No. 816,474. PATENTED MAR. 27, 1906.

W. S. JOHNSON.

STEAM TRAP.

APPLICATION FILED FEB. 17, 1905.

2 SHEETS—SHEET 1.

Fig. 1.

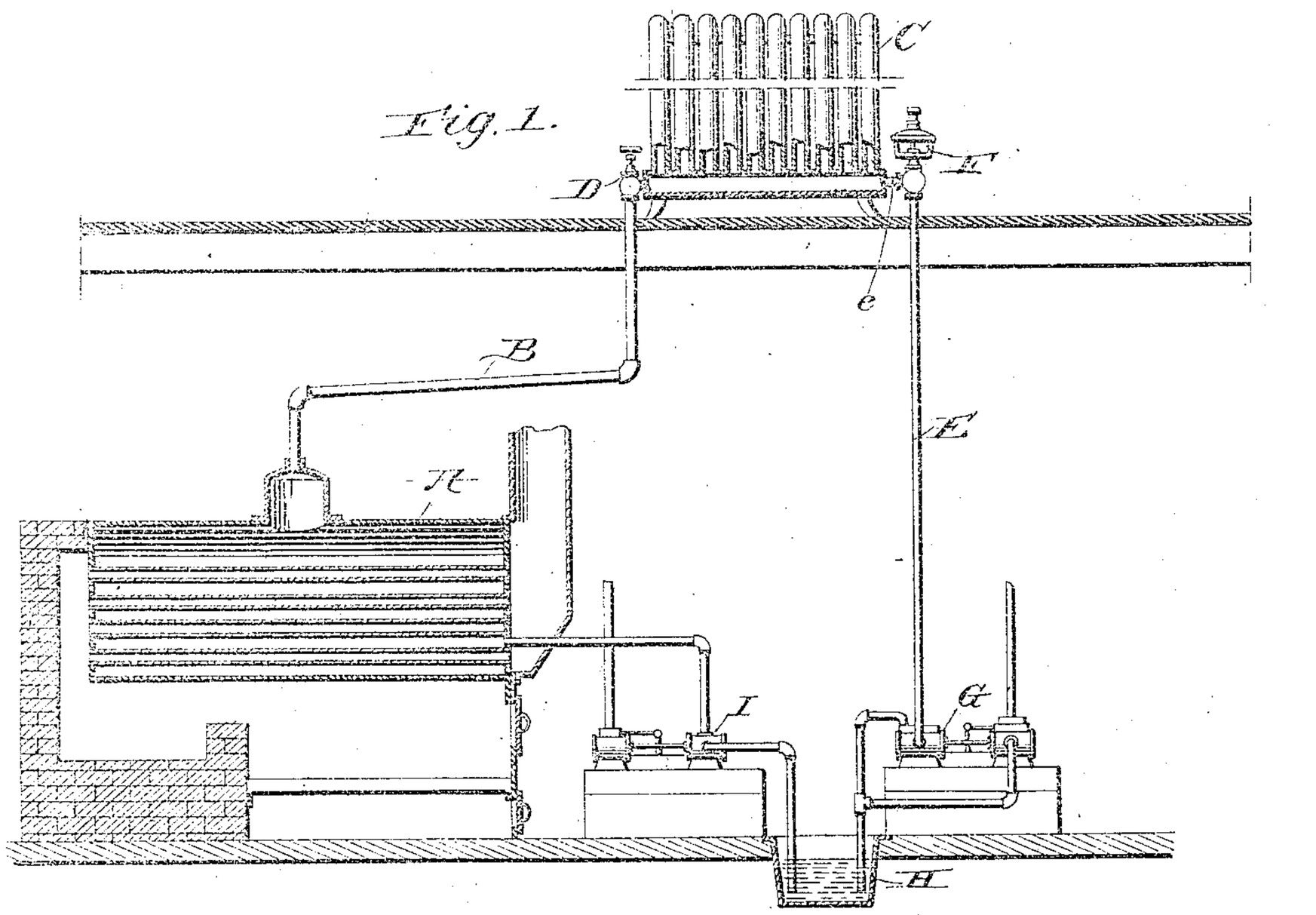

Fig. 2.

