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MERCURY BELLOWS PUMP

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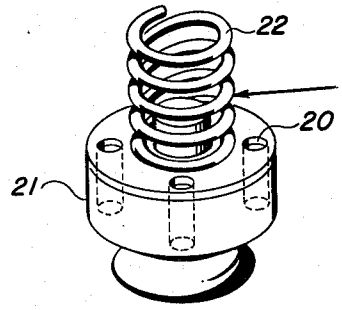


Fig. 2

Fig. 1

WITNESSES:

Ralph Carlisle Smith

Robert D. Brown

INVENTOR.

Eugene S. Robinson

Arthur C. Briesmeister

BY Berthus B. McInteer

Roland A. Anderson

Attorney

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MERCURY BELLOWS PUMP

Eugene S. Robinson, Arthur C. Briesmeister, and Berthus B. McInteer, Los Alamos, N. Mex., assignors to the United States of America as represented by the United States Atomic Energy Commission

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The present invention relates to gas pumps and more particularly to improvements in liquid piston gas transfer pumps.

In the field of radio-chemistry and in chemical processes in which highly corrosive gases must be pumped, the pumping means of the prior art are not particularly suitable. In general, the pumps of the prior art contain undesirably large volumes of either liquids or actuating gases which are allowed to come in contact with the gas being pumped. When a radioactive gas is being pumped, the danger of contamination increases with the volume of material in contact with the radioactive gas. Furthermore, many of the pumps of the prior art use oil to create a pressure or vacuum seal. With the handling of certain gases, the use of oil is undesirable because of the reaction between the liquid and the pumped gas. For example, tritium, a radioactive isotope of hydrogen, is readily absorbed by oil, and a large proportion of the tritium will be lost in an oil system. Also, in the liquid piston pumps of the prior art, the valves are usually operated by floats which are sluggish and not positive in their action. The liquid piston in the pumps of the prior art does not completely expel the gas from the pumping chamber on each cycle and, consequently, the gas transfer is not fully positive and efficient. Many of the pumps of the prior art transfer a large quantity of gas per cycle, but the time between cycles is very long. Since disturbances within most chemical process systems should be held to a minimum, it is more desirable to transfer or pump a smaller quantity of gas per cycle with, however, a short time period between cycles.

The present invention provides a gas transfer pump which has positive valve action, positive flow control, does not allow the gas being pumped to come in contact with any other gas, and keeps the amount of fluid in the pump to a practical minimum.

Therefore, it is an object of the present invention to provide a liquid piston gas transfer pump wherein the actuating liquid is sealed from the atmosphere.

Another object of the present invention is to provide a liquid piston gas transfer pump wherein the valve action is positive.

Another object of the present invention is to provide a liquid piston gas transfer pump which has a high pumping rate and wherein all of the gas drawn into the transfer chamber is expelled at the end of each stroke.

Another object of the present invention is to provide a liquid piston gas transfer pump which has a high pumping rate and which will provide an excellent ultimate vacuum on the inlet side.

Another object of the present invention is to provide a liquid piston gas transfer pump which is capable of pumping gases at a high pumping rate with modest power requirements.

Further objects and advantages will become more apparent from the following description and drawings, hereby made a part of the specification wherein: Figure 1 is a cross-sectional view of a preferred embodiment of

the present invention, and Figure 2 is a detailed view of the outlet valve of Figure 1.

The embodiment of Figure 1 comprises a base 1, having bearing supports 2 and a crankshaft 3 which is connected by coupling 4 to any suitable source of rotational power.

Suspended from plate 6 above crankshaft 3 by means of supports 5 is a bellows or similar compressible chamber 7 which is sealed to plate 6 on the upper end. The lower portion of the bellows 7 is sealed to a plug 8 by means of an O ring 9 or other similar sealing means. The plug 8 contains a pivot pin 10 on which a connecting rod 11 is rotatably mounted. The lower end of the connecting rod 10 is rotatably mounted on the eccentric portion of the crankshaft 3. In this manner, rotation of the crankshaft 3 will alternately compress and expand the bellows 7, resulting in movement of the plug 8 relative to plate 6. Vertical guides (not shown) are provided to insure controlled movement of the bellows 7.

Rigidly attached to plate 6 and sealed to the upper portion of the bellows 7 is a valve head 12 which contains a chamber 13 of known volume, an inlet 14 and outlet 15. The inlet 14 is closed or opened by means of a valve 16 which is resiliently connected to the plug 8. In this manner the upward movement of plug 8 will cause valve 16 to close the gas inlet 14. A rod 17 is attached to the plug 8 opposite the outlet 15, and a spring-actuated valve 18 is provided for sealing the outlet 15. Thus, the upward movement of plug 8 and rod 17 will force valve 18 to open, thereby connecting the chamber 13 to any associated system (not shown) connected to aperture 19.

A quantity of mercury or other suitable liquid is placed in the bellows 7 and around the plug 8, so that when the bellows is in its most expanded position the mercury level is at a predetermined level "A." The ratio of the volume 13 to that of the bellows 7 (minus the volume of plug 8) is such that upon full compression of the bellows 7, the level of the mercury is raised to above the level of the valve 18. The presence of plug 8 keeps the mercury volume near a minimum.

