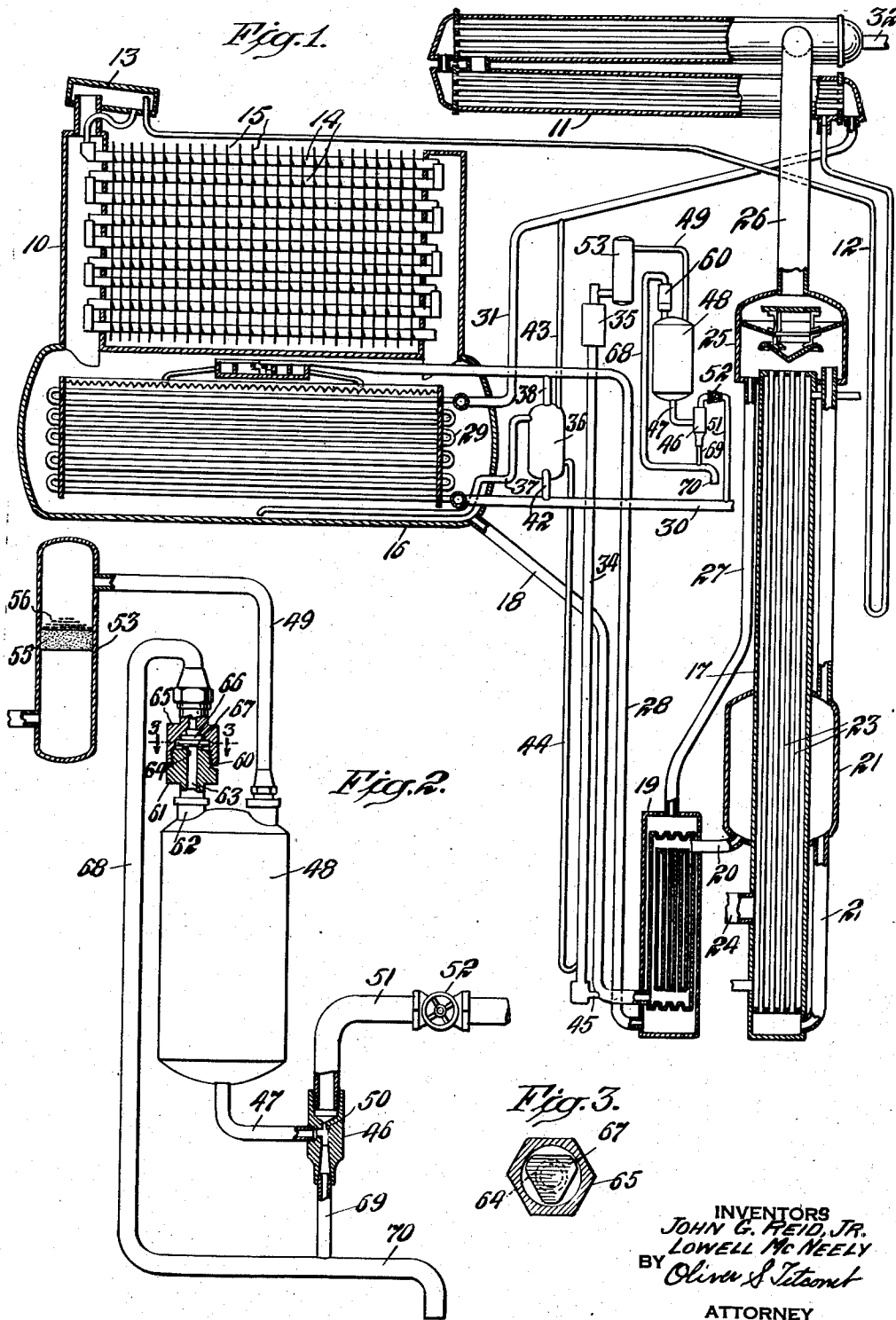


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SAFETY DEVICE FOR VALVES

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SAFETY DEVICE FOR VALVES

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The present invention relates to a safety device for mercury valves and/or seals of the type illustrated and described in the copending application for United States Letters Patent of Charles A. Roswell, Serial No. 481,729, filed April 3, 1943, entitled Valve. While such valves may have other uses they are particularly adapted for use with absorption refrigerating systems to permit purging of non-condensable gases.

