

Nov. 28, 1950

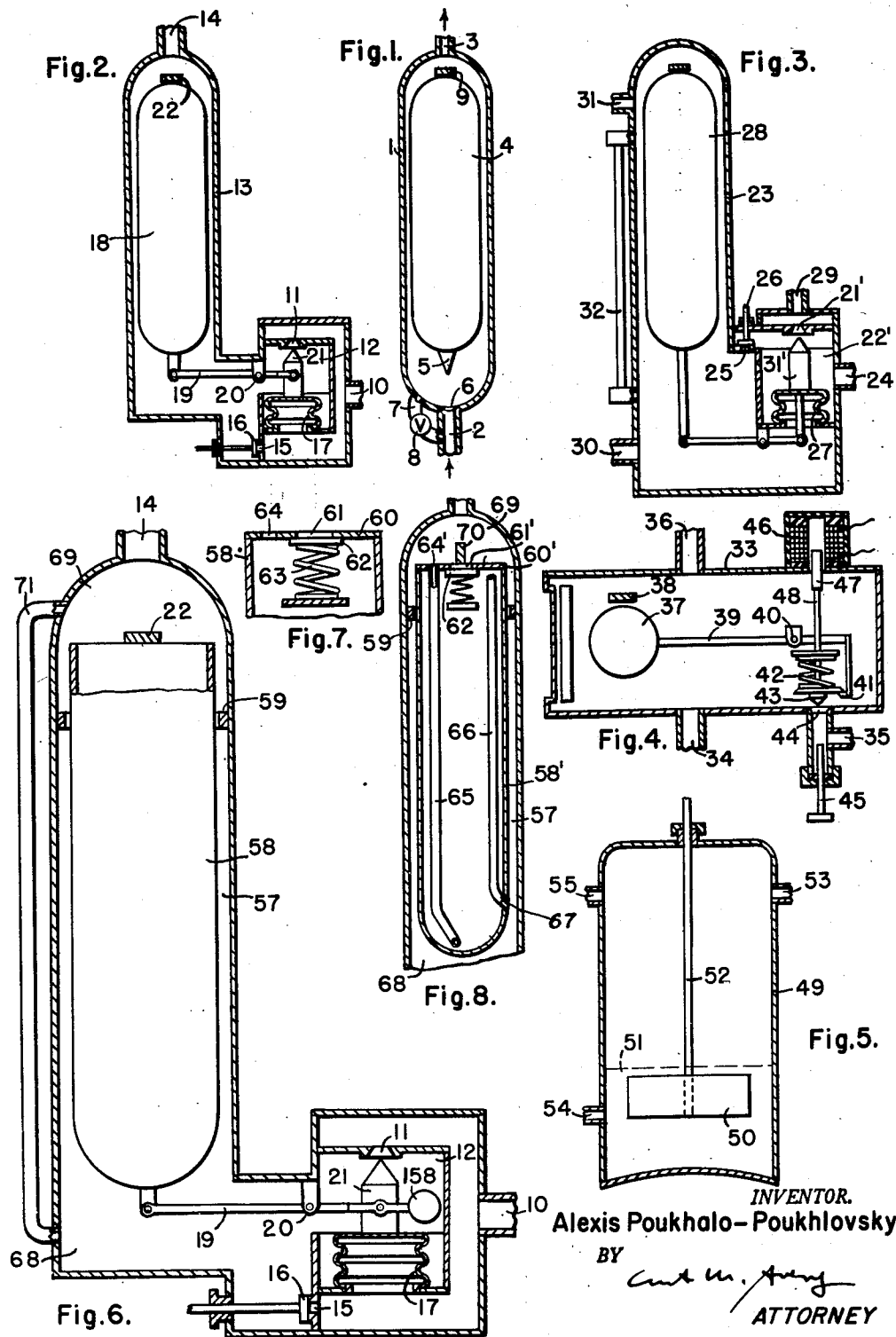
A. POUKHALO-POUKHLOVSKY

2,532,074

PROTECTIVE APPARATUS FOR REFRIGERATING SYSTEMS

Filed Nov. 19, 1946

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig4a.

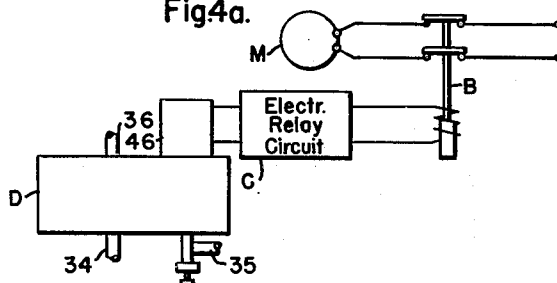


Fig4b.

