J. O. BERGMAN.

ROTARY ENGINE AND THE LIKE.

APPLICATION FILED MAR. 30, 1916.

1,262,437.

Patented Apr. 9, 1918.

5 SHEETS—SHEET 1.

Fig. 2.

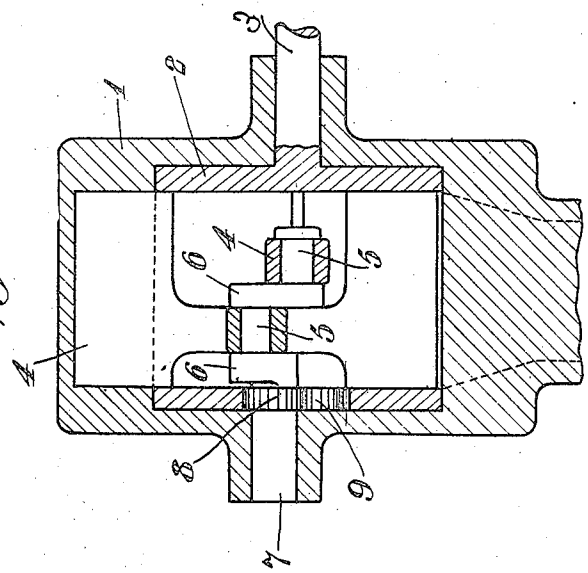
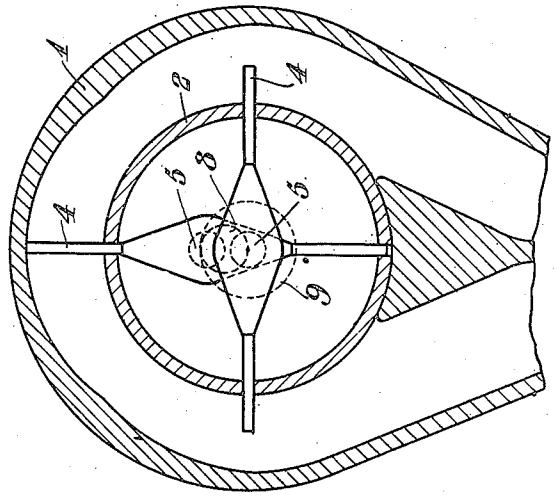



Fig. 1.




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5 SHEETS—SHEET 2.

Fig. 5.

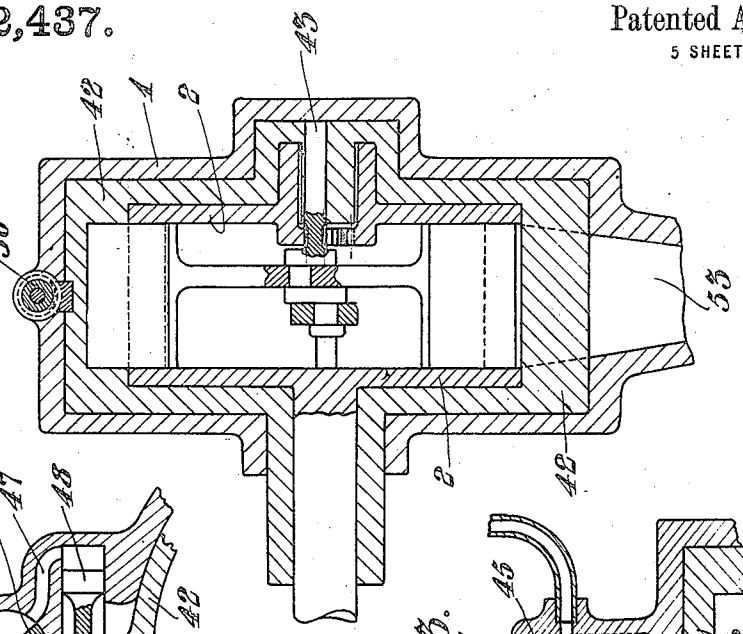



Fig. 12.

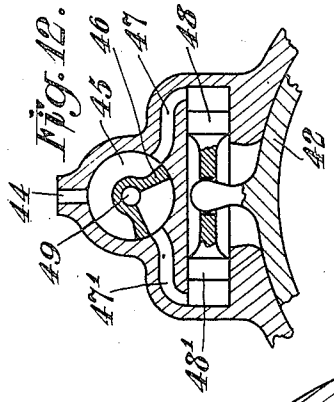



Fig. 13.

