United States Patent

Sanz

[15] **3,669,319**

[45] **June 13, 1972**

[54] METERING CUM DISPENSING APPARATUS

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[73] Assignee: **Micromedic Systems, Inc.**, Philadelphia, Pa.

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Aug. 19, 1968 Switzerland 12496/68

[52] **U.S. Cl.** **222/309**
[51] **Int. Cl.** **G01f 11/06**
[58] **Field of Search** 222/309, 380

[56] **References Cited**

UNITED STATES PATENTS

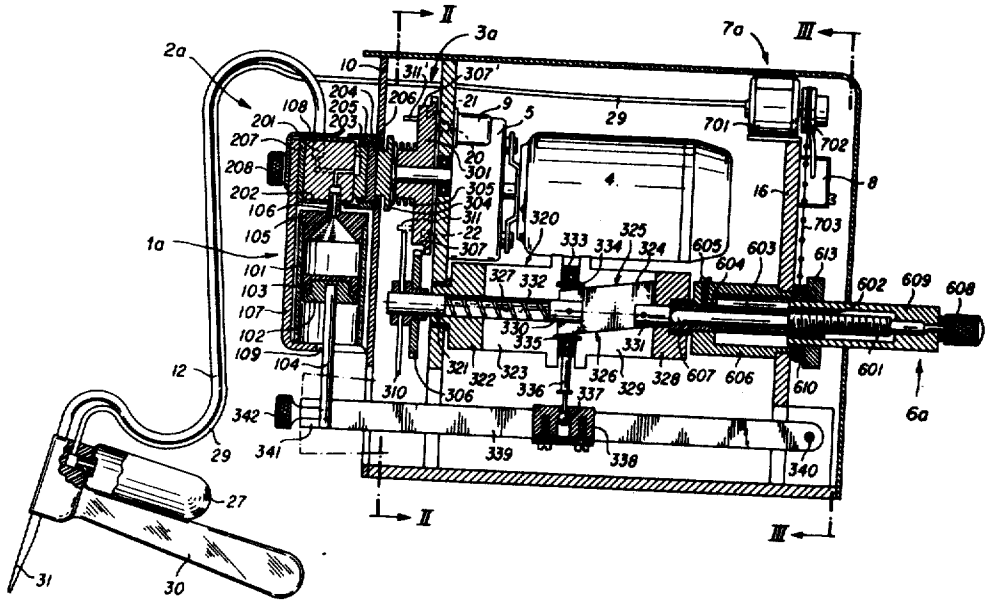
1,794,388 3/1931 Mojonnier et al. 222/380
3,024,946 3/1962 Forsyth ..... 222/309 X
3,151,778 10/1964 Olney et al. ..... 222/309 X

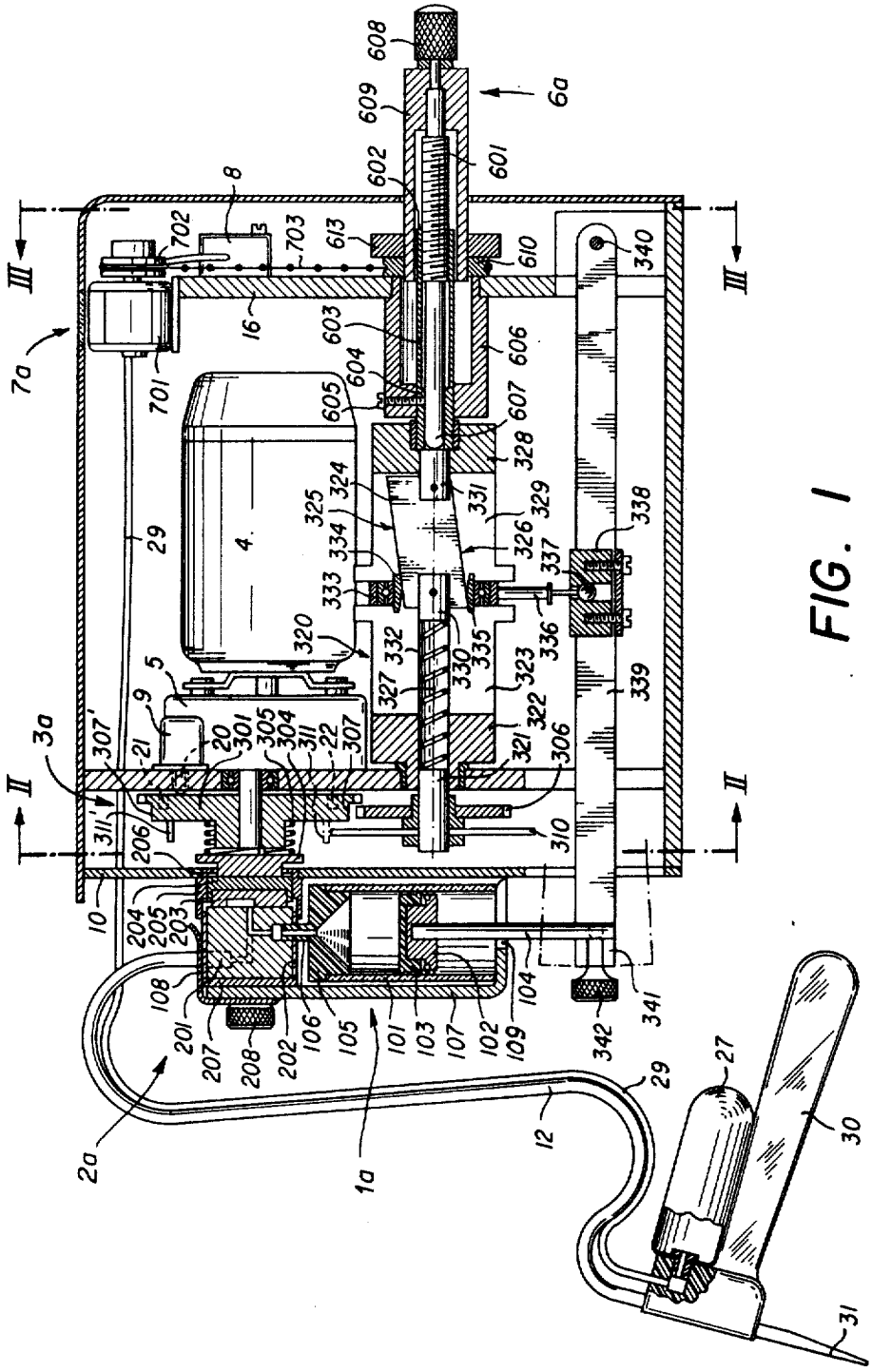
Primary Examiner—Samuel F. Coleman
Attorney—Gerry J. Elman, George W. F. Simmons and Arthur R. Eglington

[57] **ABSTRACT**

Apparatus for repeatedly metering and dispensing, by means of a piston pump, predetermined quantities of liquid via a switching valve to which are connected inlet and outlet conduits for the liquid. The pump and the valve are actuated in timed relation by a drive mechanism powered by an electric motor which is controlled by selectively operable means that automatically cut off the motor supply once the piston has completed a stroke. There are also provided means for varying the length of the piston stroke to adjust the volume of said quantities and means for displaying to the outside a number indicative of this volume.

16 Claims, 20 Drawing Figures




608
609
6a
602
601
8
702
703
613
610
340
III
III
7a
16
603
606
701
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605
607
328
331
324
325
329
326
338
334
337
29
4
333
320
336
332
330
335
323
5
9
327
339
322
3a
307'
21
20
301
305
304
311
22
307
321
306
II
II
311'
206
310
10
204
205
203
108
104
341
201
106
105
101
103
107
102
109
342
207
208
202
29
27
30
2a
1a
12
31

FIG. 1

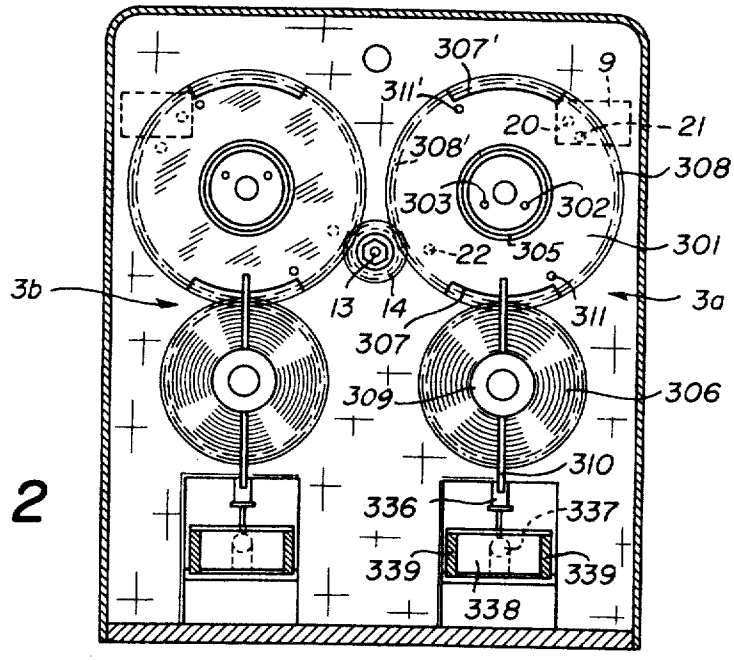
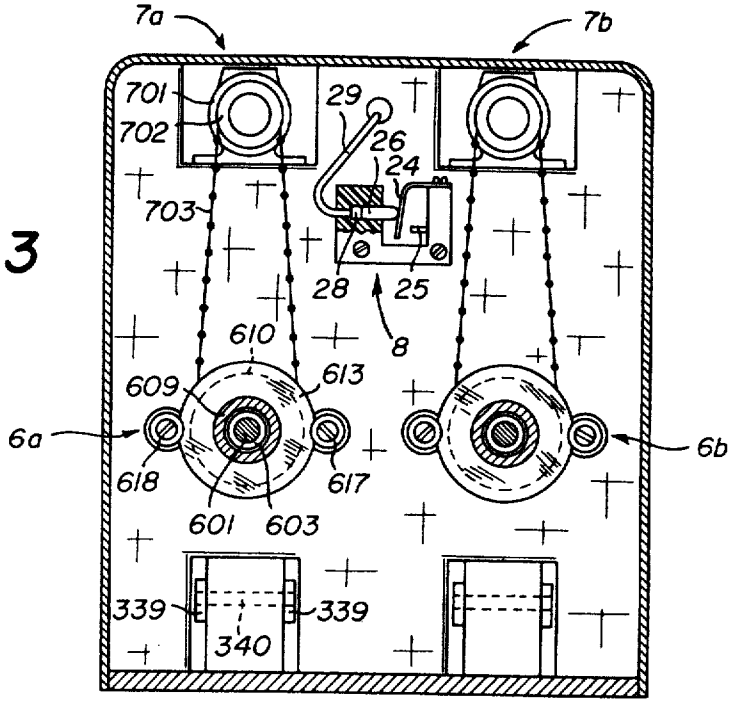

