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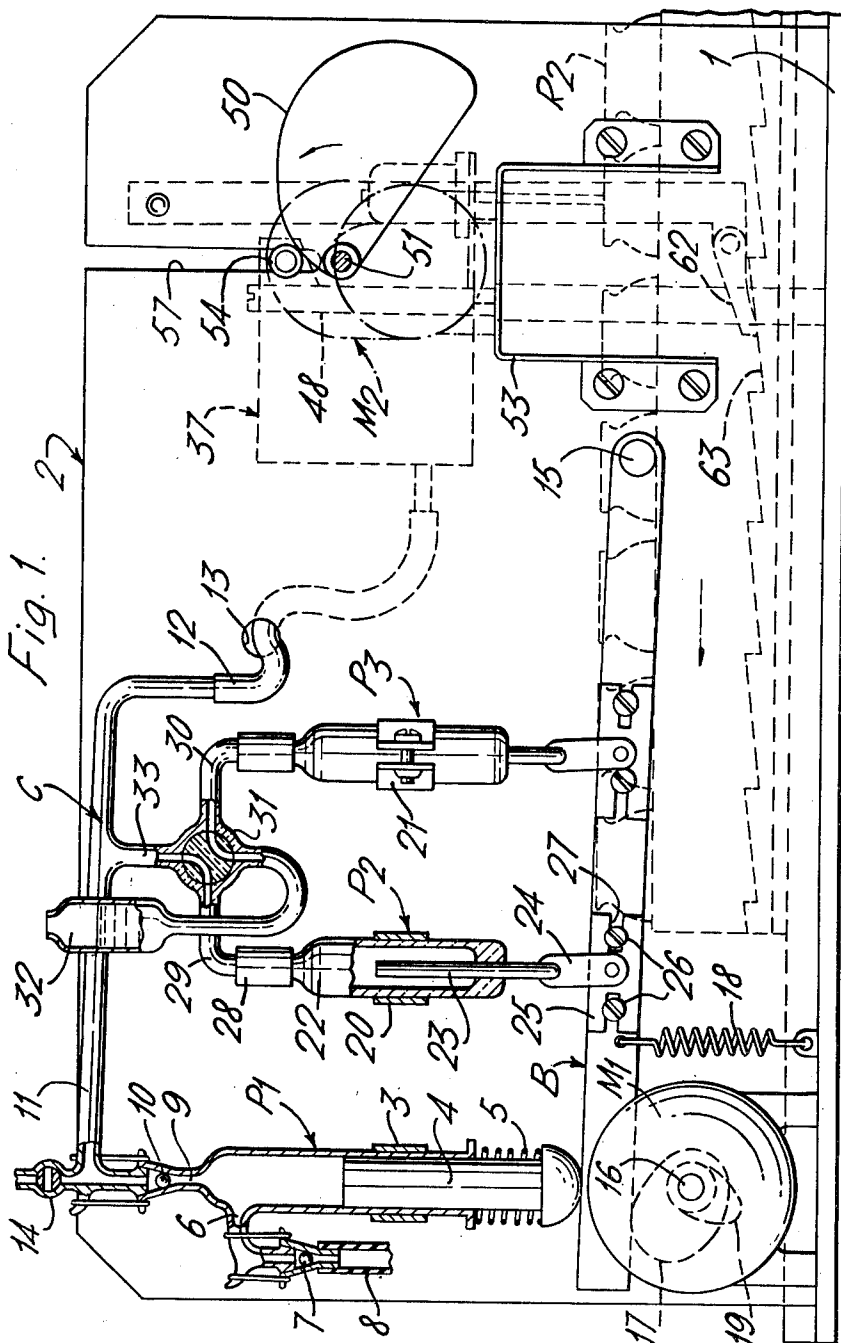
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APPARATUS FOR THE PREPARATION OF LIQUID MIXTURES

