Sept. 13, 1938. C. A. SKÄRLUND 2,130,037

FLUID MACHINE

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Fig. 1.

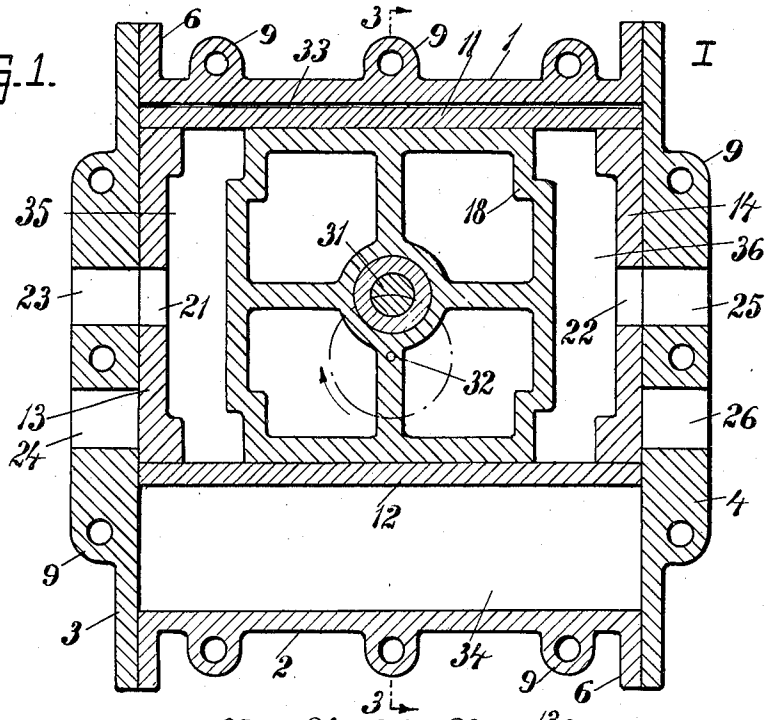
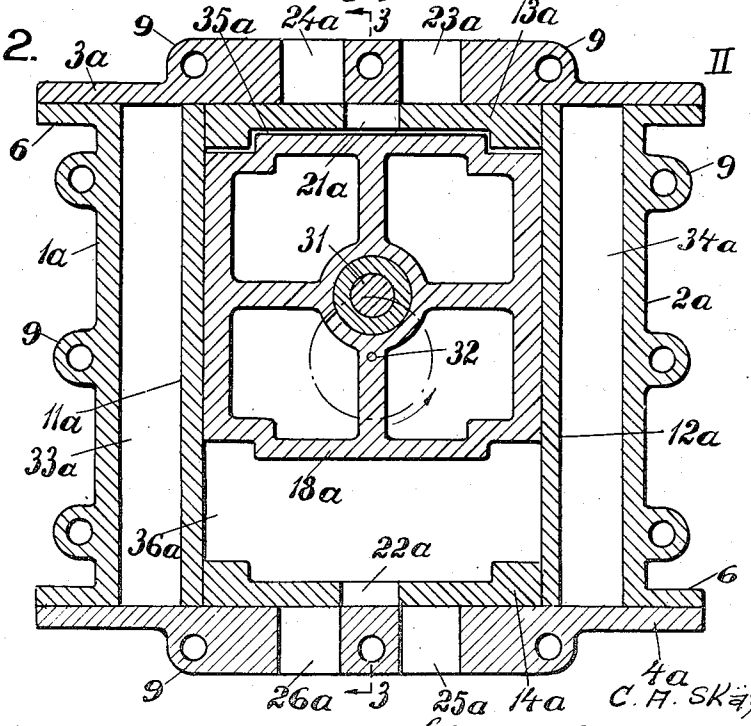


Fig. 2.



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FLUID MACHINE

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Fig. 3.

