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PUMP FOR HIGHLY VOLATILE LIQUID

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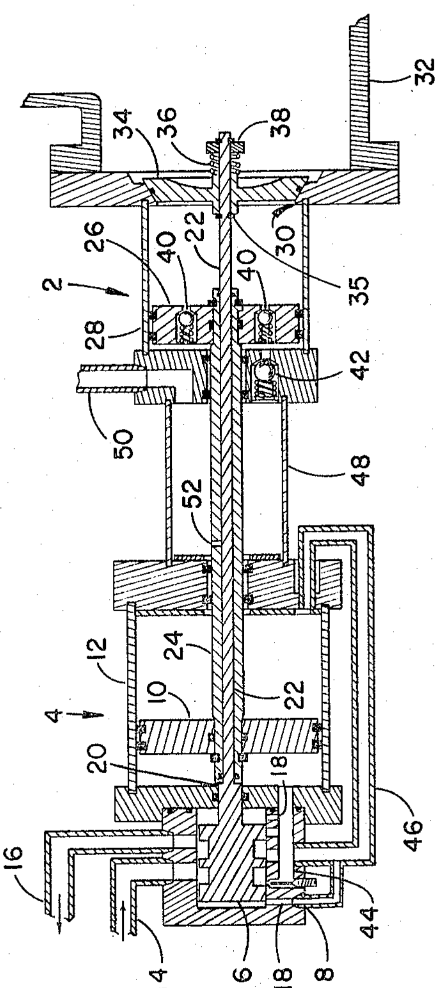

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PUMP FOR HIGHLY VOLATILE LIQUID

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This invention relates to pumps and is particularly directed to novel means for pumping highly volatile liquids.

In the handling of highly volatile liquids, such as ammonia, light hydrocarbons, and the like, great care must be taken to prevent vaporization. As is well known, pumps designed for handling liquids often become "locked," when charged with vapor, and fail to operate. Moreover, the vapors of highly volatile liquids are often subject to explosion, resulting in damage to equipment, danger to employees, and expensive loss of production during "down time" for repairs. This problem is especially severe where electric motors or the like are employed for driving the pumps.

The danger of vaporization is especially great in drawing the liquid from a reservoir, storage tank, or the like, wherein the fluid exists in both liquid and vapor phases. Under these conditions, the liquid is usually close to its critical pressure, such that any significant drop in pressure will cause vaporization of the liquid. Unfortunately, some expansion of the liquid, and associated pressure drop, is necessary in order to permit the liquid to flow into the pump chamber. Moreover, some means must be provided to hold the liquid in the chamber during the charging stroke of the piston. In accordance with the prior art, conventional pressure-responsive valves have been employed between the pump chamber and the tank, and the pressure differential established during the driving stroke of the piston has been relied upon to force the liquid to open the valve and flow into the pump chamber. However, this technique requires the creation of a substantial pressure drop between the tank and the pump chamber which is highly conducive to vaporization.

These disadvantages of the prior art are overcome with the present invention, and novel pump means are provided which permit charging of the pump chamber with a minimum pressure differential between the pump chamber and the storage tank and, thereby, reduces the likelihood of vaporization.

The advantages of the present invention are preferably attained by employing an inlet valve between the pump chamber and the storage tank which is mechanically actuated and has a circumference substantially equal to that of the pump chamber to provide a minimum pressure drop for liquid passing from the storage tank into the pump chamber.

Accordingly, it is an object of the present invention to provide an improved pump.

Another object of the present invention is to provide improved means for pumping highly volatile liquids.

A further object of the present invention is to provide means for reducing the likelihood of vaporization of highly volatile liquids during charging of a pump chamber.

An additional object of the present invention is to provide means for minimizing the pressure differential between a pump chamber and a reservoir from which the liquid is to be pumped.

