

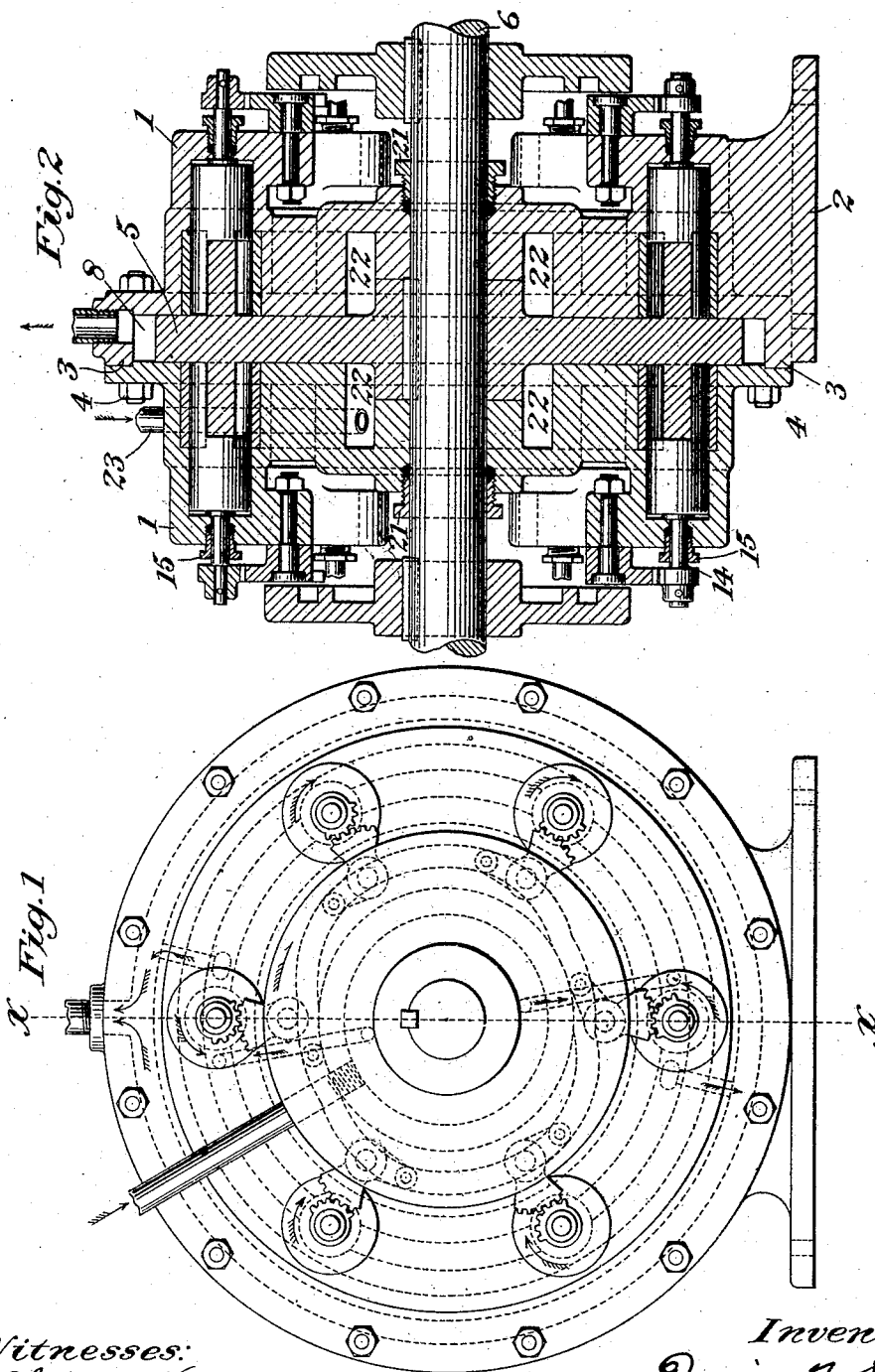
No. 848,860.

PATENTED APR. 2, 1907.

D. F. SMITH.  
ROTARY ENGINE.

APPLICATION FILED JUNE 29, 1905. RENEWED AUG. 30, 1906.

3 SHEETS—SHEET 1.



Witnesses:  
Chas. W. King,  
Adolph F. Jones,

Inventor:  
Daniel F. Smith  
by Samuel Tink  
Attys.

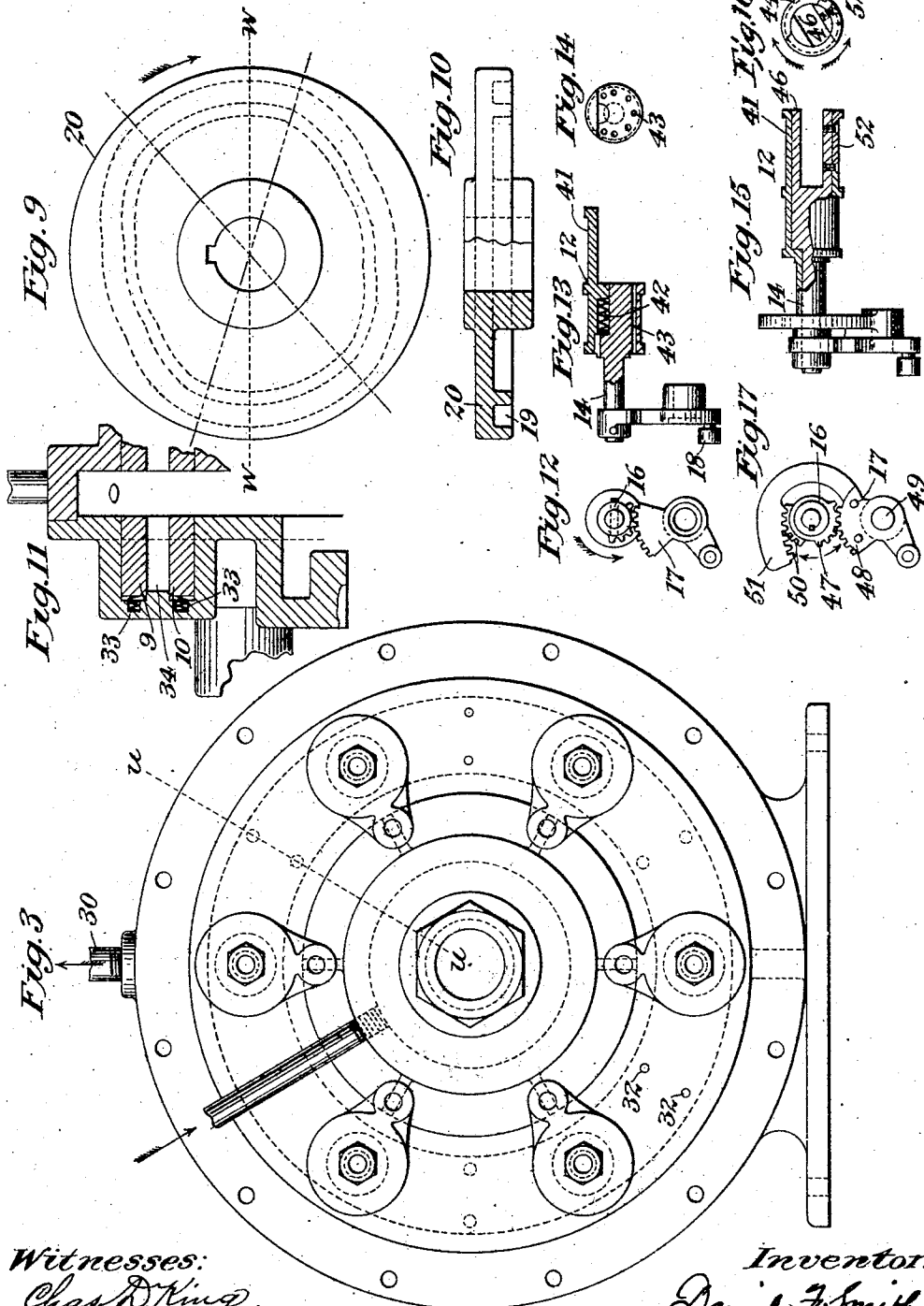
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3 SHEETS—SHEET 2.



