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E. S. CORNELL, JR

2,220,078

CLOSED THERMAL SYSTEM

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2 Sheets-Sheet 2

Fig. 2.

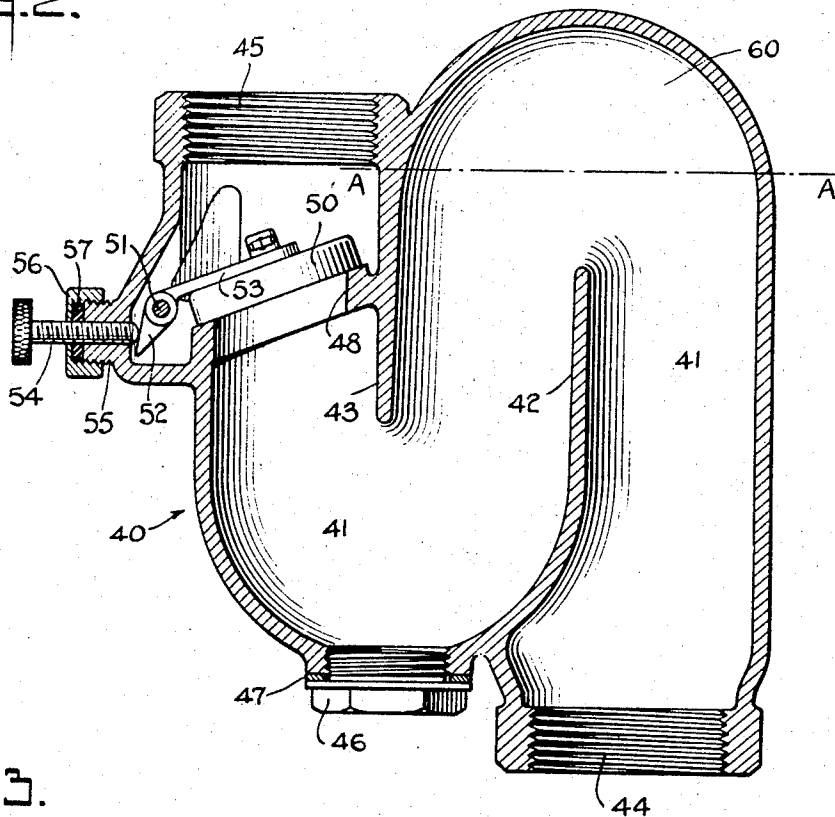
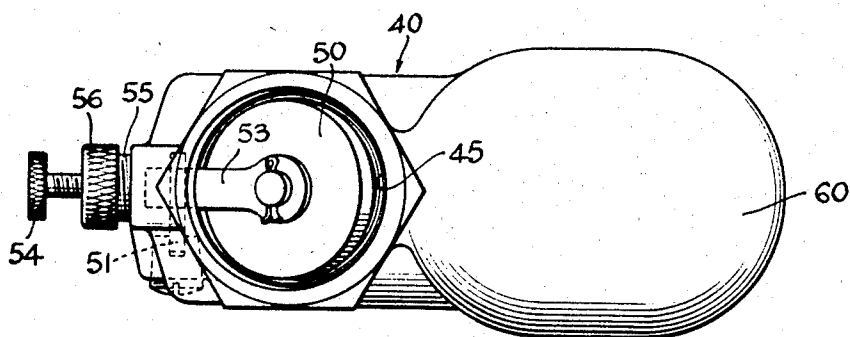


Fig. 3.



## UNITED STATES PATENT OFFICE

2,220,078

## CLOSED THERMAL SYSTEM

Edward S. Cornell, Jr., Larchmont, N. Y.

Application October 28, 1937, Serial No. 171,539  
Renewed February 7, 1940

6 Claims. (Cl. 237—63)

This invention relates to improvements in heating systems.

More particularly, this invention relates to improvements in heating systems embodying the circulation of a suitably treated thermal medium, such as heated water, through a closed piping system including one or more heat exchange units. The system may be of the "pressure" type, in which the pressure of expansion of the thermal medium, on heating, is permitted to increase to a previously established degree, whereupon means are provided to relieve the system, as by discharge of thermal medium therefrom, to prevent the creation of dangerous pressures. The heating system may be adapted to include an auxiliary system, such as a system supplying hot water for domestic use.

It is a feature of this invention that the circulation system is provided with surge- and shock-absorbent means comprising a cushioning chamber of air or other gas, said means forming a unit of the piping system. The free surface of such gas cushion is at all times in direct contact with the circulating thermal fluid in the closing piping circuit, and the area of such surface, during the range of operation of the system is preferably equivalent to or greater than the area of the main feed pipe of the piping system.

