Aug. 28, 1923. 1,466,276

F. EGERSDÖRFER

ROTARY MACHINE

Filed Sept. 10, 1920 3 Sheets-Sheet 1

Fig. 1.

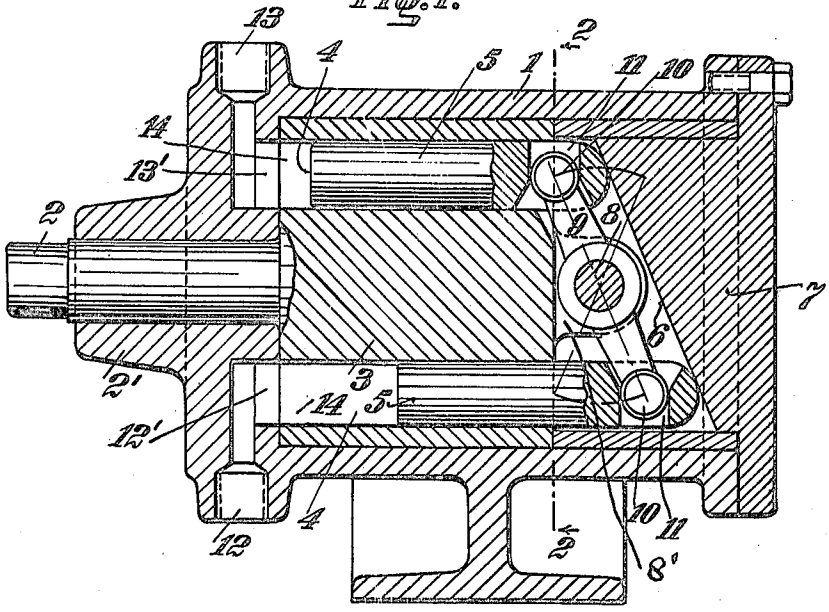
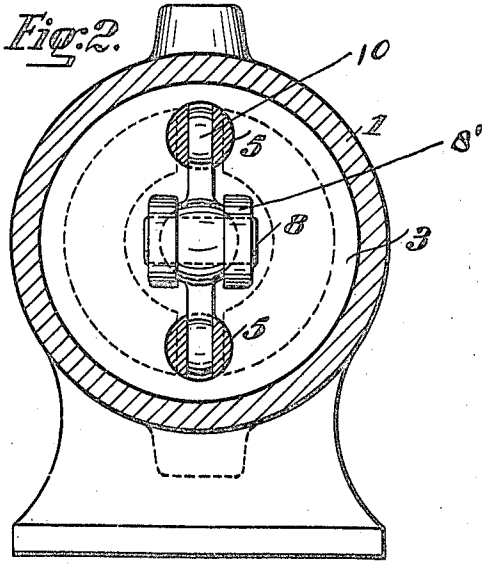


Fig. 2.



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Fig. 3.

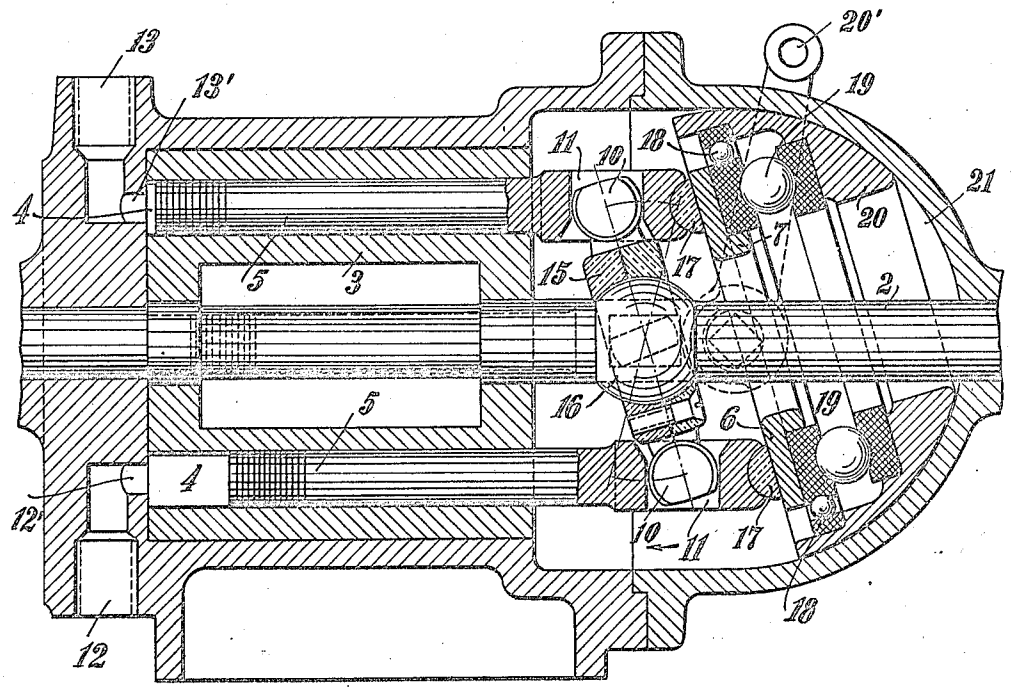
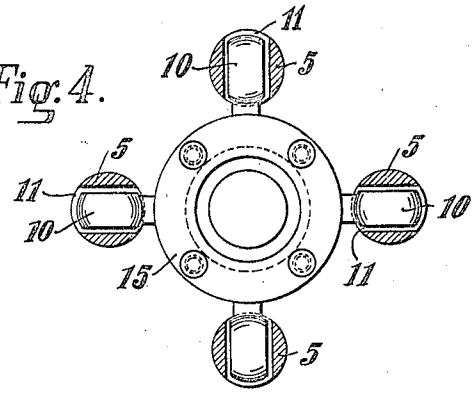