Witnesses:  
Chas. D. King,  
Adolph J. Diney,

Inventor:  
Daniel F. Smith  
by Blinn & Turk  
Attys.

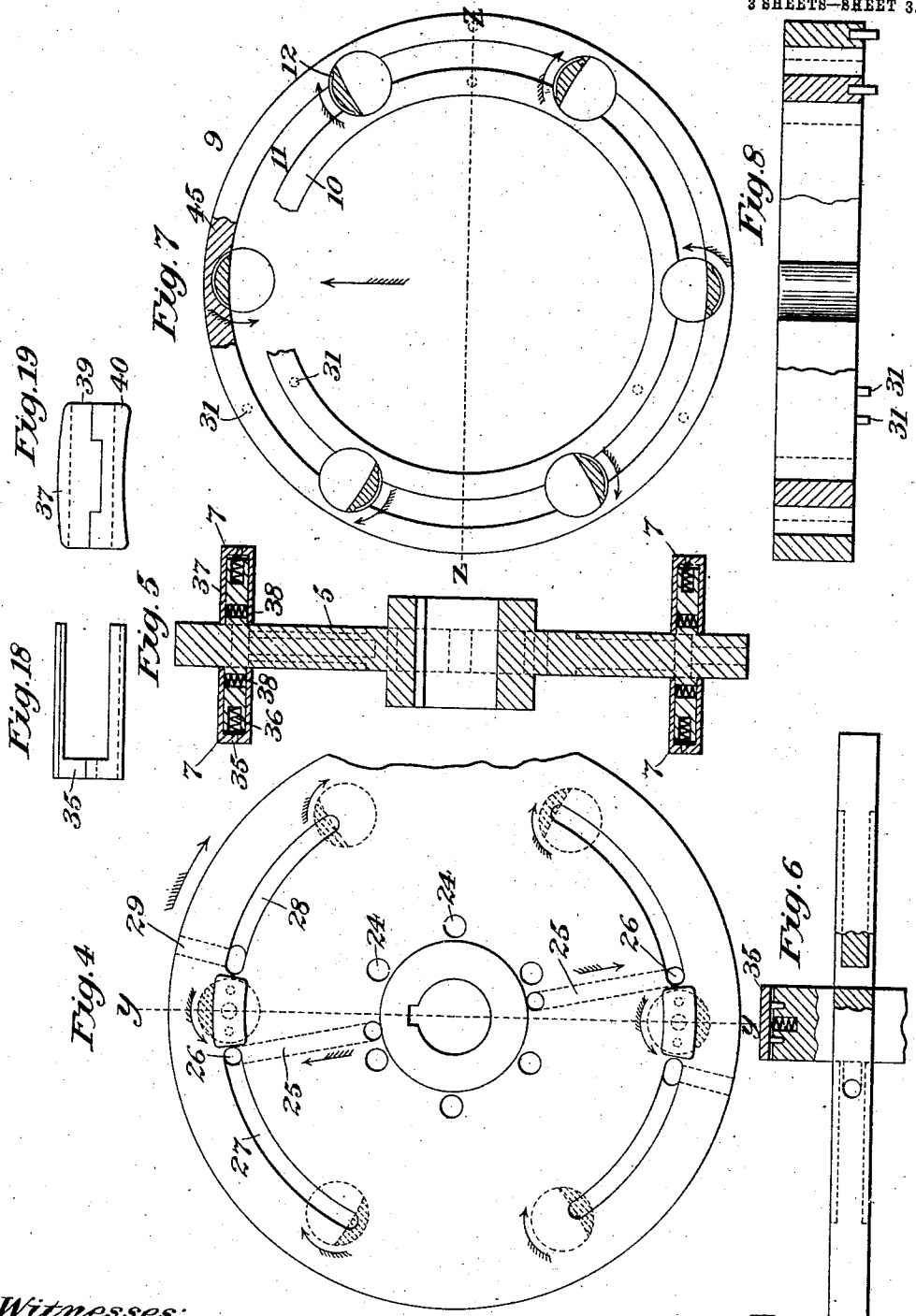
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3 SHEETS—SHEET 3.



Witnesses:  
Chas. R. King.  
Adolph J. Diney.

Inventor:  
Daniel F. Smith  
by D. W. Tuck  
Attys.

# UNITED STATES PATENT OFFICE.

DANIEL F. SMITH, OF NEW YORK, N. Y., ASSIGNOR OF ONE-FOURTH TO  
E. OSBORNE SMITH, OF NEW YORK, N. Y.

## ROTARY ENGINE.

No. 848,860.

Specification of Letters Patent.

Patented April 2, 1907.

Application filed June 29, 1905. Renewed August 30, 1906. Serial No. 332,594.

*To all whom it may concern:*

Be it known that I, DANIEL F. SMITH, a citizen of the United States, residing in the borough of Manhattan, city of New York, and State of New York, have invented certain new and useful Improvements in Rotary Engines, of which the following is a full, clear, and exact specification.

My invention relates to fluid-pressure motors or engines; and it consists in certain features and novel arrangements of parts whereby the efficiency and life of the motor is greatly increased.

The accompanying drawings, which illustrate one specific form of my various improvements, show them applied to a rotary motor—that is, one wherein the pistons are caused to travel continuously in one direction in an annular chamber, moving partitions or valves being provided which serve to inclose portions of the chamber and to coact with the pistons to form pressure and exhaust chambers, the partitions being movable to allow the pistons to pass by them during the operation of the engine.

