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(54) Automatic venting device for evacuated-tube steam heating systems

(57) An automatic venting device for heating systems comprising one or more heat exchange elements which are individually or globally connected to a heated vessel which contains a substance having convective properties and is associated with heating means which are suitable to cause its evaporation, the condensate of the steam produced by the evaporation collecting directly, by natural or mechanical means, in the heated vessel. The device comprises a closed container (24) which is connected to one or more regions of the heat exchange elements and is provided with sensors (25, 26) which are suitable to detect the presence of air and with an automatic vent valve (27). The sensors and the valve are connected to a control and management unit (28) which receives signals from the sensors and opens and closes the valve (27).

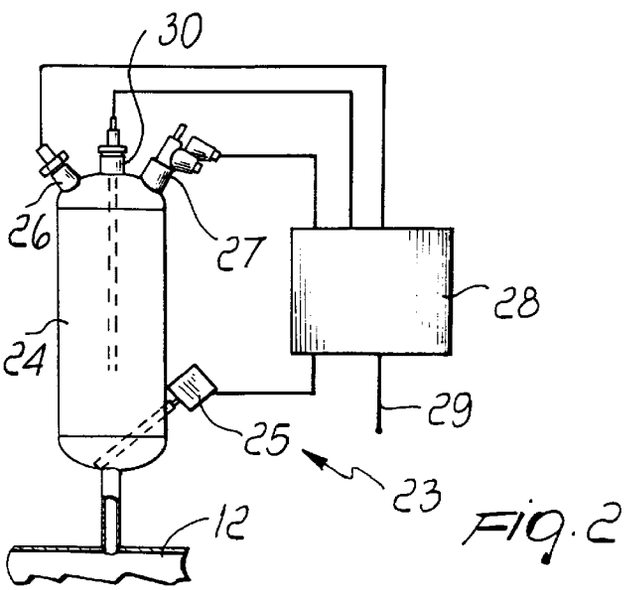

Fig. 2

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Description

The present invention relates to an automatic venting device for evacuated-tube steam heating systems.

Evacuated-tube steam heating systems are already known in the field of thermal engineering.

A system of this type is disclosed, in particular, in Italian Patent no. 1244098 filed on July 19, 1990 in the name of the same Applicant, whereto reference is made.

The system comprises at least one tube bundle or grid connected in a closed circuit as follows: at one end, to the upper part of a heated vessel which contains a substance having convective properties and is associated with heating means suitable to produce the evaporation of said substance; at the other end, to an unheated vessel (condensate collector).

As an alternative, the lower part of said heated vessel is directly connected to the tube bundle or grid.

The tube bundle or grid is arranged so that it can exchange heat with an enclosed space or with other liquid, solid or gaseous materials, either directly or indirectly.

In particular, the tubes can be struck by the air stream produced by one or more fans and the air can be fed directly and/or indirectly into the space to be heated.

As regards operation, it must be taken into account the fact that the assembly constituted by the vessels, the grid or bundle of tubes and the connections constitute a sealed vacuum unit and contain a specific amount of a substance, such as water, which is confined to the lower parts of the assembly.

By heating the heated vessel, the liquid contained therein evaporates and the steam tends to occupy all the available volume, thus propagating itself to the tube bundle or in the tube grid, which are empty.

The effect of forced ventilation or optionally natural convection or radiation removes heat from the tubes, causing the steam contained therein to condense.

This condensation creates a new vacuum (or alters the pressure conditions in that region, so that fresh steam takes the place of the condensed steam).

Due to the slope of the tubes, the condensate tends to flow towards the lower part of the circuit and from there, again due to the slope or to mechanical action, it collects in the lower part of the heated vessel.

Although these evacuated-tube steam heating systems have been particularly appreciated in recent years, they have been found to have some drawbacks, particularly due to the need to perform perfect welds between the various mutually connected parts to avoid the possibility of air infiltrations in the system.

When air (which is non-condensable) is present, it tends to be confined by the steam, preventing or reducing heat exchange at the tube bundle or nest.