The invention further provides for the restriction, inclusive of absolute preclusion, of circulation of thermal fluid through the heat exchangers forming the main system, said means including a valve structure normally arranged to permit water circulation through the system only in the circumstance of a suitable velocity head within the system.

Advantageously, such velocity head may be generated by positive pumping means, such for example as the Water circulator set forth and claimed in my presently co-pending application Serial No. 157,272, filed August 4, 1937. Such circulator may be controlled by a temperature-sensitive means, such as a conventional room thermostat, to the end that enforced circulation of the thermal medium through the main thermal system may be effected only when the air temperature within the room or other enclosure housing the thermostat is within a predetermined operative range.

A feature of operation of the invention is that whenever the circulator is in non-operative status and there is no circulation of the thermal fluid through the main thermal system, the shock absorbent means functions in full cooperation with the circulation of the thermal medium through the auxiliary heat exchange system, which remains in full operative status.

In this invention, the stated flow control valve means and cushion means may be embodied in a preferably unitary structure. The gas entrap-

ment chamber is preferably disposed anteriorly of the flow valve, and arranged to provide a cushioning volume of air at a point communicating with the main flow line of the closed piping system, said air cushion preferably having a free surface equal to or greater than the area of the main feed pipe serving the piping system. It is a feature of the invention that surges of water within the system, and sound-wave vibrations generated within and carried by the water stream of the system are thus directly intercepted by a cushioning surface of great effective area, disposed directly in the path of water flow.

It has been found that an air cushion having a relatively small volume but large free surface functions efficiently to absorb surges or shocks within the system, and it is thus a characteristic of the invention that only a part of the air, steam, vapor or other gas normally liberated from the water during and incident to the initial filling of the system or subsequent additions of water thereto, and during the stage of heating the water within the system is retained for cushioning purposes. The air chamber comprising the cushioning means may therefore be of comparatively small volumetric content, the stated volume bearing a predetermined relationship to the size of the main in which it is installed. In initiating the operation of the system, therefore, steps are taken to drive a greater portion of the normally occluded air or other gas into the radiators or other heat exchange units of the main thermal system, whence it may be removed by manipulation of the usual air-vent cocks. Advantageously an auxiliary air-receiver may be connected, as by piping, to the air-cushion chamber, the total volumetric content of the chamber, the auxiliary receiver and the piping connected therewith, being such that the free surface of the entrapped air or gas is directly exposed to the fluid in to system, and of the proper area. The use of such auxiliary receiver enables the establishment of minimum dimensions for the cushioning unit, and also makes the system readily adaptable to abnormal operating conditions.

The air entrapment chamber may be provided with air release means and a gage glass, so that the volumetric content of the air cushion may be definitely established.

It is well known that in a closed piping system, an increase in the temperature of the fluid therein effects a corresponding pressure increase within the system. Initially, the stated pressure increase is compensated for by a contraction of volume of the air cushion. Such pressure increase and air cushion contraction may be permitted to continue until a predetermined pressure has been attained, whereupon suitable mechanical pressure relief means, such as the combined pres-

sure relief and discharge valve set forth and claimed in my presently co-pending application, Serial No. 171,540, dated October 28th, 1937, may function to control the pressure by suitable discharge of the thermal fluid.

Advantageously, a pressure reducing valve may be interposed between the external source of thermal medium, such as the customary water supply, and the boiler. Such pressure reducing valve thereby serves as an automatic boiler feed, in that when the pressure within the system drops to a point below the setting of the pressure reducing valve, such pressure reduction usually being occasioned by an excessive pressure-relief valve discharge from the boiler and subsequent reduction in temperature, water will be admitted from the water supply to the boiler until the pressure within the system equals the set point of the pressure reducing valve.

Other features and advantages hereinafter appear.

In the accompanying drawings:

Fig. 1 illustrates a closed thermal heating system, installed pursuant to the principles of the invention;

Fig. 2 is a vertical sectional view of one embodiment of the combined flow-control valve and air cushion means employed in the heating system of Fig. 1; and

Fig. 3 is a plan view of the structure of Fig. 2.

