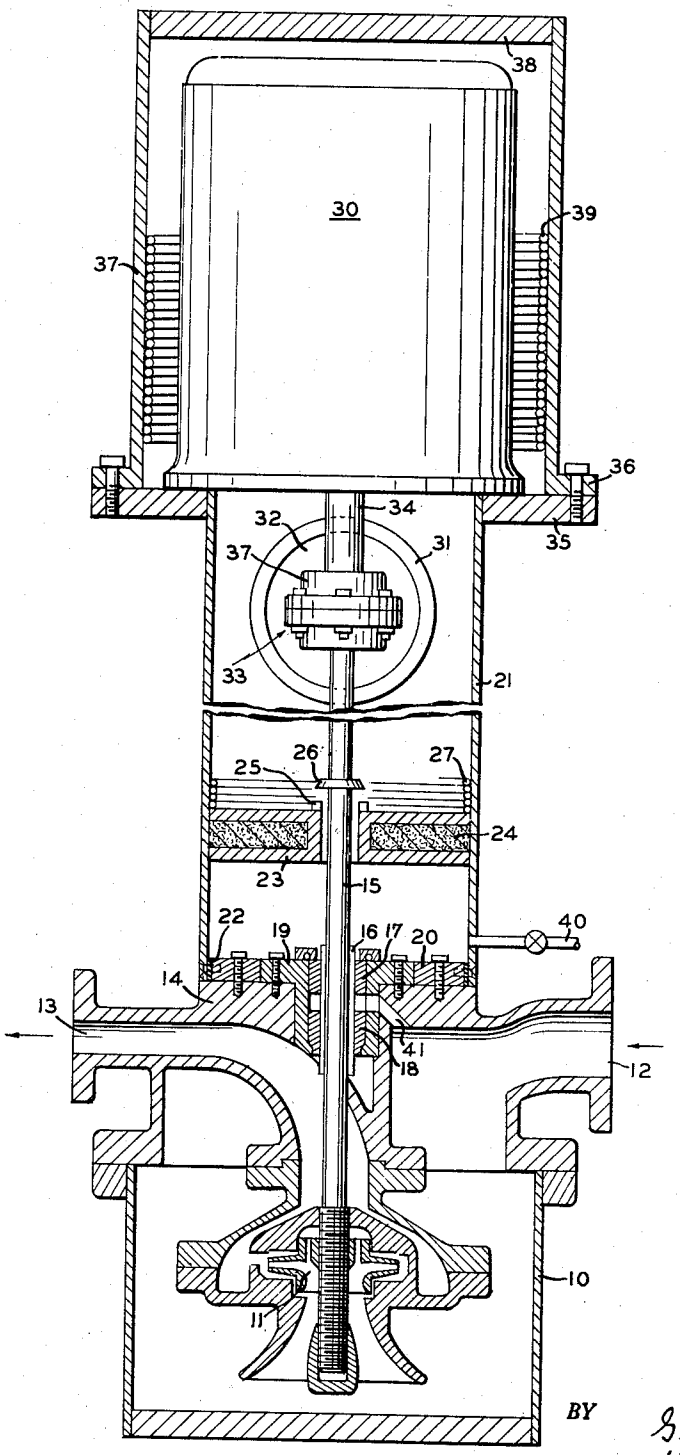
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PUMPS FOR HIGH VAPOR PRESSURE LIQUIDS

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PUMPS FOR HIGH VAPOR PRESSURE LIQUIDS

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This invention relates to pumps and particularly to pumps used in handling high vapor pressure liquids.

The pumping of high vapor pressure liquids and especially the low temperature pumping of high vapor pressure liquids, such as ethylene, propylene, methane, and the like, at —10° F. and lower, presents a serious problem by reason of the difficulties encountered in sealing the pump drive connection against leakage of the material handled. Leakage not only results in reduced pumping efficiency and a substantial money loss due to material loss but with highly volatile inflammable materials of the character specifically referred to, presents a real hazard from fire. Many attempts have been made to solve this problem. The more successful solutions involve complicated and expensive sealing systems which require constant attention and adjustment. At best seal failure is always possible so that the fire hazard remains.

