Dec. 17, 1940. A. D. ROSE ET AL 2,224,929

AIR VENTING APPARATUS

Filed March 16, 1938 3 Sheets-Sheet 1

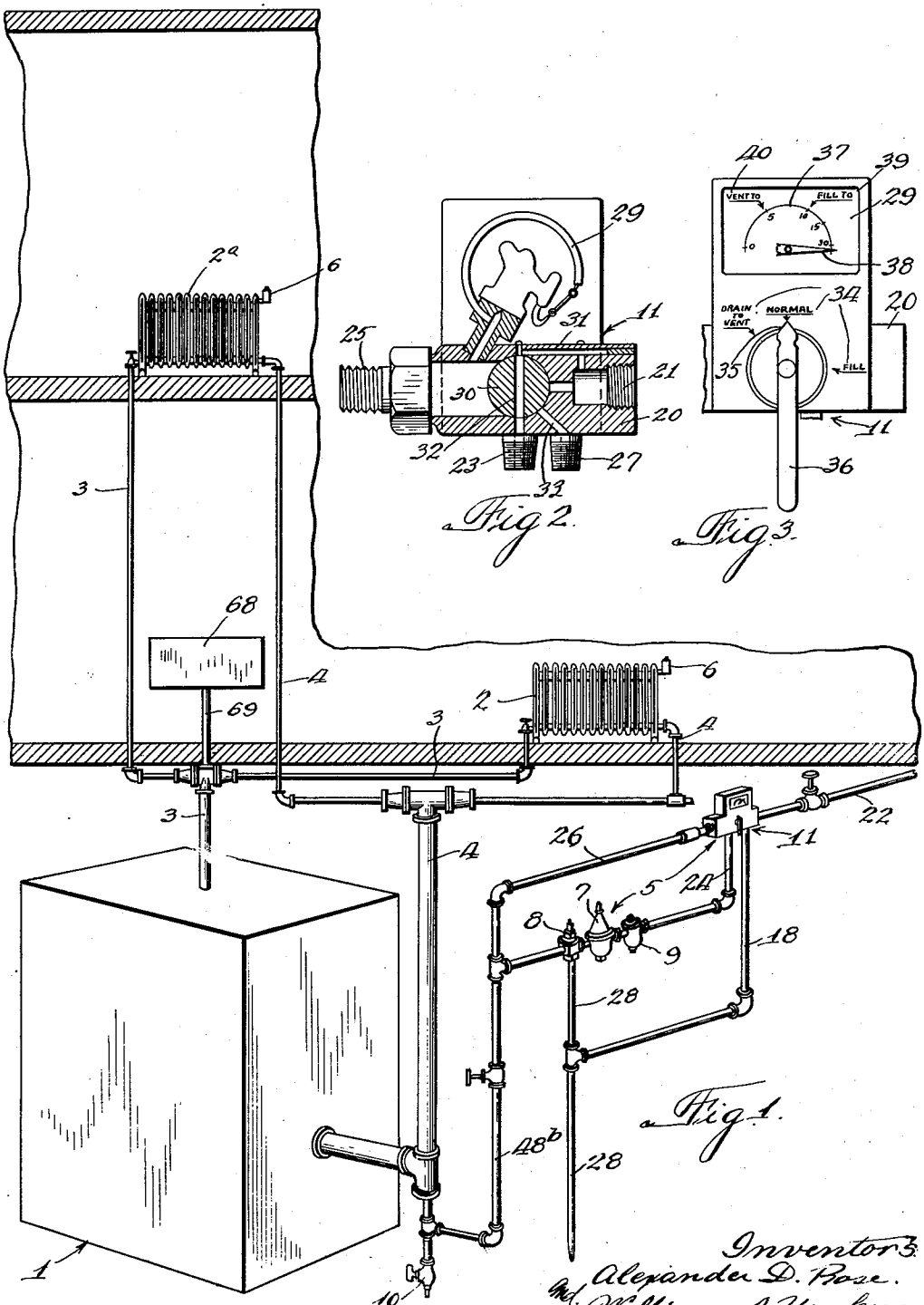


Fig 1.

Fig 2.

