United States Patent

[11] 3,558,014

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[54] **AUTOMATIC PROPORTIONER**
17 Claims, 12 Drawing Figs.

[52] **U.S. Cl.** **222/134,** 222/136, 222/334
[51] **Int. Cl.** **B67d 5/56**
[50] **Field of Search** 222/43, 134, 136, 137, 145, 309, 334

[56] **References Cited**
UNITED STATES PATENTS

2,774,364	12/1956	Brobeil	222/136X
3,401,839	9/1968	Christie	222/137

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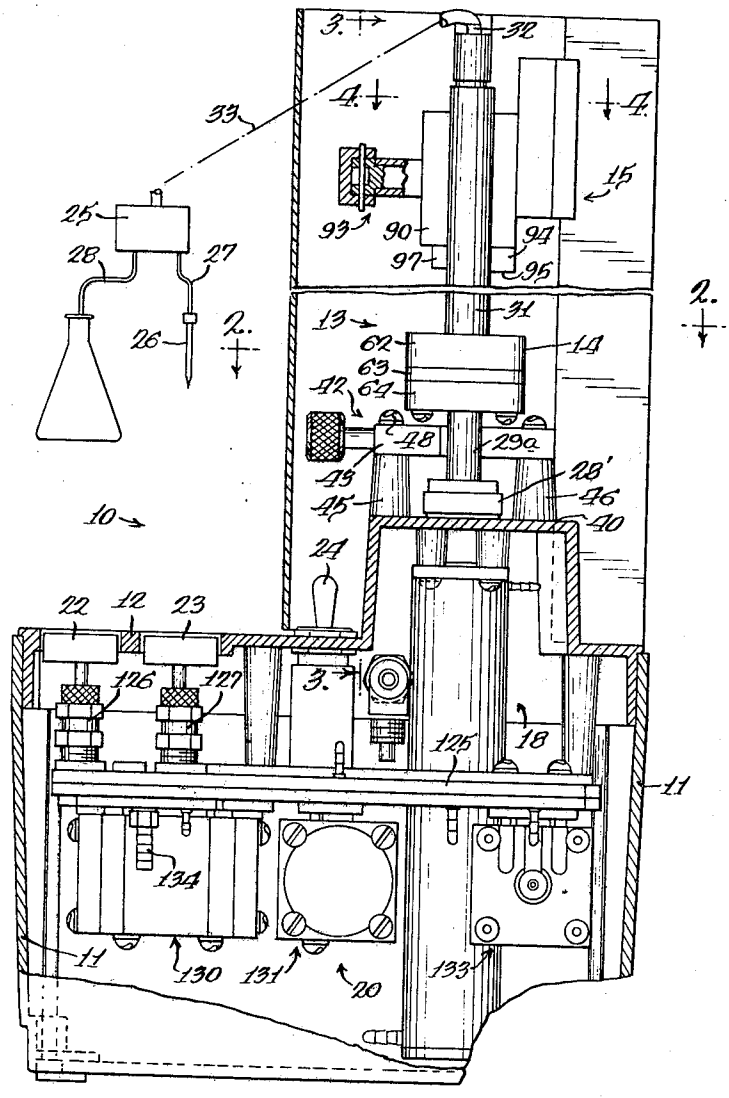
ABSTRACT: An actuator and control circuit for a standard syringe having calibration rods, including a first stop selectively engageable with one calibration rod and a second stop engageable with the other calibration rod so that the former stop can be moved out of the way of an abutment carried by the actuator permitting the actuator to drive the syringe and the abutment to the second stop, there also being provided a valve for selectively communicating the syringe with either a reagent conduit or a sample conduit with a control circuit for the actuator, valve and the movable stop which moves the movable stop into engagement with its associated calibration rod and drives the abutment toward the movable stop while the valve connects the syringe to the reagent conduit, and thereafter under manual control releases the movable stop, shifts the valve to a position connecting the syringe to the sample conduit and drives the actuator and abutment to the second stop, and thereafter in response to a manually operable delivery control retracts the actuator and maintains the valve in a position connecting the sample conduit to the syringe thereby discharging both the sample and the reagent through the sample conduit.



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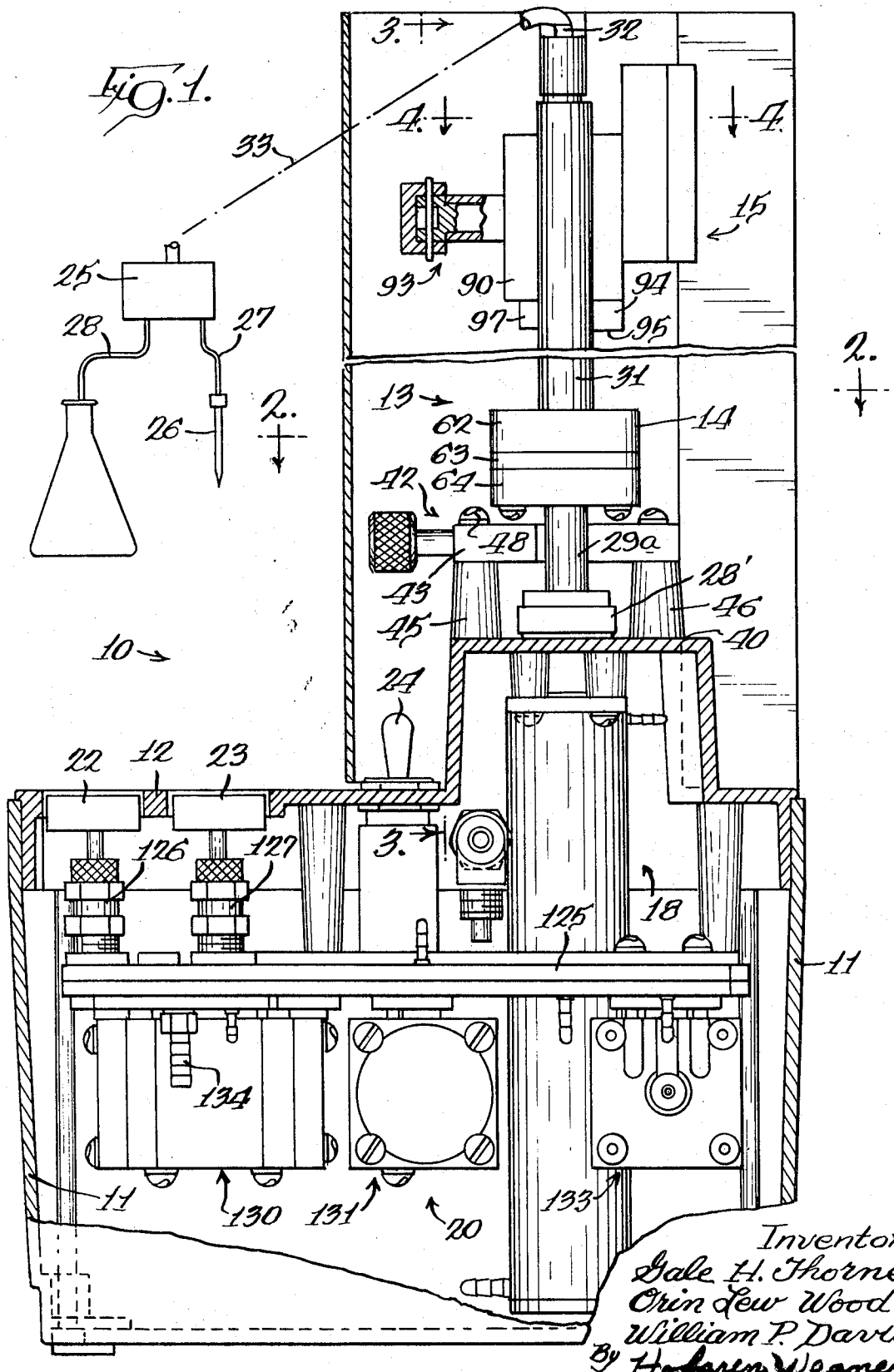
SHEET 1 OF 5

Fig. 1.