In the application referred to above the valve is shown applied to an absorption refrigerating system which operates in a partial vacuum and utilizes water as a refrigerant and a saline solution as an absorbent. With such a system non-condensable gases may accumulate which must be purged from the system. The valve through which the non-condensable gases are purged is in the form of a porous plate having a small amount of liquid, such as mercury, covering its upper surface. When the pressure on the mercury side of the plate is less than the pressure on its opposite side, gases will flow through the valve. However, when the pressure existing above the mercury on the porous plate is substantially equal to or greater than that prevailing below the plate, the mercury is effective to close and seal the pores or openings in the plate and prevent the flow of gas therethrough.

A gas separating chamber is connected to the refrigerating system through the mercury valve and seal which permits the non-condensable gases to flow from the system to the chamber when the latter is evacuated but prevents the flow of air into the system from the atmosphere. The gas separating chamber may be evacuated by any suitable means but preferably an inexpensive water operated aspirator is used for this purpose. While the mercury valve and seal operates quite satisfactorily it may sometimes happen that the restricted throat of the aspirator will become clogged causing the water of the jet to flow into the gas separating chamber. Such accumulation and backing up of the water in the gas separating chamber will increase the pressure therein above that of the surrounding atmosphere which is apt to damage the valve by forcing the mercury through the porous plate.

One of the objects of the present invention is to provide a safety device for the mercury valve which will limit the pressure applied to said valve to substantially the pressure of the atmosphere surrounding the system.

Another object is to provide a safety device of the type indicated which is adapted to vent the gas separating chamber to the atmosphere

when the pressure therein tends to exceed the pressure of the atmosphere.

Another object is to provide a safety device of the type indicated which is of simple construction and one which is efficient and positive in its operation.

These and other objects will become more apparent from the following description and drawing in which like reference characters denote like parts throughout the several views. It is to be expressly understood, however, that the drawing is for the purpose of illustration only and not a definition of the limits of the invention, reference being had for this purpose to the appended claims. In the drawing:

Fig. 1 is a diagrammatical view of an absorption refrigerating system incorporating the novel features of the present invention;

Fig. 2 is an enlarged detail view showing the mercury valve and separating chamber for purging gases from the refrigeration system and the relief valve in the chamber for protecting the mercury valve from excessive pressures; and

Fig. 3 is a transverse sectional view taken on line 3—3 of Fig. 2 showing the construction of the relief valve.

Referring to Fig. 1 of the drawing, the invention is shown as applied to a two-pressure absorption refrigerating system similar to that illustrated and described in the copending application of Charles A. Roswell referred to above. In a system of this type liquid refrigerant such as, for example, water is introduced into the upper part of an evaporator or cooling element 10 from a condenser 11 through a path of flow including a U-shaped tube 12 and a chamber 13. The liquid refrigerant evaporates in evaporator 10 with consequent absorption of heat from the ambient, as from a stream of air flowing over the exterior surface of the tubes 14 and fins 15 of the evaporator. The refrigerant vapor formed in evaporator 10 flows therefrom to absorber 16 in which the vapor is absorbed into a liquid absorbent such as, for example, a solution of lithium chloride.

The absorption liquid enriched in refrigerant is conducted from the absorber 16 to a generator 17 in a path of flow including a conduit 18, liquid heat exchanger 19, conduit 20, vessel 21, and conduit 22. Within the generator 17 are disposed a plurality of riser tubes 23 enclosed by a chamber formed by an outer shell to which steam is supplied through a conduit 24 from a suitable source of supply. The heating of the riser tubes 23 by the steam causes refrigerant vapor to be expelled from the absorbent, and such expelled vapor is

effective to raise liquid absorbent by gas or vapor-lift action.

