March 28, 1950 A. DUTREY 2,501,998

ROTO-VOLUMETRIC PUMP

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Fig. 1.

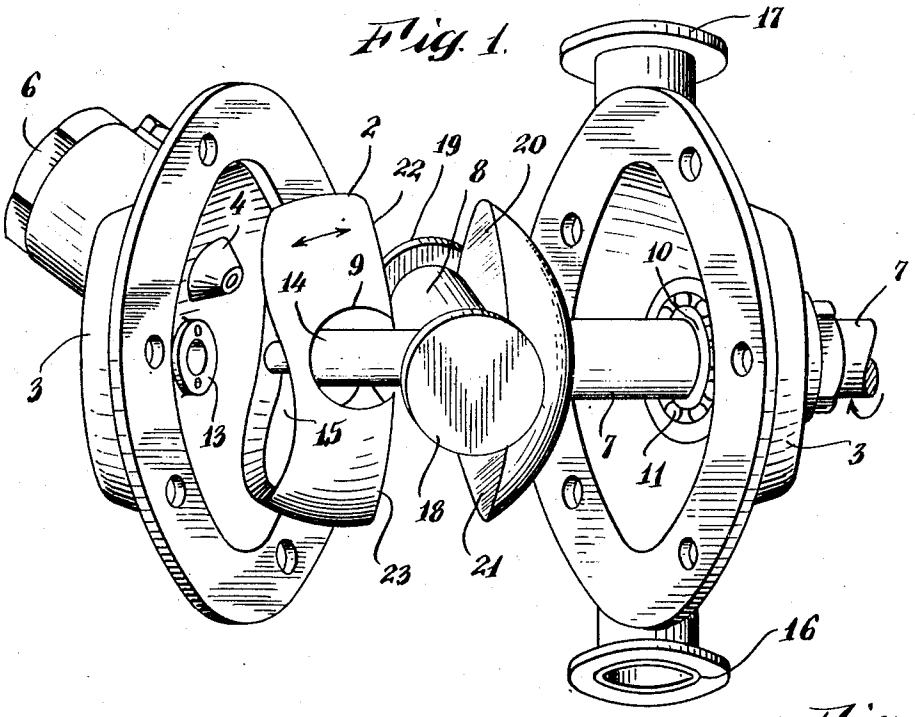


Fig. 2a.

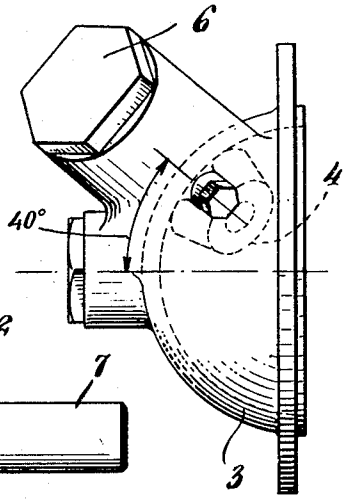
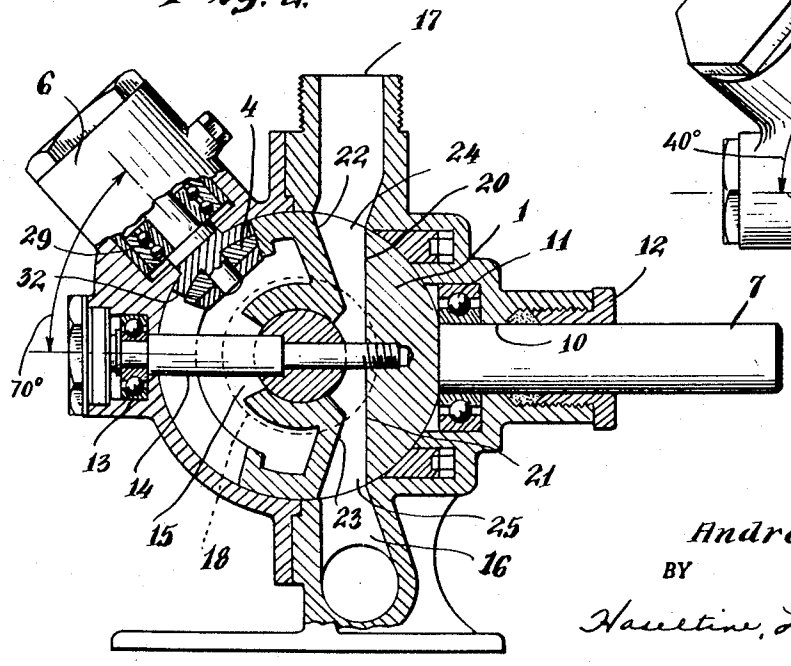


Fig. 2.



