Feb. 16, 1960 S. HEALEY 2,925,198

TITRATION APPARATUS

Filed Sept. 4, 1956

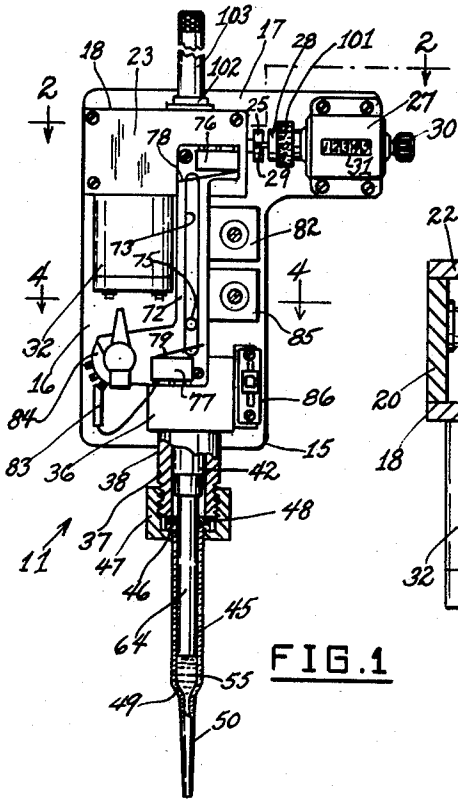


FIG. 1

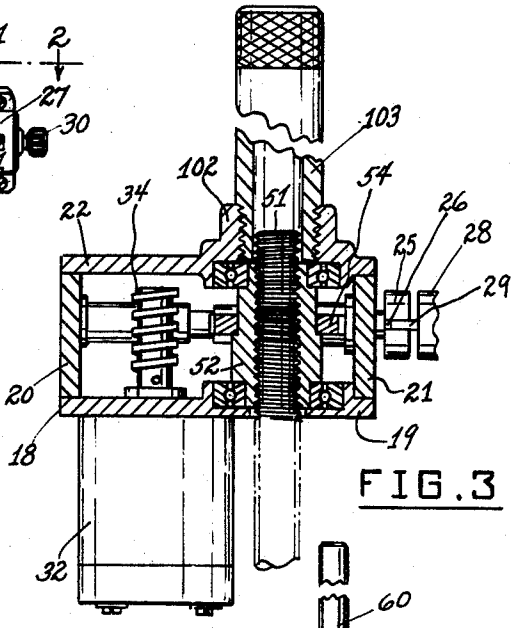


FIG. 3

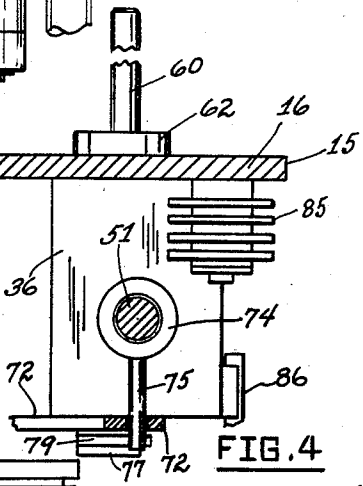


FIG. 4

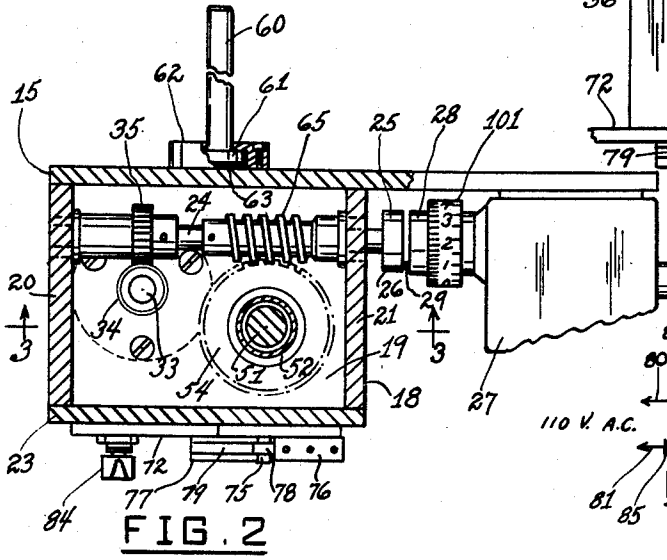


FIG. 2

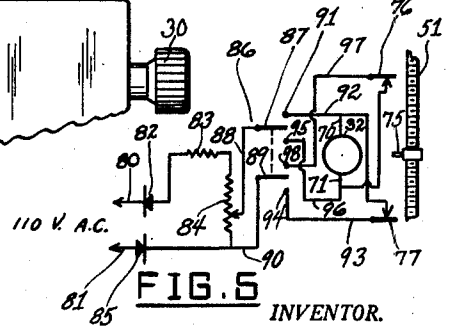


FIG. 5

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United States Patent Office 2,925,198 Patented Feb. 16, 1960

2,925,198

TITRATION APPARATUS

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Application September 4, 1956, Serial No. 607,774

8 Claims. (Cl. 222—32)

This invention relates to titration apparatus, and more particularly to a device for accurately measuring the volume of liquid discharged from a pipette.

A main object of the invention is to provide a novel and improved titration apparatus which is simple in construction, which is easy to read, and which reduces errors in titration by eliminating the necessity of reading volumetric values by observing the position of a meniscus.

A further object of the invention is to provide an improved self-reading titration device which involves inexpensive components, which is durable in construction and which is highly accurate.

A still further object of the invention is to provide an improved titration device which is easy to calibrate, which requires no manual operation of the parts thereof during titration, and which provides a positive indication of the volume of reagent delivered from the pipette element thereof, without requiring the operator to read a meniscus.

A still further object of the invention is to provide an improved titration apparatus which permits the measured dispensing of small quantities of relatively concentrated reagents, thus permitting accurate and precise microtitration techniques.

Further objects and advantages of the invention will become apparent from the following description and claims, and from the accompanying drawings, wherein:

Figure 1 is a front elevational view, partly in vertical cross-section, of an improved titration apparatus constructed in accordance with the present invention.

Figure 2 is a fragmentary, enlarged horizontal cross-sectional view taken on line 2—2 of Figure 1.