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3 Sheets-Sheet 1



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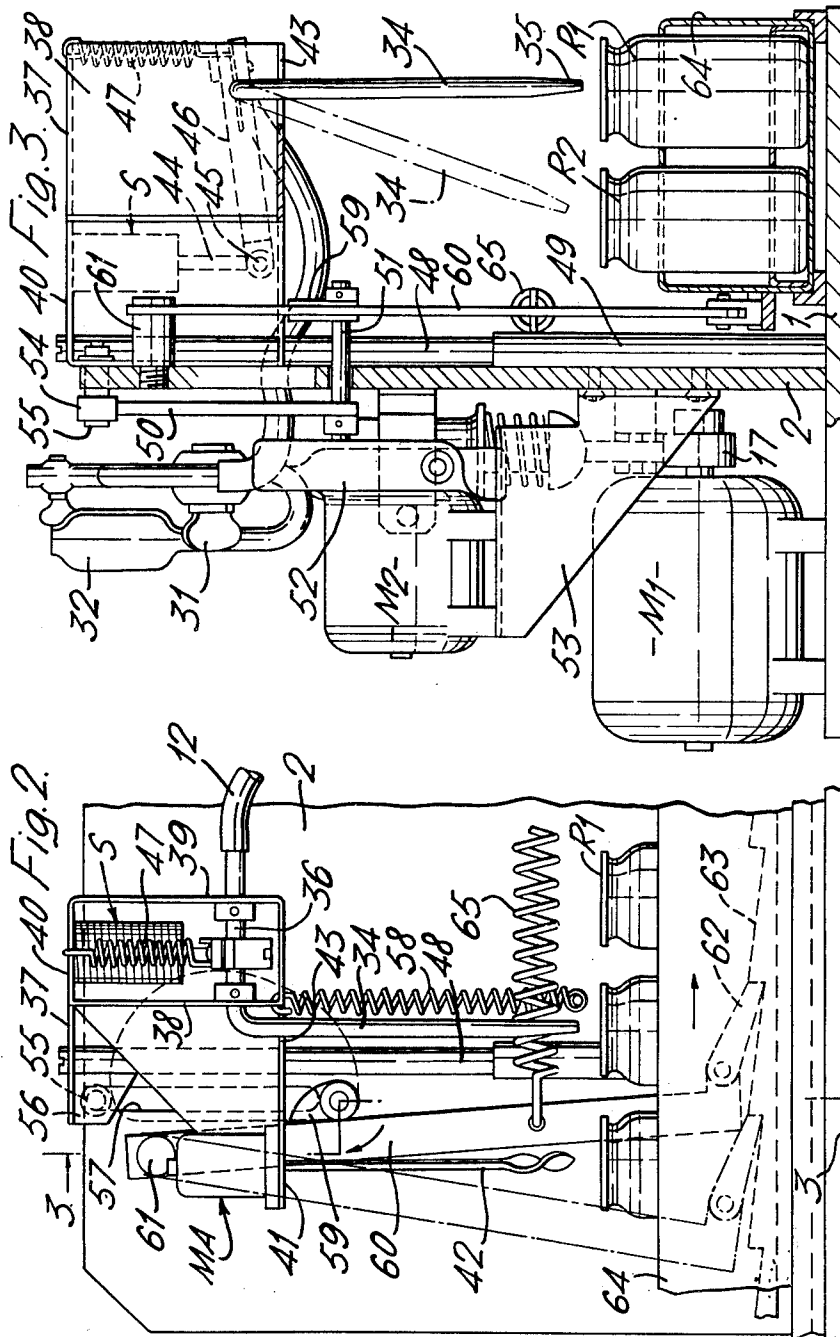
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APPARATUS FOR THE PREPARATION OF LIQUID MIXTURES