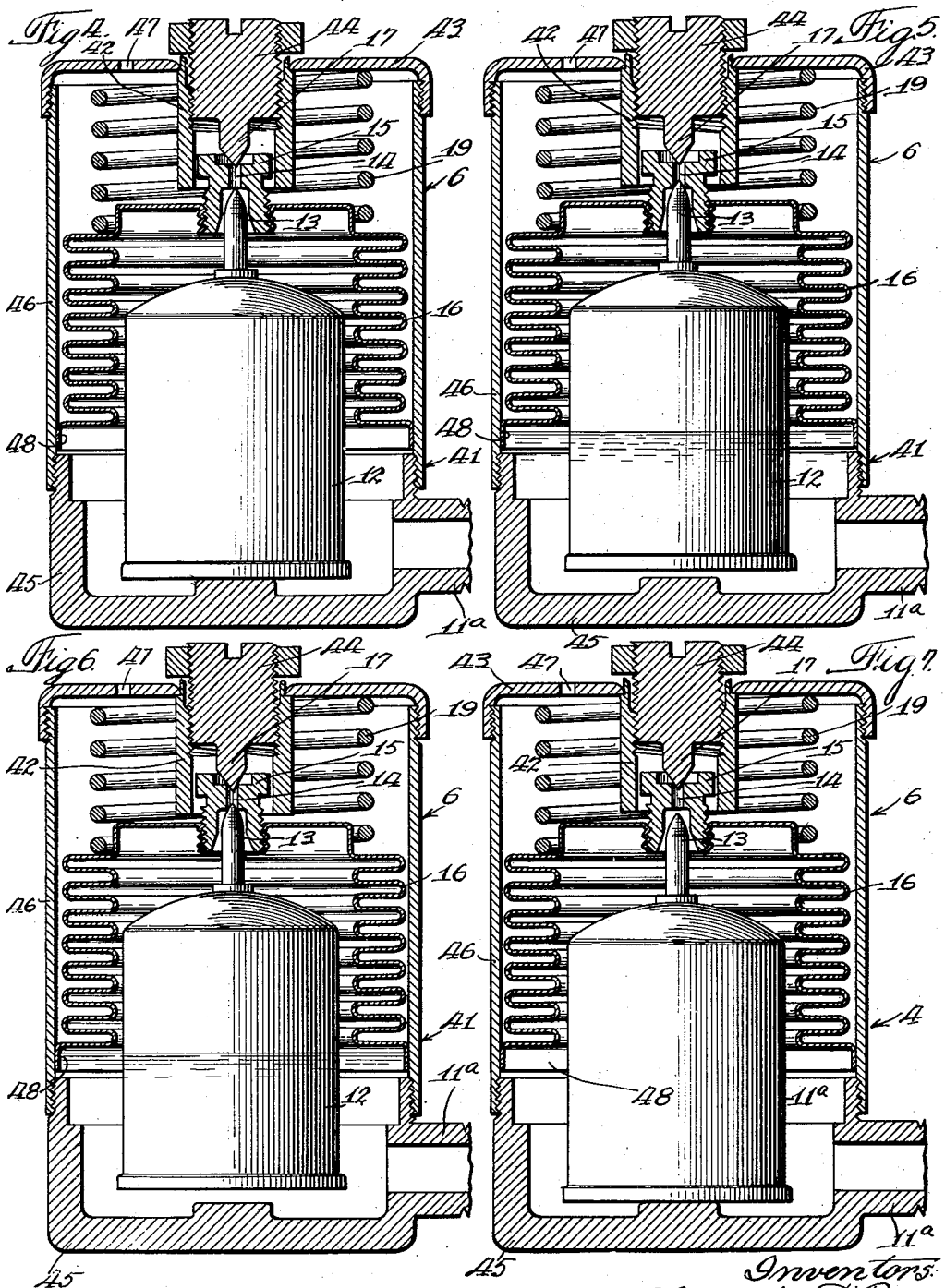
Fig 3.

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AIR VENTING APPARATUS

Filed March 16, 1938 3 Sheets-Sheet 2



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Dec. 17, 1940. A. D. ROSE ET AL 2,224,929

AIR VENTING APPARATUS

Filed March 16, 1938 3 Sheets-Sheet 3

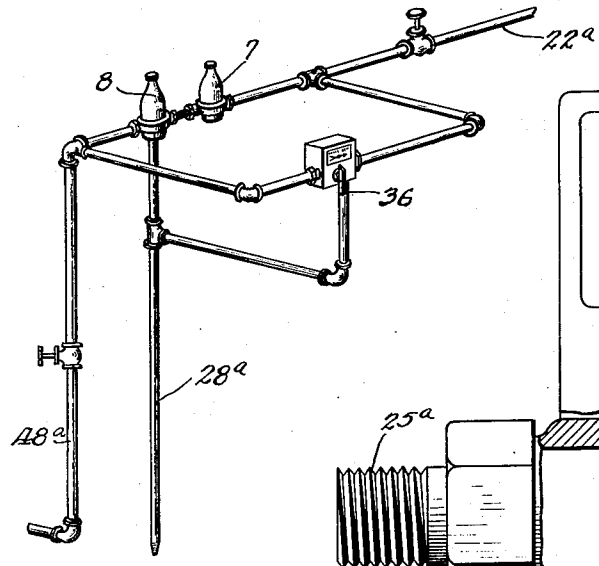


Fig. 8.

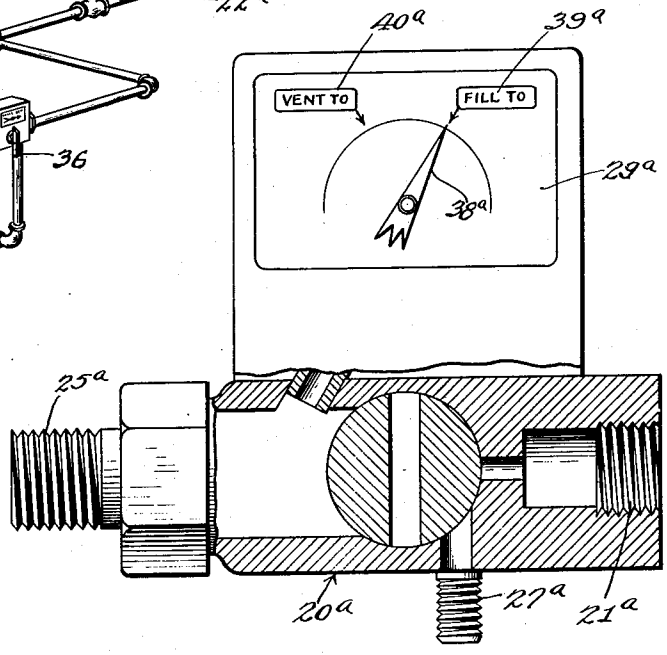


Fig. 9.

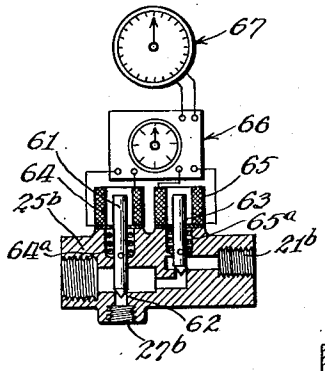


Fig. 11.

