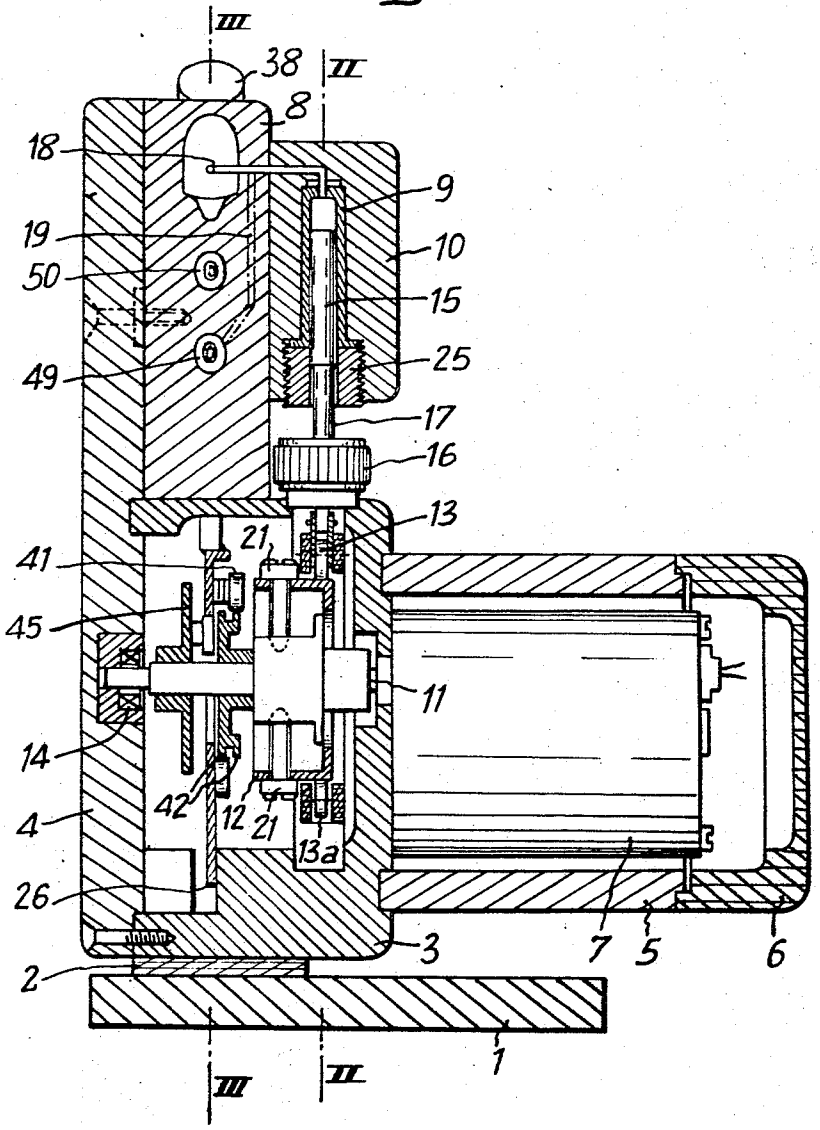
Aug. 1, 1967 G. ALBAUT 3,333,543

METERING PUMP

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Fig. 1



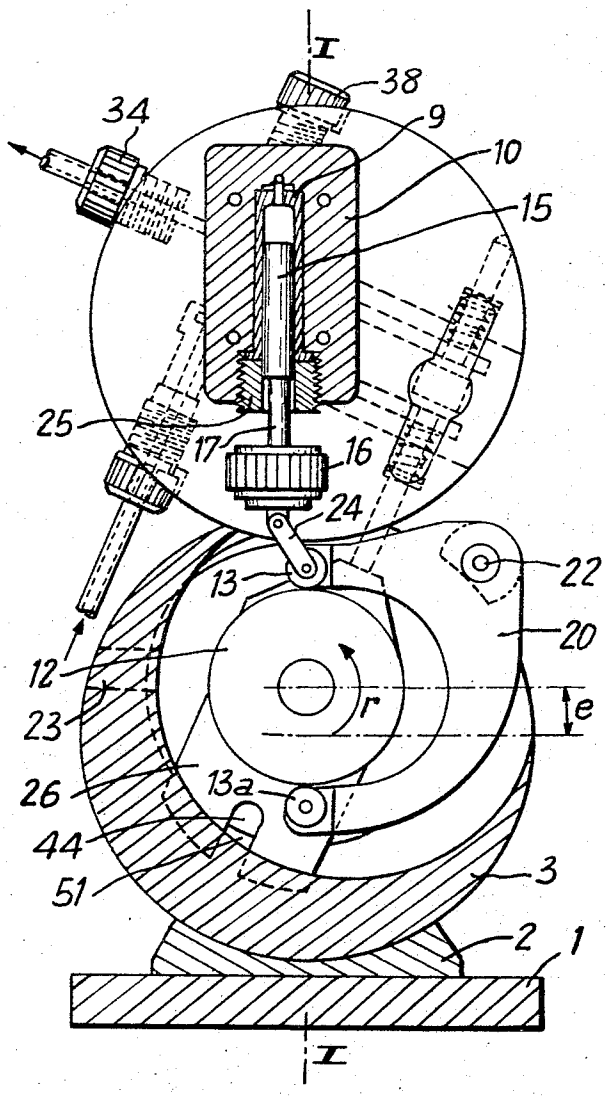
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Fig. 2