Witnesses
C. F. Roeder
J. Stewart Rice

Inventor:
Warren S. Johnson,
By Dodge and Dodge,
Attorneys.

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2 SHEETS—SHEET 2.

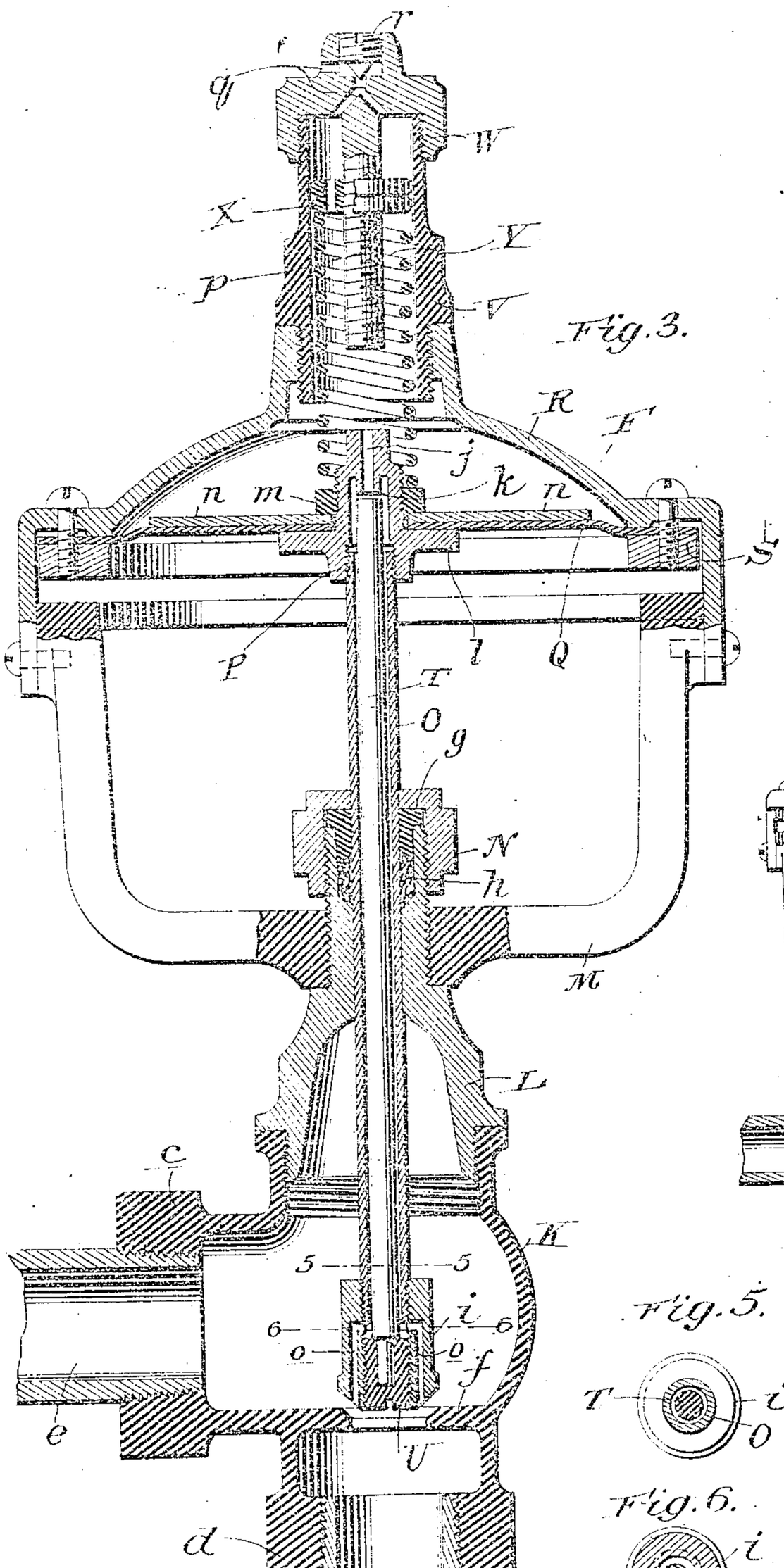

Fig. 3.

