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PUMPING METHOD AND PUMPS FOR SUSPENSIONS

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FIG. 1

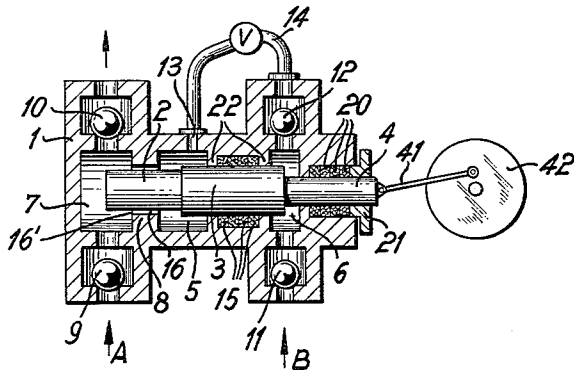
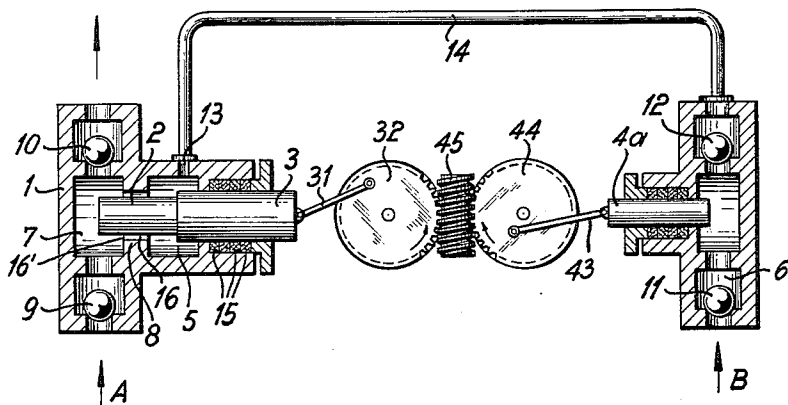


FIG. 2



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PUMPING METHOD AND PUMPS FOR SUSPENSIONS

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The present invention relates to a pumping method and to pumps for suspensions, and more particularly to a metering pump for dispensing measured amounts or volumes of a liquid suspension or dispersion containing a substance suspended or dispersed in a liquid suspension medium.

Different types of pumps are used for this purpose, but plunger piston pumps are preferred since they are extremely reliable and capable of dispensing exactly measured volumes.

When plunger pumps are used for pumping a suspension, certain difficulties arise since it cannot be avoided that solid particles contained in the suspension are deposited on the sealing means which have to be provided between the pump housing and the reciprocating plunger. When such solid particles are continuously deposited on the sealing surface of the sealing means, not only the sealing means are damaged, but also the sealed plunger surface is mechanically abraded, and damaged. When the sealing means is no longer effective, it is not possible to dispense accurately measured volumes by the pump.

It is one object of the present invention to overcome this disadvantage of known pumping apparatus for dispensing accurately metered amounts of suspensions and dispersions, and to provide a pumping apparatus and method which is particularly suited for the pumping of suspensions.

Another object of the present invention is to provide a pump which is constructed in such a manner that the pumped liquid suspension cannot come into contact with the sealing means and stuffing box of the pump.

Another object of the present invention is to provide a pumping method for separating the pumped suspension from the sealing means of the pump by the suspension medium of the suspension while small exactly measured amounts of the suspension medium are added to the pumped suspension.

With these objects in view, the present invention relates to a method for pumping a liquid suspension containing a substance suspended in a liquid suspension medium, and also to pumps for pumping the liquid suspension. One method of the present invention comprises the steps of operating a pump member, for example a plunger, in a pump chamber, in a separating chamber having sealing means, and in an opening connecting the chambers so that a liquid suspension is pumped through the pump chamber, and pressing during both strokes of the plunger only the suspension medium of the suspension into the separating chamber and through the opening into the pump chamber. In this manner, the suspension is prevented from entering the separating chamber whereby contact between the sealing means and the suspended substance is prevented.

A pump according to the present invention preferably comprises a pump chamber having an inlet and an outlet for a suspension, a separating chamber adjacent the pump chamber and having an inlet for the admission of the suspension medium only, a partitioning wall between the pump chamber and the separating chamber, the separating chamber having another wall formed with

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another opening, sealing means located in the other opening, and movable means, for example a plunger, passing through the chambers and openings and slidably engaging the sealing means. When the movable means are operated, the suspension is pumped through the pump chamber, while only the suspension medium is pumped from the separating chamber through the opening in the partitioning wall into the pump chamber not only when the suspension is discharged, but also when the suspension is drawn into the pump chamber. In this manner, the suspension cannot pass into the separating chamber through the opening in the partitioning wall, and is thus prevented from contact with the sealing means. Consequently, the suspended substance cannot be deposited on the sealing means and cause damage to the same.

