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Guigan

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[54] **MANIFOLD LIQUID DISTRIBUTOR**

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[30] **Foreign Application Priority Data**

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Feb. 24, 1971 France 7106311

[52] **U.S. Cl.** **141/34,** 23/259, 141/236, 141/245, 141/329, 233/26

[51] **Int. Cl.** **B65b 37/12,** B01l 11/00

[58] **Field of Search** 141/31, 34, 54, 57, 141/58, 59, 99, 100, 234, 236, 283, 285, 286, 297, 312, 325, 329, 330, 331, 332, 363, 369, 370, 392, 245; 222/319; 233/26; 23/259

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Primary Examiner—John Petrakes
Assistant Examiner—Frederick R. Schmidt
Attorney—Richard C. Sughrue et al.

[57] **ABSTRACT**

The present invention provides apparatus for removing a measured quantity of liquid by a series of capillary tubes with the subsequent introduction of the liquid into respective work tubes for the performance of, for example, chemical reactions. The liquid is introduced into the capillary tubes by a piston action and then subsequently forced passed a restrictive orifice under the influence of a centrifugal action. Various forms of creating the piston action are provided.

20 Claims, 10 Drawing Figures

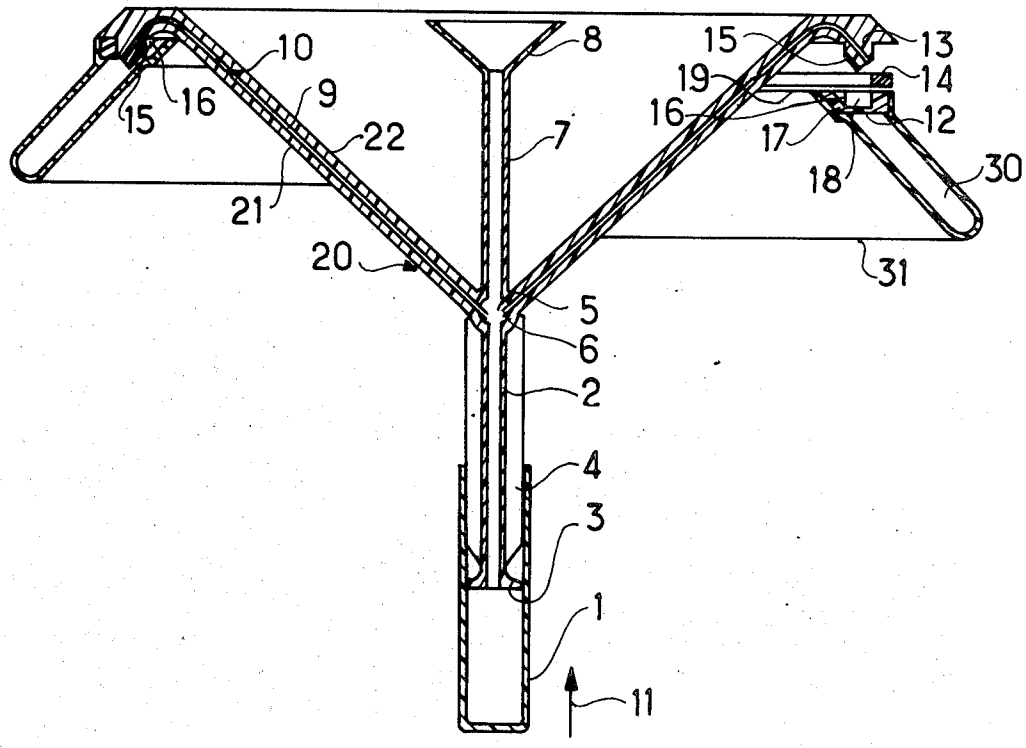


FIG. 1

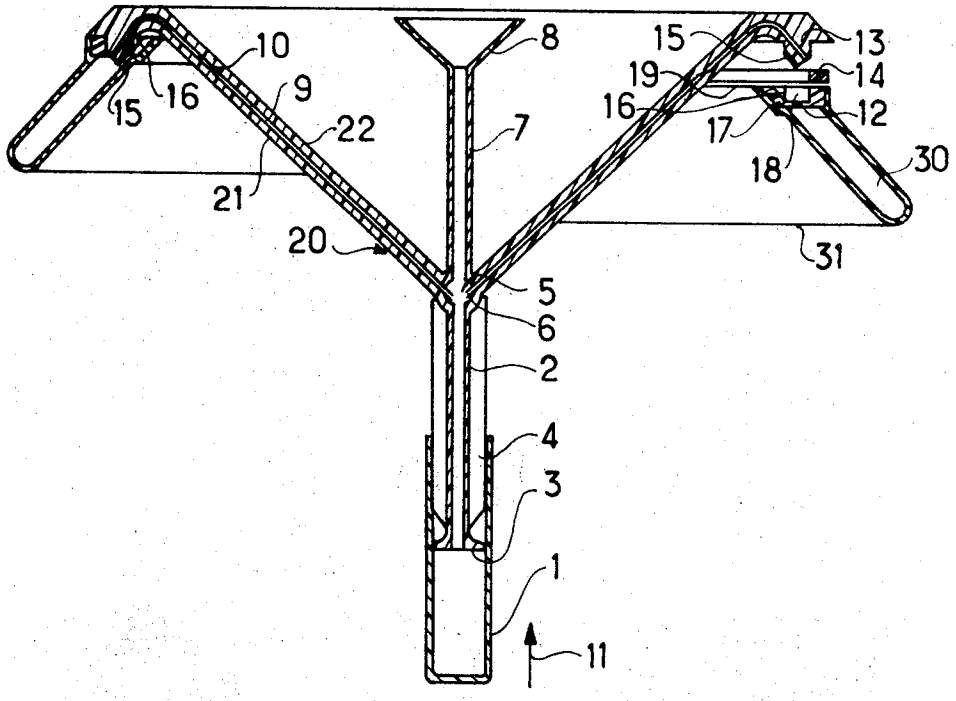


FIG. 2

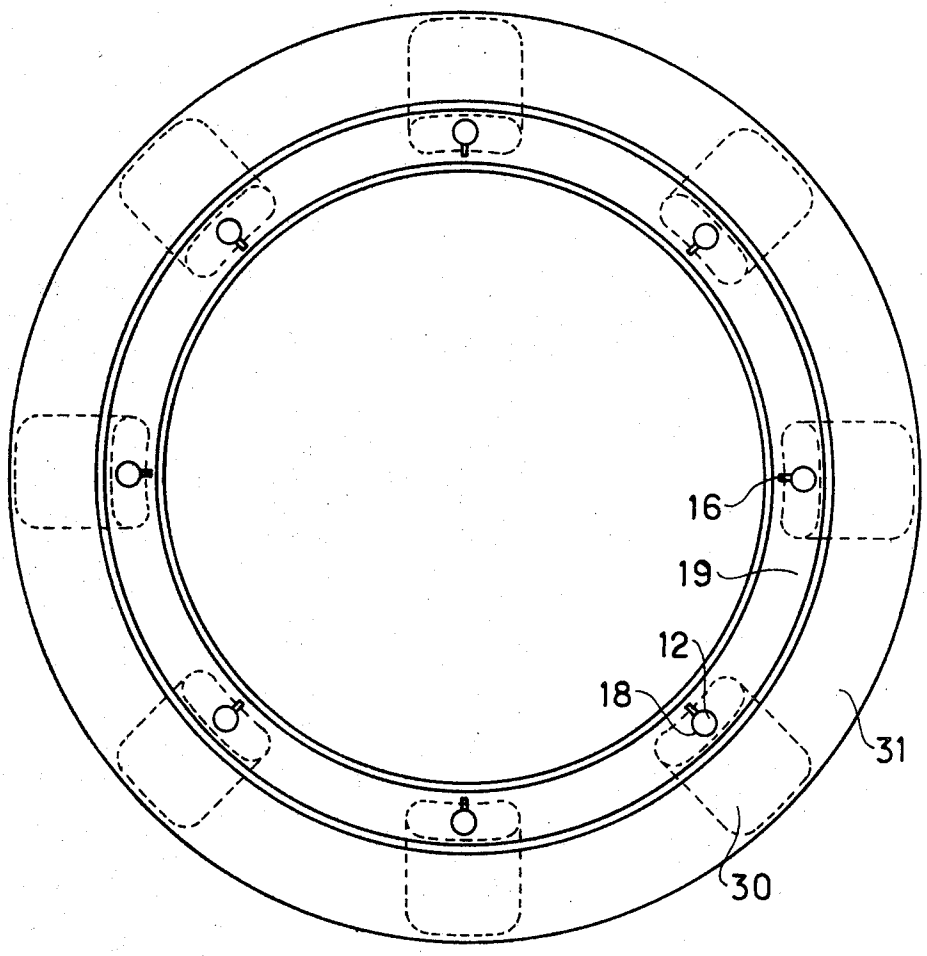


FIG. 3

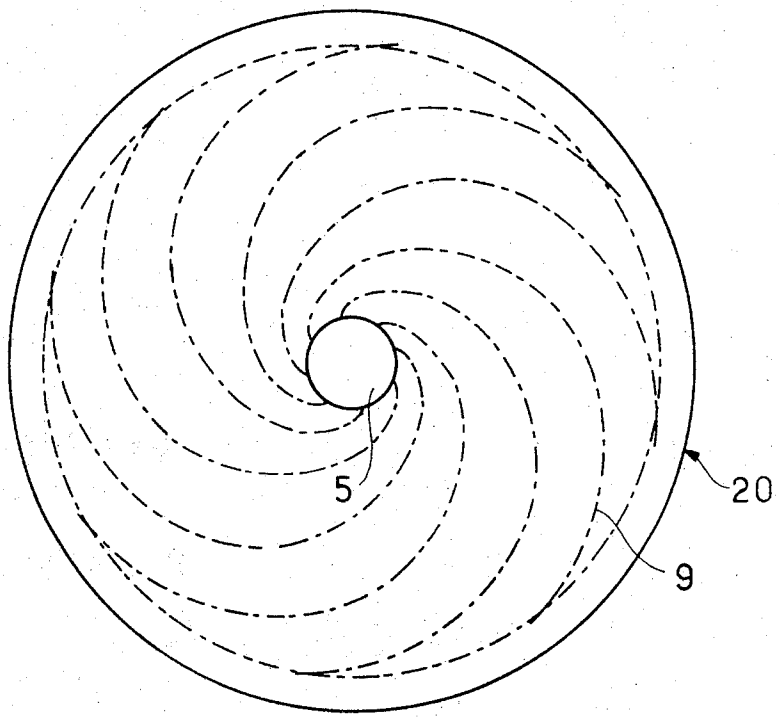


FIG. 4

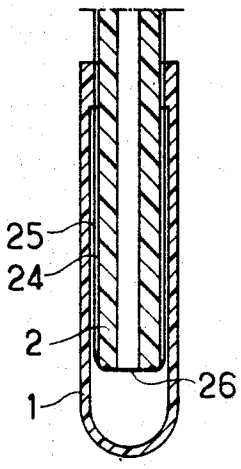


FIG. 5

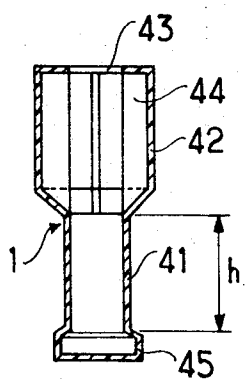


FIG. 6

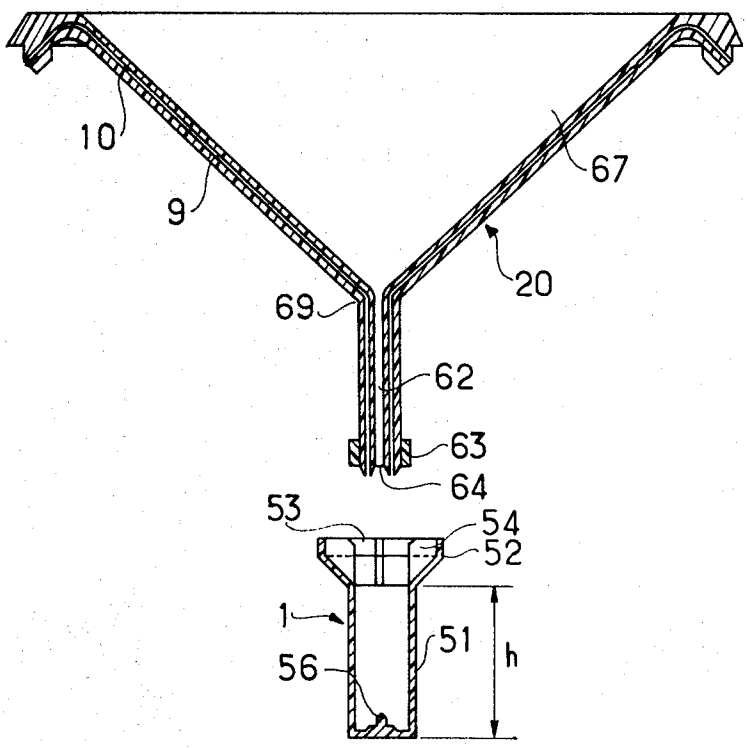


FIG. 7

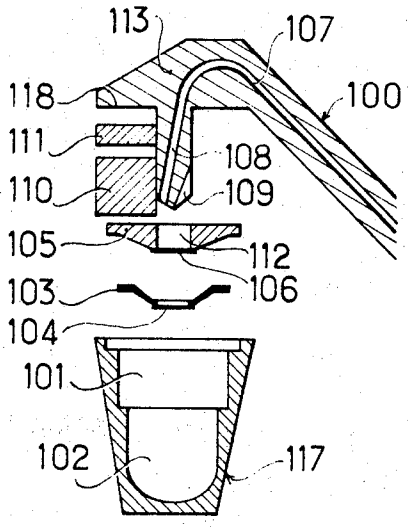


FIG. 8

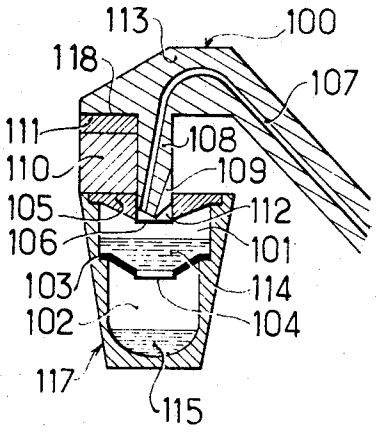


FIG. 9

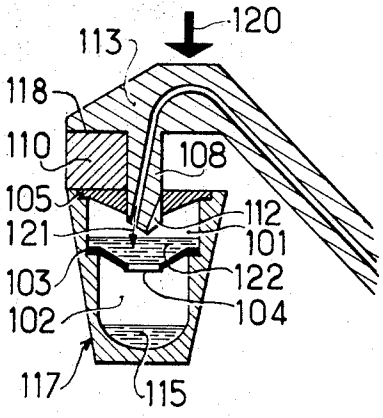
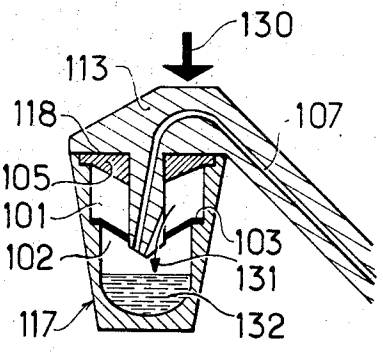