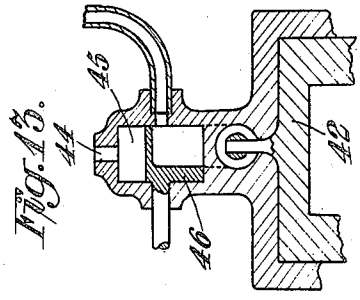
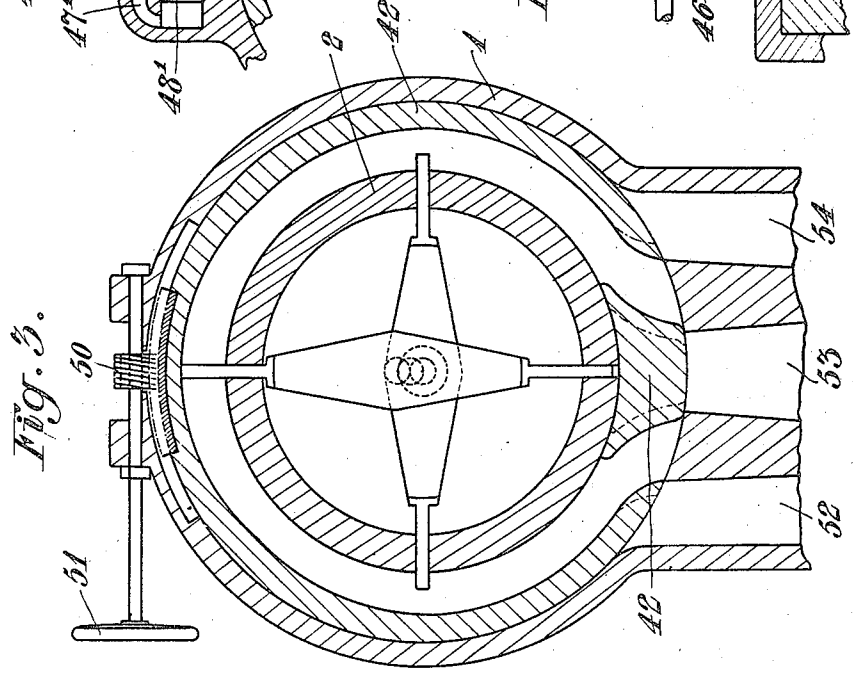



Fig. 3.




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5 SHEETS—SHEET 3.

Fig. 6.

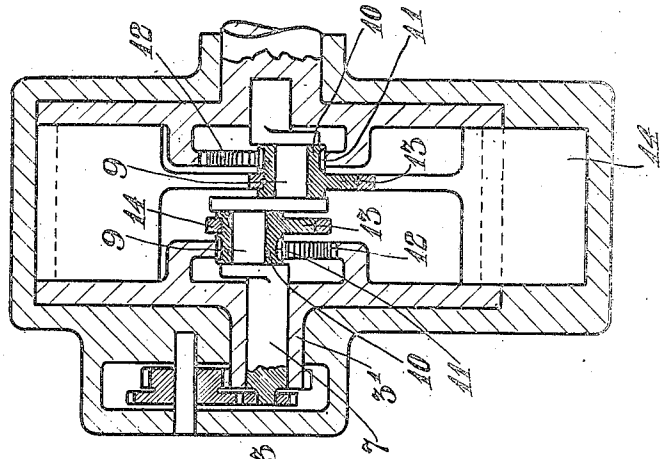



Fig. 4.

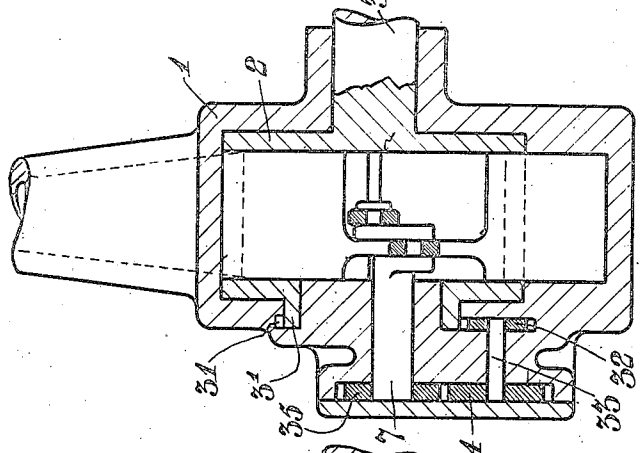
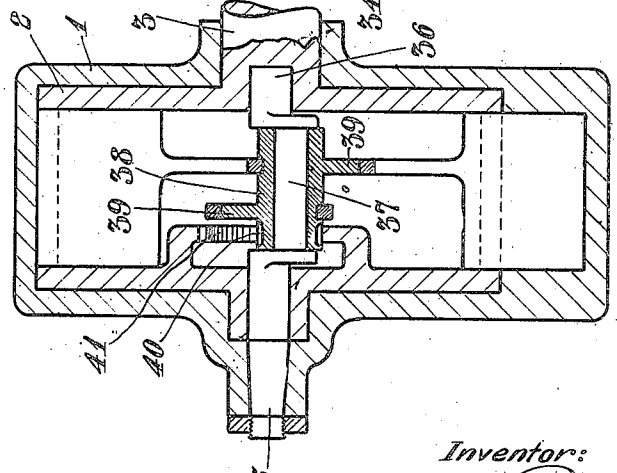