307'
9
311'
20
21
308'
308
303
302
22
305
301
3b
13
14
3a
307
311
309
306
310
336
337
339
339
338

FIG. 2


7a
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701
29
702
26
24
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28
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6b
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601
603
339
339
340

FIG. 3

FIG. 4

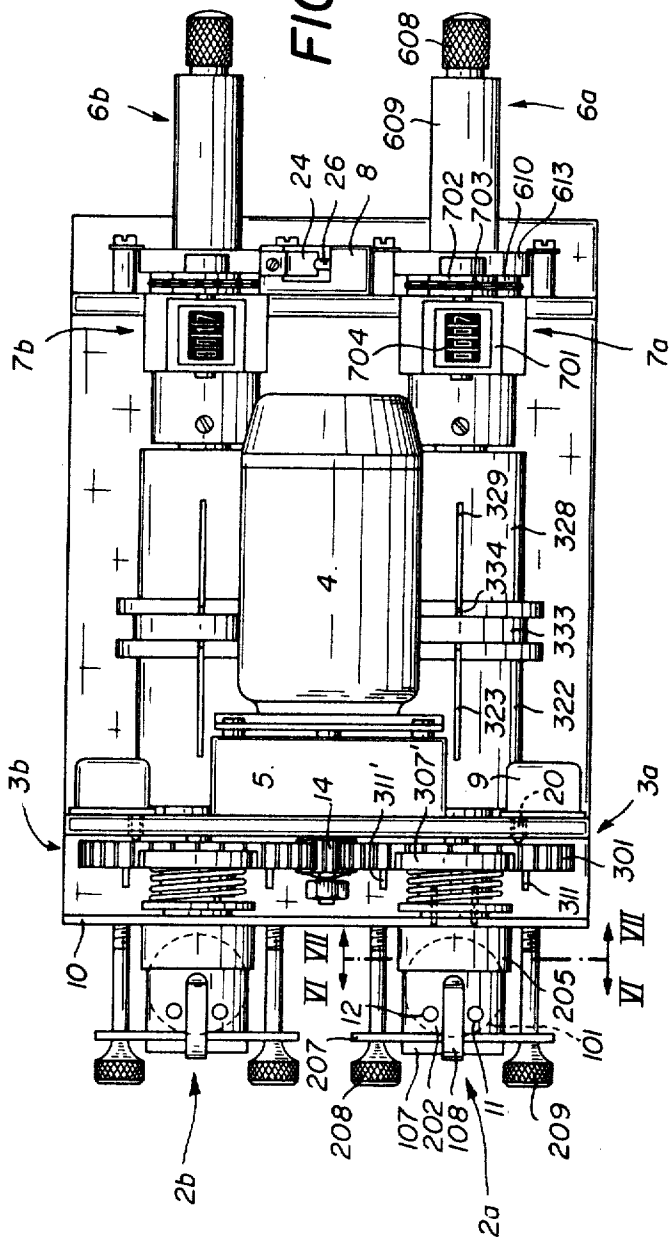


FIG. 7

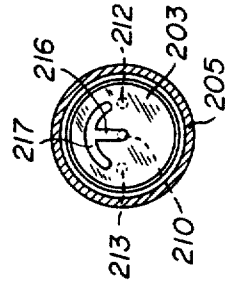
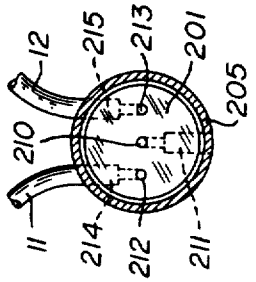


FIG. 6



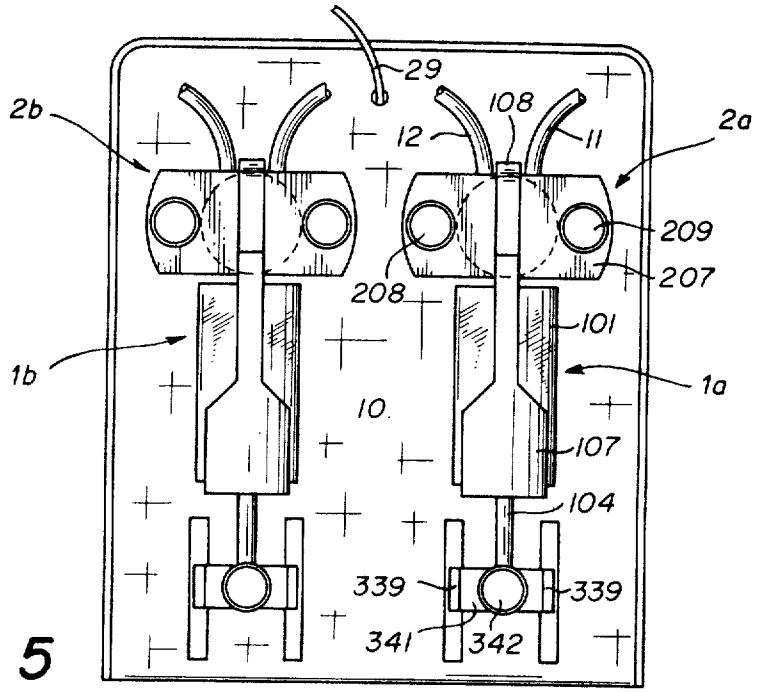


FIG. 5

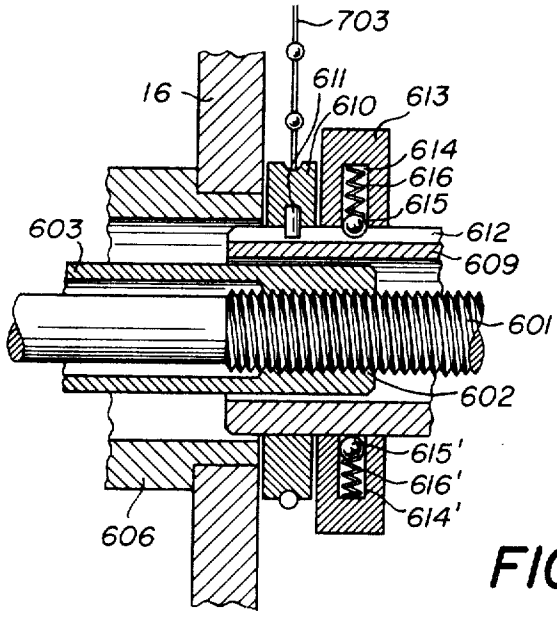


FIG. 10

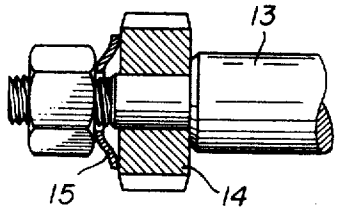


FIG. 8

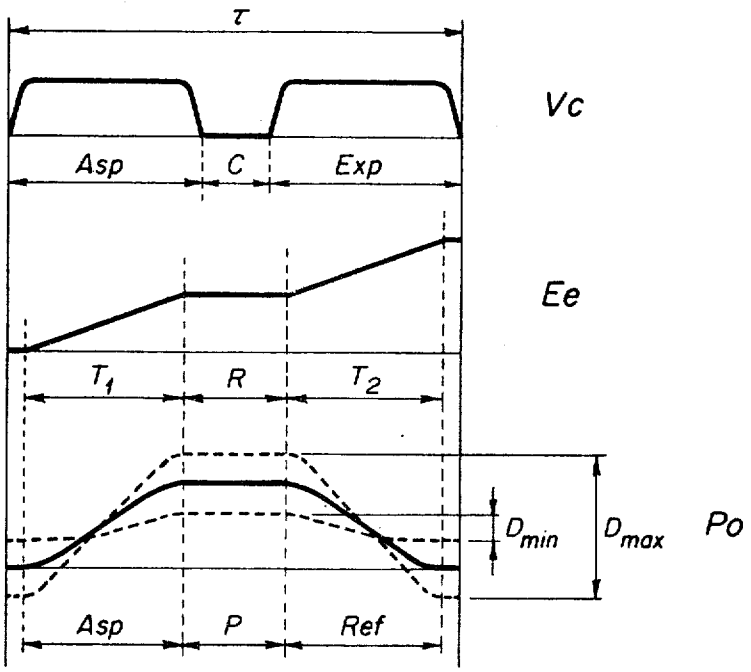
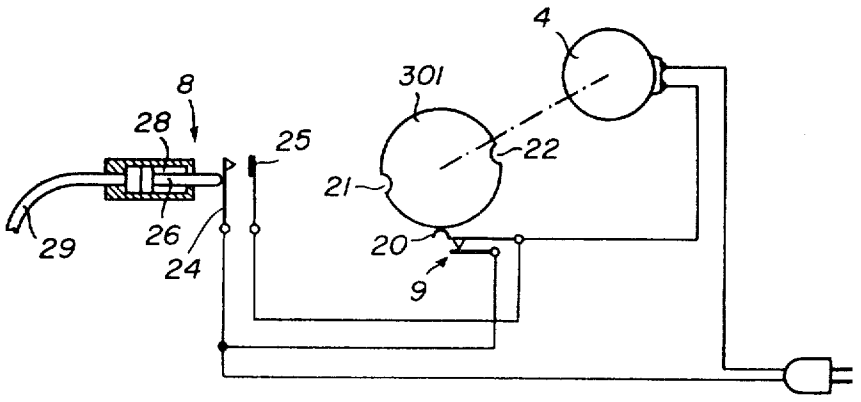