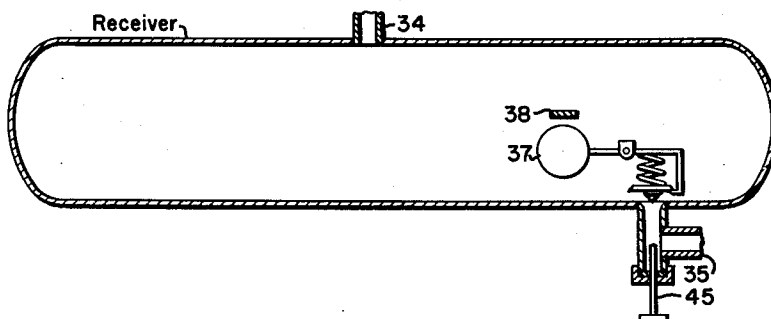


Fig7a.

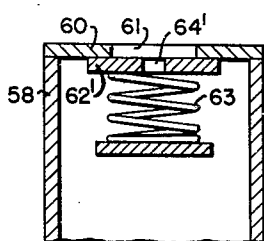
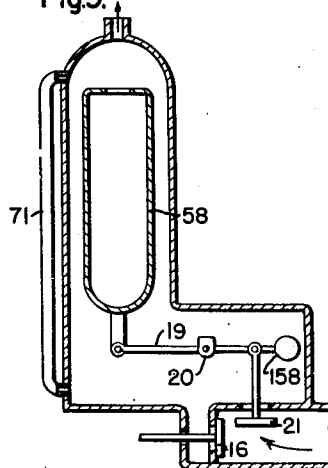


Fig9.



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UNITED STATES PATENT OFFICE

2,532,074

PROTECTIVE APPARATUS FOR REFRIG-
ERATING SYSTEMSAlexis Poukhalo-Poukhlovsky, Paris, France, as-
signor of one-half to Konstanty P. Puchlowski,
Pittsburgh, Pa.Application November 19, 1946, Serial No. 710,837
In France November 22, 1945

20 Claims. (Cl. 62-115)

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My invention relates to domestic and commercial refrigerators and, more in particular, to protective apparatus for refrigerators.

With odorless refrigerants, such as methyl chloride or Freon, the escape and loss of refrigerant, especially from small and medium-sized refrigerating systems, remains usually unnoticed until the refrigerating performance becomes unsatisfactory, i. e., when the system has lost all or nearly all of its charge.

It is, therefore, an object of my invention to provide an apparatus which automatically stops the operation of the system and confines the refrigerant as soon as a leak occurs in the system. As the above-mentioned refrigerants are expensive, the value of such a protective apparatus is evident.

With other refrigerants, such as sulphur dioxide or ammonia, a leak, as a rule, does not escape attention. However, a sudden break of a duct, preventing the attendant's access to the valves and permitting large quantities of the charge to escape, can cause considerable damage.

It is, therefore, a more general object of my invention to provide apparatus which prevent refrigerants of any kind from escaping from a refrigerating system in appreciable quantities by confining the refrigerant in the receiver or other suitable vessel in response to the occurrence of a relatively slight initial leakage or other anomaly.

In order to achieve these objects, and in accordance with one of the features of my invention, I provide a protective apparatus which has a valve disposed at a suitable place of the refrigerating system, and I control this valve by a sensing means that responds to changes in the density of the refrigerant, for instance, as caused by the occurrence of gas bubbles in the refrigerant liquid. According to a more specific feature of the invention, related to the one just mentioned, the density sensing means comprises a float member of a buoyancy so chosen that it descends in the liquid refrigerant in which it is located when the liquid suffers an appreciable change in density due to the gas inclusion caused by a leak. According to another feature of the invention, the density sensing means comprises a body, for instance cup-shaped, that is movably arranged in a vessel so as to form together therewith two chambers interconnected by an interstitial space so that the occurrence of occluded gas or bubbles causes the sensing body to move.

According to another aspect of the invention, I provide level-responsive float means which re-

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spond to an abnormal drop in liquid level, preferably in the receiver or in a vessel communicating with the receiver, and which effect a non-reversible control of a normally open valve so that the valve stops the flow of refrigerant upon occurrence of a leak or other abnormal condition.

According to another feature of my invention, I incorporate in the protective apparatus a power transforming means so that a slight force or torque produced by any of the above-mentioned sensing means suffices to control an appreciable force or torque acting on the valve controlled by the sensing means.