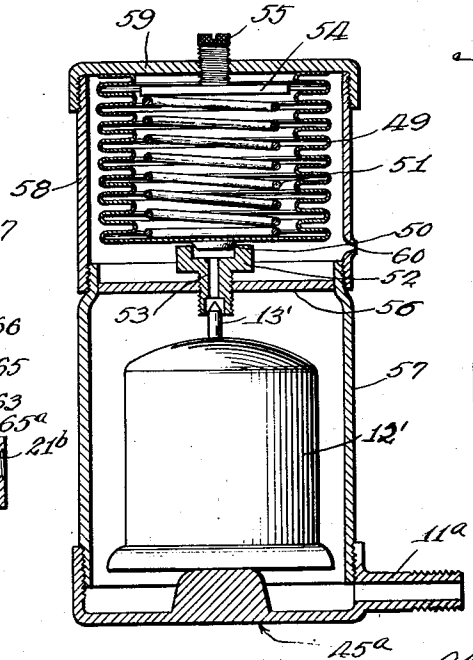


Fig. 10.

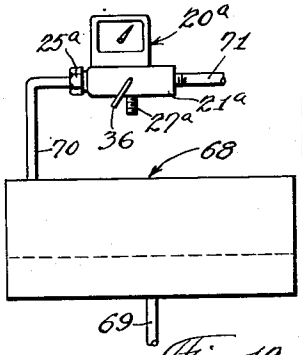


Fig. 12.

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UNITED STATES PATENT OFFICE

2,224,929

AIR VENTING APPARATUS

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Application March 16, 1938, Serial No. 196,170

22 Claims. (Cl. 237—56)

Our invention relates to air-venting apparatus for air-bound containers. More specifically, it relates to air-venting apparatus for radiators used in a hot water heating system of the so-called closed type.

The trend in hot water heating systems is toward the use of the so-called "closed" systems as against the so-called "open" expansion tank systems, operating under atmospheric pressures that have been used in the past. The closed systems operating under higher pressures have the advantage of enabling the use of higher temperature water and promoting more rapid circulation of water, two factors that aid in securing economy of operation and more heating comfort.

The use of circulating pumps is becoming general in order to still further speed up circulation. The use of circulating pumps and higher operating pressures has also had the effect of permitting the use of smaller pipe and fittings and thus materially reducing the cost of installation.

In the so-called "closed" systems the water naturally expands as it is heated and the surplus volume must be removed from the heating system. The removal of this water is accomplished by means of spring loaded pressure valves. Other spring loaded pressure valves act to replace this volume of water when the water temperature and pressure is lowered. Thus fresh water is continually being injected into the system. This fresh water from the city mains carries an appreciable amount of entrained air and this air has a tendency to collect in the individual radiators. The radiators become air-bound, the circulation of water may be impeded, and radiating capacity is reduced. It is of great importance, therefore, that the individual radiators frequently be vented so as to prevent air accumulation.

The conventional type of radiator air valve used on steam or vapor systems is not suitable for this operation, due to the danger that the float needle may not seat properly and the relatively high water pressure would cause disastrous leakage and flooding with great damage to the building structure and furnishings. As a result, the venting of hot water radiators is now done manually, each radiator being individually vented.

The venting of radiators, while being a simple operation, is being made more difficult by the use of concealed radiation. It is one of the home tasks that is usually neglected, much to the detriment of the home heating operation.

One of the objects of our invention is to provide an improved air-venting apparatus that enables one to vent all of the radiators in a system simultaneously, either by manual, automatic, or semi-automatic means.

A further object of our invention is to provide apparatus of the type indicated above in which the venting operation is accomplished by opening one or more centrally-located control valves.

A further object of our invention is to provide an apparatus of the type indicated above in which the individual vent valves are tightly closed by the relatively great operating pressure of the water in the system, thus precluding the danger of accidental flooding.

A further object of our invention is to provide apparatus of the type indicated in which radiators in the same system on different levels may be vented from a central control station.

A further object of our invention is to provide such a construction in which a valve controlled by the liquid level in the radiator acts as a relay valve.

Further objects and advantages of the invention will be apparent from the description and claims.

In the drawings, in which several forms of our invention are shown,

Figure 1 is a view, partly in perspective and partly in elevation, showing a hot water heating system in which our improved apparatus is used;

Fig. 2 is a vertical, axial section of the control valve apparatus used in Fig. 1;

Fig. 3 is an elevational view of the apparatus shown in Fig. 2;

Fig. 4 is a vertical, axial, sectional view showing a vent valve apparatus in which the venting is accomplished by a decrease of pressure in one position it assumes;

Fig. 5 is a view of the apparatus of Fig. 4 in a different position;

Fig. 6 is a view of the apparatus of Fig. 4 showing still another position;

Fig. 7 is a view of the apparatus of Fig. 4 showing still another position;

Fig. 8 is a perspective view showing a somewhat different arrangement of control for the supply of water to the heating system;

Fig. 9 is a vertical, axial, sectional view of the control valve mechanism used in Fig. 8;

Fig. 10 is an axial sectional view showing an air vent control mechanism suitable for use where the venting is effected by an increase of pressure above the normal range in a system;

Fig. 11 is a diagrammatic view showing automatic control means; and

Fig. 12 is a diagrammatic view showing the control valve in combination with a compression tank.

Referring to the drawings in detail and first to Figs. 1 to 7, inclusive, the construction shown in Fig. 1 comprises a hot water heater 1, a plurality of radiators 2 located on different floors, supply pipes 3 for supplying hot water to the radiators, return pipes 4 for the return of the water from the radiators to the heater 1, means 5 for controlling the supply of water to the system and the pressure of the water in the system, and means 6 controlled by the water level in the individual radiators and by the pressure of the water in the radiators for controlling the venting of air from air-bound radiators.

As indicated above, in hot water heating systems of the closed type shown, means are usually provided which will in general maintain the pressure in the system between upper and lower limits. Thus, a pressure-regulating valve 7 is provided which in general will cause additional water to be supplied to the system if the pressure in the system drops below a predetermined level, and a relief valve 8 is provided which will open and allow water to escape from the system in the event that the pressure in the system rises above a predetermined level due to the heating up of the water in the system or any other cause.