τ
Vc
Asp
C
Exp
Ee
T1
R
T2
Dmin
Dmax
Po
Asp
P
Ref

FIG. 9


4
301
8
28
25
22
21
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24
20
9

FIG. II

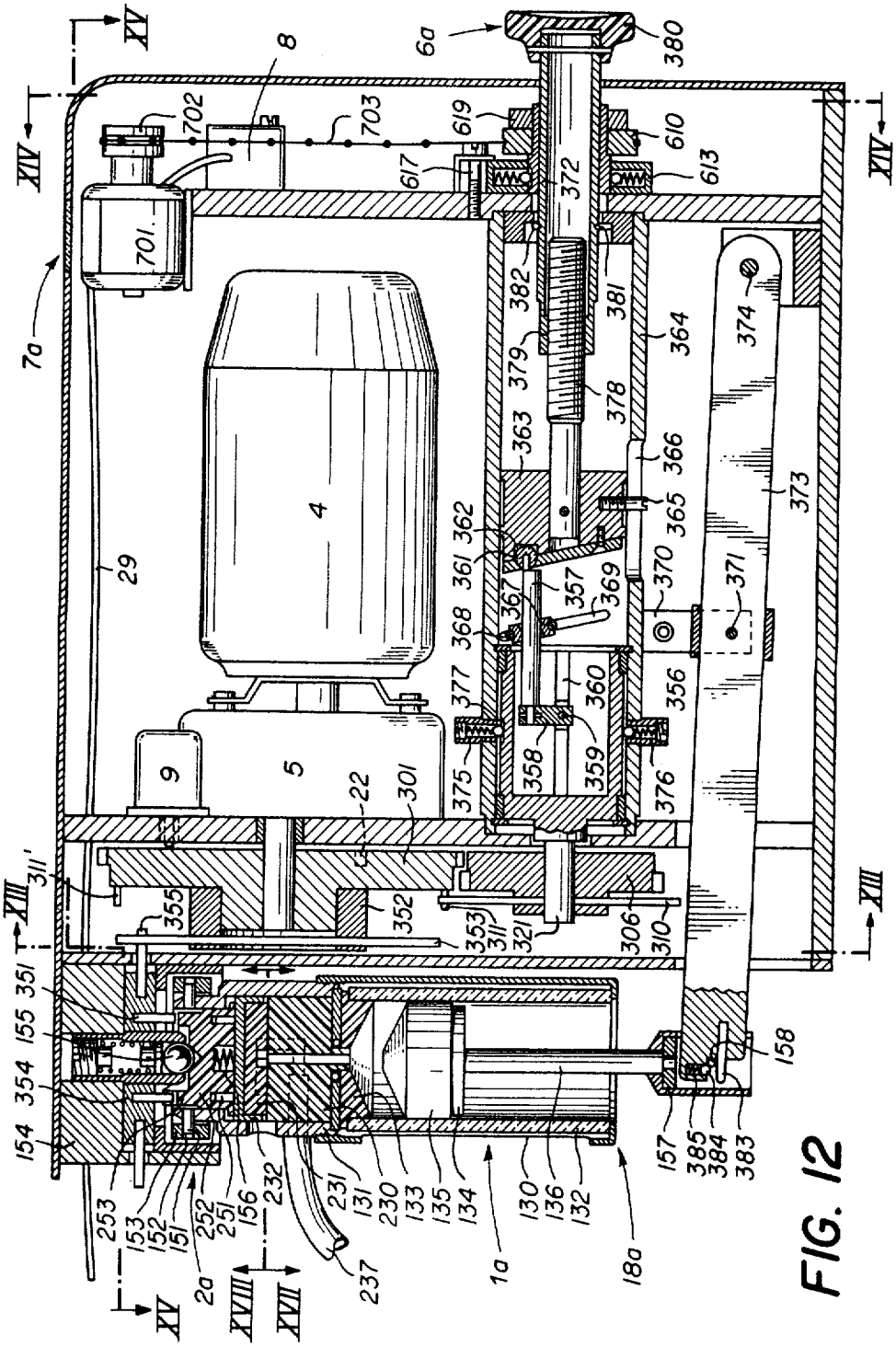

XIV
XIV
XIV
8
6a
380
702
703
619
610
613
617
372
701
7a
382
381
364
374
379
378
363
366
373
4
29
362
361
365
370
371
357
369
367
368
377
360
356
9
5
22
301
375
358
359
376
311'
XIII
XIII
XIII
355
352
353
311
321
306
310
351
155
354
154
158
157
385
384
383
253
153
152
151
252
251
156
232
231
131
230
133
135
134
130
136
132
237
2a
1a
18a
XV
XVIII
XVII

FIG. 12

FIG. 13

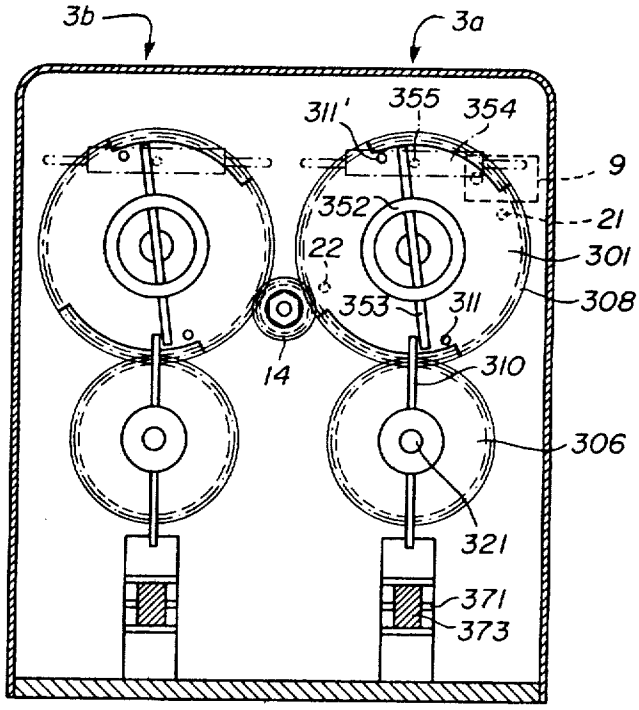
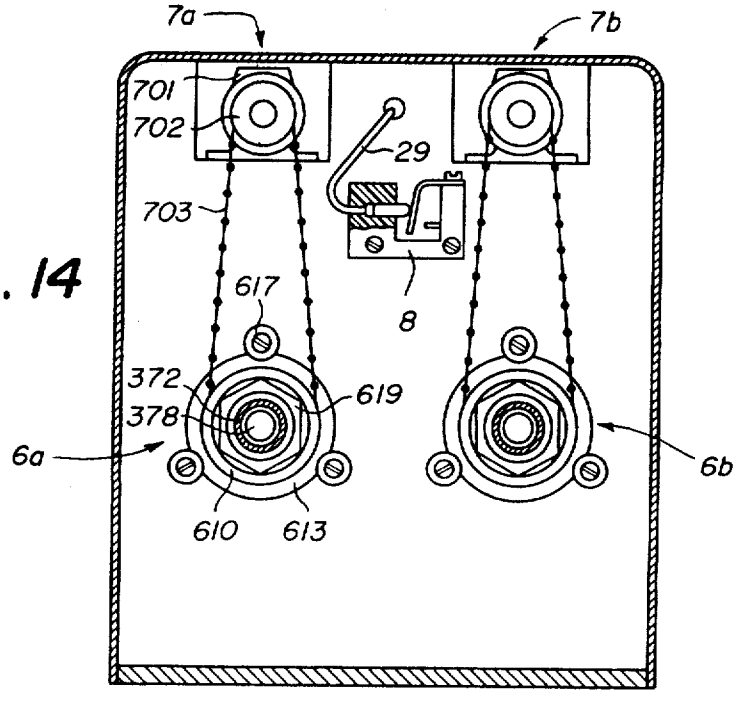

3b
3a
311'
355
354
9
352
21
22
301
353
311
308
14
310
306
321
371
373

FIG. 14


7a
7b
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702
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703
617
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372
619
378
6a
6b
610
613