Referring to Figure 1, the heating system includes a central heating source, such as the heating boiler 10, which heats water or other suitable thermal fluid for circulation through one or more supply mains 12 and return mains 14, in a closed piping system. As required along the run of the supply main or mains, one or more risers 16 are suitably connected, respectively leading to the one or more heat exchange units 17. Return lines 20, connect the respective heat exchangers with the return main 14. The heat exchange units 17, as illustrated, may be of the type disclosed in my United States Patent No. 2,038,347, dated April 21, 1936, and entitled Air conditioned heating and cooling system, in which compressed air, preferably preconditioned, serves to actuate fan means, or equivalent, for effecting the circulation of the air of the room or other space served by the respective exchange units and to add increments of conditioned air, inclusive of increments of fresh air, and to thermally treat the air of such room or other space. It is apparent that conventional heat exchange units, such as the common heating "radiators" may be employed in connection with the invention, and that the representation in Fig. 1 of two heat exchange units 17, 17, typifies any suitable thermal system employing any desired number of heat exchange units.

To effect a positive circulation of the thermal fluid through the system, there is preferably employed a circulator 23, advantageously located in a return line 14. Such circulator may be any conventional fluid-circulating pump; preferably, however, it is the improved circulator set forth and claimed in my co-pending application previously referred to.

A thermostat 24, of conventional design, may be installed in any selected room or other space served by a heating unit 17, the make and break switch mechanism of said thermostat controlling the electric circuit 25 of the circulator 23 and thus operating as a thermally responsive switch to start and stop the circulator motor in accordance with room temperature condition.

Water may be initially supplied to the boiler

10 through the supply pipe 26, in which may be located a manually operable shut-off valve 28, a pressure reducing valve 30 and a pressure relief valve 32, these units preferably being assembled in the order named and as illustrated. The water feed 26a to the boiler 10 may enter the boiler through a suitable T in return main 14, as shown.

As is well understood, an increase in pressure of a closed thermal-fluid circulating system results from increasing temperatures therein. To prevent the creation of excess pressures within the system, it is common practice to employ a pressure relief valve, as is indicated at 32, to discharge fluid through a suitably piped discharge line 33, such relief valve being set to discharge at a predetermined pressure.

It will be obvious that after a discharge of thermal medium through the discharge line 33, occasioned by the pressure-relief operation of valve 32, the water pressure and volume in the system may, on reduction in temperature, be substandard. In such a circumstance, and also in the circumstance of leakage or other removal of water from the boiler, the pressure reducing valve 30 will permit an inflow of water into the boiler until the pressure in the heating system is equal to the pressure setting of the valve 30, such pressure being the normal for a particular temperature condition. It will be understood, therefore, that the pressure reducing valve serves as a means for automatically maintaining a predetermined pressure and volume condition within the thermal system. If means other than the valve 30 are provided to maintain a desired pressure at the source of water supply, the stated valve 30 may be dispensed with. However, as is common experience, the pressure of water in the supply main is generally in excess of the safe pressure to which the conventional heating boiler may be exposed, and thus a pressure reducing valve is advantageously employed.

Supplementing the previously described thermal system or circuit, which will hereinafter be designated the "main" thermal system, this invention contemplates an auxiliary thermal system, for the purpose, for example, of heating water for domestic or other use through the agency of the same heating boiler 10.

The stated auxiliary system may include a heat exchanger 34, of conventional structure, in which water from the boiler, at elevated temperature, is arranged to circulate over a coil or other suitable arrangement of piping within the heater 34, the inlet and outlet of which coil may be connected, as by piping 36 to a storage tank 38. A pipe 37 represents a supply line to the fixtures which are to utilize the hot water. The customary water supply line is not shown.

Independent and familiar means, not shown, may be employed to control the rate of combustion within the boiler 10, and thus maintain the temperature of water therein within desired predetermined range.

In general, the heating system previously described is of a type familiar to those skilled in the art. The present invention, however, embodies means serving efficiently to absorb or dampen sound wave vibrations and/or other wave formations normally transmitted by the water-filled system to all parts of the residence or other structure served by the heating system. Additionally, means are provided whereby thermosyphonic circulation of water through the system may be positively precluded or controlled. Pref-

erably, these elements may be combined in a suitable unitary structure of the type set out in specific detail in my presently copending application Serial No. 171,540, filed October 28th, 1937

entitled Air cushion fitting for thermal systems.

Such absorbent cushion serves with equal facility during a status of operation of the system in which only the auxiliary system is in use, such circumstance contemplating a condition when it is neither desirable nor necessary that heated water be circulated to the radiators 17 serving the room or other enclosures.

