Sept. 22, 1970 E. M. SMITH 3,529,908

VARIABLE OUTPUT POSITIVE DISPLACEMENT BELLOWS PUMP

Filed Oct. 7, 1968 3 Sheets-Sheet 1

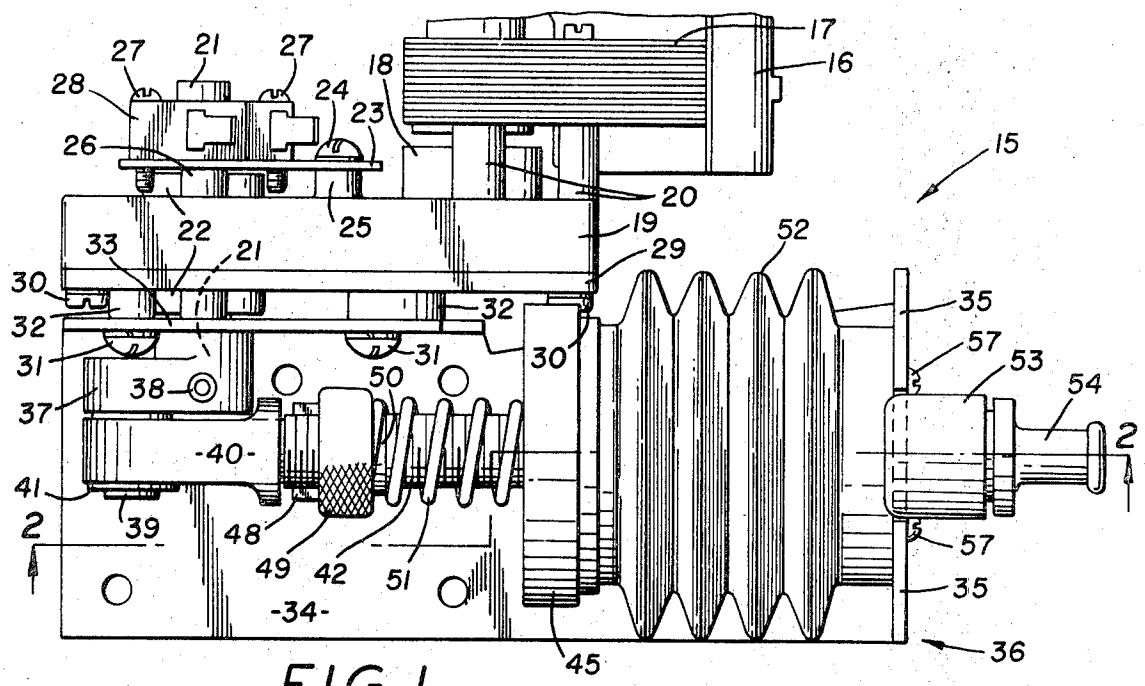

FIG. 1

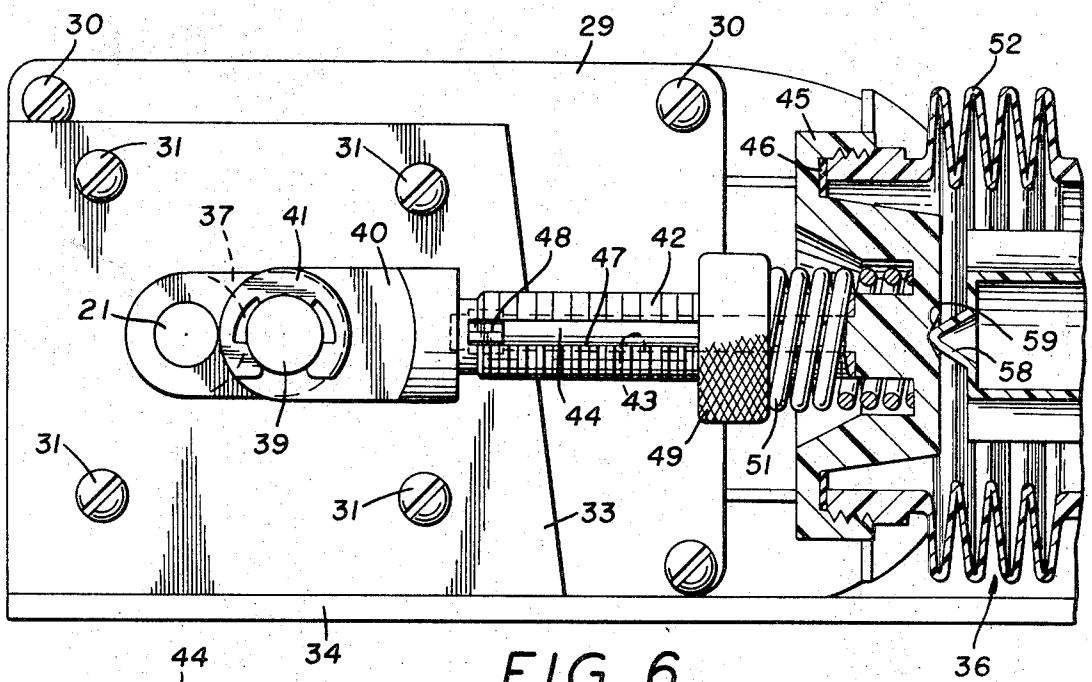

FIG. 6

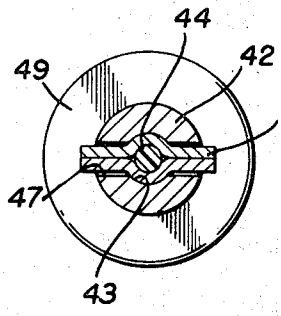

FIG. 4

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VARIABLE OUTPUT POSITIVE DISPLACEMENT BELLOWS PUMP