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Fig. 3.

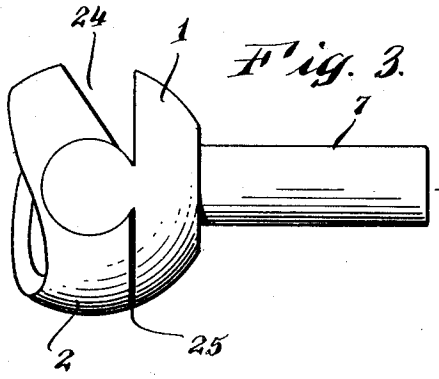


Fig. 4.

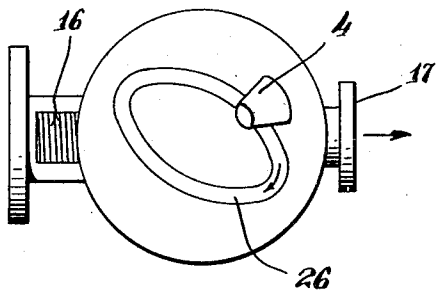


Fig. 5.

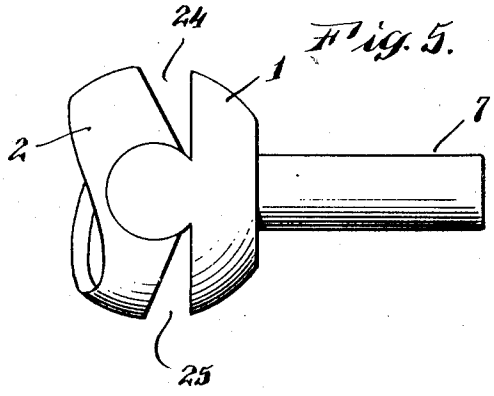


Fig. 6.

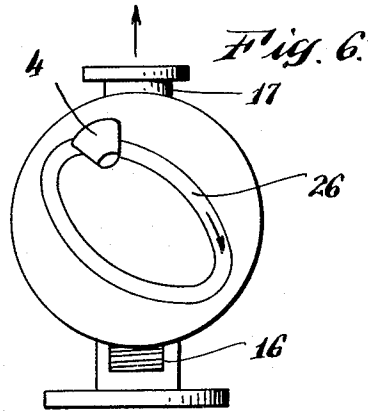


Fig. 7.

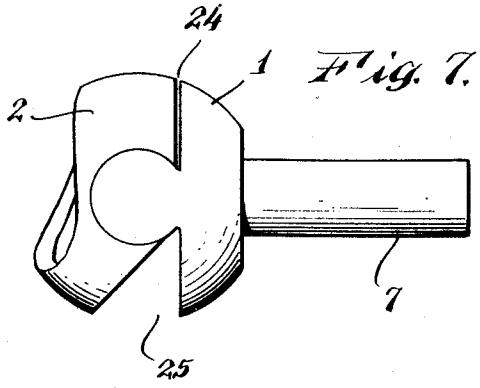
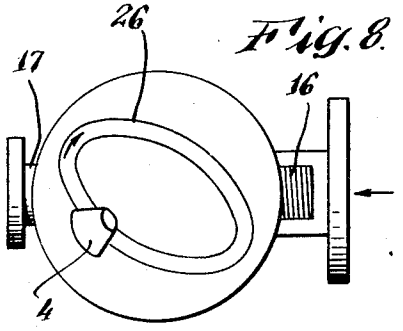


Fig. 8.



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Fig. 9.

