April 21, 1942. A. P. SULLIVAN 2,280,272

FLUID PUMP

Filed March 15, 1940

Fig. 1.

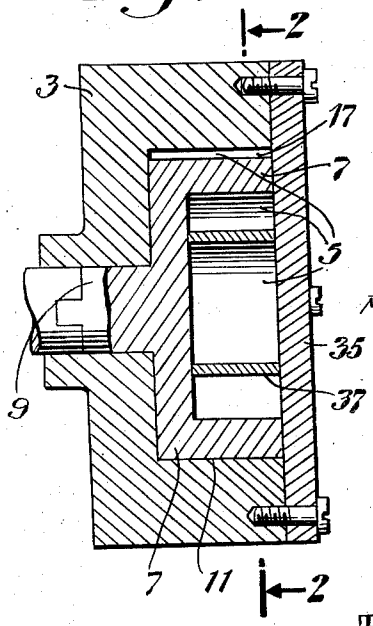


Fig. 2.

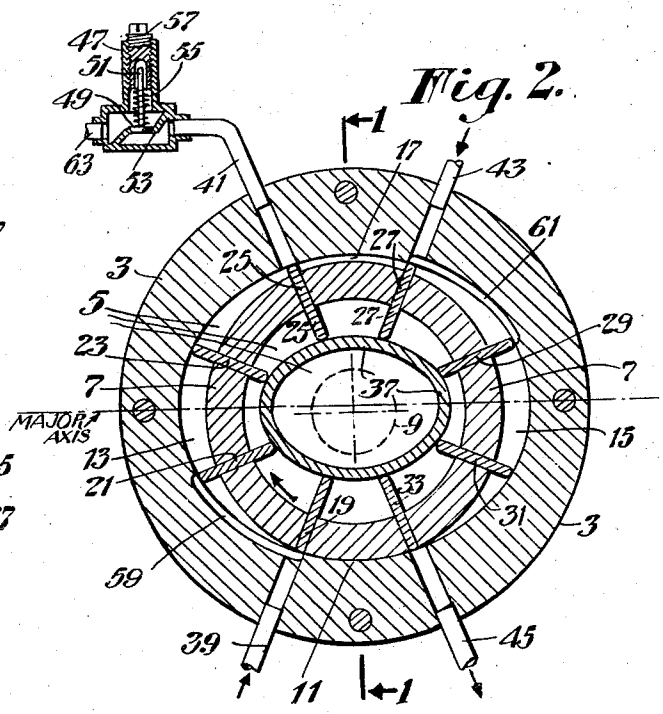
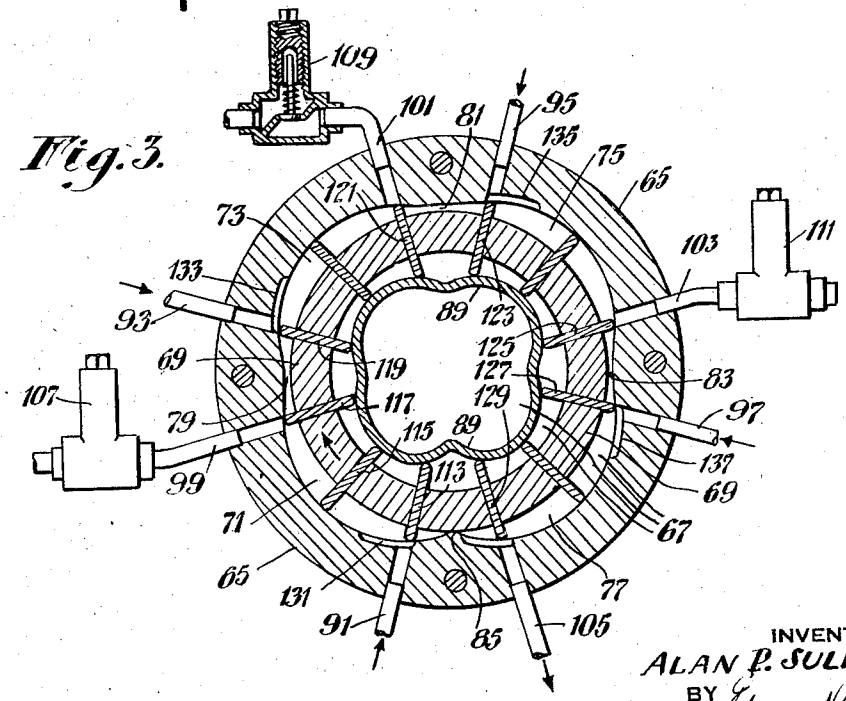


Fig. 3.



