

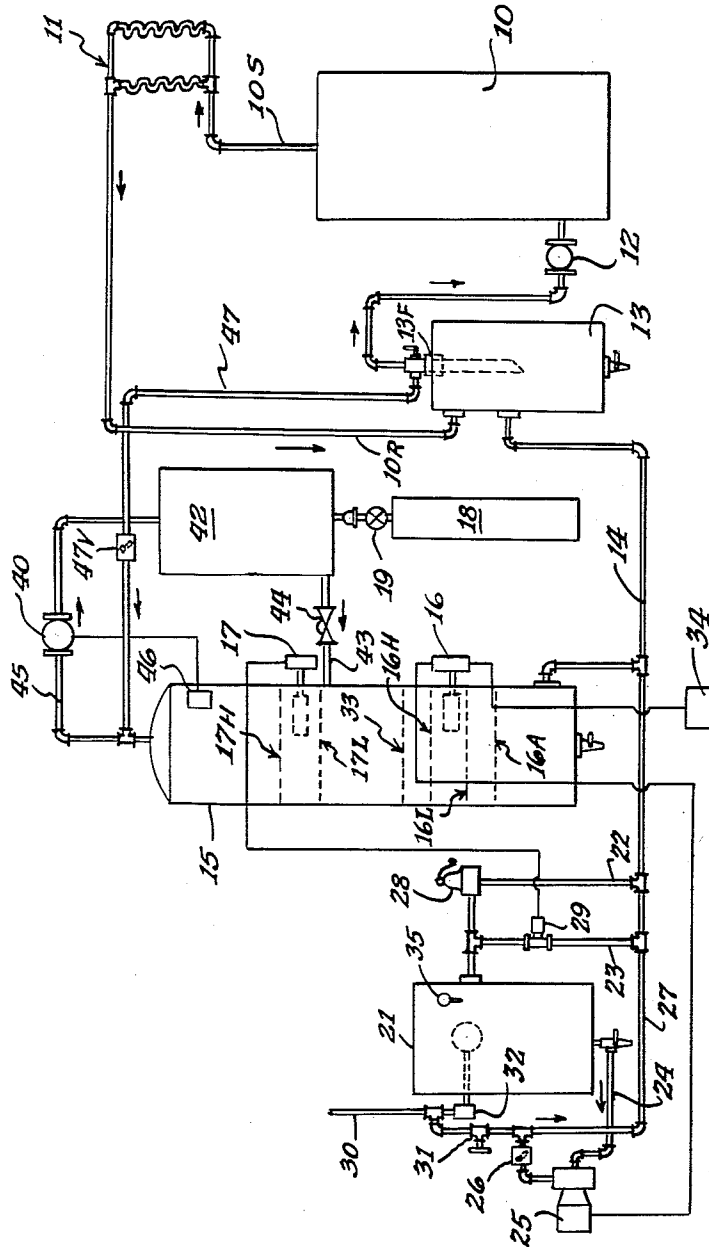
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PRESSURIZED MEDIUM TEMPERATURE HOT WATER SYSTEM

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PRESSURIZED MEDIUM TEMPERATURE HOT WATER SYSTEM

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This invention relates to a medium temperature hot water system and more particularly is concerned with providing an improved gas pressurized compression arrangement for establishing and maintaining sufficient system pressure to prevent boiling at all conditions of operation and more particularly to protect the circulating pump of the system against cavitation.

For operation at 320° F., temperature pressure tables show that water boils at pressures below 75 p.s.i.g. To provide a reasonable temperature over-ride protection, therefore, design pressures on the order of 100 to 125 p.s.i.g. are preferably employed.

In the arrangement of the present invention, pressurization of the system is accomplished by a compression tank and the tank is sized to account for differences in system water volume resulting from changing system loads.

In a system operating with constant supply water temperature, the return water temperature will approximate the supply water temperature during low load conditions and maximum water expansion volumes and system pressures will occur. The pressurization system must be capable of accommodating this low load water expansion volume without triggering the relief valve. The will avoid dumping of excess water and consequent fresh water replacement. The oxygen contained in the fresh water fill has corrosive effects on the system components.

When a system is operating at its full design load, the return water temperatures are at a minimum tending to reduce system pressure and antiboiling pressurization. The compression tank size must be such that water boiling cannot occur at full load operation.

Pressurization tanks containing a gas at high pressure (preferably nitrogen or some other inert gas) is connected to the compression tank to maintain a predetermined system pressure therein.

The principal object of the present invention is to provide a novel gas pressurized compression arrangement for a hot water heating system.

Another object of the present invention is the provision of a gas pressurized compression arrangement for a hot water heating system wherein provision is made for collecting and reusing water expelled from the compression tank.