A strainer 9 is also generally provided for preventing foreign matter from entering the heating system. A drain 10 is also usually provided to enable the water to be drained from the system when desired. In our improved system, we provide in addition to this a valve apparatus 11 by means of which when desired the pressure in the system, including the radiators, may be dropped below the lower pressure level normally maintained by the pressure-reducing valve, which drop in pressure in the system is utilized in venting the air from air-bound radiators through the air vent valve mechanism shown in detail in Figs. 4, 5, 6, and 7.

Before describing in further detail the control valve mechanism by means of which pressure in the system is dropped below the ordinary predetermined level, we will describe the construction and operation of the air vent valve mechanism provided for each individual radiator.

Fig. 4 shows the position of the valves in the air vent apparatus either when the system is empty or when the water level in the radiator is low and when the pressure in the system is subnormal.

Fig. 5 shows the position of parts when the water level in the radiator is up to normal and the water pressure in the radiator is below normal.

Fig. 6 shows the position of parts when the water level in the radiator is normal and the water pressure in the radiator is within the normal range.

Fig. 7 shows the position of parts when the water level in the radiator is below normal (that is to say, when the radiator is air-bound) and the pressure in the radiator is within the normal range.

Each radiator is provided with a vent valve apparatus 6, the nipple 11*a* of the air vent apparatus being connected so as to be in communication with the interior of the radiator so that the liquid level in the air vent apparatus will rise and fall with the liquid level in the radiator and so that the interior of the diaphragm will be subjected to a pressure equivalent to the pressure in the radiator. Assuming that the system is empty and the apparatus is therefore in the position shown in Fig. 4 and it is desired to fill the system, the control apparatus 11 will be set so as to supply water to the heating system. Water will thereupon rise in the different radiators, and when the liquid level in a radiator rises so that the liquid level in the air vent apparatus is high enough to raise the float 12 to the position shown in Fig. 5, the float valve 13 will close the passage 14 in the ported member 15 carried by the upper end of the pressure-actuated bellows or diaphragm chamber 16, thus preventing the leakage of water from the radiator. When all of the float valves in the system have thus closed each passage 14, further supply of liquid will increase the pressure in the system, causing each diaphragm chamber to expand to bring the upper end of the ported member 15 against the conical valve member 17 as shown in Fig. 6, thus further sealing the passage 14 against the leakage of water. As the area of this diaphragm 16 which is acted on by pressure is of a considerable extent, the ported member 15 will seal against the conical valve member 17 with considerable force so that a secure seal is effected between the ported member 15 and the conical valve member 17. It will be seen that if foreign matter is lodged in valve 13 or passage 14, this might temporarily prevent the effective closing of the valve but that the greater power of the diaphragm 16 will force the ported member 14 against the valve 17 regardless of the presence of the foreign material. Subsequent operation of the valve and urging of the pressure in the system will wash the foreign matter away so that the valve 13 will find a seat and effect a closure. When the pressure in the system has been brought up to the predetermined pressure, the control valve apparatus 11 is set so that any further water supply to the system will be through the pressure-reducing valve 7. The radiators have now been filled with water to the desired level and pressure, and the heating system is ready for operation.

As previously explained, when water is supplied to the system, air is entrained with the water and in time will rise and accumulate in the upper portions of the radiators causing the radiators to become air-bound and causing the float valves 13 to drop to the position shown in Fig. 7 as the liquid level in the radiators falls. In order to vent the air-bound radiators, the control valve 11 is placed in a position to connect the hot water system with the drain 18, and a small quantity of liquid is drained from the heating system to lower the pressure in the system below that predetermined pressure maintained by the pressure-reducing valve 7 to enable the coil compression spring 19 to compress the diaphragm chamber 16 and to move the ported member 15 away from the conical valve member 17 to the position shown in Fig. 4. As previously explained, Fig. 4 shows the position of the valves in the air vent apparatus when the water level in the radiator is subnormal and the pressure in the system is subnormal, which is the condition when the radiator is air-bound and the pressure in the system is low enough to enable the coil compression spring 19 to compress the diaphragm chamber 16. In this position of parts, the air can escape from the air-bound radiator, as the float valve 13 is open and the pressure-controlled valve 17 also is open. In explanation of the fact that air will escape from the system under these

conditions, it must be borne in mind that the mixture of water and entrained air in the heating system expands upon a lowering of the pressure, due to the elasticity of the entrained air, and the expansion of the body of water and entrained air will cause the air in the air-bound radiators to escape when the parts are in the position shown in Fig. 4. This expansion of the medium in the system will cause the liquid level in the float valve chambers to rise and eventually to bring the float valve 13 to the position shown in Fig. 5 in which it closes the port through the ported member 15, thus preventing leakage of water past the float valve. After the radiators have all been vented, which requires very little time, usually less than a minute, the control valve 11 is moved to a position to prevent further drainage of the system and to add further water to the system from the city main, whereupon the pressure in the system rises and the diaphragm chambers 16 thereupon expand to the position shown in Fig. 6, in which position the ported member 15 is pressed firmly against the conical valve 17 by the pressure in the diaphragm chamber, thus effectually preventing any leakage through the ported member 15. If it should happen that no air is present in some of the radiators, the valve parts will remain as shown in Fig. 5 during the period that a subnormal pressure prevails in the system.

By means of this control it is a simple matter to vent all of the air-bound radiators in a system from a central point so that this venting can be easily accomplished as often as once a day, or oftener if necessary, in order to keep the system in good working condition.

We will now briefly describe the construction and operation of the control valve mechanism 11 shown in Figs. 1, 2, and 3.

As here shown, the valve casing 20 is provided with four connections, one connection 21 with the water supply, such as the city main 22, another connection 23 for the pipe 24 leading to the pressure-reducing valve 7, another connection 25 for a pipe 26 which by-passes the pressure-reducing valve 7 and the relief valve 8, and another connection 27 for the drain 18. This drainage connection 18 may be to the same drain pipe 28 which leads from the pressure relief valve 8.