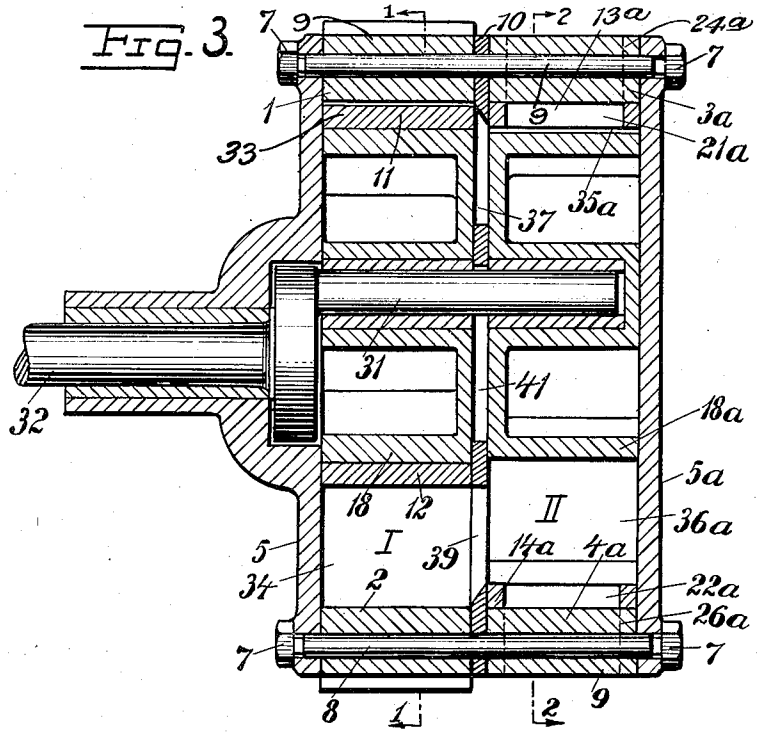
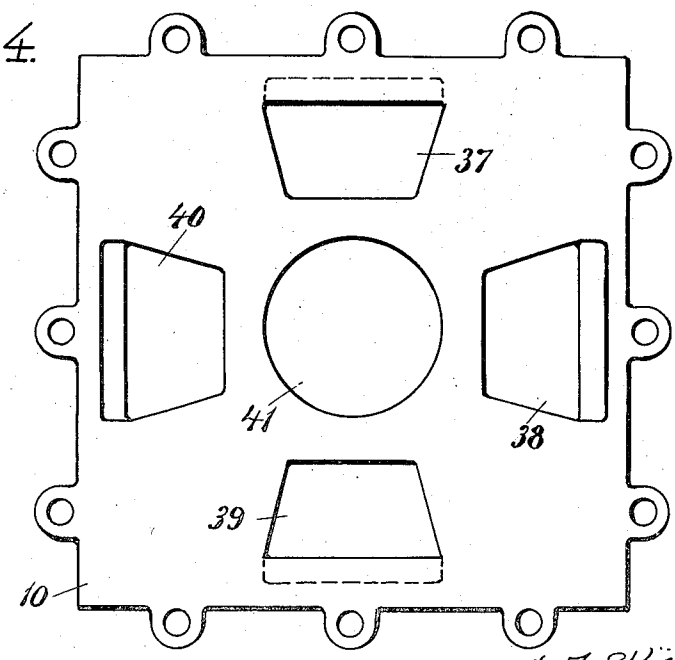


Fig. 4.



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FLUID MACHINE

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Fig. 5.