According to still another feature of the invention, I provide the protective apparatus with a trigger type mechanism which acts on the valve when released by the sensing means.

These and other objects and features of the invention will be apparent from the following description of the examples illustrated in the drawing, in which:

Figures 1 to 4 show, in section, four different embodiments, respectively, of apparatus according to the invention;

Figs. 4a and 4b show, respectively, two modifications based on the embodiment of Fig. 4;

Fig. 5 shows, in section, a receiver vessel of special design to be connected with apparatus such as shown in Fig. 3 or Fig. 4;

Fig. 6 represents a sectional view of a modification of apparatus such as shown in Fig. 2;

Figs. 7, 7a and 8 are partial views of modified details to be incorporated in apparatus as shown in Fig. 6; and

Fig. 9 shows another modification of an apparatus according to the invention.

The apparatus shown in Fig. 1 has a vertical vessel 1 whose inlet 2, at the vessel bottom, is to be connected to the receiver of a refrigerating system, while the outlet 3, at the top of vessel 1, is to be connected to the expansion valve (not shown) through which the refrigerant passes into the evaporator (not shown). In normal operation, the refrigerant leaves the receiver as a liquid and remains in this state until it reaches the expansion valve. Hence, the refrigerant, normally filling the vessel 1 and travelling in the direction indicated by arrows, is a liquid. A float 4 inside the vessel 1 is so balanced relative to the density of the liquid, i. e., has a buoyancy so chosen, that it just floats under normal conditions. The float member 4 carries at its bottom a valve needle 5 which is engageable with a valve-seat 6. The valve thus formed is by-

passed by a conduit 7 which is normally closed by a valve 8. A stop 9 is rigidly attached to the wall of vessel 1 and prevents the float 4 from obstructing the opening of outlet 3.

The normal charge of the system is just sufficient to provide the minimum level (in the receiver) at which a normal supply of liquid refrigerant to expansion valve or valves is secured. In consequence, the loss of a small quantity of refrigerant from a correctly charged system is sufficient to permit gas bubbles to enter into the liquid line. In current practice, the presence of bubbles, visible in a sight glass, is the first system of a shortage of refrigerant. Such a mixture of liquid and gas has a lower density than the pure liquid. Hence, when bubbles occur, the float will sink, obstructing with the needle the inlet port. The compressor continuing to run or the refrigerant to escape, the refrigerant will be withdrawn from the vessel 1, and the float 4 will press down with its whole weight, thus causing the needle 5 to safely close the valve at seat 6. To again start the system, the valve 8 in by-pass 7 is opened until the vessel 1 is refilled.

One of the known pressure control devices (not shown) may be provided in order to stop the compressor after the protective apparatus, above-described, has stopped the flow of refrigerant. It may happen, if the leak is relatively slight, that the compressor, before stopping and after having emptied the evaporators, temporarily reestablishes the normal level in the receiver. This however, has no effect on the protective apparatus which remains closed once a leak has been responded to. This non-reversibility of action secures a high degree of safety and hence represents a considerable advantage.

In an apparatus according to Fig. 1, the port of valve seat 6 must have a sufficient cross section to prevent too big a pressure drop. Therefore, in order to close the valve orifice by its weight, the float member 4 may have to be of inconveniently large size.

By modifying the construction of the apparatus, for instance as shown in Fig. 2, this inconvenience can be avoided. According to Fig. 2, the liquid enters at 10, passes through an orifice into a valve chamber 12 which communicates with the float chamber of vessel 13, and leaves at 14. A by-pass opening 15 is normally closed by a valve 16, and the same pressure, equal to the pressure of the condenser, exists on both sides of a gas-tight and movable partition 17 which is here shown as a bellows but may also consist of a diaphragm, piston or the like member. The float 18, when descending, transmits its movement by means of a suitable lever means 19, pivoted at 20, to a valve body 21. A stop 22, rigidly attached to vessel 13, limits the upward movement of float 18.

In contrast to the embodiment of Fig. 1, the float 18 according to Fig. 2 does not provide the force to close tightly the orifice 11. It suffices if the float closes the valve only partially so that the resulting throttling action produces a slight pressure drop in the chamber 12. The equilibrium of pressures on both sides of the bellows 17 is then disturbed, and the bellows 17 is caused to press the valve body 21 against the orifice 11. Consequently, the force that keeps the valve closed, is no longer dependent on the weight of the float but depends upon the ratio of the cross-sections of the orifice 11 and the partition or bellows 17. This force will be in-

fluenced by the ratio of the pressures in the evaporators and the condenser, but since the system is regulated by a pressure control, an elevation of pressure in the evaporators has no disturbing effect on the tightness of the seal. For starting or restarting the system, the by-pass valve 16 is to be temporarily opened.

