G. D. HOFFMAN.

THERMO VALVE.

APPLICATION FILED SEPT. 2, 1916.

1,352,808. Patented Sept. 14, 1920.

Fig. 1

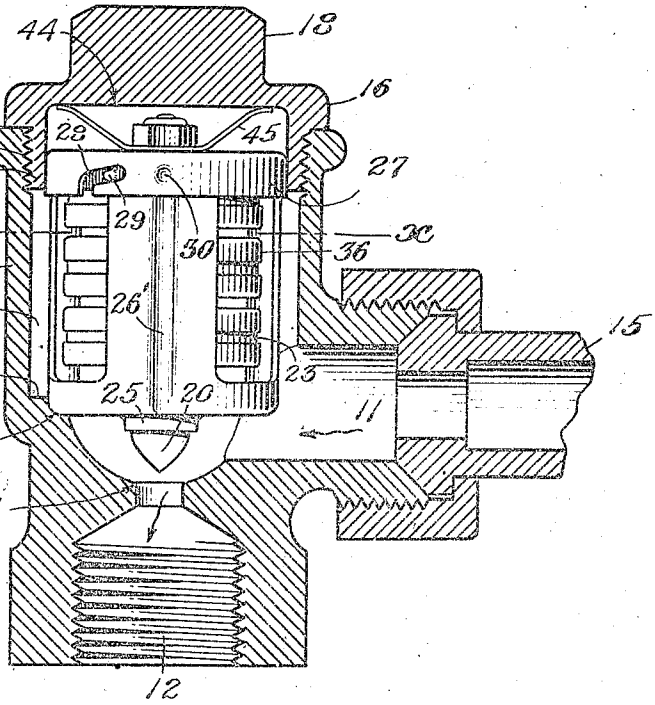


Fig. 2

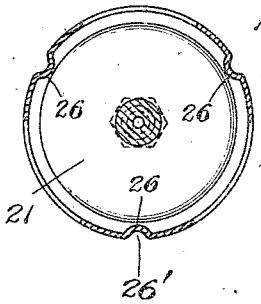


Fig. 3

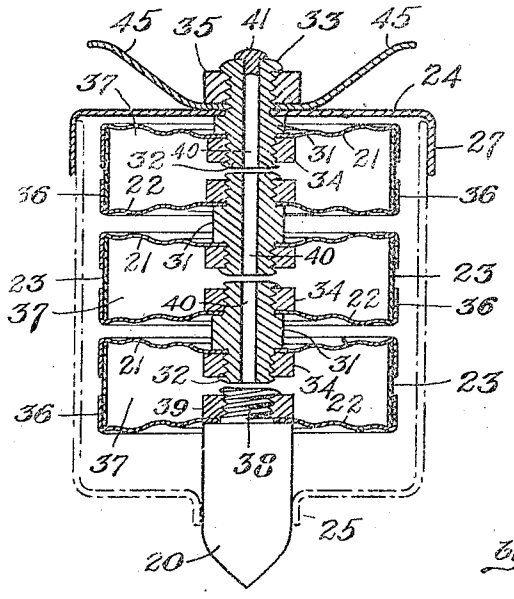
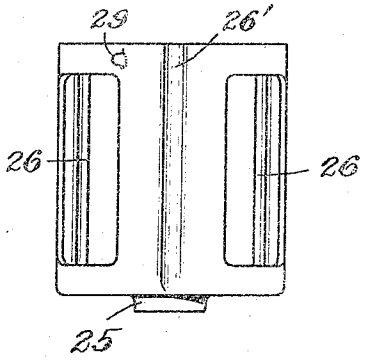


Fig. 4



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UNITED STATES PATENT OFFICE.

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THERMO-VALVE.

1,352,808. Specification of Letters Patent. Patented Sept. 14, 1920.

Continuation of application filed June 28, 1915, Serial No. 36,859. This application filed September 2, 1916. Serial No. 118,300.

To all whom it may concern:

Be it known that I, GEORGE D. HOFFMAN, a citizen of the United States, residing at Pasadena, in the county of Los Angeles and State of California, have invented a new and useful Improvement in Thermo-Valves, of which the following is a specification.