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FLUID PUMP

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7 Claims. (Cl. 103—7)

This invention relates to fluid pumps and particularly to rotary positive displacement mixing pumps. It specifically concerns pumps adapted to mix fluids in constant predetermined proportions when the pressure of any one of the fluids entering the pump may be variable.

In my copending application, Serial No. 324,178, filed March 15, 1940, an improvement in fluid pumps was disclosed for obtaining a constant volume discharge of a fluid from a pump by automatic means, when the suction pressure of the fluid entering the pump was variable. Also disclosed in the application was a combination of this constant volume discharge pump with a mixing pump, whereby a mixture of predetermined proportions was obtained from the mixing pump regardless of variations in the pressure of any one of the fluid portions entering the pump.

The pump disclosed in the present application is an improvement over the disclosure of application Serial No. 324,178 in that a mixing pump has been designed which is more simple in construction due to the fact that a single chamber is now used where formerly two or more pump chambers were required.

It is the primary object of this invention to provide a pump with a single chamber which will automatically adjust the suction pressure of any one of several fluids entering the pump and then mix a definite proportion of this fluid with definite proportions of the other fluids.

In rotary mixing pumps of the positive displacement type, the amount of each fluid drawn into the pump is determined by the location of the suction ports on the periphery of the pump chamber. To obtain a mixture having a small amount of one fluid mixed with a large amount of another fluid, the use of a pump with a single chamber has heretofore been unsatisfactory, due to the fact that the suction ports cannot be located accurately enough along its periphery to give the predetermined proportions desired. For this reason it has been the practice, in order to obtain a mixture having a small amount of one fluid in another, to use a pump with two or more chambers in series; whereby, after the two fluids are mixed in the first chamber, the proportion of one of the fluids is decreased by adding more of the other fluid to the mixture in another chamber, and then repeating this process of dilution in the succeeding pump chambers until a mixture of the desired proportions is obtained.

Another object of this invention is to provide a pump having a single chamber in which one fluid is successively added to a constant amount of another fluid, whereby a mixture is obtained which contains accurate proportions of a small amount of one fluid mixed with a large amount of another fluid.

If one of several fluids drawn into a mixing pump is available only at a variable pressure, the proportion of that fluid in the resulting mixture will vary directly with its pressure. To obtain a mixture having a small amount of one fluid mixed with a large amount of another fluid, if the fluid of small proportions is available only at a variable pressure, it is first necessary to adjust this pressure to a constant pressure before mixing it with the other fluid. Adjusting the pressure of one fluid to a constant pressure and then successfully adding another fluid to the fluid so adjusted has previously been performed only by the use of a pump having several chambers.

A further object of this invention, therefore, is to provide a pump having a single chamber which will automatically adjust the fluctuating suction pressure of a fluid to a constant pressure and will then successively add another fluid to this original fluid in order to obtain a mixture containing small amounts of the original fluid mixed with large amounts of the other fluid.

Other and more specific objects of the invention will become apparent from the following detailed specification in connection with the accompanying drawing.

Fig. 1 is a sectional view of a pump embodying a preferred form of the invention, the section being taken through the center of the pump along line 1—1 of Fig. 2.

Fig. 2 is a sectional view of the pump shown in Fig. 1, taken through its chamber along line 2—2 of Fig. 1.

Fig. 3 is a sectional view of a modified form of a pump taken similarly to the section as shown in Fig. 2.

This invention is intended to include all mixing pumps having a chamber of such design that when a circular rotor is used therein, at least two or more interconnected pump compartments will be formed, of which the first compartment will have a pressure regulating port by which the varying pressure of a fluid drawn into this compartment of the pump will be adjusted to a predetermined pressure, prior to its being mixed with the other fluids.

The preferred form of the invention is an elliptical rotary positive displacement pump having a circular rotor with eight blades, which is

illustrated by Figs. 1 and 2. In the operation of this pump, one fluid is drawn in at a suction port, is compressed, and has its pressure adjusted to a predetermined pressure maintained at a pressure regulating port. A constant volume of this fluid is then mixed with a constant volume of a second fluid, and the resulting mixture is further compressed and discharged at an exit port.