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Fig. 3

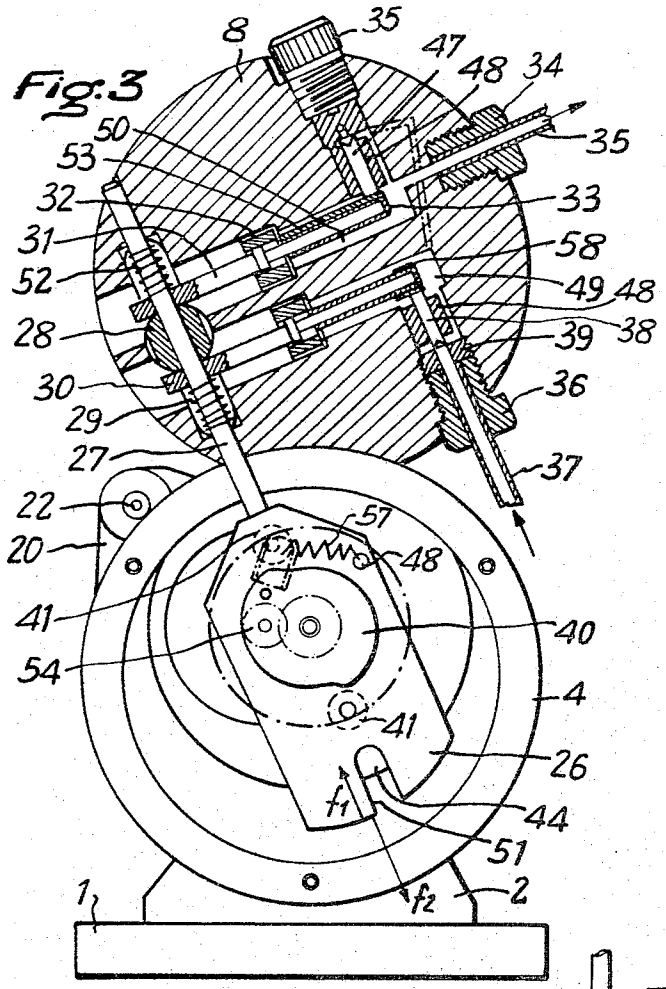


Fig. 4

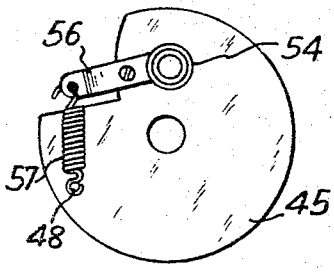


Fig. 5

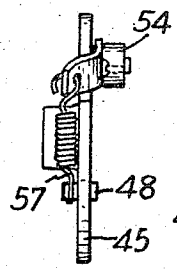
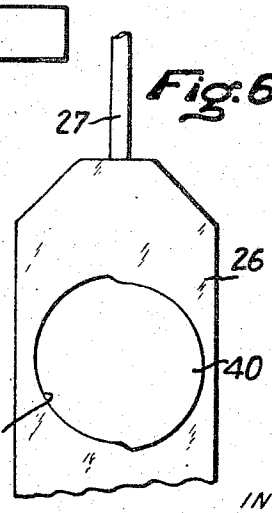


