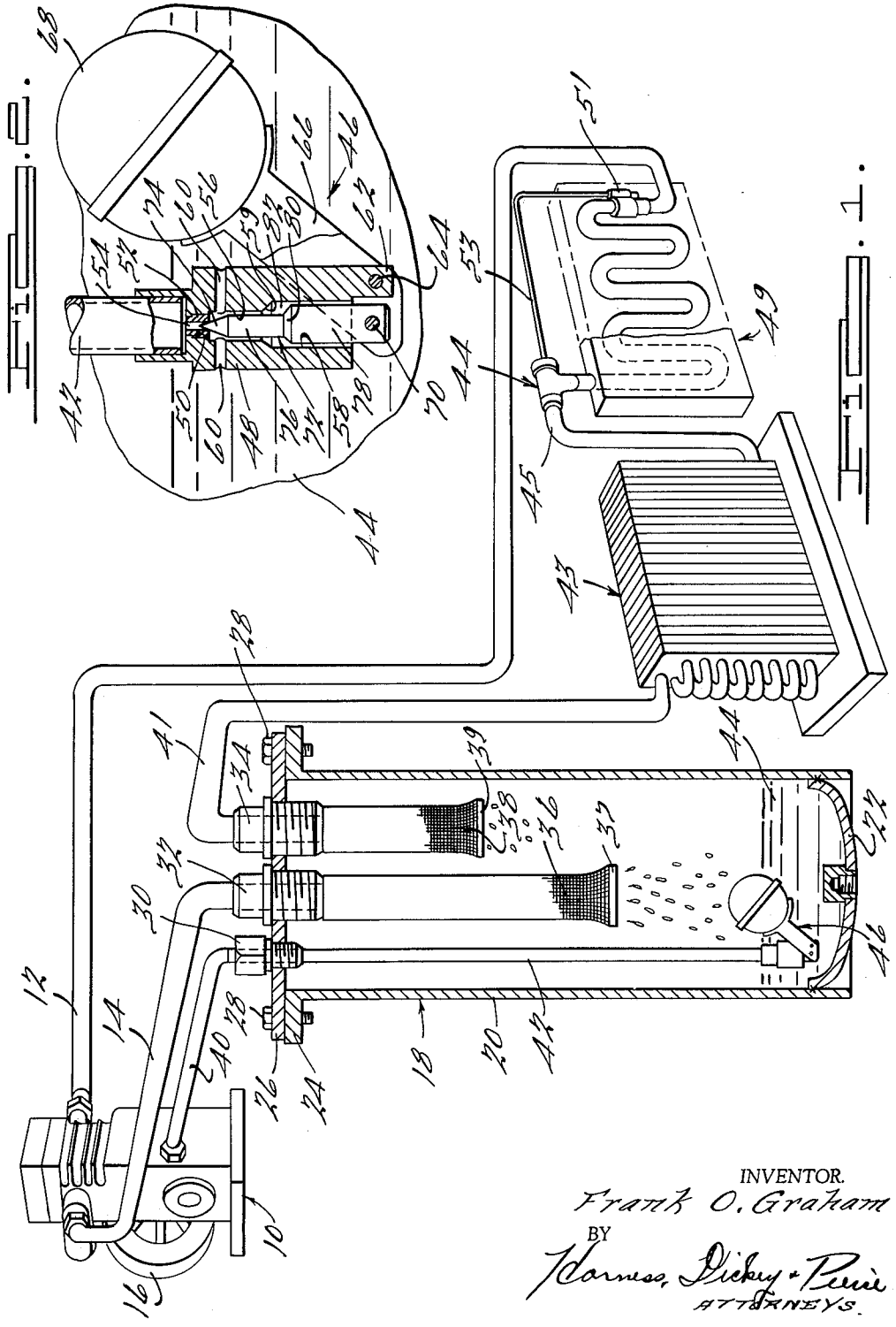
Sept. 7, 1965 F. O. GRAHAM 3,204,389

LIQUID SEPARATOR

Filed April 4, 1963



INVENTOR.
Frank O. Graham
BY
Harness, Dickey & Pierce
ATTORNEYS.

