United States Patent

Libby

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[54] **CENTRIFUGE TYPE SEPARATOR**

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Related U.S. Application Data

[63] Continuation of Ser. No. 678,659, Oct. 27, 1967, abandoned.

[52] **U.S. Cl.** **55/199**, 55/218, 55/403, 55/406, 55/432, 55/470, 417/69

[51] **Int. Cl.** **B01d 53/24**

[58] **Field of Search**.....55/400-408, 199, 55/203, 218, 432, 470; 417/69, 422, 350

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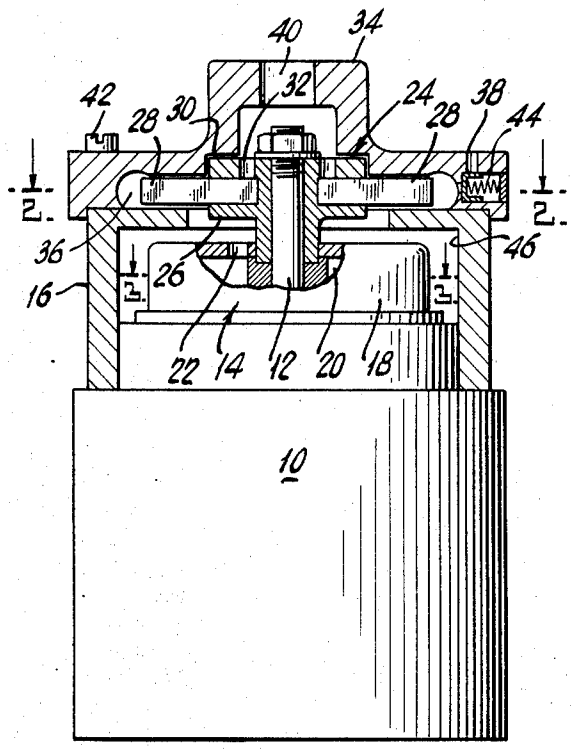
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[57] **ABSTRACT**

Apparatus requiring very small space is provided for separating the liquid and gas components of a fluid mixture. A rotating element, coupled to and downstream of a gas handling pump separates the gas from the liquid that is discharged by the pump. Apertures are provided in the rotating member to cause the separation and flow of the liquid in a direction opposite to the flow of the gas. Means are provided to control the discharge of the liquid by the use of a pressure actuated control valve in combination with the separator.

6 Claims, 4 Drawing Figures



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Fig. 1.

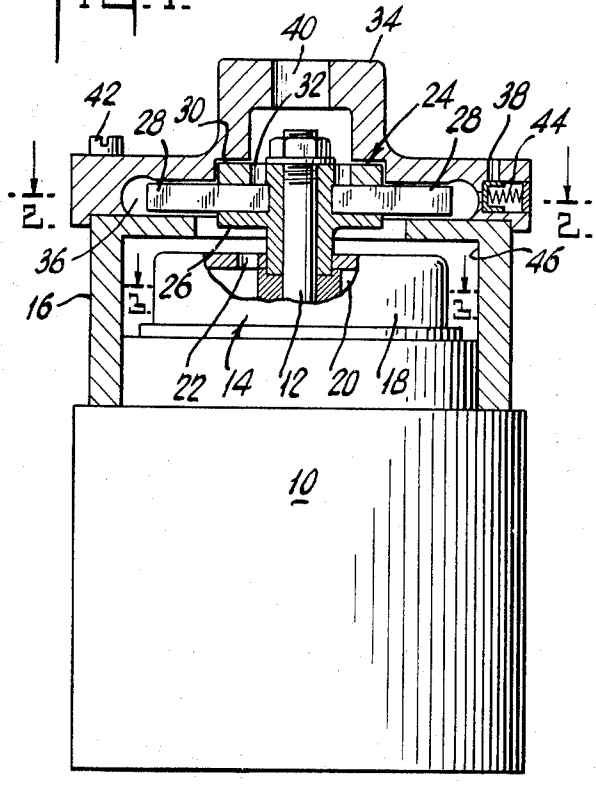
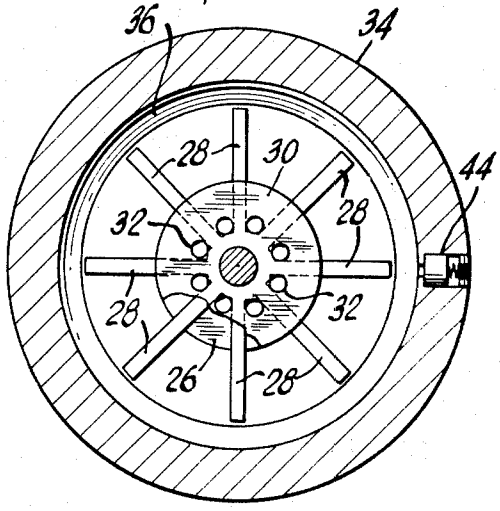