A pump chamber for the suspension medium is advantageously provided from which the suspension medium is pumped into the separation chamber.

In one embodiment of the present invention, the second pump chamber for the suspension medium is located in the same pump housing in which the first pump chamber for the suspension is located. In this arrangement, a common plunger member is advantageously used for pumping both the suspension and the suspension medium.

In another embodiment of the present invention, the second pump chamber for the suspension medium is provided in an independent second pump which has its own plunger. The second pump, and more particularly the pump chamber therein, is connected by a conduit to the inlet of the separating chamber of the main pump. In both embodiments, stepped plungers having portions of different diameter are advantageously used.

Pumps according to the invention are very well suited for pumping Kaolin or milk of lime suspended or dispersed in water which serves as suspension medium. Liquid hydrocarbons are used, for example, as suspension medium for dispersions of synthetic substances. Since the suspension medium of suspensions with which the present invention is concerned, does not contain solid particles, the suspension medium can be in contact with the sealing means of the pump without causing any damage to the same and to the sealed parts.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 is a longitudinal sectional view illustrating a pump in accordance with one embodiment of the invention; and

FIG. 2 is a longitudinal sectional view illustrating another pump arrangement according to the present invention in which two separate pumps are used.

Referring now to the drawing, and more particularly to FIG. 1, a pump casing 1 includes a pump chamber 7 having an inlet valve 9 and an outlet valve 10. A liquid suspension is sucked into the inlet means 9, as indicated by the arrow A, and is discharged from the outlet means 10 as indicated by the other arrow. A separating chamber 5 is located adjacent pump chamber 7 and communicates with the same through an opening 16' in a partitioning wall 8. Separating chamber 5 has inlet 13 which is connected by conduit 14 to the outlet of a second pump chamber 6. An inlet valve 11 and an outlet valve 12 are provided in the second pump chamber 6. A liquid suspension medium is admitted through the inlet means 11 as indicated by the arrow B.

A plunger means is provided in the pump, and includes

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a first part 4 connected by an articulated connecting rod 41 to a rotary member 42. Plunger part 4 is sealed by suitable sealing means 20 which are packed by a bushing 21. The plunger is stepped and has a part 3 of greater diameter which passes through openings in walls 22, and through a sealing means 15 located between walls 22 in an annular recess. In this manner, chambers 5 and 6 are separated from each other, and can communicate only through conduit 14. The free end part 2 of the plunger is again stepped and has a smaller diameter than the thickest plunger part 3, but a greater diameter than plunger part 4.

Plunger part 2 passes through opening 16', leaving a small gap 16 free through which the separating chamber 5 communicates with the pump chamber 7.

When the rotary crank member 42 is rotated, and the plunger performs a stroke to the right as viewed in FIG. 1, suspension medium contained in the pump chamber 6 is pressed out of the outlet means 12 since the diameter of plunger part 3 is greater than the diameter of plunger part 4, and therefore displaces a greater volume. At the same time, a portion of plunger part 3 is retracted from the separating chamber 5, so that the free volume in the separating chamber 5 is increased, and suspension medium is sucked from chamber 6 through conduit 14 into separating chamber 5.

The diameter of plunger part 2 is greater than the diameter of plunger part 4 so that a greater volume is displaced from chamber 6 than is available in separating chamber 5, so that some of the suspension medium contained in separating chamber 5 is pressed through the gap 16 into pump chamber 7.

During the stroke of the plunger to the right, the suspension is sucked into the pump chamber 7 through the inlet means 9, and, as explained above, a small amount of suspension medium enters through the gap 16 and is admixed to the suspension. Since the suspension medium flows from the separating chamber 5 into the pump chamber 7, no suspension can flow through the gap 16 into the separating chamber 5 so that the sealing means 15 is completely separated from the suspension in pump chamber 7 and cannot get in contact with the same during the suction stroke of plunger 2, 3, 4.