United States Patent Office 3,204,389 Patented Sept. 7, 1965

3,204,389

LIQUID SEPARATOR

Frank O. Graham, Detroit, Mich., assignor to Temprite Products Corporation, Birmingham, Mich., a corporation of Michigan

Filed Apr. 4, 1963, Ser. No. 270,608
4 Claims. (Cl. 55—219)

The present invention relates generally to refrigeration systems and more particularly to the provision in such a system of a novel oil separator incorporating a unique float valve having dampening action.

As is well known, most refrigeration systems utilize a conventional piston-type compressor in which lubrication of the compressor parts is achieved through the use of oil normally supplied from the compressor crankcase or a suitable reservoir. In actual practice, a certain proportion of this oil eventually leaks past the piston and into the compression chamber of the compressor, whereupon it is atomized and becomes entrained in the gaseous refrigerant as it is compressed. This gradual but continuous loss of oil is extremely undesirable for a number of reasons. For example, the compressor will burn out if it loses too much oil; the expansion valve will become gummed up and not function properly; oil will get into the condenser and evaporator and cause a substantial decrease in the rate of heat transfer and hence efficiency while increasing power consumption; and the presence of oil in the refrigerant itself alters its true boiling and condensing points, thus further reducing refrigeration efficiency.

To eliminate this problem an oil separator may be inserted in the refrigerant line between the compressor and the condenser. The oil thus separated from the refrigerant may then be filtered and forced back to the compressor crankcase by the high pressure of the refrigerant in the oil separator. The provision of an oil separator not only eliminates all the aforesaid problems but also serves to provide the compressor with a constant supply of clean oil, thus further increasing its life, and to muffle to some extent the sound of the system.

One type of oil separator which has been found to be ideally suited for this application is one which mechanically separates the oil from the compressed gaseous refrigerant by coalescing the entrained oil and allowing it to gravity flow or drip into a sump or reservoir in the separator. The flow of oil from the separator sump to the compressor may be controlled by a float valve which is responsive to the oil level in the sump to open the valve when the sump level reaches a predetermined height, whereupon the oil will be forced back to the compressor crankcase under the influence of the high pressure of the refrigerant in the separator.

It has been found, however, that in refrigeration systems which are subject to severe vibrations and sudden or abrupt physical movements, such as those encountered on trucks, buses, planes, trains, and other mobile equipment, the resultant sloshing of the oil in the separator sump causes the float valve therein to continually and needlessly pound against its seat. As a consequence, the valve does not operate effectively and both it and its seat wear out extremely fast, at which time the entire valve becomes totally ineffective.

It is therefore an object of the present invention to provide in combination with a refrigeration system an oil separator having a float valve therein provided with unique dampening means to prevent excessive wear of the valve components, as well as ineffective operation of the valve, when the system is subject to vibrations and abrupt physical movements, such as encountered on mobile equipment.

It is a further object of this invention to provide a novel oil separator in which is provided a unique float valve having dampening means for preventing the injurious effects of vibrations and abrupt physical movements of the separator.

Another object resides in the provision of an extremely simple and inexpensive float control valve having novel dampening action. A related object resides in the provision of such a valve wherein dampening is achieved by a fluid dash pot utilizing the same fluid as is being controlled.

These and other objects of the present invention will become apparent from consideration of the specification, taken in connection with the accompanying drawings in which there is illustrated a single embodiment of the present invention, by way of example, and wherein:

FIGURE 1 is a diagrammatic view illustrating an entire refrigeration system having an oil separator, shown partly in section, incorporating the principles of the present invention; and

FIGURE 2 is an enlarged sectional view of the oil separator float valve.