Air, which is a good heat insulator, by being confined to these regions does not heat and therefore compromises the operation of the system, forcing a maintenance action which consists in restoring the original degree of vacuum.

In many cases it has been observed that welds that at first glance appeared to be perfectly executed instead had porosities, with consequent air infiltrations leading to results such as the one mentioned earlier.

The aim of the present invention is to provide a device which allows automatic venting of any air present inside evacuated-tube steam heating systems.

Within the scope of the above-described aim, a consequent primary object is to provide a venting device which eliminates the need to perform perfect welds or in any case porosity-free welds between the connected parts, allowing to use other coupling systems instead of welds, consequently saving labor and time.

Another important object is to eliminate maintenance for restoring optimum vacuum conditions.

This aim, these objects and others which will become apparent hereinafter are achieved by an automatic venting device for heating systems comprising one or more heat exchange elements which are individually or globally connected to a heated vessel which contains a substance having convective properties and is associated with heating means which are suitable to cause its evaporation, the condensate of the steam produced by said evaporation collecting directly, by natural or mechanical means, in said heated vessel; characterized in that it comprises a closed container which is connected to one or more regions of said heat exchange elements and is provided with sensors which are suitable to detect the presence of air and with an automatic vent valve, said sensors and said valve being connected to a control and management unit which receives signals from said sensors and opens and closes said valve.

Further characteristics and advantages of the present invention will become apparent from the following detailed description of an embodiment thereof, illustrated only by way of non-limitative example in the accompanying drawings, wherein:

Figure 1 is a view of a first embodiment of a fan-heater heating system, provided with the automatic venting device according to the invention:
Figure 2 is an enlarged-scale view of a detail of the venting device according to the invention;
Figure 3 is a view of a variation of the system of Figure 1 in a split version;
Figure 4 is a view of a second embodiment of the system for heating liquid or gaseous substances;
Figure 5 is a schematic perspective view of a third embodiment of a radiant heating system.

With reference to the above Figures 1 and 2, a metallic box-like structure, generally designated by the reference numeral 10, is internally provided with two regions, respectively a primary one 10a and a second-

ary one 10b.

In the primary region 10a a heated vessel 11 is provided and in the secondary region 10b a condensate return system is provided, constituted in this case by an unheated vessel 12 and by a tube 14.

A bundle of finned tubes or a grid of tubes or a plate 13 is arranged in the upper part of the structure 10 and is connected to the upper part of the vessels 11 and 12.

In the primary region 10a, below the heated vessel 11, a burner 15 is provided which is coupled to conventional control and safety devices 16 which are required for its operation.

In the upper part, relative to the burner 15, there is provided a coupling 17 for a burnt gas exhaust pipe.

In the secondary region 10b, the tube bundle or grid or plate 13 is interposed between an outlet grille 18 and a ventilation system which comprises a fan 19, provided with a respective motor 20 and an air intake 21 with a filter 22.

The assembly constituted by the heated vessel 11, the bundle or grid or plate 13, the unheated vessel 12 and the condensate return tube 14 is a unit which, both when in use and when inactive, is in perfect thermodynamic equilibrium between the steam and its condensate.

The same considerations of course apply if the unheated vessel 12 is not present.

Since steam is immiscible with air, during operation, when air is present in the system the steam produced in the heated vessel confines the air.

There is a natural tendency to convey upward any air that is present in the system, but said air may also be pushed towards other confinement regions which may be even lower than the heat dissipation elements.

According to the invention, a venting device 23 is connected in an air confinement region which can be higher or lower, according to the circuit of the system, with respect to the tube bundle 13 or grid or plate (by way of example, it is shown in the highest point in Figure 1). The device comprises a closed container 24 which is provided with sensors for detecting the presence of air, constituted by a lower thermostat 25 and by a pressure switch 26 and, at the top, with an automatic electric venting valve 27 which is connected to the outside.

Also according to the invention, the thermostat 25, the pressure switch 26 and the electric valve 27 are connected to an electronic control and management unit 28 which is connected to an electric power supply 29.