I have found a simple and practical way of solving this problem which eliminates all fire hazard and product loss.

It is a principal object of this invention to provide a simple, efficient and cheap arrangement for completely eliminating product leakage in pumping high vapor pressure liquids and its attendant losses and hazards.

It is also a principal object of this invention to provide a system for pumping high vapor pressure liquids in which no effort is made to mechanically seal the pump drive connection but leakage is eliminated by generating a pressure effective on said connection which opposes the pressure tending to cause the leakage.

It is an additional principal object of the invention to provide a leakproof system for pumping high vapor pressure liquids at low temperature in which the pump drive connection and the pump drive motor are housed in a pressure vessel, the pump space being in comparatively free communication with the vessel space so that the liquid handled may pass thereinto, and heat is supplied in the vessel space to vaporize the liquid in amount sufficient to generate a high enough pressure to prevent the level of liquid in said vessel space exceeding a predetermined level.

The further objects, features and advantages of the invention will become apparent from a consideration of the following detailed description taken with the accompanying drawings in which the single figure is a sectional view illustrating a present preferred embodiment of the invention.

The invention is of general application and may be applied to systems for pumping liquids whose vapor pressure at or below the maximum safe operating temperature of the electric motor employed for driving the pump of the system, is above the pump suction pressure. The invention is particularly applicable to the pumping of low boiling point hydrocarbon materials such as ethylene, propylene, methane, etc., and particularly to the pumping of these materials at reduced temperatures in the order of —10°, and lower.

In its broader aspects the invention involves the provision of a pressure container which houses the pump drive motor and surrounds the portion of the pump casing through which the motor shaft passes into the pump. No special effort is made to seal the joint at the pump casing and motor shaft so that the liquid pumped may leak therethrough into the pressure casing. Controlled heating means are provided within the casing so that when the leaking pumped liquid reaches a predetermined level it will come under the influence of the heating means to be heated and evaporated thereby, thus raising the pressure within the pressure casing until it ultimately reaches the point where it exceeds the pressure tending to cause the leakage flow of the liquid pumped. Thereafter liquid will not leak into the pressure chamber until the pressure therein reduces sufficiently to permit leakage flow. When this happens further liquid will be evaporated to augment the pressure, ultimately a steady state or equilibrium condition is attained. The leakage path may be connected directly by a suitable passageway to the high pressure side of the pump so that on raising of the pressure in the chamber above the pump outlet pressure, excess liquid will be forced back into the pump outlet. In this case the liquid pumped must have a boiling temperature lower than the safe operative motor temperature at the pump outlet pressure. Alternately, the leakage path may be connected to the pump inlet so that the liquid forced out of the pressure chamber will flow to the pump inlet. In this arrangement the liquid handled need have a boiling point equal to or less than the safe operating pump temperature at the pump suction pressure. The manner of carrying out the invention in practice is shown in the drawings and specific reference is had thereto.

The pump **10** is of conventional design and includes a rotor **11** for acting upon the liquid supplied through the inlet **12** to increase its pressure to the desired value at the outlet **13**. The pump **10** includes an upper casing **14** through which the shaft **15** passes. The shaft **15** mounts the rotor **11**. The shaft **15** includes a bearing sleeve **16** which extends through an upper throttle bushing **17** and a lower throttle bushing **18**. The bushings **17** and **18** are mounted on a thimble **19** which extends into a bore in the casing **14** and is fastened relative thereto by a circular series of bolts or other conventional fastening means. The thimble **19** is surrounded by a ring **20** which is fastened to the casing **14** also by a circular series of bolts or other conventional fastening means. The lower end of a cylindrical casing **21** surrounds the ring **20** and is fastened thereto as by a circular series of screw bolts. A suitable gasket **22** may be employed to assure the sealing of the space within the chamber **21** from the free space therearound.