This invention relates to thermo-valves, that is, valves that are opened and closed automatically by the operation of a thermodynamic element.

The invention as shown by the accompanying drawings is embodied in a form that adapts it particularly for use in connection with the return pipes of steam-heated radiators, but it will be understood that the invention is capable of being embodied in other forms and of use for other purposes.

The particular embodiment of the invention is a carrying forward of and improvement on the device illustrated in my prior application filed June 28, 1915, Serial Number 36,859 entitled Steam trap for radiators. As to all matter common to this and the earlier application, the present is a continuation of said earlier application, and claims to the common subject matter are made in this application.

Referring to the drawings:

Figure 1 represents a sectional view of the casing of such valve, the thermodynamic unit thereof being shown in elevation in co-operative relation to the casing.

Fig. 2 represents a cross section through the thermodynamic unit, in a plane indicated by line x—x of Fig. 1.

Fig. 3 represents a vertical section, on a larger scale, through the thermodynamic unit, the bottom part of the holder therefor being represented by broken lines.

Fig. 4 represents an elevation of the barrel-shaped cage or holder for the thermodynamic unit.

The same reference characters indicate the same parts wherever they occur.

A casing of suitable form is indicated at 10. It is formed with a passageway the inlet portion of which is indicated at 11 and the outlet portion of which is indicated at 12. The inlet portion is in communication with a chamber 13, and communication between said chamber and the outlet portion 12 is through a valve seat 14. When the device is to be used for the specific purpose stated the inlet portion of the casing would be coupled to the return end of a steam-heated radiator by any suitable means, such as a union 15, and the outlet portion would be coupled to a return pipe (not shown).

For the purposes of illustration the device is shown with the axis of the casing extending vertically, and the device will be so described, although it will be understood that the position of the casing is immaterial and will be determined to suit the conditions that prevail. The upper end of the chamber 13 is open and a detachable screw-cap 16 constitutes a closure therefor. The cap and casing are provided with coöperative screw-threads 17, and the cap is provided with a polygonal head 18 adapted to coact with a wrench.

The chamber 13 is formed to receive a removable unit that includes the valve member 20, a thermodynamic element, and a holder for the latter. In the present instance the thermodynamic element is formed in three sections, but it will be understood that, so far as the fundamental principle is concerned, it may be limited to a single section or may have any desired number of sections. Each section of the thermodynamic element comprises two circular diaphragms 21 and 22, and a cylindric wall 23. The holder for the thermodynamic element comprises a substantially cylindric guide member shown separately by Fig. 4, and a cap 24. The guide member has numerous large openings that enable the steam to circulate through it and come in contact with the thermodynamic element. The lower end of the guide member is provided with a sleeve portion 25 that surrounds the valve member 20 to guide the movement of the latter. Ribs 26 (see Fig. 2) are formed upon the guide member by indenting portions of the same. Said ribs extend parallel to the direction of movement of the valve member, and their function is to keep the sections of the thermodynamic element centered and to guide their movement. The cap 24 of the guide member is provided with a flange 27 adjoining its rim, said flange being adapted to receive the upper end of the guide member. Any convenient means may be provided for keeping the cap and

guide member connected, but I prefer the well known bayonet joint. As shown by Fig. 1, the flange 27 is provided with an L-shaped slot 28, and the upper portion of the guide member is provided with a stud portion 29 arranged in said slot. There are two such couples arranged diametrically opposite each other, but the showing of one will suffice. The guide member is preferably made of thin sheet metal and pressed into the shape shown, the stud portion 29 being an integral portion struck up by a suitable tool. The guide ribs 26 are formed by indenting the guide member, and I utilize the groove 26′ that is the counterpart of one of the ribs 26, to receive an indented portion 30 of the flange 27, to prevent accidental relative rotation of the cap when it is applied as shown by Fig. 1. The indented portion 30 is arranged to register with the groove 26′ when the cap has been turned to place the stud portions 29 in the locking portions of the slots 28.