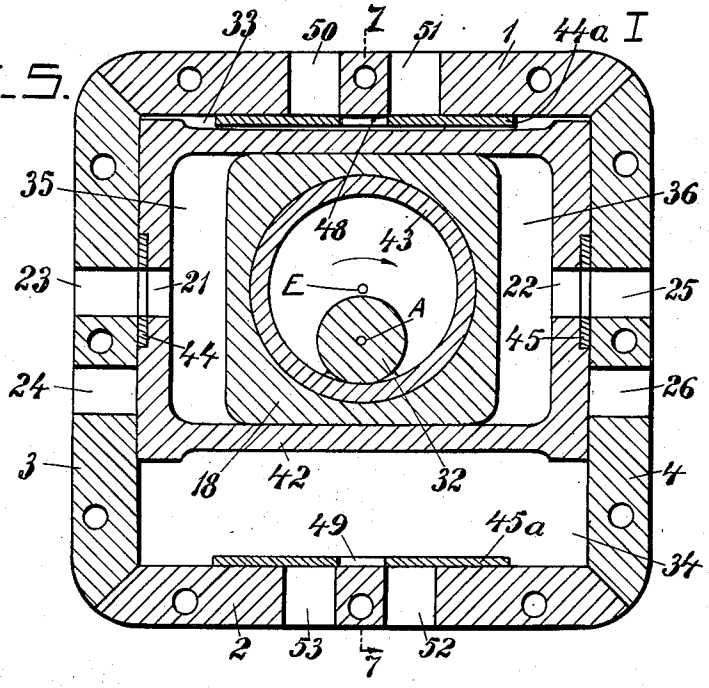
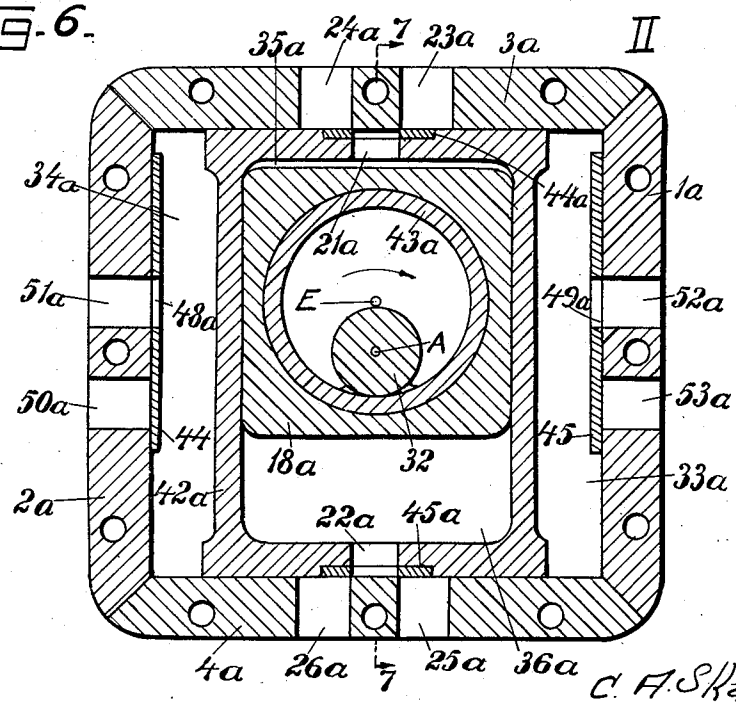


Fig. 6.



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FLUID MACHINE

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Fig. 7.

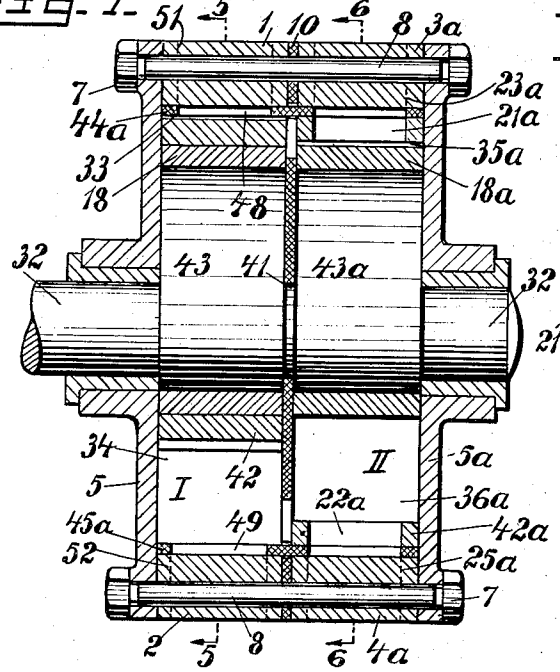


Fig. 9.