During the stroke in the opposite direction, the plunger portion 2 displaces the suspension from the pump chamber 7 through outlet means 10 while inlet valve means 9 closes. At the same time, the larger plunger portion 3 moves further into separating chamber 5 so that a part of the suspension medium therein is displaced and pressed through the gap 16 into the pump chamber 7. Consequently, some additional suspension medium is added to the suspension in chamber 7, while no suspension can flow in opposite direction through gap 16 into the separating chamber 5.

At the same time, the larger plunger portion 3 moves out of the pump chamber 6 so that suspension medium is sucked through the inlet means 11 into chamber 6, while outlet valve 12 closes, preventing any suspension medium to leave the separating chamber 5 and to pass through conduit 13.

Chambers 5 and 6, which are located on opposite sides of the sealing means 15, are always filled with the suspension medium only, so that no solid particles of the substance contained in the liquid suspension can be deposited on the sealing means 15, or on the sealing means 20. Since the continuous flow of small amounts of suspension medium through gap 16 during both pump strokes prevents the suspension from flowing from chamber 7 into separating chamber 5, the suspension cannot be admixed to the suspension medium in chamber 5, and the sealing means 22 are protected from any deposit of solid substances contained in the suspension.

The amount of the suspension medium which is added through gap 16 to the suspension in pump chamber 7 can be determined, and the suspension supplied to pump cham-

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ber 7 is made consequently slightly stronger concentrated than intended, and is diluted by the added suspension medium to the desired concentration. In the embodiment of FIG. 1, in which a common plunger is provided for pumping the suspension and the suspension medium, the ratio between the suspension and the added suspension medium remains absolutely constant.

The embodiment of FIG. 2 operates on the same principle as the embodiment of FIG. 1. However, two separate pumps are provided for the suspension and for the suspension medium. The pump for the suspension includes a pump housing 1, a pump chamber 7, inlet means and outlet means 9 and 10, a separating chamber 5, a partitioning wall 8 with an opening 16' connecting the separating chamber 5 with the pump chamber 7, sealing means 15, and a stepped plunger having two plunger portions 2 and 3. Plunger portion 2 defines a gap 16 in opening 16'. Plunger portion 3 is connected by a connecting rod 31 to a crank means 32 which is fixed to a worm gear meshing with a worm screw 45. Another worm gear is secured to a crank means 44 and meshes with worm screw 45. A connecting rod 43 connects crank means 44 with plunger 4a of the pump for the suspension medium which is provided with a pump chamber 6 having inlet means 11 and outlet means 12 communicating through a conduit 14 with the inlet 13 of the separating chamber of the other pump.

Since both crank drives are driven from the same worm screw, the two pumps operate in synchronism. When plunger 2, 3 moves to the left, as viewed in FIG. 2, suspension is displaced from pump chamber 7 and discharged through outlet means 10. The larger plunger portion 3 displaces suspension medium from separating chamber 5 through gap 16 into pump chamber 7 where it is admixed to the suspension entering at the inlet means 9, as indicated by the arrow A. At the same time, plunger 4a moves to the left, and suspension medium is sucked through inlet means 11 into pump chamber 6, as indicated by the arrow B. Outlet valve 12 closes and prevents return of the suspension medium from the separating chamber through conduit 14 into the pump chamber 6.

During the stroke in the opposite direction, plunger 4a displaces the suspension medium from pump chamber 6, while inlet valve 11 closes. The suspension medium passes through outlet valve 12, conduit 14, and inlet 13 into the separating chamber 5 whose volume is simultaneously increased since the larger plunger portion 3 moves partly out of separating chamber 5 during this stroke. However, a greater volume of suspension medium is discharged from pump chamber 6 than is made available by the retraction of the larger plunger portion 3 from separating chamber 5, so that an amount of suspension medium passes through gap 16 into pump chamber 7 to be admixed to the suspension entering through the inlet means 9 in direction of the arrow A.

The embodiment illustrated in FIG. 2 has the advantage that the ratio between the suspension and the suspension medium, or any other liquid which is to be admixed to a pumped liquid, can be adjusted by adjustment of the length of the stroke of plunger 2, 3 on one hand, and plunger 4a on the other hand. However, the dead-center positions of both plungers must be simultaneously reached. In both embodiments, it is necessary that the volume displaced by plunger 4 or 4a from pump chamber 6, is greater than the volume displaced from separating chamber 5 by the larger plunger portion 3, which is obtained by making the diameter of plunger parts 2 greater than the diameter of plunger parts 4 and 4a.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of pumping arrangements for continuously adding a liquid to another pumped liquid differing from the types described above.

