United States Patent [19]

Misima

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[45] **Mar. 18, 1975**

[54] **COMBINATION PUMPING APPARATUS**

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[30] **Foreign Application Priority Data**

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Feb. 5, 1973 Japan 48-014431

[52] **U.S. Cl.** **92/13.3,** 417/429
[51] **Int. Cl.** **F15b 15/24**
[58] **Field of Search** 74/86, 834; 92/13.3, 13.7; 417/426–429

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Primary Examiner—William L. Freeh
Attorney, Agent, or Firm—William Anthony Drucker

[57] **ABSTRACT**

A combination pumping apparatus comprising two or more unit pumps each having a driving rod installed at a fixed position; a shiftable supporting point; and a conically movable rod which is supported by said supporting point and connected with each of said driving rods at the opposite sides thereof with respect to said supporting point, thus permitting the opposite ends thereof to revolve about said supporting point so that said opposite sides may conical movements (movements to draw conical loci respectively), whereby the quantities of flow of different kinds of liquids and/or the ratio between flow among said liquids can be varied by shifting said shiftable supporting point and/or changing the conical angles of said conical movements.

6 Claims, 13 Drawing Figures

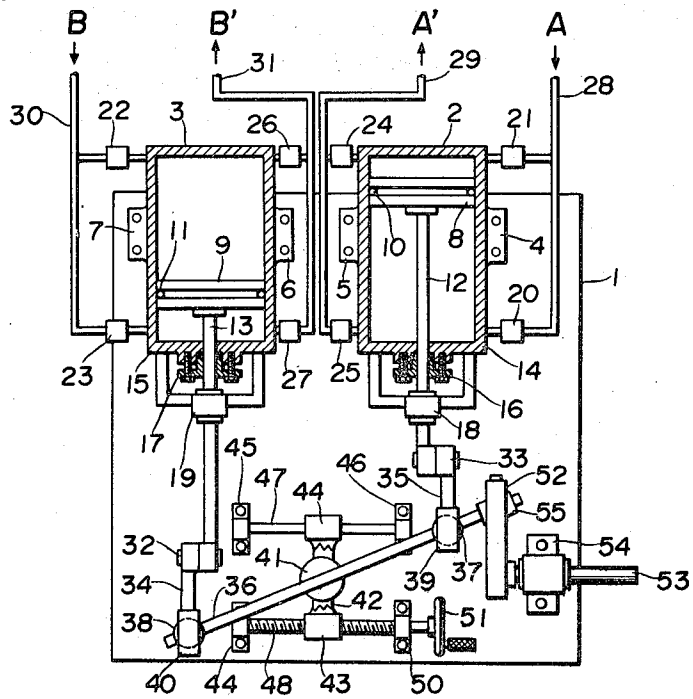


FIG. 1

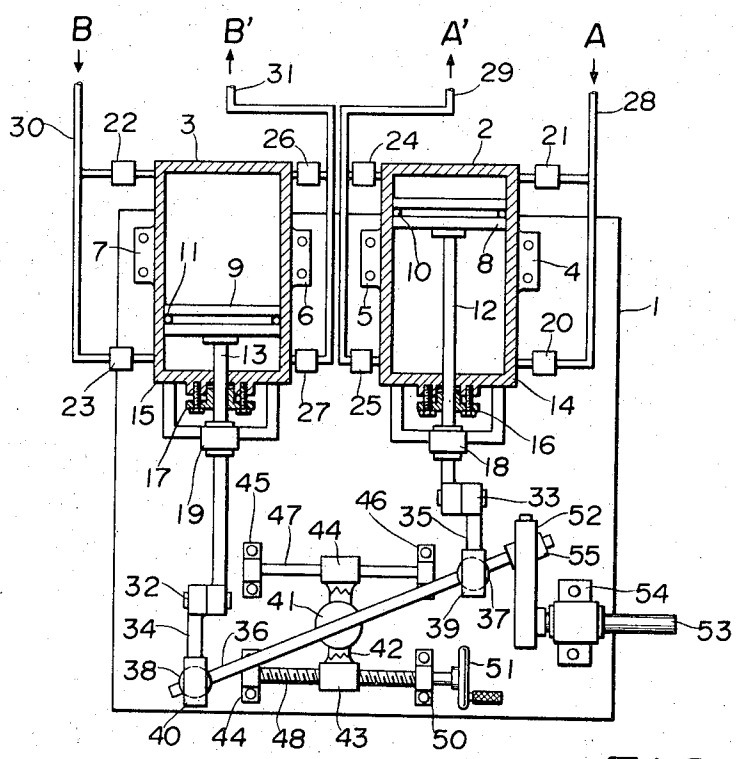


FIG. 2

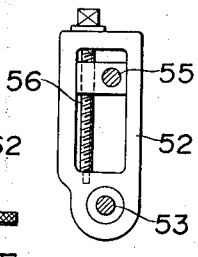


FIG. 3

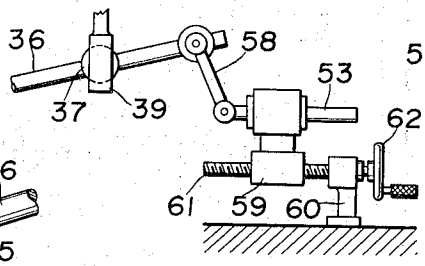


FIG. 4

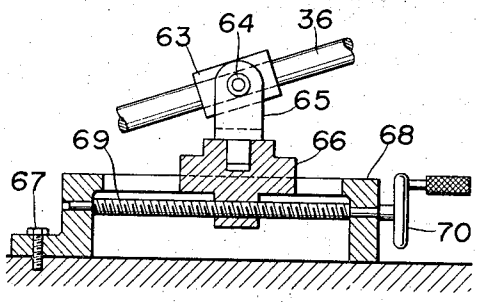


FIG. 5

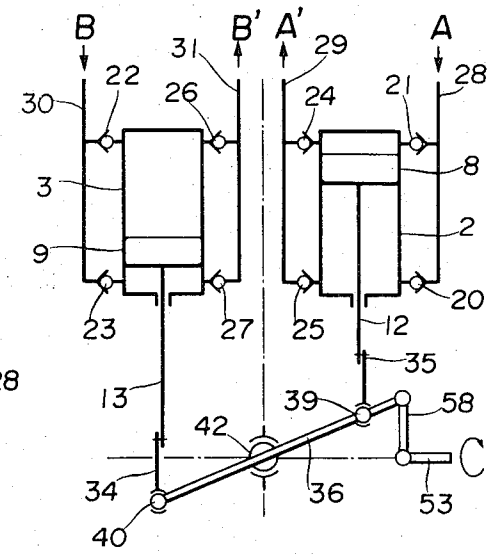


FIG. 6

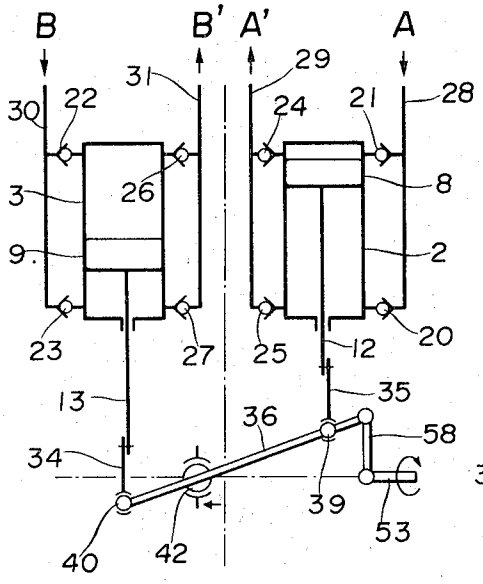


FIG. 7

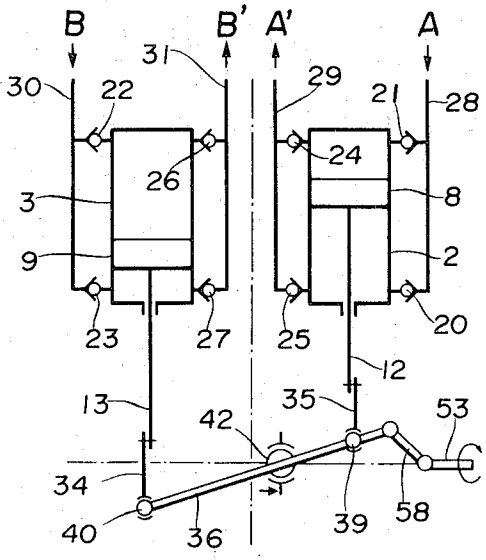


FIG. 8

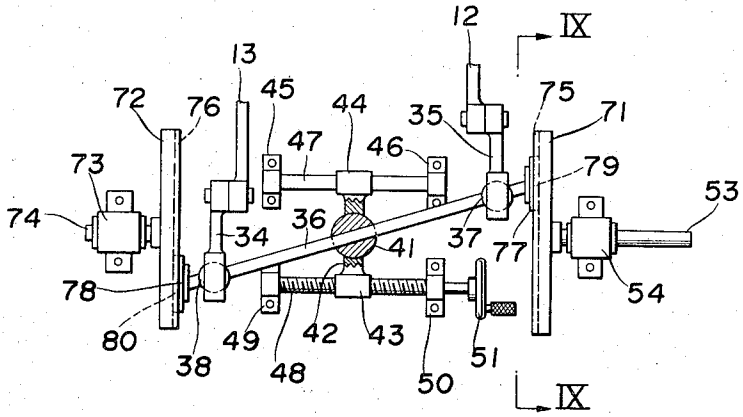


FIG. 9

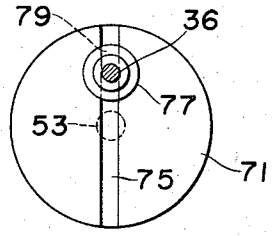


FIG. 10

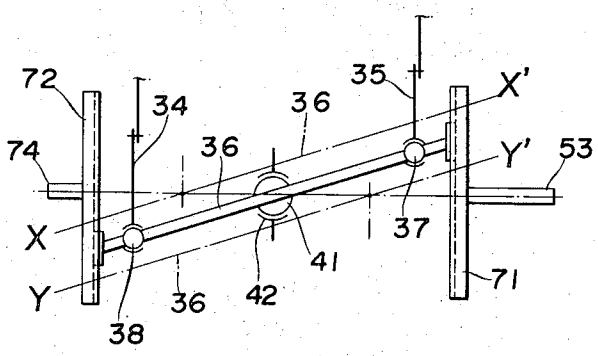