Referring first to FIGURE 1, the refrigeration system is conventional and comprises a compressor **10** having inlet and outlet fluid lines **12** and **14** respectively, and a pulley or the like **16** adapted to be engaged by a suitable driving source to power the compressor. The gaseous refrigerant compressed by the compressor flows through fluid line **14** to an oil separator **18** comprising cylindrical side walls **20**, a bottom wall **22**, an upper mounting flange **24** having a plurality of equally spaced threaded openings therethrough, a cover **26** and a plurality of machine screws or the like **28** securing the cover to the mounting flange to form a leakproof pressure-resistant seal.

In the embodiment illustrated, cover **26** is provided with several threaded openings in which are tightly secured fittings **30**, **32** and **34** respectively. Fluid line **14** communicates with the upwardly and outwardly projecting portion of fitting **32** and secured to the lower or inward portion of the fitting is a generally cylindrical separator screen **36** disposed wholly within the separator and having its lower end pinched closed and sealed, as at **37**. The lower portion of fitting **34** is provided with a similar but shorter separator screen **38** having a sealed end **39** and the upward projecting portion of the fitting is in fluid communication with a fluid line **41** for carrying compressed gaseous refrigerant from which the entrained oil has been removed out of the oil separator. The crankcase of the compressor is maintained in fluid communication with the oil separator by means of a fluid line **40** extending from the compressor to the upwardly or outwardly projecting portion of fitting **30**. The lower inside end of the oil separator defines a sump **44** for collecting the separated oil, and a fluid line **42** extends from the lower inner portion of fitting **30** to a point below the level of oil in sump **44**. The passage of fluid from sump **44** through fluid lines **42** and **40** to the compressor crankcase is regulated by means of a float valve indicated generally at **46**.

From the oil separator the compressed gaseous refrigerant passes through fluid line **41** to a condenser **43** wherein it is cooled and condensed. The condensed refrigerant passes from condenser **43** through a fluid line **45** and an expansion valve **44** into an evaporator **49**. As the condensed refrigerant passes through the evaporator it evaporates and absorbs heat from the surrounding medium to cool the latter, after which the evaporated refrigerant passes into fluid line **12** which carries it back to the inlet of the compressor. Affixed to evaporator discharge line **12** is a bulb **51** containing a thermo-responsive fluid which is communicated through a fluid line **53** to the expansion valve to control the latter. The refrig-

eration system, as thus generally described, is conventional both in principle of operation and in construction.

The oil separator functions in the following manner. Compressed gaseous refrigerant having oil entrained therein flows into the oil separator through fitting **32** and then through separator screen **36** which causes the minute droplets of entrained oil to coalesce into larger heavier drops on the screen. These relatively large drops of removed oil then drip from the separator screen into sump **44** in the manner indicated. Further separation may be effected by a sharp reversal in direction of a portion of the gaseous flow from separator screen **36** toward separator screen **38** which serves to further coalesce and separate any remaining entrained oil in the refrigerant stream. Screens **36** and **38**, which may be several layers thick, also may act to some extent as mechanical filters.

As oil is removed, it collects in sump **44** thus gradually increasing the level thereof. When the level reaches a predetermined point float valve **46** opens to allow oil in the sump to be forced by the high pressure refrigerant in the oil separator through lines **42** and **40** to the compressor crankcase. If foreign matter was originally present in this oil it will for the most part be removed by the filtering action of screen **36** or it will simply drop to the bottom of sump **44** under the influence of gravity so that the oil returning to the compressor will be cleaned. Since the inlet of fluid line **42** is disposed below the normal level of oil in the sump there is no chance of refrigerant escaping through fluid lines **42** and **40** to the crankcase of the compressor. The arrangement of the oil separator components may of course be rearranged, depending on the application contemplated.

