction in the return-flue, and this suction is of course greatly lessened or perhaps entirely overcome when live steam in any appreciable quantity escapes from the radiating system through the return-pipe.

The object of my invention is to provide means for regulating the supply of steam to the radiating system and the pressure in said system, and I accomplish this regulation by the devices hereinafter described, and which will be best understood as so described in connection with the drawings in which they are illustrated.

In the drawings, Figure 1 is a plan view of the central part of a car provided with my improvements. Fig. 2 is a cross-section taken on the line X X of Fig. 1. Fig. 3 is a plan view of a car provided with my improved apparatus; Fig. 4, a view of the improved automatic pressure-regulating device, which forms a part of my invention, partially shown in section on the line Y Y of Fig. 5. Fig. 5 is a view of the same device, shown partially in section on the line Z Z of Fig. 4; and Fig. 6 is a view showing a device for communicating motion employed in the automatic regulator. Fig. 7 is a view of a temperature-regulator on section-line *v v* of Fig. 8; Fig. 8, a section on line *u u* of Fig. 7; and Fig. 9 is a view showing a three-way cock.

A is the car; B, the steam-supply pipe; C, the return pipe or flue; D D, couplers by which the pipes B and C are connected with similar pipes on other cars.

E is a pipe leading from the steam-supply pipe and having branches E′ E², connecting, respectively, with steam-pipes F F at the sides of the car. These pipes F connect at each end of the car with radiating-coils G G, &c., which in turn connect with radiating-flues H H, from which small drums or pipe ends H′ extend beneath the seats of the car, and which should be made to slope downward from each end toward the center. From the lowest points of these pipes H, which are connected by the letter *h*, pipes I I connect with the return-flue C. A three-way cock may advantageously be placed at the point of connection between the pipes B and E, so that the radiating system of any car can be cut out, if desired. The position for such a cock is indicated at *b* and it may be of any usual construction—such, for instance, as is shown in Fig. 9. Adjustable valves *i i* are placed in each of the pipes I, so as to regulate the aperture through which the steam or water passes to the return-flue.

In all of the above features the apparatus shown is of an old construction.

In the pipes E′ E², leading from the steam-supply pipe to the radiating system, I place automatic pressure-regulating valves L, arranged so as to cut off the supply coming through the pipe when the pressure in the radiating-system has reached a determined amount, and preferably I place also in the pipes E′ and E² and between the valves L and the steam-supply pipe regulating-valves M M, arranged so as to cut off the supply of steam whenever the temperature of the car has reached a determined height. By arranging the valves in the manner shown the supply of steam is cut off irrespective of the pressure in the radiating system whenever the temperature of the car exceeds a determined maximum, and also whenever the pressure in the regulating system has reached a

determined maximum irrespective of the temperature of the car. I prefer to arrange the valves in the order shown, though they will operate usefully even if the pressure-regulating valve precedes the one governed by temperature.

In another application which I am about to file I have shown and described a valve automatically operated by the temperature of the car, and which I would prefer to use in the combination above referred to. Other known forms of regulating-valves operated by the influence of temperature may, however, be substituted for my preferred valve. In the present application I have shown in Figs. 7 and 8 the device covered in my other application, filed May 22, 1890, Serial No. 352,771.

To return to the drawings, N indicates a bypass extending around the valves L and M and provided with a cock n, by which it can be opened or closed at will.

J is a compressed-air reservoir having an outlet-pipe K, branches of which k, k', k^2, and k^3 are shown as leading to the valves L and M.

V is a pipe leading from the radiator-flue H to the valve L in the way and for the purpose hereinafter described.

Referring now to my preferred construction of pressure-regulating valve illustrated in Figs. 4, 5, and 6, O^2 is a chamber formed in a casing made up of sections O and O', and having ports o and o' for the entrance and exit of steam and a port o^2, connecting it with another chamber O^2, which chamber is formed in a casing made up of the sections Q and Q', and is provided with a port q, connecting with the pipe k', leading from the compressed-air cylinder or other receptacle containing gas or vapor under pressure, a port q' serving as an exit-passage, and in my preferred construction a contracted port or bypass q^2, leading around the diaphragm R. P is a diaphragm secured across the chamber O^2 and having attached to it a valve P', arranged to close the exit-port o' when the diaphragm moves toward it. p is a spring, which, as shown, is arranged to hold the valve P' away from its seat. R' is a valve, arranged to close the port q in the chamber Q^2, and R^2 a valve arranged to close the port q', these valves being so connected as to close and open their ports alternately. As shown, both valves R' and R^2 are attached to a diaphragm R, secured across the chamber Q^2, and a spring r is arranged to hold the valve R' to its seat. S is a valve-actuating rod by which the valves R' and R^2 are moved, and which, as shown, extends through the exit-port q'. This rod S is pivoted at s to a lever S', pivoted at s' and connected at s^2 with a rod S^2, which passes through an opening t' in a chamber T^2 and is attached to a diaphragm U, secured across the said chamber, and on the other side of which a port t is formed in the chamber which connects with the pipe V, leading from the radiator-flue H. A spring u is shown arranged to support the diaphragm U against the pressure of the steam coming from the radiating system.