My invention is particularly adapted for use in an engine of this character; but various features of it are equally valuable in connection with a reciprocating engine, and I do not mean, therefore, to limit myself to its application to motors of the former kind only.

In fluid-pressure engines heretofore in use one serious cause of inefficiency arises from the fact that the piston-chambers are not absolutely steam-tight, some leakage therefrom taking place, most frequently past the piston, which, however, usually carries packing-rings or other devices for the purpose of preventing such leakage. This leakage is particularly liable to occur in rotary engines by reason of the necessarily more complicated cylinder construction, and while packing-rings and kindred devices are of value I find that by making a portion of the walls of the piston-chamber adjustable and providing means for maintaining them in constant contact with the piston mechanism I obtain a practically steam-tight pressure-chamber and reduce to a minimum all chance of leakage, thereby greatly increasing the efficiency of the motor.

My invention also consists in providing a motor wherein portions of the walls of the

piston-chamber are adjustable and other portions stationary, with suitable expansion or fluid-sealing devices on the piston which contact with the stationary portions of the pressure-chamber wall and which effectively co-operate with the adjustable walls to produce the steam-tight chamber so much to be desired.

Another feature of my invention consists in producing in a fluid-pressure motor, by means of mechanism for properly actuating the valves and fluid-delivering means, a constant and uniform pressure upon the piston, whereby a maximum of power and efficiency is developed and which reduces to a minimum the wear and tear on the various moving parts of the motor.

Still another feature of my invention consists in the provision of means whereby all valves and partitions which operate to perform the functions above outlined are released from pressure during their period of movement, and this is a most valuable feature, as it reduces wear on such parts to a minimum and insures their accurate and positive operation.

In the specific illustration of my invention disclosed in the drawings accompanying the application it will be seen that this absence of any pressure on moving parts is provided for not only in the direction of movement of the partitions, but in all directions, which renders the operation of the same particularly efficient.

A still further improvement consists in combining one or more of the features above referred to in a rotary motor provided with a centrally-disposed piston-carrier having pistons on each side of it, which pistons travel in annular pressure-chambers located on each side of the piston-carrier.

It also consists in providing such a motor with a fluid-inlet port passing through the piston-carrier, so as to deliver the pressure fluid directly behind the pistons.

Another feature consists in the novel means for exhausting the used fluid and relieving the valve which the piston is about to pass from pressure before any movement thereof takes place.

A still further improvement consists in the specific construction of the valves, whereby the pressure of the actuating fluid serves to

aid the formation of a steam-tight connection, but automatically withdraws the pressure therefrom before the valve begins to move.

It will be understood that one or more of the features above mentioned may be utilized in conjunction with each other, and I so prefer to use them; but it will be understood that they may be separately utilized in a properly-constructed motor.

In the drawings, which illustrate a characteristic embodiment of my invention, Figure 1 is a side view or end elevation of a rotary motor embodying my improvements. Fig. 2 is a longitudinal central vertical section taken on line *x x* of Fig. 1. Fig. 3 is a similar view to Fig. 1, but shows the valve-operating mechanisms removed. Fig. 4 is a side elevation of the piston-carrier, showing by dotted lines a relative position thereto of the movable valves or partitions. Fig. 5 is a vertical central sectional view of the piston-carrier and piston, taken on line *y y* in Fig. 4. Fig. 6 is a plan view of Fig. 4, showing parts broken away for the sake of clearness. Fig. 7 is a side elevation of a pair of movable rings which form part of the walls of one of the annular chambers, also showing the valves or piston-chamber partitions in a relative position. Fig. 8 is a horizontal central section of the same, taken on line *z z* of Fig. 7. Fig. 9 is an elevation or diagrammatic view of one of the valve-controlling cams. Fig. 10 is a plan view of the same, partly in section, on line *w w* of Fig. 9. Fig. 11 is a fragmentary sectional view of the piston-chamber, showing the movable rings or walls and taken on line *u u* of Fig. 3. Fig. 12 is a side elevation of one of the bell-crank levers and gears for operating the valves. Fig. 13 is a longitudinal section of one of the valves. Fig. 14 is an end view of the same. Fig. 15 is a side elevation, partly in section, of a modified form of valve with the valve open. Fig. 16 is an end view of said modified form of valve with the valve closed, and Fig. 17 a side view of a system of segmental gears and levers for actuating the modified form of valve shown in Figs. 15 and 16. Figs. 18 and 19 are side and end views of the piston bearing plates or shoes, respectively.

Similar numerals of reference indicate like parts in all the drawings.

The main or body portion of the motor consists of two substantially similar parts or castings 1 1, one of which is provided with a base 2 and a flange or rim 3, against which the other casting is secured by bolts 4 4. The disk or piston carrier 5, rigidly secured to the shaft 6, so as to revolve therewith, is located between the two castings 1 1 and carries the pistons 7 7 7 7 near its periphery. These pistons are of equal area and are symmetrically disposed upon the opposite faces of the disk and upon diametrically opposite sides

thereof, so that when pressure is applied thereto they balance each other perfectly and prevent any undue strain upon the shaft and minimize the friction thereon. The piston-carrier is mounted between the two castings and is permitted to rotate freely between them, and the carrier is of somewhat less diameter than the inside diameter of the rim or flange 3, thus providing an annular space 8, which is utilized as an exhaust-chamber.

In the inner face of each of the castings 1 is formed an annular groove in which is fitted two rings 9 and 10, lying one within the other and so arranged that the space between them forms an annular piston-chamber 11. These piston-chambers I prefer to form quite narrow relatively to their depth, the pistons 7 7 being correspondingly formed, as by so doing the greatest amount of piston area can be obtained with the use of small valves or partitions through which the pistons pass, as will be more fully described hereafter.

At uniform intervals around the annular piston-chamber 11 the castings 1 1 are cylindrically recessed, the inner walls of the rings 9 and 10 being cut away to form continuations of the same, as shown in Figs. 2 and 7. In these recesses are located the cylindrical valves 12, the parts thereof extending through the rings 9 and 10, being so cut away (see Figs. 7, 13, 14, 15, and 16) that when the valves are in one position the pistons 7 will freely pass through or by them, as shown by the position of the upper and lower valves of Figs. 4 and 7, and when the valves are moved to a position at right angles to that just described their parts extending into the rings 9 and 10 will lie across the annular piston-chamber 11 and will form closed sections thereof, as indicated by the valves shown at the sides of the rings in Fig. 7, forming at such times stationary abutments or ends to the piston-chamber against which the steam or other motive fluid acts in forcing the pistons 7 around the annular cylinder. These valves are provided with stems 14, extending through stuffing-boxes 15, mounted in the castings 1 1, and these stems carry segmental racks or pinions 16, engaging a corresponding rack on the bell-crank levers 17, employed for operating the valves. The bell-crank levers carry at the ends opposite to the rack antifriction-rollers or cam-followers 18, which engage in the annular recesses 19 on the operating-cams 20, mounted on the main shaft of the engine, as will be seen in dotted line in Fig. 1.