Fig. 6



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METERING PUMP

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The invention concerns a metering pump having a variable and adjustable micro-delivery, capable of delivering a strictly regulated flow of fluid, for example from 0.1 cm.^{3} to 100 cm.^{3} per hour and even longer. It can be used in all kinds of fields: physics, chemistry, physico-chemical work, biology, medicine and even nuclear energy. It may be constituted in such a manner that the delivered fluid of various types come in contact only with specific materials which can be sterilised if necessary; these materials may have a mineral, vegetable and animal, metallic or plastic base.

The pump according to the invention has a certain number of features which may be used separately or in combination.

The driving device for the pump piston is constituted by a synchronous motor provided with a speed reduction box and the output shaft of the reduction box carries an eccentric on which rotates a roller connected to a positive drive for the pump piston.

The eccentric which makes it possible to vary the travel of the piston, i.e., to regulate and obtain the desired delivery, is mounted on a variable-position fork, being for this purpose mounted pivotably and the position of the pivot being geometrically chosen to automatically correct an advance or delay at the opening of the delivery valve in accordance with the amount of the delivery rate and more exactly to correct the instant the piston has reached the top in view of the instant the intake valve opens.

The admission and delivery valves are situated in two separate chambers which are in communication through suitable ducts, and said valves are controlled by rockers operated by a slide provided with a push member, the said slide carrying two diametrally opposed rollers rolling on a cam solidly fixed to the driving shaft, which ensures the alternating linear movements necessary for delivery.

The portion of each rocker incorporated in the chambers of the suction or intake and delivery valves is completely insulated from the outside by spherical sealing joints having a constant volume.

The end of the intake or suction valve is connected to the end of the sleeve of the rocker by a flexible ring which ensures the opening and closing of the valve in a positive manner, whilst the delivery valve may rest on the corresponding rocker by its own weight; in this case, an elastic tongue whose free end continually bears on the delivery valve exerts thereon a sufficient force to prevent any irregular displacement of the valve under the influence of the pressure of the delivered fluid.

The movements of the rockers causing the opening and closing of the valve are effected by a push member actuated by the aforesaid slide with interposition of springs, and so that the closing of the suction and the opening of the delivery are successively effected without the possibility of communication between the two chambers.

In order to compensate for compression and expansion forces at the springs of the rockers operating the valves and to keep the rotational speed of the motor strictly constant despite the periodic variations in the resistant torque, the slide acting on the push member of the rockers comprises two opposed ramps of such a configuration that a roller, mounted on a pivoting lever on a disc driven by

the driving shaft, in following the said ramps, compresses or relaxes a coil spring connected, on the one hand, to the disc and on the other hand, to the end of the pivoting lever, so that it becomes possible to brake the speed of the motor when the latter tends to rotate more quickly, and to speed up the motor when it tends to rotate less quickly.

Other features will become apparent from the following description which refers to the accompanying drawings wherein:

FIGURE 1 is a longitudinal sectional view of the pump assembly taken on I—I of FIGURE 2;

FIGURE 2 is a cross section of the same assembly on II—II of FIGURE 1;

FIGURE 3 is a cross section of the same assembly on III—III of FIGURE 1, looking on to the opposite face;

FIGURE 4 is a view showing the regulating mechanism and FIGURE 5 is a side view of the same mechanism;

FIGURE 6 is a partial view of the slide controlling the rockers with the regulating ramps.