The expelled vapor passes from the upper ends of the riser tubes 23 into a vapor separator 25 and thence flows through a conduit 26 to the condenser 11 in which the vapor is liquefied. Liquid refrigerant formed in condenser 11 flows through the U-shaped tube 12 to the upper part of the evaporator 10, as explained above, to complete the refrigerating cycle. The raised absorption liquid from which refrigerant vapor has been expelled is conducted from the upper part of the generator 17 to absorber 16 to absorb refrigerant vapor, this liquid being conducted to the absorber in a path of flow including a conduit 27, liquid heat exchanger 19 and conduit 28. The heat liberated by absorption of refrigerant vapor in absorber 16 is taken up by the cooling medium such as, for example, water which flows upward through vertically disposed banks of pipes 29 in the absorber. The cooling water is introduced into the lower end of the banks of pipes through a conduit 30 and is discharged from the upper ends of the banks of pipes through a conduit 31. The conduit 31 is connected to condenser 11 so that the cooling water may separately be utilized to effect cooling of the condenser 11. Cooling water is discharged from condenser 11 through a conduit 32.

The system operates in a partial vacuum with generator 17 and condenser 11 operating at one pressure and evaporator 10 and absorber 16 operating at a lower pressure. The pressure differential between the high- and low-pressure sides of the system is maintained by liquid columns as disclosed in the United States Letters Patent to Albert R. Thomas et al., No. 2,282,503, issued May 12, 1942.

During operation of the refrigeration system non-condensable gases may accumulate in the various elements of the system. As explained in detail in the copending application of Charles A. Roswell, referred to above, the gas from condenser 11 is transferred to the evaporator 10 and the non-condensable gases in the evaporator are swept into the absorber 16 by the refrigerant as it flows into the absorber at high velocity. The non-condensable gases then accumulate in a layer at the bottom of the absorber 16. In order to transfer non-condensable gases from the absorber 16 to a vertical conduit 34 and vessel 35, which may be referred to as inactive parts of the system, an auxiliary absorber 36 is provided into which the non-condensable gases in the bottom of the absorber are drawn through a conduit 37.

Absorption liquid is introduced into the auxiliary absorber 36 through a conduit 38 which is connected at its upper end to conduit 28. In this way a portion of the absorption liquid flowing to the upper part of the absorber 16 is diverted from conduit 28 into conduit 38. The diverted absorption liquid is brought into intimate contact with the gases in the auxiliary absorber 36. Preferably a cooling coil, not shown, is provided within the auxiliary absorber 36 which is connected between the conduits 30 and 31 of the cooling system by means of connecting pipes 42 and 43. A vertical tube 44, which may be referred to as a fall tube pump, is connected at its upper end to the bottom part of the auxiliary absorber 36 and its lower end to the bottom part of the vertical conduit 34. Liquid intermittently fills the upper bent end of the vertical tube 44 and siphons therefrom,

whereby small quantities of the non-condensable gases are withdrawn from the bottom part of the auxiliary absorber and trapped between successive bodies or slugs of liquid. The internal diameter of the tube 44 is such that gas and liquid cannot pass each other while flowing down through the conduit. The non-condensable gases are discharged from the lower end of the tube 44 into vertical conduit 34 and freely bubble upwardly through the liquid in the latter. As the quantity of non-condensable gases trapped in vertical conduit 34 and vessel 35 increases, the liquid level in conduit 34 falls with the gases displacing the liquid which flows from the bottom of the conduit 34 into the conduit 18 through a connection 45.

The non-condensable gases in vertical conduit 34 and vessel 35 are exhausted from the refrigeration system to the atmosphere by a suitable vacuum pump such as, for example, a simple type water operated aspirator 46. The aspirator 46 is connected by a conduit 47 to a gas separating chamber 48 which, in turn, is connected by means of a conduit 49 to vessel 35. Conduit 47 is connected to the side of the throat of a Venturi tube forming the aspirator 46, see Fig. 2. A nozzle orifice 50 is disposed within the aspirator 46 and water under pressure is delivered thereto through a conduit 51. The conduit 51 is connected to conduit 30 for supplying cooling water to absorber 16 and in the conduit 51 is a manually operable valve 52 for controlling the operation of the aspirator.

In conduit 49 connecting the gas separating chamber 48 to the vessel 35 is a mercury type valve 53 which is effective to maintain the refrigerating system at a low pressure and at the same time allow non-condensable gases to pass therethrough when the aspirator 46 is operated. As shown most clearly in Fig. 2, the mercury valve 53 comprises an elongated vertical vessel across which a porous septum plate 55 extends. A small body 56 of a liquid such as, for example, mercury covers the top surface of the porous septum plate 55. The vertical vessel of the valve 53 may be formed of non-porous glass and the plate 55 may consist of a porous body of ceramic material, fritted or sintered glass particles, or glass strands. Such porous plates 55 formed of fritted or sintered glass are described in United States Letters Patent Nos. 1,620,815, 2,115,748, and 2,136,170. As thus far described, the system of refrigeration is substantially identical with that illustrated and described in the copending Roswell application, referred to above.