Fig. 2.



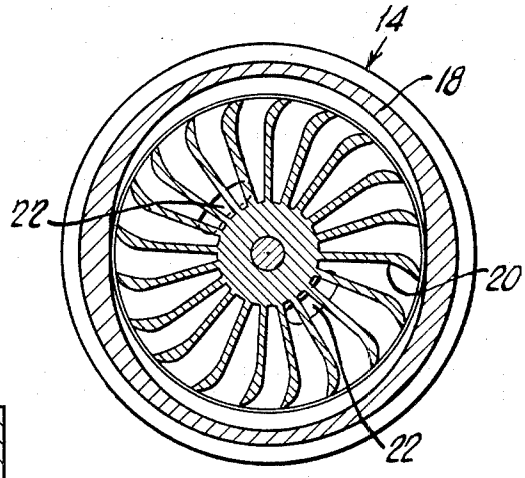
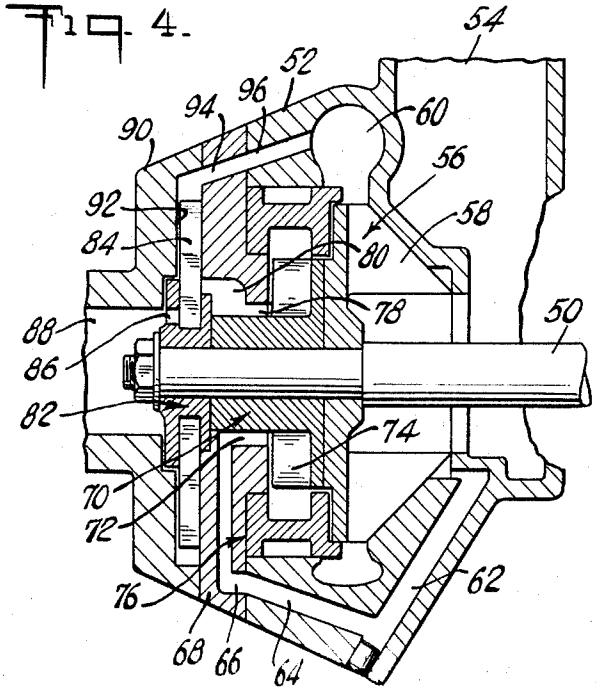


Fig. 3.

Fig. 4.



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CENTRIFUGE TYPE SEPARATOR

This application is a streamlined continuation application of application Ser. No. 678,659, filed Oct. 27, 1967, now abandoned.

This invention relates generally to pumps and in particular to improved structure used in combination therewith for separating a gas from a liquid. The present invention also includes the combination of the aforesaid improved structure and a pressure actuated valve to control the discharge of the liquid from the pump.

There are many devices available for separating gases from liquids and the devices generally have been designed on the principle of a sudden change of direction of the mixture to cause the separation. A common characteristic feature of these separators was their very large size.