Figure 3 is a vertical cross-sectional view taken on line 3—3 of Figure 2.

Figure 4 is an enlarged cross-sectional detail view taken on line 4—4 of Figure 1.

Figure 5 is a schematic diagram illustrating the electrical connections of the titration apparatus of Figures 1 to 4.

Referring to the drawings, 11 generally designates an improved titration apparatus according to this invention. The apparatus 11 comprises a vertical generally L-shaped plate 15 having the depending arm 16 and the horizontally extending top arm 17. Secured to plate 15 at the top end of arm 16 is a generally rectangular housing 18 comprising the bottom wall 19, the end walls 20 and 21, the top wall 22, and the removable front cover plate 23.

The plate 15 is provided with a supporting shank 60 adapted to be clamped to a conventional laboratory stand. Shank 60 is formed with a flange or head 61 which is rotatably received in a flange housing member 62 secured to the rear surface of plate 15 at the intermediate portion of vertical arm 16. A spherically curved circular spring disc 63 is provided in housing member 62 between head 61 and plate 15, which frictionally engages said head 61 and acts as a frictional loading means to normally hold plate 15 stationary relative to shank 60 but to permit

manual rotation of plate 15 and the assembly carried thereby at times, for example, for the expulsion of air bubbles from the pipette element of the assembly.

Designated at 24 is a horizontal worm shaft which is journalled in end walls 20 and 21 and which projects through end wall 21, as shown in Figure 2. Secured on the end of shaft 24 adjacent end wall 21 is a coupling disc 25 formed with a coupling notch 26. Mounted on the arm 17 in alignment with shaft 24 is a conventional counter 27 whose shaft is provided with the coupling disc 28 disposed adjacent to and parallel to coupling disc 25. A coupling pin 29 is secured in disc 28 and engages in notch 26.

Counter 27 is provided with a resetting knob 30 for setting the counter to zero at the beginning of a titration operation. The numbered wheels of counter 27 are visible through a viewing window 31 provided in the front wall of the counter.