The main shaft is provided with stuffing-boxes or bearings 21, suitably mounted in the main castings, and in these castings are annular spaces 22, utilized as a steam-chamber or steam-chest, an inlet to which is provided by means of the feed-pipe 23.

The main disk is preferably perforated

with ports 24 for the purpose of preventing lateral pressure on the piston-carrier by the steam in one side of the steam-chest, and the steam passes from said chest through passages 25, formed radially through the piston-carrier, which passages have outlets 26 directly behind the pistons. Annular recesses or chambers 27 are formed in the sides of the disk, communicating with said steam-inlets and extending back a distance about equal to the distance between adjacent valves, and together with the steam-inlets, they open into the annular piston-chamber 11. Similar annular recesses 28 are formed in the faces of the piston-carrier upon the opposite sides of the pistons, and these connect with an exhaust-port 29, communicating with the annular piston-chamber, and are of such a length as to extend just beyond the next partition or valve when the piston is on the center in passing any given valve. The exhaust-ports 29 open into the annular exhaust-chamber 8, as will be readily understood, the said chamber being provided with an outlet or escape 30 for the used steam. The rings or movable piston-chamber walls 9 and 10 are secured in their operative positions by means of dowel-pins 31, which enter holes in the annular grooves in the castings, as shown at 32 in Fig. 3, and the said rings, which have a movement in a direction at right angles to the plane of movement of the pistons, are forced into constant contact with the portions of the piston-carrier adjacent to the pistons by means of springs 33, seated in recesses (see Fig. 11) and which bear against the under sides of the rings, thus insuring a snug and permanently steam-tight joint between the inner edges of the rings and the sides of the disk. The rings 9 and 10 form the movable walls to the piston-chamber 11, and in order to provide a tight joint between the remaining or stationary portion of said wall 34 and the pistons an elastic-fluid-sealing device, consisting in a spring-pressed cap 35, is fitted upon the ends of each of the said pistons, a spring 36 operating to maintain a steam-tight contact between the cap on the piston and the contacting wall of the piston-chamber.

It may also be desirable to have the pistons themselves constructed with spring-pressed casings 37, made in two or more pieces and forced by springs 38 into contact with the adjustable rings. Thus any wear on the pistons and danger of leakage between the tops and sides of the pistons and the inner surfaces of the rings and end walls of the chamber is prevented, while any leakage between the piston-carrier and the rings is prevented by the automatic lateral movement of the rings to take up any wear thereon.

Figs. 5, 18, and 19 show one way of making the contacts between the pistons and the movable rings steam-tight. In Figs. 18 and

19 the upper and lower faces are constructed of two pieces or shoes 39 and 40, the ends of which form the cap for contact with the stationary part of the wall of the annular chamber and being dovetailed to prevent the passage of any steam when the shoes have been forced apart by the springs 38 to take up the wear. In this construction the shoes for bearing against the movable walls of the piston-chamber and the cap are shown in two pieces. The springs 36 force the parts endwise, while the springs 38 maintain them in contact with the rings. One or more springs may be used for the latter purpose, one set only being shown in Fig. 5 for the sake of clearness. In Fig. 6 the cap is shown alone without any adjustable bearing-plates for the upper and lower faces of the pistons.

The movable partitions or valves 12, especially the ends thereof which bear against the disk or piston carrier, are likewise subject to wear, and to compensate for this I find it advantageous to provide a longitudinal adjustment for the valves as follows: In Fig. 13, which shows a section of one form of valve, the main portion thereof, 41, is shown in the form of a sleeve which fits over and which rotates with the extension on the stem 14, and while it is keyed to rotate therewith it has a longitudinal motion thereon and by means of a spring 42 is constantly forced outward against the rotating disk and preserves a steam-tight contact therewith. To remove as much as possible frictional resistance from the rotating valves in their contact with their seats in the castings and rings, I provide means of access for the pressure fluid to all sides of the valves and for this purpose employ the holes 43 in the part 41 to permit the fluid to reach the rear thereof and provide recesses 44 with access thereto for the pressure fluid by way of apertures 45, (see Fig. 7,) and thus the active fluid will at all times have access to all parts of the valves, both at the sides and ends thereof opposite and opposed to their active surfaces and the ends opposed to or forming part of the annular pressure-chamber.

In using valves such as those shown in Figs. 12, 13, and 14 it will be seen that a rotation of at least ninety degrees must be given to said valves to permit of their complete opening and closure. In some cases it may be advisable to reduce the extent of this movement, and for this purpose I have devised a modified construction shown in Figs. 15, 16, and 17. In this modified form the valve is composed of two parts—an outer shell 41 and an inner core 46, which has a stem passing through a bearing-sleeve on the shell and on the inner end of which is secured a segmental pinion 47, meshing into the gear-teeth 48 of the lever 17. This lever is pivoted at 49 to the body of the motor and is actuated by a suitable cam and follower,

such as was described in connection with the valve shown in Figs. 12, 13, and 14. On the end of the sleeve of the shell 41, which will extend beyond the bearing in the main casting, is secured a segmental pinion 50, that gears with the teeth of the internal segments 51, carried by an arm extending from the lever 17. The part of the shell 41 that extends between the rings 9 and 10 is cut away, leaving the segmental part 41, and the corresponding part of the core 46 is likewise slotted or cut away, leaving an opening equal in width and depth to the dimension of the annular chamber 11 and the piston traveling therein.

Secured to the outside of the lower segmental part of said slotted shell is a segmental circular piece 52, which constitutes substantially a continuation of the shell. As will be seen from Fig. 16, a valve of this construction requires a movement of the lever 17 equal only to about one-half of that of the lever for actuating a solid valve. In Fig. 16, which shows the valve closed, it will be seen that the outer shell makes a part of a rotation in the direction of the upper arrow and the core a movement in the opposite direction, establishing an overlap and steam-tight joint, each part moving but a fraction over forty-five degrees. This character of valve may be provided with apertures for the equalization of pressure on all parts thereof in a similar manner to the solid valve, and further description thereof is unnecessary.

It is evident that other forms of mechanism may be employed for operating the valves—such, for instance, as levers directly connected to the stems thereof—but the means shown are sufficient illustration for the purposes of this application.