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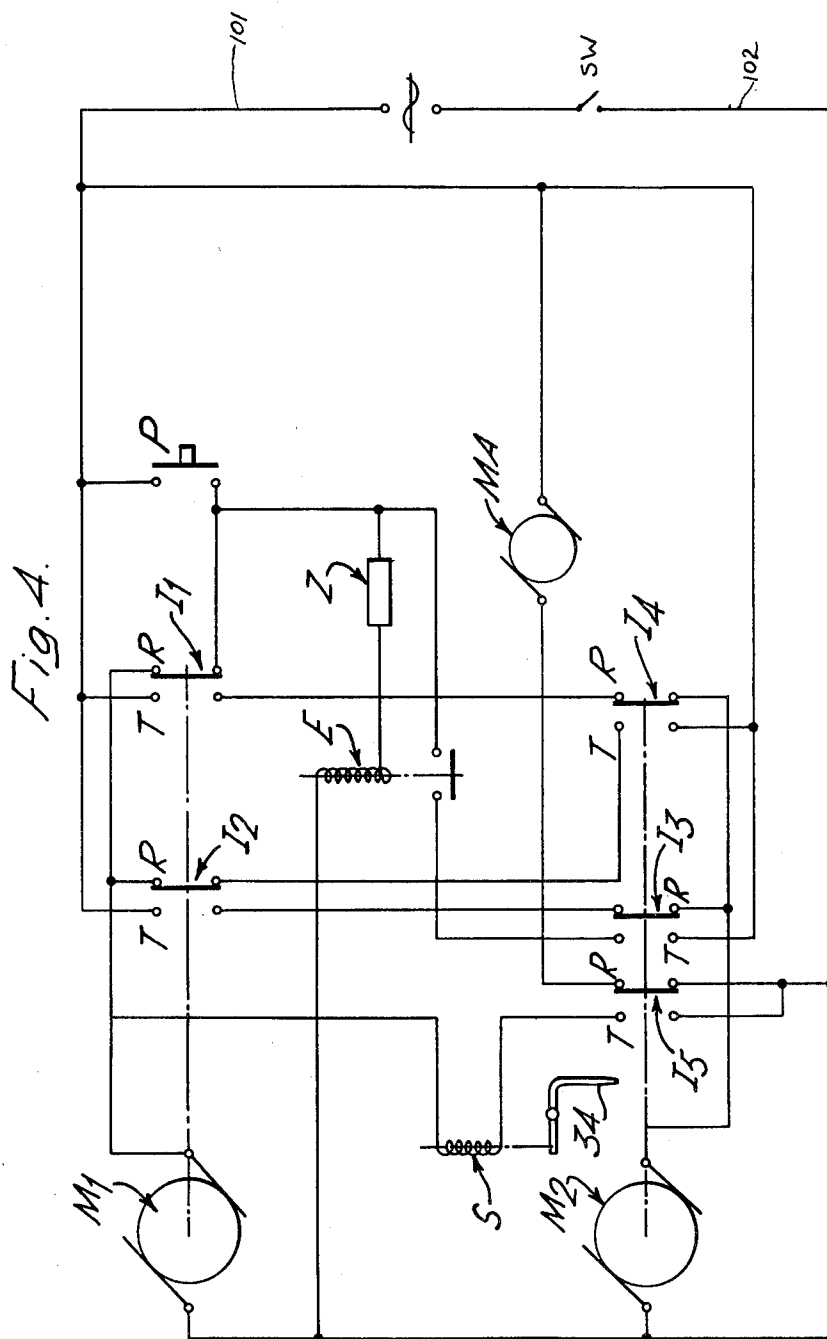
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APPARATUS FOR THE PREPARATION OF LIQUID MIXTURES

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3 Sheets-Sheet 3



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3,496,970 APPARATUS FOR THE PREPARATION OF LIQUID MIXTURES

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18 Claims

ABSTRACT OF THE DISCLOSURE

Apparatus for repetitive preparation in a mixing chamber of solutions of selectively varied dilution in which a container of concentrate and an external source of diluent are respectively connected to said chamber through reciprocal pumps which draw concentrate and diluent from said containers and thereafter, on a reverse pump piston stroke, discharge a measured volume of liquid mixture by way of a selector valve and pipet to a second container, the diluent pump being valved from connection on its first stroke with an external source of diluent and on its reverse stroke with the chamber, both pumps being coupled to a single rocking beam so that the strokes are always proportional.

This invention relates to apparatus for the preparation of accurately proportioned liquid mixtures. More particularly, in an important aspect, this invention relates to an instrument for automatically, rapidly and accurately combining a measured volume of a first liquid, a diluent liquid, with an accurately proportioned volume of a second liquid, a concentrate liquid.

Such an apparatus provides peculiarly advantageous cooperation with and flexibility to particle analysis apparatus of the type disclosed by W. H. Coulter in U.S. Patent 2,656,508. In that patent there is disclosed apparatus for analyzing a suspension of particles of one conductivity suspended in a liquid of a different conductivity. The analysis accuracy and detail effected by the apparatus of the type disclosed by the Coulter patent are enhanced by cooperation with accurately proportional diluting apparatus in accordance with the instant invention.

In addition to its utilization in connection with the Coulter apparatus above referred to, the apparatus of the invention has wide application in numerous laboratory and industrial applications. There is a need for the preparation of accurate dilutions in many fields. In chemistry and biology dilutions are used in counting and sizing particles and cells, measuring and controlling the growth of bacteria, intermixture of reagents for colorimetry, dilution of poisonous and radio-active materials, etc.

Manual diluting of suspension samples is manifestly inaccurate, tedious, and time consuming. In the case of toxic and radio-active materials, manual handling is dangerous. Accordingly, it is a principle object of the instant invention to accomplish repetitively, rapidly and automatically the proportionate mixing of first and second volumes of liquid, the desired diluent liquid and the concentrated liquid sample to be analyzed, without danger, and with great accuracy.

Further in accordance with the invention, it is an object to provide apparatus for the proportionate dilution of alternative volumes of concentrate liquid.

It is a still further object of the invention to provide apparatus for accomplishing the precisely proportioned

mixture of volumes of first and second liquids in which the proportionate relation between the two liquid volumes is readily adjustable.

It is an even further object of the invention to provide apparatus for accomplishing the aforementioned proportioned mixtures of two liquids which apparatus is adapted to readily accommodate the insertion of plural alternate liquids in the proportionate mixing processes.