While the invention has been illustrated and described as embodied in a metering pump for pumping a suspen-

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sion completely separated from the sealing means of the pump, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. A metering pump arrangement for dispensing metered volumes of a liquid suspension containing proportionate amounts of a substance and of a liquid suspension medium in which the substance is suspended, comprising first wall means defining a first pump chamber having an inlet means for a liquid suspension and an outlet means, a separating chamber adjacent said pump chamber and having an inlet, said first wall means including a partitioning wall between said first pump chamber and said separating chamber having a first opening connecting said first pump chamber and said separating chamber, and another wall bounding said separating chamber and formed with a second opening; sealing means in said second opening; second wall means defining a second pump chamber having an inlet and an outlet for the liquid suspension medium only; a conduit means connecting said outlet of said second pump chamber with said inlet of said separating chamber and including a check valve; and movable pumping means including a first part located in said first pump chamber and in said separating chamber and passing through said first and second openings while slidingly engaging said sealing means, and a second part located in said second pump chamber, said first and second parts being connected for synchronous movement to alternately effect discharge from the respective pump chambers and being constructed and arranged so that said first part dispenses during a pressure stroke a metered volume of the liquid suspension from said first pump chamber and dispenses a given metered volume of the liquid suspension medium from said separating chamber through said first opening into said first pump chamber, and so that said second part dispenses during the suction stroke of said first part a given metered volume of said liquid suspension medium from said second pump chamber into said separating chamber to effect flow of suspension medium through said first opening into said first pump chamber so that the liquid suspension is prevented from flowing into said separating chamber and said substance is prevented from contact with said sealing means during both strokes of said first part.

2. A metering pump arrangement for dispensing metered volumes of a liquid suspension containing proportionate amounts of a substance and of a liquid suspension medium in which the substance is suspended, comprising first wall means defining a first pump chamber having an inlet means for a liquid suspension and an outlet means, a separating chamber adjacent said pump chamber and having an inlet, said first wall means including a partitioning wall between said first pump chamber and said separating chamber having a first opening connecting said first pump chamber and said separating chamber, and another wall bounding said separating chamber and formed with a second opening; sealing means in said second opening; second wall means connected to said first wall means to form a casing with the same and defining a second pump chamber having an inlet and an outlet for the liquid suspension medium only, said separating chamber and said second pump chamber being located on opposite sides of said other wall and being

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sealed from each other by said sealing means in said second opening; a conduit means connecting said outlet of said second pump chamber with said inlet of said separating chamber and including a check valve; and movable pumping means including a first part located in said first pump chamber and in said separating chamber and passing through said first and second openings while slidingly engaging said sealing means, and a second part located in said second pump chamber, said first and second parts being connected for synchronous reciprocating movement to alternately perform suction strokes, and pressure strokes effecting discharge from the respective chambers and being constructed and arranged so that said first part dispenses during a pressure stroke a metered volume of the liquid suspension from said first pump chamber and dispenses a given metered volume of the liquid suspension medium from said separating chamber through said first opening into said first pump chamber, and so that said second part dispenses during the suction stroke of said first part a given metered volume of said liquid suspension medium from said second pump chamber into said separating chamber to effect flow of suspension medium through said first opening into said first pump chamber so that the liquid suspension is prevented from flowing into said separating chamber and said substance is prevented from contact with said sealing means during both strokes of said first part.

3. A metering pump arrangement for dispensing metered volumes of a liquid suspension containing proportionate amounts of a substance and of a liquid suspension medium in which the substance is suspended, comprising first wall means forming a first housing defining a first pump chamber having an inlet means for a liquid suspension and an outlet means, a separating chamber adjacent said pump chamber and having an inlet, said first wall means including a partitioning wall between said first pump chamber and said separating chamber having a first opening connecting said first pump chamber and said separating chamber, and another wall bounding said separating chamber and formed with a second opening; sealing means in said second opening; second wall means forming a second housing spaced from said first housing and defining a second pump chamber having an inlet and an outlet for the liquid suspension medium only; a conduit means connecting said outlet of said second pump chamber with said inlet of said separating chamber and including a check valve; and movable pumping means including a first part located in said first pump chamber and in said separating chamber and passing through said first and second openings while slidingly engaging said sealing means, a second part located in said second pump chamber, and a transmission means connecting said first and second parts for synchronous reciprocating movement in such a manner that said first part performs a pressure stroke into said first pump chamber when said second part performs a suction stroke out of said second pump chamber and vice versa, to alternately effect discharge from the respective pump chamber and being constructed and arranged so that said first part dispenses during a pressure stroke a metered volume of the liquid suspension from said first pump chamber and dispenses a given metered volume of the liquid suspension medium from said separating chamber through said first opening into said first pump chamber, and so that said second part dispenses during the suction stroke of said first part a given metered volume of said liquid suspension medium from said second pump chamber into said separating chamber to effect flow of suspension medium through said first opening into said first pump chamber so that the liquid suspension is prevented from flowing into said separating chamber and said substance is prevented from contact with said sealing means during both strokes of said first part.

