July 3, 1956 V. H. WALDIN 2,752,860

PUMP

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Fig. 1.

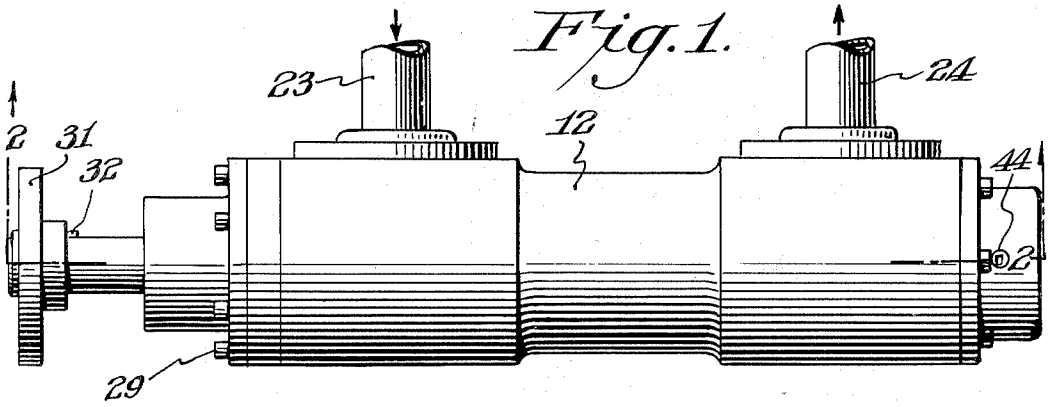


Fig. 2.

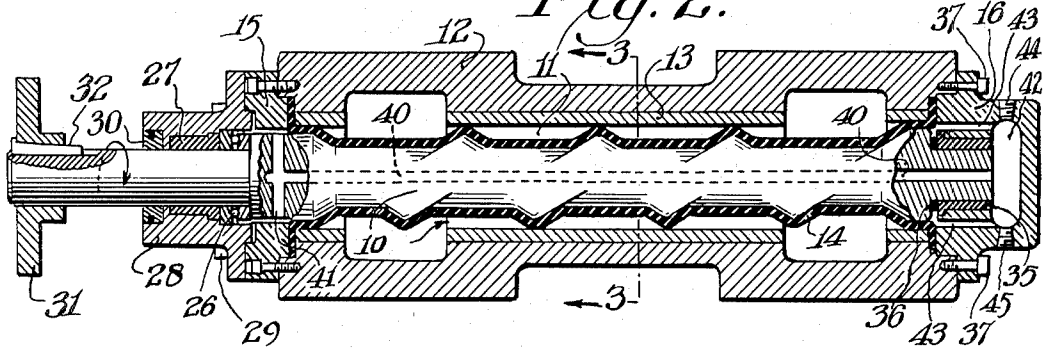
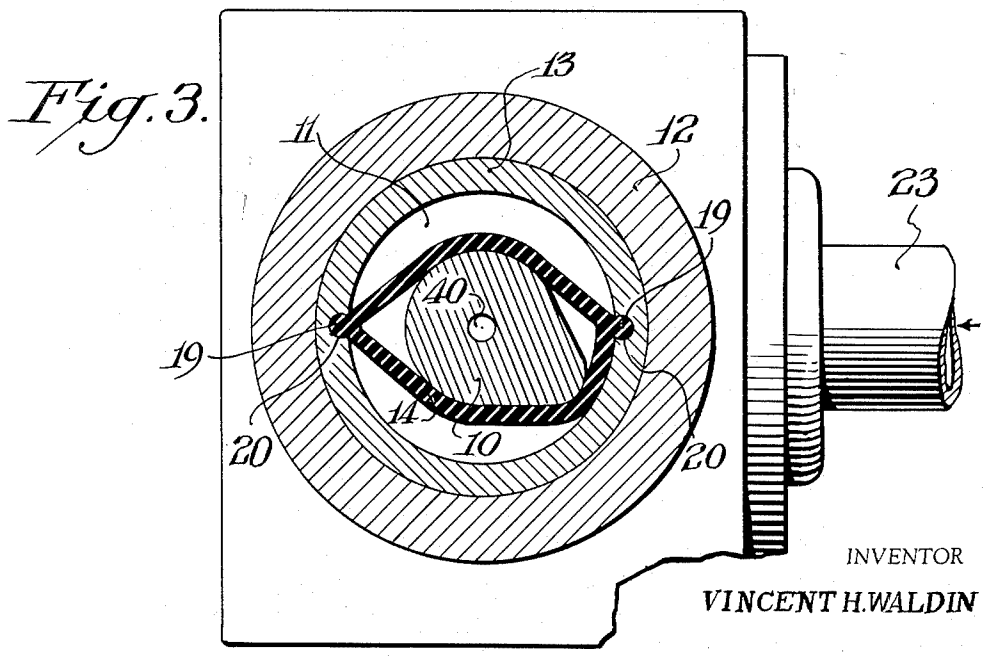