The valve casing 20 is provided with a pressure indicator 29 of any suitable type connected as shown in Fig. 2 so that it will be subjected to the pressure in the system.

A three-position rotatable plug valve 30 is provided for controlling the various connections. In the position shown, the pressure supply 21 is connected with the pipe 24 leading to the reducing valve 7 through the passage 31, the passage 32 in the valve, and through the pipe connection 23 to the pipe 24 leading to the reducing valve 7. In another position of the valve, the passage 32 through the valve connects the system with the drain pipe 18 through the by-pass 26, connection 25, passage 32, passage 33, and connection 27. In another position of the valve the passage 32 through the valve connects the water supply 22 directly with the heating system through the connection 21, passage 32, connection 25, and by-pass 26.

Fig. 2 shows the normal position of the valve 30 in which the supply 22 is connected with the pressure-reducing valve 7 so that the pressure in the system will be kept up at least to the predetermined lower limit for which the pressure-reducing valve is set. In the drainage position of the valve in which the water in the heating system is connected with the drain 18, the pressure in the heating system can be reduced to a level below that for which the pressure-reducing valve 7 is set. In the third position of the valve in which the supply pipe 22 is connected with the by-pass pipe 26, the system can be quickly filled without having to go through the pressure-reducing valve 7.

As one example of pressures which may be used, let it be assumed that the reducing valve 7 is set so that the pressure at the gauge 29 will not normally fall below ten pounds per square inch and that the level of the radiators 2 and 2a with respect to each other and with respect to the pressure gauge 29 is such that when there is a ten-pound gauge pressure, the pressure at the upper end of the radiator 2 will be seven pounds per square inch and the pressure at the upper end of the radiator 2a will be three pounds per square inch.

Let it be assumed further that the air vent apparatus 6 of the radiator 2 on the lower floor is set so that the coil compression spring 19 will cause the ported member 15 to move away from the conical valve 17 when the pressure in the upper portion of the radiator 2 drops below five and one-half pounds per square inch, and that the air vent apparatus of the upper radiator 2a is set so that the coil compression spring 19 will cause the ported member 15 to move away from the conical valve 17 when the pressure in the upper portion of the radiator 2a drops below one and one-half pounds per square inch. Under these conditions, if the radiators are air-bound, they may be vented by dropping the pressure at the pressure gauge down to eight pounds per square inch, which will cause the pressure in the upper portion of the lower radiator 2 to drop down to five pounds per square inch and will cause the pressure in the upper portion of the upper radiator 2a to drop down to one pound per square inch, since these pressures at the radiators of five pounds per square inch and one pound per square inch are less than the respective pressures of five and one-half pounds per square inch and one and one-half pounds per square inch at which these air vent valves open. As soon as the pressure has been maintained at this low level long enough to vent the radiators, the control valve 30 may be moved back to filling position which will cut off further drainage and connect the water supply with the system to cause the system to be filled up to the pressure which will be sufficient to expand the diaphragm chambers to cause the ported members to seat against the conical valves. The control valve 30 may then be moved back to normal position.

The control valve mechanism 11 may be provided with suitable indicia 34 co-operating with a pointer 35 on the valve handle 36 for indicating the position to which the valve handle shall be turned for filling, normal operation, and venting operation. The gauge 29 may be provided with a scale 37 co-operating with a gauge index 38 showing the pressure in the system, the scale 37 having indicia 39 to show the pressure to which the system should be filled when the valve handle 36 is moved to filling position, and indicia 40 to show the pressure to which the system should be dropped when venting the radiators.

Referring more specifically to the structure of the air vent apparatus, this comprises a casing

41 for enclosing the float 12 and diaphragm chamber 16, the float itself carrying at its upper end the conical valve member 13, the corrugated expansible diaphragm chamber 16, the ported member 15 secured in fluid-tight engagement with the upper portion of the diaphragm chamber 16, a guide sleeve 42 for the ported member 15 depending from the cap 43 of the casing, and a plug 44 from which the conical valve member depends having an adjustable screw-threaded engagement with the sleeve 42 which guides the ported member 15. The casing 41 as shown comprises the lower cup-like member 45 which receives the lower end of the float 12, a sleeve 46 having a fluid-tight engagement with this lower cup-like member 45, and the cap 43 on which the guide sleeve 42 and plug 44 are mounted. This cap 43 is provided with a suitable opening 47 to enable the escape of air which flows through the ported member 15. This ported member has a loose fit in the sleeve 42 so that the air can escape between the sleeve 42 and the ported member 15. The diaphragm chamber 16 may be mounted in any suitable manner as by providing it with a flange 48 secured in fluid-tight engagement with the casing sleeve 46.

It is obvious that if desired the heating system may be provided with a pump to force the water therethrough.

While we have described our invention in connection with a hot water heating system, it is obvious that in some of the phases, it is applicable to a liquid cooling system or to any system in which a liquid circulates throughout the system and in which the system has containers which become air-bound. While we have shown our invention in connection with a heating system in which separate piping is provided for the supply and return with respect to the radiators, it is obvious that it is also applicable to a hot water heating system of the "single flow type."