The operation of my device is as follows: The valve P' is normally in the position shown in Fig. 4, and the steam from the supply-pipe passes through the port o and out through port o', while at the same time steam from the radiating system passes through the pipe V and presses on the diaphragm U. Whenever this pressure on the diaphragm U exceeds a determined amount necessary to overcome the force of the springs referred to, the diaphragm U is forced outward and the rod S^2 presses down on the end of the lever S' and draws outwardly the rod S, which, being attached or connected with the valve R', causes the said valve to leave its seat on the port q, permitting the compressed air to enter through said port into chamber Q^2, whence it passes through the port o^2 to the chamber O^2 and, acting on the diaphragm P, seats the valve P' on the port o', closing the said port and cutting off the supply of steam to the radiating system. By using the diaphragm R in the manner shown in the chamber Q^2 the compressed air entering the chamber Q^2 and acting on the face of the diaphragm R assists in opening the port q and closing the port q'. When the pressure acting on diaphragm U falls below the determined amount, the action of the parts is reversed. The valve R' seating itself on the port q and the valve P' leaving its seat on the port o', the compressed air in the chambers Q^2 and O^2 then escapes around the diaphragm R by means of the contracted port q^2 and passes away through the port q', which of course is opened as soon as the port q is closed.

Instead of using compressed air, any other gas or vapor may be used, and if said gas or vapor is at a less or equal pressure than the steam in the supply-pipe the device will still operate by placing a spring as indicated at p' instead of as indicated at p. In this modification the spring p' lends its strength to the vapor or gas, acting to close the valve P', and thus enables it, even at a low pressure, to overcome the pressure of the steam on the other side of the diaphragm.

Referring now to Figs. 7 and 8, which illustrate my preferred form of regulating-valve controlled by the temperature of the car, said device forming, as above stated, the subject-matter of another application, M^2 is a chamber formed between two castings M^a and M', which are bolted together, as shown. m and m' are ports leading from the chamber M^2 and connecting with branches of the pipe E' or of the pipe E^2. I have marked it E' in the drawings. The steam enters the chamber M^2 through the port m and leaves it through the port m'. M^3 is another chamber formed between two castings M^4 and M^5 and connected with chamber M^2 by a passage m^2. M^6 is a diaphragm secured in the chamber M^2, so as to divide it into two com-

partments, and having atached to it a valve M^7, arranged so it will close the port m' when the diaphragm moves toward the port. M^8 is a spring arranged to press the diaphragm M^6 and the valve M^7 away from the port m'. In the castings inclosing the chamber M^3 ports m^3 m^4 are formed, the port m^3 connecting the chamber with a pipe, as k^3, leading to the compressed-air cylinder J. M^9 is a diaphragm dividing the chamber M^3 into two compartments, which, however, are connected by a small by-pass m^5, and on each side of the diaphragm M^9 are secured valves M^{10} and M^{11}, arranged to close the ports m^3 and m^4, respectively and alternately, as the diaphragm moves in opposite directions. M^{12} is a rod extending through the port m^4 and attached to the center of valve M^{11}. M^{13} is a lever connected to the end of rod M^{12} at one end and fulcrumed at its other end on a pivot-pin M^{15}, secured in a slot formed in the end of an arm M^{14}, extending out from the valve-casing, as shown. M^{16} M^{16} are springs situated above and below the pivot-pin M^{15} and acting to hold it in position while permitting it to move under pressure. M^{17} is a rod situated within the car, secured permanently at one end M^{18}, and secured to lever M^{13} at its other end at a point inside the pivot M^{15} of said lever, and preferably quite close to it. The operation of this device is as follows: Steam passes from the pipe E′ through the port m in the chamber M^2 and out of it through port m' into the other branch of the pipe E′, said last-mentioned branch of the pipe leading to the radiator system. As the temperature of the car increases the rod M^{17} expands, increasing its length and pressing down upon the lever M^{13}, and through it pulling outward the rod M^{12} and the attached valves M^{11} and M^{10}. When the pressure is sufficient to overcome the normal tendency which holds the valve M^{10} to its seat on port m^3, compressed air passes from the cylinder J into the chamber M^3, thence through the port M^3 into the divisions of chamber M^2 farthest from the ports, where it acts against the diaphragm M^6 and, overcoming the pressure of spring M^8, causes the valve M^7 to move down and seat itself on the port m', thus cutting off the supply of steam to the radiator system. The diaphragm Q serves to divide the chamber M^3 into two divisions and prevents the air entering through port m^3 from escaping through port m^4 before the valve M^{11} has closed it, which of course it does immediately after the valve M′ has left its seat. The narrow passage m^5 permits the air to pass from one compartment to the other, but only gradually. As the temperature of the car falls the rod M^{17} contracts, with the result of first opening the port m^4 and then closing the port m^3. The compressed air in the chamber M^2 then escapes back through the passage M^2 and, passing through the port m^5, escapes through the opened port m^4, the release of pressure on the diaphragm M^6 permitting the spring M^8 to press the valve M^7 away from its seat on port m'.