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Attys

Fig. 2.

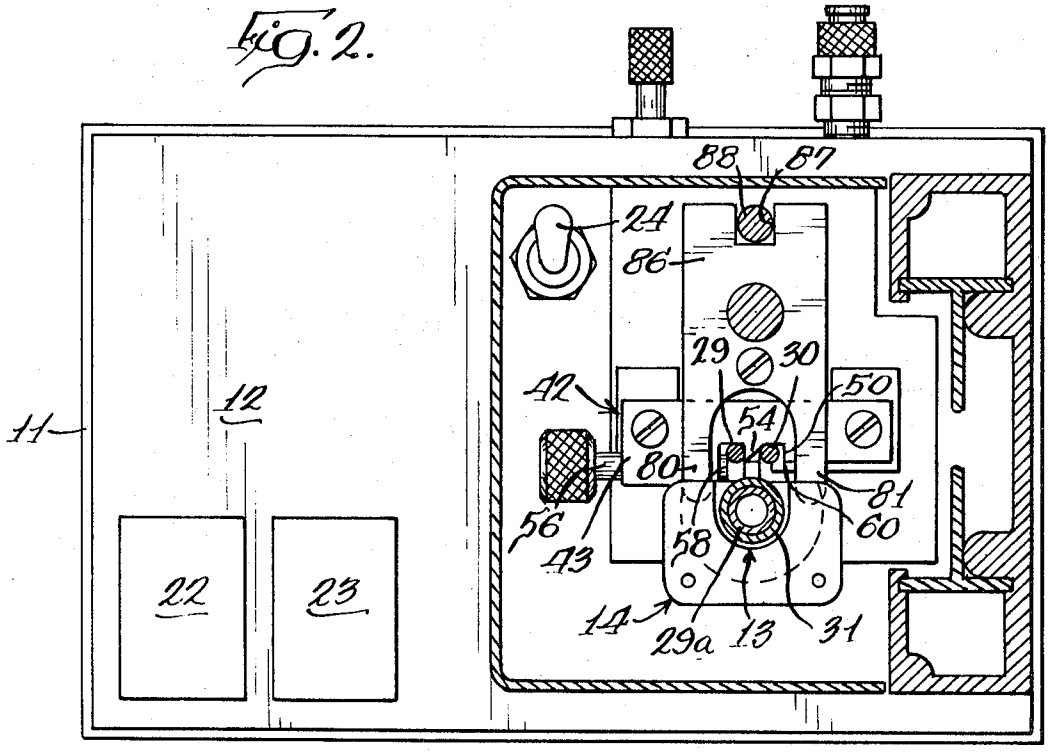


Fig. 4.

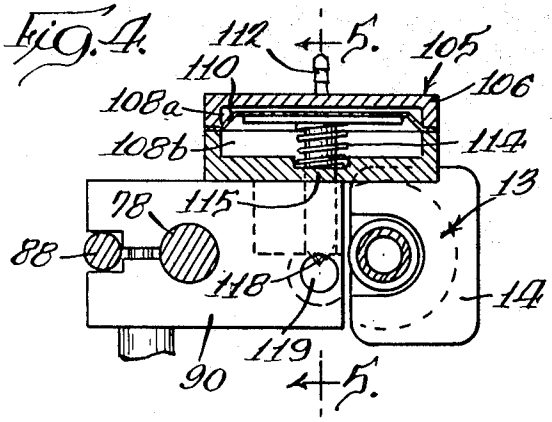


Fig. 5.

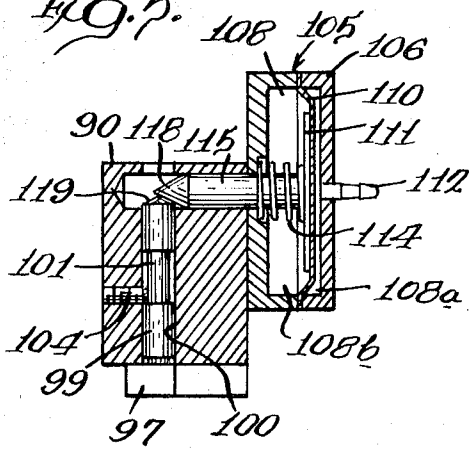


Fig. 10.

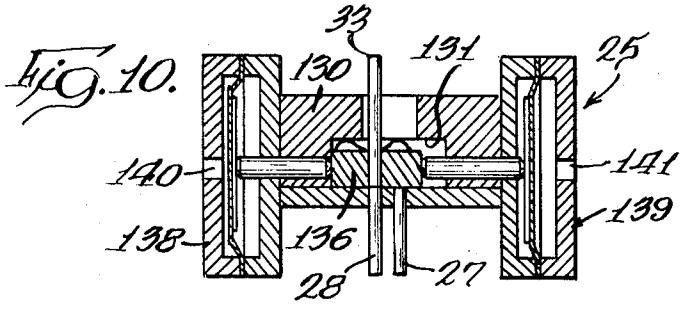


Fig. 3.

