June 2, 1964 A. A. HAYS ETAL 3,135,219

PUMPING APPARATUS

Filed Sept. 29, 1960

Fig. 1

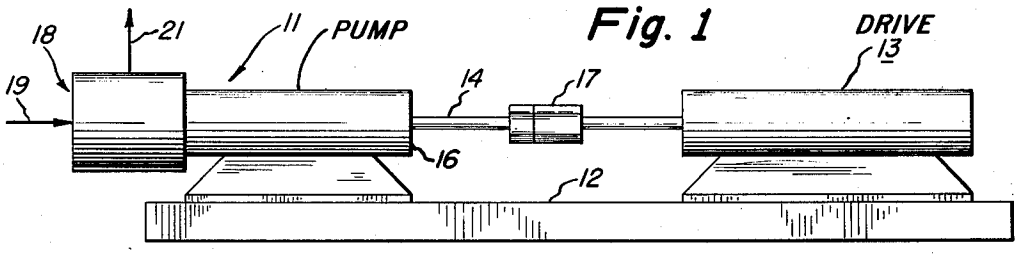


Fig. 1a

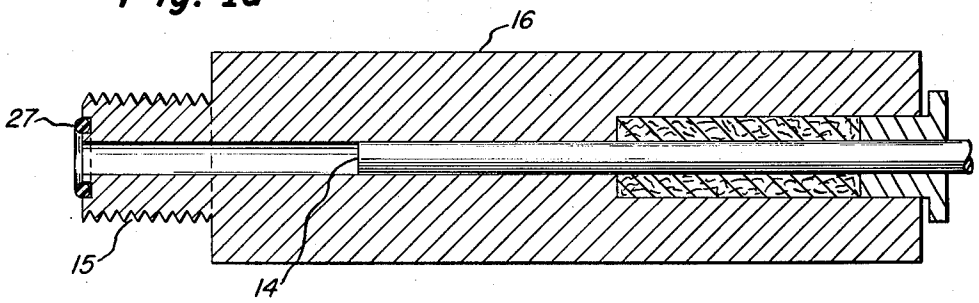


Fig. 1b

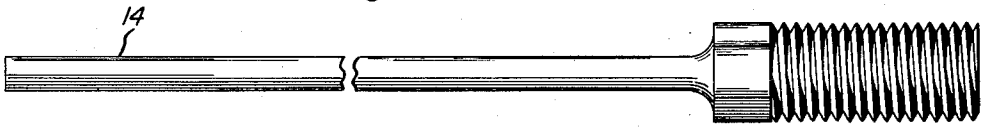


Fig. 2

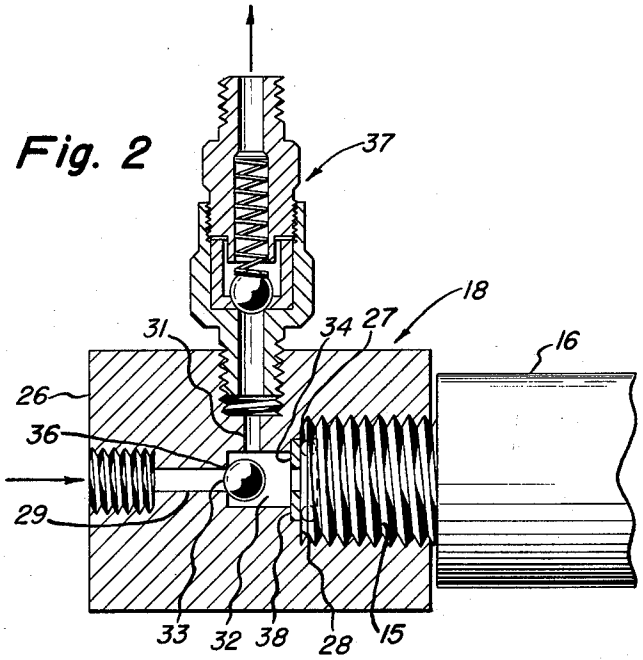
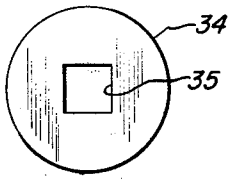


Fig. 3



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PUMPING APPARATUS

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This invention relates to reciprocating type pumps and a check valve assembly used therewith. More particularly, this invention relates to such a pump for handling relatively small quantities of liquid at high pressures.

In many petroleum and chemical processing plants it is often desirable to pump small quantities of liquid, i.e. about 10 to 150 ml. of liquid per hour, into high pressure systems, i.e. as high as about 3,000 p.s.i.g. Many available pumps are not capable of being operated effectively and economically under these conditions.

