F. C. GOFF.

PRESSURE AND VACUUM STEAM HEATING VALVE.

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935,599. Patented Sept. 28, 1909.

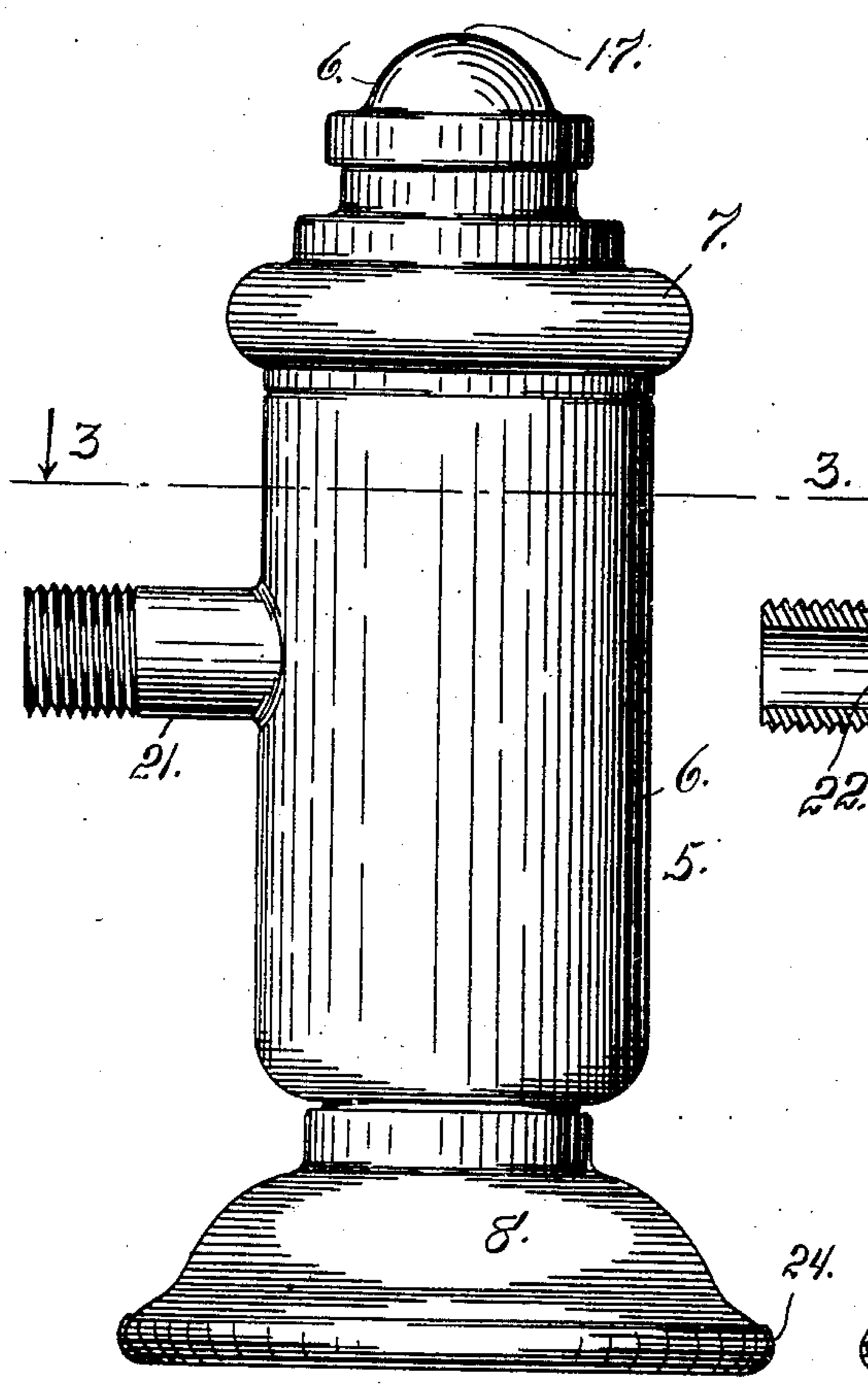

Fig. 1

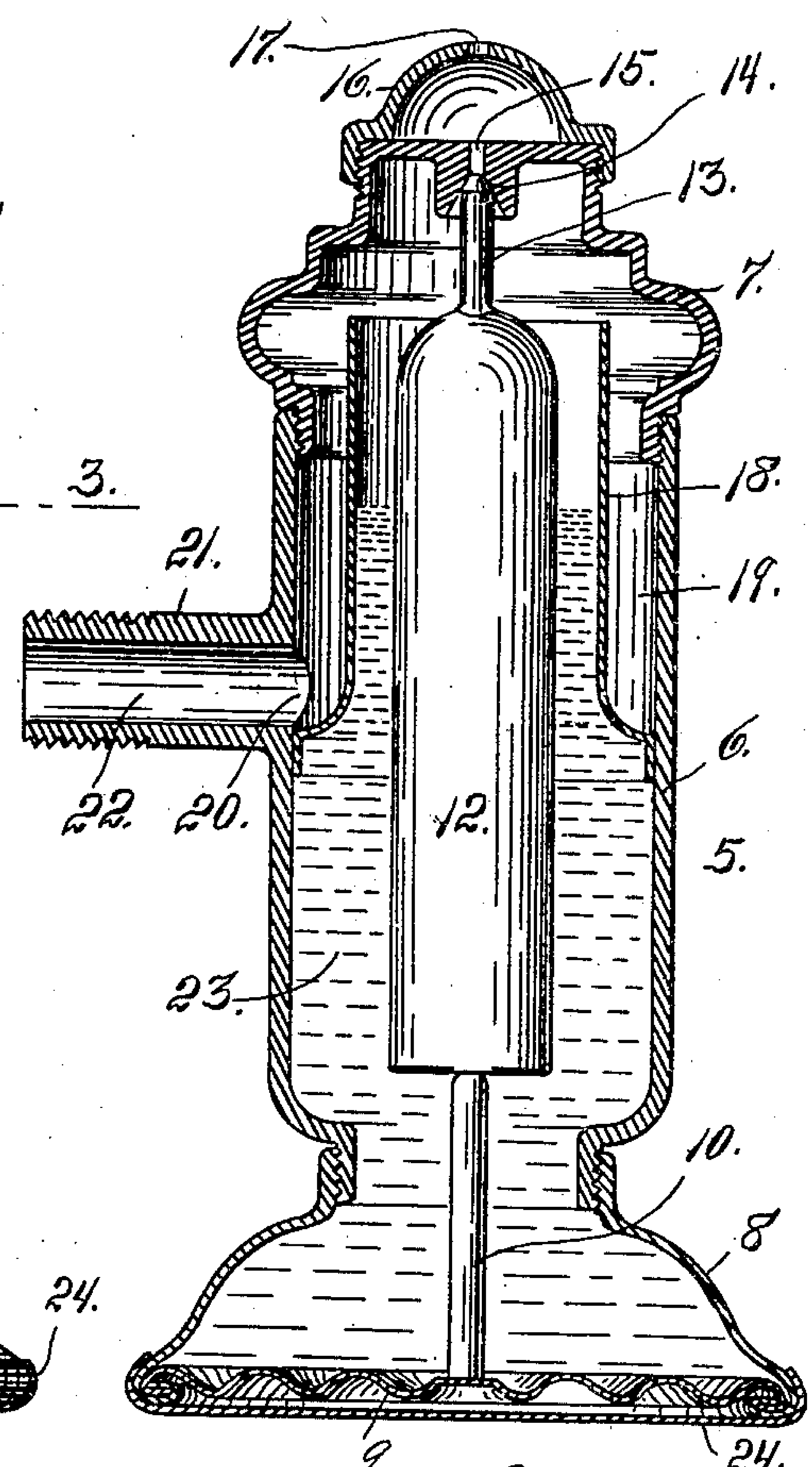

Fig. 2

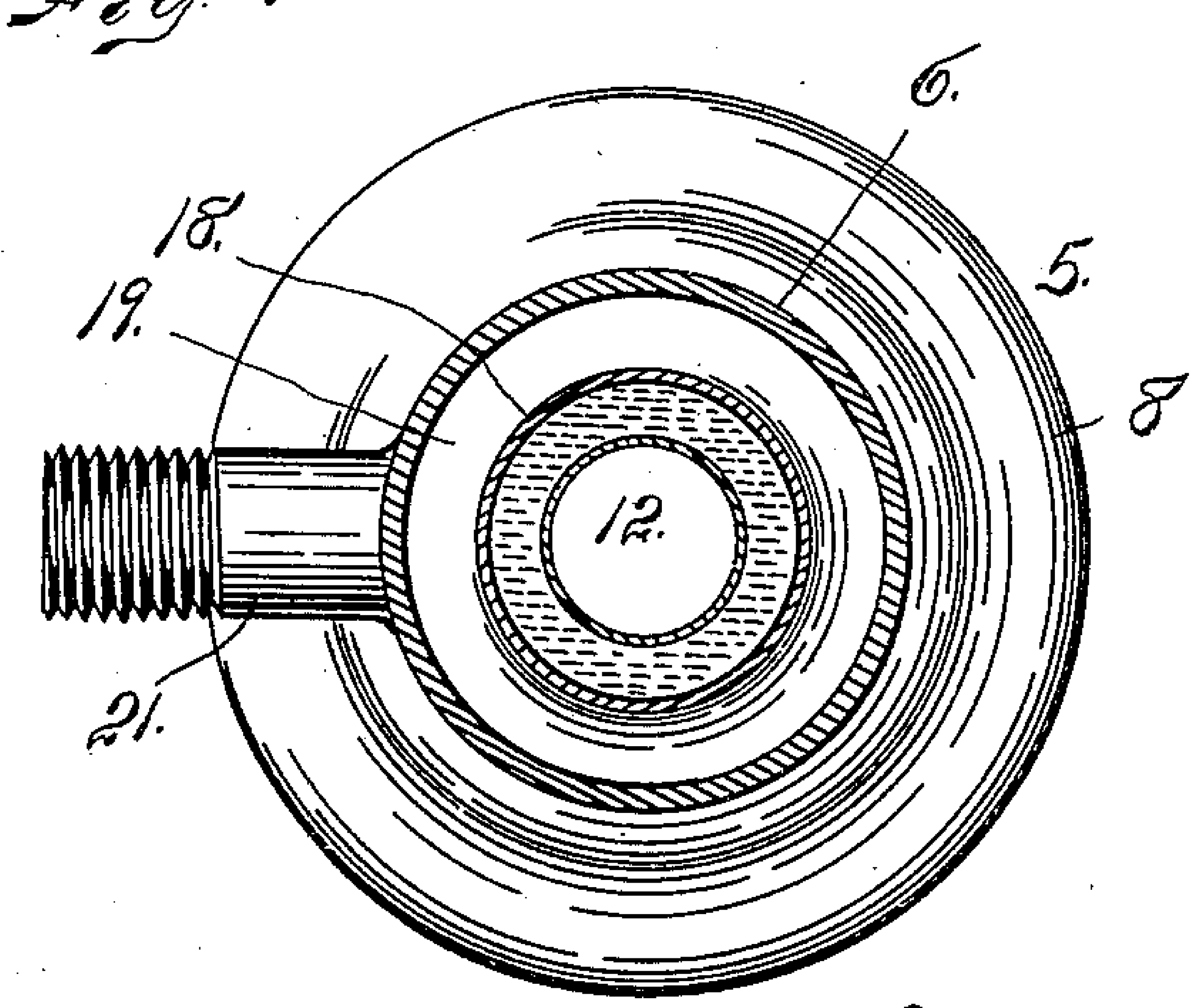

Fig. 3.

Witnesses
Otto E. Hoddick.
Dena Nelson.

Inventor
Frank C. Goff.
By N. H. Owen
Attorney

ANDREW. B. GRAHAM CO., PHOTO-LITHOGRAPHERS, WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

FRANK C. GOFF, OF DENVER, COLORADO.

PRESSURE AND VACUUM STEAM-HEATING VALVE.

935,599. Specification of Letters Patent. **Patented Sept. 28, 1909.**

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To all whom it may concern:

Be it known that I, Frank C. Goff, a citizen of the United States, residing in the city and county of Denver and State of Colorado, have invented certain new and useful Improvements in Pressure and Vacuum Steam-Heating Valves; and I do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the figures of reference marked thereon, which form a part of this specification.