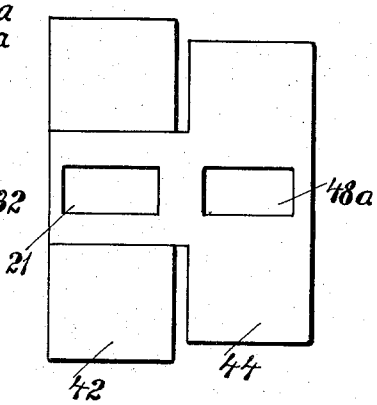
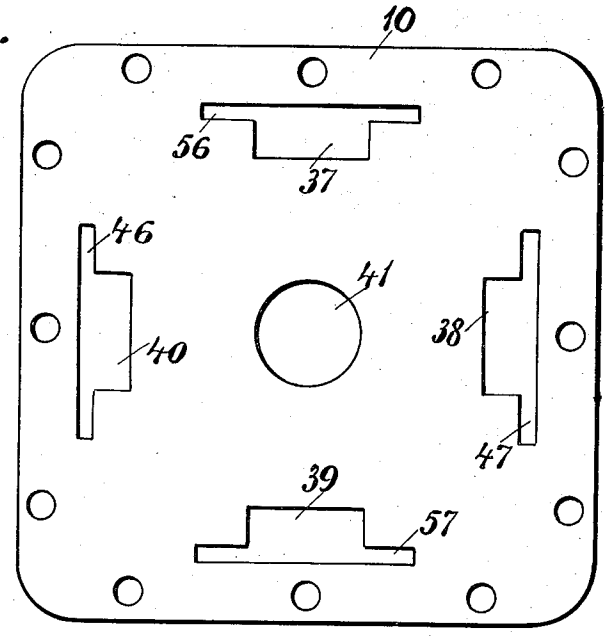


Fig. 8.



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Patented Sept. 13, 1938 2,130,037

UNITED STATES PATENT OFFICE

2,130,037

FLUID MACHINE

Carl Axel Skärlund, Stockholm, Sweden

Application January 11, 1937, Serial No. 120,114
In Sweden January 23, 1936

4 Claims. (Cl. 103—163)

The present invention relates to fluid machines, such as pumps, compressors or motors for gaseous or liquid media of the type comprising an outer housing having flat parallel inner sides and in which reciprocates a parallelopipedical or box-shaped outer piston, which itself forms a housing for a second likewise parallelopipedical or box-shaped inner piston reciprocating at an angle of 90° to the direction of movement of said first mentioned piston, outer and inner working chambers, respectively, being formed between the outer piston and the outer housing and between the said latter piston and the inner piston.

Known pumps et cetera of the said kind may be divided into two main groups, viz. one, where the outer housing proper is stationary and the driving shaft rotates and moves the pistons, and a second group, where the outer housing rotates about a stationary shaft.

Within said first mentioned group two distinguished forms of embodiment can be selected, viz. one, where the supply to and the discharge from the inner piston chambers take place through ports in the outer piston and the supply and discharge of the outer piston chambers through ports in the inner piston in combination with ports in the outer piston, and a second form of embodiment, where in combination with ports according to the above ports are further provided in the rotating driving shaft, which ports co-operate with the ports in the pistons.

In the embodiments belonging to the first mentioned main group the arrangement of the inlet and outlet ports is very complicated and very sensitive to wear, and besides the ports will be small in relation to the stroke volume, so that great losses arise.

In the embodiments according to the second main group the inlet and outlet ports are generally provided in the rotating, externally cylindrical housing, said ports corresponding to ports in an outer stationary housing. Such an arrangement makes the pump very bulky, and the peripheral speed of the rotating housing is great in comparation with the output. This causes a quick wear, and the demand of power for driving the pump will be great.

The present invention, which relates to fluid machines according to the first mentioned main group, has for its object to avoid the above mentioned drawbacks and consists essentially in this that the machine is provided with two piston systems displaced 90° with relation to each other and having the outer and the inner working chambers of each system arranged in direct communication with the inner and the outer working chambers, respectively, of the other system and having further inlet and outlet ports so arranged in the outer pistons that the ports of each outer piston form inlet and outlet ports for the working chambers of the associated inner piston and simultaneously also for the working chambers of the other outer piston.

By such an arrangement a simple construction of the ports proper and also great passage areas of said ports can be obtained.

In the annexed drawings two forms of embodiment of a machine according to this invention are shown. Fig. 1 is a cross-section along the line 1—1 of Fig. 3, viewed in the direction of the arrows. Fig. 2 is a cross-section along the line 2—2 of Fig. 3, viewed in the direction of the corresponding arrows. Fig. 3 is a cross-section along the lines 3—3 of Figs. 1 and 2, viewed in the directions of the corresponding arrows. Fig. 4 is a plan detail view of an intermediate plate separating the two piston systems. Figs. 5 to 8 are views similar to those shown in Figs. 1 to 4, respectively, of the second form of embodiment, it being observed that, while according to Fig. 3 the cross-sections 1—1 and 2—2 are viewed in opposite directions, the corresponding cross-sections 5—5 and 6—6 in Fig. 7 are viewed in the same direction. Fig. 9 is a detail view of one of the outer pistons of said latter embodiment.