Referring now to the figures, there is mounted on a base **1** by means of a cradle **2** a casing **3** closed at one side with a vertical counter-plate **4** and supporting at the other side a casing **5** with cover **6** for accommodating a synchronous motor **7**. This motor is provided with a reduction gear of any desired type capable of reducing the speed of the motor for example from 1,500 revolutions per minute to 2 revolutions per minute. Fixed on the counter-plate **4** by any suitable means are a distributor unit **8** and the pump body proper **10** whose chamber is lined with a cylindrical liner **9** which may be made of glass, plastic material, stainless steel and, generally speaking, of any sterilisable incorrodible material. The liner **9** is held in its housing by a nut **25**. The driving shaft **11** at the output side of the reduction box is supported by a bearing **14** lodged in the counter-plate **4**; it drives an eccentric **12** constituted by a sleeve of variable and regulatable eccentricity as will be indicated hereinafter, and on its external surface there rolls at one time, a roller **13** connected by a link **24** to the pump piston **15** which may be made of glass or any other material, by means of a coupling device **16**, **17**; at another time a roller **13***a*, the fixed spacing of the two rollers being such that they simultaneously rest on the sleeve **12** at the top and bottom neutral points of the piston **15**. The fluid pumped in and delivered by the displacement of the piston **15** within the pump chamber passes through the ducts **18** shown in full lines and **19** shown in dot-dash lines since the latter are situated above the section plane.

The sleeve **12** forming an eccentric is mounted in a fork **20** mounted pivotably on a pin **22**. The two rollers **13**, **13***a*, carried by the fork, successively roll on the sleeve. The fork may be optionally positioned depending on the desired travel, i.e., depending on the desired delivery to be obtained; the adjustment is obtained by two opposed screws **21** which are accessible from the exterior through a cylindrical orifice **23** in the casing **3** (FIG. 2).

In FIGURES 1 and 2, the eccentric sleeve **12** has been illustrated in its position centered on the axis **11** of the motor **7**. In this position, the piston obviously remains motionless. The possible eccentricity is *e* (FIG. 2). Considering the rotation direction *r*, when the sleeve **12** is given a certain eccentricity *e* towards the bottom, the roller **13***a*, resting on the sleeve, operates for 180° to lower the piston **15** towards the bottom, and then, immediately the roller **13** contacts the sleeve **12** and produces a reverse movement of the piston.

As it may be seen in FIGURE 2, the pin **22** of the fork **20** which carries the rollers **13** and **13***a* in its median position is substantially placed on a perpendicular axis to the piston, passing through the axis of the roller **13**. When the eccentricity *e* is changed for the adjustment of the

fluid delivery (FIG. 2), the fork **20** rotates: the roller **13** substantially remains at the same contact point on the sleeve **12**, due to the position of the pin **22**, while the roller **13***a* displaces its contact point with the sleeve **12** in the direction of rotation *r*, that is the delay direction.

It is known that in the case of small fluid deliveries, the displacement of the pumped in liquid is produced with a delay in view of the displacement of the piston. This possibly results from the fact that dissolved gases are always included in the liquid and that they slowly escape, under the effect of a decrease of pressure due to the pumping action, therefore before the liquid starts to move. This delay decreases and is subsequently nullified with the increase of the liquid delivery, because the escape of the gases does not have the time to be dissolved completely.

The shape of the cam **42** is set to produce a constant delay at the beginning of the suction action, that is in view of the passage of the piston at its upper neutral point for the little deliveries. The increase of the delivery by the variation of the eccentricity *e* results in a progressive delay of the passage of the piston at the upper neutral point, due to the corresponding rotation of the fork as it has been explained above; it results that the initial delay of the opening of the pumping through the rocker **30** is progressively reduced by the movement of the fork **20** in case of an increase in the delivery. The determination of this reduction which obviously depends on the distance of the pin **22** of the fork to the axis of the roller **13***a*, is empirically determined according to the liquids used.