FIG. 10



MANIFOLD LIQUID DISTRIBUTOR

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a manifold distributor of a measured liquid substance from a first container in which it is stored to a plurality of secondary containers.

SUMMARY OF THE INVENTION

The aim of the present invention is to provide a distributor of simple structure, which is low in cost and provides rapid and reliable operation.

Another aim of the invention is the simultaneous distribution of measured amounts of liquid into each of the secondary containers, these amounts being preferably small and accurately measured.

The present invention has as its object a manifold distributor of a liquid in measured amounts comprising a first tube for collecting the liquid to be distributed and a plurality of secondary tubes known as work tubes and intended for receiving the measured amounts of the liquid, characterized in that it also comprises a plurality of capillary conduits provided with throttling means, a piston action cooperating with the collection tube to ensure the filling of the conduits from the collection tube via a first end of the former and at least as far as the throttling means, venting means of the first end of the conduits, and centrifugal means cooperating with the work tubes to ensure the transfer into the latter of the liquid contained in the conduit.

BRIEF DESCRIPTION OF THE DRAWINGS

Other features of the manifold distributor according to the invention will be given in the following description relating to the attached drawings in which:

FIG. 1 is a sectional view along an axial plane of the device according to the invention;

FIG. 2 shows a plan view of the unit for collecting the measured amounts of the liquid;

FIG. 3 is a diagrammatic plan view of an embodiment of the retention member;

FIGS. 4 and 5 show two embodiments of one of the members of FIG. 1;

FIG. 6 is a sectional view along an axial plane of an embodiment with respect to FIG. 1;

FIG. 7 is an enlarged partial sectional view of a work tube and the conduit associated with it according to an embodiment of the invention;

FIGS. 8, 9 and 10 are sectional views of three respective positions of the work tube and the conduit associated with it as shown in FIG. 7.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

As shown in the Figures, the manifold distributor comprises essentially three parts intended to work together to ensure a simultaneous distribution of measured amounts of a same liquid.

The manifold distributor comprises a storage tube 1 of the liquid, known hereafter as the tube for collecting the liquid of which measured amounts are to be distributed, a member 20 for the retention of measured amounts of the liquid, the member ensuring the drawing off of the liquid and its distribution in measured amounts, and a plurality of storage tubes 30 for the measured amounts of the liquid, the tubes being known hereinafter as work tubes.

In FIG. 1, the collection tube 1 has a constant cross-section. The tube 1 is open at its upper end. The member 20 consists of a hollow tube 2 of slight section in relation to that of the collection tube 1, provided at a first open end intended to penetrate into the collection tube 1, with a collar 3 of the same external diameter as the internal diameter of the collection tube 1. Blades 4 disposed along the length of tube 2 are intended to ensure the guiding of the latter within the collection tube 1.

The second end of tube 2 opens into a central chamber 5 of spherical shape in FIG 1, the outer wall of which is provided, over a section along a plane perpendicular to the axis of the tube 2, with a plurality of regularly disposed orifices 6 into which issue a plurality of conduits 9 having a very small section. A tube 7 disposed in the extended part of tube 2 has a first end which also debouches into the central chamber 5. The second end of tube 7 widens out into 8.

The conduits 9 ending in the orifices 6 of the central chamber 5 are disposed radially with respect to chamber 5. These conduits 9 are constituted by tubes, for example, capillary tubes. Each comprises a throttling means 10, the volume between the end opening into one of the orifices 6 and the section of the lowest diameter of the throttling means being calibrated with precision.

The portions between the second ends of the conduit 9 and the throttling means are bent outwards, the vertices of the bends being at a similar or slightly higher level than that of the funnel-shaped part 8 of the tube 7. The second ends of the conduits 9 are regularly distributed on a circumference having as an axis the axis of the tube 2 or 7. These ends are intended to issue respectively into a plurality of work tubes 30 joined one to the other by means of an annular bearer element 31 on which they are regularly spaced, the distance between the openings of two successive work tubes 30 being equal to that between the second ends of two successive conduits 9.

Each of the work tubes 30 is closed initially by a piece 17, the central part of which forms an easily pierceable disphragm 12.

Above the disphragm 12, the piece 17 limits a recess 18 ensuring the guiding into position of a piece 13 in which is sunk the second end of the corresponding conduit 9 which is intended to open into the relevant work tube 30. This piece 13 has a section end which is substantially equal to that of the recess 18, the end terminating in a tapered point turned towards the diaphragm 12 to be pierced.