In Fig. 8 is shown an arrangement of control for the water in the heating system which may be substituted for that shown in Fig. 1. In this arrangement the pipe 48*a* leading to the heating system corresponds to the pipe shown in Fig. 1, and the pipe 22*a* corresponds to the supply pipe 22 of Fig. 1. A pressure regulating valve 7 and a pressure relief valve 8 are provided corresponding to the regulating valve 7 and the relief valve 8 of Fig. 1. A drain connection 28*a* leading from the pressure relief valve 8 corresponds to the drain connection 28 of Fig. 1. A by-pass is provided around the regulating valve 7 and relief valve 8 in which is located the control valve mechanism. This control valve mechanism comprises a casing 20*a* having three connections, one connection 21*a* for the pipe 22*a* leading from the water supply, another connection 25*a* for the pipe 48*a* leading to the heating system, and another connection 27*a* for the pipe leading to the drain. This valve mechanism is also provided with an indicator 29*a* similar to the indicator 29 shown in Fig. 3. In the position of the valve shown, both the connection 25*a* and the connection 27*a* are cut off from the supply pipe 22*a*. If the plug valve is turned 90° clockwise, the supply pipe 22*a* will be connected with the pipe 48*a* leading to the heating system, by-passing the pressure-regulating valve 7. If the plug valve is turned 45° counterclockwise, the heating system will be connected with the drainage connection 27*a*. In this construction, as in the construction of Fig. 2, the gauge is provided with indicia co-operating with the pointer 38*a* to show the pressure in the system. The indicia 39*a* show when the system has been filled to the proper pressure, and the indicia 40*a* show when the system has been vented to an extent sufficiently to cause the collapse of the expansible bellows 16 to open the valve 17 and vent the radiators.

The construction shown in Fig. 10 shows a vent valve mechanism in which the opening of the air vent valve is effected by an increase in the pressure in the radiator to supernormal as distinguished from the construction shown in Figs. 4 to 7, inclusive, in which the opening of the air vent is effected by a drop in the pressure to subnormal. The construction shown in Fig. 10 comprises a float 12' and a float valve 13' similar to the float 12 and float valve 13 of Fig. 4, a casing comprising a cup member 45*a* having a nipple 11*a* similar to the cup member 45 and nipple 11*a* of Fig. 4, an expansible diaphragm or bellows 49 carrying a valve member 50 at its lower end, a spring 51 urging the valve 50 to closed position, a ported member 52 having a passage 53 therethrough controlled both by the float valve 13' and the spring-pressed valve 50, a plate 54 bearing against the upper end of the spring 51, and an adjusting screw 55 for adjusting the tension of the spring 51. The ported member 52 is secured to a partition 56 secured to a sleeve 57 forming part of the casing. The casing comprises, in addition to the sleeve 57, an upper sleeve 58 having a screw-threaded connection with the sleeve 57, and a cap 59 having a screw-threaded connection with the sleeve 58. The sleeve 58 is provided with a suitable vent 60 for the escape of air.

In this form the bellows 49 acts merely as a mounting for the valve 50 and as a housing for the spring 51. The interior of the diaphragm is not subjected to the pressure of the system as in the construction of Fig. 4.

In a sealed pressure hot water system, the operation of the valve shown in Fig. 10 will be as follows: Let it be assumed that the relief valve 8 is set to open at a pressure of thirty pounds per square inch, thus establishing an upper limit for the normal pressure range. Under this condition the screw 55 will be adjusted to control the tension of the spring 51 in such a manner that the pressure in the system acting on the exposed surface of the valve 50 will open this valve at a pressure somewhat higher than the pressure at which the relief valve is set to open; for instance, at a pressure of thirty-five pounds per square inch. When it is desired to vent the radiators, the pressure in the system will be increased to thirty-five pounds per square inch or slightly above that. This may be accomplished by any one of the following methods: (1) closing the discharge from the relief valve until the desired supernormal pressure has been attained and held for a short time; (2) closing the connection to the relief valve until the desired supernormal pressure has been attained and held for a short time; (3) opening a by-pass connection from the water supply into the system until the desired supernormal pressure has been attained and held for a short time; and (4) opening a connection from the water supply to the heating system and closing the discharge from, or the connection to, the relief valve until the desired supernormal pressure has been accomplished and held for a short time. All of these may be accomplished by an arrangement similar to that shown in Figs. 8 and 9. Under any of the four conditions, if any air has been accumulated in a radi-

ator, the float valve will be open, the supernormal pressure will open the spring-pressed valve **50**, and the air will be discharged. The water will rise in the float valve chamber, causing the float valve to close. The pressure will then be permitted to drop back to the normal pressure at which the relief valve opens and thereupon the valve **50** will close.

If it is desired to use the valve mechanism shown in Fig. 10 in an open gravity hot water system, the operation may be as follows: Let it be assumed that the overflow of the system is at an elevation equivalent to a static head of seven and one-half pounds per square inch and that the adjusting screw **55** is set so that the valve **50** will open at a pressure of ten pounds per square inch. In order to vent the radiators, it is necessary to close the overflow temporarily, whereupon the pressure in the system can be increased to something more than ten pounds per square inch, causing the pressure-operated valves **50** to open and allow the venting of any radiators which are air-bound. As the water rises in the radiator, the float valve **13** will close and when all the radiators have been vented, the pressure is allowed to drop back to normal whereupon the valves **50** will close and the system can then operate in a normal manner.

In Fig. 11 is shown diagrammatically an automatic time-controlled valve mechanism which can be substituted for the control valve mechanism shown in Figs. 8 and 9. In Fig. 11 the connection **25***b* corresponds to the connection **25***a* of Fig. 9, the connection **21***b* corresponds to connection **21***a* of Fig. 9, and the connection **27***b* corresponds to connection **27***a* of Fig. 9. The connection **21***b* will be placed in communication with the supply pipe **22***a*, the connection **25***b* will be placed in connection with the pipe **48***a*, and the connection **27***b* will be connected with the drain pipe **28***a*.