A specific object of the present invention is to provide a mechanically actuated inlet valve between the pump chamber and the reservoir which cooperates with the pump piston to permit liquid to be drawn from the reservoir into the pump chamber with a minimum pressure drop.

These and other objects and features of the present invention will be apparent from the following detailed de-

scription taken with reference to the figures of the accompanying drawing.

In the drawing:

The figure is a transverse section through a pump embodying the present invention.

In the form of the present invention chosen for purposes of illustration in the drawing, the figure shows a pump, indicated generally at **2**, driven by a fluid motor **4**. The fluid motor **4** comprises a motor valve **6** which is slidable within a cylinder **8**, and a piston **10**, slidable within a second cylinder **12**. Inlet pipe **14** and outlet pipe **16** connect the fluid motor 4 to a source of pressurized driving fluid, not shown. Motor valve **6** is actuated by piston **10**, as hereinafter described, and vents **18** are provided in cylinder **8** to supply driving fluid to the ends of motor valve **6** to hold motor valve **6** in position at the end of each stroke until mechanically moved by the action of piston **10**. In addition, the motor valve **6** is provided with a shoulder **20** to which is rigidly secured a shaft **22**. Piston **10** is fixedly connected to a sleeve **24** which slideably surrounds shaft **22** and is rigidly coupled to drive the pump piston **26** which is slideable within the pump chamber **28**. As shown, shaft **22** and sleeve **24** extend through the walls of cylinder **12** and pump chamber **28** and suitable sealing means are provided to prevent leakage. The pump chamber **28** communicates, by opening **30** with a reservoir, or the like, indicated at **32**, of highly volatile liquid which is to be pumped; and an inlet valve **34** is provided to prevent undesired flow of liquid between the pump chamber **28** and reservoir **32**. It should be noted that opening **30** and valve **34** have substantially the same circumference as chamber **28**. As shown, inlet valve **34** is slideably mounted on shaft **22** adjacent the end of said shaft opposite motor valve **6** and is resiliently maintained in sealing engagement with the edges of opening **30** by a spring **36** and keeper **38** secured to the end of shaft **22**. Suitable means, such as spring biased ball valves **40**, are provided to permit liquid to flow through pump piston **26** during the charging stroke of piston **26** and to prevent back flow during the charging stroke of piston **26**.

In operation, with motor valve **6** in the position shown in the drawing, driving fluid flows from inlet pipe **14**, through motor valve **6** and a suitable passageway **44**, into the lefthand end of cylinder **12** to drive piston **10** to the right. This motion is transmitted by sleeve **24** to pump piston **26** and constitutes the charging stroke of the pump by allowing liquid on the right-hand side of piston **26** to flow through valves **40** to the left-hand side of the piston **26**. As pistons **10** and **26** approach the right-hand ends of their respective cylinder **12** and **28**, the end of sleeve **24** abuts the valve **34** and forces the valve **34** to open opening **30**. Spring **36** and keeper **38** transmit this motion to shaft **22** which acts to move motor valve **6** to the right-hand end of cylinder **8**. This transfers the passage of driving fluid from passageway **44** to conduit **46** to drive piston **10** to the left and, hence, starts the driving stroke of the pump. As piston **10** moves to the left, sleeve **24** causes piston **26** to move to the left also. Consequently, valves **40** close and valve **42** opens to allow liquid on the left-hand side of piston **26** to be exhausted from the pump chamber **28**.