The thermodynamic element is permanently attached to the cap 24 by a nipple that extends through a hole in the center of the cap. This nipple comprises a relatively large middle portion 31 and end portions 32, 33, both of which are formed with external screw-threads to receive clamping nuts 34 and 35 respectively. End portion 32 extends through a center hole in the diaphragm 21 of the upper section of the thermodynamic element, and said diaphragm is tightly clamped against the middle portion 31 of the nipple by nut 34. Cap 24 is likewise clamped against the said middle portion 31 by nut 35. The ends of the portions 32 and 33 are preferably headed over to prevent the nuts from working loose.

The several sections of the thermodynamic element are connected in a series by coupling members that include screw-threaded studs to all intents and purposes like the one that connects the upper section with the cap 24. Thus the lower diaphragm of one section, and the upper diaphragm of the section next below, are clamped against the relatively large middle portion of the coupling stud by the nuts, and the latter are locked on by upsetting the ends of the coupling stud. The joints between the diaphragms and coupling studs are made tight by solder. Each diaphragm has an annular flange 36 turned up or down, as the case may be, from its rim, and said flanges surround and fit closely upon the cylindric members 23. Each group of members 21, 22 and 23 forms an annular chamber 37 intended to contain a volatile liquid that will be converted into vapor at some predetermined degree of temperature. In order to make the chambers 37 tight so as to prevent the escape of such liquid or vapor, the flanges 36 are soldered to the members 23. It will be observed that the marginal portions of the diaphragms bear against the ends of the connecting member 23. The latter therefore sustains the stress of expansion between the two diaphragms without subjecting the solder that connects the flanges 36 with the members 23 to such stress. The valve member 20 is provided with a reduced shank portion 38, and the latter is arranged in a center hole in the lowest diaphragm. This shank portion is provided with an external screw-thread to receive a clamping nut 39. The upper end of shank portion 38 is headed over to prevent the nut from working loose, and the joint between the valve member and diaphragm is made tight by solder.

In order to facilitate the introduction of volatile liquid into the several chambers 37 the several coupling nipples are formed with longitudinal passages 40 which provide communication between said chambers. It is thus possible to assemble and couple the desired number of sections prior to introducing the volatile liquid, and to fill all said sections with such liquid at one operation.

When the thermodynamic element is ready to receive the volatile liquid I proceed as follows. I immerse the thermodynamic element, or at least the nipple that extends through cap 24, in the volatile liquid, said nipple being then open to receive such liquid. I then distend the several diaphragms by pulling the valve member 20 in one direction and the nipple at the opposite end of the device in the opposite direction. This enlarges the several chambers 37, whereby liquid is sucked into said chambers. The several sections may be alternately distended and collapsed by moving the valve member and the nipple in question alternately toward and from each other, thus expelling air and drawing in liquid alternately. It will be observed that the diaphragms are dished. This is their normal condition. They are preferably corrugated, the corrugations thereof being annular to afford the maximum degree of flexibility. The diaphragms are made of extremely thin metal, much thinner than the proportion shown by Fig. 3. The fact that the aggregate area of the internal space is divided into a plurality of relatively small chambers 37 permits the use of extremely thin metal for the diaphragms, and the latter may therefore be more sensitve in responding to variations in pressure than they would be if the internal area were in the form of a single chamber having but two diaphragms.

The operation of filling the chambers 37 with volatile liquid may be performed in ordinary atmospheric temperature. When the chambers have been filled I seal the outer end of the inlet nipple by putting a drop of solder 41 therein. I then heat the device to the temperature at which the volatile liquid

turns to vapor, and in the course of such heating the diaphragms become distended in consequence of the internal pressure in the chambers. While the device is at the temperature at which the liquid turns to vapor I melt the plug 41 of solder, whereupon the vapor in the chambers 37 is expelled until the internal pressure drops to the pressure of the atmosphere. Then while the device is still at the temperature stated I again seal up the receiving end of the upper nipple by putting another drop of solder therein as indicated at 41, the diaphragms having resumed their normal dished or collapsed condition as shown by Fig. 3.