The cylindrical casing **21** includes a diaphragm **23** adjacent its lower end. The diaphragm **23** may include a middle insulation section **24**. The shaft **15** passes loosely through an aperture in the center of the diaphragm **23**. The inner edge of the diaphragm **23** may have a ring barrier member **25** attached thereto so that a predetermined depth of the liquid pumped may be maintained above the diaphragm **23** at the level of the ring **25**. Shaft **15** carries a slinger **26** which is adapted to pick up liquid coming up along the shaft **15** and slings it outwardly against the heating coils **27** on the internal wall of the section **21**. The heating coils **27** may house an elongated electrical heating element which is thermostatically controlled to maintain a predetermined temperature within the upper end of the casing, said predetermined temperature being at or below the safe operating temperature of motor **30**. Alternately, the coils **27** may circulate a liquid or vaporized heating

medium supplied from a suitable source thereof and controlled through a thermostatically controlled valve, not shown, to maintain a predetermined temperature within the upper end of the casing **21**. In place of the coils **27** a jacket may be employed and the circulation of a heating medium therethrough controlled for the purposes stated.

The upper end of the casing **21** includes a handhole defining member **31** which is normally sealed by a suitable cover **32**. In the region of the handhole **31** is a coupling **33** of conventional construction through which the shaft **34** of the motor **30** is coupled to the shaft **15**. The casing **21** has an outwardly extending flange **35** united thereto upon which is mounted the motor **30**. The motor **30** is preferably a standard open motor since an explosion-proof motor is not required as the atmosphere is excluded therefrom by the casing **21** and the motor container **37**. The flange **36** which is integrally connected to the motor container **37** and is also positioned on the flange **35**; the flanges **35** and **36** are united in any conventional manner as by a circular series of bolts. Suitable gasket material may be interposed between the flanges **35** and **36** to assure a leakproof joint. The casing **37** is closed at its upper end by a disc cover **38**. Cooling coils **39**, or a jacket, not shown, are provided through which water or similar suitable cooling medium may be circulated, at a rate sufficient to remove the heat generated by the motor so that it may be maintained at or below its safe maximum temperature. The casing **21** may include a tapped hole adjacent its lower end to receive the tapped end of the line **40** which leads the pump leakage liquid from the lower end of the casing **21** to the top of the supply container thereof (not shown). In lieu of the line **40** a pasageway **41** may be provided which communicates the pump inlet to the space between the lower throttle bushing **18** and the upper throttle bushing **17**. When the passageway **41** is employed, liquid will flow from the lower end of the casing **21** into the pump inlet.

When the pump is set into operation the liquid to be pumped, as for instance, ethylene, propylene, methane, etc., is supplied from the supply container thereof, not shown, at a pressure of about 10 p. s. i. g. and at a temperature of about −10°. The rotor **11** is rotated at the proper speed through the motor **30** and the shaft **15** to receive the liquid from the inlet **12** and circulates it to the outlet **13** so that it will exit from the pump **10** at a pressure of about 70 p. s. i. g. and a temperature of −10°. In the region where the pump shaft **15** passes through the pump outlet passageway the liquid pumped is at substantially maximum pressure and will thus tend to flow along the shaft **15** and outwardly of the casing **14**. With the passageway **41** provided, some of the leaking liquid will be returned to pump inlet passageway **12**. However, there will still be a pressure differential between the suction pressure and the external pressure so that the liquid pumped will move along between the shaft **15** and the upper throttle bushing **17** into the lower end of the casing **21**. As the pumping action continues the level of the leaking liquid will raise until it passes the diaphragm **23** and reaches the slinger **26** at which time it will be thrown against the coils **27** to be vaporized thereat. The heating and vaporization of the liquid will continue until the heat absorbed by the liquid causes sufficient vaporization of the liquid to raise the pressure within the casing **21** to the point that it will overcome the pressure differential causing liquid flow into the container **21**. The vaporization of liquid will go beyond that required merely to balance the pressure to the point where a pressure differential is set up tending to force the liquid in reverse from the chamber **21** into the pump inlet **12** or if the line **40** is employed, through the line **40** back to the liquid supply container. The vaporized liquid will ultimately be insufficient to prevent leakage so that further liquid will enter the casing **21** to be vaporized thereat. This procedure will repeat itself until a substantial steady state or equilibrium is obtained for any set of conditions of suction, pressure, temperature, and pump operation.