A circular band 14 of cardboard or the like may form a cross-piece between the piece 13 and each corresponding diaphragm 12 and may thus isolate the conical end of the piece 13 from the diaphragm 12 before utilization of the device. To use the device the band is removed by using a circular tearing movement. An outwardly projecting portion of the band allows it to be gripped for this purpose.

Preferably, as illustrated in FIG. 1, a groove 15 made in the conical end of the piece 13, supplemented by a groove 16 made in the part of the piece 17 limiting the recess 18, ensures venting of the conduit 9 when the diaphragm 12 has not been pierced, and venting of the corresponding work tube 30 when the diaphragm 12 has been pierced.

It will be noted in the example of the embodiment in FIG. 1, that the conduits 9 are inclined with respect to the axis of the tube 2. The work tubes 30 have, with respect to an axis passing through the vertex of the bend and parallel to the axis of the tube 2, an inclination which is substantially symmetrical with that of the conduit 9 with which they are respectively associated.

Individual embodiments of the device will now be described.

The liquid to be distributed into the tubes 30 is collected in tube 1. The device described above is held horizontally; the tube 1 is positioned onto the central tube 2 of the device so as to establish a connection between the collection tube 1 and the central chamber 5. By applying pressure in the direction indicated by the arrow 11 on the base of the tube 1, the collar 3 adopts the role of a piston and the liquid rises in tube 1 towards chamber 5.

In proportion to the distance the hollow tube 2 penetrates the collection tube 1 and in dependence on the capacity of the capillary tubes 9 the liquid rises in the conduit 9; either by capillary attraction — as soon as a sufficient amount of the liquid reaches the chamber 5, the liquid rises as far as the level of the throttling means 10 solely by virtue of the capillary force; or by the action of the pressure maintained by continuing to push the collection tube 1 in the direction of the arrow 11. In this case, the level of the liquid is raised to the level of the throttling means 10 in the conduit 9 and even beyond this point. At the same time, the liquid rises to the same level in the tube 7 and reaches the widened part 8 intended to control the maximum level attained in the conduits 9 so that the liquid will in no event rise above the level of the bend of each conduit 9 and flow over the ends of the conduit 9.

In the two above cases, by subsequently drawing the collection tube 1 downwards, i.e., in the opposite direction to that of the arrow 11, or by pulling the unit 20 upwards the level of the liquid in the conduits 9 and/or the tube 7, the chamber 5 and the tube 2 will descend. Under the influence of the capillar forces at the level of the throttling means 10, the level of the liquid in the conduit 9 will only descend to the level of these throttling means. In the upper central tube 7, in the chamber 5 and in the lower central tube 2, the level of the liquid descends until all the liquid contained in these elements has flowed into the collection tube 1.

In this way, at the end of this operation, each conduit 9 contains a measured amount of the liquid between its lower end and the throttling means.

The device is then rotated about its symmetry axis (the axes of the tubes 2 and 7) either by hand or with the aid of a small centrifuge, which is not shown, and on which is mounted the end of the central tube 2 removed from the collection tube 1.

The ends of the conduit 9 are then engaged respectively in the work tubes 30, each piece 13 piercing the corresponding diaphragm 12.

Under the influence of centrifugal force, the amounts of liquid contained in the conduit 9 pass from these conduits into the corresponding work tubes 30 where they are mixed if necessary with the solvent, a reagent or a known quantity of any other liquid or solid substance placed in the work tubes.

Each work tube thus receives simultaneously an accurately measured amount of liquid. Preferably, the measured amounts of liquid will be identical from one tube to another.

To facilitate comprehension of the operation of the device, on the lefthand side of FIG. 1 is shown the end of one of the conduits 9 discharging into the inside of the corresponding work tube 30, the diaphragm 12 having been pierced, the grooves 15 and 16 thus bringing the inside of the tube into contact with the outside of the conduit. The end of one of the conduits 9 shown on the righthand side of FIG. 1 has not pierced the corresponding tube 30 and is thus not in contact with the inside of this work tube.

In the form of embodiment shown in FIG. 1, collection tube 1 is of a known conventional type. The member 20 for the drawing off and distribution of measured amounts of liquid may be obtained, for example, by superposing two half shells, a lower shell 21 an an upper shell 22 having on their opposing faces grooves which complement each other to form the interior parts of the conduit 9 and the central chamber 5 when the two half shells 21 and 22 are assembled in a sealed manner at least along the edges of these grooves. The lower half shell 21 comprises the lower central tube 2 fitted with the collar 3 and the blades 4 while the upper half shell 22 comprises the upper central tube 7, the widened upper part 8 of the central tube 7 preferably being a part connected to the tube 7.