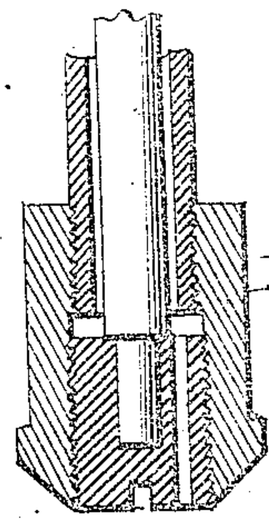

Fig. 7.

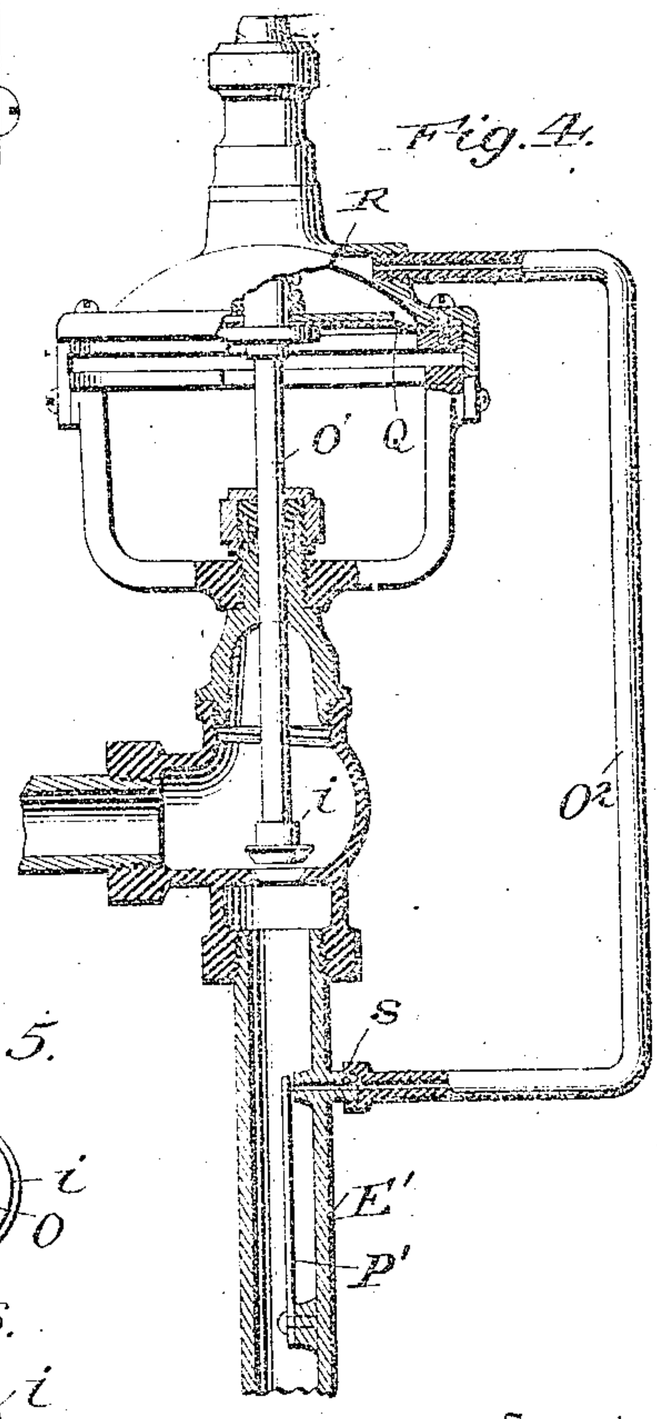

Fig. 4.