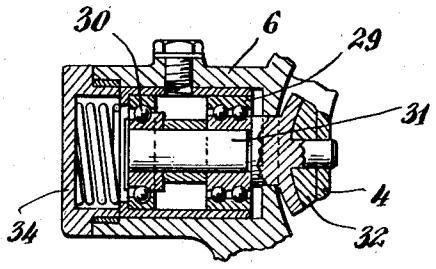


Fig. 10.

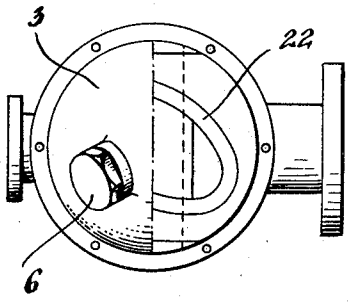


Fig. 11.

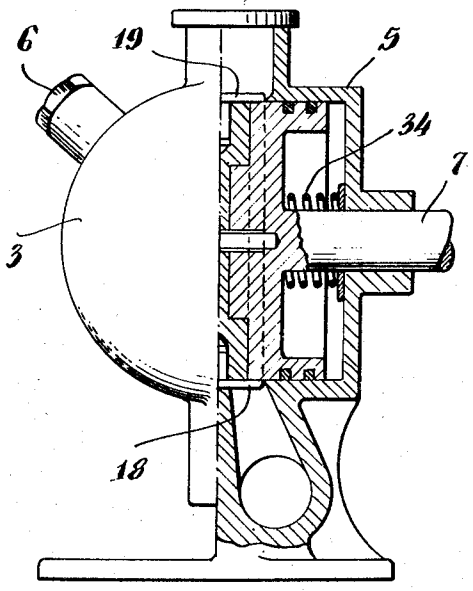
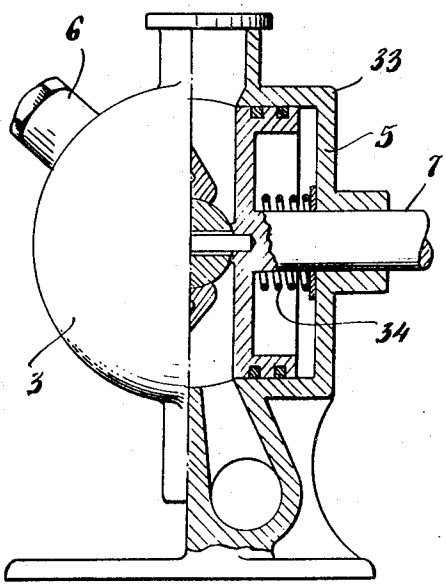


Fig. 12.



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Fig. 13.