As a loss of refrigerant in the system is accompanied by a lowering of the level in the receiver, it is also possible to base the functioning of the protective device on this level variation. Fig. 3 shows such an apparatus.

In contrast to Fig. 2, the valve chamber 22' of the apparatus shown in Fig. 3 is not in communication with the float chamber of vessel 23; and vessel 23 is not traversed by the liquid refrigerant. The float chamber is appropriately connected to the receiver by conduits 30 and 31 and the liquid in vessel 23 is on the same level as in the receiver.

In normal operation, the by-pass 25 is closed by a valve 26. The liquid enters through conduit 29, which is connected to the receiver, and passes through the orifice 21' and leaves the apparatus at 24. If the liquid level goes down in the receiver, it will go down just as much in vessel 23, and the float 28 will descend. This movement of the float is transmitted by an appropriate transmission through the movable and gas tight partition or bellows 27 to the valve body 31'. The partial closing of the valve disturbs the balance of pressures on both sides of the bellows 27 and the apparatus will then function like the one shown in Fig. 2.

In apparatus, where the closing of the valve is caused by the variation of the liquid level, the non-reversibility of the closing movement is essential because, when the liquid supply line is once closed, the compressor will pump gas from the evaporators to the condenser from which the liquefied refrigerant reaches the receiver before being stopped by the pressure control, and the level in the receiver will rise.

In apparatus according to the invention, regardless of whether they respond directly to density changes or to a change in liquid level, the float-controlled valve mechanism can be designed as a trigger device so that the movement of the controlling or sensing means is merely called upon to release an auxiliary source of power. An example of this kind is shown in Fig. 4.

According to Fig. 4, the closing of the valve of the protective apparatus is executed by a spring-operated power-storing device so that the float member during its descending movement has merely to release a detent or trigger. Such a device can be provided with springs sufficiently powerful to alone insure the closing of the valve, but the valve movement should remain non-reversible.

The apparatus shown in Fig. 4 has a vessel 33 with an inlet 34 and an outlet at 35. Another conduit is shown at 36. The upward movement of the float 37 is limited by a stop 38 which is attached to the wall of vessel 33. Conduits 34 and 36 are in communication with the receiver so that the liquid level in vessel 33 corresponds to that in the receiver, and the float 37 is given enough buoyancy to keep it afloat regardless of changes in density.

The float 37 is mounted on a lever 39, pivoted at 40, which has a trigger extension 41. A normally compressed spring 42 biases a valve disc 43 toward the appertaining valve orifice 44 but is normally held inoperative by the trigger 41. After

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the release of the trigger mechanism by the descending float, the mechanism can be reset by pushing a pin 45, operable from the outside, toward the valve disc 43 so that the disc is moved upward until the detent or trigger 41 engages the valve disc 43, provided the system has previously been recharged so that the vessel 33 is sufficiently filled with liquid to lift the float. If desired, and as also shown in Fig. 4, an electromagnet 46 may be provided to reset the mechanism electrically. The magnet 46 has a plunger type core 47 connected by a rod 48 to the valve disc 43. When the magnet 46 is energized, the core 47 moves upward and pulls the disc 43 into locking position. Such a magnet may be used with all other embodiments if desired. The setting of the spring-controlled mechanism can be accomplished simultaneously with the opening of a bypass valve and in one operation by interconnecting both devices in a suitable manner.

In all modifications of the invention, the descending movement of the float member can be utilized to vary the magnetic field of an outside magnet and to control an electrical device that will, for instance, close the liquid line or stop the compressor. This can be achieved, for instance, in apparatus similar to the one shown in Fig. 4, if the device 46, above referred to as an electromagnet, is designed as an inductance coil which changes its inductive resistance when the core 47 changes its position due to the float-controlled release and closing of the valve. This change in inductance is then used for controlling the above-mentioned electric devices (not shown). The electric devices should be of non-reversible operation so that they are reset by the attendant when resetting the float mechanism. An embodiment of this kind is shown in Fig. 4a. The device D according to Fig. 4a is similar to that shown in Fig. 4 but modified in the manner just mentioned. The inductance variations of the coil 46 control an electric relay circuit C to release the circuit breaker B of the compressor motor M thus stopping the motor when the float of device D closes the appertaining valve.