It is an even further object of the invention to provide proportionate mixing apparatus for plural liquids which is adapted for delivering the resultant mixture to a portable container adapted for ready introduction of the resultant mixture to particle analysis apparatus of the type disclosed in the aforementioned patent to W. H. Coulter.

These and other objects are accomplished in accordance with the invention by providing a common liquid transfer tubing or line having a selectively positioned terminal section arranged for alternative liquid transfer cooperation with adjacently positioned first and second liquid containers. A reciprocating pump is arranged and adapted for unidirectional filling of the liquid transfer tubing from a reservoir of diluent liquid. A second and third auxiliary reciprocally acting pumps, having a tubing connection to the transfer tubing. This latter tubing connection includes a manually operable selector valve for defecting connection between discharge ends of alternate ones of the auxiliary pumps to the transfer tubing. Hence, independent of the direction of reciprocal motion of the piston in the manually selected pump, a suction, negative pressure or positive pressure is applied to the diluent-filled transfer tubing.

The terminal section of this transfer tubing is alternatively positioned in operative engagement with a first portable concentrate liquid containing beaker or with a second similarly particle proportionate liquid mixture receiving beaker. Thus, in one direction of motion of that reciprocally operating pump which is connected to the transfer tubing by the aforementioned manually operable valve, a suction is effected to draw a pre-assigned amount of beaker contained concentrate into the transfer tubing in dependence upon the operative positioning of the selectively positioned terminal section of the transfer tubing in engagement with the portable beaker contained concentrate. The amount of concentrate drawn from the portable beaker, of course, is proportioned to the second piston area and amount of piston travel in the aforementioned one direction. Similarly, on the reverse travel of the piston, an exact corresponding amount of now mixed diluent and concentrate is driven from the transfer tubing by way of the repositioned tubing terminal section to the receiving beaker.

The invention will be more clear and further objects, features and advantages thereof will become apparent from a consideration of an illustrative embodiment of the invention as shown in the drawings and from a consideration of the appended claims.

In the drawings:

FIG. 1 is a elevation view, partially sectioned, of a rear side of important liquid transfer portions of liquid mixture preparation apparatus in accordance with the invention;

FIG. 2 is a partially sectioned elevation view of a reverse, front side of an important portion of the liquid mixture preparation instrument shown in FIG. 1;

FIG. 3 is a partially sectioned end view of the instrument shown in FIG. 1 and this FIG. 3 illustrates further features of the instrument.

FIG. 4 is a partially diagrammatic partially schematic drawing of electrical control and driving arrangements of this embodiment of the invention.

The invention comprises generally a first, reciprocally

operating diluent pump and a second and a third alternatively operative reciprocal pump. A longitudinally extending platform is provided for longitudinally transporting a first and a second transversely positioned portable beakers which are respectively adapted for containing the concentrate liquid and the desired liquid mixture. Transfer tubing is provided having a receiving inlet at one end for receiving diluent fluid from a convenient source by way of a unidirectional liquid passing check valve.

At the other, opposite end this tubing is provided with a pipet terminal portion which is rotatably arranged for selective disposition in liquid transfer relation with the interior portions of the first and second beakers. Thus, the one beaker is manually positioned on a transport platform and filled with concentrate liquid to be diluted.

The second mixture receiving beaker is positioned transversely adjacent the first beaker on the longitudinally extending transport platform. The second and third reciprocal pumps each have a single port at one end of the pump body. These ports are alternatively connected to the transfer tubing between the two ends thereof by way of a selectively operable valve. That one of the pumps not so connected is connected by way of the selectively operable valve to a filled surge tank which seals the liquid transfer arrangements from entry of unwanted air or other contaminants.

This transfer tubing with liquid connected pumps serves as a proportioned mixing chamber for concentrate and diluent liquids. Thus, with the pipet positioned within a concentrate filled beaker, a suction reciprocation of the connected pump draws concentrate from the appropriate beaker through the pipet into the transfer tubing and to the pump body by way of the aforementioned selectively operable valve. In this portion of the instrument the withdrawing concentrate is mixed with contained diluent liquid. Thereafter, on the reverse pump piston stroke, exactly the same volume of liquid mixture is discharged by way of the selector valve, transfer tubing and the repositioned pipet to a second beaker for utilization as desired.

Referring now more particularly to the drawings, in FIG. 1 a vertical plate 2, shown from a rear side of the apparatus of the invention acts with a horizontal base plate 1 to form a mounting foundation for apparatus of this embodiment. A conventional first, rotary electrical motor M₁, energized from a conventional power source (not shown) is arranged to drive a shaft 16 in rotation.