An object of the present invention is a pump adapted to pump small quantities of liquid against high pressures. Another object of the present invention is a small volume pump which may be operated efficiently and economically. A further object of this invention is a pump which is easy to maintain and which requires a minimum of maintenance. Further objects will become apparent from a reading of the following description of the pump of the present invention.

The present invention provides a pump cylinder, a reciprocating plunger within said cylinder having an intake stroke and a discharge stroke, and a particular check assembly mounted on the cylinder. The check valve assembly includes an inlet conduit, an outlet conduit, and a valve chamber in flow communication with the inlet and the outlet. A floating check member is positioned within the valve chamber which is in flow communication with the pump cylinder. A seating surface is provided in the inlet which is adapted to receive the check member in sealing contact therewith during the discharge stroke of said plunger. A check-retaining washer member is positioned at the end of the valve chamber adjacent the pump cylinder, the washer member being provided with an opening therein so that the check member is retained in the valve chamber, while permitting the fluid to be pumped to pass through the opening into the pump cylinder during the intake stroke of the plunger. A discharge check valve is provided in the outlet conduit to seal off the valve chamber during the intake stroke of the plunger and prevent the return of fluid discharged from the pump into the external system.

A better understanding of our invention will be had from the following description of a preferred embodiment of the invention and from the accompanying drawings wherein:

FIGURE 1 is an elevational view of the pump of the present invention,

FIGURE 1*a* illustrates a preferred pump cylinder employed in the pump,

FIGURE 1*b* illustrates a preferred plunger employed in the pump,

FIGURE 2 illustrates a preferred embodiment of the check valve assembly employed with the pump, and

FIGURE 3 is a preferred check-retaining washer employed in the above check valve assembly.

Referring to FIGURE 1, the pump **11** preferably is mounted on a base member **12** and is driven by a drive member **13** also mounted on the base. The drive **13** may include an electric motor with a speed reducer and a mechanical linkage to a rack and pinion assembly coupled to the pump plunger **14**. Other types of drive mechanisms may be employed, however, to impart a reciprocating motion to the plunger **14** within the pump cylinder **16**. Advantageously, the coupling **17** is adjustable and

a lock nut is provided so that the length of the plunger stroke may be adjusted over a wide range and set at the desired position.

A check valve assembly **18** is connected to the outboard end of the cylinder **16** by threaded engagement therewith. However, flanges or other suitable connections may be employed. The check valve assembly **18** is provided with an inlet line **19** through which is supplied the fluid to be pumped, and a discharge line **21** through which the fluid discharged from the pump flows into an external system.

Referring to FIGURE 2, the check valve assembly **18** is screwed onto the outboard end **15** of the pump cylinder **16**. The joint between the valve block **26** and the cylinder **16** preferably is sealed by an O-ring **27** between the outboard end of the cylinder and a shoulder **28** provided in the valve block **26**. The valve block **26** is provided with an inlet conduit **29** through the outboard end of the valve block and substantially in alignment with the bore of the cylinder **16**. An outlet conduit **31**, usually of smaller size than the inlet conduit, is also provided in the valve block **26** and, preferably, is at a substantially right angle to the inlet conduit **29**. The inlet **29** and the outlet **31** are in flow communication with a valve chamber **32** within which is positioned a check member **33**. The check member **33** may be cone shaped or of another shape particularly well adapted for use with specific fluids, but preferably is a ball having a diameter slightly less than the diameter of the valve chamber **32**. At the inboard end of the valve chamber **32** there is placed a washer member **34** which acts to retain the check member **33** within the valve chamber **32**.

During the intake stroke of the plunger **14** the fluid to be pumped passes through the inlet **29** into the valve chamber **32** and the floating check member **33** is drawn against the retaining washer **34**. The washer member **34**, as shown in FIGURE 3, is provided with a non-circular opening **35**, which advantageously is substantially rectangular in shape. The opening has appropriate dimensions so that the check member **33** will not pass through the opening into the bore of the cylinder **16**, while permitting a small volume of the incoming fluid to pass around the check and through the opening into the bore of the cylinder **16**. This arrangement permits a volume of fluid equal to the quantity to be pumped to bleed into the cylinder bore and has been found to considerably reduce shock and pulsation during the operation of the pump.