The details of construction of the float valve are best illustrated in FIGURE 2. The lower end of fluid line **42** is sealingly positioned within one end of a valve housing **48** having a longitudinally extending bore therethrough communicating with line **42**. This longitudinal bore has a first relatively small diameter portion **50** having a valve seat bushing **52** therein through which extends a passageway **54** communicating with fluid line **42**. Adjacent portion **50** the longitudinal housing bore has a slightly enlarged portion **56** and adjacent it a further enlarged portion **58**, a shoulder **59** being defined therebetween. The upper end of bore portion **56** is placed in fluid communication with the sump by means of a plurality of radially extending fluid passageways **60**.

The lower portion of housing **48** is provided with an extension **62** through which passes a pivot pin **64**, the latter pivotally supporting the mounting arm or lever **66** of a suitable float **68**. On the opposite side of pivot pin **64** from float **68** mounting arm **66** is provided with another pin **70** pivotally supporting for vertical reciprocation a valve element **72**. The two pivots should have sufficient backlash so they will not bind as the valve element reciprocates. This tendency to bind is further reduced by positioning pivots **64** and **70** substantially along a line perpendicular to the axis of the valve element when the latter is centered in its normal range of travel.

Valve element **72** is provided with a conical upper portion **74** adapted to operate as a needle valve for passageway **54**, bushing **52** serving as a valve seat. The intermediate portion **76** of valve element **72** is of a diameter slightly less than that of bore portion **56** and the lower end portion **78** is of a diameter slightly less than that of bore portion **58**, a shoulder **80** being defined between portions **76** and **78** of the valve element. The valve element is also constructed so that shoulder **80** will be spaced axially from shoulder **59** of the valve housing when the valve is closed, as shown in FIGURE 2. Thus, there is defined a chamber **82** between the valve element and housing and shoulders **59** and **80**.

Chamber **82** is positioned below the normal liquid level in sump **44** and therefore is always maintained full of the separated liquid by virtue of the clearance between the valve element and the housing. This chamber therefore acts as a dash pot or dampening device for resisting sudden reciprocations of the valve element. Consequently, when float **68** tends to bob up and down unnecessarily, such as due to sloshing or shifting of the liquid in the sump, a frequent occurrence in mobile applications, this motion is restrained by the dash pot to reduce the hammering of conical needle valve portion **74** upon the valve seat which would otherwise occur. On the contrary, the dash pot function of chamber **82** prevents the transmission of relatively high frequency changes in the fluid level to the needle valve and allows the valve to operate only upon the occurrence of relatively large and slow changes in the liquid level. As a consequence, valve life is greatly increased and the operating effectiveness of the valve is greatly improved. In addition, wear on the pivot pins and other moving parts is minimized.

Although the clearance between the valve element and housing is shown to be relatively large in FIGURE 2, for purposes of illustration, it is in fact quite small, for example in the order of .0005 inch for a valve element having a large diameter of approximately 3/16 inch. The acutal clearance used will of course depend on the size of the valve and the degree of dampening desired. For a given dampening action larger valves will have a greater clearance, and for a given size valve a smaller clearance will give greater dampening action. In addition, if desired the valve parts may be rearranged to function in a normally open manner rather than normally closed, as illustrated, depending on the specific application contemplated. Also the valve need not function as a needle valve, but may operate according to any other common valve principle.

Thus there is disclosed in the above description and in the drawings an exemplary embodiment of the invention which fully and effectively accomplishes the objects thereof. However, it will be apparent that variations in the details of construction may be indulged in without departing from the sphere of the invention herein described, or the scope of the appended claims.

What is claimed is:

1. A float valve responsive to the liquid level in a reservoir subject to relatively abrupt physical movements, comprising: a valve housing, a valve bore, a valve seat having a passage therethrough communicating with said valve bore, a valve element slidably positioned within said bore and having a needle valve thereon adapted to open and close said passage in said valve seat in different respective positions of said valve element, an annular chamber intermediate the ends of said bore between said valve element and said valve housing defining a fluid dash pot, said annular chamber being defined by a shoulder in said bore and a facing shoulder on said valve element, said annular chamber being positioned below the level of liquid in the reservoir and said bore being slightly larger than said valve element whereby said dash pot is in fluid communication with the liquid in the reservoir, and a float operatively connected to said valve element opening and closing said passage in said valve bore in responsive to changes of the liquid level in the reservoir.