The operation of my motor will be readily understood from an inspection of Figs. 4 and 7. In the relative position shown in these figures the pistons are on the center, passing the valves or partitions at the top and bottom of the engine. (Shown at line *y y* in Fig. 4.) The pressure fluid is at this time being fed from the steam-chest 22 through the passages 25 to the annular pressure-chamber, which, however, is closed by the nearest partition or valve 12 behind and adjacent to the piston. This partition thus forms an abutment and in connection with the piston an annular segmental pressure-chamber, and the pressure of the fluid seats the valve firmly in its place and prevents any leakage past the same. The pressure in this chamber forces the piston forward, (in the direction of the arrow beyond the periphery of the disk in Fig. 4,) and as steam is continually fed from the steam-chamber the pressure in said cylinder is maintained constant and uniform at the predetermined point. After the piston is clear of the valve at the top of the engine this valve begins to close, it being free from

any pressure by reason of an equal pressure on both sides thereof. Such fluid as may be contained in the annular chamber ahead of the piston is vented through the exhaust 29 as the disk and pistons rotate, and the projection of the annular by-pass 28 is of such length as to extend beyond the next valve to be passed and relieve it from pressure at all times after the piston passes the center of any valve and before any movement of the valve takes place. The next valve in succession begins to open as soon as the piston passes a valve preceding it, and it will be seen that the operative pressure-chamber into which steam is being fed from the steam-chest always progresses step by step around the engine and consists of an annular chamber of a length exceeding the distance between any two valves, except at the time of passage of a valve by a piston, at which time the chamber consists of a chamber equal in length to the distance between two adjacent valves. It will thus be seen that all the valves are operated or moved with an equal pressure of fluid acting upon both sides thereof at all times, and thus a minimum of wear is produced and positive action of the valves insured. In the foregoing description the operation of but one piston and set of valves is described; but it will be readily understood that similar operations take place with all the pistons and valves, the movement taking place six times per revolution of each piston and calling for the opening and closing of each valve but twice during each revolution. The step-by-step operation of the valves and constant overlapping of the piston-chambers enables me to maintain a uniform pressure upon each piston during its complete revolution, and thus all shocks and pulsating effects are avoided and the greatest possible efficiency obtained.

In explanation of the foregoing it should be stated that the expression "uniform pressure" means substantially uniform or constant with the pressure from the source of supply, and this of course may vary owing to lack of proper regulation of the generator. It will be understood, however, that owing to the expansion, &c., and the devious passages through which the steam passes from the generator to the pressure-cylinder, although a constant connection is maintained between the two, the pressure will not be the same in the generator and the piston-chamber; but it will at all times have a substantially definite relation.

It is obvious that the embodiment of my invention described and shown in the foregoing description and drawings is but one typical form thereof and that many modifications and changes may be made in matters of construction and arrangements with parts without deviating from the spirit of the invention, and I do not mean to limit myself to

the specific form shown and described. As an illustration of the foregoing it will be readily seen that my invention could be adapted to a rotary pump with slight modification, one side of the piston-carrier being utilized as the operating-engine and the other side being arranged as a pump.

What I claim, however, and desire to secure by Letters Patent, is—

1. In a fluid-pressure motor, the combination with a pressure-chamber and a piston traveling therein, of movable sections in frictional contact with the upper and lower faces of said piston and forming part of the walls of said pressure-chamber, substantially as described.

2. In a rotary motor, the combination of an annular chamber, a piston adapted to travel therein, and adjustable sections forming frictional contact-surfaces for the upper and lower faces of said piston and constituting the walls of said chamber, substantially as described.

3. In a rotary motor, the combination of an annular chamber, a piston adapted to travel therein, adjustable annular sections lying one within the other and forming frictional contact-surfaces for said piston and constituting the walls of said chamber, substantially as described.

4. In a rotary motor, the combination with a pair of annular pressure-chambers in circumferential alinement, of a piston-carrier between said chambers, a plurality of pistons on said carrier and traveling in said chambers, and movable sections in frictional contact with the upper and lower faces of said pistons and forming part of the walls of said chambers, substantially as described.

5. In a rotary motor, the combination with a pair of annular pressure-chambers in circumferential alinement, of a piston-carrier between said chambers, a plurality of pistons on said carrier and traveling in said chambers, and movable annular sections lying one within the other and between which the pistons move, the said sections being in frictional contact with said pistons and forming part of the walls of said chambers, substantially as described.

6. In a rotary motor, the combination with an annular pressure-chamber, of a piston-carrier adjacent to said chamber, a plurality of pistons on said carrier and traveling in said chamber, annular sections adjustable in a direction toward and away from the piston-carrier, which lie one within the other and between which the pistons move, the said sections being in frictional contact with said pistons and forming part of the walls of said pressure-chamber, substantially as described.

7. In a rotary motor the combination with a pair of annular pressure-chambers in circumferential alinement, of a piston-carrier

between said chambers, a plurality of pistons on said carrier and traveling in said chambers, and movable annular sections adjustable in a direction at right angles to the plane of movement of the pistons, lying one within the other and between which the pistons move, the said sections being in frictional contact with said pistons and forming part of the walls of the pressure-chambers, substantially as described.

8. In a fluid-pressure motor, the combination with a pressure-chamber and a piston traveling therein, of movable sections in frictional contact with the upper and lower faces of said piston and forming part of the walls of said pressure-chamber, and elastic means for adjusting said sections to take up the wear thereof, substantially as described.

9. In a rotary motor, the combination of an annular chamber, a piston adapted to travel therein, and adjustable sections forming frictional contact-surfaces for the upper and lower faces of said piston and constituting the walls of said chamber, and spring means for maintaining said sections in operative engagement with said piston, substantially as described.

10. In a rotary motor, the combination with a pair of annular pressure-chambers in circumferential alinement, of a piston-carrier between said chambers, a plurality of pistons on said carrier and traveling in said chambers, movable sections in frictional contact with the upper and lower faces of said piston and forming part of the walls of said chambers, and yielding tension devices for forcing said sections toward said piston-carrier, substantially as described.

11. In a rotary motor, the combination with a pair of annular pressure-chambers in circumferential alinement, of a piston-carrier between said chambers, a plurality of pistons on said carrier and traveling in said chambers, movable annular sections lying one within the other and between which the pistons move, the said sections being in frictional contact with said pistons and forming part of the walls of said chambers, and yielding tension devices for forcing said sections toward said piston-carrier, substantially as described.

12. In a fluid-pressure motor, the combination with a pressure-chamber and a piston traveling therein, of movable sections in frictional contact with the upper and lower faces of said piston and forming part of the walls of said pressure-chamber, and elastic-fluid sealing devices on said piston and which contact with the stationary portions of the pressure-chamber wall, substantially as described.