This shaft bears with it distinctive eccentric cams 17, 19 shown in dashed lines in this FIGURE 1. Riding on the surface of cam 17 is a horizontal beam B pivotally mounted along and on the vertical plate by pivot 15. This beam is urged against the cams by spring 18. Clearly rotary drive of shaft 16 cause the beam B to swivel about pivot 15 in accordance with the configuration of cam 17 as this beam is urged against the cam by a spring 18. This spring is in tension between the beam and the horizontal plate 1. A drive plate 25 (and a similar one for pump P₃) is held to the beam by screws 26 and is adapted for axial adjustment along the beam by the screw-accommodating slots 27 provided. Thus, the drive plate follows the beam B in reciprocal vertical motion of adjustable (by set screws 26) amplitude as the beam oscillates about pivot 15 following the urging of cam 17 and spring 18.

The axially adjustable drive plates 25 are pivotally connected by links shown in driving relation with pistons, e.g. with cylindrical piston 23 by respective links 24, associated with two concentrate pump P₂ and P₃. The bodies e.g. body 22, of these two pumps are mounted to vertical plate 2 by means of clamps 20, 21. Note that FIG. 1 is a rear view of the apparatus of the invention so that the vertical plate 2 intervenes in the viewing of many elements of the apparatus shown in FIG. 1. Thus, these so-obscured elements are shown in dashed lines.

A mounting bracket 53, seen more clearly in FIG. 3 is mounted by screws to the rear side of the vertical plate 2.

The diluent pump P₁ has a body fixed to vertical plate

2 by a clamp 3 and includes an internally reciprocating piston 4 having a shaft the capped bottom end of which is held against beam B by compressed spring 5. Connection is made from the upper body of diluent pump P₁ to a diluent reservoir (not shown) by way of port 6, a ball valve 7, and a partially-illustrated tube 8. A ball valve 10 and an upper port 9 connect the diluent pump P₁ to a transfer tubing arrangement C. This tubing arrangement comprises a rigid section 11 and toward the right hand end, a flexible portion 12 which passes through an aperture 13 in the plate 2 for further connection to the block 37, shown in dashed lines, and a terminal pipet 34, seen in FIG. 3.

The upper portions of concentrate pumps P₂, P₃, are respectively connected by way of conduits 29, 30 to a manually-operable liquid selection valve 31 having a rotatable barrel with orthogonal channels, as shown in the sectioned view of this barrel in FIG. 1. This arrangement serves the purpose of establishing alternative fluid connection paths from the concentrate pumps P₂, P₃ to the diluent-filled surge reservoir 32 and to liquid transfer tubing arrangement C by way of section 33. The pumps P₂ and P₃ conveniently will have different pumping volumes.

A second electrical motor M₂ is positioned above mounting bracket 53 to drive a shaft 51 of a reducer arrangement 52 seen in FIG. 3. This reducer arrangement includes an eccentric cam 50 fixed to shaft 51 to engage roller 54 continuously. This roller 54 is mounted on an axle 55 having an end positioned for movement in a slot 57 in vertical plate 2.

Reference may now be made to FIGS. 2 and 3, but before leaving FIG. 1, it is well to observe the advantageous functioning of the axially adjustable drive plates 25 as they are adjusted along beam B. As the left hand drive plate is adjusted to the left along the beam B, noting the pivot 15 at the right of beam B, the throw of piston 23 increases. Accordingly, on the down stroke of piston 23, an increased volume of concentrate is drawn from its container into tubing C. Similarly, a precise amount of liquid, exactly equal to the increased volume drawn from the tubing C, is driven from the pump P₂. Thus, the proportionate relation between diluent and concentrate is maintained constant after adjustment of the plates 25 to the left (or to the right) but the concentrate proportion exhausted to tubing C is increased adjustably.

The proportionality which has been established as described above and which exists between the diluent and the concentrated liquid and which has been established by suitable adjustment of the control plate 25 will be maintained at all times because the pumping action occurs on the same beam B. Should there be wear of the cam 17, for example, the dilution ratio will not change although the actual delivered amount may vary slightly.

The same reasoning applies in connection with the pump P₃ which does not materially differ in construction from the pump P₂. Its stroke may be adjusted by its own control plate 25 and the proportionality relative to the delivery of the pumps P₁ and P₂ will not change with wear of the cam 17.

In the sectioned portion of the apparatus shown in FIG. 2, there are additional features of the apparatus of FIG. 1. Here is shown the rack 63, drive arrangements by which the liquid containers R₁ (concentrate) and R₂ (dilution) are stepped along (left to right) in this figure which views the apparatus from the front instead of the rear, as in FIG. 1. A motor MA is mounted on a bottom plate 41 of block 37. This motor drives a stirring device 42 which, as shown, is positioned above a left end one of a row of concentrate containers R₁ which are positioned on a platform 64.