Vertically secured to the bottom wall 19 of housing 18 below the shaft 24 is an electric motor 32 provided with suitable switch-controlled energizing conductors 70 and 71, shown in Figure 5. The shaft of motor 32, shown at 33, extends vertically and upwardly through bottom wall 19 and has secured thereon a worm 34 which meshes with a worm gear 35 mounted on shaft 24, as shown in Figure 2. Also mounted on shaft 24 is a worm 65 located adjacent end wall 21 of housing 18.

Designated at 36 is a vertical block member which is secured to arm 16 below housing 18. Block member 36 is formed with a vertical bore 37 and a depending sleeve portion 38. Slidably mounted in bore 37 is a guide plunger 42 which preferably is substantially in sealing engagement with said bore. Rigidly secured to the lower end of plunger 42 in axial alignment therewith is a reduced bottom plunger 64 which is slidably and sealingly engaged in a transparent vertical pipette 45 sealingly secured to the lower end of sleeve portion 38. As shown, the pipette 45 is formed at its top end with an annular flange 46 supported on the bottom wall of an annular sealing bushing 47 threadedly engaged on the lower end of sleeve portion 38. An annular sealing gasket 48 of resilient deformable material is provided between the bottom rim of sleeve portion 38 and flange 46.

The pipette 45 is formed with the tapered tip 49 at its bottom end, having the capillary discharge nozzle 50.

Plunger 42 is provided at its top end with the vertical axial, externally threaded shank 51 which extends upwardly into housing 18 and is threadedly engaged through a nut member 52 rotatably mounted in housing 18, as shown in Figure 3.

Top wall 22 is formed with an annular boss 102 above the top end of nut member 52, which threadedly receives the lower end of a generally cylindrical shield cap 103 adapted to protectively cover the top portion of shank 51 when said shank is in an elevated position.

Designated at 54 is a worm gear which is rigidly secured on nut member 52. The gear teeth of worm gear 54 are in meshing engagement with the worm 65, whereby rotation of shaft 24 causes said worm gear 54 and nut member 52 to rotate and to move the plunger member 42 vertically in block member 36.

A guide plate 72 is secured vertically to housing 18 and block member 36, parallel to plate 15, said guide plate being formed with a vertical slot 73. A collar member 74 is rigidly secured on shank 51, and rigidly secured to said collar member is an outwardly projecting radial guide pin 75 which extends slidably through slot 73, preventing rotation of said shank 51 but allowing it to move vertically.

The provision of the worm 34 and worm gear 35, and the worm 65 and worm gear 54, establishes a substantial

speed reduction as between the rates of rotation of motor shaft 33 and worm gear 54, and the threads on shank 51 are relatively fine, whereby the vertical motion of plunger 42 is very slow when motor 32 is energized, and whereby the movement of the discharge plunger 64 may be accurately controlled. As will be presently described, the speed of motor 32 may be adjusted, by the provision of a speed-controlling potentiometer in the motor energizing circuit.

Normally closed limit switches 76 and 77 are provided on guide plate 72 respectively adjacent the top and bottom ends of slot 73. Switch 76 comprises a microswitch having its operating leaf spring 78 extending across the top portion of slot 73, so as to be engageable by pin 75 when said pin approaches the top end of said slot. Switch 77 comprises a microswitch having its operating leaf spring 79 extending across the lower portion of slot 73, so as to be engageable by pin 75 when said pin approaches the bottom end of slot 73.

Referring to Figure 5, it will be seen that motor 32, which is a direct current motor, is reversibly energized from a pair of alternating current line wires 80 and 81 by a circuit comprising a first rectifier 82, a voltage reducing resistor 83, a potentiometer 84, and a second rectifier 85. A two-pole, three-position switch 86 is employed to control the direction of rotation of the motor shaft. A first pole 87 of switch 86 is connected to the sliding tap of the potentiometer by a wire 88. The second pole 89 of the switch 86 is connected to the potentiometer terminal wire 90, as shown, so that an adjusted value of rectified voltage is available across the switch poles 87 and 89.

The upper contact 91, associated with pole 87, is connected by a wire 92 to the motor terminal wire 70 and the stationary contact of microswitch 77. The pole of microswitch 77 is connected by a wire 93 to the lower contact 94 associated with pole 89.

The lower contact 95 of pole 87 is connected by a wire 96 to motor terminal wire 71 and to the stationary contact of microswitch 76. The pole of microswitch 76 is connected by a wire 97 to the upper contact 98 of pole 89.

