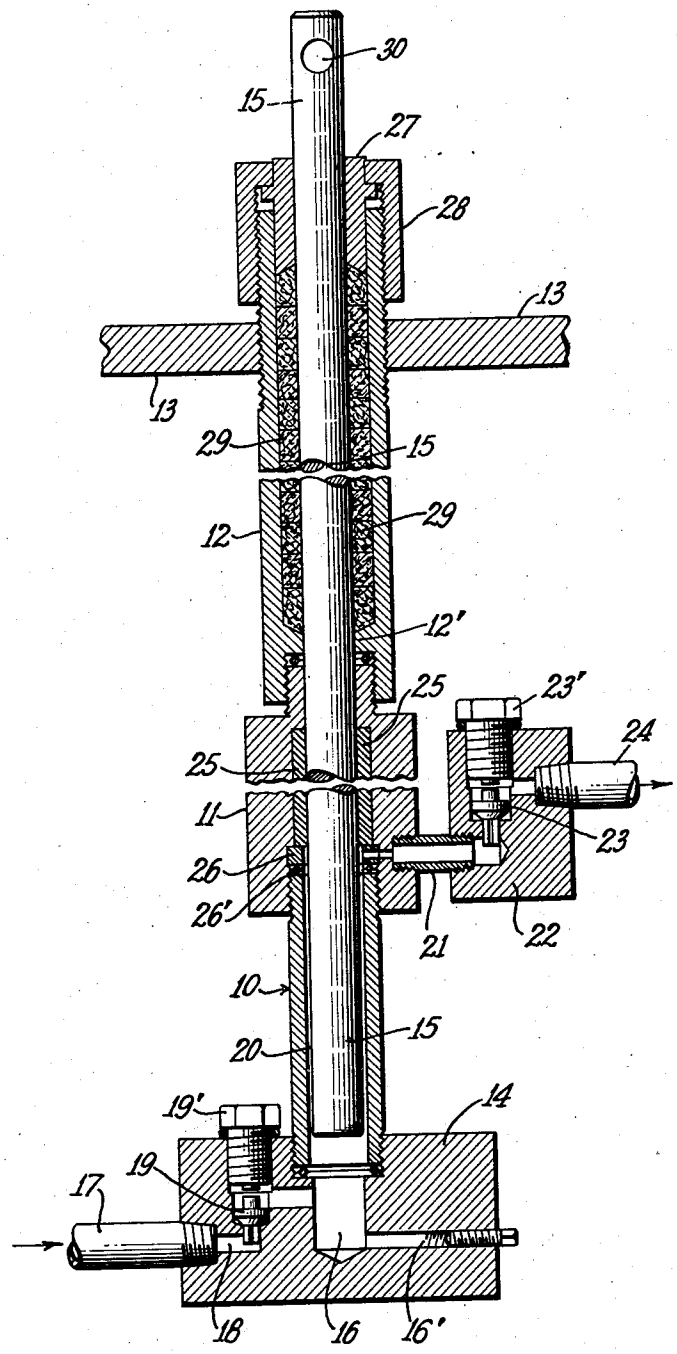
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APPARATUS FOR PUMPING A VOLATILE LIQUID

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APPARATUS FOR PUMPING VOLATILE LIQUIDS

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10 Claims. (Cl. 103—153)

This invention relates to apparatus for pumping volatile liquids and particularly to plunger pumps adapted for pumping liquefied gases which have boiling point temperatures materially below 273° K. at atmospheric pressure, such as liquid oxygen, against relatively high heads of pressure, for example, against a head of pressure of from 1000 to 2000 lbs. per square inch gauge.

The invention has for its object generally the provision of an improved construction and arrangement of parts for pumps of the character indicated which achieves precision of movement of the working parts and also assists in excluding heat from the liquid being pumped and in the lubrication of the pump plunger.

More specifically, the invention has for its object the provision of an improved construction for the pump cylinder of a plunger pump adapted for pumping highly volatile liquefied gases, such as liquid oxygen, in which liquid displacement from the pump chamber is accomplished by the countermovement of liquid and plunger and in which a bushing is provided for the plunger for guiding the same and is of a character which excludes heat and is also self-lubricating.

Another object of the invention is to provide a guiding bushing of a type which is suitable also for operation at relatively low temperatures and in the presence of a chemically active liquid agent, such as liquid oxygen, when at a relatively high pressure.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the features of construction, combination of elements, and arrangement of parts, which will be exemplified in the construction hereinafter set forth, and the scope of the invention will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention reference should be had to the following detailed description taken in connection with the accompanying drawing, in which:

The figure is a view, mainly in section, showing a plunger pump for pumping liquid oxygen, arranged in accordance with the invention.