Fig. 4.



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Fig. 6.

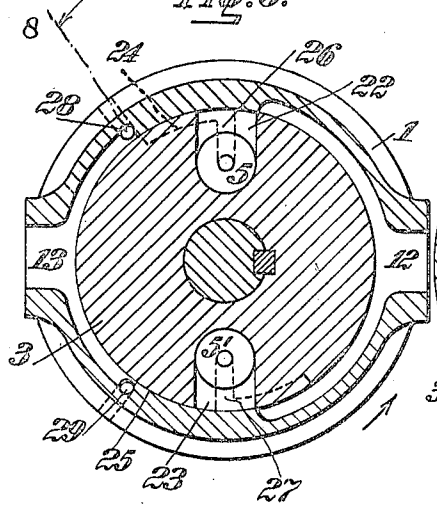
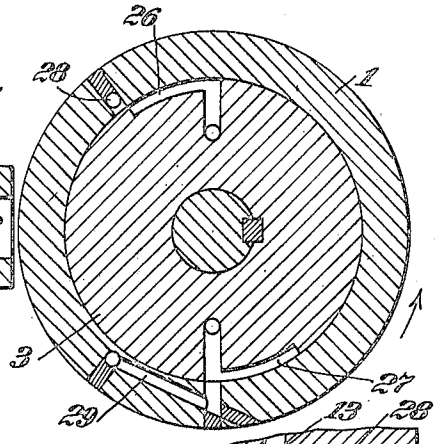


Fig. 7.



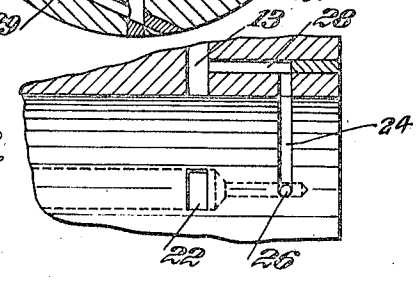
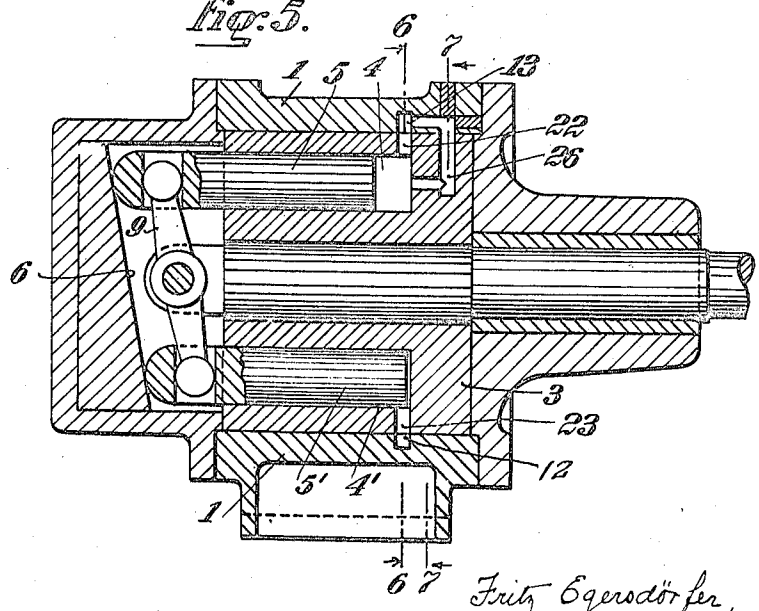


Fig. 8.

