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[54] REMOVAL OF DISPERSED GAS FROM LUBRICATING FLUIDS

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[58] **Field of Search**.....55/159, 169 X, 182 X, 219 X, 55/319; 184/6, 6 G; 62/85; 277/3, 15

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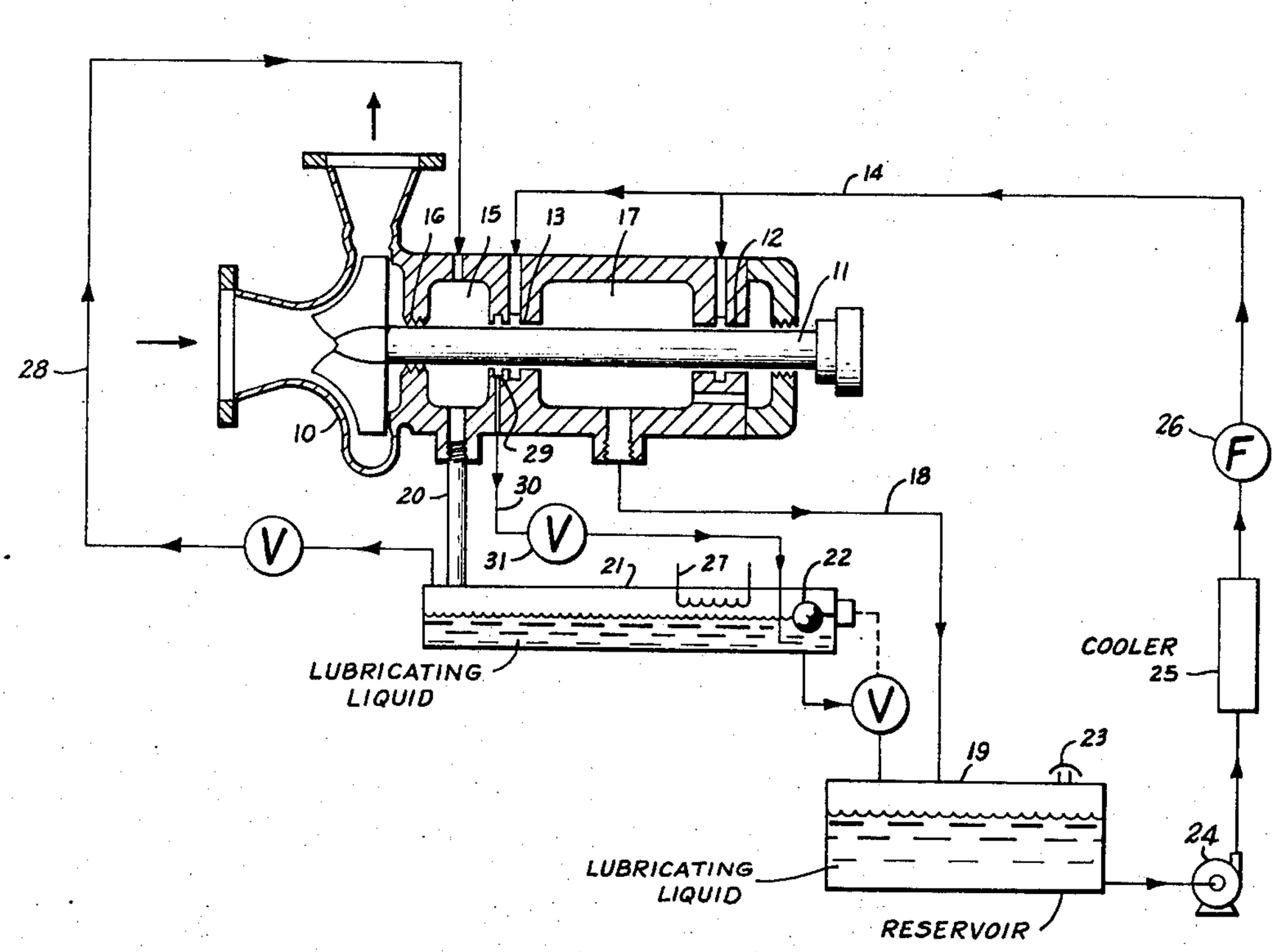
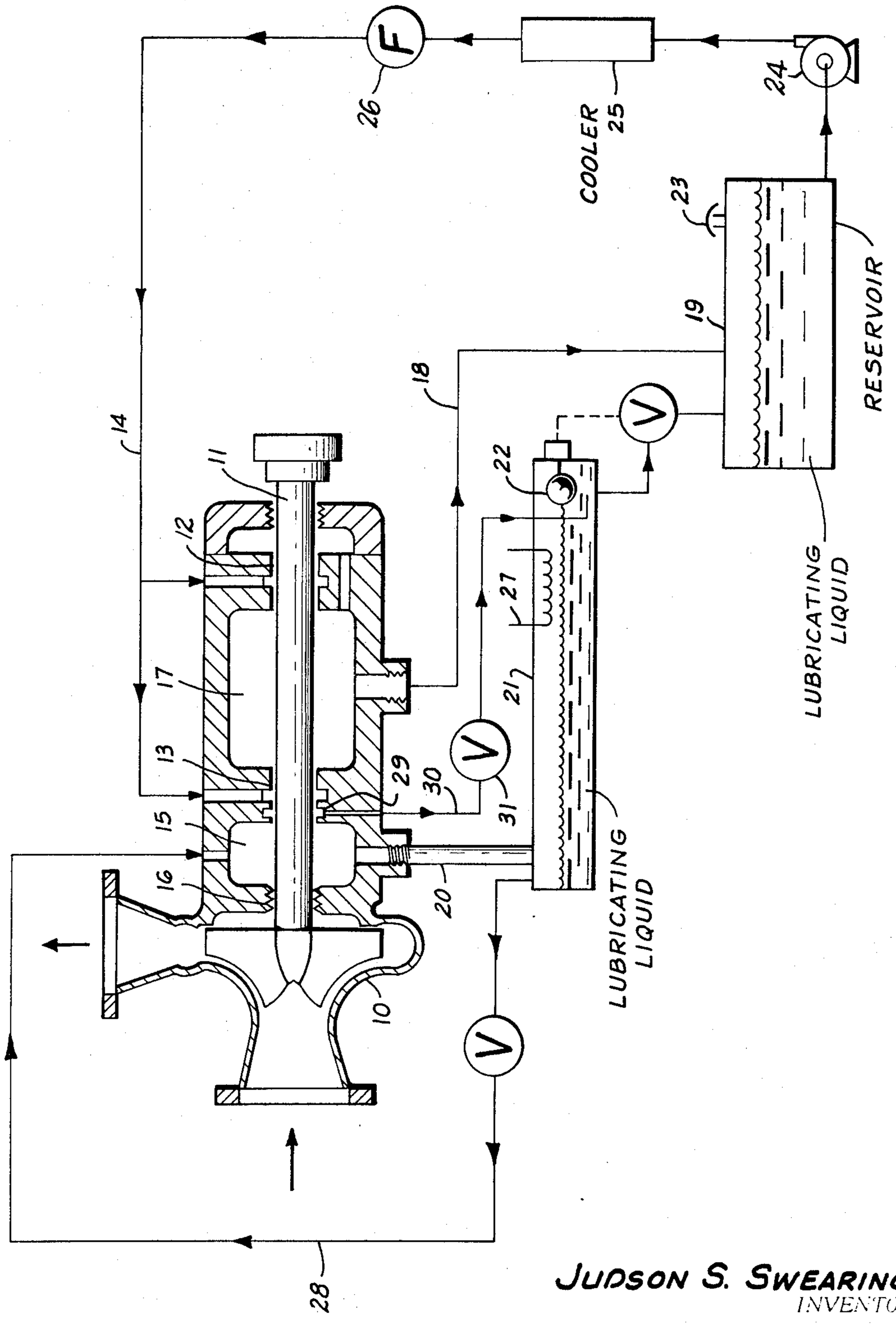
[57] **ABSTRACT**

