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Raper

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[54] **SELF CONTAINED FLUID PUMP DEVICE**

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[51] **Int. Cl.** **F04b 43/08,** F04b 35/04, H01m 1/04

[58] **Field of Search** .136/173; 415/45; 417/474, 476, 417/477, 475, 412, 411

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[57] **ABSTRACT**

A small self contained positive displacement pump which contains no mechanical type valves, and which can be utilized to transfer a finite quantity of liquid. A flexible looped tube is placed within a groove and a pumping head is superimposed thereover. The pumping head is attached to a rotatable shaft and causes fluid to flow through the tube when a peripheral edge portion of the head collapses a marginal length of the looped tube while traveling circumferentially about the groove.

The pumping head is biased into proper operative position by a combination fastener means and pressure regulator device. The pumping head is loosely captured by a portion of the main body of the pump by means of a lost motion coupling in a manner to prevent the tube from creeping longitudinally of the groove.

9 Claims, 8 Drawing Figures

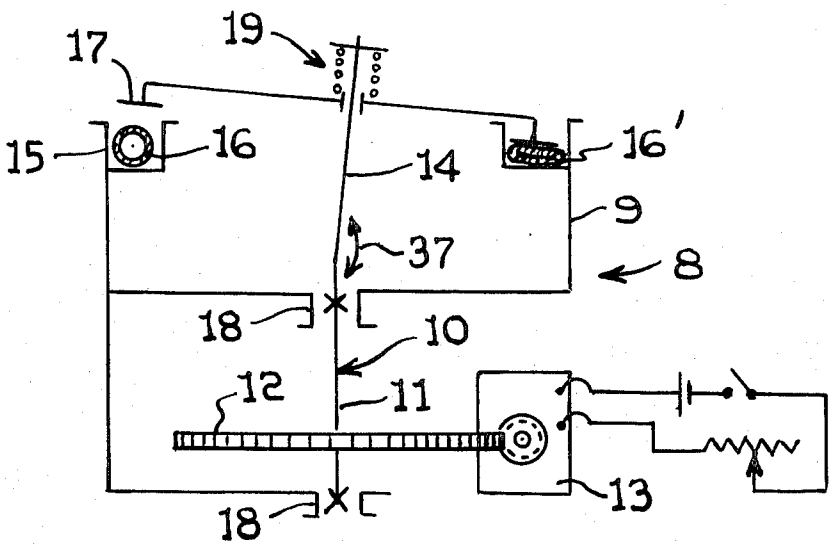


Fig. 3

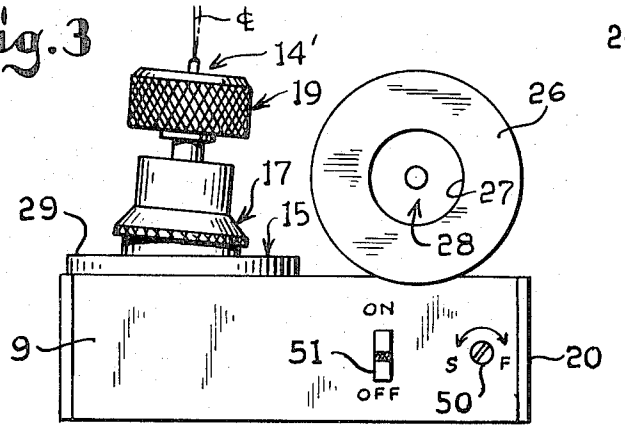


Fig. 4

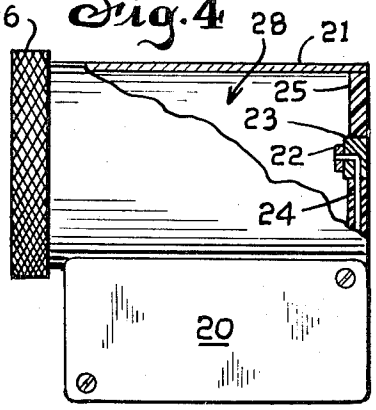


Fig. 5

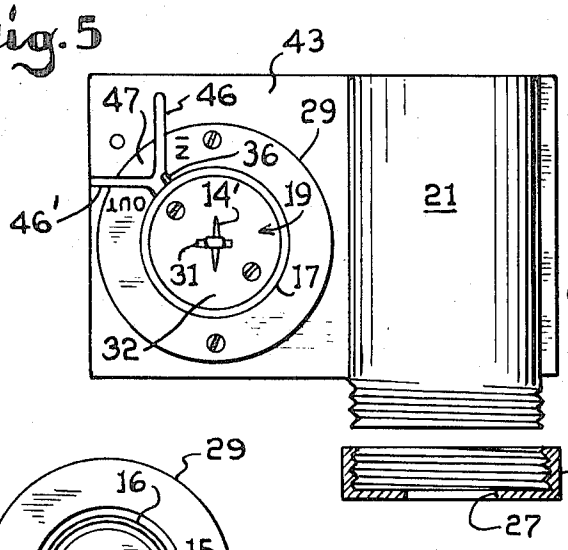


Fig. 6

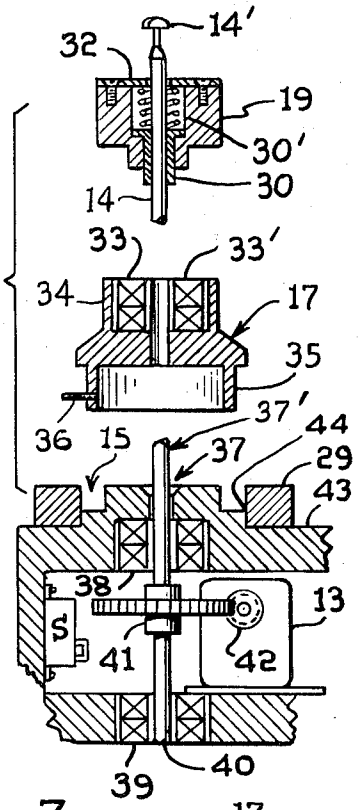


Fig. 2

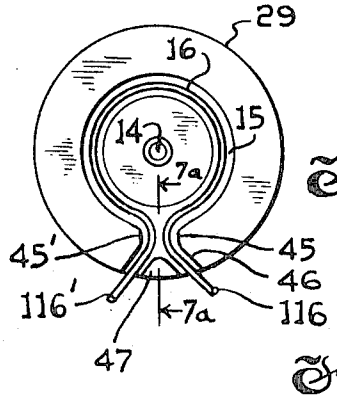


Fig. 7b



Fig. 1

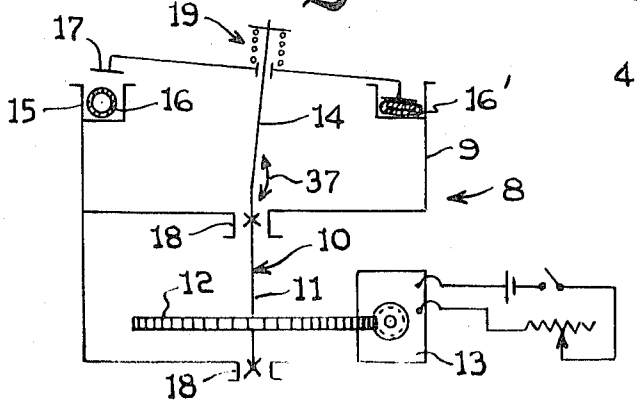
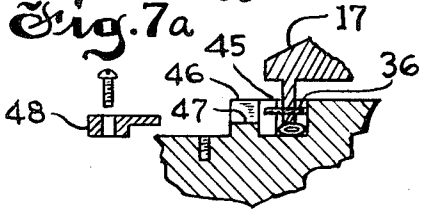


Fig. 7a



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SELF CONTAINED FLUID PUMP DEVICE

BACKGROUND OF THE INVENTION

Pumps which employ a flexible tube, wherein the tube is placed within a circular groove, and an inverted cup-like head imposed thereon so as to progressively collapse a marginal portion of the tube in a circumferentially extending manner, are known to those skilled in the art. Generally, the pump employs a bent shaft which imparts a gyrotory motion into the cup-like member.