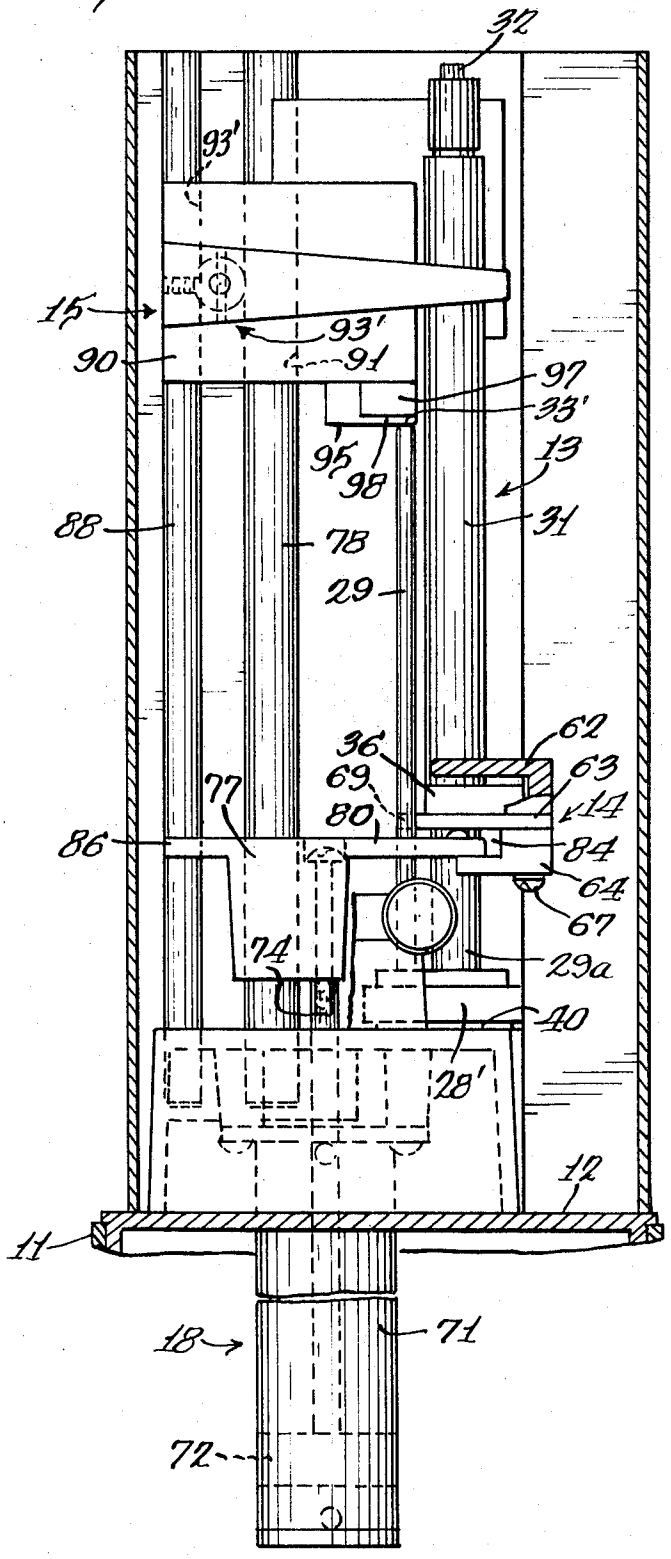

32
93'
15
93'
90
91
97
33'
95
98
13
88
78
31
29
62
36
63
69
14
77
80
86
84
64
67
74
29a
40
28'
12
11
18
71
72

Fig. 7.

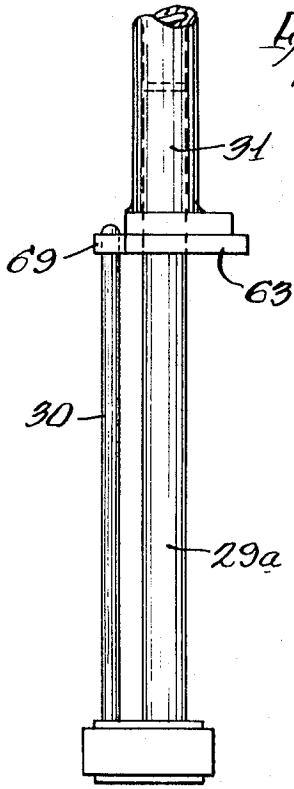


Fig. 6.

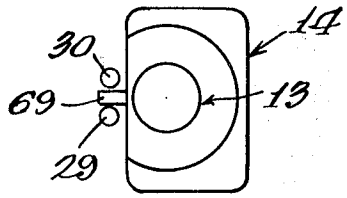


Fig. 8.

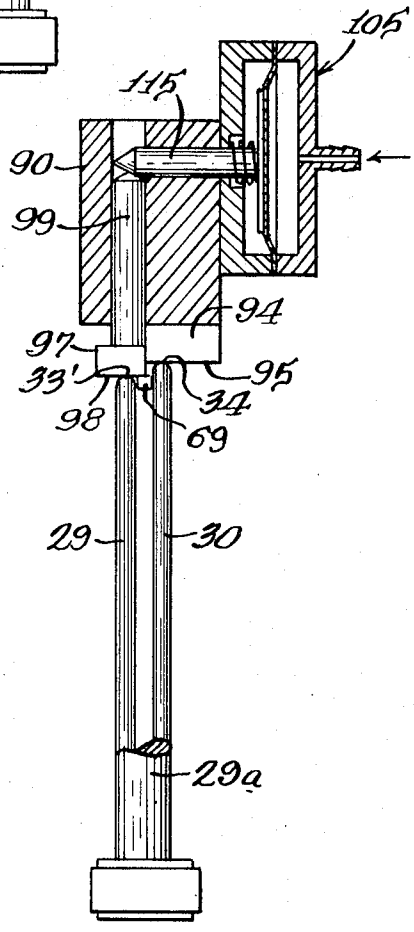
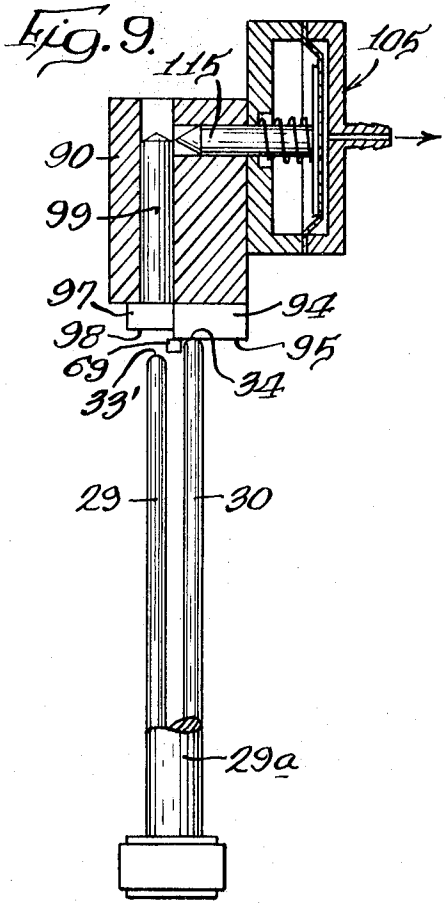


Fig. 9.