The work tubes 30 which are integrally linked to one another by an annular bearer element 31 and which are intended to receive measured amounts of the liquid may be formed, as shown in FIG. 2, by a series of regularly spaced cavities in a crown forming the bearer element 31. The crown 31 is an inclined generatrix. The cavities defined in the crown 31 are inclined with respect to the axis of the crown 31, the centers of the openings of the tubes 30 being regularly distributed on a circle having a lower diameter than that on which the central part of their respective bases are regularly distributed. The openings of the cavities or work tubes 30 are sealed by a flat annular piece 19 having on one face, as shown in FIG. 1, portions in relief, the dimension of each of which are substantially equal to those of the openings of the work tubes, such that the latter are sealed by the portions. This flat piece 19 has on its other face, hollowed portions to the right of the central part of the portions in relief. These hollow portions form the aforementioned recesses 18 which ensure the centering of the second ends of the conduits 9 on the opening of the tubes 30 and which then permit easy perforation of the thin central parts of the portions in relief, the central parts forming the aforementioned diaphragm 12.

The grooves 16 which are intended to cooperate with the grooves 15 are cut in those portions of the piece 19 limiting the recesses 18. These grooves may be seen in FIG. 1 and are intended for the venting of the tubes 30 when the ends of the conduit 9 penetrate into these tubes.

FIG. 3 is a schematic view of a variant of an embodiment of FIG. 1. In FIG. 3, the capillary conduits 9 that penetrate into the central chamber 5 instead of being radially disposed as described with respect to FIG. 1, are curved inward in the form of a spiral so as to present greater capacities with a similar load or identical capacities with a reduced load. In FIG. 3, the conduits 9 have merely been schematized by the perforated lines which refer to the capillar conduits. This form an dispo-

sition of the conduits 9 also render possible for the centrifugation, the use of the force of inertia at the start of the rotation of the displacement of the columns of liquid to be distributed into the work tubes 30.

In an embodiment shown in FIG. 4, the liquid may be discharged from the collection tube 1, not by pushing this tube 1 in the direction of the arrow 11 of FIG. 1, but by screwing it onto the lower central tube 2. This embodiment does not involve any modification to the operating principle given with respect to FIG 1.

In FIG. 4, the lower central tube 2 has an outer thread 24 and the collection tube 1 has an internal screw cutting 25. The outer diameter of the central tube 2 is substantially equal to that of the collection tube. The collection tube screws onto the central tube 2 which acts as a plunger. The liquid is then pushed in proportion to tube 1 into tube 2 which has a reduced internal section in relation to that of tube 1.

In addition, FIG. 4 discloses the central tube 2 carrying a filter 26 on its lower part. It is obvious that the lower part of the tube 2 in the embodiment given in FIG. 1 may be provided with such a filter.

In the method of operation given above, the filling of the conduits 9 and the measuring of the amounts of the liquid to be subsequently transferred into the respective work tubes 30 are effected in two stages corresponding to the pushing movement of tube 1 when the central tube 2 penetrates further into tube 1 and to the retraction of the central tube 2 from the collection tube 1.

FIG. 5 discloses another embodiment of the collection tube 1 permitting a simplified method of operation. In FIG. 5, the collection tube 1 has a lower cylindrical part 41 and an upper part 42 which is frustoconical and then cylindrical with a larger section than that of the lower part 41. The opening 43 of this tube has the same diameter as that of the lower part 41. In the upper part 42, the tube is fitted with blades 44 extending in such a way as to align approximately the edges of the openings 43 and the wall of the part 41. The lower part 41 is extended by a portion 45 forming the base of the tube. This portion 45 is slightly larger in diameter than that of the part 41.

The drawing off and distribution member is similar to that shown in FIG. 1. The lower central tube 2 has a constant transversal cross-section. The end of this central tube which is intended to penetrate into the collection tube 1 is fitted with a collar such as 3 which forms the piston. The outer diameter of this collar is substantially equal to that of the opening 43 or the part 41 of the collection tube.

The lower control tube 2 may, as shown in FIG. 1, be provided with guide blades such as 4.

When the piston of the lower central tube 2 is introduced into the lower collection tube 1, the level of the liquid in the collection tube and in the central tube rises to a level proportional to the volume displaced. As soon as the collar forming the piston reaches the part 41 having the smallest section, the volume of the liquid contained in the part 45 is isolated from that contained in part 42. As the piston descends in part 41, the level of the liquid descends in part 42, while under the influence of the generated pressure the liquid in parts 41 and 45 makes the level rise in the central tube 2 and then in the capillary conduits 9 and the central tube 7. In the embodiment of the collection tube according to FIG. 5, the level of the part 41 is calculated so that the volume of liquid displaced from the collection tube to the central tube 2 and to the conduits 9 is allowed to pass the level of the throttling means 10 of the conduits 9. The piston 3 continues to descend in the collection tube and at the end of its course reaches the part 45 forming the base of the collection tube. As the piston is lower in height than that of the portion 45, the collar 3 fitted on the end of the central tube 2 no longer forms a piston which has the effect of placing in contact the volumes of liquid contained in the parts of the tube 1 on the one hand with the liquid of the collar 3 on the other. The level of liquid in the central tube 7 descends. In the conduits 9, the level of liquid descends to the level of the smallest section of the throttling means, while the liquid rises in the collection tube as all the liquid flows from the central tube 7 of the central chamber 5 and the lower central tube 2. The measured amounts of liquid are thus contained in the portions of the conduits 9 lying between their ends opening into the central chamber 5 and the throttling means. The collection tube can then be centrifuged with the unit comprising the conduits 9. The edge at the level of the opening prevents overflow of the liquid during the distribution of the measured amounts of liquid into the respective work tubes.