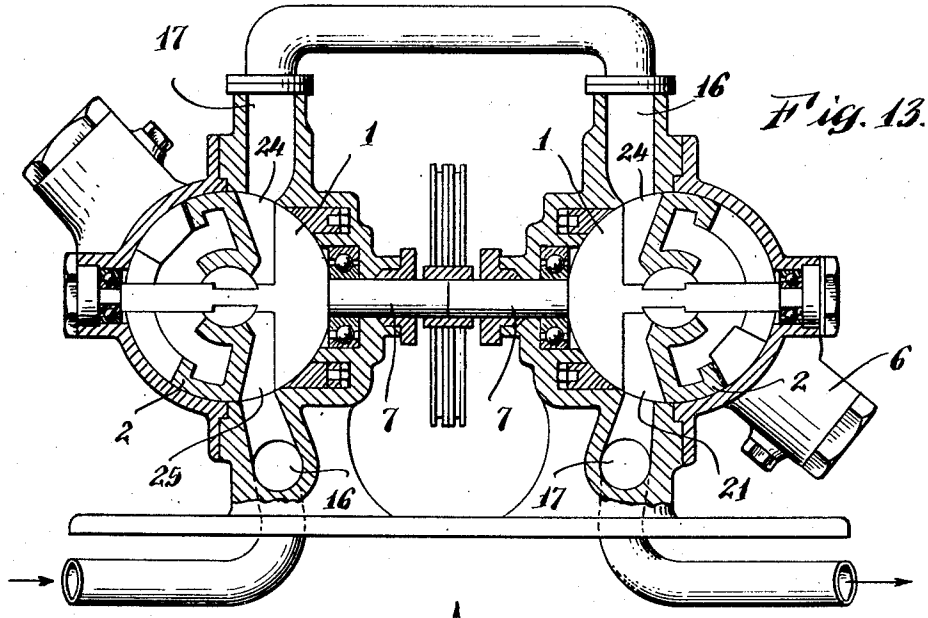
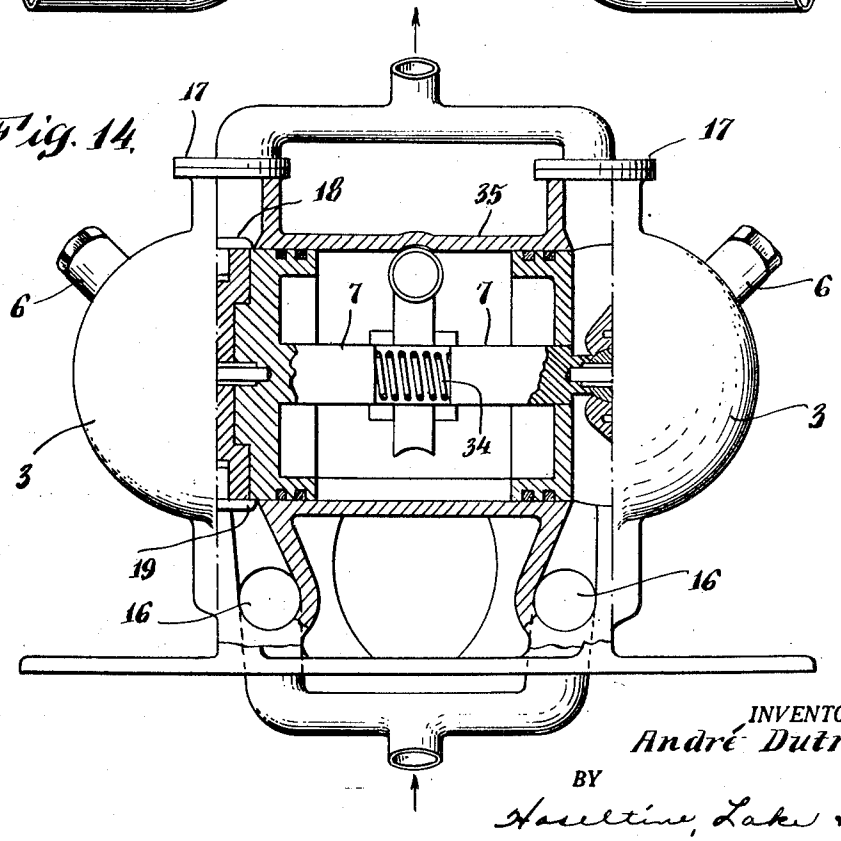


Fig. 14.



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Patented Mar. 28, 1950

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UNITED STATES PATENT OFFICE

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ROTO-VOLUMETRIC PUMP

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Patent expires February 21, 1958

5 Claims. (Cl. 103—117)

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In the field of pumps, piston pumps have a powerful suction and discharge but large overall dimensions, delicate distributing parts and a low efficiency. On the other hand, centrifugal pumps have smaller dimensions, distributing parts are eliminated, their design is simpler and their efficiency higher. But their suction and discharge power is low, their speed high, thus quicker wear.

The subject of the present invention combines all the advantages of these two systems, without retaining any of their disadvantages.

It is, in fact, a pump the movement of which is circular and continuous, having one ungula shaped piston, the torque of the motor being transmitted to one of the parts of the pump to which the piston is coupled by means of a hinge-joint, formed by the central parts of the two pieces, the piston making its to and fro movements in the spherical inner part of a casing, in pivoting around the axis of the hinge-joint, the casing fulfilling the duty of a cylinder.

The invention concerns also the arrangement of suction and discharge chambers between the walls of the power transmitting part and those of the piston, without any leaks being possible either between the two chambers or with the outside. It concerns also the arrangement of the openings in order that the suction and discharge flow remains straight and always in the same direction, these openings being closed or opened during the circular movement of the whole by the two ends of the hinge-joint, forming obturators.