A water level probe 30 is also present and its terminal is located inside the container 24 and is shown in the upper part only by way of example.

The water level probe 30 also is connected to the electronic control unit 28.

Conveniently, the container 24 is constituted by a steel tank whose volume is suitable for the size of the system whereto it is connected, and the control and management unit 28 can be mounted directly on it or be remote.

As regards operation, the initial condition is the one in which the system is cold and not in vacuum, i.e., in which the internal parts are at ambient pressure.

A few minutes after starting the burner 15, the pressure inside the system starts to increase, closing the contact of the pressure switch 26.

Since the system is cold (for example below 80°C), the contact of the thermostat 25 in series with the contact of the pressure switch 26 is in the closed state and the control unit 28 opens the electric valve 27 and thus vents the air contained in the system.

As the steady-state temperature approaches, the expelled air is replaced with the steam produced by the heating of the heated vessel 11 in which a specific amount of water is contained.

The steam, by making contact with the probe 30 of the thermostat 25, heats it and, when the set temperature (70 ÷ 80 ÷ 90 ÷ 100°C) is reached, opens the contact, interrupting the supply of power to the electric valve 27, which closes the vent.

If any water is entrained towards the container 24 during venting, the water level probe 30 interrupts the power supply of the electric valve 27, closing the vent, and restores the power supply when the water has flowed out.

During normal operation of the heating system, and if no air is present inside it, the temperature of the hot region is constant and therefore the thermostat 25 has open contacts and the electric valve 27 is in the closed state.

If any air enters the system, it is confined towards the container 24, causing a decrease in the temperature of the thermostat 25, consequently closing the contact and supplying power to the electric venting valve 27.

In any case, the electric valve 27 is never opened if the internal pressure does not exceed the setting of the pressure switch 26 (0.1 - 0.2 bar), so as to avoid the inflow of air if the burner 15 stops momentarily.

With reference to Figure 3, in a so-called "split" embodiment of the system there is, for example, a heated vessel 111 (evaporator), an exchanger 113 and outgoing and return pipes 112 and 114.

In this case also, a venting device 23 identical to the one described earlier is installed.

With reference to Figure 4, in a second embodiment of the system, the exchanger, now designated by the reference numeral 213, in practice differs from the preceding one in that it is contained in a casing and is struck directly by the liquid or gaseous material to be heated.

In this case also, a venting device 23 is provided which is identical to the preceding one.

With reference now to Figure 5, a third embodiment of the system comprises units which are each constituted by a bundle 313 of tubes which are snugly connected to a metal plate 331 constituted by a sheet of metal, in which the ends are connected, on one side, to a heated vessel 311 by means of a manifold 332 and,

on the other side, to the heated vessel 311 by means of a second manifold 333.

A burner 315, or another system suitable for heating, is associated with the heated vessel 311.

The plates 331 are also covered, in an upward region, with an insulation which is suitable to limit heat loss.

The plates can be individual or can be mutually connected so as to constitute strips of considerable length and lie on a single side of the heated vessel 311 or on either side thereof.

In this case also, a venting device 23, identical to the preceding ones, is connected in one part of the system.

At this point it should be observed that in any system configuration it is possible to provide multiple plates or multiple tube bundles or multiple grids with one or more automatic air venting devices.

In practice, it has been observed that the intended aim and objects of the present invention have been achieved.

By providing evacuated-tube steam heating systems with automatic air venting devices, said systems have in fact been equipped with devices which are suitable to produce, inside them, the vacuum required for their operation, and all the drawbacks currently observed due to air infiltrations, occurring mainly in less than perfect welds between the various couplings, have been eliminated.

The venting device can of course also be used as a repressurizer, restoring atmospheric pressure in the system when it is not used.

This can be achieved by means of a reversing contact which inverts the operation of the electric valve.

The invention thus conceived is susceptible of numerous modifications and variations, all of which are within the scope of the inventive concept.

All the details may also be replaced with other technically or functionally equivalent elements.