13. In a rotary motor, the combination of an annular chamber, a piston adapted to travel therein, adjustable sections forming frictional contact-surfaces for the upper and lower faces of said piston and constituting

the walls of said chamber, and elastic-fluid sealing devices on said piston and which contact with the stationary portions of the pressure-chamber wall, substantially as described.

14. In a rotary motor, the combination with a pair of annular pressure-chambers in circumferential alinement, of a piston-carrier between said chambers, a plurality of pistons on said carrier and traveling in said chambers, movable sections in frictional contact with the upper and lower faces of said pistons and forming part of the walls of said chambers, and elastic-fluid sealing devices on said piston and which contact with the stationary portions of the pressure-chamber walls, substantially as described.

15. In a rotary motor, the combination with a pair of annular pressure-chambers in circumferential alinement, of a piston-carrier between said chambers, a plurality of pistons on said carrier and traveling in said chambers, movable annular sections lying one within the other and between which the pistons move, the said sections being in frictional contact with said pistons and forming part of the walls of said chambers, and yielding packing devices at the ends of said pistons and which press against the stationary portions of the pressure-chamber walls, substantially as described.

16. In a rotary fluid-motor, the combination of an annular chamber, a piston traveling therein, inlet and exhaust ports communicating with said chamber, a plurality of movable partitions adapted to inclose portions of the annular chamber and by which the piston is permitted to pass, means for moving said partitions and delivering the pressure fluid so that a uniform pressure is maintained upon one side of the piston and a constant exhaust upon the other, the pressure-chamber constituting at all times except when the piston is passing a partition, the space in the annular chamber between the piston and the second partition behind it, substantially as described.

17. In a rotary fluid-motor, the combination of an annular chamber, a piston traveling therein, inlet and exhaust ports communicating with said chamber, a plurality of movable partitions adapted to inclose portions of the annular chamber and by which the piston is permitted to pass, means for moving said partitions and delivering the pressure fluid so that the pressure-chamber constitutes, at all times except when the piston is passing a partition, the space in the annular chamber between the piston and the second partition behind it, substantially as described.

18. In a rotary fluid-motor, the combination of an annular chamber, a piston traveling therein, inlet and exhaust ports communicating with said chamber, a plurality of rotating valves adapted to inclose portions of

the annular chamber and by which the piston is permitted to pass, means for moving said partitions and delivering the pressure fluid so that a uniform pressure is maintained upon one side of the piston and a constant exhaust upon the other, the pressure-chamber constituting at all times except when the piston is passing a valve, the space in the annular chamber between the piston and the second valve behind it, substantially as described.

19. In a rotary fluid-motor, the combination of an annular chamber, a piston traveling therein, inlet and exhaust ports communicating with said chamber, a plurality of rotating valves adapted to inclose portions of the annular chamber and by which the piston is permitted to pass, means for moving said partitions and delivering the pressure fluid so that the pressure-chamber constitutes at all times except when the piston is passing a valve the space in the annular chamber between the piston and the second valve behind it, substantially as described.

20. In a rotary motor, the combination with a pair of annular pressure-chambers in circumferential alinement, of a piston-carrier between said chambers, a plurality of pistons on said carrier and traveling in said chambers, a plurality of movable partitions, adapted to inclose portions of the annular chambers and by which the pistons are permitted to pass, operating mechanism connected with the main shaft for moving said partitions and delivering the pressure fluid so that a uniform pressure is maintained upon one side of the pistons and a constant exhaust upon the other, substantially as described.

21. In a rotary motor, the combination with a pair of annular pressure-chambers in circumferential alinement, of a piston-carrier between said chambers, a plurality of pistons on said carrier and traveling in said chambers, a plurality of movable partitions adapted to inclose portions of the annular chambers and by which the pistons are permitted to pass, means for moving said partitions and delivering the pressure fluid so that the pressure-chamber constitutes at all times, except when the piston is passing a partition, the space in the annular chamber between a piston and the second partition behind it, substantially as described.

22. In a rotary motor, the combination with a pair of annular pressure-chambers in circumferential alinement, of a piston-carrier between said chambers, a plurality of pistons on said carrier and traveling in said chambers, a fluid-inlet having communication through the piston-carrier with one side of the pistons, and an exhaust leading from the other side of said pistons, through said piston-carrier to an exhaust-chamber, substantially as described.

23. In a rotary motor, the combination of

an annular chamber, a piston adapted to travel therein, inlet and exhaust ports communicating with the chamber, movable partitions adapted to inclose portions of the annular chamber, operating mechanism connecting with the main shaft for moving said partitions, said partitions being so arranged as to form in connection with the piston a pressure-chamber on one side of the piston, and an exhaust-chamber on the other side thereof during the entire movement of the piston, substantially as described.

24. In a rotary motor the combination of a pressure-chamber, a piston traveling therein, movable valves or partitions adapted to inclose portions of said chamber and by which the piston is permitted to pass without contact and springs pressing on said valves in the direction of their wear, substantially as described.

25. In a rotary motor, the combination with a pair of annular pressure-chambers in circumferential alinement, of a piston-carrier between said chambers, a plurality of pistons on said carrier and traveling in said chambers, valves or partitions adapted to inclose portions of said chamber and by which the piston is permitted to pass, and automatic means of taking up the wear on said valves, substantially as described.

26. In a rotary motor, the combination with a pair of annular pressure-chambers in circumferential alinement, of a piston-carrier between said chambers, a plurality of pistons on said carrier and traveling in said chambers, movable sections in frictional contact with said pistons and forming part of the walls of said chambers, valves or partitions adapted to inclose portions of said chambers and by which the piston is permitted to pass, and automatic means for taking up the wear on said valves, substantially as described.

27. In a rotary motor the combination with a pair of annular pressure-chambers in circumferential alinement, of a piston-carrier between said chambers, a plurality of pistons on said carrier and traveling in said chambers, movable annular sections adjustable in a direction at right angles to the plane of movement of the pistons, lying one within the other and between which the pistons move, the said sections being in frictional contact with said piston and forming part of the walls of said chambers, valves or partitions adapted to inclose portions of said chamber and by which the piston is permitted to pass, and automatic means of taking up the wear on said valves, substantially as described.

28. In a rotary motor, the combination of an annular chamber, a piston adapted to travel therein, adjustable sections forming frictional contact-surfaces for said piston and constituting the walls of said chamber,

elastic-fluid sealing devices on said piston and which contact with the stationary portions of the pressure-chamber wall, valves or partitions adapted to inclose portions of said chamber and by which the piston is permitted to pass, and automatic means for taking up the wear on said valves, substantially as described.

29. In a rotary motor, the combination with a pair of annular pressure-chambers in circumferential alinement, of a piston-carrier between said chambers, a plurality of pistons on said carrier and traveling in said chambers, movable sections in frictional contact with said piston and forming part of the walls of said chambers, elastic-fluid sealing devices on said piston and which contact with the stationary portions of the pressure-chamber wall, valves or partitions adapted to inclose portions of said chamber and by which the pistons are permitted to pass, and automatic means for taking up the wear on said valves, substantially as described.