Referring to Figs. 1 and 2, a pump is illustrated having a housing 3 in which an elliptically shaped chamber 5 is centrally located. A circular rotor 7 is mounted in chamber 5 with the center of its shaft 9 below the major axis of chamber 5, the diameter of the rotor 7 being such that it will contact the bottom wall of chamber 5 along line 11. With rotor 7 so located, two pump compartments 13 and 15 are formed on opposite sides of chamber 5 with a clearance space 17 connecting the two compartments at the top of chamber 5.

The center of rotor shaft 9 passes through the minor axis of elliptical chamber 5, thus making the volume of compartment 13 equal to the volume of compartment 15. In other applications for a pump of this type, it may be desirable to have compartments 13 and 15 of unequal capacity in order that a larger volume of fluid may be drawn into one compartment than is drawn into the other compartment. In this case, rotor shaft 9 will be located to the left or right of the minor axis of elliptical chamber 5, depending upon which compartment is to have the greater capacity.

Slots are formed in rotor 7 in which are placed eight blades, 19, 21, 23, 25, 27, 29, 31 and 33, that are arranged to slide in the slots as rotor 7 turns. The use of a rotor with eight blades in a pump of this type is preferred, but it has been found that the pump will operate with similar results if a rotor having four or more blades is used.

An end plate 35 fits over the end of housing 3 in order to enclose chamber 5. Attached to end plate 35 is an elliptically shaped blade guide 37 (shown in Fig. 2), similar to the shape of elliptical chamber 5, and mounted to have its major and minor axes lie along the major and minor axes of elliptical chamber 5. When the pump is assembled, blade guide 37 touches the edge of each blade in order to hold the blades against the wall of chamber 5.

In housing 3, leading into chamber 5, are a suction port 39, a pressure regulating port 41, another suction port 43, and a discharge or exit port 45. In locating the position of pressure regulating port 41 and suction port 43 in chamber wall 5, rotor 7 is turned to the position illustrated in Fig. 2 with blades 25 and 27, 19 and 33 equidistant from the minor axis of elliptical chamber 5. In this position of the rotor, the right side of port 41 is aligned with the right side of blade 25, and the left side of port 43 is aligned with the left side of blade 27.

Attached to pressure regulating port 41 is an adjustable exhaust valve 47 which determines the pressure maintained at regulating port 41. Exhaust valve 47 comprises a valve disc 49 with a stem 51 attached thereto, and resting in valve seat 53. A spring 55 around stem 51 presses a disc 49 against a seat 53. The pressure that disc 49 exerts on slot 53 may be varied by adjusting valve nut 57.

Grooves 59 and 61, located along the periphery of chamber 5, are connected to suction ports 39 and 43 respectively. The purpose of these grooves is to extend the period of suction of fluid into the chamber space between successive blades passing each suction port until this chamber space reaches the maximum volume obtainable in the particular pump compartment through which it is then passing. For example, when rotor 7 rotating in a clockwise direction reaches the position illustrated in Fig. 2, the chamber spaces between blades 21 and 23, blades 29 and 31 are at maximum volumes; so groove 59 extends the period of suction through port 39 until each blade reaches the position of blade 21, and groove 61 extends the period of suction through port 43 until each blade reaches the position of blade 29.

In the operation of the pump, as rotor 7 turns in a clockwise direction, blade 19 moves upward drawing fluid A through suction port 39 into the chamber space between blades 19 and 21, until blade 19 reaches the position of blade 21 in Fig. 2. As rotor 7 continues to turn, fluid A is compressed until blade 19 reaches the position of blade 25. The pressure of fluid A is adjusted to the pressure maintained at port 41 as the fluid A passes this port. The function of pressure regulating port 41 is to adjust the pressure of the fluid passing the port to a constant pressure; thus any fluid drawn in at suction port 39 at a fluctuating pressure will have its pressure adjusted to a constant pressure when passing regulating port 41.

When blade 19 reaches the position of blade 25, a definite volume of fluid A at the predetermined pressure of port 41 is in the chamber space between blades 19 and 21. This volume is determined by the amount of clearance 17 between rotor 7 and the wall of chamber 5. Fluid A is then brought into compartment 15 as rotor 7 continues to turn, and is mixed with fluid B entering compartment 15 through suction port 43. Fluid B is drawn into the pump until blade 19 reaches the position of blade 29. The mixture of fluid A and fluid B is then compressed and released at discharge port 45.