FIG. 11

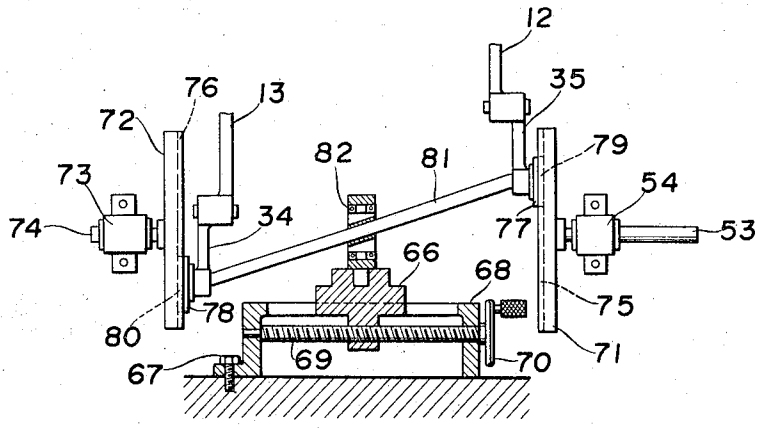


FIG. 12

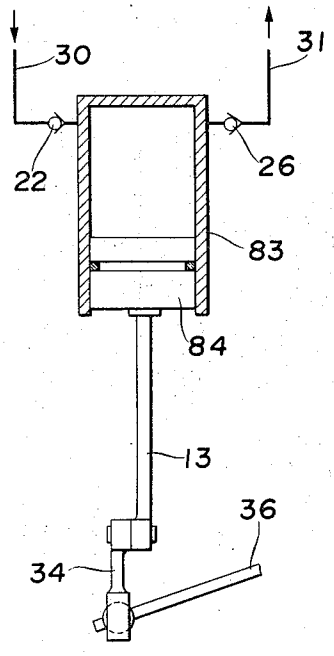
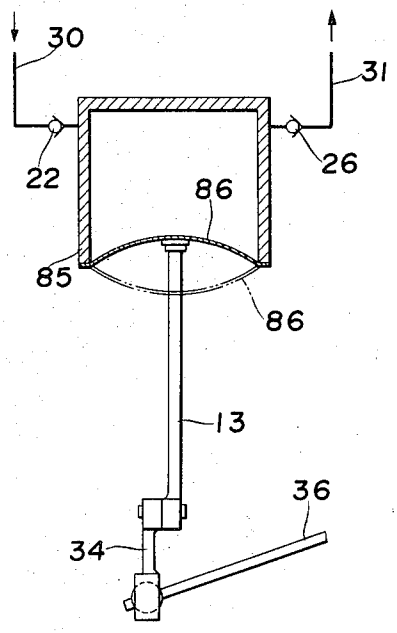


FIG. 13



COMBINATION PUMPING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a combination pumping apparatus for feeding various kinds of liquids separately in which the ratio of flow among those liquids can be varied or the quantities of flow of those liquids can be increased or decreased without varying the flow ratio thereamong.

2. Description of the Prior Art

In boring a tunnel or constructing a dam conventional boring works comprised pouring hardening accelators or hardeners deeply into the ground on which the tunnel or the dam is to be provided, in order to prevent subterranean water from gushing out and reinforce the ground.

While, the grounds on or through which said boring works are to be carried out are natural ones which are geographically complicated and are very apt to vary in structure.