Apparatus according to the invention whose operation is based upon the variation in liquid level stop the system every time the level becomes abnormally low, no matter what caused it, and thus not only protect the refrigerating system but also draw the attention to the existence of anomalies, such as leaky expansion valves, loss of refrigerant, accumulation of the liquid in one evaporator, etc., that resulted in a displacement of the refrigerant to the low side. Since an undue accumulation of oil in the receiver may interfere with the normal operation of level-responsive apparatus, an oil-separator (not shown) of any commercially available type should be inserted between compressor and condenser in the known manner. An overcharge of refrigerant may prevent this kind of apparatus from signaling the before-mentioned operational anomalies; hence, the use of a visible liquid level or sight glass, such as shown at 32 in Fig. 3, is preferred.

To increase the sensitivity of the apparatus the interior cross section of the appertaining receiver can be diminished. For instance, Fig. 5 presents a schematic cross-section of a receiver 49, inside of which a movable body 50 is placed approximately at the height of the lowest normal operating level 51 or somewhat below that level. With the sinking of the liquid below the limit level 51, the float of the protective apparatus must begin to descend. The body 50 is attached

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to a movable rod 52, operable from the outside, so that the body 50 can be adjusted to its proper position. The receiver 49 is supplied with liquid refrigerant from the compressor (not shown) through the conduit 53 and has two conduits 54 and 55 for connection to the protective apparatus, for instance to conduits 30 and 31, respectively, of the apparatus shown in Fig. 3, or to conduits 34 and 36, respectively, of the apparatus according to Fig. 4. When the liquid level in the receiver 49 (Fig. 5) drops below the minimum level 51, the effect of the reduction in cross section caused by the body 50 has the effect that small changes in quantity of liquid produce large level variations so that the protective device has a correspondingly increased sensitivity.

The level-responsive protective device according to the invention can be placed inside the liquid receiver, especially if the characteristics of the system are known in advance; in that case devices according to the invention may have an apparent resemblance to the high-side float currently used to control the feeding of refrigerant from the receiver to the evaporator; but aside from a different function, the characteristic irreversibility of the closing movement of the protective apparatus distinguishes it essentially from such feed control devices. An example of a receiver with a built-in protective device according to the invention is shown in Fig. 4b. It will be recognized that this modification, in principle, is similar to the one shown in Fig. 4.

The density of a liquid refrigerant depends on its temperature which, being a function of the condensation temperature, is variable. Hence, the density of the refrigerant may vary, for instance, between summer and winter, over a range dependent upon that of the ambient temperature. Therefore, in apparatus according to the invention as described so far, the float has sufficient buoyancy to prevent the valve from closing at the expected lowest density, i. e. highest temperature of the liquid. This renders the apparatus less sensitive at lower liquid temperatures. However, such a change in sensitivity can be avoided by modifying the construction of the apparatus in the manner exemplified by Fig. 6.

The apparatus according to Fig. 6 is largely similar to that of Fig. 2 and, therefore, the same reference numerals are used in both figures for corresponding elements. However, in the apparatus of Fig. 6 the float 18 of Fig. 2 is replaced by a cup-shaped container 58 which is open at the top. The container 58 transmits its movement to the valve body 21 in the same way as described above with reference to Fig. 2. The weight of the container 58 is balanced in any appropriate way, for instance by a spring or, as shown, by a weight 158, so that the system rests in equilibrium and the valve orifice 11 is open when the apparatus is filled and traversed by the liquid refrigerant. In normal operation the container 58 is filled and surrounded by liquid of equal density. With the occurrence of gas bubbles mixed with the liquid in the annular space 57, the balance of the system is disturbed and the container 58 moves downward and causes the valve to close.

In order to make the apparatus sensitive to the presence of a small proportion of gas bubbles in the mixture, the annular space 57 must have a small cross section. To avoid an appreciable pressure drop that would check the downward movement of the container, it is possible to di-

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minish this cross section by restricting the passage only over a small length as at 59 in the upper part of the annular space 57.

As soon as the valve will close, the liquid contained in the apparatus begins to evaporate. The container 58 should not be emptied more quickly than the annular space 57, otherwise the container 58 would rise and oppose the closing of the valve by the movable partition 17. Care should also be taken to have the apparatus ready for functioning as soon as the valve 16 of by-pass opening 15 is opened, in order to be sure that it is the protective apparatus and not an obstruction in the refrigerant circuit that causes the system to stop. In other words, when the system is in operation, the container 58 should be filled rapidly and be emptied slowly.

One of the means for obtaining such a result is to provide the container 58 with a cover as shown in Fig. 7. This cover 60 has two openings of different diameters; the larger opening 61 is closed by a valve disc 62 pressed against the cover 60 by a spring 63. This valve permits the rapid filling of the container 58 but will oppose itself to the emptying of it. The container 58 will be emptied through the other, smaller opening 64, the diameter of which is chosen in such a way that the emptying of the annular space 57 (see Fig. 6) proceeds more quickly than that of the container.