As indicated above, vents **18** in cylinder **8**, serve to supply driving fluid to the appropriate end of motor valve **6** to hold the motor valve **6** at the end of each stroke until mechanically moved by the action of piston **10**. Accordingly, when piston **10** and **26** complete the charging stroke and begin to move to the left, motor valve **6** remains at the right-hand end of cylinder **8** and acts through shaft **22** to hold valve **34** in its open position. Suitable means, such as retaining ring **35**, may be provided to prevent inadvertent closing of valve **34**. As further noted above, the circumference of valve **34** is substantially equal to that of pump chamber 28. Thus, as piston 26 moves to the left, liquid can pass from reservoir 32 through opening 30 and into pump chamber 28, on the right-hand side of piston 26, with a minimum pressure drop and, consequently, with minimal danger of vaporization. As pistons 10 and 26 approach the end of the driving stroke, the left-hand end of sleeve 24 engages shoulder 20 of motor valve 6 and drives the motor valve 6 to the left-hand end of cylinder 8. This motion is transmitted by shaft 22, keeper 38 and spring 36 to close the inlet valve 34. Meanwhile, motor valve 6 transfers the supply of driving fluid from conduit 46 to passageway 44 to initiate the next charging stroke of the pump.

Where the driving fluid circulated through fluid motor 4 is at high temperatures, such as steam, or where fricton or other factors may cause heating of the shaft 22 and sleeve 24, such heating may tend to cause vaporization of the liquid within the pump chamber 28. However, it is found that this problem can be avoided by providing a cooling chamber 48, communicating with valve 42 and exhaust pipe 50, and providing a vent, as seen at 52, extending through sleeve 24 to shaft 22 within the chamber 48. By properly selecting the dimensions of chamber 48 and vent 52, the volume of fluid exposed to sleeve 24 and shaft 22 may be made relatively large. Accordingly, the heat absorbed by any unit volume of the liquid will be relatively small so that vaporization is unlikely. Moreover, by interposing chamber 48 between the fluid motor 4 and pump 2, as shown, heat transfer between the shaft 22 and sleeve 24 and the liquid will occur within the chamber 48, rather than within the pump chamber 28. Consequently, if vaporization should tend to occur in the chamber 48, it will not interfere with the operation of the pump 2 and, upon the next driving stroke of the pump 2, a fresh supply of unheated liquid will be delivered to the chamber 48 to reduce the tendency toward vaporization. It will also be understood that the liquid in chamber 48 will be under considerable pressure, established by pump 2, and, therefore, the possibility of vaporization occurring within chamber 48 is remote, under normal conditions.

Obviously, numerous variations and modifications may be made without departing from the present invention. Accordingly, it should be clearly understood that the form of the present embodiment of the invention described above and shown in the figure of the accompanying drawing is illustrative only and is not intended to limit the scope of the invention.

What is claimed is:

1. A pump comprising:
a pump chamber having an inlet opening dimensioned to minimize the pressure drop of liquid passing through said opening,
a piston slideable within said pump chamber,
a fluid motor including
a driving piston, and

a motor valve positionable by said driving piston,
sleeve means internal of said pump coupling said driving piston to drive said pump piston and to open said valve means upon movement of said driving piston to a first position, and
shaft means carried by said motor valve and slideable within said sleeve means to close said valve means in response to movement of said driving piston to a second position.

2. The apparatus of claim 1 wherein
said last-named means serves to prevent actuation of said valve means during movement of said driving piston intermediate said first and second positions.

3. A pump comprising:
a first cylinder,
a motor valve slideable within said first cylinder to control passage of driving fluid through said first cylinder and including means for holding said motor valve at each end of the travel of said motor valve,
a second cylinder,
a driving piston slideable within said second cylinder under the control of driving fluid passed by said motor valve,
a pump chamber having an inlet opening dimensioned to minimize the pressure drop of liquid passing through said opening,
a pump piston slideable within said pump chamber,
sleeve means internal of said pump coupling said driving piston to drive said pump piston and responsive to movement of said driving piston to a first position to open said valve means and to drive said motor valve to one end of said first cylinder, and
shaft means carried by said motor valve and slideable within said sleeve means to close said valve means in response to movement of said driving piston to a second position.

4. The apparatus of claim 3 further comprising:
a cooling chamber enclosing said drive means and said shaft means between said pump chamber and said second cylinder, and
means supplying liquid exhausted from said pump chamber to said cooling chamber to effect cooling of said drive means and said shaft means.

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