The device is now ready for use, and after assembling the thermodynamic element and the cylindric guide member in the relation shown by Fig. 3 with the bayonet joints of the guide member and cap in coöperative relation as shown by Fig. 1, the assemblage may be placed in the casing 10. The latter is provided with a seat at 42 for the lower end of the holder, said seat determining the normal position of the valve member with relation to the valve seat 14. The screw-cap 16 has an annular flange 46 that surrounds and engages the flange 27 of the holder to center the upper end of the latter. The lower end of the holder is centered by the shoulder 43 that adjoins seat 42, and the valve member 20 is centered by the sleeve 25 of the holder. In order to keep the holder firmly on its seat 42 and at the same time to avoid the necessity of extreme accuracy in the proportions of the screw-cap 16, I interpose a yielding element between the surface 44 of the latter and the confronting surface of the cap 24. The preferred form of such yielding element is a leaf spring which in the present instance has two arms 45. In order to avoid the inconvenience of having to handle the spring separately, and the liability of losing the same, I prefer to attach it permanently to the removable unit, and accordingly I have shown it as being clamped between the cap 24 and the clamping nut 35 that bears against the latter. The middle portion of the spring is formed with a hole, and the upper end of the upper coupling nipple extends through such hole. Thus when the removable unit is placed in the casing 10 as shown by Fig. 1, and the screw-cap 16 is screwed down, the surface 44 of said cap bears against the free ends of the spring arms 45 and the latter are slightly flexed downwardly by the cap before the latter reaches the limit of its downward movement. In case the thermal element should continue to expand after the valve has become seated, as frequently happens, this spring will yield and permit the entire holder and thermal element to move away from the bottom of the casing, whereby the valve and seat are relieved of excessive pressure and straining of other parts of the unit is avoided.

When the device is attached to the return pipe of a steam-heated radiator, it operates as follows. In its normal condition the thermodynamic element is collapsed as shown by Fig. 3, and the valve member 20 is held away from its seat. When steam is admitted to the radiator (not shown) the water of condensation that has presumably accumulated in the radiator is blown through coupling 15 into the casing 10 and passes out through the outlet 12. Any air that may be in the radiator is likewise blown out. When the steam, after having passed through the radiator, reaches the casing 10, it comes in contact with the diaphragms and other members of the thermodynamic element, the openings in the holder affording free circulation of the steam therethrough for the purpose stated. As the temperature of the thermodynamic element rises, the volatile liquid therein expands, at first slightly, but when it exceeds the temperature at which it turns to vapor, the expanding action becomes relatively rapid. Valve member 20 is thus moved toward its seat by the cumulative distending action of all the diaphragms. Each section of the thermodynamic element is movable bodily, excepting that the middle portion of the top diaphragm 21 remains substantially stationary. The middle portion 31 of the top coupling nipple serves as the primary abutment against which the series of diaphragms act, although as between the sections of the unit the intermediate couplings afford the abutments against which the intermediate diaphragms act to increase the distance between the sections.

The valve member 20 is forced against its seat with considerable pressure, and if it should stick to the seat when the temperature of the device calls for an open passageway through the casing it will be pulled from its seat by the contractile action of the collapsible sections. Inasmuch as the valve reaches its seat before the expanding action of the vapor has spent itself, the cylindric members 23 of the collapsible sections are called upon to sustain considerable stress. It is for this reason that the ends of the members 23 are arranged in contact with the marginal portions of the diaphragms, for if there were no contact at such points the relatively great stress would have to be sustained entirely by the solder used to connect the flanges 36 with the members 23, and under such condition the solder joints would be likely to be broken and permit the expansible agent to leak out.

The volatile liquid that is to be used in the device will be chosen according to the temperature at which it is desired to have the valve close. When the device is used in con-

nection with a steam-heated radiator operating on the low pressure, or vacuum, system, it is desirable to use a liquid that vaporizes at approximately 190° F., and to meet such conditions a mixture of water and alcohol of approximately the following proportions, namely, three parts water and one part alcohol, is satisfactory.