4. A metering pump arrangement for dispensing metered volumes of a liquid suspension containing pro-

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portionate amounts of a substance and of a liquid suspension medium in which the substance is suspended, comprising first wall means defining a first pump chamber having an inlet means for a liquid suspension and an outlet means, a separating chamber adjacent said pump chamber and having an inlet, said first wall means including a partitioning wall between said first pump chamber and said separating chamber having a first opening connecting said first pump chamber and said separating chamber, and another wall bounding said separating chamber and formed with a second opening; sealing means in said second opening; second wall means defining a second pump chamber having an inlet and an outlet for the liquid suspension medium only; a conduit means connecting said outlet of said second pump chamber with said inlet of said separating chamber and including a check valve; and movable pumping means including a first part including a first plunger portion of smaller diameter located in said first pump chamber and in said separating chamber and passing through said first opening, and a second plunger portion of greater diameter located in said separating chamber and passing through said second opening while slidingly engaging said sealing means, and a second part including a third plunger portion having a diameter smaller than said smaller diameter of said first mentioned plunger portion, said second part being at least partly located in said second pump chamber, said first and second parts being connected for synchronous reciprocating movement to alternately perform suction strokes, and pressure strokes effecting discharge from the respective chambers and being constructed and arranged so that said first plunger portion dispenses during a pressure stroke a metered volume of the liquid suspension from said first pump chamber and said second plunger portion displaces a given metered volume of the liquid suspension medium from said separating chamber through said first opening into said first pump chamber, and so that said second part displaces during the suction stroke of said first part a metered volume of said liquid suspension medium from said second pump chamber into said separating chamber to effect flow of suspension medium through said first opening into said first pump chamber so that the liquid suspension is prevented from flowing into said separating chamber and said substance is prevented from contact with said sealing means during both strokes of said first part.

5. A metering pump arrangement for dispensing metered volumes of a liquid suspension containing proportionate amounts of a substance and of a liquid suspension medium in which the substance is suspended, comprising first wall means defining a first pump chamber having an inlet means for a liquid suspension and an outlet means, a separating chamber adjacent said pump chamber and having an inlet, said first wall means including a partitioning wall between said first pump chamber and said separating chamber having a first opening connecting said first pump chamber and said separating chamber, and another wall bounding said separating chamber and formed with a second opening; sealing means in said second opening; second wall means forming a second housing spaced from said first housing and defining a second pump chamber having an inlet and an outlet for the liquid suspension medium only; a conduit means connecting said outlet of said second pump chamber with said inlet of said separating chamber and including a check valve; and movable pumping means including a first part including a first plunger portion of smaller diameter located in said first pump chamber and in said separating chamber and passing through said first opening, and a second plunger portion of greater diameter located in said separating chamber and passing through said second opening while slid-

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ingly engaging said sealing means, and a second part including an extension of said greater diameter plunger portion of said first part and a third plunger portion having a diameter smaller than said smaller diameter of said first mentioned plunger portion, said second part being located in said second pump chamber, said first and second parts performing a synchronous reciprocating movement to alternately perform suction strokes, and pressure strokes effecting discharge from the respective chambers and being constructed and arranged so that said first plunger portion dispenses during a pressure stroke a metered volume of the liquid suspension from said first pump chamber and said second plunger portion displaces a given metered volume of the liquid suspension medium from said separating chamber through said first opening into said first pump chamber, and so that said second part displaces during the suction stroke of said first part a given volume of said liquid suspension medium from said second pump chamber into said separating chamber to effect flow of suspension medium through said first opening into said first pump chamber so that the liquid suspension is prevented from flowing into said separating chamber and said substance is prevented from contact with said sealing means during both strokes of said first part.

6. A metering pump arrangement as set forth in claim 5 wherein said smaller diameter plunger portion of said second part projects out of said second wall means; and including reciprocating drive means connected to the projecting part of said smaller diameter plunger portion of said second part.