2. A liquid separator comprising: an enclosed casing; inlet and outlet passages extending through said casing; separation means inside said casing for removing a liquid from a gaseous fluid entering said casing through said inlet passage; a reservoir in said casing for collecting liquid removed by said separator means; a liquid passage extending through said casing for removing liquid from said reservoir; a valve operatively associated with said liquid passage for controlling the flow of liquid therethrough, said valve being disposed below the normal liquid level in said reservoir and including a housing having a bore therein; a valve seat in said bore; a valve element slidably positioned within said bore having valve means cooperable with said valve seat; dampening means operatively associated with said valve element for reduc-

ing the operating sensitivity thereof to changes in said level due primarily to abrupt movement of said separator and to severe vibrations, said dampening means including an annular chamber defined by a shoulder in said bore and a facing shoulder on said valve element, and means for communicating liquid in said reservoir to said annular chamber; a radially extending passageway in said housing for communicating liquid in said reservoir to a point in said bore between said valve seat and said annular chamber; and a float operatively connected to said valve element for operating the latter in response to the level of liquid collected in said reservoir.

3. A liquid separator comprising an enclosed casing, inlet and outlet passages extending through said casing, separation means inside said casing for removing a liquid from a gaseous fluid entering said casing through said inlet passage, a reservoir in the bottom of said casing for collecting liquid removed by said separator means, a liquid conduit extending through the top of said casing and downwardly to a point below the normal liquid level in said reservoir for removing liquid therefrom, a valve operatively associated with the lower end of said conduit below said normal liquid level for controlling the flow of liquid through said conduit, said valve including a housing having a bore therein and a valve element slidably positioned within said bore, a float operatively connected to said valve element for operating the latter in response to the level of liquid collected in said reservoir and dampening means operatively associated with said valve element for reducing the operating sensitivity thereof to changes in said level due primarily to abrupt movement of said separator and to severe vibrations, said dampening means comprising a dash pot including an annular chamber defined by a shoulder in said bore and a facing shoulder on said valve element, the clearance between said valve element and said bore on each side of said annular chamber being suitable to provide for fluid dampening of movements of said valve element, and means for communicating liquid in said reservoir to said annular chamber.

4. A liquid separator comprising an enclosed casing, inlet and outlet passages extending through said casing, separation means inside said casing for removing a liquid from a gaseous fluid entering said casing through said inlet passage, a reservoir in said casing for collecting liquid removed by said separator means, a liquid passage extending through said casing for removing liquid from said reservoir, a valve operatively associated with said liquid passage for controlling the flow of liquid therethrough, said valve including a housing having a bore therein and a valve element slidably positioned within said bore, float means including an arm pivotally mounted on said housing and pivotally engaging said valve element for operating the latter in response to the level of liquid collected in said reservoir, and liquid dampening means operatively associated with said valve element for reducing the operating sensitivity thereof to changes in said level due primarily to abrupt movement of said separator and to severe vibrations, said dampening means comprising a dash pot including an annular chamber defined by a shoulder in said bore and a facing shoulder on said valve element, the clearance between said valve element and said bore on each side of said annular chamber being suitable to provide for fluid dampening of movements of said valve element, and means for communicating liquid in said reserevoir to said annular chamber.

References Cited by the Examiner

UNITED STATES PATENTS

610,862	9/98	Helling	137—398 XR
864,262	8/07	Robertshaw et al.	137—435
1,280,765	10/18	Kramer	62—470 XR
1,627,020	5/27	Dougherty	251—48 XR
2,064,156	12/36	Firth	137—435
2,190,138	2/40	Smith et al.	55—219
2,760,596	8/56	Kellie	137—397 XR

HARRY B. THORNTON, *Primary Examiner.*

MEYER PERLIN, *Examiner.*