Some prior art pumps are objectionable because the flexible tube associated therewith inherently creeps or progressively moves with respect to the groove within which it is placed. Previous attempts at solving this creeping problem include anchoring the tube in place as well as applying lubricant to the tube to minimize creeping.

Modern technology has recently made available to the art miniaturized low voltage electric motors, as well as inexpensive, high capacity, long life and light weight dry cell batteries. By incorporating the light weight inexpensive electric motor and battery with a pump which operates on the bent shaft principle, a new combination of a self contained pumping apparatus capable of metering a finite quantity of fluid into the body of an animal to which it can be directly attached is made possible.

SUMMARY OF THE INVENTION

The present invention encompasses a pumping apparatus comprised of an electric motor and a battery supply enclosed within a housing, with the housing having an annular groove formed in a wall thereof, and a bent shaft journaled to the base and rotated by the motor. A pumping head is journaled to the shaft and has a lost motion coupling associated therewith which prevents relative rotation thereof with respect to the shaft. A keeper means biases the pumping head into contact with a flexible tube, with the biasing force being adjustable, and with the keeper removably affixing the head to the shaft.

The entire assembly can be attached to the body of an animal along with a supply of liquid which is to be metered into the body of the animal.

A primary object of this invention is to provide a self contained pumping apparatus for metering a finite quantity of liquid into the body of an animal.

Another object of the present invention is to provide a self contained pumping apparatus having improvements incorporated therein which overcome many prior art problems.

Still another object of this invention is to provide an improved pumping apparatus for transferring a liquid therethrough.

A further object of this invention is to provide improvements in pumping apparatus operating on the bent shaft principle which eliminates creeping of the looped tube relative to the groove within which it is placed.

The above objects are attained in accordance with the present invention by the provision of a combination of elements which are fabricated in a manner substantially as described in the above abstract and summary.

These and various other objects and advantages of this invention will become readily apparent to those skilled in the art upon reading the following detailed description and claims and by referring to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a part diagrammatical, part schematical representation which sets forth the principle of operation of a pump made in accordance with the present invention;

FIG. **2** is a top plan view of one form of a pump made in accordance with the present invention, with some parts being removed therefrom;

FIG. **3** is a side elevational view of a pump made in accordance with the present invention;

FIG. **4** is similar to FIG. **3**, but with the device being rotated 90° in the horizontal plane, and with some parts being removed therefrom and some of the remaining parts being shown in section;

FIG. **5** is a top plan view of FIG. **3**, and showing part of the apparatus being separated therefrom;

FIG. **6** is an enlarged, exploded fragmentary cross-sectional view of the apparatus disclosed in FIG. **2–5**;

FIG. **7***a* is a fragmentary, part cross-sectional view of part of the apparatus disclosed in the foregoing figures; and

FIG. **7***b* is a perspective view of part of the apparatus seen in FIG. **7***a*.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. **1** of the drawings, there is generally illustrated by the arrow at numeral **8**, a pump made in accordance with the present invention. The pump includes a housing **9** and a shaft **10** having the opposed marginal end portions thereof bent towards one another. The shaft is rotatably mounted within the body of the housing with one marginal end portion **11** being affixed to a gear **12** which is driven by a worm attached to an electric motor **13**.

The electric motor is provided with the illustrated circuitry which includes a rheostat, a switch, and a battery, all connected together to provide the necessary circuitry for delivering a controlled supply of current so as to enable the proper actuation of the motor.