Since many changes may be made without departing from the scope of the invention herein involved, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not limitative.

I claim:

1. A pump system comprising a pump having a casing provided with an inlet side and an outlet side, a rotary pumping element in said casing adapted to receive liquid from said inlet side under inlet pressure and transfer it to said outlet side at an augmented outlet pressure, a shaft mounting said rotary pumping element, journal means in said casing, said shaft extending through said journal means and outwardly of said casing, an electric motor connected to said shaft to drive said shaft and said rotor element, a pressure tight container connected to said pump casing and housing said motor and the extending end of said shaft, said motor in open communication with the full length of said container, and heating means in said container positioned adjacent the pump end thereof and adapted to be contacted by liquid leaking out through said journal means when the liquid reaches the level of said heating means to vaporize said leaking liquid to maintain a pressure throughout said container at least equal to the pressure effective to cause the leakage.

2. A pump system comprising a pump having a casing provided with an inlet side and an outlet side, a rotary pumping element in said casing adapted to receive liquid from said inlet side under inlet pressure and transfer it to said outlet side at an augmented outlet pressure, a shaft mounting said rotary pumping element, journal means in said casing, said shaft extending through said journal means and outwardly of said casing, an electric motor connected to said shaft to drive said shaft and said rotor element, a pressure tight container connected to said pump casing and housing said motor and the extending end of said shaft, said motor in open communication with the full length of said container, heating means in said container positioned adjacent the pump end thereof and adapted to be contacted by liquid leaking out through said journal means when the liquid reaches the level of said heating means to vaporize said leaking liquid to maintain a pressure throughout said container at least equal to the pressure effective to cause the leakage, and heat exchange means in said pump casing positioned adjacent said motor adapted to remove heat generated by said motor to maintain said motor within its safe operating temperature range.

3. A pump system comprising a pump having a casing provided with an inlet side and an outlet side, a rotary pumping element in said casing adapted to receive liquid from said inlet side under inlet pressure and transfer it to said outlet side at an augmented outlet pressure, a shaft mounting said rotary pumping element, journal means in said casing, said shaft extending through said journal means and outwardly of said casing, an electric motor spaced from said casing and connected to said shaft to drive said shaft and said rotor element, a pressure tight container connected to said pump casing and housing said motor and the extending end of said shaft, means carried by said shaft adapted to be contacted by liquid leaking into said container along said shaft and throw it outwardly towards the walls of said container, heating means in said container adapted to be contacted by liquid thrown outwardly by said carried means thereby to vaporize said thrown out liquid to maintain a pressure in said container at least equal to the pressure effective to cause the leakage, and heat exchange means in said pump casing positioned adjacent said motor adapted to remove heat generated by said motor to maintain said motor within its safe operating temperature range.

4. A pump system comprising a pump having a casing provided with an inlet side and an outlet side, a rotary pumping element in said casing adapted to receive liquid from said inlet side under inlet pressure and transfer it to said outlet side at an augmented outlet pressure, a shaft mounting said rotary pumping element, journal means in said casing, said shaft extending through said journal means and outwardly of said casing, an electric motor spaced from said casing and connected to said shaft to drive said shaft and said rotor element, a pressure tight container connected to said pump casing and housing said motor and the extending end of said shaft, a slinger carried by said shaft adapted to be contacted by liquid leaking into said container along said shaft and throw it outwardly towards the walls of said container, a heating coil in said container adjacent the walls thereof and positioned to be contacted by liquid thrown outwardly by said slinger to vaporize said thrown out liquid to maintain a pressure in said container at least equal to the pressure effective to cause the leakage, and heat exchange means in said pump casing positioned adjacent said motor adapted to remove heat generated by said motor to maintain said motor within its safe operating temperature range.