Filed Oct. 7, 1968 3 Sheets-Sheet 2

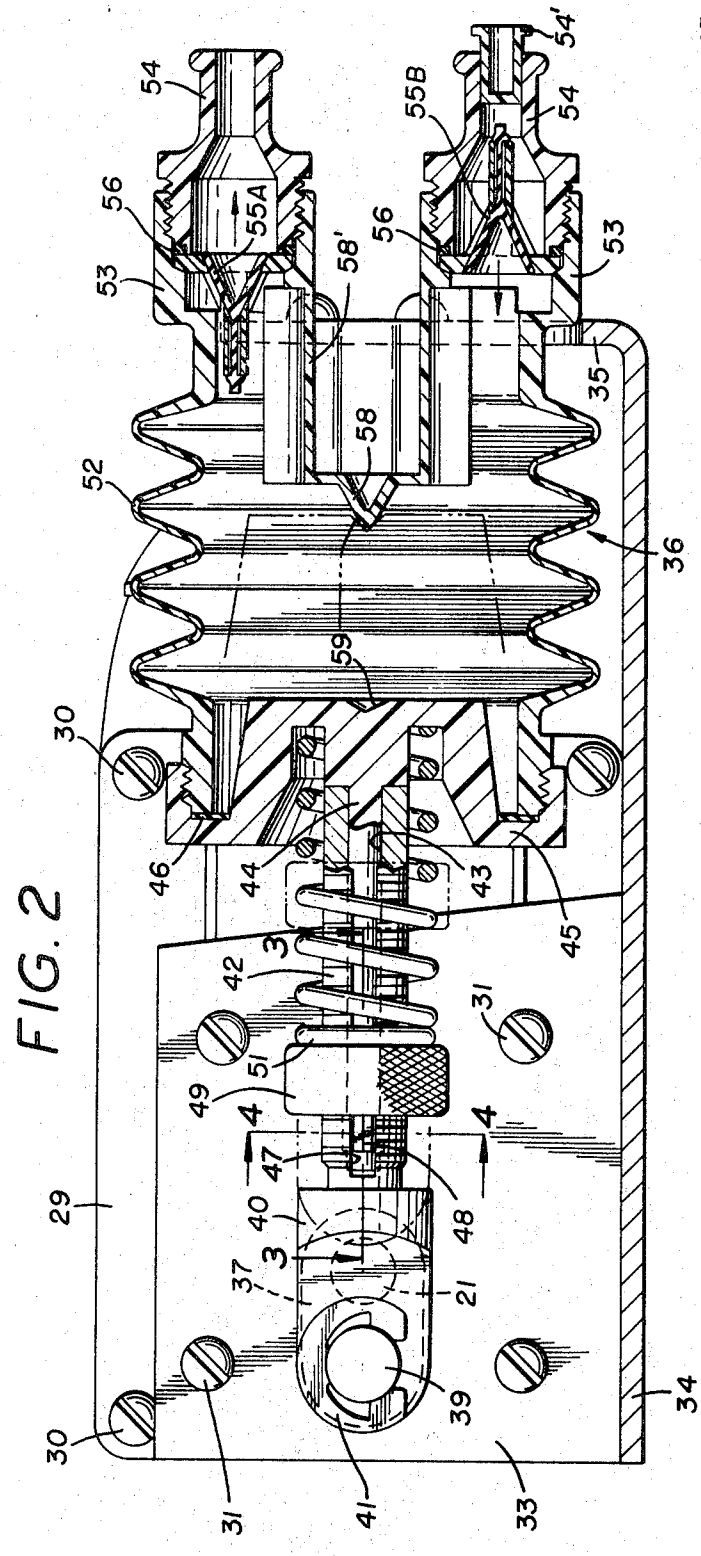

FIG. 2

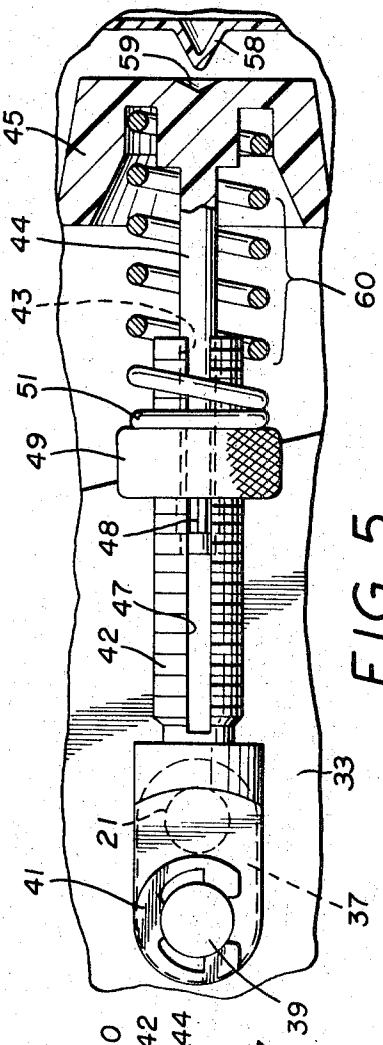

FIG. 5

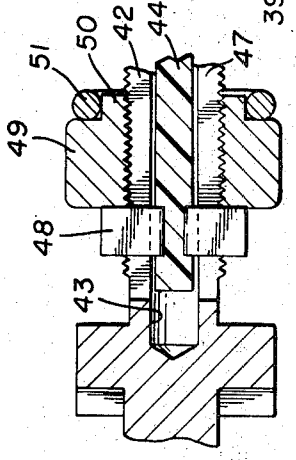

FIG. 3

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VARIABLE OUTPUT POSITIVE DISPLACEMENT BELLOWS PUMP

Filed Oct. 7, 1968 3 Sheets-Sheet 3

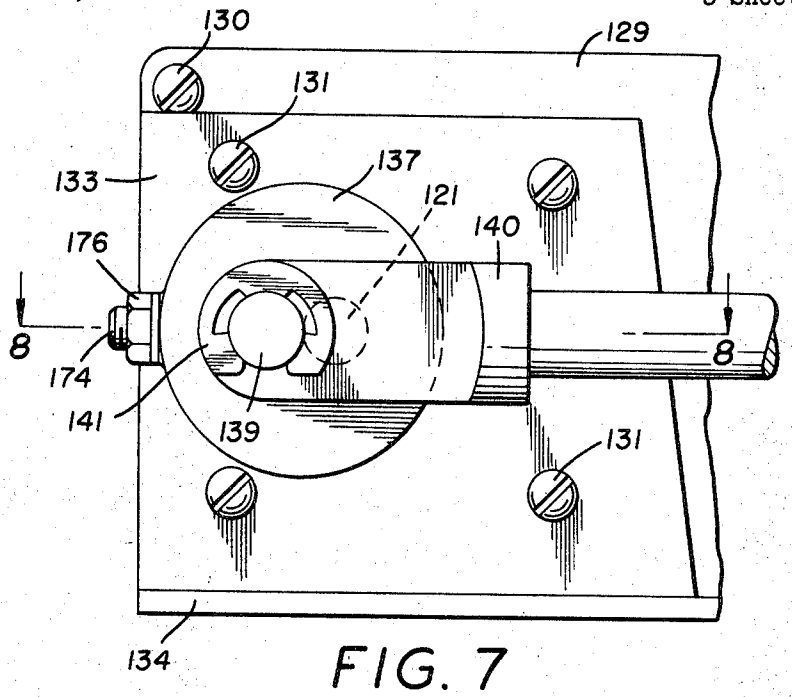

FIG. 7