Accordingly, in general the grouting method has been employed in such works, which method comprises filling hardeners into the ground to ensure a reinforced foundation.

However, according to the conventional grouting method, it has been impossible to control just during the execution of works the gelation time of the hardners used and the quantity thereof to be poured into the ground in order to comply with the structural variation of the ground, with the results of long terms of works and unsafety in the boring operations.

The hardening accelerators or hardners to be filled in the ground conventionally consists of a solution of cement and one or more solutions of additives selected from the group of bentonite resin, soda silicate, etc. which are moderate concentrated respectively, and are separately fed to the ground where they are cojoined with one another, immediately to be impregnated into the foundation.

In such process the gelation time of the hardeners to be required after those solutions are cojoined depends apon the ratios of each of said solutions of additives to the solution of cement.

However, any hardeners, regardless of their compounding ratios of such additives, will become solidified just in a few minutes or so, after those solutions are cojoined, and accordingly, it is impossible to feed those hardeners after the solutions of additives are joined with a solution of cement because of these combined solutions getting coagulated to clog the interiors of the pumps and the relevant pipes through which they pass.

In order to avoid clogging of the piping system, conventionally a pump connected with a prime mover having speed change gears was used for separately feeding a solution of cement being the principal component of the hardeners, and each of those solutions of additives, or alternatively used were a required number of pump cylinders in which the stroke of each of these pump cylinders was adjusted manually before it was set in motion.

However, the gelation time and quantity of the hardeners to be poured must be determined in accordance with the quantity of water percolated from the ground and the status of cracks in the innermost part of the ground, etc.

Further, in the boring process, it is also necessary to provide means for maintaining constant the total quantity of the hardener to be poured into the foundation while at same time permitting variation in the flow quantity of each of the component solution of cement and of the individual component solutions of additives.

Still further, generally those works and operations are required to be carried out at narrow and inconvenient places, as well as in a limited time, despite their high complexity. For these aforestated reasons, the grouting method now mainly being applied is not best utilized at the present stage.

SUMMARY OF THE INVENTION

A first object of the present invention is to provide a combination pumping apparatus separately feeding two or more kinds of different liquids while maintaining constant the total combined quantity of flow of these liquids by increasing or decreasing the individual flow quantities of said liquids with respect to each other.

A second object of the present invention is to provide a combination pumping apparatus which is capable of freely increasing or decreasing the total combined quantity of flow of two or more kinds of different liquids and feeding these liquids separately, while maintaining constant the ratio among the individual quantities of flow thereof.

A third object of the present invention is to provide a combination pumping apparatus which is capable of not only smoothly and stably controlling the ratio of the quantity of flow among the individual liquids as well as the increase and decrease in said total combined quantity of flow of the liquids but also performing fine adjustments thereof, thereby being easy to operate.

A fourth object of the present invention is to provide a combination pumping apparatus the operation of which can be promptly and efficiently adjusted without stopping its pumping motion for each adjustment.

A fifth object of the present invention is to provide a combination easy to construct at low costs.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a plan view, partly in section, of a first embodiment of the present invention.

FIGS. **2**, **3** and **4** are side views, partly in section, each of which shows a different modified portion of said first embodiment of the present invention, respectively.

FIGS. **5**, **6** and **7** are simplified views illustrating the operation of each of said modified portions of FIGS. **2**, 3 and **4** respectively.

FIG. **8** is a plan view showing, partly in section, a second embodiment according to the present invention.

FIG. **9** is a sectional view of the embodiment shown in FIG. **8** cut along line IX—IX.

FIG. **10** is a simplified view illustrating the operation of the embodiment shown in FIG. **8**.

FIG. **11** is a plan view of a third embodiment according to the present invention.

FIG. **12** and FIG. **13** are horizontally cut plan views each showing a different unit pump.

DESCRIPTION OF THE PREFERRED EMBODYMENT

Referring now to accompanying FIGS. **1** to **7**, detailed explanation is given hereinbelow on the first embodiment.

In FIG. 1 reference numeral 1 designates a flat base or bedplate on which two cylinders are disposed parallel with each other at a predetermined space. One of them designated at 2 is a cylinder for liquid A and the other designated 3 is a cylinder for liquid B. Each of the two cylinders is secured to said bedplate 1 with legs 4, 5, 6 and 7. In the interiors of said cylinders 2 and 3 are mounted pistons 8 and 9 respectively.

On said pistons 8 and 9 are fitted ring packings 10 and 11 along the circumferential edges thereof respectively.

Said cylinders 2 and 3 are maintained completely air-tight by pistons 8 and 9 provided with these ring packings 10 and 11 which are arranged in close contact with the inside walls of said two cylinders 2 and 3 to slide therealong respectively, so as not to prevent any leakage of liquids through the cylinders.