Fig. 7.




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5 SHEETS—SHEET 4.

*Fig. 8.*

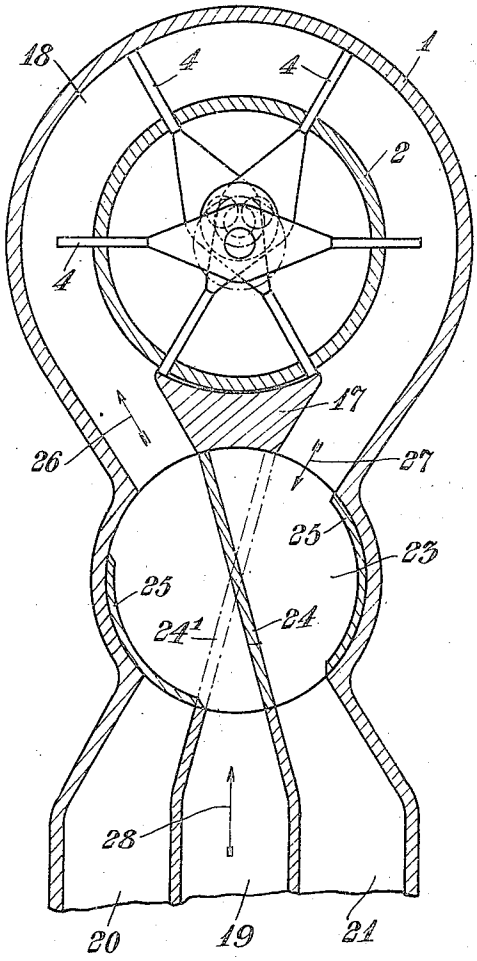
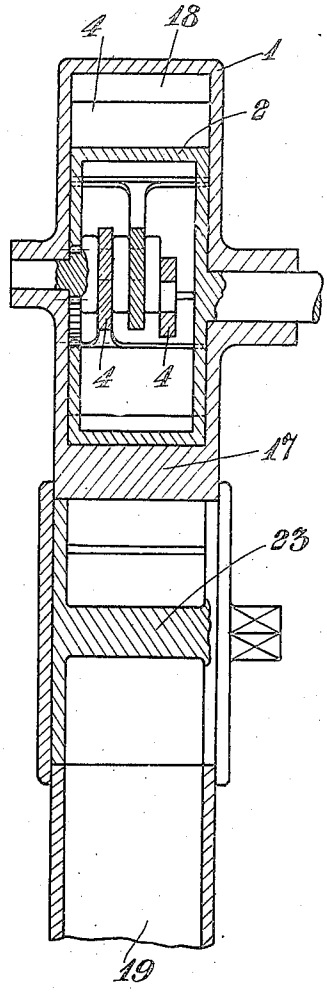



*Fig. 9.*




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5 SHEETS—SHEET 5.