The present invention provides efficient separating means for liquids and gases that occupy a very limited space and will perform satisfactorily in a moving vehicle wherein the separator is subjected to varying attitudes and vibration. Valve means are also provided in combination with the separator to control the discharge of the liquid by utilizing the additional pressure generated by liquid accumulated in the separator. Several embodiments of this invention will be disclosed, wherein a common feature to all is that the liquid is centrifuged while the separated gas and some entrained liquid is directed to a rotating member that has apertures therein. The rotating member, coupled to the pump downstream thereof, tends to direct the entrained liquid in a direction opposite to the flow of gas. Further separation of the entrained liquid from the gas returns the liquid to the main liquid flow and the gas is discharged from the apparatus.

Accordingly, an object of this invention is to provide improved means for separating liquid from gas with an arrangement that requires a very small space.

A general object of this invention is to provide a separator that will perform satisfactorily in a moving vehicle.

It is another object of this invention to provide a separator as described above that will perform satisfactorily in varying attitudes.

It is still another object of this invention to provide a separator as described above that will perform satisfactorily when subjected to vibration.

It is a further object of this invention to provide pressure actuated valve means, in combination with the separator described above, wherein the liquid is automatically discharged without loss of gas from the separator.

Still another object of this invention is to provide rotating separator means downstream of a liquid handling pump arranged to centrifuge a liquid and gas mixture.

A further object of this invention is to provide means for preventing leakage from the liquid chamber to the gas chamber and from the liquid chamber to the mixture chamber.

A specific object of this invention is to provide means that separates gases from liquids by passing a gas, having liquid entrained therewith, through a rotating member provided with apertures therein.

These and other features, objects and advantages of this invention will in part, be pointed out with particularity and will in part, become obvious from the following more detailed description of the invention taken in conjunction with the accompanying drawing which forms an integral part thereof.

In various figures of the drawing like reference characters designate like parts. In the drawing:

FIG. **1** is an elevational view partly in section illustrating one embodiment of this invention;

FIG. **2** is a sectional plan view taken along line **2—2** of FIG. **1**;

FIG. **3** is another sectional plan view taken along line **3—3** of FIG. **1**; and

FIG. **4** is a fragmentary longitudinal sectional view of another alternative embodiment of this invention.

FIG. **1** illustrates one form of construction of this invention. This embodiment is primarily a gas handling device with the liquid being used only as necessary to operate the compressor. Conventional means (not shown) are utilized to introduce the liquid into the compressor as required. Drive means **10** is provided with a shaft **12** that is arranged to rotate compressor member **14**. Fluid inlet means (not shown) are included in a housing **16** that is secured to the end face of drive means **10**. The compressor is provided with a cup-shaped housing **18** which encloses blade members **20** and which includes a plurality of discharge ports **22** that provide communication with the separating means to be described hereinafter.

Rotating separating member **24** is also secured to shaft **12** on the downstream side of compressor member **14**. The separating member includes a lower disc **26** which acts as a baffle member, a plurality of radially extending blades **28** and an upper disc **30** that has discharge apertures **32** therein, the apertures **32** providing the centrifuging action as the gas passes therethrough. It will be noted in FIG. **2** that blades **28** extend radially outward from the axis of rotation of shaft **12** and that apertures **32** are relatively close to the axis of rotation.

The separating member is enclosed by a housing **34** to define annular liquid chamber **36** in communication with a liquid discharge port **38** as well as a gas discharge port **40**. The housing **34** is secured to housing **16** by means of screws or bolts **42**. A pressure relief valve **44** shown proximate liquid discharge port **38** acts in combination with the separator in order to control the discharge of liquid from the chamber **36**. When the quantity of liquid is sufficient, pressure is generated and the valve opens. The liquid is discharged through port **38** until the remaining liquid is insufficient for generating or maintaining the pressure to hold the valve open. Thus, liquid is automatically and selectively discharged without loss of gas from the liquid discharge port.

Separation of the gas from the liquid is accomplished by the centrifuging action on the liquid particles when rotated in the space between blades or vanes **28** which are part of the separating member **24**. Both liquid and gas are discharged by the compressor at discharge ports **22**. This mixture then enters the separating member at the annular space created between the outer end of lower disc **26** and the inner diameter of housing **16**. The heavier liquid particles are centrifuged towards the

periphery of the rotating blades. As the liquid accumulates between the blades **28** it is pumped to pressure and then discharged through chamber **36** and port **38**. The control valve **44** allows the liquid to discharge as described above and automatically controls the quantity of liquid which remains in the space between the vanes.