Fixed to this platform is the toothed rack 63 engaged by an articulated digit 62 associated with an arm 60 which is in turn fixed to a tensioned spring 65 and is rotatable about a pivot 61. This pivot 61, in turn is fixed

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to vertical plate 2. Thus the tensioned spring continuously urges the rack 63 and carriage 64 to move left to right as indicated by the arrow in FIG. 2. The clockwise driven cam 59 operates to bring arm 60 to the left as indicated by broken lines in FIG. 2. This movement of arm 60 is, of course, against the tension of spring 65. The articulated digit 62 slides over the sloped engaging tooth of rack 63 to bear against the near vertical surface of the next left tooth. Thus, after the arm 60 is rotated clockwise by cam 59, the spring 65 again urges the rack 63 and stand 64 to move right toward the pipet 34 to position another concentrate container R₁ in relation beneath this pipet 34. This pipet, it will be recalled, is a terminal portion of liquid transfer tubing C, seen in FIG. 1.

As this position is reached, another concentrate liquid container is positioned beneath stirrer 42 which is dropped into engagement with the indicated container R₁ liquid concentrate. This is effected by dropping the platform 41 on which the stirrer motor MA is positioned. This dropping, in turn, is effected by movement of rod 48 in the guide 49, designated in FIG. 3.

This dropping of the stirrer 42 into beaker R₁ corresponds to suitable rotation of pipet 34 about a right angled, horizontally disposed portion 36 (see FIG. 2) passing through an aperture 43 and subsequent lowering of the rod 46 as solenoid S is energized to raise connecting rod 44. Looking particularly to FIG. 3 this operation of pipet 34 becomes more clear.

Arm 46 which supports the horizontal tubing 36 associated with pipet 34 is rotated clockwise by energizing a solenoid S to raise shaft 44.

The electrical switching operations for performing these functions will be more clear upon examination of FIG. 4.

In this partially diagrammatic FIG. 4, the electrical control circuits for the above discussed operations are illustrated. An operation cycle of this embodiment of the invention may be considered as follows:

Motor M₁ is stopped with the beam B being in the upward position. A concentrate filled bottle R₁ is placed on the stand 64. The switch SW is closed manually to energize leads 101, 102 from a conventional electric power source (shown symbolically). This starts motor MA which operates stirrer 42. The motor M₂ lowers the stirrer 42 positioned in an associated container R₁ by lowering the plate 41 as guide rod 48 drops in guide 49. This lowering is preceded, see FIG. 2, by movement of platform 64 one step to the right under drive of motor M₂ through reducer 52. This one step movement brings a new concentrate container R₁ under stirrer 42 and positions a right hand, adjacent concentrate container beneath pipet 34. The solenoid S is energized to rotate pipet 34 to a vertical position in this concentrate container for drawing concentrate into the FIG. 1 tubing C as the piston 23 of pump P₂ (or P₃) moves downwardly with the start energizing of motor M₁ by manual closure of pushbutton P.

When the pipet 34 is lowered into the associated concentrate container the motor MA is stopped. Motor M₂ which has moved the container under the pipet 34, energized solenoid S by cam closure of switch I₅, represented by the switch position designated by letter T. The rest position of the various switches is designated by the letter R in this FIG. 4.

The cam actuation of the several switches I₁, . . . I₅ by rotation of the indicated motor is represented in FIG. 4 by centerlines connecting the motor and the associated switches.

Following a complete cycle of operation in view of FIG. 4 is informative. As shown, switches I₁ . . . I₅ are in rest position and relay switch E is open. Motor M₁ is stopped despite turn-on of energizing power switch SW. The cam 17 is positioned to hold the beam B in an upper position. At this cam 17 position, cam 18 is disposed to place switches I₁ and I₂ in the operate T, position. The

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push button P completes a circuit through limiting resistor Z and relay winding E to opposite terminals of power switch SW. Meanwhile, operation of this switch energizes Motor MA through switch I₅ (in the R position) whence the stirrer 42 is rotated (See FIG. 3).

Switch I₁ is in the operate position, T, whence M₂ rotates, as we have seen, upon closure of P. This rotation of M₂ operates through shift 51 and reducer 52 to advance stand 64 by an amount corresponding to the positioning of container R₁ one step forward. As we have seen, this leads to closure of switch I₅ and rotation of pipet 34 to a vertical attitude with subsequent lowering into a concentrate filled beaker R₁.