According to FIGURE 3, the distributor casing **8** comprises two housings for the suction and delivery valves **38** and **47**, which are mobile in the rings **48** held in place by plugs **34** and **36** ensuring a tight seal. The plug **36** carries the suction pipe connection **37** and the plug **34** carries the delivery pipe connection **35**. The following arrangements aim at preventing any perturbation in the smooth operation of the pump in the variations of the volumes located at the upper and lower ends. The housings of the valves **38** and **47** open respectively into the perpendicular chambers **49** for suction and **50** for delivery. The rockers **30** and **31** have one end movable in these chambers and are centrally supported by sealed spherical bearings **32**, which enables a free angular displacement of the rockers about the said bearings without any volume variation. The end of each rocker situated within the chambers **49** and **50** acts on the valves **38** and **47** and may be covered with a sleeve **33** of flexible plastic material which is sterilisable. The end of the rocker **30** is connected to the valve **38** by a flexible ring **58** fitted on to the said valve which is provided with a suitable collar. Between the end of the delivery valve **47** and the end of the rocker **31** there is interposed an elastic tongue **53** which is parallel to the rocker, which exerts on the end of the valve a slight pressure opposing pumping movements of the valve in its housing. The chambers in which the rockers are displaceable are perfectly fluid-tight.

Displacement of the rockers is effected by a flat slide **26** carrying two rollers **41** which roll on a double cam **42** driven by a driving shaft **11**; the slide, guided by a fixed stud **44** sliding in a notch **51**, therefore has a linear alternating movement in the sense of the arrows f_1 and f_2. The slide terminates at its upper end in a push member **27** accommodated in a casing **8** and fixed to a spherical sliding bearing **28** situated between the two rockers **30**, **31**. Compressed springs **29** and **52** are lodged in the casing, which constantly apply the rockers against the bearing and are opposed in equilibrium as illustrated in FIG. 3. In its displacement, the slide **26** entrains the push member **27** and the bearing **28**. When, progressively, the rocker **31** displaces itself in the direction of the opening of the delivery valve **47**, by compressing the spring **52**; the force of the spring **29** of the suction valve previously compressed is exerted on the rocker **30** in the direction of closing the suction valve **38**. In the other part of the movement of the slide, the spring **52** which had been compressed exerts its force on the rocker **31** which acts in the sense of closing the valve **47** and the bearing **28** acting on the rocker **30** in the sense of opening the suction valve compresses the spring **29**.

It is obvious that the alternating compression and relaxation of the springs are not without influence on the running state of the motor, which in order to ensure exactly the desired delivery rate, should rotate at a constant running speed. For this purpose, the apparatus comprises a regulator capable of providing a remedy for operating shocks. The mechanism involved in regulation consists in interposing between the driving shaft and the slide actuating the rockers, but subjected to the compression and relaxation of the springs of the rockers **29** and **52**, a spring which can be compressed when the motor tends to rotate more quickly and relaxed in the opposite case. For this purpose, the slide **26** comprises at its centre an aperture **40** and opposed ramps **43**. Parallel to the slide **26** there is mounted on the driving shaft (FIGS. 3 to 6) a disc **45** on which is pivotably mounted a lever **56** carrying at its end a roller **54** capable of travelling along the ramps **43**. A coil spring **57** is fixed on the one hand to the disc **45** at **48**, and on the other hand to the lever **56**, so that any relative movement given to the lever by the roller **54** following the ramps will tend to compress or relax the spring **57**. Any movement tending to compress the spring tends to have a braking effect on the disc, that is to say to slow down the motor, and vice versa. Therefore, it is sufficient to provide a configuration for the ramps **43** to regulate the speed of the motor in an effective manner.

Thus constituted, the pump according to the invention is self-priming and its operation automatically ensures the elimination of all gaseous bubbles from the time of stating. The delivery of the fluid delivered is so regular that the level of the fluid delivered in a tube shows a very regular height without any agitation, contrary to all devices used at the present time wherein the suction and delivery periods have repercussions on the column of fluid, the level of which is not at all stable.

It is advantageous for bringing the pump rapidly into service to begin with a maximum delivery and to progressively reduce the delivery to the desired value; elimination of gaseous bubbles and the like is then effected under the best possible conditions.

What I claim is:

1. A liquid pump having a smooth and adjustable delivery, comprising a chamber containing a cylinder, a pump piston, and circulation channels for the liquid, a synchronous motor, means for actuating the piston by a positive control through the motor, suction and delivery valves, located in the chamber, a rocker control for each of the said valves passing through the said chamber, a sealed joint for supporting each rocker through the chamber, and control means for the rockers through the said synchronous motor.