My invention relates broadly considered to improvements in air valves for steam heating systems.

My improved valve is adapted to close, both by virtue of the action of the steam when entering the valve and also by virtue of suction or the vacuum pull due to condensation in the system thus preventing the entrance of air from the outside by way of the port in the valve casing. It is also adapted to open due to air pressure in the system.

My improved construction includes a casing, a float valve and a diaphragm. Within the upper part of the casing an annular chamber is formed between an inner partition and the casing proper. This chamber is in direct communication with the steam heating system by way of the opening in the nipple which is screwed into the radiator or other device. The annular partition in the upper part of the chamber, separates the annular chamber from the main chamber.

Assuming that the steam is turned on and that the system contains air, this air is forced into the chamber of the air valve and acting on the diaphragm depresses the same causing the float to drop whereby the valve is unseated. The air is thus allowed to escape through the valve port and this will continue until all the air has been driven out of the radiator. The steam then entering the casing of the air valve heats the latter and causes the water of condensation therein to expand, whereby the float is caused to rise and seat the valve thus preventing the escape of steam. When the steam is shut off and the system cools, resulting in steam condensation and a partial vacuum within the system, this vacuum-pull acting on the diaphragm causes the latter to rise and lift the float sufficiently to close the valve thus preventing the entrance of air from the outside.