Now, I₅ being in the T position, I₄ is opened to the T position to stop M₂ and to start M₁. This results in pumping by the manually selected one of the two pumps (P₂, P₃) for drawing concentrate from the beaker R₁ as the FIG. 3 arm 46 is lowered under discipline of solenoid S. Now, as the beam B is rotated completely counter-clockwise by spring 18, with rotation of cam 17, the motor M₁ is stopped. Now M₂ starts to retract the pipet 34 from the concentrate container, beaker R₁. When the pipet is fully withdrawn, M₂ stops rotating. This condition reflects in switches I₃, I₄ and I₅ being in the operate, T, position with switches I₁ and I₂ in the rest, R, position. Now push button P is again operated. The solenoid S is energized to rotate pipet 34 clockwise toward positioning above solution receiving container R₂ as illustrated in dashed lines in FIG. 3. Now M₁ resumes rotation to raise beam B by action of cam 17. Motor MA stops. Pumps P₁, P₂, driven by the beam, drive liquid back through pipet 34 for exhausting into container R₂. As the beam B rotates upwardly to an extreme position of cam 17, the beaker R₂ contains a desiredly proportioned mixture of the two liquids, the concentrate liquid from R₁ and the diluent liquid from the reservoir connected to tube 8. This mixture conveniently is removed from platform 64 in the portable beaker R₂ for further use, such as analysis processing in apparatus of the type disclosed in the aforementioned Coulter patent.

It is evident that numerous and varied and advantageous diluting structures may be effected within the spirit and scope of the invention which has been illustrated in only one exemplary embodiment.

What is sought to be secured by Letters Patent of the United States is:

1. Automatic diluting apparatus for preparing a proportioned mixture of a first concentrate liquid and a second diluent liquid which comprises, diluent supplying conduit means adapted for connection to a source of said diluent liquid, transfer conduit means having an intake-exhaust end adapted upon certain circumstances to draw into said transfer conduit means a quantity of said concentrate and upon other circumstances to exhaust a properly proportioned mixture, a first reciprocally operating pump for supplying diluent from said source to said transfer conduit means and having an internal chamber, a second and a third reciprocally operating pump for drawing concentrate into said transfer conduit means, the pumps being connected to said transfer conduit means, but the first pump having a valving arrangement interposed between the first pump and the transfer conduit means as well as between the first pump and the diluent supplying conduit means which disconnects the first pump from the transfer conduit means on one direction of the stroke of the first pump while connecting the first pump to said diluent supplying conduit means, and which provides reverse connections during the second direction of said stroke of the first pump, an articulated beam having a rotary drive for providing limited angular swinging cyclic movement of said beam, the first, second and third pumps being coupled with the beam to be reciprocated together with each swinging movement of the beam, the third pump having means to enable the third pump alternatively to be connected with

said transfer conduit means in place of said second pump, whereby on one direction swing of the beam the first pump will fill its chamber with diluent while the second pump will draw through said intake-exhaust end a predetermined quantity of concentrate into said transfer conduit means, while on the reverse direction swing of said beam, the first pump will discharge a predetermined volume of diluent from its chamber into said transfer conduit means at the same time the second pump will decrease the total volume of the transfer conduit means by the volume of concentrate drawn in as aforesaid, whereby a predetermined dilution of diluent and concentrate will discharge from said intake-exhaust end.

2. Apparatus is claimed in claim 1 in which the coupling between said pumps and said beam is adjustable whereby to vary the volumetric displacement relationship between pumps for any given swing of said beam.

3. Apparatus as claimed in claim 1 in which the coupling of said third pump with said beam is adjustable.

4. Apparatus as claimed in claim 1 in which platform means are provided for supporting a first concentrate carrying vessel and a second empty vessel in operative relation to said intake-exhaust end.

5. Apparatus as claimed in claim 4 and including means rotatably mounting said intake-exhaust end and bringing said end into liquid intake relationship with said first container prior to the said one direction swing of said beam, retaining said end in said intake relationship during said first direction swing, moving said end out of said intake relationship after said first direction swing and into exhaust position relative to said second container and retaining said exhaust position during said reverse direction swing.

6. Apparatus as claimed in claim 5 in which means are provided for automatically lowering and raising said intake-exhaust end into and out of said first vessel, respectively, before and after said one direction swing.

7. Apparatus as claimed in claim 5 in which means are provided for supporting a plurality of said containers on said platform means and moving consecutive pairs of said containers into the positions of said first and second containers for each cycle of swinging of said beam.