During the operation of the pump, relief valve 47 should be adjusted to permit a small flow of fluid A through opening 63 when the pressure of fluid A entering suction port 39 is at the lowest pressure at which it will be available. This will insure a constant pressure at relief port 41.

In designing the pump to obtain definite proportions of each fluid in the resulting mixture, the amount of clearance 17 will determine the volume of fluid A that will be mixed with fluid B. This clearance 17 can be increased or decreased by lowering or raising the location of the axis of rotor shaft 9 with respect to the major axis of elliptical chamber 5 and simultaneously decreasing or increasing the diameter of rotor 7 in order that the outer periphery will contact the bottom wall of chamber 5 along line 11. Therefore, with fluid B entering at a constant pressure and volume, and being able to add any definite volume of fluid A at a constant pressure, a mixture of any desired proportion of each fluid may be obtained.

Fluid B should be available at a pressure equal to or greater than the pressure existing at regulating port 41 in order that fluid A will not leave the pump when passing regulating port 41. Fluid B should also be available at a constant pressure in order to have a constant proportion of fluid B in the mixture of fluid A and fluid B.

Illustrated by Fig. 3 is a pump of another form embodying the invention. The construction of this pump differs fundamentally from the construction of the pump shown in Figs. 1 and 2, by

the design of the pump chamber. The pump chamber is of such a shape that four pump compartments connected together by clearance spaces, will be formed when a circular rotor is placed therein. It is intended that the scope of this invention also shall include pumps having a single chamber designed to have three, five, six or more compartments which will be connected in series by clearance spaces when a circular rotor is placed in the pump chamber. The design and construction of such pumps will be similar to the pump illustrated in Fig. 3, whose structure and operation will now be described.

A housing 65 has a chamber 67 centrally located therein. A rotor 69 having twelve slots holding twelve blades is mounted in housing 65 to rotate in chamber 67. When rotor 69 is placed in chamber 67, four pump compartments 71, 73, 75 and 77 are formed with clearances 79, 81 and 83 connecting these compartments together in series. Rotor 69 is so located in housing 65 that its outer periphery will contact the bottom wall of chamber 67, along line 85, thus separating compartment 71 from compartment 77. Although all the compartments formed in chamber 67 are illustrated as having equal volumes, the location of rotor 69, and the shape of chamber 67, can be such that all the compartments will have different volumes, depending upon the desired application of the pump.

An end plate 87 (not shown), which is similar to the one illustrated in Fig. 1, is attached to housing 65 in order to close chamber 67. A blade guide 89 is attached to the end plate. The shape of blade guide 89 is similar to the shape of chamber 67, and serves to keep the blades against the wall of the chamber. There are four suction ports 91, 93, 95 and 97; three pressure regulating ports, 99, 101 and 103; and one discharge port 105, in housing 65, leading into chamber 67. To each of the pressure regulating ports 99, 101 and 103, are connected relief valves 107, 109 and 111, respectively, for maintaining a constant pressure at the pressure regulating ports. These relief valves are of the same construction as relief valve 47, illustrated in Fig. 2.

In locating suction ports 93, 95 and 97, and pressure regulating ports 99, 101 and 103, a somewhat similar method is employed as was used to locate suction port 41 and pressure regulating port 43 in the pump of Fig. 2. Rotor 69 is turned to the position illustrated in Fig. 3, such that blades 121 and 123, 113 and 129 are equidistant from a vertical line through the center of the axis of rotor 69. The upper side of blade 117 is aligned with the upper side of regulating ports 99; the lower side of blade 119 is aligned with the lower side of suction port 93; the right side of blade 121 is aligned with the right side of port 101; the left side of blade 123 is aligned with the left side of port 95; the lower side of blade 125 is aligned with the lower side of port 103; and the upper side of blade 127 is aligned with the upper side of port 97.

By locating the suction ports and pressure regulating ports in these positions, one blade is just past a pressure regulating port when the preceding blade is just starting to pass the next suction port. Connected to suction ports 91, 93, 95 and 97 are grooves 131, 133, 135 and 137 respectively. These grooves are located in the same manner as the grooves in the pump of Fig. 2. They are so located in the wall of chamber 67 to permit fluid to be drawn through the suction ports into the chamber spaces between successive blades, until the chamber spaces are at a maximum volume in each compartment.