A method for removing dispersed gas from fluids used to lubricate bearings, shaft seals and the like on high speed gas handling equipment such as turboexpanders and compressors which comprises passing the gas-liquid dispersion through a pressurized settling zone for a time period sufficient to allow the gas and liquid to separate, the gas-free liquid being removed from the settling zone at a rate such that a gas and a liquid phase are maintained in the settling zone. The gas-free liquid is then ready for re-use and the gas removed is recovered under approximately its original pressure and reintroduced into the system at an appropriate point. The invention also encompasses the combination of high speed gas handling equipment such as turboexpanders and compressors with a suitable settling chamber for carrying out the above-described process.

7 Claims, 1 Drawing Figure





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REMOVAL OF DISPERSED GAS FROM LUBRICATING FLUIDS

BACKGROUND OF THE INVENTION

The present invention relates to the use of high speed machinery such as turboexpanders and compressors used in the processing or handling of gases. More particularly, the invention relates to the recovery of a gas such as seal gas or process gas that has become dispersed in the lubricating fluid used to lubricate high-speed rotating components of such machinery.

In the use of machinery such as turboexpanders and compressors employed in gas processing systems, speeds of the rotating components in such machinery are generally 15,000 to 20,000 rpms and higher. It has been found that the fluid used to lubricate some of the rotating components of such machinery such as the bearings, shaft seals, etc., leaves the bearings in a milky condition. This milkiness is caused by a fine dispersion of gas, which the equipment is handling or which is injected into the equipment as a sealant, in the lubricating fluid and comes about due to the violent turbulence which the fluid undergoes as it leaves the bearing housing and contacts the gas.

The circulation of lubricating fluid in a commercial system of the type described above usually ranges from about 3 to about 30 gallons per minute and it is common for dispersion which occurs to contain up to 20 percent by volume of gas. When the pressure in the bearing zone is slightly above atmospheric pressure, this can amount to somewhere between 100 to 1,000 standard cubic feet of gas per day lost to the system and discharged from the oil reservoir. Obviously, if the pressure in the bearing zone are increased, such as to 10 atmospheres, this loss is multiplied to somewhere between 1,000 and 10,000 standard cubic feet of gas per day which represents economically significant amounts. Furthermore, unless the gas is sufficiently removed from the fluid, the latter loses much of its lubricating value with the result that the machinery may undergo damage.

Prior art practices to remove the dispersed gas from the lubricating fluid have included discharging the gas-liquid dispersion into a large volume reservoir and allowing the dispersion to remain there for a relatively long period of time until the gas disengages by settling. Another method which has been used is to withdraw as much of the lubricating fluid as is possible from a zone in the bearings near its discharge edge but out of contact with the gas so that the fluid being removed contains only a minimal amount of the dispersed gas. These latter methods suffer from the disadvantages of being time consuming and at times relatively inefficient in achieving the desired result.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a method for the removal of dispersed gas in lubricating fluids.

Another object of the present invention is to remove dispersed gas from lubricating fluids used to lubricate high-speed rotating components in gas handling equipment such as turboexpanders, compressors and the like.

Still another object of the present invention is to provide a system for use with turboexpanders, compressors and other high-speed handling equipment which will remove dispersed gas from fluids used to lubricate the rotating elements of such machinery.

Another object is to provide for recovery of such gas, preferably at approximately original pressure, for reintroduction into the system at an appropriate point or for other use.

These and other objects of the present invention which will become apparent from the description given herein, the attached drawings and the claims are achieved, in one aspect of the invention, by an improvement in a process utilizing a high-speed rotating shaft having a liquid lubricated element, wherein the lubricating liquid is exposed to an enclosed gaseous environment whereby at least a portion of the gas present

in said environment intermingles with said liquid to form a gas-liquid dispersion, whereby the gas is removed from said liquid comprising introducing said gas-liquid dispersion into a pressurized settling zone, maintaining said gas-liquid dispersion in said pressurized settling zone for a time sufficient to allow substantial separation of said gas from said liquid, removing said liquid from said settling zone at a rate such that said pressurized settling zone contains a liquid phase and a gas phase at all times and removing said gas from said pressurized settling zone.