Another feature of the invention is the definition of the position on the casing of a roller, acting on a groove cut in the ungula, in order that no shearing action occurs on the axle around which the piston pivots and that the torque of the motor be transmitted to the piston with the least loss and this during the complete rotation of the whole.

Furthermore, the invention includes the possibility to design, very easily, double piston pumps, working in series or in parallel.

A construction according to the invention is illustrated by way of example in the accompanying drawings in which:

Fig. 1 is a perspective view of the main parts of the pump.

Fig. 2 is a cross-section of the pump.

Fig. 2*a* is a plan view of the left portion of Fig. 2.

Figs. 3, 5 and 7 show the position of the ungula (piston) at the beginning, in the middle and at the end of the cycle of work.

Figs. 4, 6 and 8 show in end views, the relative positions of the roller in relation to the suction and discharge openings, at the beginning, in the middle and at the end of the cycle of work.

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Fig. 9 shows the section of the arrangement allowing the roller to slide in the embossment in which it is fitted.

Fig. 10 shows the out of centre position of the roller on the casing.

Fig. 11 shows a view partly in cross-section along the axis of the hinge-joint, of a pump the casing of which is formed by a half-sphere and a cylindrical part.

Fig. 12 is a similar view, at right angles to the axis of the hinge-joint, of the same pump.

Fig. 13 is the cross-section of a double piston pump, working in series, each piston having its own casing.

Fig. 14 is a view partly in cross-section of a double piston pump, working in parallel, where the two pistons are fitted in a single casing.

The pump consists (Fig. 1) of four main parts: one driving part 1 which transmits the circular movement of the power shaft 7, a piston 2 having the shape of an ungula coupled to the driving part 7, a casing formed by two half spheres 3, and a roller 4. One of the half spheres can be replaced by a cylindrical part 5 (Figs. 11 and 12). The roller 4 is mounted in the embossment 6 of the casing (Figs. 2, 9 and 10). The driving part 1 fixed on the shaft 7 (Figs. 1 and 2) is coupled with the ungula 2 by a hinge-joint formed by the cylindrical part 8 of piece 1 and by the central part 9 of the ungula enveloping the cylindrical part 8 on a segment of over 180 degrees, preventing thus the separation of the two pieces and making it possible for the ungula to pivot as a lever, in taking its point of support on the driving piece to avoid thus any loss of power which might result from the friction on the walls of the casing.

The shaft 7 passes through the opening 10 of the casing provided with a ball bearing or any other type of bearing 11 and through a gland 12. The extension of shaft 14 fits into the part 13 of the casing in passing through the opening 15 of the ungula. The direction of shaft 7 is at right angles to the axis of the hinge-joint (Figs. 1, 2, 9 and 10).

The casing carries also the suction opening 16 and the discharge opening 17 placed in the same axis, in order that the direction of the suction and discharge remains straight and always in the same direction which facilitates the priming and reduces to a minimum the stirring and the emulsion of liquids. This is important for the transfusion of oil, hydrocarbons, wines and other liq-

uids. This arrangement increases also the efficiency of the pump (Figs. 1, 2, 4, 6 and 8).

The combined outer surfaces of the ungula and of the enlarged ends **18** and **19** of the cylindrical part of the hinge-joint conform strictly in shape to that of the inner surface of the casing, while the dimensions of the said ends are sufficient to obturate openings **16** and **17** during the rotation of pieces **1** and **2** (Figs. 2 and 9).

The walls **20** and **21** of piece **1** and those **22** and **23** of the ungula **2** form between them chambers **24** and **25** in such a way that no leaks can occur either between the two chambers or from these two chambers to the outside. One of these chambers is the suction chamber, the other the discharge chamber. They change their duty with each half revolution (Figs. 2, 3, 5 and 7). The volume of the chambers is variable and is determined by the scavenging angle which one desires to obtain. This is ensured by the formation of the groove **26** cut on the upper part of the ungula. This groove, under the action of roller **4** which rolls on its wall, imposes on the ungula, during the circular movement of the whole, a pivoting to and fro movement, determined and limited by the formation of the groove (Figs. 4, 6 and 8). Thus, piece **1** fixed on the shaft **7**, will only make a circular movement, whereas the ungula **2** will make not only this circular movement but also a to and fro movement and will act as a piston, increasing and decreasing at will the volume of chambers **24** and **25**, and, if necessary, without leaving any dead space whatever.