In the form of embodiment shown in Figs. 1 to 4, the pump housing constitutes two substantially equal half parts I and II, the part I being shown in Fig. 1 and the part II in Fig. 2. Each part consists of four frame portions 1, 2, 3, 4 and 1*a*, 2*a*, 3*a*, 4*a*, respectively, and one end plate 5 and 5*a*, respectively, Fig. 3. The frame portions 1, 2 and 1*a* and 2*a* are made exactly equal and provided at the ends with flanges 6, with which the likewise mutually exactly equally shaped frame portions 3, 4, 3*a* and 4*a* are connected, for instance by means of screws (not shown). The frame thus formed, the one displaced 90° with relation to the other, and the appertaining end plates 5 and 5*a* form each a substantially square box and are connected to each other by means of bolts 8 having nuts 7 and passed through projections 9 at the outer sides of all of the frame portions, a plate 10 of the form shown in Fig. 4 being interposed between the two boxes.

The pump housing thus formed contains two parallelopipedically shaped chambers separated by the plate 10, in which two separate, mutually similarly shaped, but differently placed piston

systems of the construction described below are adapted to work.

In the part I, Fig. 1, of the pump housing there is placed an outer parallelopipedically shaped piston, which, as is the corresponding part of the housing, is composed of suitably interconnected frame portions **11**, **12**, **13** and **14**. Within said piston is movably placed a preferably integral, hollow inner piston **18**.

Provided at each end of the outer piston in the end plates **13** and **14**, respectively, is a rectangular aperture or port **21** and **22**, respectively, which ports at the reciprocation of the piston are brought to alternately register with two similar ports **23**, **24** and **25**, **26**, respectively, in the frame portions **3** and **4**, respectively. The distance between each pair of the said latter ports is equal to the width of the ports **21** and **22**, respectively, so that at the intermediate position of the piston no communication exists between the ports **21**, **22** and the ports **23**, **24** and **25**, **26**, respectively. In the position of the piston shown in Fig. 1 the ports **21** and **22** register with the corresponding upper ports **23** and **25**, respectively. The ports **23** to **26** may be in communication with outgoing pipings, channels or the like.

Provided in the part II, Fig. 2, of the pump housing is a piston system of exactly the same construction as the above described piston system, and similar details are designated by the same reference numerals, to which, however, is applied the index letter *a*. The said latter piston system obtains a position, which is angularly displaced 90° with relation to the piston system in Fig. 1, so that, while according to Fig. 1 the outer piston reciprocates in a vertical direction, the corresponding piston in Fig. 2 moves in a horizontal direction.

The two piston systems are mounted on a common crank pin **31** of a crank shaft **32**, which is mounted in the end plate **5** and may be driven by a suitable motor or be itself driving, if the machine serves as a motor.

The parts I and II of the pump housing form working cylinders for the outer pistons, which in turn form working cylinders for the inner pistons. The working chambers located on both sides of the respective pistons are designated by **33**, **34**, **35**, **36** and **33***a*, **34***a*, **35***a*, **36***a*, respectively. The chambers **33** and **35***a*, the chambers **36** and **33***a*, the chambers **34** and **36***a* and the chambers **35** and **34***a*, respectively, are by pairs in direct communication with one another through corresponding apertures **37**, **38**, **39** and **40**, respectively, in the intermediate plate or partition **10**. Provided in the said partition is further a circular, centrally disposed aperture **41**, in which the crank pin **31** turns.

At the rotation of the drive shaft **32** the outer piston **11**, **12**, **13**, **14** in the pump part I will move up and down, and the inner piston **18** of the same pump part will reciprocate in a horizontal direction with relation to the outer piston, while in the second pump part II the outer piston **11***a*, **12***a*, **13***a*, **14***a* will reciprocate in a horizontal direction and the inner piston **18***a* will move up and down with relation to its outer piston.