Fig. 5.

Fig. 6.

Witnesses

E. C. Fowler.

Stewart Rice.

Inventor:

Warren S. Johnson,

By Dodge and Dodge,

Attorneys.

UNITED STATES PATENT OFFICE.

WARREN S. JOHNSON, OF MILWAUKEE, WISCONSIN.

STEAM-TRAP.

No. 816,474. Specification of Letters Patent. Patented March 27, 1906.

Application filed February 17, 1905. Serial No. 246,054.

To all whom it may concern:

Be it known that I, WARREN S. JOHNSON, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented certain new and useful Improvements in Steam-Traps, of which the following is a specification.

My invention pertains to that class of steam-traps in which the operation of the outlet-valve is controlled by a thermostatic device.

The invention consists in a novel construction whereby air is exhausted from a chamber having a movable wall to which the outlet-valve is connected, so that when the thermostatic device opens the exhaust-passage of said chamber the pressure of the atmosphere upon said wall will move it and open the valve. The construction thus briefly outlined and to be hereinafter explained in detail insures prompt and reliable action with adequate power to open the valve to any extent desired, the thermostatic device having no other duty to perform than alternately to open and close the suction or exhaust pipe of the chamber referred to.

The accompanying drawings represent my improved trap applied to steam-heating apparatus, for which it is primarily designed, though I do not restrict myself to any particular application or use of the invention or to the specific construction shown, the details being susceptible of considerable variation within the scope and spirit of my invention.

Figure 1 is a view, essentially diagrammatic, showing my trap in connection with a "two-pipe" steam-heating system, having an exhaust-pump; Fig. 2, a similar view showing the trap applied to a "one-pipe" steam-heating system with a jet-exhauster; Fig. 3, a vertical central sectional view of the valve on a materially larger scale; Fig. 4, an elevation, mainly in section, illustrating a modified form of the device; Figs. 5 and 6, transverse sections on the lines 5 5 and 6 6 of Fig. 3, and Fig. 7 a detail view of a modification.

Both in Fig. 1 and in Fig. 2 I have represented the trap as used in connection with an exhaust device serving, primarily, to exhaust the air from the radiator to which the trap is applied, the exhauster being thereby made to serve the additional purpose of opening the outlet-valve of the trap. It is to be understood, however, that the exhaust device may be used solely to actuate the air-valve, though I prefer the combination and arrangement shown.

In the more modern and perfect heating systems it is now a common practice to employ some form of exhaust apparatus to withdraw air from the radiators and to induce or hasten an inflow of steam or heating agent, and the action of the exhauster is preferably though not invariably or necessarily controlled by some form of thermostatic device. In such systems the exhaust apparatus serves to withdraw air from the radiator when the latter has cooled down and the steam has condensed therein; but communication between the radiator and the exhauster is ordinarily cut off when the steam or other heating medium fills the radiator. A heating plant equipped with such exhausting means lends itself peculiarly well to the convenient and economical use of a trap such as here described, and the trap in turn facilitates the prompt and certain removal of water or liquid due to condensation of steam or other heating agent, the two thus contributing to render the plant as a whole very efficient in operation.

Referring to the drawings, and first to Fig. 1, A indicates a boiler or steam-generator which may be of any type; B, a pipe opening out of the steam device; C, a radiator with which the pipe B connects; D, a valve controlling the delivery of steam to the radiator; and E, a return or discharge pipe by which water, due to condensation of the steam, is carried from the radiator. Valve D is here represented as an ordinary hand-operated valve, but may be a motor-valve controlled by thermostat, as in any of the well-known automatic temperature-regulating systems in common use. But one radiator is shown; but any desired number will of course be employed. F indicates my improved trap, which is applied between the radiator C and the return-pipe E. The return-pipe E is in this view, Fig. 1, represented as connecting with the intake of the air-cylinder of an exhaust-pump G, the delivery-pipe and steam-exhaust pipe of which deliver into a feed-water well H. From this well the water is or may be returned to the boiler A by a pump I.