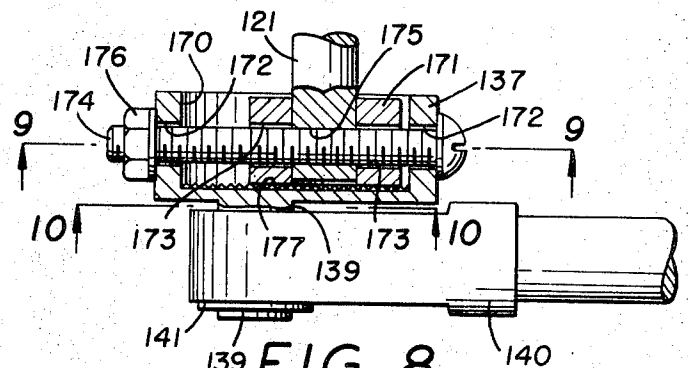

FIG. 8

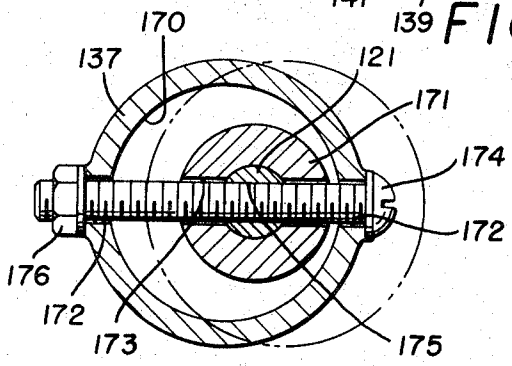

FIG. 9

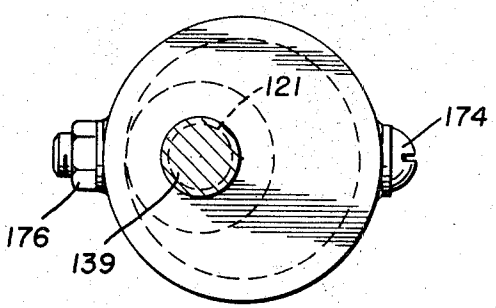

FIG. 10

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3,529,908

VARIABLE OUTPUT POSITIVE DISPLACEMENT BELLOWS PUMP

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Int. Cl. F04b 49/00, 43/08
U.S. Cl. 417—472 4 Claims

ABSTRACT OF THE DISCLOSURE

A positive displacement bellows pump having means for metering the fluid flow therefrom. The metering is accomplished by varying the effective length of a motor driven connecting rod which controls the pumping action of the bellows structure. One form of the device is adapted to be operated in such a manner so that the bellows is expelled of substantially all liquid in its "at rest" position.