FIG. 6 shows another variant of an embodiment of the collection tube 1 and the member 20 for the drawing of measured amounts of liquid.

The collection tube 1 is similar to that shown in FIG. 5. It comprises a lower cylindrical part 51 having a smaller section than upper part 52. The lower part of the part 51 bears the base of the collection tube. The base of th tube comprises a substantially conical stud 56 disposed substantially in its center. The part 52 is cylindrical at the level of the opening 53 of the tube and frustoconical to permit connection with the part 51 having an upper section smaller than part 52. Part 52 is also provided with blades 54 extending towards the inside of the tube and coming into alignment with the walls of the part 51.

The member 20 comprises the capillary conduits 9 but in this embodiment as compared to that of FIG. 1, the conduits 9 are bent at 69 such that the lower part of each of these is vertical. All the lower vertical parts of the conduits 9 extend to the end of the central tube 62 (analogous to the central tube 2 of FIG. 1). At its lower end, the group of vertical parts of the conduits 9 is provided with a collar 63 having an outer diameter which is substantially equal to the diameter of the cross-section of part 51 of the collection tube, whereas the lower end of the central tube 62 is closed by a sealed diaphragm 64.

The second end of the central tube 62 is in contact with the atmosphere. For this reason, the second end of the tube 62 emerges either in the lower part 67 of the group of median parts of the conduits 9 or in an annular conduit which is also open and which is located in the inner space formed by the median parts of the conduits 9.

As in the case of the embodiments described above, the collar 63 is introduced into the collection tube 1. As soon as it reaches the part 51, having a constant but smaller section than that of the part 52, it adopts the role of a piston. The liquid imprisoned in the part 51 below the piston rises in the conduits 9 under the influence of the pressure as the collar 63 descends in the tube 1. The volume of the part 51 of the collection tube

is selected so that it is equal or slightly greater than the sum of the volumes of the liquid in the parts of the capillary conduits lying between their lower ends and the throttling means **10**.

At the end of the stroke of the piston **63** in the part **51** of the collection tube, the conical bussing **56** pierces the diaphragm **64** initially sealing the central tube **62**. The columns of liquid in the conduits **9** thus come into contact with the atmosphere. The level of liquid descends in the conduits **9** to the level of the throttling means **10**. The collection tube is then withdrawn and the group **20** is then centrifuged to obtained distribution of the measured amount of the liquid in the work tubes.

In the above embodiment, the collection tube and/or the retention member **20** of the measured amounts of liquid and/or the work tubes are preferably of transparent plastic materials. The work tubes may contain initially reagents in the form of a liquid or solid or absorbed, for example, in blotting paper, to allow for direct analysis of the liquid distributed in the work tubes by direct examination of the colored reactions or by comparing these reactions with a colored screen.

In the embodiment of FIG. **7**, the work tube **117** comprises two superimposed compartments **101** and **102** closed respectively by a piece **105** fitted with a pierceable diaphragm **106** and a piece **103** fitted with a pierceable diaphragm **104**.

The pierceable diaphragm **106** is disposed, for example, at the bottom of a cylindrical hole **112** made in the piece **105**.

The conduit **100** comprises a channel **107** and is bent at **113** at the level of its end, towards the outside of the retention unit. The end of the channel **107** discharges through a conical point **108** disposed facing the work tube **117**.

The conical point **108** is provided with a neck **109**, which is preferably sharp. The neck **109** of the point **108** is intended to ensure the venting of the upper compartment **101** and the bringing into contact of the compartment **101** with the adjacent compartment **102**.

The superimposed cross-piece **110** and **111** are applied between a plane face **118** of the conduit **100** and a plane face of the piece **105** to limit the course of the piece **108** and to keep the neck **108** at predetermined levels in the work tube **117**.

According to a preferred embodiment, the cross-piece **111** and **110** are common to all the tubes **117** of the manifold distributor and consist of circular bands which may be removed at the time of use by a circular movement. Each of the bands may be provided with a part which is not shown but which projects outward to facilitate gripping the band.

The implementation of a device according to the invention is described below with reference to FIGS. **8**, **9** and **10**.

Compartment **101** is first partially filled with a first reagent **114** and compartment **102** with a second reagent **115** (see FIG. **8**).

The plane face **118** of the conduit **100** abuts against the cross-pieces **110** and **111** and the end of the conical point **108** is disposed slightly above the diaphragm **106** closing the compartments **101**.

In a first phase (see FIG. **9**), the cross-piece **111** is removed and pressure is applied to the bend **113** in the direction of the arrow **120**. The face **118** of the conduit **100** abuts on the cross-piece **110**. The end of the conical point **108** tears the diaphragm **106** and penetrates into compartment **101**. The beveled neck **109** ensures venting of this compartment.