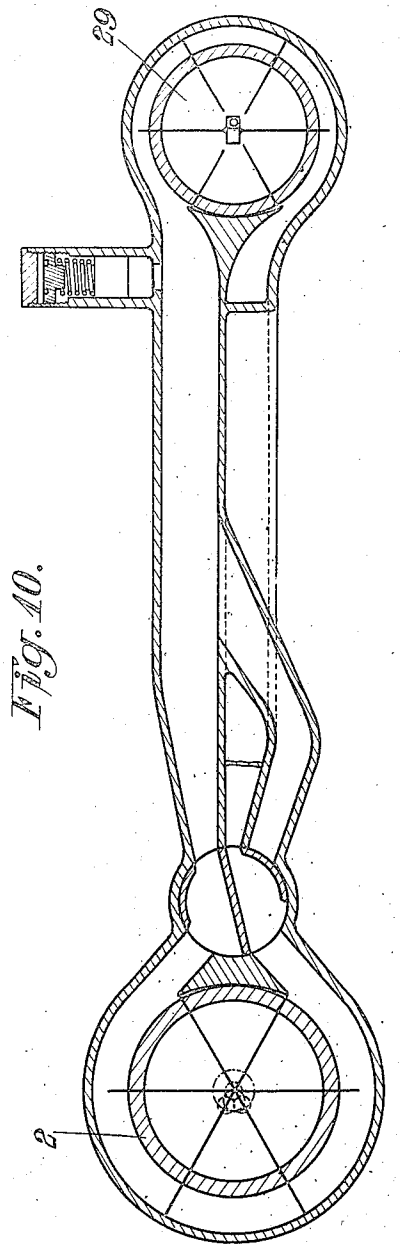



Fig. 10.

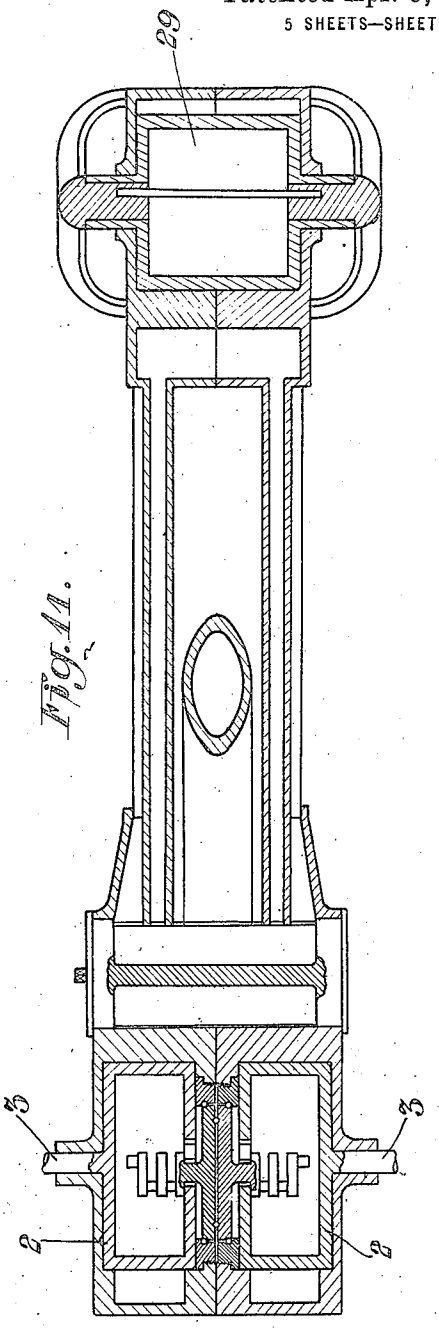



Fig. 11.

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# UNITED STATES PATENT OFFICE.

JOHAN OTTO BERGMAN, OF STOCKHOLM, SWEDEN.

## ROTARY ENGINE AND THE LIKE.

1,262,437. Specification of Letters Patent. Patented Apr. 9, 1918.

Application filed March 30, 1916. Serial No. 87,718.

*To all whom it may concern:*

Be it known that I, JOHAN OTTO BERGMAN, a subject of the King of Sweden, residing at Stockholm, in the Kingdom of Sweden, have invented a new and useful Improvement in Rotary Engines and the like, of which the following is a specification.

This invention relates to improvements in machines adapted to be used as rotary engines, pumps, gearings, power transmissions and the like.

As is well-known, a great number of rotary engines, rotary pumps and similar rotary devices are constructed, which are based on the principle of a rotary member being journaled in a casing and touching the inner side of the casing or a part projecting therefrom, said member forming together with the casing an annular chamber or channel interrupted at the said touching point. Rotatably arranged in said chamber, which serves as a working or delivery space, is a number of working pistons having usually the shape of blades or vanes and guided by the rotary member, while partaking in its rotary movement, said pistons moving diametrically or radically in said member and at the same time sliding with their outer ends along the inside of the casing.

A great number of said engines is, in regard to the construction, connected with the inconvenience, that a great friction arises between the end or ends of the pistons and the inside of the casing as well as a corresponding consumption of power and wear and tear, which depends on the circumstance, that the casing or other kinds of cam or slot guides are used directly as guides for the pistons to effect their reciprocating movements.