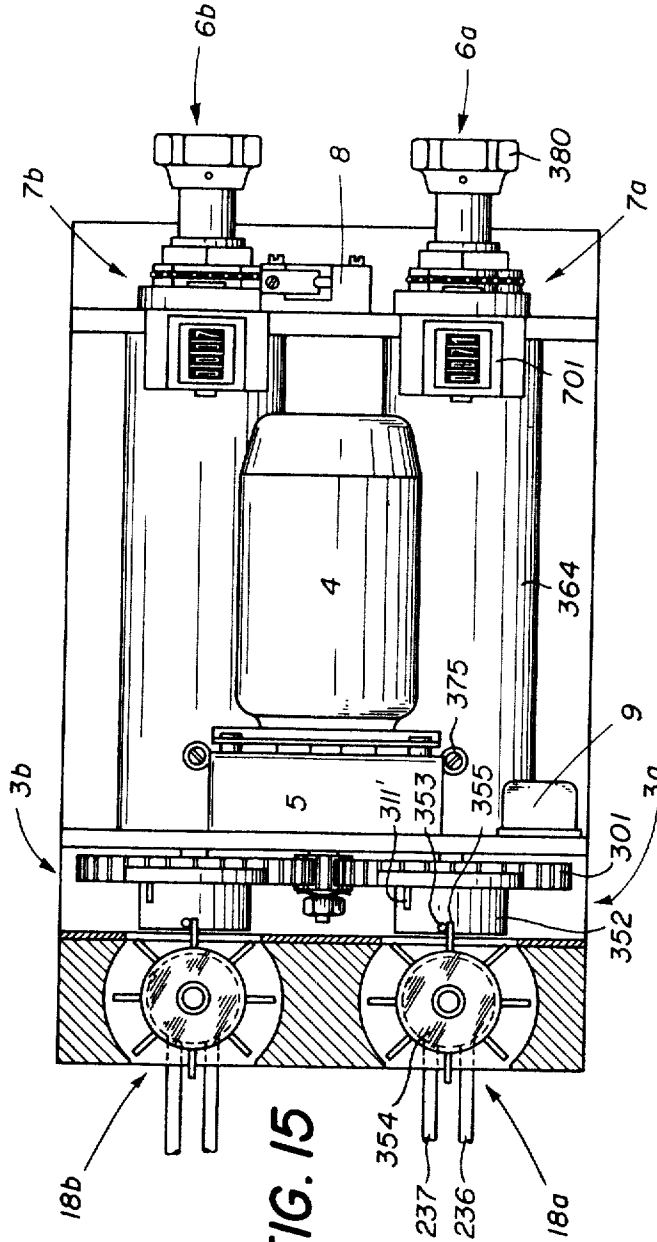


FIG. 15

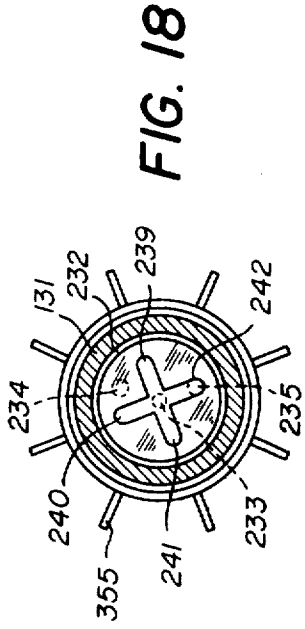


FIG. 18

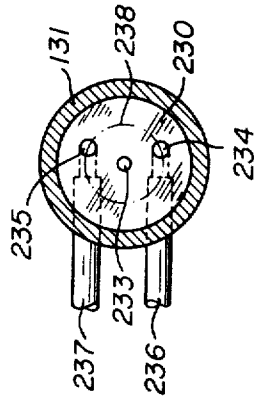
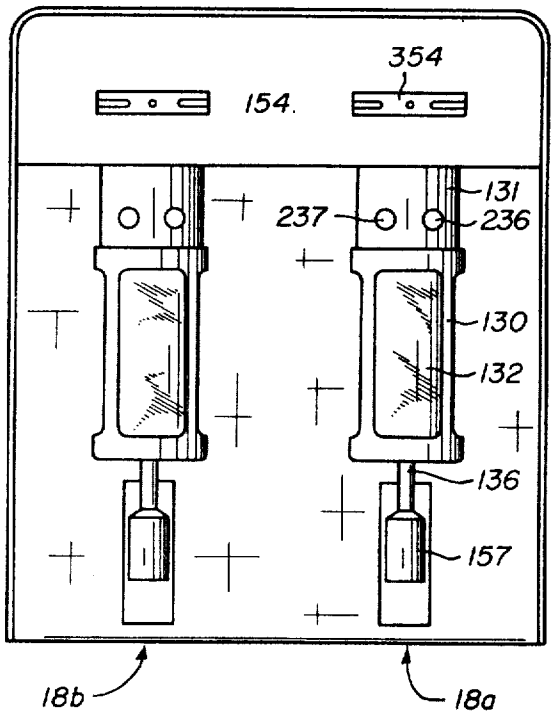
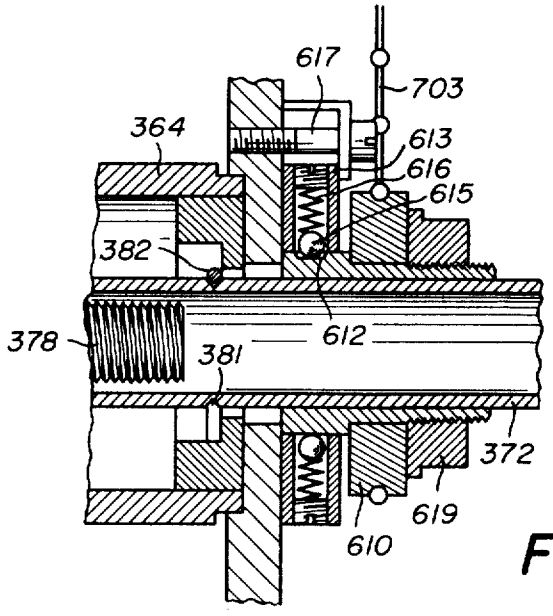


FIG. 17

FIG. 16


354
154.
131
237
236
130
132
136
157
18b
18a


617
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378
381
372
619
610

FIG. 20

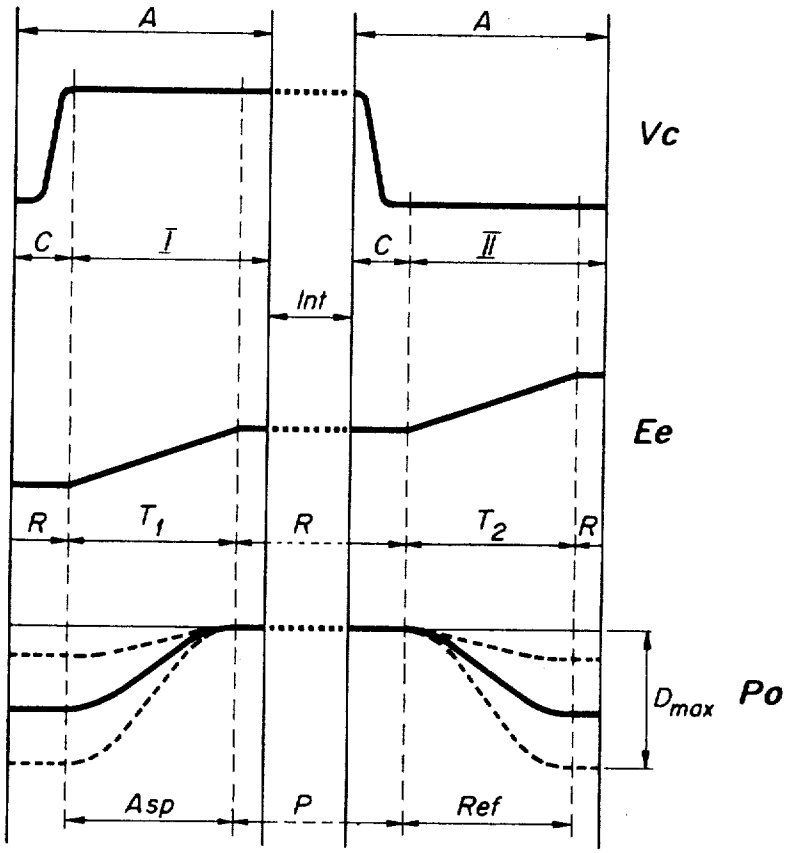

FIG. 19

METERING CUM DISPENSING APPARATUS

This invention relates to a metering cum dispensing apparatus of the kind for repeatedly drawing off, through a conduit, a volumetrically metered, freely adjustable, quantity of liquid and for discharging this metered quantity through another conduit, each drawing off operation alternating with a discharging operation.

Metering cum dispensing apparatuses of this kind are known : they are mainly used in test laboratories, e.g., biochemical and clinical laboratories, and are intended either to deliver a predetermined volume of a liquid to be analyzed (i.e., operating as a metering apparatus), or to deliver successively several metered quantities, all of identical volume, of the same liquid i.e., operating as a dispensing apparatus), or else to deliver simultaneously both a volumetrically predetermined metered quantity of a liquid having to be analyzed and a metered quantity, also volumetrically predetermined but not necessarily of same volume as the liquid to be analyzed, of a diluting liquid or of a reagent (i.e., operating as a diluting apparatus). The use of these apparatuses is becoming more and more widespread as the demand for chain testing increases. However, the known apparatuses are often of low accuracy, inasmuch as the volumetric quantities they meter lack accuracy and are not readily reproducible, particularly when these volumetric quantities are small. This defect is largely due to the fact that, in these known forms of apparatus, adjustment of the metered quantity is not "digitalized"; indeed adjustment is, as it were, continuous and such adjustment is often affected by errors in the reading of scales, these being human errors attributable to distraction, inattention or tiredness on the part of the operators. Moreover, the known forms of metering apparatus operate in a rather brutal way: first an abrupt suction action occurs, then an abrupt stoppage of the suction action and finally an abrupt discharge of the metered quantity of liquid that has been sucked in. This often results in breaks in the columns of liquid (hydraulic hammering effects) or in the formation of drops, both being a source of material errors. If it is desired to reduce the extent of these errors, this can only be achieved, with these known forms of metering cum dispensing apparatus, by having them handle relatively large quantities of liquid. This of course is a major drawback when it is required to carry out a large number of different tests on a liquid from one source since, in order to do this, a corresponding number of samples is usually required of the liquid and this means that quite a sizeable starting quantity will be needed. The only way in which this need for a sizeable starting quantity of the liquid can be avoided is to reduce to the greatest possible extent the volume of each sample. Hence the desirability of minimizing all possible causes for inaccuracy in metering. This is particularly important in haematology where it is often desired to carry out a large number of tests without having to draw off large quantities of blood from the patients. One of the most relevant examples is in pediatric haematology.

An object of the present invention is to overcome the above mentioned drawbacks by providing a metering cum dispensing apparatus which is able to meter with great accuracy very small volumes of liquid and which will lend itself, because of the reproductibility of the metered quantities it delivers, to an automatization of testing.

According to the present invention there is provided apparatus of the kind set forth which comprises

a. a unit having

i. a suction and forcing piston pump able, during a suction stroke, to draw off said predetermined volume and, during a forcing stroke, to discharge this volume,

ii. a switching valve associated with said pump and able cyclically to pass from one condition in which it causes said pump to communicate with one of said conduits, to a second condition in which it causes said pump to communicate with the other of said conduits,

iii. a drive mechanism able to cause said valve to pass from one condition to the other and able cyclically to actuate said pump by imparting to the reciprocating movement of the piston a substantially sinusoidal action, said mechanism being adapted so that the suction strokes of the pump occur when the valve is in said one condition and that the forcing strokes of the pump occur when the valve is in said other condition and so that each suction and forcing stroke may be followed by an idling pause during which the valve passes from one condition to another,

iv. adjustment means for selectively adjusting the volume of said metered quantity by varying the length of the stroke of the pump piston, and

v. display means for displaying to the outside a number indicative of said volume;

b. an electric motor coupled to the drive mechanism of said unit; and

c. control means for controlling said electric motor and adapted to trigger off at will half an operational cycle of said unit, said half-cycle being either a drawing off half-cycle, including a suction stroke of the pump, or a discharge half-cycle, including a forcing stroke of the pump.

Two embodiments of the apparatus provided by the invention will now be described by way of example with reference to the accompanying drawings, in which:

FIG. 1 is a side view, in cross-section, of the first embodiment;

FIG. 2 is a front sectional view of this first embodiment, taken along line II—II of FIG. 1;

FIG. 3 is a rear sectional view of the first embodiment, taken along line III—III of FIG. 1;

FIG. 4 is a plan view of the first embodiment;

FIG. 5 is a front elevational view of the first embodiment;

FIGS. 6 and 7 are details sectional views taken along lines VI—VI and VII—VII, respectively, of FIG. 4, on a somewhat enlarged scale;

FIG. 8 illustrates a further detail, partly in section, of the first embodiment, on a substantially enlarged scale;

FIG. 9 shows three graphs illustrating the operation of the first embodiment;

FIG. 10 shows on a substantially enlarged scale and in a more detailed manner a portion of FIG. 1;

FIG. 11 shows the electrical wiring for the first embodiment;

FIG. 12 is a side view, in cross-section, of the second embodiment;

FIG. 13 is a front sectional view of the second embodiment, taken along line XIII—XIII of FIG. 12;

FIG. 14 is a rear sectional view of the second embodiment, taken along line XIV—XIV of FIG. 12;

FIG. 15 is a top sectional view of the second embodiment taken along line XV—XV of FIG. 12;

FIG. 16 is a front elevational view of the second embodiment;

FIG. 17 and 18 are detail sectional views taken along lines XVII—XVII and XVIII—XVIII respectively, of FIG. 12;

FIG. 19 shows three graphs illustrating the operation of the second embodiment; and

FIG. 20 shows on a substantially enlarged scale and in a more detailed manner a portion of FIG. 12.