Referring now to the drawing, a vertically arranged cylinder assembly is shown comprising a cylindrical element 10 formed with a pump chamber to receive liquid and having a relatively thick wall. The cylinder 10 is attached at the upper end to a second element 11 arranged to close one end of the pump chamber, and has a third element 12 superposed and attached and serving as a packing sleeve. The sleeve element 12 is preferably mounted at its top in a plate element 13 that may be a component of frame or casing that affords rigid support to the pump assembly (the showing of such frame or casing being omitted from the drawing in the interests of clearness of illustration). The elements 10, 11 and 12, while they may be integral, are preferably separable, the attachment to one another being achieved in any convenient manner, for example, by threaded joints, as shown.

The cylinder assembly is completed by means of a block-like element 14 that is shown as threadedly attached to the lower end of the cylinder 10. The block 14 thus closes the lower end of the pump chamber and forms a suitable head for the cylinder, in which a plunger 15 is reciprocated.

The block 14 is preferably counterbored, as shown at 16, to provide a liquid receiving space, and has a supply connection 17 that communicates with the receiving space 16 through a channel 18; the latter being bored in the block 14 and formed with an offset portion having a valve seat on which a valve element 19 seats. The valve element is arranged to open in response to the incoming stream of liquid and is therefore biased to closed position. Any convenient arrangement for this purpose may be employed, for example, a gravity seating arrangement, as shown. Access to the valve chamber in the block 14 is provided in any convenient manner, for example, by means of a removable plug 19'. The extent to which the block 14 is counterbored at 16 is merely such as to provide a space beneath the plunger sufficient to receive and collect any solid bodies in the incoming liquid. The lower end of the pump casing is accordingly provided with a blow-off outlet which is shown closed by a removable plug 16'.

In order that liquid may be displaced from the pump chamber by the countermovement of liquid and plunger, a clearance space in the cylinder 10 at the sides of the plunger is also provided, whereby liquid may flow upwardly when the plunger moves downwardly. This latter clearance space is shown at 20 and leads to an offset outlet connection 21, which communicates at the upper end with the clearance space 20 through a lateral bore in the element 11. Connection 21 leads to and communicates with another valve chamber in a housing element 22 which has a valve 23 seating therein. A discharge connection is provided at 24 which communicates with the passage in the valve housing at a point be-

yond the valve seat. Access to the outlet valve chamber is provided through the removable plug 23'.

In order to provide the pump with a bushing, in accordance with the invention, adapted both to guide and to lubricate the plunger 15 and which also excludes heat, the element 11 is counterbored interiorly to a point considerably beyond the threads which engage an end of the element 10, and into this counterbored portion is fitted a bushing 25 of an inert material which both excludes heat and is self-lubricating. The material at present preferred for this purpose is a bonded graphite. The clearance of the bushing about the plunger is made relatively small and preferably not over .001 inch for plungers of the order of one inch in diameter. Axially the bushing is preferably given a length approximately equal to or greater than the stroke of the plunger. This will prevent any portion of the plunger, which has been heated by packing friction, from entering the liquid chamber.

The lower end of the graphite bushing is seen to be flush with the upper end of the enlarged portion of the deep cylindrical recess in block 11, the recess being preferably shaped or counterbored to receive a spacing collar 26 which is of metal, clears the plunger, and adapted to hold the bushing in place against any tendency to downward displacement. The diameter of the counterbored recess is slightly greater than that employed for the bushing 25; the collar 26 located in the recess being also preferably bored through radially at a point communicating with the connection 21 in order to afford a suitable exit for the liquid displaced from the pump chamber. Between the collar 26 and the cylinder 10, a sealing washer 26' is also preferably inserted to insure a pressure-tight joint between cylinder 10 and block 11.

The sleeve 12, at its lower end, has a gland 12' adapted to engage the threaded nipple of element 11, while the upper end of the sleeve is closed by a gland or follower 27 that preferably has an exterior shoulder or collar adapted to be engaged by a nut 28, which is arranged to be in screw-threaded engagement with the exterior of the sleeve. The gland or follower is arranged to press down upon a plurality of packing rings 29, which are shown as filling the space in the packing sleeve between its inner wall and the plunger 15. These packing rings are preferably of a special construction and when liquid oxygen is being pumped are of a composition avoiding the use of a hydrocarbon or other substance that may react with the liquid oxygen. A preferred form of packing ring for such service comprises a washer-like body of suitable inert compressed material, such as shredded asbestos, incorporating an inert solid lubricant in comminuted form, for example, flake graphite, as disclosed in copending application, Serial No. 341,126, filed June 18, 1940, in the name of J. F. Patterson.

The plunger 15 is provided at its upper end with a transverse opening 30, or other suitable means, by which it may be mechanically coupled to suitable driving means, for example, by a pin to a walking beam (omitted from the drawing in the interests of clearness of illustration).