The construction shown in Fig. 11 comprises the valve casing having the above-noted pipe connections **21***b*, **25***b*, and **27***b*, a valve **61** controlling the port **62** leading to the connection **27***b*, a valve **63** controlling communication between the connections **21***b* and **25***b*. solenoids **64** and **65** for controlling these valves **61** and **63**, respectively, springs **64***a* and **65***a* for closing the valves **61** and **63**, respectively, when the solenoids are deenergized, a time-controlled program cycle apparatus **66** of any suitable type controlling the solenoids and a time-controlled mechanism **67** controlling the program cycle mechanism **66**. The time-controlled program cycle mechanism **66** may be controlled by the primary time-controlled mechanism **67** in such a manner that at a certain time or certain times during the period covered by the primary mechanism **67**, the program cycle mechanism **66** will be caused to make one complete revolution in a relatively short period, for example, in a minute or thereabouts. This complete revolution of the program cycle mechanism will cause the energization and deenergization of both solenoid magnets **64** and **67**, which in turn will cause opening and closing of the solenoid controlled valves **61** and **63**. The program cycle mechanism **66** may be so designed that the valve **61** will be opened and held open for a short period, say twenty or twenty-five seconds, long enough to lower the pressure in the system sufficiently to cause venting of the air-bound radiators in the system and so that thereafter the valve **63** will be opened and held open for a short period, for example, twenty or twenty-five seconds, long enough to fill the system again to the desired pressure.

In hot water systems, it may sometimes be desirable to install venting apparatus on the pipes leading to the radiators so that some of the air entrained in the system can be vented before it reaches the radiators.

It is obvious that, if desired, two manually operated switches may be provided in addition to the time-controlled mechanism shown in Fig. 11 for controlling the action of the solenoids **64** and **65** so that if the time-controlled mechanism should fail or if it should be desired to vent the radiators at some time other than the time-controlled period, this could be done by operating the manually-operated switches.

Fig. 12 shows an arrangement in which the control valve mechanism shown in Figs. 8 and 9 may be combined with a compressed air tank **68** which is in communication with the piping **3** leading to the radiators. This compressed air tank is connected with the piping **3** by means of the pipe **69**. As the pressure in the pipe **3** rises and falls, the air in the tank **68** will be compressed or expanded in accordance with the existing pressure. By connecting the control valve mechanism **20***a* of Fig. 9 with the compressed air tank **68**, as indicated in Fig. 12, the venting of the radiators can be controlled by manipulation of the valve handle **36**. In this arrangement, the connection **25***a* of the valve **20***a* will be connected with the compressed air tank **68** by means of the pipe **70**, the connection **21***a* of the valve will be connected with any suitable source of compressed air **71**, and the connection **27***a* will be connected with any suitable air exhaust pipe. With this arrangement, the air-bound radiators may be vented by placing the valve in position to establish communication between the connection **25***a* and the connection **27***a*. This will allow the air to escape from the compression tank **68** through the exhaust **27***a*, lowering the pressure in the system and causing the venting of air-bound radiators as previously described. After the radiators have been vented, the pressure in the system may be restored to normal by moving the valve to connect the compressed air source **71** with the pipe **70** leading to the compression tank **68**. The valve will be held in this position long enough to bring the pressure up to normal whereupon the valve will be moved to the position shown in Fig. 9 to cut the compression tank off, both from the exhaust connection **27***a* and the compressed air connection **21***a*.

In the claims where the word "gas" is used, it is to be understood as including any substance in a gaseous form such, for example, as air vapor, steam, and the like.

Further modifications will be apparent to those skilled in the art and it is desired, therefore, that the invention be limited only by the prior art and the scope of the appended claims.

Having thus described our invention, what we claim and desire to secure by Letters Patent is:

1. A liquid heat transfer system comprising a source of liquid under pressure, a heat transfer liquid container in communication with said source, means for supplying heat to said system, and means for controlling the venting of air from the container when it becomes air bound comprising means controlled by a change of pressure of the liquid in the container and by a change in liquid level in the container, and automatic means for changing the pressure in the

container independently of any heat supply control.

2. A liquid heat transfer system comprising a source of liquid under pressure, a heat transfer liquid container in communication with said source, means for supplying heat to said system, and means for controlling the venting of air from the container when it becomes air bound comprising means controlled by a change of pressure of the liquid in the container and by a change in liquid level in the container, and time-controlled means for changing the pressure in the container independently of any heat supply control.

3. A liquid heat transfer system comprising a source of heat transfer liquid under pressure, a liquid container in communication with said source, means for supplying heat to said system, and means for venting the air from the container when it becomes air bound comprising means actuated by a change in pressure of the heat transfer liquid in the container, and time-controlled means for changing the pressure in the container independently of any heat supply control.

4. Apparatus for controlling the venting of air from an air-bound heat transfer liquid container, said apparatus having a passage for the escape of air from the container, two valves in series in said passage, means controlled by the pressure of the liquid in the container for controlling one of said valves, means controlled by the liquid level in the container for controlling the other valve, and time-controlled means for changing the pressure in the container independently of any heat supply control.

5. A liquid heat transfer system comprising a source of heat transfer liquid under pressure, means for supplying heat to said system, a liquid container in communication with said source, and means for venting the air from the container when it becomes air bound comprising means actuated by a change in pressure of the heat transfer liquid in the container, and automatic means for changing the pressure in the container independently of any heat supply control.

6. Apparatus for controlling the venting of air from an air-bound heat transfer liquid container, said apparatus having a passage for the escape of air from the container, two valves in series in said passage, means controlled by the pressure of the liquid in the container for controlling one of said valves, means controlled by the liquid level in the container for controlling the other valve, and automatic means for changing the pressure in the container independently of any heat supply control.

7. A heat transfer system comprising a source of heat transfer fluid, means for transferring heat with respect to said fluid, a heat transfer container having an air vent, means for maintaining the pressure of said fluid in said container within a normal range for effecting heat transfer, and means actuated by a fluid pressure outside of said range and independently of the action of said heat transferring means for venting the air trapped in said container.

8. A heat transfer system comprising a source of heat transfer liquid, a heat transfer container having an air vent, means for supplying liquid to said container, means for maintaining the pressure of said heat transfer liquid in said container within a normal range for effecting heat transfer, means for temporarily changing the liquid pressure at a pressure outside said normal range, means controlled by a liquid pressure outside of said range for venting the air trapped in said container, and means controlled by the rise of the liquid level in said container for causing said pressure-controlled means to close said air vent.