In order to prevent the said inconveniences the pistons have been guided by the aid of a shaft or a journal placed eccentrically in relation to the axis of the rotary member in such manner, that the piston is journaled on the eccentric shaft as well as on the rotary member, or the piston has been connected with the eccentric shaft by means of a connecting rod. This arrangement has brought on, besides unfavorable mechanical contrivances, the necessity of journaling each separate blade or vane, and since the space is very limited, it has been attended with difficulties to obtain the necessary space. Therefore, the use of double pistons with common journaling is an object of desire. This has earlier been effected in such manner, that the double piston is provided in its center with a preferably rectangular strap inclosing a sliding block reciprocating in the strap and mounted on a shaft, which is situated eccentrically relative to the center of rotation of the rotary member. This arrangement is, however, especially in case of a considerable oscillating movement of the double piston and great speed of rotation, not suitable in mechanical respects.

The object of this invention is the provision of a machine not suffering from the above-mentioned drawbacks. The said machine consists of a stationary casing inclosing a rotary member and pistons reciprocating through the center of said rotary member. According to the invention the pistons are controlled by the aid of the rotary member by means of toothed wheels or other similar gearings transforming the rotary movement into a rectilinear movement, whereby the pistons are reciprocated. This may be effected in such manner, that the pistons or vanes are journaled on cranks or eccentrics, which by the gear are so connected with the rotary member, that they rotate with the double speed of said member and that the centers of rotation of the pistons or vanes reciprocate through the center of rotation of the rotary member.

The invention may be carried into practice in different manners, and in the following several embodiments of the invention as well as its use as rotary engine, pump or the like as well as for gearing and transmission purposes will be described. In the latter case the invention may be used advantageously as a power and movement transmitting device between the engine and the driving wheels for instance of automobiles, in which case the power transmitting medium consists of a liquid contained in a closed space and acted upon on the one side by the engine or a suitable pump connected with the same, so as to flow through said space, and operating on the other side a motor constructed in accordance with the invention and connected in any suitable manner with the driving wheels of the automobile or the like. The liquid fills completely the closed space, so as not to admit air therein, and is therefore preferably kept under pressure.

In the accompanying drawings Figure 1 shows a sectional view of the machine or device transversely to the axis of rotation

and Fig. 2 another sectional view of the same device in the longitudinal direction of said axis. Fig. 3 shows in sectional view transversely to the axis of rotation a form of the invention when used as a driving device. Fig. 4 shows in sectional view along the axis of rotation a gear between the shaft of the rotating member and the crank shaft. Fig. 5 shows the form of the invention illustrated in Fig. 3 in a sectional view along the axis of rotation. Fig. 6 is a sectional view along the axis of rotation showing a gear between the shaft of the rotary member and the crank shaft, both shafts lying in the same center line. Fig. 7 shows in a sectional view another gear having a stationary guiding shaft. Fig. 8 shows in a sectional view transversely to the axis of rotation a suitable form of the invention, when used as a driving device, and Fig. 9 the same device in a sectional view along said axis. Figs. 10 and 11 are sectional views illustrating, viewed from the side and from above respectively, the device used as driving device in automobiles or the like. Figs. 12 and 13 are sectional views showing a reversing device used in the form of the invention illustrated in Figs. 3 and 5.

Referring to Figs. 1 and 2, 1 is the stationary casing and 2 the rotary member rotating with the shaft 3 (Fig. 2) journaled in the casing. Diametrically movable through the member 3 are the double pistons 4, the outer ends of which, in a certain position, fit tightly by suitable means to the inside of the casing 1. At the center, preferably at the point of gravity, the pistons are rotatably mounted on crank pins 5, the cranks 6 of which are rigidly attached to the shaft 7 journaled in the casing 1. Attached to the shaft 7 or, as is shown on the drawing, integral therewith is a pinion 8, the teeth of which engage an internally toothed ring 9 secured to the member 2. The ratio of transmission of the pinion 8 to the ring 9 is as one to two. The movement and the center of rotation of the cranks connected with the pistons are, consequently, adjusted to the movement and the center of rotation of the rotary member according to the law of the straight hypocycloid.

The machine described above operates as follows: When the member 2 rotates by being operated either by transmission of power to the shaft 3 or by pressure exerted on the pistons 4, the toothed ring moves the pinion 8 or, in other words, rotates the shaft 7 and the cranks 6, the latter then reciprocating the pistons 4. Supposing the ratio of transmission of the pinion 8 to the toothed ring 9 to be $=1:2$, as mentioned above, the shaft 7 and the cranks 6 will make two revolutions, while the member 2 makes one revolution. Thus the pistons 4 are moved from the one outer position to the other outer position during one revolution of the member 2 and will, during the said movement, correspond completely to the inside of the casing 1 at the part thereof forming the working chamber, so that the ends of the pistons always follow the inside thereof without frictional engagement. Besides, the device described presents a very appropriate construction, because the stresses are always uniform, *i. e.* no noxious changes of the movement or bends will arise; while the crank journal 5 engages the piston in its center or point of gravity, and on account thereof the pistons being always completely balanced will not, even at great speed, damage the construction in its totality.