On both sides of each of the upper and lower portions of said cylinders 2 and 3 partitioned respectively by pistons 8 and 9, are mounted check valves 20, 21, 22, 23, 24, 25, 26 and 27.

An inlet tube 28 for liquid A is connected with check valves 20 and 21 which are mounted on said cylinder 2 so as to introduce liquid A thereinto.

To an outlet tube 29 for liquid A are connected check valves 24 and 25 for flowing the liquid A out of said cylinder 2.

In the similar manner check valves 22 and 23 are connected to an inlet tube 30 for liquid B for introducing said liquid into cylinder 3, and check valves 26 and 27 are also connected to an outlet tube 31 for liquid B for flowing liquid B out of said cylinder 3.

Piston rods 12 and 13 are secured to the pistons 8 and 9 at ends thereof respectively, and have the other ends thereof extending out of said cylinders, respectively.

Rod sealing members 16 and 17 (members for sealing said piston rods with respect to the outside of the cylinders) are provided on lid members 14 and 15 each mounted on the skirt-side end of each of said cylinders 2 and 3 to keep the air-tight sealing from being damaged by the sliding motions of piston rods 12 and 13. In order to cause said piston rods 12 and 13 to make linear reciprocating motions sliding bearings 18 and 19 which are integrally secured to said cylinders 2 and 3 are used to support said piston rods 12 and 13 which are fitted on said bearings, respectively.

Driving rods 34 and 35 are hinged on the respective top ends of said rods 12 and 13 by means of pins 32 and 33. The other ends of said driving rods 34 and 35 are coupled respectively to the opposite ends of a conically movably rod 36 which makes conical movements as defined hereinbelow, through bearings 39 and 40 respectively which are freely rotatable with respect to spherical bearings 37 and 38 secured to the respective opposite ends of said conically movable rod 36.

The conically movable rod 36 is situated between said two driving rods 34 and 35 on which is mounted a spherical bush 41 which is movable axially of said rod 36.

Said spherical bush 41 is rotatably supported on a hemispherical bearing 42 one end of which is engaged with a tapped boss and the other end with a slide boss 44 so that this spherical bush 41 can be shifted in the direction normal to the reciprocating directions of said piston rods 12 and 13. Said bearings 39 and 40 mounted on the respective sides of said conically movable rod which is supported by said hemispherical bearings 42 are disposed at such positions that said rod 36 can make conical motions in correspondence with the longest strokes of said piston rods 8 and 9.

The movable range of said hemispherical bearings 42 is limited within the distance between the rods 34 and 35. On bearings 45 and 46 which are secured to the base 1 are supported the both ends of a slide shaft 47, respectively. On said shaft 47 is fitted a slidable boss 44 of said hemispherical bearing 42 which is movable axially of said slide shaft 47.

On the other hand a screw-threaded shaft 48 is provided parallel with the slide shaft 47 on the opposite side with respect to the spherical bush 41, the opposite ends of which screw-threaded shaft 48 are supported by bearings 49 and 50 respectively.

Thus, said screw-threaded rod 48 is engaged with the tapped boss 43 of said hemispherical bearing 42.

Further, said screw-threaded shaft 48 has one side thereof extending from said bearing 50 so that the top end of said extending side is secured to a rotary handle 51. By rotating said rotary handle 51, the tapped boss 43 being engaged with said screw-threaded shaft 48 is axially displaced. And, consequently, the hemispherical bearing 42 coupled integrally to said slidable boss 44 is caused to move.

The conically movable rod 36 has one side thereof further extending even from the spherical bearing 37, on the top end of which rod is mounted an arm 52 for revolving said rod 36.

An input shaft 53 is provided for driving the present apparatus, which shaft is located on a line coaxially extending from the moving axis of said spherical bush 41, arranged perpendicular to the reciprocating directions of the piston rods 8 and 9, and supported by a bearing 54 which is secured to the base 1.

To the tip of said input shaft 53 is secured the other end of said arm 52 and a spherical bearing 55 is provided at the rod side end of said arm 52, to freely movably support said conically movable rod 36 which is engaged with said arm 52. (See FIG. 2).

Said spherical bearing 55 is fitted in a slit of said arm 52, and a screw-threaded rod 56 is securely mounted within the arm 52, for being engaged with said bearing 55. Accordingly, the aforementioned arrangement is such that said conical angles of the conically movable rod 36 engaged with said bearing 55 can be varied with respect to said hemispherical bearing 42 correspondingly to the movement of said bearing 55 along said screw-threaded rod 56 fitted therethrough, by rotation of the latter.