In a second stage the liquid contained in the channel **107** is injected by centrifuging according to arrow **121** into compartment **101** and is mixed with the reagent **114**. **122** is the resultant mixture thus obtained.

In a third stage, for example, after a period of incubation of the mixture **122** at a given temperature, the cross-piece **110** is removed (see FIG. **10**) and pressure is applied to the bend **113** in the direction of the arrow **130**. The face **118** comes to rest against the upper face of the piece **105**. The end of the conical point **118** tears the diaphragm **104** and penetrates into compartment **102**.

The neck **109** **102** ensures contact between the two compartments. The mixture **122** flows in the direction of the arrow **131** into the reagent **115**. The new mixture obtained is designated by **132**. The tube **107**, which is now empty of liquid, ensures venting of the compartment **102**.

A particular embodiment of the device according to the invention has been described.

Naturally, the work tube **117** may comprise any number of superimposed compartments connected, for example, to a plurality of cross-piece. The reagents may be in liquid or solid form.

Various modifications can be accomplished in the present invention by those skilled in the art and accordingly the scope of the present invention shold be measured solely from the following claims.

What is claimed is:

1. An apparatus for distributing liquid in discrete measured quantities comprising:

a collection tube for holding the liquid to be distributed;

a plurality of capillary conduits having a size relative to the type of liquid to be distributed to permit a capillary action between the liquid and the conduits connected to the collection tube;

throttling means in each of the conduits;

means for forcing and passing the liquid from the collection tube into the conduits at least as far as the throttling means;

means for venting the collection tube thereby permitting the liquid to be retained in the conduits to the extent of said throttling means;

work tubes connected to each conduit for receiving its respective retained quantity of liquid, and

means for forcing the liquid retained in the conduits into the working tubes.

2. An apparatus as in claim **1** wherein: the means for forcing the liquid from the collection tube comprising means for moving the collection tube relative to the conduits to produce a piston action on the liquid in the collection tube thereby forcing the liquid into the conduits.

3. An apparatus as in claim **1** wherein the means for forcing the liquid into the work tubes includes means for rotation of the conduits to produce a centrifugal action.

4. An apparatus as in claim **1** wherein the means for forcing the liquid from the collection tube includes a plunger conduit connected to each of the conduits that receive a measured quantity of liquid and wherein, at least a portion of the outside diameter of the plunger

conduit corresponds approximately to at least a portion of the inside diameter of the collection tube.

5. An apparatus as in claim 4 wherein guide flanges are attached to the plunger conduit.

6. An apparatus as in claim 4 wherein the plunger conduit and the collection tube are respectively threaded to permit a screw action between each other.

7. An apparatus as claimed in claim 4 wherein: the collection tube has a central narrow position of the same inside diameter as the outside diameter of the plunger conduit with the upper and lower portions of the collection tube having larger diameters.

8. An apparatus as in claim 4 wherein the conduits extend to the bottom of the plunger conduit, the plunger conduit having a vent conduit sealed with a diaphragm and the collection tube having a piercing stud located on its inside surface for piercing the diaphragm.

9. An apparatus as in claim 4 wherein: the radially outer ends of said conduits terminate in a sharp puncturing tip and the work tubes having a sealing diaphragm across their surface designed to be punctured by the conduit tips.

10. An apparatus as in claim 9 where the throttling means includes a restricted orifice.

11. An apparatus as in claim 1 wherein an overflow tube is connected to the conduits.

12. An apparatus as in claim 1 wherein the conduits are conically arranged about the collection tube and the work tubes are arranged approximately perpendicular to the plane of the cone.

13. An apparatus as in claim 1 wherein: the conduits terminate at their radially outer ends, in a sharp puncturing tip and the work tubes have a sealing diaphragm acros their surface designated to be punctured by the conduit tips.

14. An apparatus as in claim 13 wherein: the means for venting includes a groove adjacent the puncturing tip of each conduit.

15. An apparatus as in claim 1 wherein the conduits are bent approximately 90° before connection with the work tubes but after the throttling means.

16. An apparatus as claimed in claim 1 further comprising a ring portion for holding the work tubes at circumferentially spaced positions.

17. An apparatus as in claim 1 wherein the conduits are arranged in a conical plane and spiral outward fro the collection tube.

18. An apparatus as in claim wherein: the work tubes are divided into two liquid retaining portions by a diaphragm, the top portion adapted to hold one reactant while the bottom is adapted to hold another reactant.

19. An apparatus as in claim 1 wherein; the conduits terminate at their radial outer ends in a sharp tip, the work tubes have an outer and inner sealing diaphragm spaced axially from each other and a spacer is provided between said conduits and said tubes for limiting the respective tip of each conduit to pierce only the outer diaphragm when the outer ends of the tubes are connected to the conduits.

20. An apparatus as in claim 19 wherein the conduits have an adjacent bearing shoulder for receiving the spacer.

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