The metering cum dispensing apparatus shown in FIGS. 1 to 5 is dual, inasmuch as it comprises a pair of suction and forcing pumps 1*a* and 1*b* , a pair of switching valves 2*a* and 2*b*, a pair of drive means 3*a* and 3*b* (powered however by a single common motor 4 through a single common speed-reducing gear), a pair of adjustment means 6*a* and 6*b*, a pair of display means 7*a* and 7*b* , but a single control means comprising an electric automatically cutting out contact-maker 8 and an electric cam-actuated contact-breaker 9. Of each of the dual members only one need be described, the components of each such member being identified by three-figure reference numerals so chosen that their first figure corresponds to the reference numeral of the member to which they belong. Thus, all of the components forming part of the pump, whether it be pump 1*a* or pump 1*b*, will be identified by numerals ranging

from 101 to 199, all those forming part of the valve, whether it be valve 2*a* or valve 2*b*, will be identified by numerals ranging from 201 to 299, and so forth. In view of the constructional symmetry of the dual members, the letter symbol that distinguishes one member from the other within a pair will be omitted.

1. Pump

In the present embodiment, the suction and forcing pump consists of a syringe 101 in which can move a piston 102 having a cap 103 and mounted at the end of a rod 104. Cylinder 101 is closed off by a plug 105 formed at its top end with a nipple 106 by means of which it communicates with the switching valve. Cylinder 101 is preferably made of glass, piston 102 and rod 104 are preferably made of metal, cap 103 and plug 105 are preferably made of a hard synthetic material, such as Teflon (Registered Trademark for polytetrafluoroethylene) or Kel–F (Registered Trademark for fluorochloroethylene); but other materials may be used. The syringe is kept in place by an L-shaped element 107 which, in conjunction with a spring blade 108, holds it tight against the switching valve, with the nipple 106 of its plug 105 engaged in a recess formed for that purpose in the valve. As for the rod 104, it extends through a slot 109 formed in the short arm of the L-shaped element 107 and its free end portion is connected to the free end portion of a lever 339 forming part of the drive means.

2. Switching valve

The switching valve comprises a stationary body 201 which is fitted into a stationary socket 202, and a rotary valve member 203 which is fitted into a rotary socket 204. The valve body and the valve member are held together by an assembly sleeve 205 which fits into an opening 206 formed in a front wall 10 of the apparatus frame.

The valve is kept in place in this opening by a releasable holding device which consists of a plate 207 and of two knurled-headed tightening screws threaded into holes formed in the front wall 10 of the apparatus frame. When in position, the valve fits, by means of two holes formed in the base of the rotary socket 204, on to two driving pins 302 and 303 which form part of the drive means and which will be further described below. In this way, the valve member 203 can, as it were, be plugged on to the latter. Because of its design and of its manner of attachment, the switching valve can be exchanged as a unit, with the valve member and the valve body remaining connected together by means of the assembly sleeve 205, and such changes are exceedingly easy to perform, this being an advantage for servicing.

The valve body 201 is formed (see FIG. 6) with an axial passage 210 which communicates with a recess 211 into which is inserted the nipple 106 of pump 1 and with two lateral passages 212 and 213 which communicate with recesses 214 and 215 adapted to receive, respectively, one end of a flexible suction tube 11 and one end of a flexible discharge tube 12. The suction tube 11 communicates with an outside reservoir (not shown) from which the apparatus is required to draw off metered quantities of a liquid contained therein; the discharge tube 12 communicates with an outside receptacle (not shown) to which these metered quantities are to be discharged or with a nozzle 31 fitted to a handle 30 enabling the metered quantities being discharged to be delivered at a desired location.

The valve member 203 is formed, in its face adjacent valve body 201, with a channel 216 having the approximate shape of an anchor (see FIG. 7), which, depending on the angular position of the valve member, causes the axial passage 210 in body 201 to communicate with either one or the other of the two lateral passages 212 and 213 in the body. Thus, upon rotation of the valve member 203 in relation to the stationary valve body 201, the pump successively comes to communicate with the suction tube and with the discharge tube. Such communication lasts for as long as it takes the arcuate portion 217 of channel 216 to sweep past the orifice of one or other of the lateral passages 212 and 213, which length of time is dependent, for a given speed, on the length (in degrees) of the arcuate portion 217. The length of portion 217 is of course less than 180° to avoid the possibility of direct communication between these two lateral passages.

3. Drive means

As mentioned earlier, the drive means are powered by one motor through a common speed-reducing gear. The motor, identified as 4, is preferably synchronous and the speed-reducing gear, identified as 5, comprises an output shaft 13 which carries a pinion 14. Pinion 14 is coupled to shaft 13 through the intermediary of a frictional torque-limiting device 15 (see FIG. 8) and meshes with the first wheel of each of the two drive means 3*a* and 3*b*. Although only drive means 3*a* will be described, it will of course be understood that what is about to be said in connection with drive means 3*a* is also true of drive means 3*b* since these are identical to 3*a*. Pinion 14 thus meshes with a cogged wheel 301 which carries the two pins 302,303 mentioned earlier. The later extend through a flanged disc 304 and project, as already stated, into recesses formed in the base of the rotary socket 204 holding the rotary valve member 203 of the switching valve. Disc 304 forms, in conjunction with a spring 305, a resilient axial abutment which presses, through opening 206 and inside sleeve 205, the valve member 203 against the valve body 201. Wheel 301 drives a cogged wheel 306 secured to the input shaft 321 of an eccentric 320. Along two portions of the periphery of cogged wheel 301, the teeth have their axial length reduced by about half by means of milled arcuate recesses 307 and 307'. The axial length of the teeth on the cogged wheel 306 is less than the depth of the recesses 307 and 307' (see FIGS. 1 and 2). Moreover, wheel 306 is located in the plane of these recesses. Consequently, wheel 301 only drives wheel 306 during those portions of its rotation which coincide with the action of the non recessed portions 308 and 308' of its periphery. Wheel 306 is mounted on a hub 309 which carries a radial spoke 310 spaced from wheel 306 and dimensioned to cooperate alternately with two pins 311 and 311' projecting from the side of wheel 301. Spoke 310 and pins 311 and 311' are so positioned that, upon engagement, they cause the teeth of wheels 301 and 306 to mesh as the front end of one or other of the non-recessed portions 308 and 308' is about to come into engagement with the wheel 306. The peripheral length of the non-recessed portions 308 and 308' is equal to half the circumference of wheel 306 so that for each half turn of the wheel 301, wheel 306 carries out one-half turn followed by a pause corresponding to the passage of one or other of the recessed portions 307 and 307'. The wheels 301 and 306 thus together form an intermittent drive able to convert the continuous rotation of wheel 301 into an intermittent rotary motion on the part of wheel 306 while leaving the later free to rotate when either of the recessed portions 307 and 307' lies opposite thereto.

The eccentric 320 comprises a first rotary member 322 which is secured to the input shaft 321 and which is formed with a diametral slot 323 in which can slide axially an eccentricity setting member consisting of a blade 324 whose edges 325 and 326 are oblique in relation to the rotational axis 327 of the rotary member 322. The latter is positioned opposite a second rotary member 328 which is also formed with a diametral slot 329 enabling axial sliding motion of the blade 324. Slide members 330 and 331, mounted in a slideway 332, are provided to prevent this blade from moving otherwise than axially. Blade 324 extends into an offset core formed by the inner race of ball bearing 333; this inner race carries, on the radially inner surface thereof, two spur-like elements 334 and 335 which engage the edges 325 and 326 of blade 324 and which project from opposite sides of the race into the diametral slots 323 and 329 of rotary members 322 and 328 whereby this inner race may rotate with the latter. The extent to which this ball bearing 333 is offset in relation to the axis 327 is determined by the axial position of blade 324 and this axial position is governed by a micrometer screw 601 which forms part of the adjustment means hereinafter described. The outer race of the ball bearing 333 is secured to a radial push-rod 336 which is connected, by means of a ball 337 held in a

socket **338**, to a rocking lever **339** of which one end is pivotally mounted on a pin **340** mounted in the casing of the apparatus and of which the other end carries a tightening clamp **341** in which is held, by means of a knurled-headed screw **342**, the lower end of the piston rod **104** of the pump described earlier.

The drive means are thus able both to drive the switching valve **2** in a continuous manner, thereby to place the pump **1** cyclically in communication with the suction tube **11** and with the discharge tube **12**, and to drive the eccentric **320** in an intermittent manner, whereby its output member **336**, which is connected to pump **1**, may have imparted thereto an intermittent reciprocating motion having a freely regulatable amplitude. Wheels **301** and **306** are so keyed in relation to the valve member **203** and to the input shaft **321** of eccentric **320** as to achieve between these various movements the phasing illustrated by the graphs of FIG. **9**. In this Figure, curve Vc illustrates the operation of the switching valve, curve Ee represents the motion of the input shaft of the eccentric and curve Po illustrates the operation of the pump. Cycle τ consists, as regards the valve, of a portion "Asp" during which the pump communicates with the suction tube, a portion C during which switching occurs and during which communication of any kind is interrupted, and a portion "Exp" during which the pump communicates with the discharge tube (graph Vc). As regards the input shaft of the eccentric, cycle τ consists of a portion T_1 during which this shaft rotates through 180°, a portion R during which it is at rest, and a portion T_2 during which it completes its revolution (graph Ee). As regards the output member of the eccentric, i.e., as regards the pump, cycle τ consists of a suction phase "Asp" during which the pump carries out a suction stroke, a pause P during which the pump remains stationary, and a phase "Ref" during which the pump discharges the liquid it has sucked in during the "Asp" phase. Pause P, during which the pump is idle, overlaps portion C of the valve operation, i.e., the portion during which switching takes place. Curve Po in FIG. **9** further illustrates the sinusoidal nature of the pump's motion, the effect of this sinusoidal motion being progressively to set the liquid in motion and progressively to bring it to rest, thereby avoiding any hydraulic hammering effect. In this graph Po, there has also been sketched in the extent to which the amplitude of the stroke of piston **102** can be varied, such variation enabling the metering of liquid to be freely varied between a maximum quantity D_{max} and a minimum quantity D_{min}, with the possibility of this latter quantity being nil if the axial position of blade **324** is such that the roller bearing **333** is made concentric with axis **327** of the eccentric.