Fig. 5.



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UNITED STATES PATENT OFFICE.

FRITZ EGERSDÖRFER, OF CHARLOTTENBURG, GERMANY.

ROTARY MACHINE.

Application filed September 10, 1920. Serial No. 409,504.

To all whom it may concern:

Be it known that I, FRITZ EGERSDÖRFER, a citizen of Germany, residing at Charlottenburg, Germany, have invented certain new and useful Improvements in Rotary Machines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to improvements in rotary machines, and more particularly in machines of that class in which one or more reciprocating pistons or plungers are provided within cylindrical chambers provided lengthwise and eccentrically of the axis of rotation of a rotary member, which pistons are reciprocated upon rotation of the rotary member by a relatively stationary cam disk disposed at an angle to the axis of rotation and in loose engagement with the said pistons. One of the objects of the improvements is to provide a machine which is simple in construction and which permits operation of the machine at high speeds. With this and other objects in view my invention consists in the matters to be described hereinafter and particularly pointed out in the appended claims.

For the purpose of explaining the invention several examples embodying the same have been shown in the accompanying drawings in which the same reference characters have been used to indicate corresponding parts. In said drawings—

Fig. 1 is a longitudinal section of one embodiment of the invention,

Fig. 2 is a cross section taken on the line 2—2 of Fig. 1 and seen in the direction of the arrow,

Fig. 3 is a longitudinal section showing a modification of the invention,

Fig. 4 is a detail view partly in section showing the oscillating member connecting the reciprocating pistons,

Fig. 5 is a longitudinal section showing a further modification of the invention,

Fig. 6 is a cross-section of Fig. 5 taken on the line 6—6,

Fig. 7 is a cross section taken on the line 7—7 of Fig. 5 and

Fig. 8 is a sectional detail view showing the arrangement of one of the fluid ducts and the cooperating by-passage. The plane of section through the casing as shown in Figure 8 is approximately that indicated by the dotted line marked with the character 8 in Figure 6.

The example illustrated in Figs. 1 and 2 is particularly designed to be used as a pump or compressor. But I wish it to be understood, that my invention is not limited to the use of the machine as a pump, and that the improvements apply also to machines which operate as engines. As shown the pump consists of a cylindrical casing 1 enclosing a rotary member 3 made integral with a shaft 2 projecting through a suitable bearing 2′ formed in the head of the casing 1. Eccentrically of the axis of rotation of the drum 3 and parallel to the said axis, cylindrical bores or pockets 4 are formed in the member 3 within which plungers or pistons 5 have reciprocating movement. The head 7 of the casing 1 which is opposite to the bearing 2′ is formed with a cam face 6, which is disposed at an angle to the axis of rotation of the drum 3 and engages the rear ends of the plungers 5. Upon rotation of the drum 3 the plungers 5 slide on the inclined cam face 6 of the head 7, and they are forced inwards during one half of the rotation of the said drum. In such cases in which the machine is used as a pump the cam face 6 is not adapted to retract the plungers 5 from the cylinders. For this purpose special means are provided which consist of a rocker 9 which is mounted on a pivot bolt 8 supported in suitable bearings 8′ made integral with the drum 3. The rocker is formed at its ends with rounded heads 10 which engage in slots 11 made in the ends of the plungers 5. Therefore when one of the plungers is forced inward by sliding upward along the cam face 6, it retracts the plunger which is mounted on the opposite side of the axis of rotation. So both plungers are always in loose engagement with the cam face 6, and none of the pistons can get out of contact with the said cam face, even if the pump rotates at high speeds. It appears that no parts are provided in the machine which by inertia would exert an objectionable force on one of the movable parts.

Within the head of the casing 1 inlet and outlet ports 12′ and 13′ are formed, which communicate with the inlet and outlet passages 12 and 13, and with which upon rotation of the drum 3 the open ends 14 of the

bores 4 come alternately into register. By this construction the admission and the outlet of the fluid is controlled merely by the rotation of the drum 3 and no valves are necessary for this purpose.