30. In a fluid-pressure motor, the combination with a pressure-chamber and a piston adapted to travel therein, of movable valves in said chamber, and means for equalizing the pressure on all sides of said valves during the period of their movement, substantially as described.

31. In a rotary motor, the combination of an annular chamber, a piston adapted to travel therein, inlet and exhaust ports communicating with said chamber, movable partitions adjustable longitudinally and adapted to inclose portions of said chamber, being so arranged as to form in connection with the piston a pressure-chamber on one side of the piston, and an exhaust-chamber on the other side thereof during the entire movement of the piston, and means for equalizing the pressure on both sides of said valves during the period of their movement, substantially as described.

32. In a rotary motor, the combination of a pair of annular chambers, a piston-carrier between said chambers a plurality of pistons on said carrier and adapted to travel in said chambers, inlet and exhaust ports communicating with said chambers, movable valves adjustable longitudinally and adapted to inclose portions of said chamber and by which the pistons are permitted to pass, and means for equalizing the pressure on both sides of said valves during the period of their movement, substantially as described.

33. In a fluid-pressure motor, the combination with a pressure-chamber and a piston traveling therein, of movable sections in frictional contact with said piston and forming part of the walls of said pressure-chamber, movable valves in said chamber, and means for equalizing the pressure on both sides of said valves during the period of their movement, substantially as described.

34. In a rotary motor, the combination of an annular cylinder, a piston adapted to travel therein, adjustable sections forming frictional contact-surfaces for said piston and constituting the walls of said chamber, of movable valves in said chamber and means for equalizing the pressure on both sides of said valves during the period of their movement, substantially as described.

35. In a rotary motor, the combination with a pair of annular pressure-chambers in circumferential alinement, of a piston-carrier between said chambers, a plurality of pistons on said carrier and traveling in said chamber, valves or partitions adapted to inclose portions of said chambers and by which the pistons are permitted to pass, and means for equalizing the pressure on both sides of said valves during the period of their movement, substantially as described.

36. In a rotary motor, the combination with a pair of annular pressure-chambers in circumferential alinement, of a piston-carrier between said chambers, a plurality of pistons on said carrier and traveling in said chambers, movable annular sections adjustable in a direction at right angles to the plane of movement of the pistons, lying one within the other and between which the pistons move, the said sections being in frictional contact with said pistons and forming part of the walls of said chambers, valves or partitions adapted to inclose portions of said chambers and by which the pistons are permitted to pass, automatic means of taking up the wear on said valves, and means for equalizing the pressure on both sides of said valves during the period of their movement, substantially as described.

37. In a rotary motor, the combination of an annular chamber, a piston adapted to travel therein, adjustable sections forming frictional contact-surfaces for said piston and constituting the walls of said chamber, elastic-fluid sealing devices on said piston and which contact with the stationary portions of the pressure-chamber wall, valves or partitions adapted to inclose portions of said chamber, and by which the piston is permitted to pass, automatic means of taking up the wear on said valves, and means for equalizing the pressure on both sides of said valves during the period of their movement, substantially as described.

38. In a rotary motor, the combination with a pair of annular pressure-chambers in circumferential alinement, of a piston-carrier between said chambers, a plurality of pistons on said carrier and traveling in said chambers, movable sections in frictional contact with said pistons and forming part of the walls of said chambers, rotary valves adapted to inclose portions of said chambers, and means for equalizing the pressure on both

sides of said valves during the period of their movement, substantially as described.

39. In a rotary motor, the combination with a pair of annular pressure-chambers in circumferential alinement, of a piston-carrier between said chambers, a plurality of pistons on said carrier and traveling in said chambers, movable annular sections lying one within the other and between which the pistons move, the said sections being in frictional contact with said pistons and forming part of the walls of said chambers, movable valves adapted to inclose portions of said chambers, and means for equalizing the pressure on both sides of said valves during the period of their movement, substantially as described.

40. In a rotary motor, the combination of an annular chamber, a piston adapted to travel therein, inlet and exhaust ports communicating with the chamber, movable partitions adapted to inclose portions of the annular chamber, and being so arranged as to form, in connection with the piston, a uniform-pressure chamber on one side of the piston and an exhaust-chamber on the other side thereof during the entire rotation of the piston, and a movable by-pass or port communicating with said exhaust-chamber and connecting both sides of the partition at the end of said chamber, substantially as described.

41. In a rotary motor, the combination of an annular chamber, a piston adapted to travel therein, inlet and exhaust-ports communicating with the chamber, movable partitions adapted to inclose portions of the annular chamber and by which the piston is permitted to pass, means for moving said partitions so that when the piston is passing any given partition, the adjacent ones are closed, said adjacent partitions forming in connection with the piston a uniform-pressure chamber on one side thereof, and an exhaust-chamber on the other side, and a movable by-pass or port communicating with said exhaust-chamber and connecting both sides of the partition at the end of said chamber, substantially as described.

42. In a rotary fluid-motor, the combination of an annular chamber, a piston traveling therein, inlet and exhaust ports communicating with said chamber, a plurality of movable partitions adapted to inclose portions of the annular chamber and by which the piston is permitted to pass, means for moving said partitions and delivering the pressure fluid so that a uniform pressure is maintained upon one side of the piston and a constant exhaust upon the other, the pressure-chamber constituting at all times except when the piston is passing a partition, the space in the annular chamber between the piston and the second partition behind it, and a movable

by-pass or port communicating with said exhaust-chamber and connecting both sides of the partition at the end of said chamber, substantially as described.

5 43. In a rotary fluid-motor, the combination of an annular chamber, a piston traveling therein, inlet and exhaust ports communicating with said chamber, a plurality of rotating valves adapted to inclose portions of  
10 the annular chamber and by which the piston is permitted to pass, means for moving said partitions and delivering the pressure fluid so that the pressure-chamber constitutes at all times, except when the piston is  
15 passing a valve, the space in the annular chamber between the piston and the second valve behind it, and a movable by-pass or port communicating with said exhaust-chamber and connecting both sides of the partition at  
20 the end of said chamber, substantially as described.

44. In a rotary motor, the combination with a pair of annular pressure-chambers in circumferential alinement, of a piston-carrier  
25 between said chambers, a plurality of pistons on said carrier and traveling in said chambers, a plurality of movable partitions, adapted to inclose portions of the annular chambers and by which the pistons are permitted  
30 to pass, means for moving said partitions and delivering the pressure fluid so that a uniform pressure is maintained upon one side of the pistons and a constant exhaust upon the other, and a movable by-pass or port communicating with said exhaust-chamber and  
35 connecting both sides of the partition at the end of said chamber, substantially as described.