In Fig. 2 the boiler A, steam-pipe B, radiator C, valve D, well H, and pump I are shown as in Fig 1; but the steam-trap F is

shown near the top of the radiator, connected with the usual air valve or vent, and instead of the discharge-pipe E′ having its lower end connect with a pump it is carried into a pipe J, through which steam or other fluid is caused to pass under pressure. The end of pipe E′ is fashioned into or furnished with a nozzle *a*, centrally placed within pipe J, and as a consequence the rapid passage of steam or other fluid through pipe J and about the nozzle *a* causes air to be drawn downward through the pipe E′.

Referring now to Fig. 3, the construction of the steam-trap F will be explained. K indicates a valve shell or casing having two threaded necks *c* and *d* to receive, respectively, the short pipe or nipple *e*, by which it is connected with the radiator and the end of pipe E or E′. Within the shell is formed a diaphragm *f*, provided with a circular passage or opening, the wall of which is beveled to form a valve-seat. L indicates a cap or cover for the casing K, terminating in a neck which is externally threaded to receive a yoke or frame M and a cap-nut or gland N, which latter serves to retain in place and press down a follower *g*, by which is compressed the wicking or other packing *h*, placed within the recessed upper end of the neck. The packing serves to form an air and steam tight joint around a tube O, of iron or other material, having a relatively low coefficient of expansion and contraction and carrying at its lower end a valve-plug *i*, adapted to fit the valve-seat in diaphragm *f* and to close the passage therein. Tube O is movable through the stuffing-box in the valve-cap and terminates in a cap-piece P, preferably screwed upon the upper end of the tube. The cap-piece is bored out for a considerable portion of its length to form, in effect, a continuation of tube O, and its upper portion has an axial perforation *j* of smaller diameter, around the lower end of which is formed an annular valve-seat *k*. The cap-piece P is also formed with a horizontal flange or circular plate *l* and above this is exteriorly threaded to receive a nut *m*. Encircling the portion of cap-piece P above the flange or plate *l*, resting upon said flange and clamped between the same and a metal plate *n*, is a sheet Q, of leather, rubber, or other flexible material, impervious to air, the parts being clamped together by the nut *m*, as shown. R indicates a dome-shaped shell or casing, carried by the yoke or frame M and preferably of circular form. To the lower face of the shell R and between it and a clamping-ring S is secured the circular edge of the flexible sheet Q, which is thus made to serve as a movable lower wall to the chamber of shell R. T indicates a rod of metal or other material, having a relatively high coefficient of expansion and contraction as compared with the tube O, so that when subjected to the same or approximately the same increase in temperature said rod will elongate more rapidly than the tube O. The lower end of the rod T is stepped in a screw-threaded block U, which is screwed into the lower end of the valve-plug *i*, the screw-threaded block and the valve-plug having a common axis. Block U has a nick or groove in its lower end to receive the blade or bit of a screw-driver by which it may be turned in or out to adjust the block and the rod T, carried by it, so that the upper end of said rod shall be nearer to or farther from the valve-seat *k*. The diameter of rod T is enough less than the internal diameter of tube O to afford a clear passage-way for the travel of air between them, and the valve-plug *i* is provided with passages *o*, opening from the lower end of the valve into the space between the interior of the tube O and the rod T. A passage may, however, be made through the block U, provided only it open at the lower end of the valve-plug and within the area of the opening in the diaphragm *f*. Fig. 7 shows the block U with such passage-way through it. The shell or casing R is formed with an upwardly-extending neck or boss, into which is threaded a tubular extension V, to which is applied a cap-nut W, formed with a downwardly-extending centrally-arranged stem *p*. This stem is formed or furnished with an enlargement X, serving as an abutment or bearing for one end of the spring Y, the upper end of which bears against the abutment X, and the lower end of which encircles the upper end of cap-piece P and bears upon the nut *m* thereof, as plainly seen in Fig. 3. The abutment X may be a fixture upon the stem, but will preferably be in the form of a nut adjustable upon the stem in any convenient way—as, for instance, by threading the two parts and screwing one upon the other. Such adjustment will enable the user to vary the compression of the spring Y as desired, the purpose of the spring being to press down the cap-piece P, the rod O, and the valve-plug *i*. The abutment X will be constructed to permit passage of air from one to the other side of it, a perforation being shown in Fig. 3 for that purpose. The cap-nut W is provided with an air-inlet *q*, controlled by a conical-pointed screw-plug *r*, nicked or slotted to receive the bit or blade of a screw-driver, so that the plug may be turned to vary the capacity of the inlet *q* as desired. In practice it will be adjusted so that the area of the inlet shall be appreciably less than that of the passage *j* in the cap-piece P. These proportions may be fixed, in which case the screw-plug *r* may be omitted; but it is deemed better to provide for adjustment in order that the necessity for extreme accuracy in drilling or producing passages may be avoided and that the relation may be established and varied according to requirements.