In accordance with the present invention a relief valve 60 is provided in the gas separating chamber 48 and is operated by the pressure therein to vent the chamber to the atmosphere. As shown most clearly in Fig. 2 the relief valve 60 comprises a valve body 61 in the form of a nipple attached at one end to a pipe connection 62 at the upper end of the chamber 48. The valve body 61 has an axial opening 63 communicating with the interior of the chamber 48 and an annular valve seat 64 at its upper end. A bonnet 65 is attached to the valve body 61 by means of cooperating screw threads, welding or the like. The bonnet 65 and valve body 61 cooperate to provide a chamber 66 therebetween in which a valve plate 67 is freely movable. As shown in detail in Fig. 3, the valve plate 67 is of generally triangular shape and adapted to cooperate with the valve seat 64 to seal the

axial opening 63 in the valve body 61. A conduit 68 connects the upper end of the bonnet 65 to a discharge tube 69 extending from the aspirator 46 and continues beyond the latter to provide a drain pipe 70.

When it is desired to effect removal of non-condensable gases from the refrigerating system the valve 52 is opened so that water will be supplied to the nozzle 50 of the aspirator 46. The water passing through the nozzle 50 acquires a high velocity and entrains gas or liquid flowing through the conduit 47 from the gas separating chamber 48 whereby to evacuate the chamber and effect a partial vacuum on the upper or outside of the mercury valve 53 in communication with the chamber through the conduit 49. When the pressure on the top or outside of the mercury valve 53 is less than the pressure below or on the inside of the valve the non-condensable gases in the vessel 35 and tube 34 of the refrigerating system will pass upward through the porous septum plate 55 and bubble through the small body of mercury 56. As the non-condensable gases are drawn through the valve 53 they pass through the conduit 49 into the chamber 48 and through the conduit 47 where they are entrained with the water of the aspirator 46 and exhausted through the discharge tube 69 and drain pipe 70. This operation is continued until the liquid in the conduit 34 rises to a predetermined level. When this level is reached the valve 52 is closed to discontinue the operation of the aspirator 46. The atmosphere then enters through the drain pipe 70, discharge tube 69, conduit 47, chamber 48 and conduit 49 to apply atmospheric pressure on the top of the body of mercury 56 or outside of the valve 53. The mercury 56, however, seals the pores of the plate 55 to prevent air from passing through the valve to enter the refrigeration system.

It sometimes happens during the operation of the aspirator 46 that the throat of the venturi becomes clogged or plugged which prevents the free flow of the water therethrough. Instead of evacuating the chamber 48 the water for the aspirator 46 then will flow into the chamber and tend to create a pressure therein greater than the pressure of the atmosphere surrounding the refrigeration system. Immediately upon the occurrence of such an abnormal condition the increase in pressure in the chamber 48 will be transmitted through the axial opening 63 in the valve body 61 of the relief valve 60 and unseat the valve plate 67 to vent the interior of the chamber 48 to the atmosphere through the conduit 68 and drain pipe 70. During the normal operation of the aspirator 46 the chamber 48 will be partially evacuated and the atmospheric pressure operating on the top of the valve plate 67 of the relief valve 60 will tend to engage the plate tightly with the valve seat 64. Any slight leakage which may occur between the valve plate 67 and valve seat 64 will tend to create a vacuum in the conduit 68 and draw part of the water discharged from the aspirator 46 upwardly in the conduit. Such column of water in the conduit 68 will then tightly seal the connection so as to adapt the chamber 48 to be efficiently evacuated.

The increase in pressure in the chamber 48 necessary to vent the latter will be equal to the sum of the pressure required to lift the valve plate 67 and the pressure drop through the valve passages 63, 65 and conduit 68 less the pressure head of the column of water in the conduit. Preferably the conduit is made relatively short so that

the pressure in the chamber 48 necessary to unseat valve plate 67 is substantially equal to or only slightly in excess of the atmospheric pressure. It will be understood, however, that the conduit may be made comparatively long so that the valve plate will open at pressures below the pressure of the atmosphere upon the occurrence of an abnormal condition such as the plugging of the throat of the aspirator.