Another object of the invention is the provision of a reclamation system for water expelled from the compression tank to substantially eliminate need of fresh water fill to the system and thereby avoid corrosion problems attendant thereto.

Still another object of the invention is the provision of a simplified arrangement for recirculating and reusing nitrogen or other compressed gas.

A further object of the invention is the provision of a gas compressor arrangement for a gas pressurization system for expanding the range of the pressurization system.

Other objects and advantages will become apparent during the course of the following description.

The accompanying drawing is a diagrammatic schematic illustration of a pressurized compression tank arrangement for a hot water heating system and providing for reuse of compression gas and providing for repressurization of the compression tank.

Referring now to the drawing, a hot water heating sys-

tem is shown as including a boiler 10, having a supply line 10S, and return line 10R, for circulating water through radiation facilities 11 of the system. A circulating pump 12 is shown connected in the return line and a gas separation tank 13 is connected in the return line at the suction side of the circulating pump 12. The gas separation tank 13 has a relatively large cross-sectional area to create a markedly reduced system water flow rate therein.

The pressurization system floats on the return line 10R, it being connected through a small sized balance line 14 that opens into the separation tank 13. The sizing of the balance line 14 is selected to avoid thermal convection and heating of the equipment and mass of water of the pressurization system. This thermal isolation of the mass of water in the pressurization system avoids the necessity for insulating this section of the equipment and confines the system expansion due to water temperature changes to the water actually circulating through the boiler 10 and radiation 11.

The pressurization system includes a compression tank 15 having a low level float control 16 and a high level float control 17, a source 18 of gas under pressure (here represented as a nitrogen bottle) connected through a pressure reducing valve 19 to supply nitrogen to the compression tank, a fill tank 21 having alternate infeed lines 22 and 23 and having an outfeed line 24 equipped with a fill pump 25 and check valve 26 and connected to a fill line 27 that feeds into the balance line 14 to feed into the lower end of the compression tank 15. A pressure relief valve 28 is connected in the infeed line 22 to the fill tank 21 and a solenoid control valve 29 is connected in the other infeed line 23 and is electrically connected for actuation by the high level float control 17 of the compression tank.

A fresh water supply line 30 is shown connected into the fill line 27 through a manually operable valve 31 and is shown connected into the fill tank 21 through a float operated valve 32. Manual drains are provided for the fill tank 21, the compression tank 15, and the gas separation tank 13 for removing sediment from the system.

It may be noted that the system is particularly adapted for marketing as a packaged unit. The illustrated gas pressurization system for a medium temperature hot water system eliminates the need for extremely critical design relationships and provides sufficient pressurization at the pump suction for all conditions of system operation. These packaged units may be of relatively small size and, with the exception of the gas separation tank, may readily be standardized to accommodate quantity production and eliminate the possibility of improper application. System flow rates for various possible applications seem to vary so greatly as to necessitate separate selection of the gas separation tank 13. This tank serves two functions in the system; it separates gas from the system water and it provides a place for dropout of system sediment without need for a system piping strainer.

The system is initially filled through the fresh water supply line 30 by means of the manual fill valve 31 which is closed off when the water in the system rises to the level indicated at 16A in the compression tank. The minimum system pressure is then established in the compression tank by appropriate setting of the reducing valve 19. Thereafter the continuous supply of nitrogen from the nitrogen bottle 18 will always maintain this minimum pressure in the system and by way of example, a minimum value on the order of 80 p.s.i.g. is employed where the system water temperature is 300° F. With the compression tank 15 located close to the suction side of the circulating pump 12 of the system, pump suction pressures can never fall below this initial 80 p.s.i.g. setting, a value

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well above the saturation pressure for 300° water, namely, 52 p.s.i.g.

As water in the system is heated, it undergoes expansion creating a flow of water out through the air separation tank 13, through the balance line 14 and into the compression tank 15. As the water level increases in the compression tank, a corresponding increase in tank pressure occurs and, by way of example for the system illustrated, the tank pressure could rise to 100 to 125 p.s.i.g. a value more than adequate to prevent water boiling and to protect the pump suction against cavitation.

Should the expanding water in the system cause the system pressure to increase above a predetermined maximum, the pressure relief valve 28 in the infeed line 22 to the fill tank 21 will open transferring water from the compression tank to the fill tank until the system pressure is reduced to a value less than the setting of the relief valve 28. Correspondingly if the expansion of the water in the system should be greater than anticipated, and rise to above the high range level 17H of the high level float, the high level float control 17 would trigger the solenoid valve 29 into open position to allow for transfer of water from the compression tank to the fill tank. The solenoid valve would close when the water level in the compression tank drops to the low range level 17L for the high level float.