7. A metering pump arrangement for dispensing metered volumes of a liquid suspension containing proportionate amounts of a substance and of a liquid suspension medium in which the substance is suspended, comprising first wall means forming a first housing defining a first pump chamber having an inlet means for a liquid suspension and an outlet means, a separating chamber adjacent said pump chamber and having an inlet, said first wall means including a partitioning wall between said first pump chamber and said separating chamber and having a first opening connecting said first pump chamber and said separating chamber, and another wall bounding said separating chamber and formed with a second opening; sealing means in said second opening; second wall means forming a second housing spaced from said first housing and defining a second pump chamber having an inlet and an outlet for the liquid suspension medium only; a conduit means connecting said outlet of said second pump chamber with said inlet of said separating chamber and including a check valve; and movable pumping means including a first part including a first plunger portion of smaller diameter located in said first pump chamber and in said separating chamber and passing through said first opening, and a second plunger portion of greater diameter located in said separating chamber and passing through said second opening while slidingly engaging said sealing means, a second part including a third plunger portion having a diameter smaller than said smaller diameter of said first mentioned plunger portion, said third plunger portion being located in said second pump chamber, and a transmission means connecting said first and second parts for synchronous reciprocating movement in such a manner that said first part performs a pressure stroke into said first pump chamber when said second part performs a suction stroke out of said second pump chamber and vice versa, to alternately effect discharge from the respective pump chamber and being constructed and arranged so that said first plunger portion dispenses during a pressure stroke a metered volume of the liquid suspension from said first pump chamber and said second plunger portion displaces a given metered volume of the liquid suspension medium from said separating chamber through said first opening into said first pump chamber, and so that said third plunger portion displaces during the suc-

tion stroke of said first part a given metered volume of said liquid suspension medium from said second pump chamber into said separating chamber to effect flow of suspension medium through said first opening into said first pump chamber so that the liquid suspension is prevented from flowing into said separating chamber and said substance is prevented from contact with said sealing means during both strokes of said first part.

8. A metering pump arrangement as set forth in claim 7 and including drive means for reciprocating said transmission means, said transmission means and said drive means being located outside of said first and second housings.

9. A metering pump arrangement as set forth in claim 8 wherein said transmission means include two crank drives respectively connected to said first and second parts so that said plunger portions of said first and second parts simultaneously arrive at dead center positions.

10. A pump arrangement for dispensing volumes of a mixed liquid containing first and second liquids comprising first wall means defining a first pump chamber having an inlet means for a first liquid and an outlet means, a separating chamber adjacent said pump chamber and having an inlet, said first wall means having a first opening connecting said first pump chamber and said separating chamber, and including a wall bounding said separating chamber and formed with a second opening; sealing means in said second opening; second wall means defining a second pump chamber having an inlet and an outlet for the second liquid only; a conduit means connecting said outlet of said second pump chamber with said inlet of said separating chamber and including a check valve; and movable plunger means including a first plunger part located in said first pump chamber and in said separating chamber and passing through said first and second openings while slidably engaging said sealing means, and a second plunger part located in said second pump chamber, said first and second plunger parts being connected for reciprocating synchronous movement to alternately effect discharge from the respective pump chambers and being constructed and arranged so that

said first plunger part displaces during a pressure stroke the mixed liquid from said first pump chamber and displaces the second liquid from said separating chamber through said first opening into said first pump chamber, and so that said second plunger part displaces during the suction stroke of said first part said second liquid from said second pump chamber into said separating chamber to effect flow of the second liquid through said first opening into said first pump chamber so that the first liquid is prevented from flowing into said separating chamber and from contact with said sealing means during both strokes of said first part.

11. A method for dispensing metered volumes of a liquid suspension containing proportionate amounts of a substance and of a liquid suspension medium, comprising the steps of dispensing metered volumes of the liquid suspension from a pump chamber by pressure strokes of a first pump member, and simultaneously dispensing during the pressure stroke of said first pump member metered equal amounts of the liquid suspension medium into said pump chamber through an opening formed between the wall of said pump chamber and said pump member, and dispensing by another pump member only during the suction stroke of said first pump member metered equal amounts of the suspension medium through said opening so that proportionate amounts of said substance and of said liquid suspension medium are dispensed by said first pump member from said pump chamber while no sealing means are required in said opening to prevent passage of said liquid suspension through said opening.

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