Switch 86 is preferably similar to Centralab Model No. 1467, made by Globe Union, Inc., Milwaukee, Wisconsin, namely, a two-pole, three-position, positive and spring return, non-shorting switch, whose operating lever must be manually held down to retain poles 87 and 89 in engagement with contacts 95 and 94, and which returns the poles to open circuit positions when released. However, the switch may be operated to move poles 87 and 89 into engagement with upper contacts 91 and 98 by merely elevating the operating lever of the switch, and the poles will remain in engagement with said upper contacts without requiring any holding force.

When poles 87 and 89 engage contacts 95 and 94, motor 32 will be energized in a direction to move shank 51 downwardly, through a circuit comprising pole 87, contact 95, wire 96, wire 71, motor 32, wire 70, wire 92, microswitch 77, wire 93, contact 94, and pole 89. When pin 75 engages element 79 of microswitch 77, this circuit is broken, and the motor is deenergized.

In using the apparatus, with potentiometer 84 preset at the desired output rate, the operating lever of switch 86 is held down by hand until the end point of the titration is reached, and is then released. This returns the switch to neutral position. To elevate the lead screw 51, the switch lever may be raised, causing poles 87 and 89 to engage their upper contacts 91 and 98. This again energizes motor 32, but in a reverse direction, through pole 87, contact 91, wire 92, wire 70, motor 32, wire 71, wire 96, microswitch 76, wire 97, contact 98, and pole 89. When pin 75 engages the element 78 of upper microswitch 76, this circuit is broken, and the motor becomes deenergized.

The cross-sectional area of plunger 64, the pitch of lead screw 51, and the ratio of the gear train are so related that each unit on the counter 27 equals a definite volumetric displacement in the reservoir of the pipette 45, for example, 0.001 milliliter. Decimal fractions of this value can be read from a graduated drum 101 provided on the counter shaft.

In operation, a suitable quantity of reagent 55 is placed in th pipette 45 in any suitable manner, as by immersing the pipette in a vessel containing the reagent, with the ring 47 loosened and the plunger 64 elevated to allow air to escape from the pipette. The plunger 64 is lowered into the pipette into contact with the reagent (by energizing motor 32), after which ring 47 is tightened to seal the plunger 64 with respect to the pipette.

Counter 27 may be then set to zero by means of its resetting knob 30, whereby the apparatus is ready for a titration operation. When motor 32 is subsequently energized, plunger 64 is moved downwardly to discharge the reagent 55 from the nozzle 50, the volume of liquid discharged being accurately determinable from the reading of counter 27, whose indicating elements may be calibrated in volumetric units, as above described, whereby the apparatus is direct-reading. When the end point of the titration is reached, the motor 32 is deenergized by releasing the switch 86, and the volume of reagent 55 employed in the titration may be then read directly from the counter 27.

For a subsequent titration using the same reagent 55, the counter 27 may be set to zero by means of its resetting knob 30, and the titration may be then performed by energizing motor 32 to discharge the reagent, as in the previous titration, where again, the volume of liquid reagent discharged may be read from counter 27.

It will be noted that it is never necessary to read the volume discharged by observing a meniscus, as in prior methods of titration, whereby a great source of previous error is eliminated by the use of the apparatus above described.

While a specific embodiment of an improved titration apparatus has been disclosed in the above description, it will be understood that various modifications within the spirit of the invention may occur to those skilled in the art. Therefore it is intended that no limitations be placed on the invention except as defined by the scope of the appended claims.

What is claimed is:

1. A titration apparatus comprising a support, a vertical pipette mounted on said support and being adapted to receive titration reagent, a piston slidably and sealingly mounted in said pipette, said piston having a threaded top portion, a nut member rotatably mounted on said support and threadedly engaged with said top portion, an electric motor mounted on said support, means gearingly coupling the shaft of said motor to said nut member, a revolution counter means coupling said motor shaft to said revolution counter, an energizing circuit connected to said motor, a normally closed limit switch on said support and connected in said energizing circuit, and means operatively coupled to said piston and being engageable with said limit switch to open said energizing circuit when said piston reaches a predetermined position in said pipette.