The opposite marginal portion of the shaft at **14** upwardly depends from and is concentrically aligned with a groove **15**. A collapsible tube **16** is circumferentially disposed within the upwardly opening groove. The tube may be made of plastic or plastic-like material including polyethylene and silicone rubber. The collapsed marginal intermediate portion of the tube is generally illustrated at **16'**.

A pumping head **17** gyrates with respect to the groove and cooperates with the tube to provide a pumping action, thereby causing fluid to flow through the interior of the tube.

Shaft hole **18** receives one end of the shaft therethrough, with the shaft preferably being journaled therein by means of the schematically illustrated low friction bearings, or the like.

Keeper **19** is removably affixed to the free terminal end of the shaft and includes a spring which biases the pumping head into contact with the tube.

As seen in FIGS. **3** and **4**, end plate **20** is attached to the body **9** by means of the illustrated fastener means to

enable access to the interior thereof. A battery case **21** has an electrical contact **22** centrally located on an interior wall thereof by means of insulator **23**. Electrical conductor **24** electrically connects one terminal of the battery to the before mentioned motor. The rear interior wall **25** preferably is made of plastic or plastic-like material so as to avoid the inadvertent shorting of the battery to the case.

Closure means **26** threadedly engages the case, although other attachment means could be employed if deemed desirable. As best seen illustrated in FIG. **5**, together with FIGS. **3** and **4**, aperture **27** is axially aligned with terminal **22** and is of a reduced diameter with respect to the interior diameter of the case, and substantially larger than the ordinary central terminal of a dry cell.

The base of battery **28** makes electrical connection with the cap **26**, however, should the relationship of the battery and the case be reversed, the central terminal thereof which normally contacts terminal **22** will be precluded from contacting the cap because of the relative large diameter of the aperture **27**, and accordingly this expedient will render the apparatus inoperative due to the lack of current flow.

The body **9** includes a ring platform **29** which is attached to the upper wall surface thereof, and cooperates therewith to form one interior wall surface of the groove, as will be discussed in greater detail later on.

The keeper has an axial passageway **30'** formed by two series connected counterbores of different diameters to thereby reciprocatingly accommodate a movable bushing **30** therewithin, with the bushing reciprocatingly received within the limits formed by the walls of chamber **30'**. Cover **32** is provided with an axially aligned aperture.

Enlargement **14'**, located on the free terminal end of the shaft, cooperates with the apertured cover in the manner of a bayonet fastener so as to enable the keeper to be removably attached to a marginal end portion of the shaft.

Low friction bearing means **33** are located within the upstanding cylindrical portion **34** of the pumping head with the center race of the bearing being received against the lowermost surface of the before mentioned bushing.

Downwardly depending circumferentially extending skirt member **35** is an integral part of the pumping head, and radially depending in an outward direction from and attached to the wall which forms the skirt member is a pin **36** which forms an important teaching of this invention.

The before mentioned shaft extends through shaft hole **37** which is formed in the body, with the hole enlarging into the illustrated counterbore so as to receive bearings **38** therein. Diametrically opposed to the bearings **38** are another set of bearings **39** which are adapted to receive lower shaft end **40** therein.

Gear **12** includes a boss **41** which is attached to a marginal portion of the shaft. Worm gear **42** is driven by motor **13** and meshed with gear **12**.

The upper surface **43** of the body is provided with a circumferentially extending shoulder **44** against which the before mentioned split ring **29** abuts. The second raised shoulder **37** is spaced apart from shoulder **44** so as to form the before mentioned annular groove **15** therebetween.

The ring **29** is provided with a cutout which defines spaced apart shoulders **45**, **45'** which outwardly diverge at **46** so as to present a contoured entrance into the groove. The entrance forms an inlet and an outlet recess for accommodating the tube **16**. Raised portion **47** of the entrance receives a wedge **48** thereon, with the wedge being of a width to fill the entrance area seen located between the opposed shoulders. The details of the wedge is seen in FIG. **7b**.

The control for the rheostat of FIG. **1** preferably is recessed within the body and provided with an adjustment screw **50** so as to enable the speed of the motor to be regulated. Switch **51** is mounted in the illustrated position of FIG. **3**.