The gas escapes from the space between the vanes through ports **32**. Any particles of liquid which escape with the gas are separated from the gas in the ports **32** and return to spaces between the blades through clearance between upper disc **30** and an inner diameter of housing **34**. Gas is discharged from the separator through port **40**.

FIG. **4** illustrates another alternative construction of this invention as applied, for example, to a fuel pump. This embodiment of the invention illustrates the application of a compressor and centrifuge separator to a device that is capable of handling liquids at a high altitude. For efficient operation of this type of device, gas must be continuously withdrawn from the liquid handling pump. In the embodiment to be described immediately hereinafter gas is withdrawn by a compressor type pump and is separated from the liquid by the blades of a rotating member. The separated liquid and gas are then discharged through separate passages. It is contemplated that this embodiment of the present invention will be utilized in a moving vehicle that is subject to vibration and which can assume a wide variety of attitudes. It may also be desirable to provide a relief valve functioning in substantially the same manner as previously described.

Drive means (not shown) is provided with a shaft **50** that extends into a housing **52**. The main inlet port **54** for the mixture of liquid and gas communicates directly with the interior of a liquid handling pump **56** having a plurality of radially extending blades **58**. Housing **52** is also provided with an annular chamber **60** that receives the liquid centrifuged by blades **58** so that the liquid may be discharged from the housing through a suitable port (not shown). Gas and some particles of liquid not separated from the main body of liquid flow through passageways **62** and **64** and then into a passageway **66** in end plate **68**. Suitable means (not shown) are provided for rigidly securing end plate **68** to housing **52**.

A gas handling pump **70** having an inlet port **72** in communication with passageway **66** is provided with suitably shaped blades **74** that are utilized in combination with a housing **76** having a suitable internal shape to pump the gas separated from the liquid. Pump member **70** is disposed at least partially within housing **52** and is secured to shaft **50** for rotation therewith. Exit ports **78** in the pump housing are in communication with the space between blades **74** and permit passage of the compressed gas through ports **80** in the end plate **68** whereby it is acted upon by rotating separator means **82** that is also secured to shaft **50**. The separator means includes a plurality of radially extending vanes **84**. The gas is discharged through ports **86** in the separator means **82** and port **88** in cover member **90**. Liquid is pressurized by the centrifugal action of vanes **84**. Any particles of liquid escaping with the gas into ports **86** are separated and pass through the space between the separator means **82** and the housing, into the spaces between the vanes **84**. The liquid passes through a suitably positioned port **94** in member **68** and then through passageway **96** that communicates with the discharge port in housing **52**.

From the foregoing it will be apparent that a combination centrifuge type separator and regulator valve to automatically and selectively discharge liquid without allowing discharge of gas through the liquid port has been provided in a minimum of space. The rotating blades, operating in close proximity to the housing provides sealing means to prevent leakage from the liquid chamber to the gas chamber and from the liquid chamber to the mixture chamber. The separation of gas from liquid is accomplished by passing the mixture through suitable openings in the rotating member. The apparatus is particularly well suited for use on a moving vehicle where it is subjected to varying attitudes and vibrations.

There has been disclosed heretofore the best embodiment of this invention presently contemplated. It is to be understood however that various changes and modifications may be made by those skilled in the art without departing from the spirit of the invention.