5. A pump system comprising a pump having a casing provided with an inlet side and an outlet side, a rotary pumping element in said casing adapted to receive liquid from said inlet side under inlet pressure and transfer it to said outlet side at an augmented outlet pressure, a shaft mounting said rotary pumping element, journal means in said casing, said shaft extending through said journal means and outwardly of said casing, an electric motor spaced from said casing and connected to said shaft to drive said shaft and said rotor element, a pressure tight container connected to said pump casing and housing said motor and the extending end of said shaft, a transverse diaphragm in said casing having a central hole through which said shaft passes, a slinger carried by said shaft outwardly of said diaphragm adapted to be contacted by liquid leaking into said container along said shaft and throw said liquid towards the walls of said container, an upstanding lip at said central hole to retain a predetermined depth of liquid on said diaphragm, a heating coil in said container adjacent the walls thereof and positioned immediately outwardly of said diaphragm to be contacted by liquid thrown outwardly by said slinger to vaporize said thrown out liquid to maintain a pressure in said container at least equal to the pressure effective to cause the leakage, and heat exchange means in said pump casing positioned adjacent said motor adapted to remove heat generated by said motor to maintain said motor within its safe operating temperature range.

6. A pump system comprising a pump having a casing provided with an inlet side and an outlet side, a rotary pumping element in said casing adapted to receive liquid from said inlet side under inlet pressure and transfer it to said outlet side at an augmented outlet pressure, a shaft mounting said rotary pumping element, journal means in said casing, said shaft extending through said journal means and outwardly of said casing, an electric motor spaced from said casing and connected to said shaft to drive said shaft and said rotor element, a pressure tight container connected to said pump casing and housing said motor and the extending end of said shaft, a slinger carried by said shaft adapted to be contacted by liquid leaking into said container along said shaft and throw it towards the walls of said container, a heating coil in said

container adjacent the walls thereof and positioned to be contacted by liquid thrown outwardly by said slinger to vaporize said thrown out liquid to maintain a pressure in said container at least equal to the pressure effective to cause the leakage, heat exchange means in said pump casing positioned adjacent said motor adapted to remove heat generated by said motor to maintain said motor within its safe operating temperature range, and means for removal of liquid from said container.

7. A pump system comprising a pump having a casing provided with an inlet side and an outlet side, a rotary pumping element in said casing adapted to receive liquid from said inlet side under inlet pressure and transfer it to said outlet side at an augmented outlet pressure, a shaft mounting said rotary pumping element, journal means in said casing, said shaft extending through said journal means and outwardly of said casing, an electric motor spaced from said casing and connected to said shaft to drive said shaft and said rotor element, a pressure tight container connected to said pump casing and housing said motor and the extending end of said shaft, a slinger carried by said shaft adapted to be contacted by liquid leaking into said container along said shaft and throw it towards the walls of said container, a heating coil in said container adjacent the walls thereof and positioned to be contacted by liquid thrown outwardly by said slinger to vaporize said thrown out liquid to maintain a pressure in said container at least equal to the pressure effective to cause the leakage, heat exchange means in said pump casing positioned adjacent said motor adapted to remove heat generated by said motor to maintain said motor within its safe operating temperature range, and a passageway communicating the journal and shaft interface to one of said sides.

8. A pump system comprising a pump having a casing provided with an inlet side and an outlet side, a rotary pumping element in said casing adapted to receive liquid from said inlet side under inlet pressure and transfer it to said outlet side at an augmented outlet pressure, a shaft mounting said rotary pumping element, journal means in said casing, said shaft extending through said journal means and outwardly of said casing, an electric motor spaced from said casing and connected to said shaft to drive said shaft and said rotor element, a pressure tight container connected to said pump casing and housing said motor and the extending end of said shaft, a slinger carried by said shaft adapted to be contacted by liquid leaking into said container along said shaft and throw it towards the walls of said container, a heating coil in said container adjacent the walls thereof and positioned to be contacted by liquid thrown outwardly by said slinger to vaporize said thrown out liquid to maintain a pressure in said container at least equal to the pressure effective to cause the leakage, heat exchange means in said pump casing positioned adjacent said motor adapted to remove heat generated by said motor to maintain said motor within its safe operating temperature range, and a passageway communicating the journal and shaft interface to said inlet for flow of liquid from said container thereinto.

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