Since, as mentioned, the working chambers **33** and **35***a*, the working chambers **36** and **33***a*, the working chambers **34** and **36***a* and the working chambers **35** and **34***a*, respectively, communicate by pairs with one another, the ports **21** and **22** in the outer piston **11**—**14** will at the stated piston motions alternately serve as inlet and outlet ports, respectively, for the working chambers **35** and **36** of their own inner piston **18** and simultaneously also for the working chambers **34***a* and **33***a* of the second outer piston **11***a*—**14***a*, and in the same manner the ports **21***a* and **22***a* in the outer piston **11***a*—**14***a* will alternately serve as inlet and outlet ports for the working chambers **35***a* and **36***a* of their own inner piston **18***a* and also for the working chambers **33** and **34** of the first mentioned outer piston **11**—**14**.

At the rotation of the crank shaft in the direction of the arrow in Figs. 1 and 2 a discharge will thus continuously take place through the ports **25**, **26***a*, **24** and **23***a*, while a suction will continuously occur through the ports **23**, **24***a*, **26** and **25***a*. The said ports may be connected outside the pump housing by groups to a common discharge and suction channel or pipe, respectively.

By arranging the separate working chambers to communicate with one another by pairs through the ports **37** to **40** in the partition **10** a certain equalization will be brought about between the larger outer working chambers and the smaller inner working chambers communicating with them, so that the velocity of flow will be practically the same in all ports.

As already stated, in machines of the present kind it is of a very great importance not to let the flow velocity in the ports be too high, since then the efficiency of the machine will be low. On the other hand, however, it is advantageous to keep the number of revolutions high in order thereby to obtain a small machine.

In Figs. 5–9 there is shown an embodiment, in which attention is particularly paid to the flow conditions in a machine according to the present invention, in order to considerably increase the passage areas of the ports and thereby to render it possible, while maintaining a suitable flow velocity, to considerably increase the number of revolutions, i. e. in other words to considerably increase the capacity of the machine without increasing its dimensions.

The machine according to the said latter embodiment is as to its general construction similar to that one according to Figs. 1–4, and similar parts are designated by the same reference numerals as in the said latter figures. The ports **37**, **38**, **39** and **40** of Fig. 8 correspond exactly with the similarly numbered ports of Fig. 4 and function exactly in the same manner as described with relation to the embodiment shown in Figs. 1 to 4, though the said ports are of less importance and, if desired, may wholly be dispensed with in the embodiment according to Figs. 5 to 9, where all of the eight working chambers have their own inlet and outlet ports.

However, the box-shaped outer pistons, which according to Figs. 5–9 are each made of a single piece, are here designated by **42** and **42***a*, respectively, and the inner pistons **18** and **18***a*, which at their motion drive the outer pistons, are mounted on equally located eccentrics **43** and **43***a*, respectively, secured to the drive shaft **32**, which is mounted in both of the end plates **5** and **5***a* of the housing. In Figs. 5 and 6 the centre of the shaft is designated by A and the centre of the eccentrics with E.

Secured to the ends of the outer piston **42**, at which are provided the ports **21** and **22**, are slide plates **44** and **45**, respectively, the plate **44** being shown also in Fig. 9. The said plates project through guide slots **46** and **47** in the partition **10** into the working chambers **34***a* and **33***a* of the adjacent outer piston **42***a*. The plates **44** and **45**,

which slide closely against the inner sides of the corresponding frame portions 3 and 2a and 4 and 1a, respectively, are provided with ports, which wholly coincide with the corresponding ports 21 and 22, respectively, in the piston, and besides with ports 48a and 49a at the parts, which project into the working chambers 34a and 33a, said latter ports being brought at the movements of the piston to alternately register with ports 50a, 51a, and 52a, 53a, respectively, in the said frame portions 2a and 1a.

Similarly slide plates 44a and 45a are secured to the pistons 42a, and said plates pass through guide slots 56 and 57 in the partition 10 and project into the working chambers 33 and 34 of the adjacent piston 42 and are here provided with ports 48 and 49 registering in certain positions with ports 50, 51 and 52, 53, respectively, in the corresponding frame portions 1 and 2 of the part I of the pump housing.

At the rotation of the drive shaft 32 in the direction indicated by the arrows in Figs. 5 and 6 the several pistons will move as described above with reference to Figs. 1 to 4.