It will also be apparent that the construction will provide a water seal in the conduit 66 in case of improper or faulty seating of the valve plate 67. Should the valve plate 67 fail to properly seat, the water exhausted from the aspirator 46 through the discharge tube 69 will be drawn upwardly through the conduit 68 and fill the valve chamber 66. The small amount of water which might leak between the valve plate 67 and valve seat 64 will not materially affect the operation of the aspirator 46 in evacuating the chamber 48.

It will now be observed from the foregoing specification that the present invention provides a safety device for a mercury valve and seal to prevent it from being subjected to excessive pressures. It will also be observed that the present invention provides a simple and compact structure which is positive and efficient in operation.

While a preferred embodiment of the invention is herein shown and described as applied to a particular absorption refrigeration system, it will be apparent to those skilled in the art that the invention may be applied to other systems and that various modifications and changes may be made in the construction of the parts without departing from the spirit or scope of the invention. For instance, the safety device for the mercury valve and seal may be used in other absorption refrigerating systems than that herein illustrated and described or may be applied to other kinds of systems such, for example, as vapor pressure heating system or the like. Therefore, without limiting ourselves in this respect, we claim:

1. In an absorption refrigerating system having a valve for permitting the escape of gases therefrom while preventing the flow of gases thereto, the combination with said valve of a chamber connected thereto, a jet type aspirator for evacuating the chamber, means for supplying fluid to said aspirator at a pressure above the atmosphere surrounding the system, and a relief valve in said chamber for venting the latter to the atmosphere, said relief valve being normally closed by the pressure of the atmosphere and opened automatically by pressure in the chamber.

2. In an absorption refrigerating system having a valve for permitting the escape of gases therefrom while preventing the flow of gases thereto, the combination with said valve of a chamber connected thereto, a water operated aspirator for evacuating the chamber and having a discharge tube, means for supplying water to said aspirator, a relief valve in said chamber, and a conduit connecting said relief valve and discharge tube from the aspirator whereby any leakage through the relief valve will produce a partial vacuum in the conduit to cause the relief valve to be opened by a pressure in the chamber below the pressure of the surrounding atmosphere.

3. In an absorption refrigerating system a valve for purging non-condensable gases comprising a porous plate and a body of mercury covering the outside of said plate, a chamber con-

nected to said valve at the outside of said plate, means for evacuating the chamber, and a relief valve in said chamber for venting the latter to the atmosphere.

4. In a closed system for circulating gases or vapor at a pressure below the pressure of the surrounding atmosphere, a valve for permitting the escape of gases from the system while preventing the flow of gases thereto, said valve comprising a porous plate and a body of mercury covering the outside of said plate, means for producing a vacuum on the outside of the plate of said valve to cause gases to flow outwardly therethrough, and means cooperating with said last named means and automatically operable to limit the pressure applied to the outside of the plate of said valve.

5. In a closed system for circulating gases or vapor at a pressure below the pressure of the surrounding atmosphere, a valve for permitting the escape of gases from the system while preventing the flow of gases thereto, said valve comprising a porous plate and a body of mercury covering the outside of said plate, a chamber connected to the outside of the plate of said valve,

a water operated aspirator for evacuating said chamber, and a relief valve in said chamber for venting the latter to the atmosphere upon a predetermined increase of pressure therein.

6. In an absorption refrigerating system, a gas storage vessel, a vacuum pump connected to a storage vessel, a valve between the vacuum pump and storage vessel for permitting the escape of gases from the system while preventing the flow of gases thereto, and a relief valve between the valve and vacuum pump and automatically operable to limit the pressure applied to the valve.

7. In an absorption refrigerating system, a gas storage vessel, a chamber connected to the storage vessel, a valve between the storage vessel and chamber for permitting the escape of gases from the vessel while preventing the flow of gases thereto, a vacuum pump connected to evacuate the chamber, and a relief valve in said chamber for venting the latter to the atmosphere upon a predetermined increase of pressure therein.

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