This pump may be used for several different purposes, two of which being: a pump for adjusting the variable pressure of one fluid to a constant pressure, and then successively adding another fluid to this fluid in several stages; and a pump for mixing four different fluids in definite proportions of each fluid and at the same time adjusting the variable pressure of one of said fluids to a constant pressure.

The pump illustrated in Fig. 3 is designed specifically to be operated for adjusting the variable pressure of one fluid, and then successively adding another fluid to this fluid. In operating the pump for this purpose, rotor 69 turns in a clockwise direction, drawing a fluid A into the space between blades 113 and 115, through suction port 91, until blade 113 reaches the end of groove 131. The fluid is then compressed, having any variations in its suction pressure adjusted to the pressure maintained at regulating port 99 until blade 113 reaches the position of blade 117. The volume of fluid A which will be then carried into compartment 73, is determined by clearance 79. As rotor 69 continues to turn, fluid B is drawn in between blades 113 and 115 at suction port 93 and mixed with fluid A until blade 113 reaches the end of groove 133. This mixture then passes regulating port 101 where part of the mixture is discharged from the pump. The amount of fluid which is held between the blades 113 and 115 when blade 113 reaches the position of blade 121 will depend upon the amount of clearance 81. This mixture is then brought into compartment 75 where some more of fluid B is drawn in at port 95. The mixture then passes port 103 where part is discharged and the remainder is brought into compartment 77 where more of fluid B is drawn in at port 97 to be added to the mixture. The finished mixture of fluid A and B is compressed and discharged at port 105.

For example, a pump may be so designed that the maximum capacity of the chamber space between blades 113 and 115 for each compartment is 100 cc., and the volume of the clearances 79, 81 and 83 is 10 cc. In the operation of the pump, after the pressure of fluid A is adjusted at port 99, 10 cc. of fluid A will be brought into compartment 73 to be mixed with 90 cc. of fluid B drawn in at suction port 93. As 10 cc. or 10% of this mixture will enter compartment 75, then 1 cc. of fluid A and 9 cc. of fluid B will enter compartment 75, to be mixed with 90 cc. more of fluid B, drawn in at suction port 95. A mixture of 1 cc. of fluid A and 99 cc. of fluid B will leave compartment 75 of which 10% will pass into compartment 77; or 0.1 cc. of fluid A and 9.9 cc. of fluid B will enter compartment 77. Then 90 more cc. of fluid B will be drawn into compartment 77 through suction port 97, to be mixed with the fluid coming from compartment 75. The resulting mixture leaving at discharge port 105 will consist of 0.1 cc. of fluid A, and 99.9 cc. of fluid B, or one part of fluid A in 999 parts of fluid B.

Fluid B should be available for ports 93, 95 and 97 at a pressure equal to or greater than the pressure maintained at relief valves 107, 109 and 111. Relief valve 107 should have its pressure so adjusted that a small amount of fluid A will pass through it when fluid A is entering suction port 91 at the lowest pressure at which it will be available.

In designing the pump in Fig. 3 for mixing

four different fluids in definite proportions of each while adjusting the variable pressure of one of said fluids, the regulating ports 101 and 103 are not used; and pump chamber 67 is so shaped that when rotor 69 is placed therein, the compartments formed are not of equal volume, but each compartment increases in capacity, starting with compartment 71 and going in a clockwise direction around the chamber.

In the operation of the pump of Fig. 3, fluid A is drawn in at port 91 and has its pressure adjusted to a constant pressure at regulating port 99. A definite volume of fluid A depending upon the size of clearance 79 then enters compartment 73 where it is mixed with fluid B, drawn in at suction port 93. The amount of fluid B drawn into the pump is determined by the volume of compartment 73. This volume of fluid B will be equal to a maximum chamber space between successive blades, less the volume of fluid A. The mixture of fluid A and fluid B then enter compartment 75 where fluid C is drawn into the pump through suction port 95. The volume of fluid C drawn into the pump will be equal to the maximum chamber space between successive blades, less the volume of fluids A and B. The mixture of these three fluids then enters compartment 77 to be mixed with fluid D, drawn into the pump through port 97. The amount of fluid D drawn in will equal the volume of the maximum chamber space between the blades, less the combined volumes of fluids A, B and C. The resulting mixture is compressed and discharged through port 105.

Relief valve 107 should be adjusted to have a small discharge of fluid A, when fluid A enters the pump at the lowest suction pressure at which it will be available.