The structure 40 embodying the cushioning means and therewith combined flow valve may comprise a cast or otherwise fabricated fitting having a generally S-shaped passage 41 there-through, the configuration of the passage being achieved by the oppositely disposed, spaced-apart baffles 42 and 43, the termini of such baffles having an appreciable overlap. Advantageously, the structure 40 may be cast from brass or grey iron, and may be provided with suitable screw threaded inlet and outlet connections 44, 45, respectively. Obviously, suitably flanged connections may be provided. A screw plug 46 and therewith associated gasket 47, may serve as a clean-out or drain. A preferably upwardly-inclined valve seat 48 may be provided in the outflow passage of the structure, and a weighted valve disc 50 may be pivotally secured on a pin 51, the weight of the disc urging it to rest on the stated valve seat; thus the valve is in normally closed position. An ear 52, preferably integral with the tongue 53 to which the valve disc 50 is secured for the stated pivotal mounting, may be adapted to cooperate with an adjustment screw 54 to permit regulation of the degree of closing of the valve disc 50, in any position from full closed, as indicated in Fig. 2, to full open. Screw 54 may pass through a suitable tapped lug 55; a compression nut 56 and suitable packing 57 serve to insure the water tightness of the adjustment means.

As indicated in Fig. 2, the configuration of the fitting 40 forms a dome-like chamber 60 above the fluid-passage 41, such chamber serving to entrap a volume of occluded air or gas, or steam or vapor driven off from the water in the heating system. The entrapped air in chamber 60 serves very effectively to cushion the system against the transmission of shocks or vibrations because, as indicated by the line A-A in Fig. 2, representing the normal level of the surface of the entrapped gas within the chamber 60 under usual operation conditions, the area of free surface of the gas is ordinarily greater than the greatest area of the heating main 12. The area of the main 12 is at a maximum at the point of its connection with the boiler 10, and the structure 40 is installed in the system at the boiler, as is indicated in Fig. 1. It will thus be seen that an air cushion of particularly great free surface is interposed directly in the path of water flow in the system.

The air cushion need not be of large volume, in order to function efficiently. It is, however, desirable that the free surface of the air cushion be of large area, and that the stated free surface be in contact with the circulating water in the system.

It will thus be seen, that in the circumstance of full closed position of the valve 50, and consequent preclusion of water circulation through the main thermal system, the air cushion 60 functions in its normal manner to absorb shocks or vibrations arising within the boiler 10 during the operation of the auxiliary heating system, and

thus minimizes the transmittal of such vibration to other parts of the system. Such vibrations may be generated through the operation of the relief valve 32, the pressure reducing valve 30 or any of the other accessories to the heating system.

In initiating the operation of the system, air or other gas occluded in the water or other thermal fluid is driven through the passage 41 of structure 40 and into the radiators 17 or associated piping connections, from which such gas may be released by the customary vent valves 17a. The air may traverse the passage 41 by the action of the positive water circulation generated by the circulator 23, the velocity of water flow through the system serving to carry entrapped air past the barriers 42 and 43 of the structure 40 and into the mains 12. Such movement of air or other gas into the units 17 and associated piping continues until the position of the free surface of air within structure 40 provides for a liquid passage between the stated air surface and the top of barrier 42 adequate to permit the free flow of fluid through the structure 40 without further entrainment of air or gas. No further removal of air from the chamber 60 will occur.

When the fluid pressure in the system rises due to the increase in temperature of the water, a corresponding reduction in the volume of air within the chamber 60, and a corresponding reduction in the area of free surface of the air occurs, due to the dome configuration of the air chamber 60. Such contraction will continue until the pressure throughout the entire system, including the pressure of gas within the chamber 60 attains the setting point of the relief valve 32, whereupon on increasing temperature, the valve 32 will function to discharge a definite volume of the thermal fluid through vent pipe 33, thus preventing the creation of excess pressure conditions within the system. The volume and configuration of air chamber 60 are preferably such that under conditions of maximum pressure within the system permitted by relief valve 32, the area of free surface of the entrapped gas is equal to or greater than the maximum diameter of main 12.

It will thus be seen, therefore, that in this invention, an adequate sound and shock absorbing cushion is maintained at all times, the free surface of the air cushion being equal to or greater than the area of the heating main.

On reduction of water temperature, and consequent reduction of pressure of fluid within the system, an expansion of the air cushion will take place. On the reduction of pressure to below the point of setting of pressure reducing valve 30, the stated valve will function to admit water through the supply piping 26 to make up the deficiency in the system. Accordingly, therefore, the entire heating system is maintained in a state of pressure balance.

In the operation of the main heating system, the thermostat 25 functions to close the electrical circuit to the circulator 24 if the temperature condition surrounding the thermostat is subnormal. The circulator 24 will immediately function, and the resulting velocity head of water within the main 12 will exert sufficient pressure against valve 50 to cause it to open, thereby permitting the circulation of heated fluid through the heat exchange units 17. Upon the attainment of the desired temperature of air in the enclosure in which the thermostat is located, the thermostat will function to break the electrical circuit, thus stopping the operation of the circulator 24.