The guidance of the pistons according to the above description has been practically tested in a machine working as water pump, vacuum pump and air compressor. As water pump the apparatus worked with a pressure of 6 atmospheres and a suction head of 3.7 meters and gave an efficiency of up to 90%. As vacuum pump its evacuating power amounted to 95.7%. As compressor it worked with an overpressure of 1.25 kg./sq. cm. and gave an adiabatic efficiency of 41%. Said experiments prove the excellent arrangement of the guides of the pistons, when taking into consideration the fact that the pistons were not provided with any tightening device but slid with their metallic surfaces on the casing in the working chamber.

In the gearing device shown in Fig. 4 1 is the stationary casing. 2 is the member rotating therein and, on the one hand, around the shaft 3, and, on the other hand, around a cylindrical extension $3^1$ of the rotary member 2. Secured to said extension is a toothed wheel 31 engaging a toothed wheel 32, which by the shaft 33 transmits the movement to a toothed wheel 34 engaging a toothed wheel 35 secured to the crank shaft 7. The diameters of said toothed wheels are so adjusted that there is a ratio of transmission of the shaft of the rotary member to the crank shaft $=1:2$.

According to Fig. 6 the gear between the shaft $3^1$ of the rotary member and the crank shaft 7 is arranged in the same manner as in Fig. 4, though the axes of the crank shaft and of the rotary member coincide in Fig. 6. In order to obtain the same movement of the eccentrics 13, on which the pistons 14 are journaled, as in case the crank shaft is mounted eccentrically in relation to the rotary member, the crank shaft 7 is provided with two cranks 9, on which the members 10 are mounted. Said members 10 are connected with pinions 11 engaging toothed rings 12 secured to the rotary member. Extending from the members 10 are eccentries 13 journaled in the pistons.

The device shown in Fig. 6 operates as follows: When the shaft 7 with the cranks 9 rotates with the double number of revolutions relatively to the toothed rings 12 of the rotary member and since the ratio of the pitch circle of the pinions 11 mounted on the members 10 to the pitch circle of the toothed rings 12 is=1:2, and because the centers of the eccentrics 13 and of the crank shaft 7 are located at equal distances from the centers of the cranks 9, it follows from this, that the members 10 move sidewise without rotation or in other words in parallel to themselves, and that the eccentrics 13 mounted on the members 10 move in accordance with the movement of the crank pins 5 shown in Fig. 2.

In the constructional form illustrated in Fig. 7, 1 is the stationary casing and 2 is the rotary member placed therein and journaled at the one side of the casing by means of the shaft 3. Coinciding with the axis of the rotary member is a guide shaft 35 secured to the casing and supporting the rotary member. The other end of the guide shaft forms a journal 36 engaging a recess in the center of the shaft of the rotary member thus constituting a bearing for the stationary shaft 35. This shaft is formed with a crank 37 supporting, on the one hand, the member 38 provided with the eccentrics 39 and, on the other hand, the pinion 40 engaging an internally toothed ring 41, the ratio of transmission of the pinion to the toothed ring being=1:2. When the member 2 rotates, the member 38 with the eccentrics 39 supporting the pistons are rotated with the double number of revolutions in relation to the rotary member 2. Since the center of the crank 37 is situated at equal distance from the centers of the eccentrics 39 and from the center of the rotary member 2, the eccentrics are moved in the same manner as the crank pins in Figs. 1 and 2, while the pistons are guided accordingly.

In the driving device shown in Figs. 8 and 9 the rotary member 2 is provided with three diametrically reciprocating pistons 4. The rotary member 2 is mounted concentrically in the casing and touches a stationary portion 17 thereof, which, consequently, at each side limits the space 18 between the outer side of member 2 and the inner side of casing 1. Instead of the member 2 touching a portion of the casing 1 thus dividing the channel and working space between the outer side of member 2 and the inner side of casing 1, two cylindrical bodies may rotate touching each other and thereby dividing said working space into two channels. The device effecting the reciprocation of the pistons 4 in relation to member 2 is the same as in Figs. 1 and 2. Connected with the casing 1 are three channels 19, 20, 21 between which and the casing 1 is placed a rotatable valve 23 or the like. The valve 23 is provided with a diametrical partition wall 24 and two peripheral side walls 25.