The diaphragm may be at any desired location which will permit it to perform the aforesaid function. As illustrated in the drawing the diaphragm is located at the bottom of the casing and closes the latter at its lower end. To this diaphragm is attached a pin upon which the lower extremity of the float rests. Normally the diaphragm is in such position that the pin holds the float in position to seat the valve or hold the same practically in the closed position. It is evident, however, that the diaphragm may be otherwise located.

Having briefly outlined my improved construction, I will proceed to describe the same in detail reference being made to the accompanying drawing in which is illustrated an embodiment thereof.

In this drawing, Figure 1 is a side elevation of my improved air valve. Fig. 2 is a central longitudinal section of the same. Fig. 3 is a cross section taken on the line 3—3 Fig. 1.

The same reference characters indicate the same parts in all the views.

Let the numeral 5 designate the casing of the air valve which as shown in the drawing consists of a body portion 6, a top portion 7, and a bottom portion 8, the parts 7 and 8 being connected with the body portion by securing the parts together. To the base 8 is attached a flexible diaphragm 9, to the center of which is secured a pin 10 upon which rests a float 12 to the upper portion of which is attached a valve pin 13 adapted to engage a seat 14 and close a port 15. To the top of the upper portion 7 of the casing is screwed a cap 16 having a port 17 communicating with the outer air. In the upper portion of the casing is located an annular partition 18 forming an auxiliary chamber 19 between the partition and the casing. This chamber is in communication with a port 20 surrounded by a nipple 21 having a passage 22 communicating with the steam heating system (not shown).

From the foregoing description the use and operation of my improved air valve will be readily understood. Assuming that the parts are in the position illustrated in Fig. 2 of the drawing or in what may be termed the normal position, the operation is as follows: When steam is turned into the system it first acts to drive the air therefrom into the air valves of the radiators. As the air enters an air valve the pressure acts upon the diaphragm 9 to depress the latter whereby the float 12 is caused to drop, thus carrying the valve 13 away from its seat and opening the port 15 allowing the air to escape as long as there is any in the system. As soon as the air has all been expelled, the steam enters the valve casing and heating the water 23 therein, expands the same and causes the float to rise with the result that the valve is seated and the port 15 closed to prevent the escape of steam. This is the normal condition of the device when the steam is turned on for heating purposes. I will now assume that the radiator becomes cooled from any cause, sufficiently to produce steam condensation. In this event the vacuum pull will act on the diaphragm 9 to lift the latter or cause it to move inwardly thus forcing the pin 10 against the float 12 and causing the latter to move upwardly whereby the valve 13 is caused to seat and close the port 15 thus preventing the entrance of air to the system.

It is a scientific fact that water when heated from a temperature of 80° to 212° Fahrenheit, or to the boiling point, expands $\frac{1}{25}$ of its volume; or, in other words, the expansion of the water under the circumstances as stated, is about $\frac{1}{10}$ that of air. I have determined mathematically that the water will rise within the contact space of the well surrounding the upper part of the float, $\frac{5}{8}$ of an inch, due to the expansion of the water, by virtue of its being heated to, or approximately to the boiling point. This rise is more than sufficient to actuate the valve to close the latter when steam enters the radiator. It is true that when steam enters the radiator, condensation takes place; but the heat of the steam acts practically instantaneously upon the water, since the annular partition 18 forming the chamber 19, presents a relatively large heating surface in contact with the steam, whereby the volume of water within the well or casing of the valve, is increased sufficiently to raise the float and close the valve. Hence, when there is sufficient pressure within the valve to keep the diaphragm depressed, the closing action of the valve due to water expansion takes place before there is sufficient condensation to cause the float to rise.

My improved valve is operated through the action of the float 12 acting as a float and fluctuating with the rise and fall of the water in the well or casing, except when there is sufficient vacuum pull within the system due to steam condensation, to cause the diaphragm to move inwardly sufficiently to close the valve for the purpose of preventing the entrance of air to the system when the latter is cooled.

It is well known that a cubic inch of water when converted into steam has a volume of approximately one cubic foot: Hence, when steam is condensed, almost a perfect vacuum results and this vacuum pull within the system acts to pull the diaphragm inwardly sufficiently to lift the float and close the valve, whether or not sufficient water were in the well to perform this function. It may be stated that the weight of the water within the well or casing of the valve is never sufficient to depress the diaphragm or cause the valve to drop, since the diaphragm is of sufficient resistance to support a column of water several times the height of that within the well or the casing of the valve.