What is claimed is:

1. Apparatus for separating a fluid mixture into a substantially liquid-free gaseous phase and a substantially gas-free liquid phase comprising a drive shaft, a wheel mounted on said shaft and having a plurality of generally radial vanes said vanes having an axial dimension, a housing enclosing said wheel, an internal space defined by axially spaced, opposed housing walls, the axial spacing between the walls being only slightly greater than said axial dimension of said vanes, said vanes being rotatable within said space, each axial edge of at least the radially outer portion of said vanes defining between them and an adjacent part of the housing walls a running clearance only, there being between each two adjacent vanes and said walls a separating chamber which is effectively sealed from an adjacent similar chamber by the close relationship of said vanes and walls and said running clearance, said housing internal space extending radially outwardly of the envelope defined by rotation of said vanes and comprising means for defining a liquid receiving chamber disposed radially outwardly of said wheel, a fluid mixture inlet to said space in one of said walls, an innermost edge of said inlet being spaced radially from the shaft, a liquid outlet port in said liquid receiving chamber, pressure responsive valve means associated with said liquid outlet, a gas outlet disposed in the other of said walls and having an outermost edge located radially inwardly of the radially innermost edge of said fluid mixture inlet whereby upon the admission of a fluid mixture to the internal space substantially all liquid is centrifuged to said liquid receiving chamber by rotation of said wheel and said gas outlet and said liquid receiving chamber are isolated from one another.

2. Apparatus as claimed in claim **1** wherein a portion of said one wall is constituted by a disks secured to said shaft and rotatable with said wheel and said fluid mixture inlet is defined between the periphery of said disk and a remaining stationary annular portion of said one wall, said disk being of lesser diameter than said wheel.

3. Apparatus as claimed in claim **2** wherein a portion of said other wall is constituted by a disk secured to said shaft and rotatable with said wheel and said gas

outlet is formed in said disk, said disk being of lesser diameter than said wheel.

4. Apparatus as claimed in claim 1 further comprising a compressor mounted on said shaft upstream from said separator, the outlet of said compressor being in communication with said fluid inlet chamber for said separator.

5. Apparatus as claimed in claim 1 wherein each vane edge is free at said outer portion of chordial connection to an adjacent vane.

6. Apparatus for separating a fluid mixture into a substantially liquid-free gaseous phase and a substantially gas-free liquid phase; comprising a housing, a fluid inlet in said housing, a rotatable drive shaft, a liquid handling centrifugal pump being mounted on said drive shaft and having a plurality of blades, an annular chamber surrounding said blades, a liquid outlet for the liquid centrifuged from said mixture by said centrifugal pump, a compressor having an inlet for gaseous components and an outlet therefor and a plurality of blades also mounted on said drive shaft and positioned downstream of said pump, a first passageway connecting said annular chamber with said compressor inlet for entry of the gas components of said mixture with a minor amount of said liquid component into said compressor, a rotatable separator means having a fluid mixture inlet, a gas outlet, and a liquid outlet separate from the gas outlet, said separator being mounted on said drive shaft and located downstream of both said centrifugal pump and said compressor and being in communication therewith and handling the mixture therefrom, a second passageway for the gas component of said fluid mixture communicating at one end with said compressor outlet and at the other end with said separator inlet, a gas outlet in said housing for said gas component of said fluid mixture substantially aligned with said gas outlet of said separator, a third passageway communicating at one end with said liquid outlet of said separator and at the other end with said liquid outlet in said housing for removing said minor liquid component of the fluid mixture out of the housing substantially free of said gas component said separator comprising a pair of spaced superimposed disks having a plurality of radially extending blades therebetween, said radially extending blades extending substantially beyond the outer diameters of said disks, one of said disks being a solid wall the other of said disks being provided with a plurality of ports located relatively close to the axis of rotation of said separator, said ports being in communication with both the spaces between said radially extending blades and said gas outlet, said one solid wall disk extending radially beyond said ports and the space extending radially beyond said one solid wall disk forming a passage in communication with said fluid inlet chamber, said housing defining close clearance relationship to the sides of said radially extending blades with said liquid component for preventing back-flow thereof, and a collecting chamber for the liquid component of said mixture located on the periphery of said radially extending blades said collecting chamber being in communication with said liquid outlet, said collecting chamber being a common collecting chamber the outer ends of the passage walls, a pressure relief valve in said collecting chamber, said valve releasing said liquid component of the fluid mixture therethrough when the pressure of said separator is raised above a predetermined level by the rotation of said radially extending blades.

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