BACKGROUND OF THE INVENTION

Pumps may be classed in two main groups, positive displacement pumps and centrifugal pumps. Positive displacement pumps may be further classified as either reciprocating or rotary. A prime feature of the reciprocating positive displacement pump is that a definite quantity of liquid will be delivered for each stroke of the prime mover. Heretofore, that quantity has been determined by such parameters as pump size, design and suction conditions. Most attempts at accurate metering of the quantity of liquid delivered for each stroke of the prime mover of a pump having fixed parameters have been unacceptable in many regards.

Such accurate metering of liquids is highly desirable in the pumping of industrial chemicals wherein the precise amount of a certain liquid is needed to carry out a process or manufacture. An example of such an application would be the pumping of photographic chemicals in the film developing process.

Another important application of an accurately metered pumping device is found in modern soft drink dispensing machines. Such machines require that a precise amount of the viscous syrup be injected into the cup to be mixed with the precise amount of carbonated liquid. At times, in the last mentioned application, it becomes quite important to vary the amount of liquid provided by an existing pump, as when changing the type of soft drink to be dispensed. Heretofore, there have been no highly acceptable methods of doing so, other than changing the pump itself to provide a new pump of different parameters.

One type of pump in current use, both in industrial applications and the aforementioned soft drink dispenser application, is the common piston type pump. Here the volume of the output depends entirely on the volume of the cylinder which, of course, cannot readily be adjusted.

Further, these pumps have their disadvantages in size, initial cost and, more importantly, maintenance cost. For example, the piston seals often need replacing, particularly when used to dispense soft drinks where the syrup will tend to crystallize if allowed to set, or when used to pump corrosive chemicals.

Many piston pumps have been replaced by diaphragm type pumps. However, these pumps are inherently limited in stroke by the relative diameter of the diaphragm.

More recently, the pump most often used, particularly for soft drink dispensing, is what is known as a "bellowfram" pump. This pump combines the principles of the piston pump with the diaphragm pump in that a diaphragm is stretched over a cylindrical housing with a piston of

smaller diameter than the housing being fastened to the diaphragm. An annular convolution of the diaphragm slidably fits between the piston and the cylinder walls. This device has been found to be efficient for the downward or dispensing stroke; however, it is unable to pull a high vacuum, due primarily to the unpredictable relationship of the convolution to the piston. Thus, these pumps must be aided in their filling stroke by gravity. This fact alone, of course, necessitates placing the pump at a point lower than the supply source. Further, this means that the pump will always remain filled in its "at rest" position. If allowed to stand for any length of time, the liquid could corrode the working parts. In the case of the soft drink dispenser, the syrup will not only tend to crystallize, but it will also be warmed to room temperature and be undesirable to drink.

To vary the quantity of liquid dispensed by the "bellowfram" pump, the allowable motion of the piston is controlled by an adjustable cam. However, this results in an increase in working parts and thus an increase in initial and maintenance costs. Further, the adjustment of the cam is often a delicate and time consuming procedure.

SUMMARY OF THE INVENTION

It is therefore a primary object of the present invention to provide a positive displacement pump which can be accurately adjusted to vary the fluid output.

It is another object of the present invention to provide a pump, as above, which is capable of remaining closed and substantially empty in the "at rest" position.

Still another object of the present invention is to provide a pump, as above, which need not rely on gravity to be filled when used for dispensing soft drink syrup.

It is yet another object of the present invention to provide a pump, as above, which does not require seals and the like and thus needs a minimum of maintenance.

These and other objects which will become apparent from the following specification are accomplished by the structures hereinafter described and claimed.