2. A pump according to claim **1**, wherein each rocker is a bar, the means to control the rockers comprising a rod substantially perpendicular to the rockers, a spherical piece solidly fixed to the rod for supporting the rockers, two springs, one for each rocker, compressed in opposite direction, a cam carried by the output shaft of the said motor, guiding means for the said rod in translation according to its axis, at least one roller carried at the free end of said rod and bearing on the said cam.

3. A pump according to claim **2**, wherein the control means for the rockers by the said motor include the said cam carried by the said output shaft of the motor, a slide solidly fixed to the said control rod of the rockers, with a linear guiding slot, two rollers carried by the slide and resting on both sides of the said cam.

4. A pump according to claim **3** comprising a compensating means for the variations of the efforts supported by the motor due to the alternative compression of the

springs resting on the rockers, comprising a cam carried by the said slide, a disc solidly fixed to the output shaft of the motor and perpendicular to the latter, a lever actuated on the said disc, a roller carried at one end of the said lever and resting on the said cam, a spring under tension between the other end of the said lever and a point on the said disc.

5. A pump according to claim 1, wherein the positive control comprises an eccentric constituted by a cylindrical sleeve carried by an output shaft of the motor, adjusting means for the eccentricity of the said eccentric, two rollers having a fixed spacing corresponding to the simultaneous contact point across a diameter of the sleeve of the eccentric, a fork supporting the said rollers, a fixed pivoting shaft for the said fork, parallel to the driving shaft of the motor, and substantially located on an axis perpendicular to the piston passing through the median position of one of the rollers, a link articulated on a roller and on the pump piston.

6. A pump according to claim 1, wherein the suction and delivery valves and the part of the rockers located within the said chamber are completely located in the volume of the chamber containing the liquid circulation.

7. A pump according to claim 6, wherein the rockers are connected to the valves, the upper valve being connected by its own weight, and the lower valve being connected by a connecting piece made of flexible material between the ends of the rocker and the valve.

8. A metering pump having a smooth adjustable delivery flow comprising:

(a) a pump body including a cylinder and a pump piston,
(b) a synchronous motor,
(c) positive driving means connecting said motor to the said pump piston,
(d) suction and delivery valves mounted in a distributor unit,
(e) duct means to provide the circulation of a liquid from the said pump body to the said valves,
(f) rocker means for actuating each valve,
(g) a pusher member connected to the rocker means for actuating successively each valve through the positive driving means,

whereby a regular and smooth liquid delivery is obtained during the actuation of the valves.

9. A pump as recited in claim 8, wherein the rocker means comprise two bars, actuated by the pusher member at approximately 90° to the bars, a spherical bearing solidly mounted on the pusher member between the two

bars, each bar being biassed against the said bearing by a spring, a cam member mounted on an output shaft of said motor, the said pusher member being actuated by the rotation of the cam member.

10. A pump as recited in claim 9, comprising a slide fixed to the pusher member, a linear guiding slot in said slide, two rollers mounted on said slide and resting on the cam so as to follow the contour of the cam.

11. A pump as recited in claim 10, comprising compensation means for the variations of the speed of the motor due to the compressions of the springs.

12. A pump as recited in claim 11, wherein the compensation means comprise a second cam connected to the slide, a disc solidly mounted perpendicular to the output shaft of the motor, a lever pivoted on said disc, a roller mounted at one end of said lever and biassed in the direction of the said second cam whereby the said second cam is computed to damper any variation in speed of the motor.

13. A pump as recited in claim 8, wherein the positive driving means comprise an eccentric constituted by a cylindrical sleeve axially mounted on the output shaft of the motor, means for throwing the said sleeve off center, two rollers having a fixed spacing corresponding to the diameter of the sleeve and rolling on the said sleeve, a fork for supporting the said rollers, the said fork pivoting on an axle parallel to the axis of the shaft of the motor, and substantially perpendicular to the axis of the piston passing through the median position of one of the rollers, and a pivoting link between one of the rollers and the pump piston.

14. A pump as recited in claim 8, wherein the suction and delivery valves and a part of the rockers are located within a liquid circulation chamber, the upper valve being connected to one rocker by its own weight and the lower valve being connected to the other rocker at their extremities by a connecting piece made of flexible material.

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