Another way to obtain the same result would be to provide the cover 60 with only one opening and to close that opening by a leakage valve so that the valve presents less impedence to the influx than to the outflux of liquid. Such a modification is schematically shown in Fig. 7a. According to this figure, the cover 60 has only one opening 61 while the valve member 62' has a leakage opening 64'.

Gas bubbles and oil present in the refrigerant circuit can possibly penetrate into the container 58. If the oil is lighter than the liquid refrigerant, it will be evacuated through the opening 64 (Fig. 7). If it is of the same density, its presence will not affect the working of the apparatus. Gas bubbles will leave the container through the same opening 64.

In the case of oil heavier than the refrigerant, the construction of the container 58 should preferably be altered as exemplified by Fig. 8.

According to Fig. 8, the modified container 58' has inside two tubes of small diameter. The first tube 65 starts at the bottom of the container 58', where oil may accumulate, and issues into the opening 64'. Tube 65 serves the same purpose as opening 64 in the modification of Fig. 7. The second tube 66 communicates with the annular space 57 through an orifice 67 in the wall of the container 58' close to its bottom. Tube 66 terminates close to the cover 60'.

A pressure difference between spaces 68 and 69, due to the pressure drop in the annular space 57 and the narrow passage at 59, creates a current in both tubes that causes the evacuation of oil.

Gas bubbles may penetrate in the container 58' at the moment when the system is started or through the tube 66. This gas will make the container (including its contents) lighter so that container 58' rises. However, a stop 70, firmly secured to vessel 68, then engages the valve 62 and prevents the valve from following the rising movement of the container 58'. Hence, the valve opens and the gas will escape through the opening 61'. As a result, the weight of the con-

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tainer 58' is restored to its normal value so that the container sinks back to its normal position.

Density-sensitive apparatus according to the invention, in any of the above-described embodiments and modifications, may be equipped with a second by-pass conduit or duct, such as exemplified at 71 in Fig. 6, which shunts the sensing member and the interstitial passage formed thereby. This by-pass (71 in Fig. 6) extends between the chambers 68 and 69 below and above the cup member 58 and may contain an exteriorly operable adjusting valve (not shown).

In cases where the diminution of the difference between the pressures of the high and low sides is not to be feared, it is possible, by placing the valve on the side of the arriving liquid, to close it tightly by the direct action of the float or floating container. This is schematically shown in Fig. 9. The apparatus illustrated in this figure is largely similar to that of Fig. 6 as will be recognized from the corresponding reference numbers. The flow direction of the liquid in Fig. 9 is denoted by arrows.

As is evidenced by the modifications shown and described, and as will be understood by those skilled in the art, my invention permits of various modifications and alterations other than those specifically disclosed without departing from the objects, principles and essential features of my invention and within the scope of the claims annexed hereto.

I claim as my invention:

1. Protective apparatus for refrigerating systems, comprising a refrigerant vessel having conduit means for connection to the system to be protected, movable control means responsive to a refrigerant condition and disposed in said vessel, a refrigerant control valve connected to said control means to be controlled thereby in order to continuously prevent the flow of refrigerant in the system when said control means responds to a given abnormal value of said condition, and exteriorly actuable resetting means for said valve.

2. Protective apparatus for refrigerating systems, comprising a vessel for refrigerant having conduit means for connection to the system to be protected, valve means for controlling the flow of refrigerant in the system, density-responsive control means disposed in said vessel to respond to changes in density of the refrigerant, and means connecting said control means with said valve for controlling the latter to prevent the flow of refrigerant in the system when said density drops below a given value.

3. Protective apparatus for refrigerating systems, comprising a vessel for refrigerant having conduit means for connection to the system to be protected, valve means for controlling the flow of refrigerant in the system, density-responsive control means disposed in said vessel to respond to changes in density of the refrigerant, and means connecting said control means with said valve for closing said valve to prevent the flow of refrigerant in the system when said density drops below a normal value, and exteriorly actuable resetting means for causing said valve to open.

4. Protective apparatus for refrigerating systems, comprising a vessel for refrigerant having conduit means for connection to the system to be protected, valve means for controlling the flow of refrigerant in the system, a float member movably disposed in said vessel and balanced relative to the refrigerant so as to descend in said refrigerant when the refrigerant density

drops below a given value, and means disposed between said float member and said valve for causing the latter to close in response to descending movement of said float member.