In general, the variable output positive displacement bellows pump constructed according to the concept of the present invention comprises a motor driven crank which has a connecting rod attached thereto. The connecting rod has a cylindrical bore therein for receiving a guide rod extending from an end closure of a bellows. Further, the connecting rod is threaded throughout most of its length to receive an adjusting nut thereon. A coil spring is positioned around the connecting rod between the nut and the end closure of the bellows. The connecting rod is also slotted through its threaded length for receiving a stop yoke which is on the end of the guide rod. By moving the nut toward the bellows, the end closure of the bellows is moved away from the connecting rod so that there is a certain amount of "lost motion," that is, movement of the connecting rod which is not directly reflected by movement in the bellows. Thus, by adjusting the nut, the stroke of the bellows can be varied proportionally.

In another embodiment of the invention, the throw of the connecting rod is adjusted by merely changing the eccentricity thereof. This can be done by turning a screw which selectively adjusts the amount of displacement between the drive shaft of the motor and the crank pin of the connecting rod.

Preferred embodiments of the present invention are shown by way of example in the accompanying drawings and hereinafter described in detail without attempting to show all the various forms and modifications in which the invention might be embodied; the invention being measured by the appended claims and not the details of the specification.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top elevational view of an embodiment of the invention showing the bellows of the present invention in fully expanded position just prior to the output stroke.

FIG. 2 is a sectional view taken substantially along line 2—2 of FIG. 1.

FIG. 3 is a sectional view taken substantially along line 3—3 of FIG. 2.

FIG. 4 is a sectional view taken substantially along line 4—4 of FIG. 2.

FIG. 5 is a partial view similar to FIG. 2 showing the adjustment feature of the present invention prior to the output stroke.

FIG. 6 is a similar view showing the bellows in a contracted position at the end of the output stroke, the nut having been adjusted as shown in FIG. 5.

FIG. 7 is a broken-away elevational view of another embodiment of the invention showing the crank and connecting rod thereof.

FIG. 8 is a sectional view taken substantially along line 8—8 of FIG. 7.

FIG. 9 is a sectional view taken substantially along line 9—9 of FIG. 8.

FIG. 10 is a sectional view taken substantially along line 10—10 of FIG. 8.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The variable output positive displacement bellows pump of the present invention is indicated generally in FIG. 1 by the numeral 15. Pump 15 is shown as being powered by a standard electric motor 16 having a stator 17 and a rotor and rotor shaft (not shown) which are connected to a hub 18 of a gear reduction unit 19 supported on the stator by posts 20.

Gear unit 19 has an output drive shaft 21 extending through hubs 22 thereof. Fastened to the rear or motor side of gear unit 19 is a switch plate 23, attached by screws 24 through posts 25 (only one screw 24 and post 25 are shown). Plate 23 is further maintained in a spaced relationship with gear unit 19 by boss-like spacer 26. Fastened to switch plate 23 by screws 27 is a limit switch 28 which can be attached when it is desired to limit drive shaft 21 to one revolution per activation. Such an adaptation is desirable, for example, when the pump 15 is used in a soft drink dispensing machine. It is understood, however, that should multiple revolutions be desired, the limit switch 28 can be removed quite readily from plate 23.

Gear unit 19 has, on its front or pump side, a cover plate 29 fastened thereto by screws 30 so that the gears are readily accessible should replacement or repair be necessary. Attached to gear unit 19 via a plurality of screws 31 extending through posts 32 is a pump mounting bracket 33 which includes a horizontal base plate 34 and an upstanding U-shaped flange 35 which, as will hereinafter be described, serves to mount the bellows pump member indicated generally by the numeral 36.

Drive shaft 21 extends from gear unit 19 through an aperture in mounting bracket 33 and is connected to crank 37 by a set screw 38. Crank 37 has an output shaft 39 extending therefrom which carries a connecting rod 40 that is held thereon by a lock ring 41. Connecting rod 40 has a threaded extension 42 which, as best shown in FIG. 2 or FIG. 3, has a cylindrical recess 43 therein. Telescopically slidably received within recess 43 is a guide rod 44 extending from the end closure 45 which is M-shaped in section and threaded onto the bellows 36. A gasket 46 is provided to prevent leakage between end closure 45 and bellows 36.