With this arrangement, the conical angles of the conical loci drawn by the motions of the conically movable rod 36 coupled to the bearing 55 with respect to the spherical bearing 41 can be varied by rotating the screw rod 56.

In addition to the arrangement shown in FIG. 2, another arrangement of the arm 52 and the elongated portion of the rod 36 which are in engagement with each other may be provided as shown in FIG. 3 in order to vary the conical angles; an arm 58 is provided which has one end thereof hinged to the elongated portion of the conically movable rod 36 and the other end thereof to the input shaft 53.

Said shaft 53 is supported by a bearing 54 which now is secured to a tapped boss 59. Said tapped boss 59 is fitted on a screw-threaded rod 61 supported by a bear-

ing 60 which is secured to the base 1. Accordingly, it is possible to vary the angles of conical motions of said conically movable rod 36 by rotating a rotary handle 62 affixed to said screw-threaded rod 61 to axially move the bearing 54.

As to the means for shifting the supporting point for "conical motions" which is one of the most important keys of the present invention, a modified embodiment whose operations are the same as those of shown in FIG. 1 is shown in FIG. 4 to more clarify the arrangement of the present invention:

On the conically movable rod 36 is fitted a slidable bush 63 which has the central portion thereof pivotally supported on a support member 65 with a pin 64 fitted therethrough so as to permit said conically movable rod 36 to make up-and down motions about the support 65. The lower portion of said support member 65 is rotatably mounted on a cradle 66 which is mounted on a fixed frame 68. The fixed frame 68 is secured to the base 1 with several bolts 67 and is integral with a tapped boss which is fitted in a groove so as to permit said cradle 66 to move normally to the reciprocating directions of the piston rods 12 and 13. In said fixed frame 68, a screw-threaded rod 69 is engaged with a tapped boss of said cradle 66 in the direction of said groove being cut.

Accordingly, the axial movement of the cradle 66 caused by rotating a handle 70 mounted on one side of the screw-threaded rod 69 causes sliding of the supporting point of said rod 36 to which the bush 63 corresponds and about which the rod 36 is adapted to make conical motions.

To more clarify the principle of operation of the present invention, simplified embodiments thereof are illustrated in FIGS. 5, 6 and 7:

In FIG. 5 the hemispherical bearing 42 is disposed at the middle point between the two cylinders 2 and 3. By rotating the input shaft 53 the rod 36 which is pivotally connected to the arm 58 of a given length is caused to make conical motions about the hemispherical bearing 42, with the opposite ends thereof revolving.

At this time, the driving rods 34 and 35 supported by the opposite ends of the rod 36 respectively are caused to revolve about the supporting point of the rod 36 respectively, with the respective revolving strokes corresponding to the conical angles, thus to actuate the piston rods 12 and 13 as well as the pistons 8 and 9 in respective engagement therewith.

Since the rod 36 is supported by a single supporting point, it is self-evident that said pistons 8 and 9 are actuated to make motions relative to each other.

In the cylinder 2 for liquid A, liquid is discharged from the outlet tube 29 when the piston 8 is pushed to open the check valve 24. At the same time the check valve 20 is opened to introduce the liquid thereinto and the check valve 25 is closed.

On the contrary, in the cylinder 3 for liquid B, the piston 9 is pushed backward so that the check valve 23 is closed, and then the check valve 27 is opened to discharge the liquid from the discharge tube 31. At the same time, the check valve 22 is opened to suck the liquid and the check valve 22 is closed. In this manner, the apparatus of the present invention is capable of continuously discharging and sucking both liquids A and B, concurrently.

What is important is that the arrangement of the hemispherical bearing 42 at the middle point between said cylinder 2 for the liquid A and the cylinder 3 for the liquid B ensures the mutually equal conical angles of the conical motions of the rod 36, as well as the equal reciprocating strokes between the lower ends of the driving rods 34 and 35 and the pistons 9 and 10, which results in the mutually equal displacements of said two liquids.

Next, referring to FIG. 6, description is made on the operation of the hemispherical bearing 42 in the case of the bearing 42 being shifted toward liquid B (in the direction of the cylinder 3).

By rotating the handle 51 the hemispherical bearing 42 is shifted toward liquid B (toward the cylinder 3), and then by rotating the input shaft 53 the rod 36 which is pivotally mounted on the arm 52 of a certain length makes conical motions about the hemispherical bearing 42 being the supporting point of the rod 36.

As the hemispherical bearing 42 is shifted toward liquid B, (or toward cylinder 3), the interval between the hemispherical bearing 42 and the bearing 40 for the driving rod 34 linked with said cylinder 3 for liquid B becomes smaller, and at the same time, contrariwise the interval between said hemispherical bearing 42 and the bearing 39 for the other driving rod 35 linked with said cylinder 2 for liquid A becomes larger, so that the radius of gyration of the bearing 40 (linked with the cylinder 3 for the liquid B) becomes smaller, while that of the bearing 40 linked with the cylinder 2 for liquid A becomes larger.