During the circular movement of the whole the ends **18** and **19** will act as obturators, opening and closing the suction and discharge openings in accordance with the suction and the discharging produced by the pivoting movements of piston **2** (Fig. 9). In order that the torque of the motor be transmitted to the piston with the least loss and in order that no shearing reaction should occur on the axle around which the piston pivots, the position of the roller on the casing must be made very accurately. This position must be out of centre in two directions in relation to the point where the axle of the extension **14** of the shaft would pass through the casing: in the vertical direction by an angle not exceeding 70 degrees (as shown in Fig. 2), and in the direction of rotation of piston **2** by an angle not exceeding 40 degrees (as shown in Fig. 2*a*). The ideal position is in the forward direction of rotation at an angle to the extension **14** of half the angle of sweep which one wants to obtain at each compression. To insure efficient operation of the pump, the case must be considered where the fluid would introduce solid bodies into the compression chamber of the pump which might produce such a high resistance that it would be harmful. To offset such a non-desired resistance, the roller can be placed so as to move back and thus annul the resistance resulting from the said bodies (Fig. 9). To that effect the embossment **6** (Fig. 9) is provided with a sleeve which can slide in the inside of this embossment. This sleeve is provided with bearings **29** and **30** in which the shaft **31** of the roller is fitted. One of the bearings **30** forms a thrust bearing. By means of this sleeve, the roller, fixed on shaft **31**, will move back each time when it will be under the influence of an unforeseen resistance.

But the pump must maintain its required discharge power, therefore the roller must, during the normal run of the pump, resist the axial thrust corresponding to this power and it must not move back except from the moment that this thrust is exceeded. This is ensured by a counterpressure element, like the spring **27**, resting against the sliding sleeve, maintaining thus the necessary resistance. In order to have an easy and silent movement of roller **4** it can be provided with a flexible element **32**.

The operation of the pump can be followed on the drawings shown on Figures 3 and 4, 5 and 6, 7 and 8 which represent the relative positions of the suction and discharge openings as well as the volume of the suction and discharge chambers at the beginning, in the middle and at the end of the cycle of work. The cycle is made during a rotation of 180 degrees, thus twice during a complete revolution. It must be noted that the chambers **24** and **25** change their duty at each half revolution, the suction chamber will become discharge chamber and the discharge chamber will become suction chamber at each successive half revolution.

Figures 3 and 4 show the disposition at the beginning of the cycle of work. In this position the suction openings and the discharge opening **17** are entirely closed. The chamber **24** is at this moment at the maximum and it has the duty of suction chamber. The chamber **25** is, in this position, the discharge chamber and is at the minimum. During the circular movement of the pieces forming hinge-joint, the openings **16** and **17** uncover and enter into communication with the respective chambers. The chamber **24** will become discharge chamber and the chamber **25** suction chamber. Figures 5 and 6 show the relative positions of the whole as well as the volumes of the two chambers in the middle of the cycle of work.

During the continuous circular movement of the piston, the openings **16** and **17** will be again closed, the volume of the chamber which is discharge chamber is reduced to a minimum and the chamber **25**, acting as suction chamber, comes to a maximum and the cycle of work is finished (Figures 7 and 8).

Continuing the circular movement, chamber **25** will become again discharge chamber and chamber **24** will become again suction chamber and at the end of the second half-revolution, a second cycle of work will be completed. The cycles of work will occur successively in the same manner. The progression of work is established according to parabolic laws or according to any other laws answering to the duty to be fulfilled by the pump. It is the shape of the groove which will determine the to and fro movements of the piston as well as the dead centres which might be necessary.

Thus to reproduce a cycle of work, for instance the sinusoidal cycle obtained by the system of connecting rod and crank, it will be sufficient to give to the groove the corresponding shape and in changing this shape one will modify at will the cycle of work.