The low level control 16 is operative to sense falling water levels in the compression tank whether caused because of system water contraction or because of a system water leak. When the system water level falls below the low range level 16L for the low-level float, the low level float control 16 operates the fill pump 25 to draw water from the fill tank 21 and deliver it to the compression tank 15. Once actuated, the fill pump operates until the water level in the compression tank reaches the high range level 16H for the low range float. Should the water level in the compression tank drop below the level 16A, the low level control will operate a signal alarm 34 and will cause cut-off of the boiler.

The water level in the fill tank 21 is maintained at a selected minimum position by the float level control 32 which is connected in the fresh water supply line. The fill tank is equipped with an over-flow drain 35 for limiting the maximum level of water in the fill tank.

In accordance with this invention, the diameter of the compression tank 15 need be only one-half of the diameter normally to be expected, this saving being accomplished by providing a gas compressor 40 in the pressurization system. In the typical system, the compressor 40 may operate from a suction pressure of 100 p.s.i.g. to a discharge pressure of 175 p.s.i.g. The nitrogen bottle 18 is shown feeding through the pressure reducing valve 19 that connects into a nitrogen receiver tank 42. The receiver tank 42 is arranged to supply nitrogen to the compression tank 15 through a feed line 43 that includes a pressure reducing valve 44. For the system conditions previously described, the pressure reducing valve 44 should be set at 80 p.s.i.g. in order to prevent reduction of the pressure in the compression tank below 80 p.s.i.g. The gas compressor 40 is connected in a return line 45 leading from the top of the compression tank 15 to the receiver tank and the compressor is controlled through a pressure sensitive switch element 46 that is exposed to the pressure conditions within the compression tank 15.

The air separator tank 13 is shown equipped with a fitting 13F having a separate outlet for discharging air or gas separating from water in the separation tank. A fitting of this type is shown in Tidd Pat. No. 2,395,697. This outlet is connected by a return line 47 to return the entrapped gas to the compression tank pressurization system. A check valve 47V is provided in return line 47. Thus the arrangement reclaims any gas that becomes absorbed in the water in the compression tank and ultimately escapes into the heating system.

While cavitation is eliminated as a problem by virtue

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of the high static pressure conditions maintained at the pump suction, air, gas, or vapor entering the pump suction can create the same type of mechanical difficulties normally associated with cavitation; that is to say, free gas or air entering the pump suction can gather around the seal and cause unbalanced impeller bearing thrust load and also can cause possible dry operation of a mechanical seal. It has been found that free air or gas causes increasing difficulties as water temperature is raised for systems operating at elevated temperatures, such as the present. It is necessary to separate gases prior to entry into the pump suction in order to avoid pump damage problems similar to that experienced under cavitation operation. The separator tank 13 separates air or gas immediately prior to entry into the pump suction and the separated air or gas is delivered to the compression tank 15, thereby eliminating free air or gas from the pump and main radiation supply and return system.

The operation of the pressurization arrangement is such that when the compression tank pressure increases above 100 p.s.i. (or any other selected maximum pressure) the pressure switch 46 triggers the compressor to draw nitrogen out of the compression tank 15 and supply it to the receiver tank 42 where it will be stored for subsequent delivery through line 43 leading to the compression tank. Thus the compressor acts to draw off excessive gas during high pressure system conditions, and this eliminates the necessity for discharging such excess gas and thereby depleting the available supply.

The principal advantages of the pressurization system utilizing a separate gas compressor are the markedly increased life of the nitrogen supply and the important cost savings resulting from the decrease in size of the compression tank.

By way of example, a small amount of water expansion can cause such an increase in gas pressure in the compression tank of from 80 to 100 p.s.i.g. To avoid repeated spillage of the nitrogen gas the compression tank volume allotted to the nitrogen gas must be a very large percentage of the total tank volume.

To illustrate: A 36" diameter compression tank, 6 1/2' high contains about 350 gallons. For a tank of this size for operation between 80 and 100 p.s.i.g. only 50 gallons would be allowed for water expansion space. Therefore, the volume allowed for gas space would have to be on the order of 200 gallons.

However, when separate pressurization, incorporating a compressor and receiver tank 42, is used, approximately 200 gallons could be allowed for water expansion space and thus the useable tank volume increases by about four times. Consequently, for the same tank height, and the same system conditions the compression tank 15 may be one-half the diameter of the compression tank that would otherwise be required. The differences in cost for approved tank constructions of these sizes is very high not to mention the additional advantages in handling and shipping the smaller size unit.