In another aspect, the present invention provides the combination of (1) a gas processing system employing at least one high-speed gas handling component, said component having a liquid lubricated element, at least a part of said element being exposed to a gas containing chamber whereby said liquid and at least a part of the gas present in said liquid containing chamber are intermingled to form a gas-liquid dispersion with (2) a pressurized settling chamber in communication with said gas containing chamber, means to maintain a gas phase and a liquid phase in said settling chamber, means to remove said liquid from said settling chamber and means to remove said gas from said chamber.

BRIEF DESCRIPTION OF THE DRAWINGS

The FIGURE is a simplified flow diagram illustrating the method and apparatus of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the description of the invention which follows herein, a compressor has been used for purposes of illustration. It is to be understood, however, that the invention is equally applicable to turboexpanders and other high-speed machinery which is employed in the processing and handling of gases. Referring now to the FIGURE, there is shown a compressor generally referred to as **10** having shaft **11** rotatably supported in bearings **12** and **13**. A liquid lubricant via line **14** is injected into the internal section of bearings **12** and **13**. Bearing **13** acts as a lubricated shaft seal also so that the liquid lubricant injected into bearing **13** is at a pressure above that prevailing in seal chamber **15**, chamber **15** being essentially totally enclosed. Chamber **15** contains gas which either comes from the gas source being processed by compressor **10** and leaking through labyrinth seal **16** or from a source such as a gas stream being injected into chamber **15** or into labyrinth seal **16** to serve as a sealing medium. The liquid lubricant entering bearing **13** leaves from both ends of bearing **13** along shaft **11**, a portion along with the liquid lubricant leaving bearing **12** draining out of bearing chamber **17** and then through line **18** into reservoir **19**. The liquid lubricant leaving the other side of bearing **13** enters seal chamber **15** in a highly turbulent form and is immediately contacted by the gas present in seal chamber **15**. This turbulence results in at least part of the gas present in chamber **15** being finely dispersed in the liquid lubricant. The liquid lubricant containing the dispersed gas drains out of seal chamber **15** through conduit **20** and then into pressurized settling chamber **21**. Settling chamber **21** is of a size such that as the liquid lubricant flows through settling chamber **21** and then to reservoir **19**, it has a large enough surface area and sufficient residence time to allow the dispersed gas to be disengaged therefrom. Flow of the gas-free liquid lubricant out of chamber **21** is controlled by level controller **22** which acts to maintain a liquid phase in chamber **21** at all times. Reservoir **19** which holds the substantially gas-free liquid lubricant contains vent **23** through which any small amount of remaining gas is allowed to escape. The liquid lubricant from reservoir **19** is supplied to compressor **10** by means of pump **24**, cooler **25** and filter **26** which serves to remove any solid particulate matter therefrom. It is generally more convenient to have conduit **20** through which the dispersion from seal chamber **15** flows to be of such a size such that it is never completely filled. In this instance the gas which disengages from the liquid lubricant in settling chamber **21** is al-

lowed to pass back into seal chamber **15** therethrough. If, however, conduit **20** is of the size such that it is generally flowing in a filled condition, the gas in the vapor space of chamber **21** can be returned to seal chamber **15** by means of gas line **28**. As will be readily recognized, if the pressure of the gas phase in chamber **21** is equal to or greater than that in seal chamber **15**, the gas may be easily returned to seal chamber **15** and there is essentially no loss of gas externally of the system. If, however, for some reason, the pressure in chamber **21** is less than that of seal chamber **15**, the gas removed from chamber **21** can be sent to some other usage so as to obtain the maximum economic value from the gas. It sometimes occurs that the gas space above the liquid in chamber **21** will foam excessively. When this occurs, a suitable foam breaking device such as heated coil **27** can be utilized to dissipate the foam. As will be obvious, other methods of breaking the foam can be employed.