Connecting rod 40 is further provided with a transverse slot 47 which extends for the full length of the threaded extension 42. Slot 47 is adapted to slidably receive a stop yoke 48 which is fixed to the end of guide rod 44 and restrains the relative motion thereof.

A knurled adjusting nut 49 is threaded onto connecting rod extension 42 and preferably has an annular spring-centering flange 50 on one side thereof. A coil spring 51 encircles the threaded extension 42 of connecting rod 40, between nut 49 and end closure 45 of bellows 36.

Bellows 36 and all other liquid-touching structures are preferably formed out of a polypropylene or other plastic compound, bellows 36 being shown in FIG. 2 as generally cylindrical in shape and having convolutions 52 which terminate at the front end in two valve housing extensions 53. Valve nipples 54 are threaded into housing 53. Together, valve nipples 54 and housings 53 contain standard poppet valves 55A and 55B. Valve 55A is shown as being an output or dispensing valve, while valve 55B is the input or suction valve. Each valve 55 has an O-ring 56 acting as a seal therefor. A plug 54' is shown in FIG. 2 in conjunction with valve 55B and fits within nipple 54 to maintain the housing 53 and associated members free from dirt or other obstructions during shipment or storage.

The bellows 36 is attached to flange 35 of mounting bracket 33 by a series of screws 57 received in the front of bellows 36 between valve housings 53. Medially of the entire bellows structure 36 is an internally pointed V-shaped stop surface 58 formed on a reentrant portion 58' of the bellows end wall, which is adapted to receive a similarly shaped recess 59 on the inside of end closure 45.

In operation, with the adjusting nut 49 in the far left position as shown in FIG. 1, the bellows end closure 45 is shown in FIG. 2 as being in contact with the end of the threaded extension 42 of connecting rod 40. Such being the case, the entire motion of the crank 37 is translated via rod 40 to bellows 36. The position of the nut 49 and end closure 45 at the end of the stroke are shown in chain lines in FIG. 2.

As the adjusting nut 49 is moved to the right, away from the crank as shown in FIG. 5, spring 51 moves the bellows closure 45 and thus the guide rod 44 and pin 48 by a proportionate amount, leaving a space 60 between the end closure 45 and extension 42 of connecting rod 40, which space is bridged by spring 51. Then, as crank 37 operates, bellows 36 will be compressed proportionately until recess 59 contacts stop surface 58, at which time the compression of the bellows ceases and the remainder of the travel of the crank is taken up by operation of the lost-motion connection comprising compression of spring 51 and the sliding of guide rod 44 within recess 43 of portion 42. This condition is shown in FIG. 6.

It is evident that if the adjusting nut 49 is moved by an amount equivalent to the throw of crank 37, recess 59 of closure 45 will remain in contact with stop surface 58 throughout the entire stroke and the bellows will not move.

In adapting the above disclosed apparatus to one of the aforementioned uses, that of a soft drink dispensing pump, the bellows 36 would be compressed and the recess 59 in contact with stop surface 58 during the "at rest" position previously discussed. Thus, little or no corrosive syrup would remain within the bellows chamber. In this regard, as previously noted, all structures which would come in contact with the syrup are of a plastic material to not only prevent corrosiveness but also to assure that the material coming therefrom remains nontoxic. Upon actuation, the crank would open the bellows drawing in syrup through valve 55B. During the second half of the crank throw, the syrup previously drawn in would be expelled into a cup through valve 55A. The switch 28 would, of course, limit the pump to one cycle and, further, it should now be evident that the precise amount of syrup required for the type of soft drink being dispensed can be regulated by simple adjustment of nut 49.

It has been found that the previously discussed structure is not only acceptable for soft drink dispensing, but

also for any industrial use which requires either a one cycle or a slow speed operation. This slow speed limitation is due to the fact that, during the suction stroke of the above described pump in an adjusted state, the pump bellows does not move until the nut **49** hits the stop **48**, and therefore at high speeds a sudden acceleration occurs.