In practice, the materials employed, so long as they are compatible with the contingent use, as well as the dimensions, may be any according to requirements.

Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly, such reference signs do not have any limiting effect on the interpretation of each element identified by way of example by such reference signs.

Claims

1. An automatic venting device for heating systems comprising one or more heat exchange elements which are individually or globally connected to a heated vessel which contains a substance having convective properties and is associated with heating means which are suitable to cause its evaporation, the condensate of the steam produced by said evaporation collecting directly, by natural or mechanical means, in said heated vessel; characterized in that it comprises a closed container which is connected to one or more regions of said heat exchange elements and is provided with sensors which are suitable to detect the presence of air and with an automatic vent valve, said sensors and said valve being connected to a control and management unit which receives signals from said sensors and opens and closes said valve.

2. A venting device according to claim 1, characterized in that it comprises a probe for indicating the water level inside said container.

3. A venting device according to claim 1, characterized in that said sensors suitable to detect the presence of air comprise a thermostat and a pressure switch.

4. A venting device according to claim 1, characterized in that said automatic venting valve is an electric venting valve.

5. A venting device according to claim 4, characterized in that it comprises a reversing contact to invert the operation of said electric venting valve.

6. An evacuated-tube steam heating system in thermodynamic equilibrium, characterized in that it comprises at least one heat-exchange element with at least one automatic venting device according to claim 1.