In operation, the liquid oxygen, or other highly volatile fluid that is to be pumped, is introduced to the pump chamber through the inlet connection 17, the valve 19 being opened by the impact of the fluid which passes into the cylinder chamber under the influence of the suction stroke of plunger 15. The plunger, when moved upwardly, executes the suction stroke; the plunger moving from the lowermost position to the uppermost position to execute a complete stroke. The discharge stroke then follows; the plunger moving in the opposite direction or from uppermost position to lowermost position.

The relatively long packing sleeve here employed, together with the relatively large amount of packing, is, of course, fitted tightly into the space in the gland about the plunger 15, in order thereby to avoid leakage and to prevent the escape of any substantial quantity of the volatile material being pumped. This engagement of the packing with the plunger necessarily generates heat in the plunger 15, mainly in its surface, when the pump is working. Some of the heat thus generated is conductively transmitted to the block 11. The transference of this heat to the liquid being pumped while in the upper part of the pump chamber, where it would impede pumping, is in large measure blocked by the bushing 25 which is interposed between the packing and the pump chamber. The reduced clearance provided, as indicated above, insures that the bushing shall also serve as a self-lubricating guide for the plunger.

The method and arrangement of connections for operating the pump above described are disclosed and claimed in copending application, Serial No. 340,848, filed June 15, 1940 in the name of O. A. Hansen.

Since certain changes may be made in the above construction and different embodiments of the invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In apparatus for pumping a volatile liquid having a boiling point temperature materially below 273° K. at atmospheric pressure, the combination with a low pressure supply of such liquid, of a pump assembly comprising a cylinder formed with a pump chamber and having a closure at the suction end provided with a valve controlled inlet passage communicating with said supply, a single-acting plunger arranged to reciprocate in said cylinder and to clear the inner wall thereof providing thereby an appreciable clearance space, a discharge passage provided with a valve and communicating with said clearance space, a gland element closing said cylinder and affording entrance for said plunger and provided with a packing space, an inert lubricated packing for said plunger in said packing space, and a solid self-lubricating and relatively close-fitting bushing for said plunger of a length at least as long as the stroke of said plunger and disposed in said assembly between said packing space and said clearance space.

2. In apparatus for pumping a volatile liquid having a boiling point temperature materially below 273° K. at atmospheric pressure, the combination with a low pressure supply of such liquid, of a pump assembly comprising a vertically mounted cylinder recessed to provide a pump chamber, a head closing said cylinder at its lower end and provided with an inlet passage adapted to be connected to said supply, flow actuated valve controlling said inlet, a single-acting plunger arranged to reciprocate in said cylinder and to

clear the inner wall thereof providing thereby an appreciable clearance space, a closure for the upper end of said cylinder provided with an outlet passage communicating with said clearance space, a flow actuated valve controlling said outlet, a gland element associated with said last-named closure in which said plunger works and provided with a space adapted to receive annular packing for sealing the passage of said plunger, and a bushing of solid self-lubricating material disposed in said last-named closure adapted to fit closely about said plunger, said bushing having an axial length sufficient to impede adequately the transfer of heat from said packing to said pump chamber.

3. In apparatus for pumping a volatile liquid having a boiling point temperature materially below 273° K. at atmospheric pressure, the combination with a low pressure supply of such liquid, of a pump assembly comprising a vertically mounted cylinder recessed to provide a pump chamber, a head closing said cylinder at its lower end and provided with an inlet passage adapted to be connected to said supply, flow actuated valve controlling said inlet, said valve being located on the exterior of said cylinder and provided with means affording access thereto, a single-acting plunger arranged to reciprocate in said cylinder and to clear the inner wall thereof providing thereby an appreciable clearance space, a closure for the upper end of said cylinder provided with an outlet passage communicating with said clearance space, a flow actuated valve controlling said outlet, said second-named valve being located on the exterior of said cylinder and provided with means affording access thereto, a gland element associated with said last-named closure in which said plunger works and provided with a space adapted to receive annular packing for sealing the passage of said plunger, and a bushing of solid self-lubricating material of a length at least equal to the stroke of said plunger and disposed in said last-named closure about said plunger for effectually impeding transfer of heat from said packing to said pump chamber.

4. In apparatus for pumping liquid oxygen, the combination with a low pressure supply of such liquid, of a pump assembly comprising a vertically mounted cylinder recessed to provide a pump chamber, a head closing said cylinder at its lower end and provided with an inlet passage adapted to be connected to said supply, a gravity controlled valve controlling said inlet, a single-acting plunger arranged to reciprocate in said cylinder and to clear the inner wall thereof providing thereby an appreciable clearance space, a closure for the upper end of said cylinder provided with an outlet passage communicating with said clearance space, a flow and gravity actuated valve controlling said outlet, a gland element associated with said last-named closure in which said plunger works and provided with a space adapted to receive annular packing for sealing the passage of said plunger, and a bushing of bonded graphite having a length at least equal to that of a plunger stroke and disposed in said last-named closure about said plunger for effectually impeding transfer of heat from said packing to said pump chamber.