And since the respective strokes of the pistons 8 and 9 are determined by these radii of gyration of the bearings 39 and 40, on one hand the stroke of the piston 8 for the cylinder 2 for liquid A becomes larger, and on the other hand the stroke of the piston 9 for the cylinder 3 for liquid B becomes smaller, so that the quantity of flow of liquid A increases, whereas that of liquid B decreases.

In the embodiment shown in FIG. 6, if the volumes of the cylinders are made equal to each other, the sum of the quantities of flow of both the liquids A and B is maintained constant. Accordingly, even if the ratio between the quantities of flow of said two liquids is varied by shifting the hemispherical bearing 42 being the supporting point of the rod 36, the sum of the displacements remains constant.

Next, if the bearing 54 is shifted by rotating the handle 62 in one direction, then the input shaft 53 is moved axially thereof so that also one end of the crank arm 58 is moved to vary the angle of inclination of said crank arm 58 with respect to the axis of the input shaft 53. The variation of the angle of inclination causes the change of the conical angles of the conical motions of said rod 36 about the hemispherical bearing 42 supporting said rod 36, as shown in FIG. 7.

The FIG. 7 shows the embodiment of the present invention in which said input shaft 53 is positioned outward.

In the embodiment in this position, said conical angles become smaller to diminish the radii of gyration of the crank motions of the driving rods 34 and 35, so that the strokes of pistons 8 and 9 connected with said rods 34 and 35 through piston rods 12 and 13 respectively become shorter, thus resulting in the reduction of the displacements of the respective pumps.

Consequently, the sum of the quantities of the flow of liquids A and B becomes smaller, however, it is ex-

pected that the ratio between the quantities of flow of both liquids remains constant.

A second embodiment of the present invention is illustrated in FIGS. **8, 9** and **10.** One end of said input shaft **53** which is supported on the bearing **54** while connected to a driving source through a stepless transmission (speed change gear not shown) is secured to the center of a disc-shaped crank arm **71,** and one end of a supporting shaft **74** which is supported by a bearing **73** is secured to the center of another disc-shaped crank arm **72** disposed opposite to said crank arm **71** at a given interval therebetween. Said supporting shaft **74** may be connected directly to another driving source provided separately from the driving source connected with the input shaft **53.** In this case, a means may be provided for synchronizing said shaft **74** with the shaft **53** in speed, and starting and stopping operations, etc. Such provision of another driving source will be of much use in the case of relatively many unit pumps being employed. And, all said two shafts **53, 74** and spherical bearing **41** are coaxially disposed. On the insides of said oppositely disposed crank arms **71** and **72** are formed respectively elongated narrow grooves **75** and **76** of a constant width radially of said insides for engaging the outsides of engaging discs **77** and **78** respectively. Said engaging discs **77** and **78** are secured to the opposite ends of said conically movable rod **36** (which makes conical motions) respectively.

To the outsides of said disc **77** and **78** are affixed elongated protrusions **79** and **80** each having a constant width for being axially movably engaged within said grooves **75** and **76** respectively.

When the handle **51** is rotated, the screw-threaded rod **48** is caused to rotate and the spherical bearing **42** screw-engaged with said screw-threaded rod **48** is also actuated to move axially of said shafts **53** and **74.**

At this time, since said elongated protrusions **79** and **80** on said both engaging discs **77** and **78** which are fixed to the opposite ends of said conically movable rod **36** are engaged within the grooves **75** and **76** in said crank arm **71** and **72** respectively as described before, these two protrusions **79** and **80** are forced to simultaneously move in the same direction along said engaging grooves **75** and **76** respectively.

Accordingly, as shown in FIG. **10,** the rod **36** is horizontally displaced along said parallel opposite crank arms **71** and **72** while maintaining itself in constant angular relation to the crank arms **71** and **72** respectively.

Thus, as said spherical bearing **42** is moved toward the cylinder **3** for liquid B, the stroke of the piston **8** of the cylinder **2** for liquid A becomes larger, and contrariwise, the stroke of the piston **9** of the cylinder **3** becomes smaller, so that the displacement of liquid A increases whereas that of liquid B decreases. And, as described above, with the movement of the conically movable rod **36** perpendicular to the reciprocating directions of the pistons **8** and **9,** the displacements of liquids A and B are exactly inversely proportional to each other. In this manner, it is feasible to vary the ratio between the quantities of flow of both liquids while maintaining constant the sum of the displacements thereof at the same time.