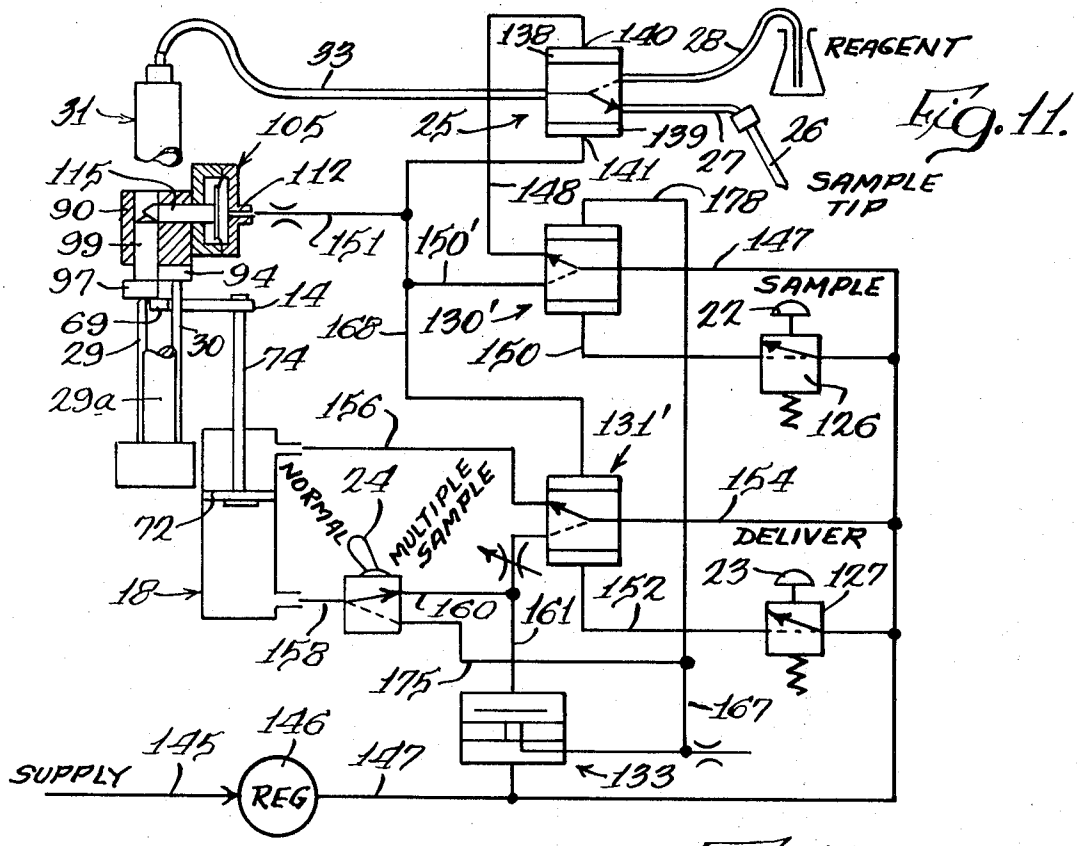

33
138
140
28
REAGENT
31
105
25
139
26
115
112
141
27
SAMPLE TIP
148
178
90
151
150'
147
99
94
SAMPLE
97
14
168
130'
22
69
30
150
29
74
126
29a
156
131'
NORMAL
24
MULTIPLE SAMPLE
154
72
DELIVER
23
127
18
160
161
152
158
175
167
145
146
147
SUPPLY
REG
133

Fig. 11.

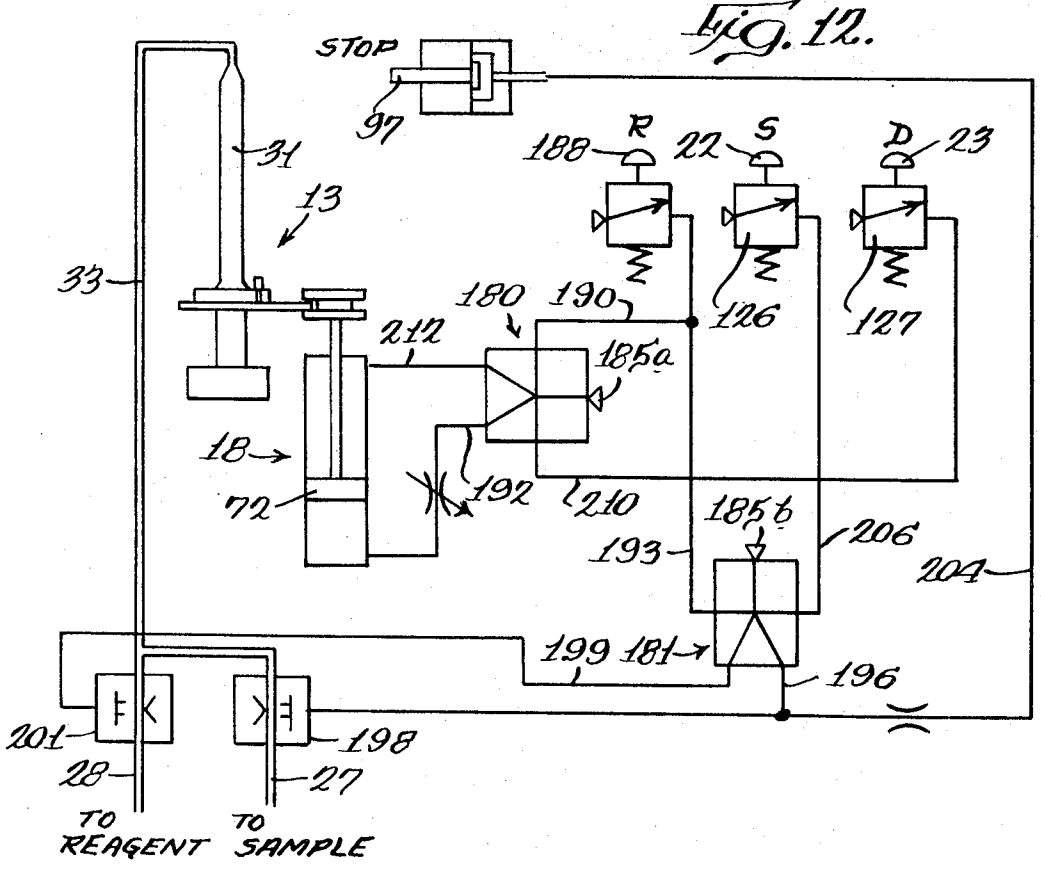

STOP
97
31
188
R
22
S
D
23
13
33
180
190
126
127
212
185a
18
72
192
210
185b
206
193
204
199
181
196
201
198
28
27
TO REAGENT
TO SAMPLE

Fig. 12.

AUTOMATIC PROPORTIONER

BACKGROUND OF THE PRESENT INVENTION

There have been provided in the past various devices for proportioning two fluids, and more particularly, for proportioning two liquids. Such devices are generally of utility in chemical analysis of one of the fluids and in such analysis it is desirable to dilute the fluid under analysis with a diluent for the purpose of subsequent analysis. An exemplary analysis where devices of this character find utility are in hemoglobin measurement.

A syringe type proportioning device known in the art for this general purpose includes a plunger with a telescopic barrel member slidably received on the plunger and defining a syringe. Such a construction is shown and described in detail in the Marbach et al. U.S. Pat. No. 3,326,423 and reference should be made thereto for a more complete description of the proportioner device. Generally, this device includes two calibration rods extending axially upwardly from the base of the plunger along the side of the barrel itself. The difference in length of these two calibration rods determines the volume of the sample to be drawn by the proportioning device. A flange is provided on the bottom of the slidable barrel member for selective engagement with the ends of the rods during operation of the device.

This device has been operated manually in the following manner. After suitable washing the pipet connected to the end of the barrel member is emersed in a suitable diluent or reagent and the barrel member is slid outwardly from the plunger drawing diluent into the pipet and the barrel member until the flange on the bottom of the barrel member reaches the position where it can be rotated onto the top of the shorter calibration rod, and at this point, the operator must push downwardly on the barrel member to assure an accurate amount of diluent. After wiping the excess diluent from the end of the pipet while maintaining the flange in tight engagement with the shorter calibration rod the operator then emerses the pipet in the sample and rotates the flange into engagement with the longer calibration rod and further extends the barrel from the plunger drawing the sample into the pipet This is generally a very short movement as the sample required for most analyses is very small in comparison to the diluent, e.g., not over **10** percent. As the flange reaches the end of the longer calibration rod, which may be beveled, the operator rotates the flange carefully on top of the longer calibration rod making certain that the barrel member has not been extended to a position where the flange is beyond the longer calibration rod.