2. A titration apparatus comprising a support, a vertical pipette mounted on said support and being adapted to receive titration reagent, a piston slidably and sealingly mounted in said pipette, said piston having a threaded top portion, a nut member rotatably mounted on said support and threadedly engaged with said top portion, an electric motor mounted on said support, means gearingly coupling the shaft of said motor to said nut member, a revolution counter, means coupling the motor shaft to said revolution counter, a source of current, a multiple-pole, multiple-position switch, respective cir-

cuits connecting said motor to said source through the poles of said switch and being formed and arranged to energize said motor in opposite directions in accordance with the operation of said switch to either of two of its positions, a normally closed limit switch connected in each of said circuits, and means operatively coupled to said piston and being respectively engageable with said limit switches to open same in two predetermined positions of said piston in said pipette.

3. A titration apparatus comprising a support, a vertical pipette mounted on said support and being adapted to receive titration reagent, a piston slidably and sealingly mounted in said pipette, said piston having a threaded top portion, means limiting rotation of said piston relative to said pipette, a nut member rotatably mounted on said support and threadedly engaged with said top portion, an electric motor mounted on said support, means gearingly coupling the shaft of said motor to said nut member, a revolution counter, means coupling said motor shaft to said revolution counter, an energizing circuit connected to said motor, a normally closed limit switch on said support and connected in said energizing circuit, and means operatively coupled to said piston and being engageable with said limit switch to open said energizing circuit when said piston reaches a predetermined position in said pipette.

4. A titration apparatus comprising a support, a pipette mounted on said support and being adapted to receive titration reagent, a piston slidably and sealingly mounted in said pipette, an electric motor mounted on said support, means drivingly coupling said motor to said piston, a normally closed switch, an energizing circuit connected to said motor, through said switch, and means on the piston constructed and arranged to open said switch when said piston reaches a predetermined position in said pipette.

5. A titration apparatus comprising a support, a pipette mounted on said support and being adapted to receive titration reagent, a piston slidably and sealingly mounted in said pipette, an electric motor mounted on said support, means drivingly coupling said motor to said piston, an energizing circuit connected to said motor, a normally closed limit switch on said support and connected in said energizing circuit, and means on the piston constructed and arranged to open said limit switch when said piston reaches a predetermined position in said pipette.

6. A titration apparatus comprising a support, a pipette mounted on said support and being adapted to receive titration reagent, a piston slidably and sealingly mounted in said pipette, an electric motor mounted on said support, a nut member rotatably mounted on said support and threadedly engaged with said piston, means drivingly coupling to said motor to said nut member, a normally closed switch, an energizing circuit connected to said motor through said switch, and means on the piston constructed and arranged to open said switch when said piston reaches a predetermined position in said pipette.

7. A titration apparatus comprising a support, a pipette mounted on said support and being adapted to receive titration reagent, a piston slidably and sealingly moutned in said pipette, an electric motor mounted on said support, a nut member rotatably mounted on said support and threadedly engaging said piston, means drivingly coupling said motor to said nut member, an energizing circuit connected to said motor, a normally closed limit switch on said support and connected in said energizing circuit, and means on the piston constructed and arranged to open said limit switch when said piston reaches a predetermined position in said pipette.

8. A titration apparatus comprising a support, a pipette mounted on said support and being adapted to receive titration reagent, a piston slidably and sealingly mounted in said pipette, an electric motor mounted on said support, a nut member rotatably mounted on said support and threadedly engaging said piston, said nut member being formed with gear teeth at its periphery, a worm shaft journalled on said support and being meshingly engaged with said gear teeth, means gearingly coupling the shaft of said motor to said worm shaft, an energizing circuit connected to said motor a normally closed limit switch on said support and connected in said energizing circuit, and means on the piston constructed and arranged to open said limit switch when said piston reaches a predetermined position in said pipette.

References Cited in the file of this patent

UNITED STATES PATENTS

1,383,379	Blain	July 5, 1921
1,470,381	Lamb	Oct. 9, 1923
1,829,789	Danmeyer	Nov. 3, 1931
1,901,178	Malm	Mar. 14, 1933
2,714,472	Richardson	Aug. 2, 1955
2,804,991	Burleyson	Sept. 3, 1957