In carrying out the process of the present invention, it is necessary that the gas laden liquid lubricant be maintained in the pressurized settling zone for a period of time sufficient to allow the gas to disengage from the liquid lubricant. Generally speaking, a residence time of from 15 to 30 seconds is adequate to allow complete disengaging of the gas. The chamber employed as the settling chamber should be of a size such that the surface area of the liquid lubricant held therein ranges from about 0.1 square feet per gallon of lubricant passing through the chamber per minute to about 0.5 square feet per gallon of lubricant passing through the chamber per minute. In a typical commercial operation employing a compressor, it has been found that if the liquid lubricant has a residence time of 30 to 60 seconds in a chamber which allows the lubricant to have a surface area of around 0.3 square feet per gallon passing through the chamber per minute, that the separation of gas from liquid is substantially complete. Even more lubricant may be circulated without increasing the size of the settling chamber by withdrawing a quantity of fluid from the bearing adjacent the chamber **15**, as at **29**, through a line **30** and throttle valve **31** to a point of discharge in the settling chamber adjacent its liquid outlet.

The liquid lubricant employed in the process herein can be a hydrocarbon oil, silicon oil, a high boiling polyether or other liquids commonly employed in high speed lubricating applications. Usually, the liquid lubricant will comprise a hydrocarbon oil. The term hydrocarbon oil as used herein refers to any hydrocarbon liquid which is commonly used as a lubricant in high-speed compressors, turboexpanders and other such equipment.

While the system described above has been shown with reference to a compressor, it is to be understood as was pointed out, that its use with a turboexpander or other such equipment is within the scope of the invention. Furthermore, liquid lubricant may be used to effect lubrication of ordinary mechanical seals, including "sleeve" type seals as well as bearings, bearings being the element of the high-speed equipment normally requiring the lubrication. It is also to be understood that the system described herein can be used with more than a single compressor or more than a single turboexpander and in fact can be used with a combination of two or more of the above or for that matter any number and in any combination. In this case the settling chamber may be made common to all of the gas handling components.

I claim:

1. In a process utilizing a high-speed rotating shaft having a liquid lubricated element wherein a lubricating liquid is introduced to an enclosed gaseous environment whereby at least a portion of the gas present in said environment intermingles with said liquid to form a gas-liquid dispersion, the improvement whereby said gas is removed from said dispersion comprising: withdrawing said gas-liquid dispersion from said environment and introducing it into a settling zone at substantially the same pressure as said environment while retaining gas which is free of said dispersion in said environment; maintaining said gas-liquid dispersion in said settling zone for a time sufficient to allow substantial separation of said gas from said liquid; removing said liquid from said settling zone at a rate such that said settling zone contains a liquid phase and a gas phase at all times; and allowing said gas from said zone to return to said environment.

2. The process of claim **1** wherein said time is from about 15 seconds to about 30 seconds.

3. The process of claim **1** wherein said settling zone has from about 0.1 square feet of surface area per gallon of said liquid passing through said zone per minute to about 2 square feet of surface area per gallon of said liquid passing through said zone per minute.

4. The process of claim **1** wherein said liquid comprises a hydrocarbon oil.

5. In a gas processing system employing at least one high-speed gas handling component, said component having a liquid lubricated element, at least a part of said element being exposed to a gas containing chamber whereby said liquid and at least a part of the gas present in said gas containing chamber are intermingled to form a gas-liquid dispersion, the combination of a settling chamber in communication with said gas containing chamber, means to maintain a gas phase and a liquid phase in said settling chamber, means to remove said liquid from said settling chamber and accumulate it at atmospheric pressure and means to remove from said chamber gas accumulating therein and return it to said system.

6. The system of claim **5** wherein there are a plurality of gas handling components, and said settling chamber is common to all of said components.

7. A system as set forth in claim **5** wherein said settling chamber is sized relative to the remainder of the system so as to provide between about 0.1 square feet of surface area per gallon of liquid which said system is designed to pass through said chamber per minute, and about 2 square feet of surface area per gallon of such liquid designed to pass through said chamber per minute.

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