Having now described my invention, what I claim as new, and desire to protect by Letters Patent, is—

1. In a steam-heating system, the combination, with a supply-pipe, a radiating system, a return pipe or flue, and pipes connecting the supply and return pipes with the radiating system, as described, of an automatic valve operated by the temperature of the chamber containing the radiating system and situated in the pipe connecting the steam-supply pipe with the radiators, and an automatic pressure-regulating valve situated in the same pipe, substantially as and for the purpose specified.

2. In a steam-heating system, the combination, with a supply-pipe, a radiating system, a return pipe or flue, and pipes connecting the supply and return pipes with the radiating system, as described, of an automatic valve operated by the temperature of the chamber containing the radiating system and situated in the pipe connecting the steam-supply pipe with the radiators, and an automatic pressure-regulating valve situated in the same pipe and between the first-mentioned valve and the radiating system, substantially as and for the purpose specified.

3. In a steam-heating system, the combination, with a pipe leading from the steam-supply pipe to the radiating system, of an automatic pressure-regulating valve having, in combination, a chamber O^2, having ports $o\,o'$ for the entrance and exit of the steam, a chamber Q^2, having a port q, adapted to connect with a receptacle for gas or vapor under pressure, a port o^2, connecting with chamber O^2, and an exit-port q', a diaphragm P, secured in chamber O^2 and having secured to it a valve P′, arranged to close exit-port o', valves R′ R^2, arranged to close, respectively, the ports q and q' of chamber Q^2 and to act alternately, a spring arranged to hold valve R′ to its seat and close port q, a chamber T^2, having a port t, connected to the radiating system, and a passage t' leading from it, a diaphragm U, secured in chamber T^2, a rod S^2, secured to said diaphragm and extending through passage t', and mechanism connecting rod S^2 with valve Q′, as described, so as to lift said valve from its seat when the pressure on diaphragm U exceeds the force holding the valve seated.

4. In a steam-heating system, the combination, with a pipe leading from the steam-supply pipe to the radiating system, of an automatic pressure-regulating valve having, in combination, a chamber O^2, having ports $o\,o'$ for the entrance and exit of the steam, a chamber Q^2, having a port q, adapted to connect with a receptacle for gas or vapor under pressure, a port o^2, connecting with chamber O^2, a contracted by-pass q^2, and an exit-port q', a diaphragm P, secured in chamber O^2 and having secured to it a valve P′, arranged to close

exit-port o', a diaphragm R, secured in chamber Q^2, valves R' R^2, attached to diaphragm R and arranged to close, respectively, the ports q and q' of chamber Q^2 and to act alternately, a spring arranged to hold valve R' to its seat and close port q, a chamber T^2, having a port t, connected to the radiating system, and a passage t' leading from it, a diaphragm U, secured in chamber T^2, a rod S^2, secured to said diaphragm and extending through passage t', and mechanism connecting rod S^2 with valve R', as described, so as to lift said valve from its seat when the pressure on diaphragm U exceeds the force holding the valve seated.

5. In a railway-car having a compressed-air chamber J and a steam-heating system consisting of a steam supply and return pipe connected with a radiating system in the car, the combination, with the pipe leading from the steam-supply pipe to the radiating system, of an automatic pressure-regulating valve having, in combination, a chamber O^2, having ports o o' for the entrance and exit of the steam, a chamber Q^2, having a port q, adapted to connect with the compressed-air chamber, a port o^2, connecting with chamber O^2, and an exit-port q', a diaphragm P, secured in chamber O^2 and having secured to it a valve P', arranged to close exit-port o', a spring p, arranged to hold valve P' away from its seat, valves R' R^2, arranged to close, respectively, the ports q and q' of chamber Q^2 and to act alternately, a spring arranged to hold valve R' to its seat and close port q, a chamber T^2, having a port t, connected to the radiating system, and a passage t' leading from it, a diaphragm U, secured in chamber T^2, a rod S^2, secured to said diaphragm and extending through passage t', and mechanism connecting rod S^2 with valve Q', as described, so as to lift said valve from its seat when the pressure on diaphragm U exceeds the force holding the valve seated.

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