To discharge the sample and reagent, the operator places the pipet in still another container and rotates the flange clear of the calibration rods and pushes the barrel member backdown to its retracted position forcing both the sample and the diluent out of the proportioning device.

While this proportioning device has found considerable acceptance in the field of chemical analysis, both because of its simplicity and its extreme accuracy, it nevertheless requires a certain amount of manual dexterity to achieve accurate proportioning even though the device itself may be calibrated very accurately. Therefore, in accordance with the present invention a proportioning device of this general character has been completely automated with a control system which permits the withdrawal of the diluent, the withdrawal of the sample, and the delivery of the sample and the diluent completely automatically under the operation of pushbutton control. Certain features, as will appear hereinbelow, are applicable to proportioning devices even of a somewhat different character than that described above.

SUMMARY OF THE PRESENT INVENTION

In accordance with the present invention, an automatic actuator and control system is provided for a syringe proportioner of the type described generally above. It includes a double-acting reciprocating actuator for driving the barrel

member in both directions, as well as a selectively operable valve for connecting either a sample pipet or a reagent tube to the barrel member. The calibration rods are utilized as locating elements for two stops for limiting movement of the actuator. One of these stops which is engageable with the end of the longer calibration rod is immovable while the stop associated and engageable with the shorter calibration rod is selectively movable so that it may be withdrawn from the path of the actuator as it moves from the movable stop to the stationary stop during a period when the sample is drawn into the sample pipet

The control circuit is operable to drive the barrel and the actuator against the movable stop and at the same time connect the syringe with the reagent drawing reagent into the syringe. The sample control circuit is arranged so that when the sample button is depressed the movable stop will be withdrawn and the barrel will be connected by the valve to the sample pipet so that the actuator drives the barrel member to the second stationary stop drawing sample into the sample pipet.

A delivery control circuit associated with a delivery button is operable when actuated to reverse the actuator driving the barrel downwardly and delivering both the sample and the diluent out the sample pipet into another container placed thereunder.

The control circuit is operable to automatically recycle when the actuator has driven the barrel member to its completely retracted position and in response to such positioning of the actuator it reverses the valve connecting the barrel member to the reagent conduit and reverses the actuator so the reagent is drawn into the syringe. At the same time, a fluid signal is delivered to the movable stop to lower it into engagement with the gauge rod so that the actuator stops at the lower stop and the proportioner is again ready to receive a sample.

A further feature of the present invention is that multiple samples may be drawn into the the sample tip without contaminating the proportioner or tubing associated therewith. More particularly, a multiple sample control circuit is provided which when the barrel member is in a position where the actuator engages the uppermost stop after the sample has been withdrawn switches the valve connecting the barrel member to the reagent and activates the movable stop so that the movable stop drives the actuator and barrel downwardly expelling diluent or reagent, but not sample, through the reagent conduit. The valve member at this time serves to hold the sample in the sample tip since it is downstream of the valve with respect to the barrel. When the movable stop engages the lower calibration rod the sample button may be depressed again and another sample will be drawn into the sample pipet in the above described manner. Thereafter the double sample may be delivered by depression of the delivery button in the above described manner.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a fragmentary section of an automatic proportioner according to the present device;

FIG. **2** is a cross section taken generally along **2–2** of FIG. **1**;

FIG. **3** is a fragmentary side elevation of the proportioner shown in FIGS. **1** and **2**;

FIG. **4** is a section taken generally along line **4–4** of FIG. **3**;

FIG. **5** is a section taken generally along line **5–5** of FIG. **4**;

FIG. **6** is a schematic illustration of the syringe stop bracket and tang;

FIG. **7** is a schematic showing of the syringe stop bracket from the side;

FIG. **8** is a schematic illustration of the syringe stop bracket in engagement with the movable stop;

FIG. **9** is a schematic illustration of the stop bracket in engagement with the stationary stop with the movable stop retracted;

FIG. 10 is a cross section of a diaphragm operated valve used in the fluid handling as well as the control circuit of the present invention;

FIG. 11 is a schematic illustration of the preferred control circuit according to the present invention; and

FIG. 12 is a somewhat modified control circuit according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIGS. 1—3, an automated proportioning device 10 is illustrated which is seen to include generally housing members 11 and 12, a syringe assembly 13, a syringe stop bracket assembly 14, a syringe stop assembly 15, an actuator assembly 18 for driving the syringe stop bracket, and control elements 20 mounted within housing 11 and controlled by sample and delivery push buttons 22 and 23 as well as a multiple sample toggle switch 24.

The syringe 13 is selectively connectable by a valve 25 to either a sample pipet 26 through conduit 27 or a reagent conduit 28.

The syringe assembly 13 includes a base member 28' having a hollow plunger 29*a* extending upwardly therefrom. Slidable on the plunger 29*a* is a barrel member 31 having a suitable fitting 32 at the upper end thereof adapted to receive a main syringe conduit 33 shown schematically in FIG. 1.

Fixed to the rear side of the syringe base 28' are calibration rods 29 and 30. Calibration rods 29 and 30 extend parallel to the barrel and plunger members and have upper locating surfaces 33' and 34 (see FIG. 8) which are spaced apart a precise distance to determine the desired amount of movement of the barrel member 31 when the syringe is drawing sample into pipet 26 to accurately measure the sample.

The barrel member 31 has a flange 36 at its lower end. The syringe or proportioner 13 is of conventional construction and it should be understood that the automatic proportioner, actuator and control system is adapted to receive different proportioners or syringes 13 having calibration rods 29 and 30 of different heights and calibrations.

The syringe 13 is mounted in the automatic proportioner 10 by locating the base on the upper surface of a projecting boss 40 of the housing 12. The plunger 29*a* is held fixed in a stationary position and maintains the base 28' in engagement with boss 40 by a clamp assembly 42 which includes a plate 43 fixed to projections 45 and 46 extending upwardly from the boss 40 fastened thereto by suitable fasteners 48. A recess 50 in the plate 43 has a central wedging surface 54 which is positioned between the calibrating rods 29 and 30. A thumbscrew 56 has a camming end portion 58 which engages one side of the rod 29 and clamps this rod in position. The other rod 30 is held in position in the recess 50 by an overhanging plate 60 shown clearly in FIG. 2.

The stop bracket assembly 14 is provided for reciprocating the barrel 31 and providing a stop for the barrel at predetermined calibrated points of movement to assure accurate proportioning. Toward this end, the stop bracket assembly is seen to include a generally flat U-shaped upper plate 62 partially surrounding the barrel member 31, a central stop plate 63 and a lower plate 64 fastened together as a unit by suitable fasteners 67 thereby clamping the stop bracket assembly to the flange 36. Projecting from the stop plate 63 is a small stop tang 69 which slides between the calibrated rods 29 and 30. As will appear below, the stop tang 69 cooperates to limit movement of the barrel member 31 to the desired positions.

For reciprocating the stop bracket assembly 14 and the barrel 31, the actuator 18 includes a cylinder 71 with a piston 72 slidable therein having a rod 74 projecting upwardly from the housing member 11, through the projecting boss 40 of the housing member 12 and is rigidly fixed to a slide member 77 slidably received on a stationary vertically extending carriage rod 78. Rod 78 is seated in boss 40. Suitable means may be provided for supporting the other end of the carriage rod 78. The carriage or slide 77 has arms 80 and 81 extending horizontally on the upper surface thereof, flanking the proportioner barrel 31 and closely received in recesses 84 between the lower stop plate 64 and the intermediate stop plate 63.