As the plunger **14** moves in the outboard direction on the discharge stroke, the check member **33** is forced against a seating surface **36** provided in the inlet **29** and contacts this seating surface to seal the inlet from the high pressure fluid. An additional check valve may be employed in the suction conduit upstream of the pump if desired, but this is not generally required. The fluid being pumped passes from the cylinder bore into the valve chamber, through the outlet **31** and through a check valve member **37** provided in the discharge conduit **31**. The check valve member **37** permits fluid to be discharged from the pump during the discharge stroke and seals off the valve chamber **32** from the external system during the intake stroke of the plunger.

Preferably the check-retaining washer **34** is positioned in a recess **38** provided adjacent the inboard end of the valve chamber **32** and is held in place between the outboard end of the cylinder **16** and the shoulder **28**.

The materials used in the construction of the various parts of the apparatus as described above may be any suitable material which is compatible with the fluid to be pumped under the service conditions employed. Normally the pump cylinder **16**, the plunger **14**, and the valve block **26** will be steel or a corrosion resistant alloy, and

the check member 33 and the washer 34 are made from a material having the desired corrosion resistance and hardness. Furthermore, the seating surface 36 in the block 26 and the seating surface on the washer 34 may be provided with a suitable soft seat, such as tetrafluoroethylene or the like.

A pump such as described above has been tested and operated successfully over long periods of time, pumping small volumes of liquid against a high pressure with minimum variations in the flow rate. One such pump was constructed as shown in FIGURE 2. This pump had a 7½" long by ¼" diameter AISI 4140 steel plunger operating in an 18–8 chrome-nickel stainless steel cylinder through a Teflon packed packing gland. The valve block of 18–8 chrome-nickel stainless steel was provided with a ¼" IPS inlet, reduced to a 5/16" diameter bore in the block, and a ⅛" IPS outlet reduced to a ⅛" diameter bore in the block. A ¼" diameter ball was used in the valve chamber which was ½" deep by 0.26" diameter. The washer 34 was ⅝" diameter by 1/16" thick, provided with a 3/16" square hole in its center. A spring loaded ball check valve was employed in the discharge conduit.

The above-described pump handled heavy catalytic cycle oil at a consistent flow rate of about 37 ml. per hour and was pumped into an external system against about 1,000 p.s.i.g. Thus, the pump of the present invention has been found to be capable of pumping small quantities of fluid against high pressures and has overcome the difficulties encountered with previous apparatus.

While we have described a preferred embodiment of our invention in considerable detail, it is understood that alternative details of construction and operation will be apparent from the foregoing description to those skilled in the art.

Having described our invention, what we claim is:

1. Fluid pumping apparatus comprising a pump cylinder, a reciprocating plunger within said cylinder and a valve assembly mounted on the outboard end of said cylinder, said valve assembly comprising an inlet conduit, an outlet conduit, a valve chamber communicating with said inlet conduit and said outlet conduit, a ball member positioned in said chamber, said chamber communicating with the outboard end of said cylinder, a ball-retaining washer member positioned between said ball and said cylinder, a first seating surface in said inlet conduit adapted to receive said ball member in sealing contact therewith during the discharge stroke of said plunger, said washer member being provided with a non-circular opening therein, said opening being adapted to retain said ball member in said chamber while permitting fluid from said chamber to pass through said opening into said cylinder during the intake stroke of said plunger, and ball check valve means in said outlet conduit adapted to seal off said valve chamber from fluid discharged therefrom during the intake stroke of said plunger.

2. Apparatus adapted for pumping small quantities of liquid at high pressure which apparatus comprises a pump cylinder, a reciprocating plunger within said cylinder and a valve assembly threaded on the outboard end of said cylinder, said valve assembly comprising a block member adapted for threaded engagement with the outboard end of said cylinder, a first conduit at the outboard end of said block being in substantial alignment with said cylinder, a second conduit in said block of a smaller size than said first conduit positioned in said block at substantially a right angle to said first conduit, a valve chamber in said block communicating with said first conduit and said second conduit, a ball member positioned in said chamber, said chamber communicating with said cylinder, a ball-retaining washer member positioned in a recess provided in said block adjacent the end of said chamber communicating with said cylinder, a first seating surface in said first conduit adapted to receive said ball member in sealing contact therewith during the discharge stroke of said plunger, said washer member being provided with a rectangular opening therein, said opening being adapted to retain said ball member in said chamber while permitting fluid from said chamber to pass around said ball through said opening into said cylinder during the intake stroke of said plunger, O-ring sealing means positioned between the outboard end of said cylinder and a shoulder provided in said block adjacent said washer means and spring loaded ball check valve means in said second conduit adapted to seal off said valve chamber from fluid discharged therefrom during the intake stroke of said plunger.

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