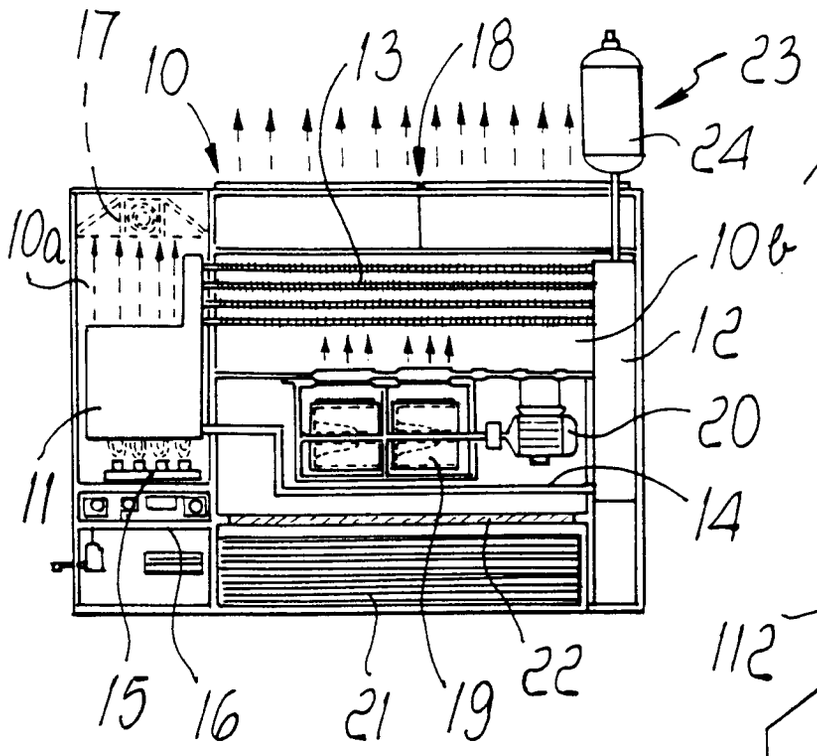

FIG.1

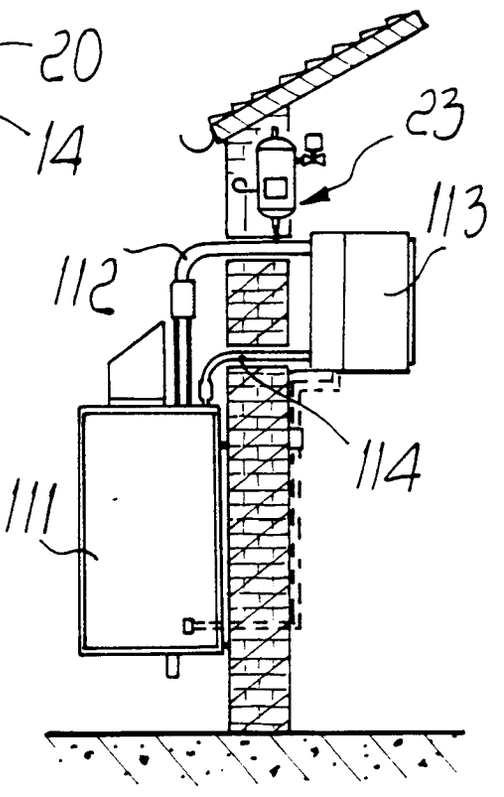

FIG.3

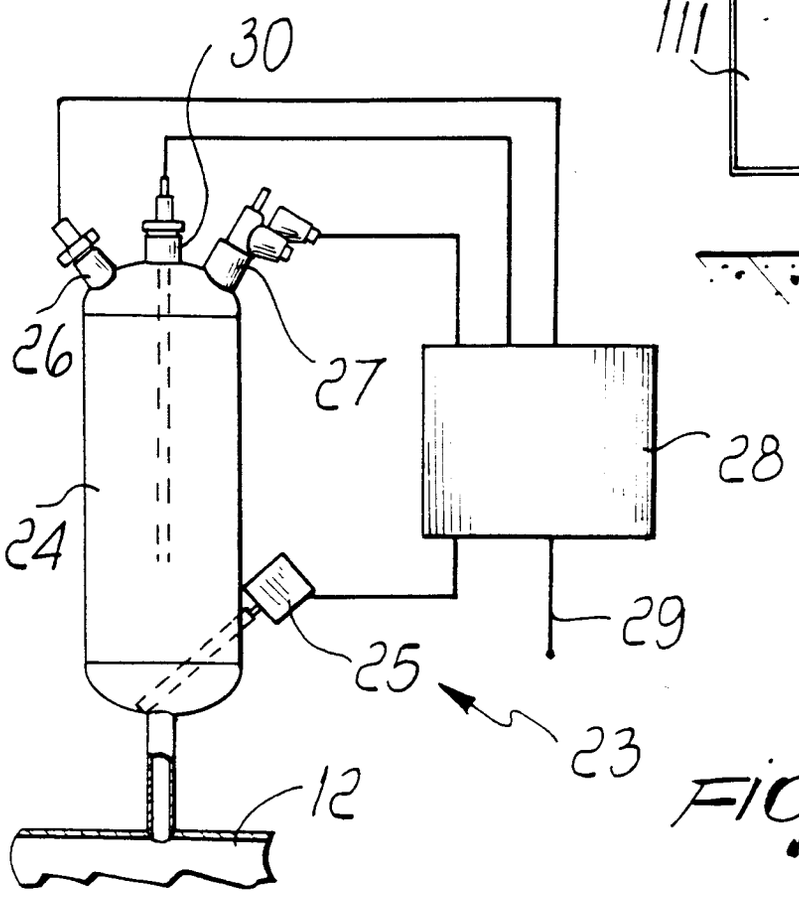