For the purpose of rotatively stabilizing the carriage 77 a projection 86 extends rearwardly therefrom and has a recess 87 therein shown clearly in FIG. 2 which is slidable on a vertically extending stationary rod 88 mounted in the housing boss 40.

Thus, as fluid is delivered to the double-acting actuator 18, the piston 72 is operable through the carriage 77 to reciprocate the stop bracket assembly 14 and the syringe barrel 31 upwardly and downwardly on the relatively stationary plunger 29*a*.

The stop head assembly 15 is provided to effect accurate limit stops for the stop bracket tang 69 after the diluent has been drawn into the syringe as well as after the sample has been drawn into the sample pipet 26. Toward this end, the stop head 15 is seen to include a block 90 having a bore 91 extending vertically therethrough so that the block may be selectively positioned on the main rod 78. The guide rod 88 is received in a suitable recess 93' in the block 90 to provide rotative alignment and stability to the block. For locking the block 90 to the rod 78, a hand screw assembly 93 is provided.

Block 90 carries a stationary stop 94 having a lower surface 95 engageable with the upper end 34 of the longer guide rod 30. The block 90 is positioned after the proportioner or syringe has been fixed in position by lowering the block 90 until the lower surface 95 of the stationary stop engages the end of the longer rod and at that time the handscrew 93 is tightened securely locking the stop head assembly 15 in position.

The stop surface 95 limits the end of the sample stroke of the barrel 31 by engagement with the tang 69 as it moves upwardly with the stop bracket assembly 14.

For limiting movement of the stop bracket assembly 14 in its upward movement when drawing diluent into the syringe 13 a movable stop 97 is provided with a lower surface 98 selectively engageable with the upper surface 33' of the shorter calibrated rod 29.

As seen more clearly in FIG. 5, the stop 97 is carried by a stop pin 99 slidable in a vertical bore 100 in the block 90. The pin 99 is shown in FIG. 5 in its uppermost position and has a central reduced stem portion 101 which cooperates with a threaded member 104 projecting within bore 100 to prevent the pin 99 and the stop 97 from falling out of the bore.

A diaphragm operator 105 is provided for driving the pin 99 and the stop 97 downwardly until stop surface 98 engages the upper surface of the shorter calibration rod. The diaphragm operator is seen to include a housing 106 fixed to the stophead 90 by suitable fasteners (not shown) and having an annular chamber 108 with a diaphragm 110 therein having a rigid member 111 fixed thereto. Diaphragm 110 separates the chamber 108 into chamber 108*a* and 108*b*. For supplying fluid to the chamber 108*a* a suitable air fitting 112 is provided and when fluid is supplied to chamber 108*a* the diaphragm shifts to the right against the bias of the spring 114 forcing a pin 115 slidable in block 90 to the right. Pin 115 and pin 99 have interengaging conical surfaces 118 and 119 respectively. As the pin 115 moves to the right from its inactive position shown in FIG. 5, conical surface 118 engages conical surface 119 and drives the pin 99 and stop 97 downwardly. When the delivery of fluid under pressure to fitting 112 is terminated spring 114 returns the diaphragm and pin 115 to its right position shown in FIG. 5.

Referring more particularly to FIG. 1, the control circuitry 20 is mounted within the frame member 11 and includes generally a manifold board 125 carrying pushbutton valves 126 and 127 associated with the sample and delivery buttons 22 and 23 respectively. Also mounted on the manifold board are valves 130' and 131' as well as as a fluid amplifier 133. The various air fittings are defined by barbed members such as at 134 extending or projecting from the manifold member 125 thus providing a unitized control circuit for the proportioner.

Referring to FIGS. 6—9 for description of gauging of the present device, let it be assumed that the barrel **31** is in its lowermost position and is driven upwardly by the actuator **18** with stop bracket plate **63** and stop tang **69** at a time when the valve **25** connects the reagent tube to the main syringe conduit **33**. This draws reagent or diluent into the syringe. The control circuit described in more detail below supplies air pressure to the diaphragm operator **105** forcing the stop pin **99** downwardly until the lower surface **98** of the movable stop engages the top of the shorter rod **29**. Movement of the barrel **31** continues upwardly until tang **69** engages stop **97** as shown clearly in FIG. **8**. The control circuit then releases the fluid pressure applied to the diaphragm operator **105** and at the same time switches valve **25** to connect the main syringe conduit **33** to sample conduit **27**. The actuator then automatically drives the tang **69** and the barrel **31** upwardly and the tang in turn drives the movable stop **99** upwardly until the tang engages the stationary stop **94** as shown in FIG. **3**. This latter movement of the syringe barrel **31** serves to accurately draw the sample fluid into the sample pipet **26**.

It should be understood from the above description that the present stop assembly may be used with a plurality of proportioners of different size and calibration since the fixed stop **94** may be positioned by positioning block **90** and the movable stop **97** can accommodate a wide range of short calibration rods **29**.

A liquid handling valve **25** is shown in more detail in FIG. **10** and while the details thereof form no part of the present invention, certain functions of the valve are particularly useful in the operation of the present automatic proportioner. This valve is shown and described in more detail in the application of William P. Davis, Ser. No. 794,099, filed Jan. 27, 1969, assigned to the assignee of the present invention, and reference should be made thereto for a more complete understanding thereof. Briefly, however, the valve **25** consists of a valve block **130** having a recess **131** therein slidably receiving and guiding a movable valve slide **136** for rectilinear movement from a position connecting main conduit **33** with reagent conduit **28** as shown in the drawing to a right-hand position connecting main conduit **33** with sample conduit **27**. It should be understood that one of the functions of the valve slide **136** is to seal the conduit **27** when conduit **33** is connected to conduit **28** so that any sample in conduit **27** will be held therein by the sealing engagement of valve slide **136** with valve block recess **131**. Diaphragm operating assemblies **138** and **139** are provided for shifting the valve slide **136** from its reagent coupling position shown in FIG. **10** to its right-hand sample coupling FIG. and back to the position shown. Diaphragm operator **138** includes an air fitting **140** and diaphragm operator **139** includes an air fitting **141**, both adapted to be selectively connected to sources of air supply from the control circuit described in more detail below.

The control circuit shown in FIG. **11** is adapted to automatically cycle the proportioner to the position shown where the stop **97** is in its actuated position and the barrel member **31** is moved upwardly to a position where tang **69** engages stop **97**. Thus, at the beginning and at the end of each cycle the reagent has already been drawn into the syringe **13**. Moreover, the control circuit is operable to connect the syringe conduit **33** to the reagent conduit **28**.

Beginning at this point in the operation, if the operator desires a single sample of fluid to be drawn into the sample tip, he inserts the sample tip into a sample receptacle and depresses the sample button **22** actuating the pushbutton valve **126**. The sample valve as well as the other valves in the system are connected to a suitable source of supply indicated schematically at **145** through a suitable regulator **146** and a fluid supply line **147**.