By reason of the characteristics hereinbefore described the thermo valve is highly efficient in operation and exceedingly sensitive, and I find that it will operate upon a difference of temperature of no more than one or two degrees; that is, after the temperature has risen in the trap to the point which causes closing of the valve, a drop of temperature of the water of one degree is usually enough to cause the valve to open. The practical result is that when applied to heating systems operating under substantially constant temperature and pressure, the valve will reach a position of equilibrium wherein it is opened just enough to permit escape of the water as fast as it collects in the passage in the casing. But apart from the scientific accuracy and efficiency of the device, a feature which, from the practical point of view is of the utmost importance, is that the entire unit, consisting of the expansible thermal elements, valve, and holder or guide member can be furnished to users separately and any one of these units is interchangeable with any other. Thus in case a unit in use should wear out and fail, or become accidentally damaged, the owner of the establishment in which it is installed need only purchase a new unit and substitute it for the old one with no more effort than is required to remove the cap 16 and replace the cap after having substituted the new unit. The services of a skilled workman for this purpose are not needed. The fact that the thermal unit is not mechanically connected with any part of the casing is further of advantage in that it permits newly installed heating systems to be tested for leaks by application of high pressure steam or water, and permits the entire system to be flushed out to remove chips and other foreign matter. This advantage arises from the fact that the thermal valve units may be removed and the caps 16 applied to all of the valve or trap casings in the system, wherefore the absence of the valve unit leaves all outlets wide open to permit steam or water at any temperature and pressure to pass freely through them.

I claim:

1. A device of the character described comprising a casing having a chamber and a valve-seat therein, a removable unit arranged in said chamber and comprising a thermodynamic element, a holder therefor, and a valve member coupled to said element, said holder having a portion arranged to guide said valve member, said chamber having an opening for the removal of said unit, a closure for said opening, and means arranged to fix the position of said holder relatively to said valve-seat.

2. A device of the character described comprising a casing having a chamber and a valve-seat therein, a removable unit arranged in said chamber and comprising a thermodynamic element, a holder therefor, and a valve member coupled to said element, said valve member and a portion of said element being movable relatively to said holder, said holder having guiding portions arranged to engage said valve member and said element respectively to guide such relative movement, said chamber having an opening for the removal of said unit, a closure for said opening, and means arranged to fix the position of said holder relatively to said valve-seat.

3. A device of the character described comprising a casing having a chamber and a valve-seat therein, a removable unit arranged in said chamber and comprising a thermodynamic element, a two-piece holder therefor including a barrel and a cap, and a valve member coupled to said element, said element being fastened to said cap, said barrel having a guiding portion arranged to guide said valve member, said chamber having an opening for the removal of said unit, a closure for said opening, and means arranged to fix the position of said holder relatively to said valve-seat.

4. A device of the character described comprising a casing having a chamber and a valve-seat therein, a removable unit arranged in said chamber, said unit comprising a plurality of thermodynamic sections coupled in series, a holder for said sections, and a valve member coupled to one of said sections at one end of said series, the one of said sections at the other end of said series being coupled to said holder, said holder having guiding portions arranged to guide said valve member and said sections, respectively, said chamber having an opening for the removal of said unit, a closure for said opening, and means arranged to fix the position of said holder relatively to said valve-seat.

5. A device of the character described comprising a casing having a chamber and a valve-seat therein, a removable unit arranged in said chamber, said unit comprising a plurality of thermodynamic sections coupled in series, a holder for said sections, and a valve member coupled to one of said sections at one end of said series, the one of said sections at the other end of said series being coupled to said holder, said holder having a plurality of ribs arranged to engage and guide said sections, said cham-

ber having an opening for the removal of said unit, a closure for said opening, and means arranged to fix the position of said holder relatively to said valve-seat.

6. A device of the character described comprising a casing having a chamber and a valve-seat therein, a removable unit arranged in said chamber and comprising a plurality of thermodynamic sections, a holder therefor and a valve member, said chamber having an opening for the removal of said unit, a closure for said opening, and means arranged to fix the position of said holder relatively to said valve-seat, said thermodynamic sections being arranged in a series and each of them having two confronting diaphragms, rigid coupling devices connecting said sections one with another, each of said coupling devices being arranged to connect the contiguous diaphragms of two contiguous sections, said valve member being carried by the diaphragm at one end of said series, said holder having guiding portions arranged to engage said valve member and said sections respectively, to guide them relatively to said valve seat.