The immediate reduction in the velocity head of water, will permit the valve 50 to close, precluding thermo-syphonic circulation of heated water to the heat exchange units 17. The heating system is, accordingly, quickly responsive to thermostatic control, and quiet and smooth in operation.

Should it be desirable that thermo-syphonic circulation in some degree be permitted throughout the system, to the end that a sufficient flow of heated water may reach heat exchange units having exposed locations and thus prevent the possibility of freezing of water within such heat exchangers, a manipulation of the adjustment screw 54 readily provides for holding valve 50 open in any desired degree.

It will be observed that the auxiliary heating system is independent from the main heating system only in that the auxiliary system may function without the transmission of the heated water through the main heating system to the heat exchangers 17. The function of the air cushion means, however, continues in full force and effect under all service conditions.

The circulation pump 23 may be dispensed with, in which circumstance the valve 50 may be retained in full open position through the agency of the adjustment screw 60. Thermo-syphonic circulation through the system may be precluded by permitting the valve 50 to assume its normal closed position, or may be regulated in any degree by a suitable degree of closure of the stated valve means.

Whereas I have described my invention by reference to specific forms thereof it will be understood that many changes and modifications may be made without departing from the spirit of the invention.

I claim:

1. In a heating system employing the circulation of heated water through a closed piping system incorporating one or more heat exchange units, the combination of a heating boiler, and valve means for regulating or precluding thermo-syphonic circulation of water through the system, said valve means including gas-entrapping means communicating directly with said closed piping system and interposing a resilient gas-cushion directly in the path of flow of water through the system, the stated gas-cushion having its free surface disposed in and serving to define a portion of the path of water circulation.

2. In a heating system employing the circulation of heated water through a closed piping system incorporating one or more heat exchange units, the combination of a heating boiler, and valve means for regulating or precluding thermo-syphonic circulation of water through the system, said valve means including gas-entrapping means communicating directly with said closed piping system and interposing a resilient gas-cushion directly in the path of flow of water through the system, the stated gas-cushion having its free surface disposed in and serving to define a portion of the path of water circulation, said free surface being at least equal to the area of the maximum pipe of the piping system.

3. In a heating system employing the circulation of heated water through a closed piping system incorporating one or more heat exchange units, the combination of a heating boiler with combined flow-valve and air-cushion means, said

last-mentioned means comprising a unitary structure embodying a normally closed, weighted valve and an air entrapping chamber disposed anteriorly thereof, said chamber being directly disposed in and serving to define a portion of the path of water flow through said system and thereby serving to absorb shocks or water borne wave-formations.

4. In a heating system employing the circulation heated water through a closed piping system incorporating one or more heat exchange units, the combination of a heating boiler with combined flow-valve and air-cushion means, said last-mentioned means comprising a unitary structure embodying a normally closed, weighted valve and an air entrapping chamber disposed anteriorly thereof, said chamber being directly disposed in and serving to define a portion of the path of water flow through said system and thereby serving to absorb shocks or water-borne wave-formations, said cushion having its free surface above and in direct contact with the water circulating through said closed piping system.

5. In a heating system employing the circulation of heated water through a closed piping system incorporating one or more heat exchange units, the combination of a heating boiler with gas-entrapping means communicating directly with said closed piping system and interposing a resilient gas-cushion directly in the path of flow of water through the system, the heated gas-entrapping cushion having its free surface disposed in and serving to define a portion of the path of water circulation, said free surface being at least equal to the area of the maximum pipe of the piping system; said pressure-relief means cooperating with said air cushioning means to provide an upper limit of pressure within said air cushioning means, whereby the area of free surface of said air cushion may be maintained at all times within predetermined limits.

6. In a heating system employing the circulation of substantially incompressible, heated fluid, the combination with means for heating said fluid, a closed piping system for effecting circulation of the fluid through the heating system, said piping system including one or more heat-exchange devices, means for mechanically circulating such fluid through the system, temperature-sensitive means for controlling the operation of such circulating means, and valve means disposed in the piping system closely proximate the connection of the piping with the heating means and anterior to the connection of the said one or more heat-exchange devices, said valve means being arranged to be moved to open position during the stage of operation of said circulating means, of means having a hollow interior for entrapping gas to cushion surges of the heated fluid, said air-entrapping hollow interior communicating directly with the interior of the piping and providing for contact of the free surface of the entrapped air with the fluid and serving to define a portion of the path of flow of the fluid in the piping system, said free surface being disposed between said valve means and said heating means, the area of said surface being at least equal to the maximum pipe area of the piping system during the normal stage of operation of the heating system.

EDWARD S. CORNELL, JR.