Further, if the rotational speed of the input shaft **53** is changed through a step-less transmission (not shown), the revolving speed of the conically movable rod **36** is correspondingly changed, with the result that the reciprocations of the pistons **8** and **9** connected thereto are correspondingly changed. In this manner, it is feasible to vary the sum of the displacements of both liquids while simultaneously maintaining constant the ratio between the quantities of flow thereof.

A third embodiment of the present invention shown in FIG. **11** is a partially modified one of the aforestated second embodiment, in which an oblique bearing **82** is axially movably mounted on the middle portion of a conically movable rod **81,** the lower portion of which bearing is fixed to a cradle **66.** Further, the both ends of said conically movable rod **81** are curved enough for the both ends thereof to be perpendicular to said opposite crank arms **71** and **72** (that is, parallel with said both shafts **53** and **74**), to which curved ends are connected the ends of said driving rods **34** and **35** respectively through radial ball bearings (not shown).

In this arrangement, when the handle **70** is rotated, said oblique bearing **82** is moved to displace the conically movable rod **81** with its angular relation to said crank arms **71** and **72** remaining unchanged, thus the ratio between the quantities of flow of both liquids being controlled.

The embodiments described heretofore relate to general piston pumps. However, as shown in FIG. **12,** in practise the combination pumping apparatus according to the present invention can alternatively employ not only a plunger pump as a unit pump in which a plunger **84** is inserted in a cylinder **83** so as for the piston to make reciprocal motions by means of the driving rod **34,** or but also a diaphragm pump provided with a diaphragm **86** covering the opening of the cylinder **85** and being actuated by reciprocal motions of the driving rod **34.**

In addition, it is also possible to provide more than two cylinders for the present apparatus without deviating from the objects and effects of the present invention.

That is, a desired number of driving rods may be connected with the conically movable rod **36,** or a plurality of driving rods may be mounted on a conically movable rod like branches radially stretching out each of which rods is provided with a cylinder.

As described in the foregoing, the present invention can encompass a wide range of applications, for instance, pumping means for simultaneously reacting different kinds of liquids to one another, a fixed displacement pump for solutions of mediums to be employed in bonding agents and other kinds of bulking agents or fillers, and so forth.

The important features of the combination pumping apparatus of the present invention consist not only in its simple structure, but also in its capability of smoothly adjusting the flow rates of different kinds of liquids correlatively.

These features, therefore, will bring about various advantages with the present apparatus, such as stable operation, high durability, or easy maintenance, etc.

The present invention is not limited to the embodiments described and illustrated hereinbefore, of which modification may freely be possible in designs, shapes, sizes, etc. without departing from the spirit and scope of the appended claims.

What we claim is:

1. In a combination pumping apparatus including:

I. at least two unit pumps each including a piston rod fixedly arranged parallel with one another to a base;

II. a supporting point shiftable perpendicularly with respect to the reciprocation directions of said piston rods of said unit pumps;

III. a conically movable rod supported on said supporting point, and connected to each of said piston rods of said unit pumps at each ends thereof; said shiftable supporting point comprising a screw-threaded shaft arranged perpendicular with respect to the reciprocating directions of said piston rods of said unit pumps, a pair of bearings each supporting each of the ends of said screw-threaded shaft, a tapped boss of a hemispherical bearing engaging with said screw-threaded shaft, and a spherical bush supported on said hemispherical bearing; the strokes of said rods of said unit pumps being varied according to the shift of said support point caused by rotating said screw-threaded shaft the improvement characterized in that a disc-shaped crank arm is mounted on one end of an input shaft supported by a bearing secured to said base, and another crank arm is mounted so as to be opposite to said disc-shaped crank arm on a supporting shaft supported by a bearing which is oppositely disposed to said base bearing at a given interval therebetween, and each of said crank arms is connected to a respective end of said conically movable rod.

2. A combination pumping apparatus, according to claim **1,** wherein an elongated narrow groove of constant width is formed radially on each of the insides of said oppositely disposed disc-shaped crank arms.

3. A combination pumping apparatus, according to claim **2,** wherein an engaging disc providing an elongated protrusion having a constant width for being axially movably engaged within each of said grooves is secured to each of the ends of said conically movable rod.

4. A combination pumping apparatus, according to claim **2,** wherein a driving source through a stepless transmission is secured to the other end of said input shaft supported on the bearing.

5. The pumping apparatus according to claim **1** in which said tapped boss is formed integrally with said supporting point and screw-engaged with said screw-threaded rod, whereby said screw-threaded rod is rotatable to displace said supporting point integral with said tapped boss.

6. The apparatus according to claim **1** whereby said supporting shaft is connected to a driving source and rotatable in synchronism with said first-mentioned input shaft.

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