4. Adjustment means

The adjustment means comprise a micrometer screw **601** which cooperates with a nut **602** formed by one of the ends of a stationary element **603** whose other end **604** acts as a bearing for the second rotary member **328** of eccentric **320**. Element **603** is kept stationary by a set screw **605** driven into a socket **606** fixed to the rear wall **16** of the apparatus frame. The micrometer screw **601** is formed with a smooth, push-rod forming, portion **607** having a rounded tip which cooperates with the slide member **331** of the eccentricity setting member **324** of the eccentric. Rotation of the screw **601** is controlled by a knurled knob **608**, which is rigidly secured to the outside end of a socket **609** which projects out of the casing wall and which, at its inner, open, end, fits over the stationary element **603**. Socket **609** carries a sprocket **610** whose function will be explained further on. This sprocket **610** (see FIG. **10**) is provided with a pin **611** which projects into a longitudinal groove **612** formed in the outer face of socket **609**. In this way, socket **609** can slide axially through the sprocket while remaining angularly solid therewith. Socket **609** extends also through a setting disc **613** which lies on the outside of sprocket **610** and which is formed with two diametrically opposite recesses **614** and **614'**. In these two recesses are movably housed balls **615** and **615'** against which act springs **616** and **616'**. The function of these balls is to signal tactually to the operator the passage of the groove **612** therepast; these balls thus in effect form spring-loaded detents which enable the operator called upon to actuate the knurled adjustment knob **608** to feel when he has rotated screw **601** by half a turn. Setting disc **613** is immobilized by lugs through which extend screws **617** and **618** (see FIG. **3**) and its function, as will be explained further on, is to set the zero of the display means.

5. Display means

The display means comprise a revolution counter **701** whose input shaft has secured thereto a sprocket **702** connected by chain **703** to the previously referred to sprocket **610**. This revolution counter is formed with a window **704** (FIG. **4**) through which can be seen a set of figures indicating the number of rotations made by its input shaft. This number is directly related to the rotation carried out by the knurled, eccentricity adjusting, knob **608** and the use of a sprocket chain **703** helps to maintain this relationship by preventing any slip between the wheels **610** and **702**. The diameters of the wheels **610** and **702**, the slope of the edges **325** and **326** on the eccentricity setting blade **324** and the ratio between the arms of lever **339** are so chosen that the volume of the quantity of liquid being metered and discharged can directly be determined by multiplying the number displayed in the window **704** by a calibration figure indicative of the maximum capacity of the pump-acting syringe and which is inscribed on the syringe cylinder. Further, the ratio between the sprockets **610** and **702** is **2** to **1** so that sprocket **702** will perform one whole turn for every half-turn of the sprocket **610**, and hence of the micrometer screw **601**. Moreover, the angular position of the setting disc **613** is so chosen that each click made by the spring-loaded detent can cause the number visible in window **704** to vary by one unit. Since the operator will, when making an adjustment, always stop at a click, the number displayed in window **704** is always a full number.

Clearly, the eccentricity of eccentric **320** can only be adjusted by means of the micrometer screw **601** within certain limits; consequently the range within which can be selected the quantity of liquid which is to be metered and dispensed by the pump is determined by the maximum capacity of the syringe used to form the pump. Accordingly, in order to increase the range within which this quantity can be chosen, the apparatus is provided with a set of interchangeable syringes having diameters such that their maximum capacities will define a suitably stepped series to form the desired broad range, for example: 0.2; 2; 5; 10; 20; and 50 μ1.

6. Control means

The control means comprise the contact-breaker **9** which may for instance consist of a microswitch and which is provided with a push-button **20** actuated by a cam formed by a pair of cavities **21** and **22** in one of the members of the drive mechanism, e.g. in wheel **301** (FIGS. **1**, **2**, and **4**). This switch is connected, as is shown by the electrical wiring diagram of FIG. **11**, so as to cut off the motor's supply whenever one of the cavities comes to lie opposite the push-button **20**, i.e., twice per revolution of wheel **301**. It is therefore they which cause the breaks R previously mentioned in connection with FIG. **9**. The control means also comprise the automatically cutting out contact-maker **8** which, as can be seen from FIG. **3**, includes a contact blade **24** adapted to come into contact with a contact head **25** under the action of a thrust exerted by a push member **26** pneumatically actuated by squeezing a resilient air container **27** adjacent handle **30** (see FIG. **1**) and which is connected by a flexible tube **29** to a cylinder **28** wherein the push member **26** is slidably mounted. The contact blade **24** is arranged to lie, at rest, away from the head **25**. Between the head of the push member **26** and its cylinder **28** there is provided some play such that the push member will be propelled forward by a sudden increase in pressure brought about by squeezing the air container **27**, but such that it will allow the air to leak out so that the pressure of the air is made to drop progressively until it is unable to counteract the elastic force of blade **24**. This play is so chosen that the time taken by the contact-maker **8** to open again, through push member **26**

being forced back to its position of rest, is enough to enable the motor to rotate wheel **301** by a sufficient angular extent to cause the cavity which had brought about actuation of the contact-breaker **9** to be moved past push button **20**. Since the contact-maker **8** is connected in parallel with contact-breaker **9**, the return of **8** to its "open" position will have no effect on the electric supply to the motor. The latter will therefore carry on rotating wheel **301** until the next cavity comes to lie opposite push button **20** to actuate contact-breaker **9**. The electrical diagram of FIG. **11** is sufficiently self-explanatory as regards this particular aspect of the operation of the apparatus to make further explanation unnecessary. Attention is however directed to the advantage that such a pneumatically actuated, automatically cutting out, contact-maker has for the operator's safety in view of the risks that are inherent in handling electrical equipment in premises where it would be exposed to splashing by conductive liquids such as water. Since the present metering cum dispensing apparatus is in fact meant to be used in laboratories where such risks do exist, the advantage of this pneumatically actuated contact-maker will be obvious.

This safety feature enables the control means **27** for the contact-maker **8** to be mounted adjacent the handle **30** by means of which the operator holds the nozzle **31** at the end of the discharge conduit **12**.

The apparatus hereinbefore described thus provides the following advantages :

- because of the sinusoidal motion of the pump, the liquid can be metered smoothly, the drawing off of a metered quantity and its discharge beginning and ending in progressive manner;
- the adjustment of a metered quantity is achieved by means of a micrometer screw and is accordingly highly accurate;
- the determination of the volume of a metered quantity is achieved by means of a click system thereby helping to increase the accuracy of a metering operation and its reproducibility; and
- the volume of a quantity so metered is displayed in numerical form.

The metering cum dispensing apparatus shown in FIGS. **12** to **16** is, like the first embodiment, dual, inasmuch as it comprises a pair of distributor pumping units **18***a* and **18***b* , a pair of drive means **3***a* and **3***b* (with however only a single, common, motor **4** and only a single, common, speed-reducing gear), a pair of adjustment means **6***a* and **6***b* , a pair of display means **7***a* and **7***b* , but only a single control means comprising an electric, automatically cutting out, contact-maker **8** and an electric, cam-operated, contact-breaker **9**. Of each of the dual members only one need be described, the components of each such member, except for the distributor pumping units, being identified by three-figure reference numerals so chosen that their first figure corresponds to the reference numeral of the member to which they belong. Thus, all of the components forming part of the drive means, whether they be drive means **3***a* or drive means **3***b*, will be identified by numerals ranging from **301** to **399**, all of those forming part of the adjustment means, whether they be adjustment means **6***a* or adjustment means **6***b*, will be identified by reference numerals ranging from **601** to **699**, and so forth. The only exceptions to this rule are the distributor pumping units **18***a* and **18***b* whose components will be identified by reference numerals ranging from **100** to **199** (for one part of these components) and from **200** to **299** (for another part of these components). In view of the constructional symmetry of the dual members, the letter symbol that distinguishes one member from the other within a pair will be omitted.

1. Distributor Pumping Unit

The distributor pumping unit comprises a holder consisting of two tubular casings **130** and **131**, fixedly screwed to one another, which enclose a suction and forcing pump and a switching valve, the suction and forcing pump consisting of a syringe made up of a cylinder **132**, of a plug **133** and of a piston **134** which is provided with a cap **135** and which is mounted at the end of a rod **136**, and the switching valve including a stationary valve body **230** and a valve member **231** housed in a rotary socket **232**. The holder is provided with a bayonet fitting having studs **151** which engage in slots **152** formed in a Cardan ring **153** which is pivotally mounted, in relation to a fixed portion **154** of the apparatus frame, on a pair of pins (not visible) lying at right angles to the studs **151** and to the plane of the paper. Socket **232**, which houses valve member **231**, is rendered angularly solid, by means of a pair of pins **251**, with a drive transmission member **252**. The top end of transmission member **252** is formed with a crenellated crown **253** defining merlons of triangular shape (saw-toothed). When the distributor pumping unit is in place, the crenellated crown **253** of member **252** cooperates with driving pins **351** forming part of the drive means and a spring-loaded abutment ball **155** exerts an axial force on the center of member **252**, this force being transmitted through member **252** and socket **232** to the valve member **231** thereby pressing the latter against the valve body **230** to ensure fluidtightness. A spring **156** is provided between the transmission member **252** and the socket **232** so as to maintain this fluidtightness when the distributor pumping unit is removed from the apparatus.

The valve body **230** is formed, in its operative face adjacent valve member **231**, with a central orifice **233** (FIG. **17**), which communicates, via an axial passage, with the interior of the syringe cylinder **132**, and two lateral orifices **234** and **235** which communicate, via further passages, with conduits **236** and **237**. These lateral orifices lie on a circle **238** which is concentric with central orifice **233**, and are spaced from one another by an angular distance of 135°. The valve member **231** is formed, in its operative face adjacent valve body **230**, with four radially extending link channels **239** to **242** (FIG. **18**) which lie at right angles to one another and which serve to put the central orifice **233** of valve body **230** in communication with either one or the other of the two lateral orifices **234** and **235**; in a first condition, that shown in FIG. **18**, it is lateral orifice **235** which is made to communicate by the valve member **231** with the central orifice **233** and, in a second condition, which is reached when the valve member **231** has rotated through 45°, it is lateral orifice **234** which is made to communicate with the central orifice.

Consequently, every time valve member **231** rotates through 45°, the valve changes over from one condition to the other. It will thus be observed that with this arrangement of radial link channels, the valve must be driven in an intermittent manner and is required to rotate through 45° at each step, whereas, in the first embodiment, the valve was driven in a continuous manner, the valve member in this latter case being formed with an anchor-shaped arrangement of link channels.

2. Drive means

The drive means comprise a first intermittent drive made up of a driving cogged wheel **301** meshing with a driven cogged wheel **306**. This intermittent drive is identical to that in the first embodiment and will therefore not be described again here. Suffice it to say that the teeth of wheel **301** are of reduced axial length along two portions of its periphery so that, during each half turn of wheel **301**, wheel **306** also carries out one-half turn followed though by a pause which lasts the length of time taken by one set of axially shortened teeth to travel past wheel **306** and during which the teeth of the latter are disengaged from the teeth of wheel **301**, and to say that studs **311** and **311'** on wheel **301** and spoke **310** on wheel **306** are provided to facilitate reengagement of the teeth of these two wheels at the end of the above-mentioned pause.