5. Protective apparatus for refrigerating systems, comprising a vessel for refrigerant having conduit means for connection to a system to be protected, valve means for controlling the flow of refrigerant in the system, a float member movably disposed in said vessel and balanced relative to the refrigerant so as to descend in said refrigerant when the refrigerant density drops below a given value, and means disposed between said float member and said valve for closing said valve to prevent the flow of refrigerant, and exteriorly actuable resetting means for opening said valve.

6. Protective apparatus for a refrigerant line, comprising a vessel having conduits for connection into the line, a member movably disposed in said vessel so as to change its position in response to an abnormal refrigerant condition, a normally open valve for blocking the refrigerant line when the valve is closed, a power translating means connected with said valve for providing closing force for the latter and being controlled by said member to apply said force when said float member moves in response to said condition, and separately controllable resetting means for opening said valve.

7. Protective apparatus for a refrigerant line, comprising a vessel having conduits for connection to the line so that said vessel is normally traversed by refrigerant, a control member movably disposed in said vessel so as to change its position in response to an abnormal refrigerant condition, a normally open valve for blocking the refrigerant line when the valve is closed, a movable partition disposed in said vessel to separate therein two chambers for refrigerant, said valve being connected with said partition to be closed by movement of said partition due to pressure difference between said chambers, and means actuable by said member to control said pressure difference so as to cause closing of said valve when said member moves in response to said condition.

8. Protective apparatus for a refrigerant line, comprising a vessel having conduits for connection to the line so that said vessel is normally traversed by refrigerant, a control member movably disposed in said vessel so as to change its position in response to an abnormal refrigerant condition, a normally open valve for blocking the refrigerant line when the valve is closed, power means disposed to bias said valve toward closing, a trigger mechanism normally preventing said valve from responding to said power means, said member being connected with said trigger mechanism to release said valve for closing in response to said condition, and separately controllable means for resetting said valve and said power means.

9. Protective apparatus for a refrigerant line, comprising a refrigerant vessel having conduits for insertion of said vessel in the high pressure zone of the line so that said vessel is normally traversed by liquid refrigerant, a normally open valve in said vessel for blocking the refrigerant line when closed, movable control means in said vessel responsive to an abnormal refrigerant condition for causing said valve to close upon occurrence of said condition, a by-pass shunting said valve and a separately controllable check valve disposed in said by-pass and normally closing

the latter to permit opening said first valve by opening said check valve.

10. Protective apparatus for a refrigerant line, comprising a refrigerant vessel having an inlet conduit for connection to the high pressure side of the line and an outlet conduit for connection to the evaporator side of the line so that said vessel is normally traversed and filled by liquid refrigerant, a normally open valve disposed in said vessel near said inlet conduit, movable control means in said vessel responsive to an abnormal refrigerant condition for causing said valve to close upon occurrence of said condition, a by-pass shunting said valve, and a separately controllable and normally closed valve disposed in said by-pass to permit opening said first valve by opening said second valve.

11. Protective apparatus for a refrigerating line, comprising a vessel having conduits for connection into the line at the high pressure side thereof so that a given minimum level of liquid refrigerant obtains in said vessel under normal refrigerant conditions, a float member disposed in said vessel and movable in response to changes in refrigerant level, a normally open valve controlled by said float member to close in response to occurrence of a level below said minimum to then prevent the flow of refrigerant in the line, and exteriorly actuable means for resetting said valve to open position.

12. Protective apparatus for a refrigerating line having a receiver for liquid refrigerant, comprising a vessel having two conduits for connection to the receiver so that said vessel contains normally a quantity of liquid refrigerant above a given minimum level, a normally open valve for preventing the flow of refrigerant in the line when closed, a float member disposed in said vessel to move in accordance with changes in level and connected to said valve for controlling the latter to close in response to the occurrence of a level below said minimum, and separately controllable means for resetting said valve to open position.

13. Protective apparatus for a refrigerant line, comprising a vessel having respective inlet and outlet conduits for insertion into the line of the high pressure side thereof so that said vessel is normally traversed by liquid refrigerant, a member disposed in said vessel so as to form together therewith an annular interstice and two chambers above the top side and below the bottom side respectively of said member, said member being balanced relatively to the refrigerant so as to move relatively to said vessel when the difference in pressures in said respective chambers exceeds a given value, and a normally open valve for preventing the flow of refrigerant in the line when closed, said valve being controlled by said member to close in response to movement of said member, and separately controllable means for resetting said valve to open position.