Fig. 3.



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2 Claims. (Cl. 103—149)

This invention relates to pumps, and particularly to an improved type of metering pump having an isolated screw type pumping element.

In certain industries, particularly in the chemical industry, it is necessary to meter precisely fluids or slurries which are extremely corrosive or abrasive, and conventional designs of pumps have not been altogether satisfactory for such purposes, either because their construction is too intricate to permit fabrication of the pump elements from materials of optimum chemical corrosion resistance or because the less complicated designs permit a varying amount of back leakage which precludes use where metered delivery is necessary. Other disadvantages of known designs of pumps are the necessity for leakproof packing glands, limitation to unidirectional pumping, reliance on check valves and injuriously high shear rates applied to the medium pumped.

An object of this invention is to provide an improved metering pump which is designed so as to permit construction from a wide variety of corrosion-resistant materials.

Another object of this invention is to provide an improved metering pump which is adapted to pump in either direction by merely reversing the direction of rotation of the pumping element.

Another object of this invention is to provide an improved metering pump which is hermetically sealed and thus requires no packing glands.

Yet other objects of this invention consist in the provision of a metering pump which is adapted to pump either liquids, gases, or slurries with equal facility and at low shear rates applied to the medium pumped, and which obviates check valves and like devices.

The manner in which these and other objects of this invention are attained will become apparent from the detailed description and the following drawings in which:

Fig. 1 is a plan view of one embodiment of pump constructed according to this invention,

Fig. 2 is a sectional view taken along line 2—2 of Fig. 1, and

Fig. 3 is an enlarged sectional view taken along line 3—3 of Fig. 2.

Generally, this invention comprises a pump having a pumping element and a companion element disposed concentric therewith, the pumping element and companion element being relatively rotatable with respect to one another, and an elastomeric sleeve of generally annular form disposed in co-axial relationship with respect to the pumping element and the companion element intermediate thereof, the pumping element being provided with a screw thread adjacent the companion element in abutment with the elastomeric sleeve and the elastomeric sleeve being in abutment with the companion element along the crest line of the thread and sealed thereto in a manner preventing leakage of fluid circumferentially of the thread, so that fluid introduced into the space between the elastomeric sleeve and the companion element is impelled in the direction of thread advance.

Referring to Figs. 1 and 2, one embodiment of this invention utilizes a pumping element comprising a screw 10 journaled within the cylindrical bore 11 of fluid-tight casing 12, which is provided with a liner 13 fabricated from corrosion-resistant material of high abrasion resistance, such as Type 304 stainless steel, a linear polyamide or the like. Screw 10 is enclosed within elastomeric sleeve 14 of generally annular form running the full length of the screw, the ends of sleeve 14 being secured in liquid-tight abutment against the ends of casing 12 by bolted flange 15 at the inlet end and closure member 16 at the discharge end of the pump.