In case the valve 23 is in the position shown in Fig. 8 and if a liquid be introduced through the channel 19 in the direction of the arrow 28 by means of an adjustable pump operated by a motor, the liquid passes to the left of the partition walls 24, as shown in the drawing, and enters the working space 18 in the direction of the arrow 26 thereby operating the pistons 4, so that the member 2 and any device connected therewith, for instance the driving axle of an automobile or the like, are rotated. During the rotation the pistons or vanes 4 operate as described above and consequently slide along the innerside of the casing 1 without any other frictional engagement than that caused by the tightening devices arranged, if desired, between the pistons and the casing. The liquid flowing through the space 18 passes out of the casing to the right of the partition wall according to the arrow 27, enters the channel 21, returns to the motor driven pump, and passes thence back to the channel 19 and through the valve 23 into the space 18. If the valve 23 be reversed, so that the partition wall 24 occupies the position $24^1$ shown in dotted lines, the liquid passes from the channel 19 to the right of the member 2, whereby the direction of movement is reversed. By further turning the valve 23 the inlet may be shut altogether.

Figs. 3 and 5 illustrate a further embodiment of the driving device, which differs from that shown in Figs. 8 and 9 by the control device or valve consisting of a casing 42 inclosing the rotary member 2 and adapted to turn in the casing 1, for instance, as shown in the drawing, by the aid of a screw wheel 50 and a hand wheel 51. By turning the casing 42 the channels surrounding the rotary member may be connected with the channels 52, 53, 54, situated between the pump and the driving device (the hydraulic motor) in the same manner as in Figs. 8 and 9. According to the drawing (Fig. 3) the casing 42, in which the rotary member 2 and the guide shaft 43 are journaled, occupies a middle position, so that the inlet 53 is shut. If the casing 42 be turned opposite to the hands of a clock, so that the portion thereof bearing against the rotary member 2 be positioned at the side of the channel 53, the rotary member will be rotated in the opposite direction, and the rotation will be reversed, if the casing 42 be turned in the other direction.

Figs. 12 and 13 illustrate a control device adapted to be substituted for the screw wheel and the hand wheel shown in Fig. 3. By connecting the channel 44 with the inlet 53 (Fig. 3) the liquid kept under pressure

by means of the pump or the like is injected into the cock chamber 45. If the position of the cock be that shown in Fig. 12, the liquid passing through the channel 47 operates the piston 48, which, on account of the liquid pressure acts upon the casing 42 turning it a direction contrary to that of the hands of a clock. Then the liquid is passed by the piston $48^1$ through the channel $47^1$ and the inner chamber of the cock out of the pipe 49, which, preferably, may be connected with the inlet of the pump (low pressure). By turning the cock 46 in a direction opposite to the hands of a clock, the channels 47 and $47^1$ may be shut altogether thus locking the control device. By further turning of the cock 46 in the same direction the cock chamber 45 will be connected with the channel $47^1$ and, consequently, the liquid moves the piston $48^1$ to the right, Fig. 12, thereby turning the casing 42 to the right.

The constructional form shown in Figs. 10 and 11 is adapted to serve as a power and movement transmitting device between the engine and the driving axle of an automobile. The part of the device shown to the left in Figs. 10 and 11 corresponds completely to the device illustrated in Figs. 8 and 9, each of the shafts 3 of the rotary members 2 being connected with a back wheel or driving wheel of the automobile. The two members 2 may rotate independently of each other and may therefore rotate with different speed or on the whole under different circumstances, which depends on the fact, that the back wheels of the automobile rotate in different manners. The two members thus rotating independently are, preferably, provided with a common inlet of liquid. Said device consisting of two independently rotating members 2 corresponds, consequently, to the differential gear of the driving axle of an automobile. Extending between such differential driving device and a, preferably, adjustable pump 29 is a closed system of channels, part of which conducts the driving liquid inclosed in the system from the pump 29 to the driving device, and another part of which conducts the liquid in opposite direction. The closed system mentioned above may be surrounded by or connected with a suitable cooling device.

Obviously, all the devices described above and shown on the drawings may be changed in part without deviating from the principle of the invention. Thus for instance, different pumps may be used in the movement transmitting device illustrated in Figs. 10 and 11, and the channel system extending between the pump and the driving device may be arranged in various manners different to that shown on the drawing.

I claim:

1. A driving device, comprising a casing, a rotary member journaled in said casing, members reciprocating in said rotary member and sliding on the innerside of the casing and means comprising gearings actuated by said rotary member and effecting the reciprocation, substantially as and for the purpose set forth.