A single 1.5 volt size D cell, such as a number 1050 transistor battery by Union Carbide Company is inserted into the case with the positive or central terminal contacting the centrally located electrode **22**, and with the negative or rear of the battery contacting the inside wall of the cap. Should the battery inadvertently be reversed the positive terminal will be centrally aligned with aperture **27** and hence there can be no current flow, and accordingly, it is impossible to reverse the drive direction of the pump whereby fluid flow in the reverse direction could inadvertently occur. When the switch **51** is moved to the "on" position, current flows from the battery through the switch, through the rheostat, and to the motor. The speed of the motor is adjusted at **50** to attain any predetermined flow rate.

The motor drives the worm gear, which in turn imparts rotational motion into the shaft. Since the shaft is bent near and above the shaft hole at **37**, the pumping head gyrates with a lower marginal portion of skirt **35** riding in the groove and collapsing a marginal length of the looped portion of the tube in the manner illustrated in FIG. **1**. Hence the tube is continuously and progressively collapsed along a marginal edge portion of the loop to thereby force fluid to flow from the inlet portion of the tube, through the looped portion of the tube, and through the outlet portion of the tube each revolution of the pump head.

As the shaft rotates the pumping head in a clockwise direction, pin **36** abuts shoulder **45'** to thereby prevent rotation of the head with the shaft. The pin cycles up and down each revolution of the shaft and accordingly the combination of the shoulder, the skirt, and the pin is called "a lost motion coupling."

The wedge **48** bears against a marginal portion of each leg of the tube near channels or elongated depressions **46**, **46'** before it commences to form the loop. The wedge provides sufficient force to keep the tube from inadvertently being pulled from the groove in case of a mishap. Each time an edge portion of the skirt crosses over adjacent legs of the tube at **45**, **45'**, it releases the slight amount of tension which has been imparted into the looped tube. Since the pumping head is journaled to and prevented from rotating with the shaft, very little tension is imparted into the looped portion of the tube.

The force with which the lower face of the skirt bears against the tube should be of a magnitude which supplies an upstream pressure slightly greater than the back pressure of the system into which the fluid is flow-

ing so as to positively preclude reverse fluid flow. This pressure is determined by the compressive forces of the biasing means seen illustrated in the form of the spring located in chamber 30'. The spring is readily exchanged for another by merely removing cap 32 and substituting a spring having a different compressive force therefor.

The apparatus is assembled by first placing the tube into the groove, and locking the wedge 48 into place; after which the pumping head is slid into its operative position, taking care that pin 36 is placed between shoulders 45, 45'. The before mentioned bayonet fastener of the keeper has a rectangular slot 31 and a depression 41' turned 90° to the slot. The slot receives the enlargement 14' therethrough whereupon a 90° twist of the keeper aligns the depression with the enlargement thereby preventing inadvertent removal of the keeper.

In operation, a small plastic bottle of liquid can be taped to one end plate of the apparatus, the inlet tube secured within the interior of the bottle, and the entire apparatus can be attached to an animal by any convenient means. The outlet end of the tube is usually affixed to a needle and the hollow needle inserted into and affixed to the animal. The switch is turned on, the speed adjusted so as to meter a predetermined constant flow of chemical into the animal, whereupon the animal is left unrestrained while the chemical is being injected for any length of time which may be as much as several days.