In Figs. 3 and 4 I have shown an example which is adapted to be operated at high speeds and to supply large amounts of fluid. As shown the drum 3 is formed with four cylindrical chambers 4 and plungers 5 are formed at their outer ends with slots 11. Each of the said slots is engaged by the rounded end 10 of an arm projecting from a disk 15. The disk with its radiating arms is star-shaped, as shown in Fig. 4. The said star disk is connected by a universal joint with the rotary head 3. As shown the shaft 2 to which the said head is secured is formed with a spherical pivot 16 and the annular star disk 15 is formed with a spherical bearing surface having universal movement on the said pivot. The disk 15, it will be observed, is in this instance formed of two disk parts bolted together, and the socket is an equatorial zone of a sphere. The compound structure of the disk, here alluded to, is a provision to facilitate assembly. When the structure is assembled, shaft 2 and disk 15 are, it will be observed, articulated together in a universal joint complete in itself. The parts are relatively movable both by turning and by tipping. There is no dependence on any other member of the assembly to make the joint complete and secure. Such a self-contained joint I find of particular value in a high-speed machine, and in the ensuing claims I define the joint having the characteristics here dwelt upon, in the phrase, "inherently complete universal joint."

When the drum 3 is made to rotate the plungers slide with their outer heads on the inclined cam face 6, whereby they are reciprocated within the cylindrical chambers 4. Inasmuch as the path described by the tips of the arms of the star disk is truly circular while the path described by the ends of the plungers when referred to the plane of the disk is somewhat elliptical, there is in the course of operation some slight relative movement, in radial direction with respect to the center of turning of the disk, between disk and plunger. Such movement is provided for in the slot engagement of the parts. The pressure of the plungers on the star and of the star on the plungers is always in the direction of the axis of the plungers. In order to provide a large contacting surface between the ends of the pistons 5 and the inclined cam face and yet permit the oscillating movement of the plungers and cam relatively one to the other I prefer to equip the plungers with shoes 17 which are in spherical engagement with the plungers and are formed with broad-bearing faces engaging the cam face. (See Fig. 3.) These spherical shoes have universal movement relatively to the plungers. Therefore their flat bearing faces are always in full bearing contact with the cam face throughout the rotation of the drum 3, and the said shoes also follow the slight elliptical path of the plunger ends, the departure from a truly circular path being due to the inclined position of the cam.

Under normal conditions the flat bearing face of the shoe upon the cam disk is effective to transmit considerable pressure without difficulty due to friction. In case the invention is applied to a pump designed to compress fluid to very high pressures I prefer further to reduce friction by means of an anti-friction bearing. As shown a rotary disk 7 is mounted on two anti-friction bearings 18 and 19; the anti-friction bearing 18 is provided peripherally between the outer circumference of the disk 7 and a bearing block 20, and the anti-friction bearing 19 is provided rearwardly between the rear face of the disk 7 and an obliquely disposed surface of block 20. The bearing 18 takes up the lateral pressure on the disk 7 caused by the inclined position of the latter, while the bearing 19 takes up the actual pressure. In this construction the annular disk 7 is free to take part in the revolution of the plungers 5, and the movement of the shoes 17 relatively to the disk 7 is only so much as is necessary to permit the elliptical paths of the shoes on the disk. Therefore friction between the shoes 17 and the disk 7 is reduced to a minimum.

In the example shown in Fig. 3 the block 20 is formed with a spherical outer surface and the head of the casing 1 which supports the block 20 is in the form of a hollow sphere. Therefore the block 20 can be set within the head 21 in different positions, for varying the angularity of the cam face relatively to the axis of rotation. For setting the block 20 in different positions a crank arm 20′ is connected therewith.

The left hand head of the casing 1 is provided with inlet and outlet ducts 12 and 13, with which upon rotation of the member 3 the cylinders 4 are alternately brought in communication. Communication is through slots 12′ and 13′ which extend circumferentially but which are discontinuous and separated one from the other by intervening unslotted portions of the body of the casing head. The unslotted intervals between the ends of the circumferential slots must be wide enough effectively to cut off communication between one duct and one cylinder before communication is opened between that cylinder and the other duct. When the open end of a cylinder 4 is traversing one of these intermediate areas between the ends of the cir-

cumferential slots, the piston within the cylinder being in progress longitudinally of the cylinder (say in direction from right to left, Fig. 3), considerable pressure will (unless provision is made to prevent) be produced within the cylinders 4, because the fluid which is being compressed by the movement of the plungers cannot flow to the pressure duct 13. By reason of the high pressure, a part of the fluid is then forced between the head of the casing 1 and the member 3 and into the suction duct 12, so that the proper operation of the pump is interfered with. Furthermore the pressure of the plungers on the cam face 6 is in this position of the plungers too high. An important feature of my invention consists in providing means whereby such high pressures and such escape of liquid under pressure from the pressure side to the suction side are avoided.