The operation of the valve may be briefly described as follows: It may be assumed that there is not sufficient water in the valve casing to float the valve, but that the valve is supported in the closed position by the normal rigidity or strength of the diaphragm. Now, if we assume that steam enters the system and drives the air before it into the valve casing, the pressure of this air acted upon by the steam, will be sufficient to depress the diaphragm and open the valve, holding the latter open by virtue of the pressure of the air acting on the diaphragm, until the steam enters the valve. As soon as the steam enters, the pressure will be practically the same, and if it were not for the heat of the steam, the valve would remain open until the water of condensation was sufficient to float the valve regardless of the outward pressure of the diaphragm. The heat of the steam, however, acts upon the water to expand the latter, causing the same to rise within the reduced part of the well surrounding the upper part of the float, sufficiently to seat the valve. Again, if the system cools sufficiently to reduce the volume of water, the valve, acting as a float, may drop for this reason. When, however, there is sufficient condensation within the system to produce an inward vacuum pull upon the diaphragm, the valve will be closed to shut out the entrance of air to the system. The condensation which is constantly taking place in the system when supplied with steam, results in a partial vacuum which, acting on the diaphragm, serves to hold the valve tightly against its seat, thus preventing the entrance of air to the system when the temperature of the latter is too low to produce the necessary water expansion in the well for that purpose. In explanation of this it may be stated that water vaporizes at a low temperature in the presence of the partial vacuum due to condensation. Hence, steam may be maintained in the system when at a temperature far below the water boiling point of 212° Fahrenheit at sea level, assuming that the pressure within the system is considerably below that of the atmosphere, due to the vacuum condition resulting from steam condensation. It may, therefore, be stated that my improved valve is kept closed at proper times through the two agencies, one being the vacuum condition due to condensation, acting on the diaphragm; and the other to the heat of the system acting to expand the water and raise the float, when the pressure within the system is greater than that of the atmosphere.

As shown in the drawing a plate 24 is applied to the base 8 below the diaphragm 9. This plate conceals and protects the diaphragm and at the same time permits the diaphragm sufficient movement or vibration in the downward direction to perform the valve-opening function or to allow the float valve to move downwardly sufficiently to unseat the valve pin 13.

Having thus described my invention, what I claim is:

1. In an air valve for steam radiators, the combination of a casing having an inlet adapted to communicate with a radiator, said inlet being located intermediate the extremities of the casing, the latter being provided with a partition forming the upper portion of a water-containing well extending above the inlet and cut off from communication with the latter, except at the top, the casing having an outlet port at the top of restricted cross section, a float within the well, provided with a valve for controlling said port, a flexible diaphragm forming the bottom of the well, the diaphragm being provided with an upwardly projecting member forming a support for the float, substantially as described.

2. An air valve for steam radiators provided with an inlet opening, an outlet port, a float chamber having an inlet opening at the top, a valve float in said chamber, the said float carrying a valve to control the outlet port, and a flexible diaphragm located below and connected in operative relation with the said float, the said valve being adapted to be operated solely by the diaphragm, and the water in the said chamber.

3. In an air valve for steam radiators, the combination of a casing having an inlet opening and provided with a partition extending above the inlet and forming the upper portion of a water-containing well which is cut off from communication with the inlet, except at the top of the well, the water within the well being maintained at a level varying near the top of the well, a valve float supported by the water in the well, a valve controlled by the said float, the casing having an outlet port controlled by said valve, and a flexible diaphragm forming the bottom of the well, the diaphragm being connected in operative relation with the float, whereby, when under the influence of pressure below that of the atmosphere, it will act to close the valve by actuating the valve float.

4. In an air valve for steam radiators, the combination of a casing having an inlet intermediate its ends, said inlet adapted to communicate with the radiator, the casing having a restricted outlet at its top, and provided with a hollow member open at both ends, the lower end forming a water tight joint with the inside of the casing below the inlet, its upper part extending above the inlet, the said hollow member being spaced from the casing; a float carrying a valve adapted to close the air outlet, the float being located within a water-containing well formed by the hollow member and the casing, a flexible diaphragm forming the bottom of the well, and an operative connection between the diaphragm and the float, whereby, when the diaphragm is raised by the reduction of pressure within the chamber, the valve closes the air outlet port, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

FRANK C. GOFF.

Witnesses:
DENA NELSON,
ALODIA HUTCHISON.