The device being constructed as above set forth, its operation is as follows: Assuming that the radiator should become filled with steam or other heating medium, the rod T would be expanded by the heat thereof and would close the passage *j* by seating against the valve-seat *k*. Hence no air could be drawn by the exhauster through the tube O or from the chamber in the dome-shaped shell or casing R. As air is admitted through the inlet *q* and the flexible diaphragm or wall Q is depressed by the pressure of spring Y upon the cap-piece P, said parts, and with them the valve-plug *i*, are pressed down so that the valve seats and closes the outlet from the valve shell or casing into the pipe E. If at any time the steam be shut off with valve-plug *i* seated, the radiator will gradually cool, the steam will condense and form water, which will accumulate in the base of the radiator and in the valve-shell K, and will cause the tube O and rod T both to contract; but owing to the higher ratio or coefficient of expansion and contraction of the rod T it will shorten more than the tube O, and hence its upper end will be withdrawn from the valve-seat *k*, thus opening passage *j*. The valve-plug *i* being at this time upon its seat, the entire force of the suction will be applied to drawing air through the passage *j* and between rod T and the interior of tube O. Thus air will be withdrawn from the interior space or chamber of the dome-shaped shell or casing R and will produce a more or less nearly perfect vacuum therein, according to the force of the suction and the relative capacities of passages *j* and *q*. As the passage *q* is purposely made very small, sufficient only to permit destruction of the vacuum when the device remains for some time from suction, the air will be almost wholly exhausted from the chamber of said shell or casing R. As a consequence of the absence of pressure on the upper side of the flexible wall or diaphragm Q and the full pressure of the atmosphere on the lower and extended surface thereof, said wall or diaphragm will be forced upward with a pressure of many pounds, insuring the prompt and adequate movement of the valve-plug *i* from its seat and the full opening of the outlet-passage. The water accumulated within the base of the radiator will then flow freely into pipe E, aided by the suction in said pipe, and this outflow will continue as long as there is either water or air contained within the radiator, the downflow of the water around the valve-plug *i* itself tending to produce a downward flow of air through the tube O. When the water and air are both drawn from the radiator and steam or other heating medium enters and fills the same, the increase in temperature produced by the heating agent will cause both the tube O and the rod T to expand; but said rod T expanding more rapidly than tube O its upper end will speedily seat itself against the valve-seat *k* and close the passage *j*, thus preventing any further withdrawal of air from the shell or casing R. As, however, the passage *q* remains open, air will find its way into the shell or chamber above the flexible wall or diaphragm Q, so that the atmosphere will press equally on both faces thereof and the spring Y will be free to force down the flexible wall and the valve-plug connected and moving with it. In this way the valve will be closed whenever the air has been withdrawn from the radiator and steam or other heating medium has been drawn in to take its place. The stem *p* serves or may serve as a stop to limit the rise of the flexible wall and parts carried by it.