The depression of sample button **22** ports fluid through line **150** to one side of valve **130'** shifting the valve to connect supply line **147** with passageway **148** supplying fluid to the diaphragm operator **138** causing valve **25** to connect main syringe conduit **33** to sample conduit **27**. Valve **130'** may preferably take the same form as the valve **25** described in more detail above. The shifting of valve **130'** depressurizes outlet line **150'** and stop control line **151** thereby depressurizing the diaphragm operator **105** for stop **97**. This permits the barrel member **31** along with the stop tang **69** to be driven upwardly by the actuator **18** drawing sample fluid into the sample tip **26**, until tang **69** engages stop **94**.

The accurately proportioned sample and diluent or reagent are then discharged from the sample tip by the operator after placing the tip in a suitable container, by the depression of delivery button **23**. This ports supply fluid through pushbutton valve **127**, through passage **152** to the lower side of valve **131'** shifting the valve to the position shown in the drawing connecting supply conduit **154** to actuator feed line **156**. Valve **131'** is similar in construction to valve **25** and serves to selectively deliver fluid to the opposite sides of piston **72**. The piston **72** is thus driven downwardly along with the barrel **31** discharging the sample and the reagent through the sample tip **26** until completely discharged when barrel **31** reaches its lowermost position.

The actuator and the barrel member automatically move back to the position shown in FIG. **11** in response to the actuator and barrel member reaching their lowermost positions. Toward this end, and with the toggle valve **24** in its position shown connecting conduit **158** with conduit **160** and conduit **161**, the discharge of fluid through the toggle valve and conduit **161** as the piston **72** reaches its lowermost position, actuates a pin and diaphragm type amplifying valve **133** constructed to provide a sufficient signal in line **167** when the piston **72** reaches its lowermost position. The fluid signal in line **167** is delivered to the upper side of valve **130'** shifting it downwardly to a position connecting line **147** and line **150'**. This resets the stop **97** to its lowermost position and shifts valve **25** upwardly to a position connecting syringe conduit **33** and reagent conduit **28**. At the same time, the pressure in line **168** shifts valve **131'** downwardly connecting supply conduit **154** and delivery conduit **160** driving the actuator **18** upwardly while the syringe is connected to the reagent conduit drawing reagent into the syringe until the stop tang **69** engages the bottom of stop **97**, at which time the apparatus is at rest.

There is also provided according to the present invention, means for delivering multiple samples for a given amount of diluent without contaminating the main syringe line **33** with any portion of the sample fluid. It should be noted that the samples are generally of such a small volume that they remain in the sample pipet **26** and are never drawn into the main conduit **33**.

Assuming that a multiple, or at least one additional sample is required and the sample button **22** has already been depressed so that the barrel **31** is in its uppermost position with tang **69** engaging the upper stop **94**, the operator switches the multiple sample toggle to its right position connecting line **158** with line **175**. This connects the lower part of actuator **18** from the pressure source **154** and pressurizes line **175**, and line **178** shifting valve **130'** downwardly, connecting supply passage **147** and **150'** thereby shifting the valve **25** to connect syringe conduit **33** to reagent conduit **28** and at the same time pressurizing the movable stop diaphragm operator **105** driving the stop **97** downwardly along with tang **69** until the stop **97** abuts the shorter calibration rod **29**. Since the pressure in the lower half of the actuator has been relieved and the pressure applied to the diaphragm operator **105**, this downward movement of the barrel is permitted. The operator then moves the toggle valve **24** back to the normal position shown, and then the system is ready to receive another sample. The operator may then depress sample button **22** and a second sample will be drawn into the sample tip **26**. Thereafter both samples along with a single quantity or volume of diluent may be delivered to the sample tip by the depression of the delivery button **23**.

A somewhat modified form of the present invention is shown in FIG. **12**. The proportioner **13**, the stop pin **97**, the actuator **18**, the delivery button **23** and associated valve **127**,

the sample button **22** and associated valve **126** are identical to that described above. The difference in the circuit shown in FIG. **12** is that it employs pure fluidic elements rather than movable part valve members in several instances and does not include either the automatic recycling feature of the circuit of FIG. **11** or the multiple sample capability.

The fluidic elements **180** and **181** are provided as the primary control components of this circuit. These fluidic elements are of well-known construction in the pure fluidic art and are referred to generally as fluidic flip-flops in that they are bistable devices. Both are connected to a source of supply **185***a* and **185***b* and shift supply fluid from one outlet port to another in response to the application of one of two opposed fluid signals interacting with the supply stream. The bistable characteristic of this device is achieved by conventional wall attachment techniques, which is well known in the fluidic art.

Assuming the barrel **31** to be in its lowermost position along with actuator **18**, the operator presses the reagent button **188** supplying fluid to upper signal port **190** associated with valve **180** shifting the outlet flow to outlet passage **192** supplying fluid to the underside of piston **72** driving the piston upwardly. At the same time, a fluid signal is provided in line **193** shifting the fluidic element **181** to supply fluid through line **196** which actuates a pinch valve **198** occluding the sample conduit **27** and at the same time depressurizing line **199** releasing pinch valve **201** and providing communication between reagent line **28** and syringe conduit **33**. At the same time, line **204** is pressurized actuating the stop pin **97** to its lowermost position. The actuator then moves upwardly drawing reagent into the syringe until the stop tang engages the movable stop **97**.

The operator then may draw sample into the device by pressing sample button **22** providing a signal in line **206** which switches flip-flop **181** to connect line **191** with supply and depressurize line **196** so that pinch valve **201** occludes line **198** and pinch valve **198** is released, and at the same time line **204** is depressurized releasing the stop **97**. Since flip-flop **180** is already pressurizing line **192** the actuator **18** automatically drives the barrel **31** upwardly into engagement with the upper stop drawing sample into sample line **27**.

To deliver the sample, the delivery button **23** is depressed providing a signal in line **210** switching flip-flop **180** to pressurize line **212** and depressurize line **192** driving the actuator and the barrel **31** downwardly delivering both sample and diluent out sample line **27**.

We claim:

1. An automatic driver and controller for a fluid proportioning device of the type having a plunger member and a relatively movable telescopic barrel member, comprising: first conduit means adapted to be connected to convey fluid to and from said barrel member, second conduit means adapted to communicate with a first fluid, third conduit means adapted to be connected to a sample fluid, valve means for selectively connecting one of said second and third conduit means to said first conduit means, actuator means for moving one of said members and selectively drawing fluid through said second and sample conduits, control means for said actuator means to limit movement of said movable member when said valve means communicates said first and sample conduit means to a predetermined sufficiently small value so that the sample fluid does not enter the first conduit but remains in the sample conduit means.

2. An automatic driver and controller as defined in claim **1**, including means for delivering multiple samples including second control means moving said valve means to a position connecting said first and second conduit means and simultaneously moving said actuator in a direction to expel at least a portion of said first fluid from said first conduit to said second conduit, said valve means at that time being constructed to hold the predetermined sample in said sample conduit means, said control means thereafter being operable to move said movable member in a direction drawing said second fluid from said third sample conduit means toward said first conduit means, said actuator means then being movable in the opposite direction after the control means connects said first conduit means to said sample conduit means whereby a second predetermined sample may be drawn through said sample conduit means.