The operation of the present invention is as follows: The inlet 14 of valve head 12 is connected to any suitable source of gas, and the outlet aperture 19 is connected to the system into which the gas is to be transferred. The coupling 4 is connected to any suitable source of rotational power, and crankshaft 3 is thereby rotated. The rotation of crankshaft 3 moves connecting rod 11 up and down so that through its pivot pin 10 the plug 8 is moved up and down. The plug 8 being attached to the bellows 7 is moved with relation thereto as the bellows is alternately compressed and expanded. On the upward movement of the plug 8 rod 17 moves up to open valve 18 at the top of its stroke and the mercury in the bellows and between the top of plug 8 and level "A" is forced upwardly through the known volume chamber 13, past valve member 18, and into outlet 15, forcing ahead of it the gas in chamber 13. This same upward movement forces valve 16 to seat in inlet 14, thereby closing the inlet. It should be noted that valves 16 and 18 are not open at the same time because of the resilient connection between valve 16 and plug 8. Therefore the chamber from which the gas is being removed and the chamber into which the gas is being delivered are not connected at any time. This feature is necessary to insure positive, efficient pump action. The gas contained within the chamber 13 is forced through the open valve 18 and through the seal formed by mercury in outlet 15 left from the previous stroke, as hereinafter described, and on to the associated receiving system.

Figure 2 shows a detailed view of valve 18. Holes 20 in guide member 21 allow the pumped gas to enter aperture 19 above the valve. Spring 22 serves to keep

valve **18** closed except when held open by rod **17** of Figure 1, or except when the gas fills the chamber **13** at such a pressure as to force this valve open during the compression stroke.

After the plug **8** reaches its highest position, continued rotation of crankshaft **3** will move plug **8** downwardly, expanding the bellows and permitting the mercury to return to volume **13**. However, as the mercury level drops, valve **18** closes before all the mercury has left outlet **15**. This action results in a complete vacuum (equal to the vapor pressure of mercury) in chamber **13**. As the mercury in plug **8** continues the downward movement, valve **16** is unseated and the source of gas thereby transferred is connected to the evacuated chamber **13**. Gas enters through inlet **14** and the cycle is then repeated.

Thus, it is apparent that the present invention provides a new and novel means for transferring quantities of gas from one system to another at reasonably high rates of speed. The pump contains no oil which may contaminate the gas, and the liquid piston material which is allowed to come in contact with corrosive or radioactive gases is confined within a closed chamber so that a hazard to operating personnel does not exist. The vacuum created on each pumping stroke is so excellent that the source from which the gas is being transferred can be evacuated to a degree heretofore not possible. Furthermore, the valve action is positive and the reliability of the pump is not dependent upon float valves which may stick or otherwise become inoperative.

While a certain specific embodiment has been shown and described, it is understood that various modifications may be made without departing from the scope of the invention as defined in the appended claims. For example, the bellows which seals the mercury from the atmosphere and allows the upward motion of plug **8** could be replaced by a metal piston in a cylinder sealed by a suitable packing such as an O ring. Also the source of power which imparts reciprocal motion to bellows **7** and plug **8** may be any means for achieving that end. The liquid piston material, though described as mercury, could be any other liquid suitable for the conditions required.

What is claimed is:

1. A gas transfer pump comprising in combination a bellows, a plug attached to and sealing one end of said bellows, a valve head sealed to the other end of said bellows, said valve head containing a gas inlet and gas outlet and a transfer chamber, said outlet being located higher than said inlet, said transfer chamber communicating with said other end of said bellows, valve means for controlling the flow of gas through said outlet and inlet, means attached to said plug for actuating said valve means, a quantity of liquid in said bellows, means for moving said bellows and plug with respect to said valve head whereby the liquid within said bellows is forced into said gas transfer chamber and said valve means is actuated to control the flow of gas through said chamber.

2. A gas transfer pump comprising a bellows, a plug sealed to one end of said bellows, a valve head sealed to the other end of said bellows, said valve head containing a gas inlet and gas outlet and a known volume chamber communicating with said other end of said bellows, said outlet being located higher than said inlet, valve means for controlling the flow of gas through said outlet and inlet, means attached to said plug for actuating said valve means, a quantity of liquid in said bellows and chamber, mechanical means for compressing said bellows and moving said plug with respect to said valve head and forcing said liquid upwardly into said chamber whereby the upward movement of said plug closes said inlet and opens said outlet so that the gas contained within said chamber is forced through said outlet by the upward movement of said liquid.

3. A gas transfer pump comprising a bellows, a plug sealed to one end of said bellows, a valve head sealed to the other end of said bellows, said valve head containing a gas inlet, a gas outlet and a known volume chamber, said inlet, outlet and known volume chamber communicating with said other end of said bellows, a valve in said gas inlet, a valve in said gas outlet, means connecting said inlet and outlet valves to said plug, a quantity of liquid in said bellows and known volume chamber, a pivot pin attached to said plug, a rotatable crankshaft, a connecting rod having one end connected to the eccentric portion of said crankshaft and the other end rotatably connected to said pivot pin, whereby rotation of said crankshaft will move said bellows relative to said valve head causing actuation of said valves and forcing said liquid into said chamber so that said gas will be forced through said outlet valve.

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