Sleeve 14 may be fabricated from any elastomeric material such as rubber or the like and, in fact, may be constructed of materials having only a limited range of elasticity of between about 8–10%, which is usually considered below the lower limit of elasticity characterizing elastomers as a class. Sleeve 14 may be circular in cross-section in the unstressed condition or may be molded to present a somewhat elliptical cross-section similar to that shown in Fig. 3, the latter configuration being somewhat preferred for the reason that the stress load on the sleeve is thereby reduced, both of these shapes and variations thereof being comprehended by the term "annular" as used in this specification. As indicated in Figs. 2 and 3, the internal diameter of sleeve 14 should be such that the inside surface of the sleeve is constricted into contact with the surface of the thread of screw 10 over the crest and preferably also at two diametrically opposed points at the root disposed along the vertical axis (except when the crest is in the vicinity of this axis) at any cross section by the natural elasticity of the sleeve, whereupon the screw provides back-up support for the sleeve over the entire length of the sleeve. The outside surface of sleeve 14 overlying the crest line of the thread of screw 10 is in snug abutment with the bore of linear 13, providing a seal against longitudinal leakage of fluid reverse to the direction in which the screw, by its rotation, impels the fluid. As shown in Fig. 3, the outside of sleeve 14 is provided with diametrically opposed integrally formed beads 19, disposed parallel to the axis of the sleeve and extending the full length of the threaded portion of screw 10, which beads engage tightly within complementary grooves 20 formed in liner 13, thus preventing leakage of fluid circumferentially of the thread during rotation of screw 10. It will be understood that only one bead 19 is required for circumferential sealing; however, it is preferred to utilize two oppositely disposed beads for the reason that the sealing load is thereby distributed and, in addition, circumferential stressing of sleeve 14 under rotation of screw 10 is rendered more uniform.

Liner 13 is cut away at the inlet and discharge ends of the pump assembly, and the interior of casing 12 is provided with a larger diameter bore at these points to receive fluid which is supplied to the casing through flanged inlet conduit 23 and discharged from the casing through flanged discharge conduit 24. The inlet end of screw 10 is provided with a thrust-receiving ball bearing 26 abutting the shoulder of the screw, and the screw is journaled in sleeve bearing 27, both bearings being press-fitted in the inner stepped bores of closure member 28, which is secured to casing 12 by bolts 29 offset an amount preventing interference with the bolts securing flange 15 to the casing. A conventional annular oil seal 30 mounted within the exterior bore of closure member 28 is sprung over the drive end of screw 10, and the extending shaft of the screw is provided with a drive flange 31 secured thereto by key 32 for connection with a motor or other suitable power source. The discharge end of screw 10 is journaled in sleeve bearing 35 press-fitted within the bore of closure member 16 secured to casing 12 by bolts 37, and a spacer washer 36 is provided inter-

mediate this end of the screw and the inner shoulder of bearing **35**.

While not absolutely essential to the operation of the pump hereinbefore described, it is desirable to lubricate the inside surface of sleeve **14** in contact with the thread of screw **10** to reduce frictional drag on the sleeve during operation and also to reduce wear. This is conveniently accomplished by providing screw **10** with an axial drilled passage **40** opening into transverse passage **41** at the inlet end of the screw and into the lubricant reservoir space **42** within closure member **16**. The outside diameter of the shaft of screw **10** at the inlet end is made somewhat smaller than the inside diameter of flange **15** and the bore receiving the outer race and the balls of thrust bearing **26**, thereby providing an annular passage for the simultaneous supply of lubricant to both the bearing and the inside surface of sleeve **14**. Closure member **16** is provided with a multiplicity of lubricant discharge passages **43** annularly arranged around the inside face upon the same radius as the sealed discharge end of sleeve **14** and in open communication with the space between screw **10** and sleeve **14** and with reservoir space **42**. Screw plug-closed ports **44** and **45** are provided in member **16** for the convenient supply and relacement of lubricant which may be any light oil or a synthetic material possessing lubricating properties having no deteriorative effects on sleeve **14** or the metal surfaces of the pump.

In operation it will be understood that the fluid pumped is introduced through inlet conduit **23** and, as screw **10** turns in a clockwise direction as viewed from the inlet end of the pump, the fluid is progressively squeezed along the bore of liner **13** between successive threads of the screw sealed by sleeve **14** until discharge is had through conduit **24**. At the same time lubricant is forced between the sleeve and the screw by the screw's advance, but at a lower rate of delivery, and recirculated back to the inlet end of the pump by return through passages **40** and **41**. An experimental pump of the design hereinabove described had a pumping screw formed with three full threads (root diameter 1.25", crest diameter 1.865") of a pitch length of 2.67" and a circular cross-section synthetic rubber sleeve (chloroprene polymer) 0.092" thick with an internal diameter of 1.50". The internal diameter of the liner was 2.00". This pump was operated with water as the pumped fluid at speeds up to and including 700 R. P. M., at which speed it delivered 6 G. P. M. in metered flow at a delivery pressure of 100 lbs./sq. in. Tests with the pump showed that good pumping action was obtained at all pressures up to and including 160 lbs./sq. in. Furthermore, the pump was completely reversible upon merely reversing the direction of rotation of the screw, it being understood that where extensive reverse operation is required that it is desirable to provide a second thrust bearing identical with bearing **26** at the discharge end of the pump as well as at the inlet end.