It should be understood that the description of the preferred form of the invention is for the purpose of complying with section 112, title 35, of the United States Code, and that the appended claims should be construed as broadly as the prior art will permit.

What is claimed is:

1. A gas pressurized compression arrangement for a medium temperature type closed hot liquid heating system having a source of hot liquid, radiation gear, and means for circulating hot liquid between said source and said radiation and including main supply and return lines and a pump and gas separation tank connected in series in one of said lines, said separation tank having a vent for releasing gas separating from liquid in said tank, said arrangement comprising a compression tank having a low level control and a high level control, means connected to supply gas under pressure to said compression tank for maintaining a minimum pressure therein of a value to pre-

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vent cavitation in said pump at all operating conditions of said system, a balance line connecting the liquid phase in said compression tank to one of said lines to provide for liquid flow from said system to said compression tank during expansion of liquid in said system and to provide for liquid flow from said compression tank to said system during contraction of liquid in said system, a gas return line connected from said vent to communicate with the upper end of said compression tank to return gas to said compression tank, a fill tank, a normally closed transfer line connected for transferring liquid from said compression tank to said fill tank, means responsive to operation of said high level control for unblocking said transfer line until the level of liquid in said compression tank is reduced a predetermined amount by flow of liquid from said compression tank to said fill tank, means including a normally closed return line connected for transferring liquid from said fill tank to said compression tank, and means responsive to said low level control for unblocking said return line until the level of liquid in said compression tank is raised a predetermined amount by flow of liquid from said fill tank to said compression tank.

2. A gas pressurized compression arrangement for a medium temperature type closed hot liquid heating system having a source of hot liquid, radiation gear, and means for circulating hot liquid between said source and said radiation and including main supply and return lines and a pump and gas separation tank connected in series in one of said lines, said separation tank having a vent for releasing gas separating from liquid in said tank, said arrangement comprising a compression tank having a low level control and a high level control, means connected to supply gas under pressure to said compression tank for maintaining sufficient pressure therein to prevent cavitation in said pump at all operating conditions of said system, said last named means including a receiving tank, a source of gas under high pressure connected to said receiving tank through a reducing valve, a compressor having its suction side connected to the gas in said compression tank and having its discharge side connected to said receiving tank, a line including a pressure reducing valve connected to supply gas under pressure from said receiving tank to said compression tank and a control responsive to operate when pressure in said compression tank falls to a predetermined value to actuate said compressor for maintaining a predetermined pressure in said compression tank, a balance line connecting the liquid phase in said compression tank to one of said lines to provide for liquid flow from said system to said compression tank during expansion of liquid in said system and to provide for liquid flow from said compression tank to said system during contraction of liquid in said system, a gas return line connected from said vent to communicate with the upper end of said compression tank to return gas to said compression tank, a fill tank, a normally closed transfer line connected for transferring liquid from said compression tank to said fill tank, means responsive to operation of said high level control for unblocking said transfer line until the level of liquid in said compression tank is

reduced a predetermined amount by flow of liquid from said compression tank to said fill tank, means including a normally closed return line connected for transferring liquid from said fill tank to said compression tank, and means responsive to said low level control for unblocking said return line until the level of liquid in said compression tank is raised a predetermined amount by flow of liquid from said fill tank to said compression tank.

3. In a gas pressurized compression arrangement for a closed hot liquid heating system of the type having a source of hot liquid, radiation gear, and means for circulating hot liquid between said source and said radiation and including main supply and return lines and a pump and gas separation tank connected in series in one of said lines, said separation tank having a vent for releasing gas separating from liquid in said tank, said compression arrangement including a compression tank, means connected to supply gas under pressure to said compression tank for maintaining a minimum pressure therein of a value to prevent cavitation in said pump at all operating conditions of said system, a balance line connecting the liquid phase in said compression tank to one of said lines to provide for liquid flow from said system to said compression tank during expansion of liquid in said system and to provide for liquid flow from said compression tank to said system during contraction of liquid in said system, a fill tank, means for transferring liquid between said compression tank and said fill tank to maintain predetermined upper and lower liquid levels in said compression tank; the improvement comprising a gas return line connected to the vent to return the gas from said separation tank to said compression tank, and wherein said means to supply gas under pressure includes a receiving tank, a source of gas under high pressure connected to said receiving tank through a reducing valve, a compressor having its suction side connected to the gas in said compression tank and having its discharge side connected to said receiving tank, a line including a pressure reducing valve connected to supply gas under pressure from said receiving tank to said compression tank and a control responsive to operate when pressure in said compression tank falls to a predetermined value to actuate said compressor for maintaining an increased pressure in said compression tank.

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