I claim:

1. A pumping apparatus comprising:

a housing, means forming an upwardly opening circumferentially extending annular groove in said housing, a shaft having opposed marginal end portions bent towards one another, journal means, a pumping head, and a keeper means;

said journal means being concentrically arranged with respect to said annular groove and rotatably mounting one said marginal end portion of said shaft to said housing, with the remaining marginal end portion of said shaft depending away from said housing;

means for rotating said shaft;

said pumping head having a downwardly depending circumferentially extending skirt member, said skirt member having a lower peripheral edge portion thereof received within said groove; means by which said pumping head is journaled to said remaining end portion of said shaft;

fastener means for enabling said keeper means to be removably affixed to said remaining marginal end portion of said shaft, and in abutting relationship with respect to said pumping head, to thereby retain at least a portion of said skirt member in said groove; and a deformable tube having a looped section disposed within said groove

said keeper includes an axially drilled passageway; a bushing reciprocatingly received within said passageway and adapted to be moved from one to another position; said bushing having a portion thereof adapted to engage said pumping head, biasing means urging said bushing into one position; whereby: when the keeper is affixed to the shaft, the bushing urges a portion of the skirt of the pumping head into the groove to engage the tube.

2. The pumping apparatus of claim 1 wherein said groove is defined in circumference by spaced apart shoulders;

said skirt includes a pin affixed thereto and depending outwardly therefrom, said pin adapted to engage a shoulder to thereby prevent rotation of the skirt with respect to the groove.

3. The pumping apparatus of claim 2, and further including a removable wedge having opposed shoulders, said wedge adapted to be received between the opposed shoulders of said groove.

4. The pumping apparatus of claim 1 wherein said means for rotating the shaft includes an electric motor, a cylindrical battery, a cylindrical battery case adapted to slidably receive the battery therein, circuit means connecting said battery to said motor;

a closure means on said case, means forming an axial aperture in said closure means, to thereby prevent said battery from being installed with reversed polarity.

5. A pumping apparatus comprising:

a housing, means forming an upwardly opening circumferentially extending annular groove in said housing, a shaft having opposed marginal end portions bent towards one another, journal means, a pumping head, and a keeper means;

said journal means being concentrically arranged with respect to said annular groove and rotatably mounting one said marginal end portion of said shaft to said housing, with the remaining marginal end portion of said shaft depending away from said housing;

means for rotating said shaft;

said pumping head having a downwardly depending circumferentially extending skirt member, said skirt member having a lower peripheral edge portion thereof received within said groove; means by which said pumping head is journaled to said remaining end portion of said shaft;

fastener means for enabling said keeper means to be removably affixed to said remaining marginal end portion of said shaft, and in abutting relationship with respect to said pumping head, to thereby retain at least a portion of said skirt member in said groove;

a deformable tube having a looped section disposed within said groove;

said means for rotating the shaft includes an electric motor, an elongated battery having a centrally located terminal thereon; a battery case adapted to slidably receive the battery therein, circuit means electrically connecting said battery to said electric motor;

a closure means on said case, means forming an axial aperture in said closure means so that when said battery is installed with reversed polarity, said terminal will be received within said axial aperture, thereby preventing reversed polarity current flow.

6. The pumping apparatus of claim 8 wherein said groove is defined in circumference by spaced apart shoulders;

said skirt includes a pin affixed thereto and depending outwardly therefrom, said pin adapted to engage a shoulder to thereby prevent rotation of the skirt with respect to the groove.

7. The pumping apparatus of claim 9 wherein there is further included a removable wedge having opposed shoulders, said wedge adapted to be received between the opposed shoulders of said groove.

8. The apparatus of claim 5, wherein said keeper includes an axially drilled passageway; a bushing reciprocatingly received within said passageway and adapted to be moved from one to another position; said bushing having a portion thereof adapted to engage said pumping head, biasing means urging said bushing into one position; whereby: when the keeper is affixed to the shaft, the bushing urges a portion of the skirt of the pumping head into the groove.

9. The pumping apparatus of claim 5, wherein said keeper includes an axially drilled passageway; a bushing reciprocatingly received within said passageway and adapted to be moved from one to another position; said bushing having a portion thereof adapted to engage said pumping head, biasing means urging said bushing into one position;

said groove being defined in circumference by means forming spaced apart shoulders;

said skirt includes a pin affixed thereto and depending outwardly therefrom, said pin adapted to engage a shoulder to thereby prevent rotation of the skirt with respect to the groove.

* * * * *