The drive means further comprise a second intermittent drive which is made up of a driving wheel **352** which is mounted on the same shaft as cogged wheel **301** and which carries a diametral spoke **353**, and of a driven wheel **354** whose axis lies at right angles to that of driving wheel **352** and coincides with that of valve member **231** in the distributor pumping unit. The driven wheel **354** carries eight radial spokes **355** which are spaced 45° apart, and it is on this driven

wheel that are secured the pins **351** that serve to rotate valve member **231**. With this arrangement, the driven wheel **354** is rotated by 45° at each half turn of the driving wheel **352** whereupon it becomes completely disengaged from the latter. The position of the radial spokes **355** is so chosen that each rotational step of the intermittently driven wheel **354** will cause the switching valve of the distributor pumping unit to pass from the first to the second of the above-mentioned conditions, then back to the first, and so on, cyclically.

The drive means comprise, moreover, a special eccentric of variable eccentricity. It is special inasmuch as it enables asymmetric variation of its eccentricity. It includes a rotary member **356** rigidly secured to an input shaft **321** on which is keyed the driven wheel **306** of the first intermittent drive. Into this rotary member **356**, which is cup-shaped, extends an axially movable crank-pin **357** consisting of a cylindrical rod to one end of which is rigidly secured a cross-piece **358** pivotally mounted on a transversely extending pin **359** carried in blocks slidably mounted in longitudinally extending grooves **360** formed in the rotary member, and to the other end of which is secured a ball **361** housed in an off-center socket **362** formed in an axially slidable, angularly stationary, head **363**. The effective length of cross-piece **358** and the position of socket **362** are so chosen that the axis of crank-pin **357** may describe, upon rotation of the rotary member **356**, a cone which includes a generatrix that lies parallel to the rotational axis of member **356**; it is in this, so called "uppermost," position that crank-pin **357** has been shown in FIG. **12**. Head **363** is guided, during its axial displacements, by a fixedly mounted sleeve **364** which forms a casing for the eccentric, and a stud **365** which projects into a longitudinal slot **366** formed in casing **364** prevents head **363** from rotating, so that the ball and socket connection **361–362** can only move in a straight line parallel to the rotational axis of member **356**, i.e., along the above-mentioned generatrix. A runner **367** is slidably mounted on the crank-pin **357** and is compelled to move, under the combined action of a transverse slide **368** and of slideways **369** in which slide **368** is mounted, in a plane lying at right angles to the axis of the cone described by crank-pin **357**. Runner **367** therefore describes a circular trajectory which coincides with the intersection of the surface of the cone by the above plane. Since the crank-pin slides in relation to the runner, the diameter of this circle varies, but since the crank-pin lies, in its "uppermost" position, parallel to the axis of its rotational drive, the topmost point of this circle occupies an invariable position. Consequently, any variation of eccentricity brought about by axial displacement of the crank-pin is asymmetrical as opposed to eccentrics wherein the crank-pin describes a cone having an axis which coincides with the rotational driving axis and having no generatrix lying parallel to this rotational driving axis. In order that the crank-pin **357** may be moved to an axial position such that the apex of the cone comes to be located at the center of runner **367**, thereby to cause all motion on the part of runner **367** to cease, ball **361** is off-set in relation to the axis of the crank-pin **357**. If it is not necessary for the motion of runner **367** to be caused to cease, ball **361** can of course be centered on the crank-pin axis.

A yoke **370**, of which only a lower portion can be seen in FIG. **12**, connects the slide **368**, through the intermediary of a hinge **371**, to a lever **373** pivotally mounted at one end on a stationary pin **374**. There is thus imparted to lever **373** a reciprocating motion having an amplitude which can be made to vary asymmetrically. The opposite, free, end of lever **373** is connected to the piston rod **136** extending out of the distributor pumping unit, by a play-free, readily releasable, coupling which is constructed as follows.

The lower corner of the free end of lever **373** is cut away at right angles and the vertical face of the resulting notch has driven thereinto a supporting stud **383**. In the upper, unnotched, part of the free end of the lever is formed a recess in which is held a ball **384** caused to project by a spring **385**, housed in the recess, towards stud **383**. As for the piston rod **136**, it carries at its free end a slotted socket **157** through which extends a pin **158** having a diameter such that when socket **157** is fitted on to the free end of lever **373**, pin **158** comes to be trapped at the bottom of the notch, above stud **383**, by the action of the spring-loaded ball **384** which it will have lifted on the way in.

The eccentric is provided with an arrangement of spring-loaded detents **375** and **376** mounted on opposite sides of the casing **364** so as to cooperate with a longitudinally extending slot **377** on the outside of rotary member **356**. These detents are so positioned in relation to the slot as to be actuated each time crank-pin **357** passes through its "uppermost" and "lowermost" positions. Their purpose will be explained further on.

Head **363** is secured to a screw **378**, preferably a precision micrometer screw, which cooperates with a nut **379** formed at one end of a tubular casing **372** adapted to be rotated by a knurled knob **380** whereby the axial position of head **363** may be changed by actuating knob **380**. In so doing, the amplitude of the reciprocating movement of the eccentric output member formed by yoke **370**, and hence the stroke of the pump piston **134**, can be varied and the fact that crank-pin **357**, in its "uppermost" position, always lies parallel to the rotational drive axis, causes this variation to be asymmetrical, i.e., that the top dead point of piston **134** is always at the same place whatever the length of its stroke. The interest of such asymmetry for stroke variation purposes, by resorting to an eccentric of asymmetrically variable eccentricity, will become apparent later on.

To avoid the difficulties that could arise, as regards accuracy of adjustment, with misalignments of the axes of rotary member **356**, of the cylindrical space inside casing **364**, and of screw **378**, the tubular casing **372** formed with nut **379** is preferably mounted in an elastic bearing, consisting, in the present instance, of three spring wires arranged to form a triangle and engaging more or less tangentially in a groove formed in the periphery of the tubular casing (in FIG. **12** only two of these wires can be seen, to wit wires **381** and **382**).

As in the first embodiment, the electric motor drives, through a speed-reducing gear **5** and a frictional torque-limiting device **15** (FIG. **8**), a single pinion **14** which rotates both driving wheels **301** by meshing with the uncut portions of their teeth.

3. Adjustment means

In addition to the screw **378** and its nut **379**, which, in fact, belong to the eccentric, the adjustment means comprise a setting disc **613** (FIG. **20**) having balls **615** which cooperate, under the action of springs **616**, with a cavity **612** formed in a stepped bush fixed on the tubular casing **372**, which disc **613** is secured, once set, to the apparatus frame by washers and screws **617**, and the adjustment means further comprise a sprocket **610** secured to the stepped bush by a blocking nut **619**.

4. Display Means

The display means are the same as those described in relation to the first embodiment, i.e. they include a revolution counter **701** actuated by a chain **703** driven by wheel **610** (FIG. **1**).

5. Control Means

The control means, which act on the supply of motor **4**, comprise, as in the first embodiment, an automatically cutting out contact-maker **8**, e.g. one that is pneumatically actuated via a tube **29**, and a contact-breaker **9**, e.g., a microswitch, actuated by a cam, here consisting of a pair of cavities **21** and **22** formed in driving wheel **301**.

6. Operation of the apparatus

The setting of the various members that have been described is such that:

cavities **21** and **22** will actuate contact-breaker **9** when the first intermittent drive (wheels **301** and **306**) has caused wheel **306** to become disengaged from the driving wheel **301**;

diametral spoke **353** has not yet come into engagement with a radial arm **355** when contact-breaker **9** has cut off the supply of motor **4**; and

slot 377 is in engagement with one of the spring-loaded detents 375 and 376 when contact-breaker 9 causes motor 4 to stop : the crank-pin 357 of the eccentric is then accurately immobilized in its "lowermost" position or in its "uppermost" position and the same applies to piston 134.

This being so, the automatically cutting out contact-maker 8 can be actuated to supply electric current to the motor 4 which is thus set in motion. Cavity 21 (or 22 as the case may be) is caused to move past the push-button of contact-breaker 9, thereby depressing the push-button to render the contact-breaker inoperative. Thus, upon contact-maker 8 automatically returning to its inoperative position after a predetermined lapse of time, the resulting cut out will by then have no effect on the motor which continues to rotate. The second intermittent drive, through its diametral spoke 353 acting on a radial arm 355, causes, at the same time, valve member 231 to be angularly moved thereby causing it to pass from one of its two conditions to the other (portion C of each half-cycle A, curve Vc, FIG. 19). At that point in time, the first intermittent drive comes into action and starts to drive rotary member 356 of the eccentric (end of pause P of each half-cycle A, curve Ee, FIG. 19). When this member has turned through 180°, i.e., when driving wheel 301 has completed half a turn, cavity 22 causes the contact-breaker 8 to become operative and motor 4 stops. During the half-turn of rotary member 356, piston 134 will have completed one stroke ("Asp" or "Ref," curve Po, FIG. 19). These movement together constitute half an operational cycle, such a half-cycle either being a drawing off half-cycle (if the pump has performed a suction stroke, i.e., if piston 134 has moved downwardly), or being a discharging half-cycle (if the pump has performed a forcing stroke, i.e., if the piston 134 has moved upwardly). The operator can then take whatever time he needs to change the containers into which dip the ends of conduits 236 and 237 and once this is done he can then trigger off, by means of contact-maker 8, the next half-cycle (interruption "Int," FIG. 19).

It will thus be observed that this second embodiment, constructed as has just been described, operates in much the same way as the first embodiment; it has, however, in relation to the latter the following distinctive features:

the pump and the valve, through being grouped together to form a distributor pumping unit which can readily be removed without any form of dismantling, can easily be exchanged (for instance to alter the range within which the volume of a metered quantity can be varied by resorting to a syringe of different maximum capacity);

the separate sterilization of the pump and of the valve, involving subsequent reassembly under sterile conditions, can be replaced by sterilization of the distributor pumping unit as a whole (including even, conduits 236 and 237);

since each half-cycle starts off with the actuation of the valve there is no need to take any particular steps, when putting the distributor pumping unit back in place, to set the valve member in the correct position as this will be done automatically, and the saw-toothed outline of the crenellated crown 253 helps to achieve smooth interengagement of the teeth and the driving pins 351;

the valve can readily be moved by the operator from one of its operative conditions to the other by acting on the radial arms that project from the front portion 154 of the apparatus frame: this possibility enables the roles assigned to conduits 236 and 237 to be reversed, so that either can selectively be used for drawing off liquid or for discharging liquid;

any change in volume of a metered quantity by rotating knurled knob 380 (which, by changing the axial position of crank-pin 357 causes the eccentricity of the eccentric, and hence the stroke of piston 134, to be varied) does not cause the piston to move at all when the crank-pin lies in its "uppermost" position, and hence does not cause any movement of liquid in the conduits: this is an important advantage afforded by the use of an eccentric of asymmetrically variable eccentricity.