With this object in view I provide by-passages by means of which the pockets 4 are brought into pressure-relieving communication with the pressure duct 13 while they are moving over the intermediate areas of the casing head which separate the circumferential slots.

Such by-passages are preferably provided in both the examples shown in Figs. 1 to 4. For the purpose of illustration I prefer to show the said by-passages in separate views. For explaining this part of my invention I have shown in Figs. 5 to 8 a pump of simple construction which is equipped with two plungers 5 and 5′ and a relatively fixed cam 6. The plungers bear with their free ends directly on the said cam and they are connected by a rocker 9, the construction of which is similar to that of the rocker 9 shown in Figs. 1 and 2.

In the ensuing description I shall follow the minute construction shown in Figs. 5–8, and which differs in detail somewhat from that of Figs. 1–4. The differences however will be found to be mere matters of structure—variations within the knowledge and skill of the engineer.

The inner ends of the pockets 4, 4′ are made continuous with radial ducts 22, 23 which extend from the said pockets to the outer circumference of the drum 3. These ducts are adapted upon rotation of the drum 3 to be brought alternately into communication with the suction and pressure ducts 12 and 13. As appears from Fig. 6 the said ducts extending circumferentially of the casing are separated from each other by unslotted portions 24, 25 of the casing wall. When the drum 3 is rotated in the direction of the arrow shown in Figs. 6 and 7 the plungers 5, 5′ move with their outer ends on the inclined cam 6 and they are forced during one half of their revolution into the cylindrical pockets 4 and they are retracted therefrom by means of the rocker 9 during the other half of the revolution. While the plungers perform their suction strokes the ducts 22, 23 are in register with the suction passage 12, and during the pressure stroke they are in register with the pressure passage 13. When the ducts 22 and 23 move over the wall surfaces 24 and 25 disturbances of pressure tend to be produced within the cylinders because the ducts 22 and 23 are closed from the suction and pressure passages and liquid can neither enter into nor escape from the pockets 4 and 4′. Within that pocket whose plunger is beginning its suction stroke a tendency to vacuum is produced, and within the pocket whose plunger is beginning its pressure stroke a tendency to an increase of pressure is produced. The latter particularly can if no preventive expedient be provided be very high and objectionable.

To avoid such pressure disturbances I provide by-passages 26 and 27 which in the example shown in the figures are formed within the drum and which are disposed in such a way, that they establish communication between the pockets 4 and 4′ with the pressure passage 13, while the ducts 22 and 23 are closed by the wall portions 24 and 25. If the pump be in the position shown in Figs. 5 and 6, the plunger 5 being withdrawn to its full extent from the pocket 4, and the plunger 5′ being at the end of its inward stroke, further rotation of the drum 3 will carry the plunger 5 to the left as shown in Fig. 6, and at the same time to the right as shown in Fig. 5. The fluid within the chamber 4 will then be subject to pressure. But at this point the by-passage 26 comes into communication with a by-passage 28 provided in the wall of the casing 1 and connected with the pressure passage 13, as is best shown in Fig. 8. Thus the bore 4 is brought into communication with the pressure passage 13. By reason of the circumferential extent of the groove 24 this connection is maintained, until the duct 22 attains the pressure passage 13. During this part of the rotation of the drum 3 the plunger 5 performs the first part of its pressure stroke and, though the duct 22 is closed by the wall 24, the liquid is free to escape through the by-passage 26 to the pressure passage 13, so that excessive pressures are avoided.

As the drum 3 is further rotated the duct 22 comes into full communication with the pressure passage 13, so that the compressed liquid can flow directly into the said passage. When the duct 22 moves so far that it is covered by the wall 25, the by-passage 26 comes into communication with by-passage 29 provided in the lower part of the wall of the casing 1 and opening into the pressure passage 13. Upon further rotation of the drum 3 the plunger 5 performs the last part

of its pressure stroke, while the duct 23 is closed from the pressure passage and connection between the pocket 4 and the pressure passage is maintained through the by-passages 26 and 29, until the piston comes into the position which in Fig. 6 the piston 5′ occupies. At this point duct 22 opens to suction passage 12 and the piston 5 begins its suction stroke. Plunger 5′ performs in duplicate the same operation.