9. A heat transfer system comprising a source of heat transfer liquid, a heat transfer container having an air vent, means for supplying liquid to said container, means for maintaining the pressure of said heat transfer liquid in said container within a normal range for effecting heat transfer, means for temporarily changing the liquid pressure at a pressure outside said normal range, means controlled by a liquid pressure outside of said range for venting the air trapped in said container, and means controlled by a rise in liquid level in the container for preventing the flow of air through said vent.

10. A heat transfer system comprising a source of heat transfer fluid, means for transferring heat with respect to said fluid, a plurality of heat transfer containers, each having an air vent, means for maintaining the pressure of said fluid in said containers within a normal range for effecting heat transfer, and means actuated by a fluid pressure outside of said range and independently of the action of said heat transferring means for venting the air trapped in said containers.

11. A heat transfer system comprising a source of heat transfer liquid, a plurality of heat transfer containers, each having an air vent, means for supplying liquid to said container, means for maintaining the pressure of said heat transfer liquid in said containers within a normal range for effecting heat transfer, means for temporarily changing the liquid pressure at a pressure outside said normal range, means controlled by a liquid pressure outside of said range for venting the air trapped in said containers, and means controlled by the rise of the liquid level in said containers for causing said pressure-controlled means to close said air vents.

12. A heat transfer system comprising a source of heat transfer fluid, a heat transfer container having an air vent, means for transferring heat with respect to said fluid, means for maintaining the pressure of said fluid in said container within a normal range for effecting heat transfer, means for temporarily changing the fluid pressure to a pressure outside of said normal range, and means controlled by said fluid pressure and independently of the action of said heat transferring means for closing the vent when the pressure is within the normal range and for opening the vent when the pressure is outside the normal range.

13. A heat transfer system comprising a source of heat transfer liquid, a heat transfer container having an air vent, means for supplying liquid to said container, means for maintaining the pressure of said heat transfer liquid in said container within a normal range for effecting heat transfer, means for temporarily changing the liquid pressure to a pressure outside of said normal range, and means controlled by said liquid pressure for closing the vent when the pressure is within the normal range and for opening the vent when the pressure is outside the normal range.

14. A heat transfer system comprising a source of heat transfer liquid, a heat transfer container having an air vent, means for maintaining the

pressure of said heat transfer liquid in said container within a normal range for effecting heat transfer, means for temporarily changing the liquid pressure to a pressure outside of said normal range, means in said system controlled by the liquid level, means in said system controlled by the liquid pressure, and means controlled by said liquid level controlled means and by said liquid pressure controlled means for venting said container at coincident low liquid level and pressure outside said normal range and for holding said vent closed at pressures within said normal range.

15. A heat transfer system comprising a source of heat transfer liquid, a heat transfer container having an air vent, means for maintaining the pressure of said heat transfer liquid in said container within a normal range for effecting heat transfer, means for temporarily changing the liquid pressure to a pressure outside of said normal range, means in said system controlled by the liquid level, means in said system controlled by the liquid pressure, and means controlled by said liquid level controlled means and by said liquid pressure controlled means for venting said container at coincident low liquid level and pressure outside said normal range and for closing said vent at high liquid levels and at pressures within said normal range.

16. A heat transfer system comprising a source of heat transfer liquid, a heat transfer container having an air vent, means for maintaining the pressure of said heat transfer liquid in said container within a normal range for effecting heat transfer, means for temporarily changing the fluid pressure to a pressure outside of said normal range, means controlled by said fluid pressure for closing the vent when the pressure is within the normal range and for opening the vent when the pressure is outside the normal range, and means controlled by a rise in liquid level in the container for preventing the flow of air through said vent.

17. An air vent control device comprising pressure expansible chamber means, a ported valve seat carried thereby for venting air through said chamber, a valve member cooperating with said seat to close the port by the pressure controlled movement of the chamber, and a float valve for controlling the flow of air through said port.

18. An air vent control device comprising pressure expansible chamber means, a ported valve seat carried thereby for venting air through said chamber, a valve member co-operating with said seat to close the port by the pressure controlled movement of the chamber, and a valve-carrying float for controlling the passage of air through said port.

19. An air vent control device comprising pressure expansible chamber means, a ported valve seat carried thereby for venting air through said chamber, a valve member co-operating with said seat to close the port by the pressure controlled movement of the chamber, and a valve-carrying float for controlling the passage of air through said port, said float having a portion lying in said expansible chamber.

20. The combination of a liquid filled heat transfer system and means for venting the system at several points simultaneously from a single point, said means comprising a pressure controlling member designed to change the internal pressures of the system to exceed the normal range of internal pressures, and a ported member at each of the points to be vented controlled by liquid pressure and liquid level, said ported members being designed to close when the internal pressures are within the normal range and to be opened when the internal pressures of the system exceed the normal range, said ported members being designed to close with the rise of liquid level.

21. A liquid filled heating system comprising a means for heating the liquid, heat transfer units, connections therebetween, means for maintaining the internal pressure of the system within a predetermined range, means for changing said pressure range independently of said heating means, a container at each of the several units to be vented communicating with the interior of said units, a port in each container communicating with the atmosphere, a pressure responsive member within each container, a valve member actuated by each said pressure responsive member cooperating to close each said port when the internal pressure of the system is within the predetermined range, and a float actuated valve member cooperating to close each of said ports to the passage of liquid.

22. A remotely operated leak-proof vent valve for venting the air from air-bound hot water radiators comprising a chamber, the lower end of which is designed to be brought into communication with the interior of the radiator, the upper end of the chamber having a port communicating with the outer atmosphere, a float valve designed to close the port to the passage of water, a second valve member, a pressure responsive member cooperating therewith forcibly to close the port by the normal internal pressures of the system, said pressure responsive member being adjustably set to open the port when the pressure within the system is below normal, and means for reducing the internal pressures to below the normal range independently of any fire control.

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