Hereby, in the part I of the pump a discharge will take place continuously through the ports 25, 52, 24 and 50 and suction through the ports 26, 53, 23 and 51, whereby the ports 50—53 are controlled by the slide plates 44a and 45a connected to the outer piston 42a in the part II of the pump.

Similarly, in the part II of the pump a discharge will take place continuously through the ports 52a, 25a, 50a and 24a, while suction takes place through the ports 53a, 26a, 51a and 23a, the ports 50a—53a being controlled by the slide plates 44 and 45 connected to the outer piston 42 of the part I of the pump.

The ports 23 to 26 and 23a to 26a are controlled as described above directly by the respective outer pistons 42 and 42a.

As compared with the form of embodiment according to Figs. 1 to 4, and assuming the pumps according to the two embodiments shown having the same dimensions, the passage areas of the ports in Figs. 5 to 9 will be about twice as great as those of the ports in Figs. 1 to 4, and as a consequence the number of revolutions may be doubled, while maintaining a suitable flow velocity in the ports.

Obviously, the invention is not limited to the above described and shown embodiments, but the pump housing and the pistons may as to the construction proper be made in any other suitable manner. Besides, a plurality of pump systems may be combined and for instance be driven by a common shaft having angularly displaced crank pins or eccentrics. Further, the ports need not be arranged with the mutual relation shown, but this may be suited according to the number of revolutions, the pressure and so on.

The slide plates shown in Figs. 5 to 7 and 9 may also be made integral with the respective outer pistons.

What I claim as new and desire to secure by Letters Patent of the United States of America is:—

1. A fluid machine for gaseous or liquid media, comprising a housing having flat inner sides and inlet and outlet ports in the walls, and two separate piston systems in said housing, each of said piston systems comprising an outer parallelopipedical piston reciprocable in said housing and an inner parallelopipedical piston reciprocable in said outer piston at an angle of 90° to the direction of movement of said outer piston, said two piston systems being displaced 90° with relation to each other, outer working chambers being formed between each of said outer pistons and said housing, and inner working chambers being formed between each of said outer pistons and each of said inner pistons, the outer and the inner working chambers of each of said piston systems being in direct communication with the inner and outer working chambers, respectively, of the other piston system, ports being provided in each of said outer pistons adapted to communicate with the ports in the housing during the reciprocation of said pistons and forming inlets and outlets, respectively, on the one hand for the working chambers of the associated inner piston and on the other hand also for the working chambers of the other outer piston.

2. A fluid machine for gaseous or liquid media, comprising a housing having flat inner sides, a partition in said housing dividing the interior thereof into two box-shaped outer working chambers, a piston system in each of said chambers, each of said piston systems comprising an outer parallelopipedical piston reciprocable in each of said chambers and forming itself an inner working chamber, and an inner parallelopipedical piston reciprocable in said inner chamber at an angle of 90° to the direction of movement of said outer piston, said two piston systems being displaced 90° with relation to each other, ports being provided in the said partition and forming direct communications between the outer and the inner working chambers of each piston system and the inner and outer working chambers, respectively, of the other piston system, ports leading to said inner working chambers being further provided at opposite sides of the outer pistons and adapted to communicate with ports in the housing during the reciprocating movement of said outer pistons.

3. A machine according to claim 2, characterized by the sides of the outer pistons, which are provided with ports being provided with slide-valves, projecting into the working chambers of the adjacent outer piston for the control of outer ports leading to said last named working chambers.

4. A fluid machine for gaseous or liquid media, comprising a housing having flat inner sides, a partition in said housing dividing the interior thereof into two box-shaped outer working chambers, a piston system in each of said chambers, each of said piston systems comprising an outer parallelopipedical piston reciprocable in each of said chambers and forming itself an inner working chamber, and an inner parallelopipedical piston reciprocable in said inner chamber at an angle of 90° to the direction of movement of said outer piston, said two piston systems being displaced 90° with relation to each other, ports leading to said inner working chambers being provided at opposite sides of each of said outer pistons and adapted to alternately communicate with ports in the outer housing at the reciprocation of said outer pistons, the said opposite sides of the outer pistons being provided with slide-valves projecting into the working chambers of the adjacent outer piston for the control of corresponding ports in the housing leading to said last-named working chambers.

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