In Figs. 6–8 I have shown an example, in which for avoiding excessive pressures the cylindrical pockets 4 and 4′ are connected by the by-passages with the pressure side of the pump, and I prefer this construction (because thereby any loss of compressed fluid is avoided), as compared to the construction in which the by-passages are so arranged as to connect the bores 4 and 4′ with the suction side of the pump, (because in such a construction a part of the compressed fluid would flow back into the suction passage.) Though the amount of fluid so wasted would be very small, I generally prefer the construction shown in the figures, and particularly so in cases in which the pump is designed for high pressures and high efficiency. But I wish it to be understood that my invention is not in this respect limited to the particular arrangement described herein and shown in the drawings.

While in describing the invention reference has been made to various embodiments of the same, I wish it to be understood that my invention is not limited to the particular constructions shown in the drawings. More particularly, I wish it to be understood that the construction of the by-passages has been illustrated in a pump provided with two plungers merely because in such a pump the invention can best be explained. But I wish it to be understood that such by-passages may also be provided in constructions in which more than two plungers are employed—such for example as shown in Figs. 3 and 4.

I claim herein as my invention:

1. In a rotary machine, a cylindrical drum, and a cam member provided with a surface extending opposite and oblique to one head of said drum, and means for imparting to one of said members rotation relative to the other on the axis of the drum, the said drum being provided with a plurality of bores, their axes parallel with the axis of the drum and the axis of one lying outside of a plane common to the axis of the other and to the axis of the drum, pistons within said bores adapted to reciprocate in said bores and adapted to bear upon the said obliquely disposed surface of said cam, and a rocker fulcrumed to said drum, and engaging said plungers, the fulcrum joint including a ball integral with the drum and a plurality of rocker parts adapted to be secured together and presenting when secured together a bearing surface in shape the equatorial zone of a sphere, substantially as described.

2. In a rotary machine, a cylindrical drum, a cam member provided with a plane surface extending opposite and oblique to one head of said drum, and means for imparting to one of said members rotation relative to the other on the axis of the drum, said drum being provided with a plurality of bores remote from but extending parallel with its own axis, a plurality of plane-faced shoes adapted to slide upon the surface of said cam and provided each on its opposite side with a spherical bearing surface, a plunger in each of said bores provided with a sperical bearing surface adapted to engage one of said shoes by the spherical bearing surface aforesaid, the said shoes in the operation of the machine being freely movable upon said cam surface radially with respect to the axis of rotation, according as the distance measured on the cam surface from the plunger end to the center of rotation varies.

3. In a rotary pump, the combination, with a cylinder member, a cam member, and means to impart relative rotary movement to said members, of pistons mounted in cylinders formed in said cylinder member and on opposite sides of the axis of said rotary movement, separate slide shoes on each of said pistons having universal movement thereon and in loose engagement with said cam member for lengthwise movement in one direction upon relative rotary movement of said members, a direct operative connection between said pistons adapted to impart movement from one to the other, and pressure and suction ducts adapted to be alternately brought in communication with at least one of said cylinders.

4. In a rotary pump, the combination, with a cylinder member, a cylindrical casing enclosing the same and having suction and pressure ducts which when the parts are assembled are separated from each other by intervening portions of the substance of the casing, a cam member, and means to impart relative rotary movement to said members, of a cylinder formed in said cylinder member eccentrically of the axis of rotary movement but extending parallel with said axis, a piston reciprocable in said cylinder and when the rotation of parts above noted is in progress reciprocated while in engagement with said cam member, said cylinders being adapted to be alternately brought in communication with said pressure and suction ducts, and a by-passage adapted to establish connection between the cylinder and one of said ducts while the cylinder is moving over the duct-separating portions of the casing wall.

5. In a rotary pump, the combination, with a cylinder member, a cylindrical casing

enclosing the same and having suction and pressure ducts which when the parts are assembled are separated from each other by intervening portions of the substance of the casing, a cam member non-rotatable relatively to said casing, and means to impart relative rotary movement to said members, of a cylinder formed in said cylinder member eccentrically of the axis of rotary movement extending parallel with the said axis, such cylinder being provided with a piston in engagement with said cam member for lengthwise movement, said cylinder being adapted to be alternately brought in communication with said pressure and suction ducts, and a by-passage located in position to establish connection between the cylinder and one of said ducts while the cylinder is moving over the duct-separating portions of the casing wall and while the plunger is performing its pressure stroke.

In testimony whereof I hereunto affix my signature.

FRITZ EGERSDÖRFER.