14. Protective apparatus for a refrigerant line, comprising vertically elongated vessel having an inlet conduit at its bottom and an outlet conduit at its top for insertion of said vessel into the line at the high pressure side thereof so that said vessel is normally traversed by liquid refrigerant, a vertically elongated member movably disposed in said vessel so as to form together therewith an annular interstitial space and two chambers respectively located above the top side and below the bottom side of said member, said member being balanced relative to the refrigerant so as to descend in said vessel when the difference

of pressure in said two chambers exceeds a given value due to the occurrence of gas bubbles, a normally open valve disposed for closing said inlet conduit under control by descending movement of said member, a by-pass for refrigerant shunting said valve, and a normally closed valve disposed in said by-pass and separately controllable to open said by-pass.

15. Protective apparatus for a refrigerating line, comprising a vessel having conduits for connection into the line at the high pressure side thereof so that said vessel is normally traversed by liquid refrigerant, a cup-shaped member open at the top and movably disposed in said vessel so as to form together therewith an annular interstice and two chambers respectively disposed above the top and below the bottom of said member, said member being substantially balanced so as to move relatively to said vessel in response to the occurrence of an abnormal pressure difference between said chambers, and a normally open valve controlled by said member to close the line upon occurrence of movement of said member.

16. Protective apparatus for a refrigerating line, comprising a vessel having conduits for connection into the line at the high pressure side thereof so that said vessel is normally traversed by liquid refrigerant, a cup-shaped member open at the top and movably disposed in said vessel so as to form together therewith an annular interstice and two chambers respectively disposed at the top and bottom of said member, said member being substantially balanced so as to move relatively to said vessel in response to the occurrence of an abnormal pressure difference between said chambers, means covering the top of said member and having an opening and check valve means disposed for rapid filling and slow emptying of said member, and a normally open valve controlled by said member to close the line upon occurrence of movement of said member.

17. Protective apparatus for a refrigerating line, comprising a vessel having conduits for connection into the line at the high pressure side thereof so that said vessel is normally traversed by liquid refrigerant, a cup-shaped member open at the top and movably disposed in said vessel so as to form together therewith an annular interstice and two chambers respectively disposed at the top and bottom of said member, said member being substantially balanced so as to move relatively to said vessel in response to the occurrence of an abnormal pressure difference between said chambers, means covering the top of said member and having two openings of different cross section, a check valve disposed for closing the larger arc of said opening so as to obstruct the discharge of liquid from said member through said larger opening while permitting the entrance of liquid into said member through said larger opening, and a normally open valve controlled by said member to close the line upon occurrence of movement of said member.

18. Protective apparatus for a refrigerating line, comprising a vessel having conduits for connection into the line at the high pressure side thereof so that said vessel is normally trav-

ersed by liquid refrigerant, a cup-shaped member open at the top and movably disposed in said vessel so as to form together therewith an annular interstice and two chambers respectively disposed at the top and bottom of said member, said member being substantially balanced so as to move relatively to said vessel in response to the occurrence of an abnormal pressure difference between said chambers, means covering the top of said member and having an opening and a check valve disposed to reduce the flow of liquid from said member while facilitating the flow of liquid into said member, a stop disposed in said vessel to engage said check valve to open the latter when said member is in said vessel beyond a given position, and a normally open valve controlled by said member to close the line upon occurrence of movement of said member.

19. Protective apparatus for a refrigerating line, comprising a vessel having conduits for connection into the line at the high pressure side thereof so that said vessel is normally traversed by liquid refrigerant, a cup-shaped member open at the top and movably disposed in said vessel so as to form together therewith an annular interstice and two chambers respectively disposed at the top and bottom of said member, said member being substantially balanced so as to move relatively to said vessel in response to the occurrence of an abnormal pressure difference between said chambers, means covering the top of said member and having a check valve controlling said opening to obstruct the flow of liquid out of said member through said opening while facilitating the flow of liquid through said opening into said member, a tube disposed in said member having one open end near the bottom of said member and running to the outside of said member through said covering means, a second tube disposed in said member and having one end in communication with said annular interstice and the other end extending close to said covering means and in communication with the interior of said member, and a normally open valve controlled by said member to close the line upon occurrence of movement of said member.

20. Protective apparatus for a refrigerating system, comprising a refrigerant vessel having conduit means for connection to the system to be protected so that said vessel is normally traversed by refrigerant, a control member disposed in said vessel and movable in response to an abnormal refrigerant condition, a conduit communicating with said vessel so as to by-pass said member, a refrigerant control valve under control by said member to prevent the flow of refrigerant in the system when said member responds to said condition, and separately controllable means for resetting said valve.

ALEXIS POUKHALO-POUKHLOVSKY.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,947,574	Williams	Feb. 20, 1934