The thermostat may obviously be located elsewhere than in the valve-stem—as, for instance, in the outlet or discharge pipe. Such an arrangement is illustrated in Fig. 4, in which corresponding parts are designated as in Fig. 3. Instead, however, of placing the thermostat within the valve rod or stem a solid rod O′ is employed to carry the valve-plug *i*, and an independent air-pipe O^2 is carried from the shell or casing R down to the outlet-pipe E, where it connects with a nipple *s*, extending inward toward the center of said pipe. The thermostat in this case consists, preferably, of a bimetallic bar or strip P′, made fast to the interior of the pipe E at one end and having its other or free end arranged to lie against and close the mouth of the nipple *s* when the temperature rises and to move away therefrom as the temperature falls. This action is due to the well-known bending of a bar composed of two metals of unequal coefficients of expansion and contraction, the more expansible metal responding more quickly and strongly to changes of temperature than the less expansible one. In the example represented the steel side would therefore be next the nipple and the brass side away therefrom. Hence upon the elevation of temperature the bimetallic bar P′ would swing to and bear against the mouth of the nipple, and on a lowering of the temperature it would swing away from and open the nipple. The action of the apparatus thus constructed is precisely the same as that of the apparatus shown in Fig. 3—that is to say, when the radiator is full of steam and the outlet-passage into pipe E′ is open thermostatic bar P′ will close the nipple *s*, and hence the air will not be exhausted from the space or chamber above the flexible wall or diaphragm Q. When, however, the heating medium is cut off and the radiator cools, bar P′ will swing away from and open the nipple *s*, and the suction downward through pipe E will cause air to be exhausted from the space or chamber above the diaphragm Q through pipe O^2, thus creating a vacuum more or less nearly perfect above

the wall or diaphragm Q and causing the same to be forced upward by the pressure of the atmosphere beneath. This in turn will cause the lifting of valve-plug *i* and the outflow of the water, and the suction will become effective to remove air from within the radiator and induce an inflow of steam thereinto. This is but one of numerous variations of which the invention is susceptible.

It will be observed from the foregoing description that this apparatus is constructed and arranged to permit the escape of water of condensation, and that it is well adapted to use wherever water accumulates through such condensation in a chamber containing steam under considerable pressure, because while allowing the water to pass off freely the valve is promptly closed when through discharge of the water the steam is permitted to come into contact with the thermostatic device. It is thus rendered practically impossible for water to accumulate in any considerable quantity in a steam radiator, trap, or the like provided with this valve and exhaust mechanism, because as soon as the valve seats and the water accumulates the thermostatic bar contracts and opens passage *j*, thus connecting the exhaust with the valve-retracting motor.

The utilization of suction apparatus already present and provided for other purposes renders unnecessary the provision of other and special suction-pipes or suction apparatus, and since the suction required is small it is found unnecessary to increase the capacity of apparatus commonly provided, this being found to be sufficient for both purposes.

Having thus described my invention, what I claim is—

1. In combination with a steam-trap having an outlet provided with a valve-seat, a chamber having a movable wall exposed on one side to the atmosphere; a valve-plug connected to and movable with said wall and adapted and arranged normally to close said outlet; and a suction device connected with the interior of said chamber and serving to withdraw the air therefrom and thereby to unseat the valve, substantially as described.

2. In a steam-trap, the combination of a valve shell or casing provided with an outlet having a valve-seat; a valve-plug adapted and arranged normally to close said outlet; a hollow shell or casing provided with a movable wall having one face exposed to the external atmosphere; a connection between said movable wall and the valve-plug; a suction device communicating with the interior of the shell or casing and serving to withdraw air therefrom; and a thermostatic device controlling communication between the suction device and said shell or casing, substantially as described.