8. Apparatus for automatically preparing a proportioned dilution of a first, concentrate liquid and a second diluent liquid which comprises, a base plate and a vertical plate, said plates being arranged for providing a foundation for said apparatus, a first electric motor, a first reciprocating pump having a body and a piston disposed for sliding motion therein, a second reciprocating pump having a body and a piston disposed for sliding motion therein, said second pump body having an exit port at an end portion thereof, transfer tubing having an inlet end and a terminal end, said tubing being connected in liquid transfer relation with said first reciprocating pump and said second reciprocating pump, whereby on alternate, reciprocal strokes of said first reciprocating pump piston like amounts of a contained liquid are interchanged between said tubing and said first reciprocating pump body, a third reciprocally operating pump having a body and a piston disposed for sliding motion therein, means to enable said third pump alternatively to be connected with said transfer tubing in place of said second pump, check valve means for providing a unidirectional liquid transfer coupling from a source of diluent liquid to said transfer tubing inlet end, a beam having a pivotal mount at one end to said vertical plate, a cam mounted for rotation with said first electric motor, said cam disposed for engaging an under surface of said beam, a tensioned spring fixed to said base plate urging said pivotally mounted beam to contact with said cam, whereby said beam is urged to reciprocal rotation about said pivotal mount, means engaging an upper surface of said beam in driving relation with said first, second and third pump pistons, a pipet connected in liquid transfer relation with said transfer tubing terminal end, a second

electric motor, gear means connecting said second motor in driving relation with said pipet means for selectively shifting said pipet between raised and lowered positions with respect to said base plate.

9. Apparatus as claimed in claim 8 wherein said pipet comprises a right angle portion rotatably mounted in liquid connection with said transfer tubing for movement of the terminal portion of said pipet between two positions toward and away from said vertical plate in accordance with rotation of said right angle portion.

10. Apparatus as claimed in claim 9 and in combination therewith, a longitudinally extending platform positioned above said base plate, said platform being dimensioned for supporting first and second vessels in transverse disposition in correspondence with the two positions of said pipet upon rotation of said pipet right angle portion.

11. Apparatus in accordance with claim 10 and in combination therewith, a rack having plural teeth spaced therealong and being connected to said platform for driving said platform to stepped longitudinal motion parallel to said base plate.

12. Apparatus as claimed in claim 11 which comprises means connecting said second electric motor in rotating relation with said drive arm for bringing said drive arm lower end successively into driving relation with consecutive ones of said plural rack teeth.

13. Apparatus as claimed in claim 10 wherein said gear means connecting said second electric motor with said pipet includes further means for alternately raising and lowering said pipet with respect to said platform whereby, when said pipet is lowered to engagement with concentrate in a vessel on said platform, said concentrate is drawn into said transfer tubing in measured amount corresponding to the volume swept out by a downward stroke of said second pump piston.

14. Apparatus as claimed in claim 13 wherein switching means are provided to coordinate said gear means for raising and lowering said pipet with the positioning of said pipet away from said vertical plate.

15. Apparatus as claimed in claim 13 including means for rotating said pipet, said gear means for raising and lowering said pipet and said means for rotating said pipet being coordinated with the motion of said pump piston in a direction for ejecting liquid in metered amount from said second pump by way of said transfer tubing and said pipet to a vessel positioned on said longitudinal platform adjacent said vertical plate.

16. Automatic diluting apparatus for preparing a proportioned dilution of a first concentrate liquid and a second diluent liquid which comprises transfer tubing having a terminal end, means connected with a source of said diluent liquid for supplying said diluent to said transfer tubing, said last named means comprising a check valve for stopping flow of liquid from said transfer tubing to said diluent liquid source, pump means connected to said transfer tubing for reciprocally interchanging a metered amount of liquid with said transfer tubing, said pump means including at least two reciprocally operating pumps and having means to enable either of said pumps alternatively to be connected with said transfer tubing, pipet means connected in terminal liquid transfer relation with said transfer tubing, a first portable vessel for containing liquid concentrate to be diluted and a second portable vessel for receiving said proportioned dilution, a longitudinally extending platform for supporting said first and second vessels in adjacent transverse relation, and means for longitudinally moving said platform in discrete steps whereby upon movement of said platform a preassigned number of steps said first and second portable vessels are brought into liquid transfer relation with said pipet.

17. Apparatus as claimed in claim 16 wherein said moving means comprises electric motor means, a toothed rack linked to said platform, and a rotatably mounted arm driven in arcuate movement for engaging successive

teeth on said rack whereby said platform is driven to stepped longitudinal motion for disposing said adjacent first and second vessels in operative alignment with said pipet.

18. Apparatus as claimed in claim 16 and in combination therewith means for successively lowering said pipet into operative engagement with interior portions of said vessels in time coincidence with respective suction and ejection operations of said pump means.

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U.S. Cl. X.R.

137—567; 141—98, 130, 181, 190; 222—135, 145, 266