It is thus possible to ensure that the progression of work occurs according to a given curve which might even follow a proportional law, as for instance:

$$\frac{A}{A'}=\frac{B}{A'+B'}=\frac{C}{A'+B'+C'}$$

where A, B, C, are fractions of the angular displacement of the whole and A', B', C' are fractions of the movement of the pistons.

In consequence, one can distribute on a liquid column the efforts according to a chosen curve, to compensate at will the points of inertia of the liquid. One can thus ensure that the work be

made for instance in the following manner: at the beginning of the cycle, the piston will make during 40 degrees of the circular movement of the whole, half of its complete movement in discharging one half of the discharge chamber. It will then remain stationary during the following angle of 100 degrees and the other half of the chamber will be discharged during the following 40 degrees of the rotation.

The wear of the pump is slight. It can be compensated by piston-rings **33** or by any other known means. In the case, where one part of the casing is cylindrical, counterpressure elements **34**, interposed between the casing and the driving piece f help to compensate the wear.

The manufacture of double piston pumps is extremely easy. They can consist of two separate casings (Figure 13) or of one single common casing **35** (Figure 14) containing the two pistons the driving shaft of which is driven either by a worm, or by gears, or otherwise.

To obtain a double pressure, the pistons should work in series (Figure 13). The position of the two hinge-joints is parallel in this case and the discharge opening of one of the casings is connected with the suction opening of the other casing. The arrows indicate the direction of the passage of the liquid.

To obtain a double volume, the pistons should work in parallel. In this case the position of the two hinge-joints is displaced by

$$\frac{\pi}{2}$$

and the two suction and discharge openings are connected together (Fig. 14).

It is understood that the invention has been described and represented here only in an explanatory and non-limitative way. It can include all variations and modifications of detail conforming to its spirit.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:

1. A pump comprising in combination a driving shaft, a casing spherical on at least one portion of its inner surface and provided with diametrically opposed openings for intake and discharge, a member driven by said shaft and adapted to fit compactly within the casing, a second member spherical on a part of its outer portion and adapted to fit compactly with the spherical portion of the casing, means driven by said shaft and adapted to obturate periodically and simultaneously both opposed openings, means connecting said second member with the said rotatable member to permit said second member to oscillate about an axis perpendicular to the driving shaft and oriented along the diameter of the spherical portion of the casing, the facing surfaces of the said two members being formed in such a manner as to define between them two non-intercommunicating chambers arranged on either side of the connecting means, the sections of said chambers varying inversely with respect to each other during the relative oscillations of the said two members, and cooperating means for

controlling the oscillations of the second member comprising a cam integral with said oscillating member and a fixed axis roller carried by the casing.

2. A pump comprising in combination a driving shaft, a casing spherical on at least one portion of its inner surface in which the shaft is supported for rotation and provided with diametrically opposed intake and discharge openings, a first member rotatable within the casing and driven by the shaft, a second member having a part-spherical outer surface adapted to fit compactly in the spherical inner casing surface, means connecting the first and second members to cause the second member to rotate with the first member and to oscillate about a diameter of the spherical portion perpendicular to the shaft, the connecting means comprising a transverse shaft having enlarged end portions adapted to obturate the openings intermittently and simultaneously, the opposed surfaces of the two members mutually defining two chambers separated from each other by the connecting means, the volumes of the two chambers varying inversely with respect to each other as the second member oscillates, and means controlling the oscillations of the second member comprising a cam surface integral with the second member and a cam follower having its axis fixed relatively to the casing.

3. A pump as claimed in claim 2 wherein the cam follower is a conical roller having its axis inclined to the shaft axis by not more than 70 degrees in a vertical plane and not more than 40 degrees in the forward direction of movement in a horizontal plane.

4. A pump as claimed in claim 2 wherein the cam follower is an axially movable conical roller, yielding means being provided urging the roller into contact with the cam.

5. A pump as claimed in claim 2 wherein the casing is part-spherical and part-cylindrical, the first member being cylindrical and axially slidable in the corresponding cylindrical portion of the casing, yielding means being provided urging the cylindrical member toward the spherical portion of the casing.

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