I claim:

1. A metering and dispensing apparatus for repeatedly drawing off, through a conduit, a volumetrically metered, freely adjustable, quantity of liquid and for discharging this metered quantity through another conduit each drawing off operation alternating with a discharging operation, which comprises a unit having;

a. an interchangeable suction and forcing piston pump able, during a suction stroke, to draw off said predetermined volume and, during a forcing stroke, to discharge this volume,

b. a switching valve associated with said pump and adapted cyclically to pass from a first condition in which it causes said pump to communicate with a first conduit, to a second condition in which it causes said pump to communicate with a second conduit,

c. a drive mechanism able to cause said valve to pass from one condition to the other and able cyclically to actuate said pump by imparting to the reciprocating movement of the piston a substantially sinusoidal action, said mechanism being adapted so that the suction strokes of the pump occur when said valve is in said first condition and that the forcing strokes of the pump occur when the valve is in said second condition and so that each suction and forcing stroke may be followed by an idling pause during which the valve passes from one condition to another,

d. adjustment means for selectively adjusting the volume of said metered quantity by varying the length of the stroke of the pump piston, and

e. display means for displaying to the outside a number indicative of said volume; and

a motor coupled to the drive mechanism of said unit; and control means for controlling said motor.

2. Apparatus as claimed in claim 1, wherein said switching valve includes a stationary body associated at one axial end thereof with a rotary valve member driven by said drive mechanism, said valve body and said valve member having mutually cooperating operative surfaces, with the operative surface of the valve body having therein a central orifice communicating with said pump and a pair of lateral orifices communicating with said two conduits respectively, and with the operative surface of the valve member having channel means formed therein so arranged as to put said central orifice in communication with one of the lateral orifices for a length of time corresponding substantially to one half-turn of the valve member and with the other of the lateral orifices for a length of time corresponding substantially to the other half-turn of the valve member, so that said valve is operative in a continuous manner, during rotation of the valve member.

3. Apparatus as claimed in claim 1, wherein said drive mechanism includes an intermittent drive having an input which is drivingly connected to said motor and to the continuously operative switching valve, and having an output, said mechanism further including an eccentric of variable eccentricity having an input drivingly connected to the output of said intermittent drive and having an output member drivingly connected to said pump piston, said output having imparted thereto a substantially sinusoidal and rectilinear motion having an amplitude dependent on the extent of said eccentricity.

4. Apparatus as claimed in claim 3, wherein said eccentric is of asymmetrically variable eccentricity whereby one of the two dead points through which passes the sinusoidally moving output member may be a fixed point whose position is independent of the variable amplitude of the output member's sinusoidal motion.

5. Apparatus as claimed in claim 3, wherein said adjustment means include a micrometer screw so arranged as accurately to adjust the eccentricity of said eccentric and wherein said display means include a mechanical revolution-counter having a window and connected to said micrometer screw via a non-slip transmission whereby the number appearing in the window of said revolution-counter may be in direct relation to the angle through which said screw is rotated, wherein said adjustment means further include a click system associated with said

micrometer screw whereby an operator actuating the micrometer screw may feel when the screw passes through predetermined angular positions, the angular motion of the screw from one click to another corresponding to a variation of one unit in the number displayed in the window of the revolution-counter.

6. Apparatus as claimed in claim 3, wherein said motor being electrical said control means is adapted to trigger off at will half an operational cycle of said unit, said half-cycle being either a drawing off half-cycle, including a suction stroke of the pump, or a discharge half-cycle, including a forcing stroke of the pump and said control means include a contact-breaker actuated by cam means driven off the input of said intermittent drive, said contact-breaker and said cam means being arranged to cut off the electric supply of said motor every time said input has rotated through an angle corresponding to half an operational cycle of the apparatus, and an automatically cutting out contact-maker connected in parallel with said contact-breaker and adapted to provide for the supply of said motor, when being started, for a predetermined length of time which is substantially less than the time taken to complete one said operational half-cycle and greater than the time taken by said cam means to render said contact-breaker inoperative.

7. Apparatus as claimed in claim 6, wherein said automatically cutting out contact-maker is pneumatically actuated and includes a stationary contact, a movable contact acted upon by elastic means urging it away from said stationary contact, a push member consisting of a piston slidably mounted in a cylinder-defining chamber, a control pump and a conduit connecting said pump to said cylinder-defining chamber, said pump, said conduit and said cylinder together forming a pneumatic circuit in which said pump can set up a pressure able to actuate said piston to move said movable contact into engagement with said stationary contact against the action of said elastic means, said pneumatic circuit including a leak so calibrated that, after actuation of said control pump, there occurs in said circuit a drop in pressure until the latter reaches a value enabling said elastic means to force the movable contact away from the stationary contact and said piston back in said cylinder-forming chamber, the time taken for said pressure in said circuit to drop to said value corresponding to said predetermined time.

8. Apparatus as claimed in claim 6, wherein said eccentric is of asymmetrically variable eccentricity whereby one of the two dead points through which passes the sinusoidally moving output member may be a fixed point whose position is independent of the variable amplitude of the output members sinusoidal motion and said intermittent drive includes a driving wheel having two equidistantly spaced apart toothed segments arranged to mesh with a circumferentially cogged driven wheel having actuating arms, said toothed segments having a length equal to half the circumference of said cogged driven wheel and being each followed by an inoperative segment so that each half turn of the driving wheel causes the driven wheel to rotate through 180° and then to pause for a length of time corresponding to the passage of one of said inoperative segments, wherein said cam means and said eccentric are so set in relation to the input and to the output of said intermittent drive, respectively, that the end of one said operational half-cycle coincides with the arrival of said eccentric at one of said dead points, and wherein the length of each of the inoperative segments of said driving wheel and the dimensions of said actuating arms are so chosen that, during a pause at the end of an operational half-cycle, said driven wheel may be freely rotated to reverse the direction of the next operative reciprocatory movement of the output member of said eccentric.

9. Apparatus as claimed in claim 1, wherein said drive mechanism includes an intermittent drive having an input which is drivingly connected to said motor and said switching valve and said switching valve includes a stationary body associated at one axial end thereof with a rotary valve member driven by said drive mechanism, said valve body and said valve member having mutually cooperating operative surfaces, with the operative surface of the valve body having therein a central orifice communicating with said pump and a pair of lateral orifices respectively communicating with said two conduits which lie on a circle concentric with the central orifice and which are spaced from one another by an angular distance of 135°, and with the operative surface of the valve member having channel means formed therein, said channel means including four radially extending arms which have a length at least equal to the radius of said circle and which lie at right angles to one another thereby to put said central orifice in communication with either one or the other of said two lateral orifices every time said rotary valve member comes to occupy one of eight particular angular positions, so that said valve is operative in a discontinuous manner, when said rotary valve member is at a stop in any one of said angular positions.

10. Apparatus as claimed in claim 9, wherein said piston pump and the discontinuously operative switching valve are housed in a common casing to form a distributor pumping unit removably mounted on the apparatus frame by means of a bayonet connection such that upon said distributor pumping unit being put in place said switching valve is automatically coupled to said drive mechanism, the piston rod of said pump being connected to said drive mechanism through the intermediary of a releasable coupling, and wherein said drive mechanism includes a second intermittent drive having an input drivingly connected to said motor and an output drivingly connected to the rotary valve member of said switching valve to cause said rotary valve member to move in angular steps of 45°, said second intermittent drive being positionally so set in relation to the first intermittent drive that said switching valve may pass from one of its two conditions to the other during a first portion of each of said operational half-cycles, while the pump piston is stationary, and that said switching valve may remain stationary in either of its two conditions during a second portion of each of said operational half-cycles, while said pump piston is moving.

11. Apparatus as claimed in claim 10, wherein said second intermittent drive includes a driving wheel drivingly connected to the input thereof and carrying a diametral spoke, and a driven wheel drivingly connected to the output thereof and carrying eight radial spokes spaced 45° apart, said two wheels having their axes orthogonally disposed and being positionally so set in relation to one another that the arms of the diametral spoke carried by the driving wheel engage, during one quarter of each half turn thereof, the radial spokes carried by the driven wheel to cause the latter to move by angular steps of 45°, while remaining disengaged therefrom during the remaining three quarters of each said half-turn.

12. A metering and dispensing apparatus comprising a motor means, a first motion translating means adapted to translate rotary motion into sinusoidal reciprocal motion, power transmitting means operatively connecting said motor means and said motion translating means to provide rotation to said motion translating means, at least one removable pump means having a piston and cylinder chamber, two port means, said port means adapted to be in communication with the same end of said cylinder chamber, a valve means, said valve means capable of alternately connecting said cylinder chamber with said port means, a valve switching means operatively connected to said valve means, a second motion translating means operatively associated with said valve switching means and said power transmitting means and adapted to translate the rotational movement of said power transmitting means into movement of said valve switching means and operative to position said valve means in a predetermined position between strokes of said piston, a piston activating member, said member connected to said first motion translating means and said piston and adapted to translate the sinusoidal reciprocal motion of said first motion translating means to said piston, said first motion translating means having an adjustment assembly adapted to vary the amplitude of said reciprocal sinusoidal motion, said adjustment assembly

having control means whereby the piston stroke length can be adjusted externally of said apparatus.

13. An apparatus as in claim 12 including a display means for indicating the setting of said adjustment assembly and thereby the volumetric capacity of said pump for a given stroke length of said piston.

14. An apparatus as in claim 12 wherein said valve means comprises a generally cylindrical member mounted atop said cylinder chamber and having a passage means in communication with said chamber and having channel means in said member adapted, upon a predetermined movement of said member, to place one of said port means in open communication with said chamber.

15. An apparatus as in claim 12 wherein said first motion translating means comprises a housing, a member mounted for non-rotary longitudinal movement within said housing, linkage means connected to said member and adapted to generate a cone upon rotation of said housing and means associated with said linkage means and connected to said reciprocating arm to convert the rotary movement into reciprocal movement.

16. An apparatus as in claim 5 wherein said piston pump consists of a syringe of calibrated capacity, the value of the calibration being inscribed on the syringe and the syringe being removably mounted whereby it may selectively be exchanged for any one of the syringes of a set of calibrated syringes having calibrations covering a range within which can be selected a quantity of liquid to be metered and dispensed, and wherein the range of calibrations of said set of syringes, the pitch of said micrometer screw, the limits within which said eccentricity can be adjusted and the transmission ratio of said non-slip transmission are so chosen that the volumetric valve of a quantity being metered and dispensed may be equal to the inscribed calibration value of the syringe being used multiplied by the number displayed in the window of the revolution-counter.

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