Thus, another adjustment feature for high speed multiple cycle operations is shown in FIGS. 7–10. Here the eccentricity of crank **137** can be adjusted.

Shown in FIG. 7 is a cover plate **129** of a gear unit fastened thereto by screws **130**. A mounting bracket **133** is attached to plate **129** by screws **131**, bracket **133** including a base plate **134**.

Drive shaft **121** extends from the gear unit through an aperture in mounting bracket **133**. Crank **137** is similar to crank **37** except that it is shown to be circular and has also been hollowed out to form a circular recess **170** therein. Crank **137** has a crank pin or output shaft **139** extending therefrom which carries a connecting rod **140** maintained in position by a lock ring **141**.

Riding within the recess **170** of crank **137** is an annular spacer **171** which is slidably received on drive shaft **121**. Crank **137** and spacer **171** are provided with aligned bores **172** and **173**, respectively, which are transverse to their axes and which are slightly larger than an adjusting bolt **174** which is adapted to pass therethrough. A bore **175** through drive shaft **121** is aligned with bores **172** and **173**, but bore **175** is threaded to receive the threads of adjusting bolt **174**. A nut **176** maintains bolt **174** in the position shown in the drawings. To prevent misalignment of the crank **137** and crank pin **139**, a corrugated spring **177** is provided between the bottom of recess **170**, in crank **137**, and annular spacer **171**, maintaining crank **137** and spacer **171** in a constant relationship by eliminating any play between the parts.

The operation of this embodiment should now be evident. By merely turning the adjusting bolt **174**, crank **137** moves with respect to the drive shaft **121** to vary the eccentricity of the cranking mechanism. When the center line of drive shaft **121** becomes aligned with the center line output shaft **139**, there is zero eccentricity and the connecting rod **140** will not move linearly upon actuation of the motor mechanism. This is shown in FIG. 10. By merely changing the size of spacer **171**, it is evident that a greater maximum eccentricity could be obtained since one of the purposes of spacer **171** is to define limits of the eccentric movement and therefore provide a pump with certain parameters. The result of the operation of this embodiment is that the throw of the crank is adjusted without a "lost motion" factor. Thus the structure shown in FIGS. 7–10 lends itself quite well to high speed operation.

It should thus be clear that a positive displacement pump made under the above specification will carry out the aforementioned objectives and substantially improve the pump art.

What is claimed is:

1. A variable output positive displacement bellows pump comprising, a motor driven drive shaft, a crank mounted on said drive shaft, a connecting rod fastened to said crank, a closed bellows input and output valve means in said bellows, and a lost-motion connection means between said connecting rod and said bellows for alternate expansion and contraction of said bellows, said connection means having adjusting means separately accessible externally of said connection means so that the effective motion of said bellows can be readily varied to meter the amount of liquid pumped by said bellows during each expansion and contraction cycle.

2. A variable output positive displacement bellows pump comprising, a motor driven drive shaft, a crank mounted on said drive shaft, a connecting rod fastened to said crank, a closed bellows, input and output valve means in said bellows, a guide rod on said bellows telescopically received in said connecting rod, an adjusting nut on said connecting rod, a compression spring between one side of said nut and said bellows, and stop means on the end of said guide rod for abutting the opposite side of said nut so that the alternate expansion and contraction of said bellows can be varied to meter the amount of liquid pumped by said bellows during each expansion and contraction cycle.

3. A variable output positive displacement bellows pump as defined in claim **1**, in which a stop surface is provided within said bellows for abutting said one end of said bellows when said lost-motion connection means is operating.

4. A variable output positive displacement bellows pump as defined in claim **2**, in which a stop surface is provided within said bellows for abutting said one end of said bellows during contraction of said bellows.

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HENRY F. RADUAZO, Primary Examiner

U.S. Cl. X.R.

92—13.2, 43, 44, 84; 103—150