It will be apparent that pumps according to this invention can be readily fabricated from a wide variety of corrosion-resistant materials and that the pump is adapted, because of its hermetically sealed construction, to the handling of any corrosive or toxic fluids, both liquids and gases, providing the fluids are not reactive with the materials from which the pump is constructed.

Numerous modifications of the embodiment hereinabove described are possible, each having special merit. Thus it is possible to employ a stationary screw in conjunction with a rotatable casing and sleeve, although rotary seals of somewhat complicated design are then required for the introduction and discharge of the pumped fluid. A somewhat preferred construction involves providing the bore of the liner with an internal thread, utilizing a simple cylindrical mandrel as a substitute for screw **10**, in which case passage **40** and the connections from the sleeve-mandrel interspace to the bearings are eliminated and pumping occurs between the stationary sleeve and the mandrel sealed to the sleeve to prevent circumferential leakage upon rotation of the threaded casing. With this construction introduction and discharge are made through stationary connections with suitable passages provided at each end of the mandrel. It is also possible to obtain pressure staging in the pumping of fluids or gases by decreasing the fluid storage volume between the threads of the pumping element and the sleeve by changing the root diameter of the thread from the inlet end of the pump to the discharge end. In the case of the screw pump of Figs. 1–3 this can be conveniently achieved by increasing the root diameter of screw **10** linearly in the direction of pump delivery, it being understood that pressure staging in this manner requires unidirectional pumping. Also, while longitudinally disposed sealing beads **19** have proved to be entirely satisfactory, these beads may have some other orientation, a helical configuration normal to the screw flight providing a particularly effective seal. Obviously various other modifications of the invention can be made such as, for example, providing a bellows element within the casing at the discharge end having the open end secured to the discharge end of the sleeve to stress the sleeve longitudinally in the direction of pumping to a degree proportioned to the delivery pressure to thereby minimize circumferential strains on the sleeve, and in other ways wherefor it is desired to be limited only by the scope of the following claims.

What is claimed is:

1. A pump comprising in combination a pumping element, a companion element in concentric relationship with said pumping element, said pumping element and said companion element being rotatable relative to one another, and an elastomeric annular sleeve disposed intermediate said pumping element and said companion element in coaxial relationship therewith, said pumping element being provided with a threaded portion of a minimum of one pitch length, at least the crest of said threaded portion being in abutment with said sleeve and said sleeve being in abutment with said companion element along the crest line of said threaded portion, sealing means disposed parallel to the axis of said sleeve between said sleeve and said companion element substantially preventing passage of pumped medium circumferentially of said threaded portion, closure members at each end of said sleeve and companion element defining therewith a fluidtight pumping chamber, a supply port adjacent one closure member in communication with the space between said sleeve and said companion element, a discharge port adjacent the other of said closure members in communication with the space between said sleeve and said companion element, and means for rotating one of the pair comprising said pumping element and said companion element.

2. A pump comprising in combination a rotatable screw, a companion element having a circular bore, said screw being journaled within said bore in co-axial relationship therewith and being provided with an internal lubrication passage extending the full length thereof, an elastomeric annular sleeve surrounding said screw and in abutment with at least the crest thereof, the diameter of said bore being slightly less than the crest diameter of said screw plus twice the wall thickness of said sleeve in maximum radially stressed condition, sealing means disposed parallel to the axis of said sleeve between said sleeve and the wall of said bore substantially preventing passage of pumped medium circumferentially of said screw, closure members at each end of said sleeve and companion element defining therewith a fluidtight pumping chamber, a supply port adjacent one closure member in communictaion with the space between said sleeve and said companion element, a discharge port adjacent the other of said closure members in communication with the space between said sleeve and said companion element, means for rotating said screw, and lubrication conduits

in open communication with said lubrication passage and the space between said sleeve and said screw at both ends of said screw.

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