FIG.2

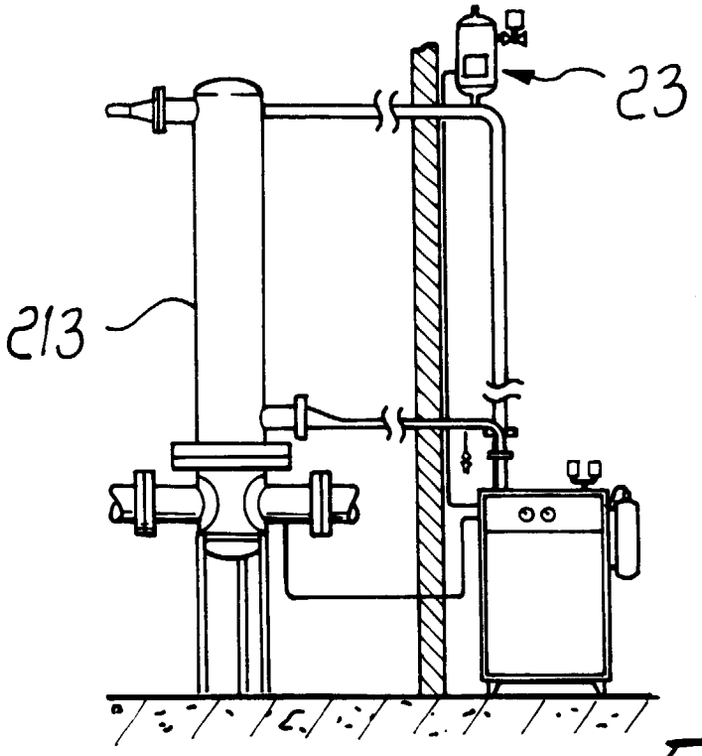

Fig. 4

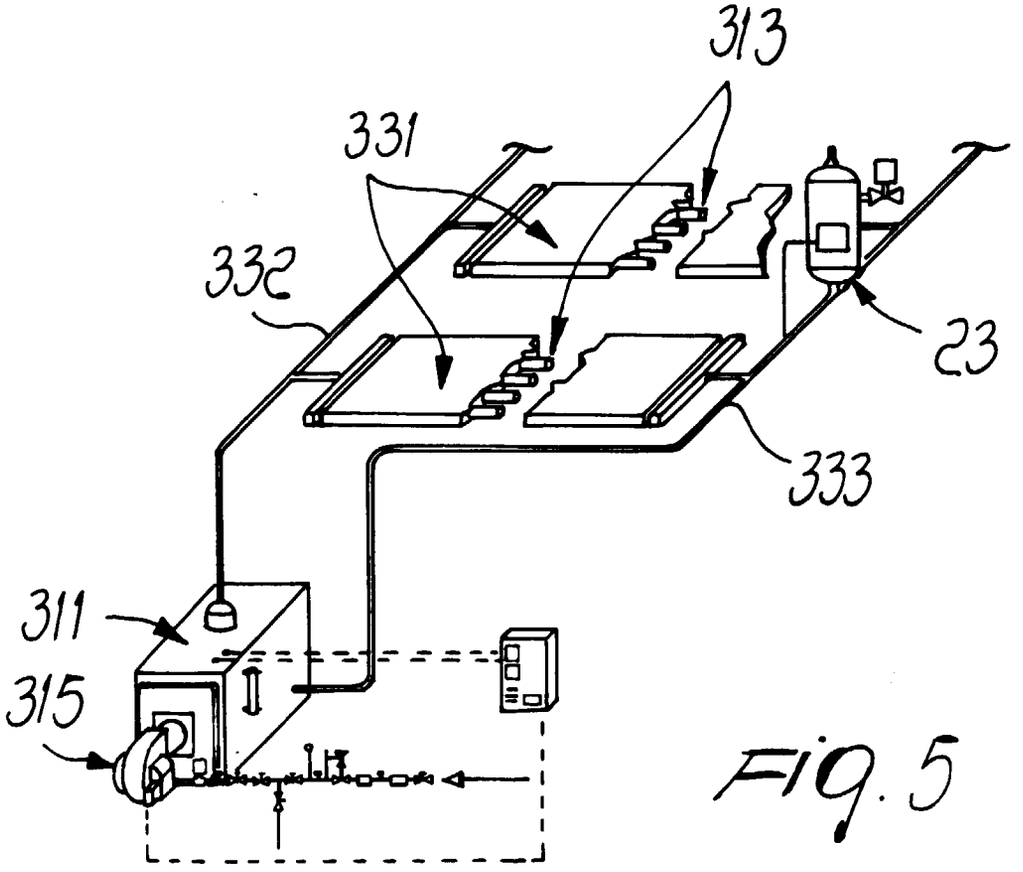

Fig. 5