5. In apparatus for pumping a volatile liquid having a boiling point temperature materially below 273° K. at atmospheric pressure, the combination with a low pressure supply of such liquid, of a pump assembly comprising a vertically mounted cylinder recessed to provide a pump chamber, a head closing said cylinder at its lower end and provided with an inlet passage adapted to be connected to said supply, a valve controlling said inlet, a single-acting plunger arranged to reciprocate in said cylinder, an outlet for said cylinder, a closure for the upper end of said cylinder, a valve controlling said outlet, a gland element associated with said last-named closure in which said plunger works and provided with a space adapted to receive annular packing for sealing the passage of said plunger, and a bushing of solid self-lubricating material disposed in said last-named closure about said plunger, said bushing being relatively closely fitted around said plunger for eliminating substantially all clearance space at the upper portion of said pump chamber and having an axial length sufficient to impede adequately transfer of heat from said packing to said pump chamber.

6. In apparatus for pumping a volatile liquid having a boiling point temperature materially below 273° K. at atmospheric pressure, the combination with a source of supply of such liquid, of a pump assembly comprising a cylinder formed with a pump chamber, a connection thereto from said source of supply, valve means controlling said connection, a pump plunger arranged to reciprocate in said cylinder and having an appreciable clearance with respect to the walls of the pump chamber, a discharge passage communicating with a high point of said chamber, valve means therefor, a gland and packing means through which said plunger operates at one end of the pump assembly, and a close-fitting guide bushing for said plunger located interiorly of the pump with respect to said gland and packing means, said bushing being of solid self-lubricating material and having a substantial axial length sufficient to impede adequately transfer of heat from said packing to said pump chamber.

7. In apparatus for pumping a volatile liquid having a boiling point temperature materially below 273° K. at atmospheric pressure, the combination with a source of supply of such liquid of a pump assembly comprising a cylinder formed with a pump chamber, a connection thereto from said source of supply, valve means controlling said connection, a pump plunger arranged to reciprocate in said cylinder, a discharge passage with valve means therefor, a gland and packing means through which said plunger operates at one end of the pump assembly, and a close fitting guide bushing for said plunger of a length substantially equal at least to the stroke of the plunger located interiorly of the pump with respect to said gland and packing means, said bushing being of inert solid self-lubricating material whereby the heat transferred to the liquid in the pump chamber from that generated by friction at said packing means is restricted at least to an immaterial amount.

8. In apparatus for pumping a volatile liquid having a boiling point temperature materially below 273° K. at atmospheric pressure, the combination with a source of supply of such liquid, of a pump assembly having a pump chamber, a plunger adapted to reciprocate therein, a valve controlled inlet connection from said source to said cylinder, a valve controlled discharge passage, packing means for sealing the chamber about the opening for said plunger, and a guide bushing for said plunger located interiorly of the pump with respect to said packing means, said guide bushing being of solid self-lubricating bonded graphite material and of substantial

length and close fitting about said plunger, whereby the heat transferred to the liquid in the pump from that generated by friction at said packing means is restricted at least to a low value.

9. In apparatus for pumping a volatile liquid having a boiling point temperature materially below 273° K. at atmospheric pressure, the combination with a source of supply of such liquid, of a pump assembly comprising a cylinder formed with a pump chamber and provided with a valve controlled inlet passage communicating with said supply, a pump plunger arranged to reciprocate in said cylnder and to clear the inner wall of the pump chamber providing thereby a clearance space, a discharge passage provided with a valve and communicating with a high point of said clearance space, a gland and packing means through which said plunger operates at one end of the pump cylinder, and a solid self-lubricating guide bushing of substantial length fitted around said plunger and disposed in said assembly between said packing means and said clearance space, said discharge passage communicating with said clearance space at a point thereof adjacent said bushing.

10. In apparatus for pumping a volatile liquid having a boiling point temperature materially below 273° K. at atmospheric pressure, the combination with a low pressure supply of such liquid of a pump assembly comprising a cylinder formed with a pump chamber and provided with a valve controlled inlet passage communicating with said supply, a pump plunger arranged to reciprocate in said cylnder and to clear the inner wall of the pump chamber providing thereby a clearance space, a discharge passage provided with a valve and communicating with a high point of said clearance space, a gland and packing means through which said plunger operates at one end of said cylinder, and a close fitting solid self-lubricating bushing for said plunger of a length about as long as the stroke of said plunger and disposed in said cylinder between said packing means and said clearance space, whereby the heat transferred to the liquid in the pump chamber from that generated by friction at said packing means is restricted at least to an immaterial amount.

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