The invention having been thus described, what is claimed as new is:

1. A fluid mixing pump comprising a housing, a chamber contained therein, a rotor having radial slots mounted to rotate in said chamber, a plurality of blades slidably mounted in the rotor slots, the side walls of said chamber being so designed as to form a guide face for the outer edge of the blades which is eccentrically placed with respect to the rotor and which is shaped so as to touch the circumference of the rotor at one sealing zone only and so as to alternately recede from and approach the circumference of the rotor without touching at other points to form a series of connected compartments in open communication with each other, a pressure regulating port in the compression side of each compartment, a suction port in each compartment, and a discharge port in the last compartment of the series.

2. A fluid mixing pump comprising a housing, a chamber contained therein, a circular rotor having radial slots mounted to rotate in said chamber, a plurality of blades slidably mounted in the rotor slots, the side walls of said chamber being so designed as to form a guide face for the outer edge of the blades which is eccentrically placed with respect to the rotor and which is shaped so as to touch the circumference of the rotor at one sealing zone only and so as to alternately recede from and approach the circumference of the rotor without touching at other points to form a series of connected compartments between the inner wall of the housing and the outer wall of the rotor, a pressure regulating port in the compression side of each compartment except the last compartment of the series, an exhaust valve connected to one of said pressure regulating ports, a suction port in each compartment, and a discharge port in the last compartment of the series.

3. A fluid mixing pump comprising a housing, a chamber contained therein, a rotor having radial slots mounted to rotate in said chamber, a plurality of blades slidably mounted in the rotor slots, the side walls of said chamber being so designed as to form a guide face for the outer edge of the blades which is eccentrically placed with respect to the rotor and which is shaped so as to touch the circumference of the rotor at one sealing zone only and so as to alternately recede from and approach the circumference of the rotor without touching at another point to form a series of connected compartments between the rotor and the inner wall of the housing, a pressure regulating port in the compression side of the first compartment of the series, a suction port in each compartment, and a discharge port in the last compartment of the series.

4. A fluid mixing pump comprising a housing, a chamber contained therein, a rotor having radial slots mounted to rotate in said chamber, a plurality of blades movably mounted in the rotor slots, the side walls of said chamber being so designed as to form a guide face for the outer edge of the blades which is eccentrically placed with respect to the rotor and which is shaped so as to touch the circumference of the rotor at one sealing zone only and so as to alternately recede from and approach the circumference of the rotor without touching at other points to form a series of compartments between the inner wall of the chamber and the outer wall of the rotor which are connected together by clearance spaces, the cross-sectional area of said compartments being greater than the cross-sectional area of said clearance spaces, a pressure regulating port in the compression side of each compartment except the last compartment of the series, a suction port in each compartment, and a discharge port in the last compartment of the series.

5. In a fluid mixing pump comprising a housing, a chamber contained therein, a rotor having radial slots mounted to rotate in said chamber, a plurality of blades slidably mounted in the rotor slots, the side walls of said chamber being so constructed as to form a guide face for the outer edge of the blades which is eccentrically placed with respect to the rotor and which is shaped so as to touch the circumference of the rotor at one sealing zone only and so as to alternately recede from and approach the circumference of the rotor without touching at other points to form a plurality of pump compartments, said compartments connected in series by clearance spaces between the rotor and the chamber wall, a pressure regulating port in the compression side of each compartment except the last compartment of the series, a suction port in each compartment, and a discharge port in the last compartment of the series.

6. In a fluid mixing pump comprising a housing, an elliptical chamber contained therein, a rotor having radial slots mounted to rotate in said chamber, said rotor mounted in a position off the major axis and on the minor axis of the elliptical chamber touching the surface of the chamber forming two compartments connected together by a clearance space between the rotor and the chamber wall, a plurality of blades slidably mounted in said rotor slots, a suction port in each compartment, a pressure regulating port in the

compression side of the first of the two compartments, and a discharge port in the other compartment.

7. A fluid mixing pump comprising a housing, a chamber contained therein, a circular rotor having radial slots mounted in the housing, a plurality of blades movably mounted in the rotor slots, said chamber being so designed as to form a guide face for the outer edge of the blades which is eccentrically placed with respect to the rotor and which is shaped so as to touch the circumference of the rotor at one sealing line only and so as to alternately recede from and approach the circumference of the rotor without touching at three other points to form four compartments which are connected together in series by clearance spaces, a suction port in each compartment, a pressure regulating port in the compression side of each of the first three compartments of the series, and a discharge port in the last compartment.

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