2. A driving device, comprising a casing, a rotary member journaled in said casing, members reciprocating in said rotary member and sliding on the innerside of said casing, a gear actuated by the rotary member, and cranks driven by the gear and supporting the reciprocating members, substantially as and for the purpose set forth.

3. A driving device, comprising a casing, a rotary member journaled in said casing, members reciprocating in said rotary member and sliding on the inner side of said casing, a gear actuated by the rotary member, and cranks driven by the gear and supporting the reciprocating members, said cranks rotating with twice the number of revolutions of the rotary member, substantially as and for the purpose set forth.

4. A driving device, comprising a casing, a rotary member journaled in said casing, members connected with and reciprocating in said rotary member, the path of reciprocation passing through the center of rotation of the rotary member, a gear actuated by the rotary member, and cranks driven by the gear and supporting the reciprocating members, said cranks rotating with twice the number of revolutions of the rotary member, substantially as and for the purpose set forth.

5. A driving device, comprising a casing, a rotary member journaled in said casing, members connected with and reciprocating in said rotary member, a shaft extending through the rotary member and rotating therein, said shaft being parallel to the journal of the rotary member, cranks on said shaft supporting the reciprocating members, and a gear actuated by the rotary member and rotating the said shaft, substantially as and for the purpose set forth.

6. A driving device, comprising a casing, a rotary member journaled in said casing, pistons reciprocating in said rotary member, a shaft extending through the rotary member and rotating therein, said shaft being parallel to the journal of the rotary member, cranks on said shaft supporting the reciprocating pistons, and a gear actuated by the rotary member and rotating said shaft with twice the number of revolutions of the rotary member, substantially as and for the purpose set forth.

7. A driving device, comprising a casing, a rotary member journaled in said casing, pistons reciprocating in said rotary member and sliding on the inner side of the casing, a shaft extending through the rotary mem

ber and rotating therein, said shaft being parallel to the journal of the rotary member, cranks on said shaft supporting the reciprocating pistons, a gear connected with the rotary member, and another gear meshing with the first-named gear and connected with the rotating shaft, the ratio of transmission of the former gear to the latter gear being equal to 2:1, substantially as and for the purpose set forth.

8. A driving device, comprising a casing, a rotary member journaled in said casing, pistons reciprocating through the center of rotation of said rotary member and sliding on the inner side of the casing, a shaft extending through the rotary member and rotating therein, said shaft being parallel to the journal of the rotary member, cranks on said shaft supporting the reciprocating pistons, said cranks engaging the piston at their points of gravity, a gear connected with the rotary member, and another gear meshing with the first-named gear and connected with the rotating shaft, the ratio of transmission of the former gear to the latter gear being equal to 2:1, substantially as and for the purpose set forth.

9. Rotary engine capable of being used as a motor, pump, driving and gearing device and the like with one member revolubly journaled in a casing, and one or more pistons or vanes rotating with and reciprocating to and fro in the said member and fitting closely to the casing, characterized by this that the pistons are guided by the rotating member and actuated by means of toothed gearing or similar gearing transforming the rotary motion into a rectilinear motion, in which the pistons are moved to and fro (forward and backward).

10. A driving device, comprising a casing, a rotary member journaled in said casing so as to form a working chamber therein, pistons reciprocating in said rotary member and sliding against the inner surface of the casing, means comprising gearing actuated by said rotary member and reciprocating the pistons, feeding and discharge channels, and a regulating device for alternately connecting the said channels with the ends of the working chamber, substantially as and for the purpose set forth.

11. A power transmission device, comprising a casing, a rotary member journaled in said casing so as to form a working chamber therein, pistons reciprocating in said rotary member and sliding against the inner surface of the casing, means comprising gearing actuated by said rotary member and reciprocating the pistons, feeding and discharge channels, a regulating device for alternately connecting the said channels with the ends of the working chamber, and a pump the suction and pressure conduits of which are connected respectively with the discharge and the feeding channels, substantially as and for the purpose set forth.

12. A power transmission device, comprising a casing provided with two working chambers, two independently rotating members one of which is journaled in each of said working chambers, pistons reciprocating in each of said rotary members and sliding against the inner surface of the casing, means for each working chamber comprising gearing actuated by the rotary member and reciprocating the pistons in the same, feeding and discharge channels, a regulating device for alternately connecting the said channels with the two ends of the working chambers, and a pump the suction and pressure conduits of which are connected respectively with the discharge and the feeding channels, substantially as and for the purpose set forth.

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