7. A device of the character described comprising a casing having a chamber and a valve-seat therein, a removable unit arranged in said chamber, said chamber having an opening for the removal of said unit, a closure for said opening, said casing and closure having coöperative connecting screw-threads, said removable unit comprising a thermodynamic element, a holder therefor, and a valve member, a portion of said casing being formed and arranged to center one end of said holder relatively to said valve-seat, a portion of said holder being formed and arranged to center said valve member and to guide the movement thereof, and said closure having an internal surface formed and arranged to center the other end of said holder.

8. A thermodynamic unit comprising a plurality of thermodynamic sections arranged in a series, means connecting said sections one with another to accumulate the movement of all of them, a valve member carried by one of said sections at one end of said series, and a holder comprising a barrel and a cap therefor, said sections being arranged in said barrel, a portion of said barrel being formed and arranged to guide said valve member.

9. A thermodynamic unit comprising a plurality of thermodynamic sections arranged in a series, means connecting said sections one with another to accumulate the movement of all of them, a valve member carried by one of said sections at one end of said series, a holder comprising a barrel and a cap therefor, said sections being arranged in said barrel, a portion of said barrel being formed and arranged to guide said valve member, and a spring fastened to the outside of said cap, said barrel and cap having coöperative portions for holding them connected.

10. A thermo valve comprising a casing having a valve seat, an annular shoulder surrounding the axis of said valve seat, and a removable cap or end closure in combination with a unit consisting of a holder adapted to enter said casing and rest on said shoulder, a valve in said holder so arranged as to coact with said valve seat when the holder is thus placed, and a series of thermal chambers expansible by heat arranged to press said valve toward said seat and to react against the holder and transmit pressure through one another.

11. A thermo valve comprising a casing having a valve seat, an annular shoulder surrounding the axis of said valve seat, a removable cap or end closure in combination with a unit consisting of an outer holder adapted to enter said casing and rest on said shoulder, a valve in said holder so arranged as to coact with said valve seat when the holder is thus placed, and a series of thermal chambers expansible by heat arranged to press said valve toward said seat and to react against the holder and transmit pressure through one another, and a spring between the casing cap and said holder pressing the latter and the valve toward the valve seat, and being adapted to yield when said thermal elements continue to expand after seating of the valve.

12. A thermodynamic valve comprising a casing having inlet and outlet passages and a valve seat surrounding one of said passages, a detachable cap or cover closing the casing at one end opposite to said valve seat, a valve coöperating with said seat, an expansible thermodynamic element arranged to act upon said valve, a holder for said thermodynamic element, a seat in the casing coöperating with said holder to position the thermodynamic element and valve relatively to the valve seat, and a spring acting against said holder and thermodynamic element, and reacting against said cap, being adapted to yield when action of the thermodynamic element continues after seating of the valve in the same manner as the action occurring prior to such seating.

13. A thermo valve comprising a casing having inlet and outlet passages and a valve seat surrounding one of said passages, a detachable cap or cover closing the casing at one end opposite to the said valve seat, a valve coöperating with said seat, an expansible thermodynamic drum, and a holder having a guide portion for said valve arranged to embrace and guide said thermodynamic element and constructed to bear the reaction of said element when the latter presses against the valve, said holder, ther-

modynamic drum, and valve being made as a unit structure arranged to react against said cover when in the casing, but being mechanically separate therefrom and removable as a unit from the casing when the cover is removed.

14. A thermostatic valve unit for steam traps comprising a holder having opposite end portions and longitudinal connecting side walls, one of the end portions having an opening, a valve extending through said opening and being movable endwise therein, and an expansible thermodynamic element contained in said holder and containing a fluid adapted to be expanded and contracted by rise and fall of temperature, respectively, said element being confined between the valve and the opposite end portion of the holder and coöperating with the valve.

15. A thermostatic valve unit for steam traps comprising a sheet metal holder of skeleton form having spaced apart side walls and provided with a guide sleeve at one end and an attached cap at the other end, a valve extending through and guided by said sleeve, and an expansible and contractible thermodynamic element confined between said valve and said cap and coöperating with the valve, said side walls having longitudinal stiffening grooves formed in them.

In testimony whereof I have affixed my signature.

GEORGE D. HOFFMAN.