3. An automatic driver and controller as defined in claim **2**, including first stop means for limiting movement of said movable member while said first fluid is being drawn through said first conduit means, second stop means for limiting movement of said movable member after a predetermined amount of sample fluid is drawn through said sample conduit means, said control means including means for moving said movable member to said first stop means, and at the same time moving the valve means to connect said first and second conduit means, third control means controlling said first and second control means to move said valve means to a position connecting said first and sample conduit means and to move said movable member to said second stop, said means for delivering multiple samples including fourth control means for controlling said first and second control means to move the valve means to a position connecting said first and second conduit means and to move said movable member in a direction expelling fluid from said second conduit means thereby permitting the movable member to return to the first stop ready to draw a second sample.

4. A control system for a proportioner of the type having a plunger member and a telescopic barrel member movable relative thereto to proportion accurate volumes of two or more fluids, comprising: first stop means for accurately limiting movement of the movable one of said members during drawing of a first fluid, second stop means for limiting movement of said movable member during drawing of a second fluid, fluid operable actuator means for moving said movable member from a predetermined retracted position to said first stop means, from said first stop means to said second stop means, and from said second stop means back to said retracted position, first conduit means adapted to communicate with one of said members, second conduit means adapted to communicate with a first fluid, third conduit means adapted to be connected to a sample fluid, valve means for selectively connecting said first conduit means to one of said second or third conduit means, manually operable sample control means for moving said movable member from said first stop means to said second stop means and for moving said valve means to a position connecting said first and third conduit means, and manually operable delivery control means for moving said movable member from said second stop means to said retracted position and for moving said valve means to a position connecting said first conduit means and said third conduit means.

5. A control system for a proportioner as defined in claim **4**, including second valve means for selectively porting fluid to said actuator to drive said actuator in a first direction from said retracted position or a second direction toward said retracted position, fluid operable means for moving said first valve means, and control means for automatically controlling said fluid operable means to move the valve means to a position connecting said first and second conduit means and controlling said second valve means to move the actuator means in said first direction toward said first stop means, and automatic control means being responsive to actuator movement to a retracted position corresponding to the retracted position of the movable member whereby the cycle of the proportioner ends and begins at the first stop means.

6 An automatic proportioner for two fluids, comprising: a syringe including a stationary plunger member and a movable member cooperating with said stationary plunger member to vacuum draw fluid toward said stationary plunger member, first locating means fixed with respect to said stationary plunger member and representing by position the desired amount of one of said fluids, second locating means separate from the first locating means and fixed with respect to said stationary plunger member and representing by its distance from the first locating means the desired amount of the other fluid,

first stop means separate from but adapted to contact said first locating means, second stop means separate from but adapted to contact said second locating means, and actuator means for moving said movable member to predetermined position with respect to said first stop means drawing by vacuum pressure one of said fluids toward said stationary plunger member during said first movement and for thereafter moving said movable member to a predetermined position with respect to said second stop means for drawing by vacuum pressure the other of said fluids toward said stationary plunger member.

7. An automatic proportioner for two fluids, comprising: a syringe including a stationary plunger member and a movable member cooperating with said stationary plunger member to draw fluid toward said stationary plunger member, first locating means fixed with respect to said stationary plunger member and representing by position the desired amount of one of said fluids, second locating means fixed with respect to said stationary plunger member and representing by its distance from the first locating means the desired amount of the other fluid, first stop means selectively movable into and out of engagement with said first locating means, second stop means engageable with said second locating means, abutment means on said movable member adapted to serially engage the first and second stop means only at predetermined times during a cycle of the proportioner, actuator means for moving said movable member to a position where the abutment means engages said first stop means, control means for thereafter releasing said first stop means said actuator means moving said movable member to another position where said abutment means engages said second stop means.

8. An automatic proportioner as defined in claim 7 wherein said actuator means includes control means for biasing said abutment means against said first stop means so that when the first stop means is released by said first control means the actuator means will automatically move to a position where the abutment means is in engagement with said second stop means.

9. An automatic proportioner as defined in claim 8 wherein said actuator means includes a double-acting piston and cylinder device, said second control means including means for delivering fluid to said actuator means to drive the moveable member in a first direction drawing fluid into said plunger member, said second control means maintaining the fluid pressure on the appropriate side of said piston to continue urging said movable member in said first direction after said abutment means engages said first stop means so that when the first stop means is moved the piston will automatically drive the movable member to a position where the abutment means engages the second stop without further control by said second control means.

10. A device for automatically controlling a fluid proportioner of the type having a stationary plunger member and a relatively movable telescopic barrel member with at least two calibration means fixed with respect to one of said members, comprising: first stop means selectively movable into physical contact with said first calibrating means, second stop means physically engageable with said second calibrating means, abutment means on said movable member and normally spaced from the first and second stop means, actuator means for moving said movable member to a position where the abutment means contacts said first stop means, to momentarily restrain further movement of the movable member, control means for thereafter moving said first stop means, said actuator moving said movable member to a position where said abutment means contacts said second stop means to terminate said last-mentioned movement of the movable member.

11. A device as defined in claim 10, including an elongated support for one of said members, stop head means on said elongated support having said second stop means fixed thereon, said stop head means being positionable along said support to a place where the second stop means engages said second calibrating means, means for fixing said stop head means on said support in said place, said first stop means being carried by said stop head means and being movable from a retracted position to a plurality of extended positions whereby the device can accommodate proportioners having differently positioned calibration means.

12. A device as defined in claim 11, including fluid operable means for shifting said first stop means from its retracted position into engagement with said first calibration means, said fluid operable means being carried by said stop head means.

13. A device as defined in claim 12, wherein said control means for moving said stop means is independent of actuator movement.

14. A device as defined in claim 10 including an elongated movable support for one of said members, slide means on said elongated movable support engageable with and fixed with respect to the movable member, said abutment means being carried by said slide means.

15. A device as defined in claim 10, including first conduit means adapted to be connected to said movable member to convey a first fluid thereto, second conduit means adapted to be connected to said movable member to convey a second fluid thereto, valve means movable to a first position connecting said first conduit means to convey said first fluid to said movable member and block flow through said second conduit means and a second position connecting said second conduit means to convey fluid to said movable member and block flow through said first conduit means, said control means for moving said first stop means, said control means for moving said first stop means also controlling said valve means so that as said first stop means is retracted the valve means will move substantially simultaneously from said first position to said second position.

16. An automatic proportioner as defined in claim 15, including second valve means for controlling fluid flow to said actuator to move said movable member in a first direction drawing fluid toward said plunger member or a second direction expelling fluid from said movable member through one of said conduit means, manually operable control means for controlling said control means to move said first valve means to said second position to retract said first stop means to draw said first fluid toward said plunger member through said second conduit means, and manually operable delivery means for controlling said second valve means to move said actuator means in said second direction, said delivery means not affecting said first valve means so that the fluid expels through said one conduit means.

17. An automatic proportioner as defined in claim 16 wherein said actuator means includes a double-acting piston and cylinder device, automatic means responsive to the completion of movement of said actuator means in said second direction for activating said control means to place said valve means in said first position and move said first stop means in engagement with said first calibration means and also to move the actuator in the first direction drawing fluid through said first conduit means until said abutment means engages with first stop means.