3. In combination with a valve shell or casing provided with an outlet-opening having a valve-seat, a suction-pipe communicating with the valve-casing on the delivery side of said opening; a valve-plug adapted and arranged normally to close said opening; a motor shell or casing provided with a movable wall or member exposed on one side to the external atmosphere; a pipe or tube connecting the interior of the motor shell or casing with the suction-pipe; and a thermostatic device applied to said pipe or tube and serving to cut off all communication between the valve-chamber and the motor-chamber when the temperature rises, and to open the same when the temperature falls below a predetermined point.

4. The herein-described steam-trap comprising a shell or casing having an outlet-passage, and adapted to be connected with the steam or water space of a vessel or chamber to be relieved, and with an exhauster; a motor shell or casing R carried by the valve shell or casing and provided with movable wall Q exposed on one side to the atmosphere; tube O connected with said wall, passing into the valve shell or casing, and provided with a valve-plug *i* and passage *j;* expansible rod T mounted within tube O, and adapted to seat and unseal the passage *j;* and spring Y, serving to press downward the movable wall Q and the parts carried thereby.

5. In combination with a chamber or vessel adapted to contain heated pressure fluid; a valve shell or casing connected with said chamber or vessel and provided with an outlet having a valve-seat; a valve controlling said outlet; a motor-chamber fixed in relation to the valve shell or casing and provided with a movable wall exposed on one face to the atmosphere; a tube connecting said movable wall with the valve-plug and forming a passage of communication between the motor-chamber and the space below the valve-seat; a suction apparatus connected with the outlet of the valve shell or casing and adapted to draw air from the motor-chamber through the tube connecting the valve-plug and the movable wall; and a rod or bar contained within, and of relatively greater expansibility than, the tube, adapted and arranged to close the passage through said tube upon an increase of temperature beyond a predetermined point, and to open said passage when the temperature falls below said point.

6. The herein-described steam-trap comprising valve shell or casing K; valve-plug *i;* tube O, provided with cap-piece P, having passage *j;* rod T mounted within the tube O; flexible disk or diaphragm Q having one face exposed to the atmosphere; shell or casing R, provided with air-inlet *q;* and spring Y, all substantially as described and shown.

7. In combination with valve shell or casing K, and valve-plug *i;* shell or casing R provided with movable wall Q, having one face exposed to the atmosphere, and with an air-inlet *q;* a stem connecting said wall with the valve-plug *i;* spring Y bearing upon wall Q; a pipe or tubular connection extending from the space within the chamber R, to a point below the valve-plug; and a thermostatic device serving to close and open said connection, as the temperature rises and falls.

8. In a steam-trap of the character described, the combination of a valve-casing and valve; a fluid-pressure motor for actuating said valve, comprising a hollow shell or chamber R and a movable wall or member Q for said chamber, connected with said valve; means for normally pressing said valve toward its seat; means for exhausting the air from the motor-chamber to cause the pressure of the atmosphere on the exposed face of the movable wall or member to move the valve in opposition to the closing devices; and an air-inlet opening into the motor-chamber and provided with a regulating-valve, whereby air is permitted constantly to enter said motor-chamber, but is prevented from destroying the action of the suction device therein.

9. The herein-described steam-trap, comprising a valve shell or casing having an outlet-opening provided with a valve-seat; a valve-plug to close said outlet; a yoke or frame supported by the casing; a shell or chamber supported by the yoke or frame; a flexible disk or sheet forming one wall of said chamber; a neck or extension rising from said chamber; a cap applied to said neck and provided with an air-inlet; a valve for regulating the capacity of said inlet; a spring contained within the neck; an adjustible abutment for said spring; a tube connecting the diaphragm or movable wall and the valve-plug; and an expansible rod mounted within said tube and adapted by its expansion and contraction to close and to open the passage through said tube, all substantially as set forth.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

WARREN S. JOHNSON.

Witnesses:

ADELINE A. JOHNSON,

CLIFFORD A. LOEW.