45. In a rotary motor, the combination  
40 with an annular pressure-chamber, of a piston-carrier adjacent to said chamber, a plurality of pistons on said carrier and traveling in said chamber, valves adapted to inclose portions of said annular chamber, a fluid-inlet having communication through the piston-carrier with one side of the pistons and  
45 an exhaust leading from the other side of said pistons, and a relief-port in said carrier communicating with the exhaust-chamber and connecting both sides of the valve at the end  
50 of said chamber, substantially as described.

46. In a rotary motor, the combination with a pair of annular pressure-chambers in circumferential alinement, of a piston-carrier  
55 between said chambers, a plurality of pistons on said carrier and traveling in said chambers, valves adapted to inclose portions of said annular chamber, a fluid-inlet having communication through the piston-carrier with one side of the pistons, an exhaust leading from the other side of said pistons, and a relief-port in said carrier communicating with the exhaust-chamber and connecting  
65 both sides of the valve at the end of said chamber, substantially as described.

47. In a rotary motor, the combination with a pair of annular pressure-chambers in circumferential alinement, of a piston-carrier between said chambers, a plurality of pistons on said carrier and traveling in said chambers, valves or partitions adapted to inclose  
70 portions of said chambers and by which the pistons are permitted to pass, automatic means of taking up the wear on said valves, and a relief-port in said carrier communicating with the exhaust-chamber and connecting  
75 both sides of the valve adjacent to said chamber, substantially as described.

48. In a rotary motor the combination with a pair of annular pressure-chambers in circumferential alinement, of a piston-carrier between said chambers, a plurality of pistons on said carrier and traveling in said chambers, movable annular sections adjustable in a direction at right angles to the plane of  
80 movement of the pistons, lying one within the other and between which the pistons move, the said sections being in frictional contact with said pistons and forming part of the walls of said chambers, valves or partitions adapted to inclose portions of said  
85 chambers and by which the pistons are permitted to pass, automatic means for taking up the wear on said valves, and a movable by-pass or port communicating with said exhaust-chamber and connecting both sides of the partition at the end of said chamber, substantially as described.

49. In a rotary motor, the combination of an annular chamber, a piston adapted to travel therein, adjustable sections forming frictional contact-surfaces for said piston and constituting the walls of said chamber, elastic-fluid sealing devices on said piston and which contact with the stationary portions of the pressure-chamber wall, valves or partitions adapted to inclose portions of said chamber and by which the piston is permitted to pass, automatic means for taking up the wear on said valves, and a relief-port  
100 in said carrier communicating with the exhaust-chamber and connecting both sides of the valve adjacent to said chamber, substantially as described.

50. In a rotary motor, the combination with a pair of annular pressure-chambers in circumferential alinement, of a piston-carrier between said chambers, a plurality of pistons on said carrier and traveling in said chambers, movable sections in frictional contact with said piston and forming part of the walls of said chambers, elastic-fluid sealing devices on said pistons and which contact with the stationary portions of the pressure-chamber wall, valves or partitions adapted to inclose portions of said chamber and by which the pistons are permitted to pass, automatic means for taking up the wear on such valves, and a relief-port in said carrier communicating with the exhaust-chamber and connect-  
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ing both sides of the valve at the end of said chamber, substantially as described.

51. In a rotary motor, in combination, an annular cylinder, a rotating disk arranged to form one of the side walls of the cylinder, a piston connected to the disk and fitted to slide or travel around the cylinder, and a valve comprising a body portion seated to rotate in a cylindrical recess formed in the other side wall of the annular cylinder, a segmental part fitted to slide longitudinally on the body portion and adapted to extend athwart the annular cylinder and to rock into circular recesses formed in the cylindrical walls thereof, and a spring for holding the end of this segmental part against the side of the disk, and means for rocking the valves, substantially as described.

52. In a rotary motor, in combination, an annular cylinder, a piston adapted to travel therein; inlet and exhaust ports in communication with the cylinder; and a valve seated to rotate in a recess formed in one of the side walls of the cylinder and having an extension adapted to lie athwart the cylinder to act as an abutment and to move into circular recesses formed in the circular walls of the cylinder, and openings through the main portion for access of the active fluid in the cylinder to all parts of valve, and means for rocking the valve, substantially as described.

53. In a rotary motor, in combination an annular cylinder, a piston adapted to travel therein, inlet and exhaust ports in communication with the cylinder, and a valve seated to rotate in a recess formed in one of the side walls of the cylinder and having an extension adapted to lie athwart the cylinder to act as an abutment and to move into circular recesses formed in the circular walls of the cylinder, and provided with a recess or pocket in its outer surface; recess-grooves extending from the circular wall of the cylinder into the circular recess; and means for rocking the valve, substantially as described.

54. In a rotary motor, in combination, an annular cylinder; a piston adapted to travel therein; inlet and exhaust ports in communication with the cylinder; and a valve seated to rotate in a recess formed in one of the side walls of the cylinder and having an extension adapted to lie athwart the cylinder to act as an abutment and to move into circular recesses formed in the circular walls of the cylinder, and openings through the main portion for access of the active fluid in the cylinder to all parts of valve; a recess or pocket formed in the outer surface of the segmental part of the valve, and recess-grooves extending from the circular wall of the cylinder into the circular recess to afford communication between the recess in the segmental part of the valve and the interior of the cylinder; and means for rocking the valve, substantially as described.

55. In a rotary motor, in combination, an annular cylinder, a rotating disk arranged to form one of the side walls of the cylinder; a piston connected to the disk and fitted to slide or travel around the cylinder; and a valve comprising a body portion seated to rotate in a cylindrical recess formed in the other side wall of the annular cylinder, a segmental part fitted to slide longitudinally on the body portion and adapted to extend athwart the annular cylinder and to rock into circular recesses formed in the cylindrical walls thereof, and a spring for holding the end of this segmental part against the side of the disk; openings and recesses extending from the interior of the annular cylinder to the surfaces of the valve opposed to those under the influence of the active fluid in the cylinder, and means for rocking the valve, substantially as described.

56. In a rotary motor, in combination, a body composed of two parts, each provided with an annular groove formed in its inner face; a disk fitted to rotate between the inner faces of the two parts of the body, the sides of which cover the open sides of the grooves, thus forming therewith an annular cylinder on either side of the disk; pistons extending from the sides of the disk, fitted to slide around the annular cylinders and diametrically arranged on the sides of the disk; valves fitted to rock in the annular cylinder and formed to permit the pistons to pass through or by them and also to act as abutments in the cylinders; a shaft having bearings in the body concentric with the annular cylinders and on which the disk is secured; means for rocking the valves; and inlet and outlet passages and ports for the flow or live active fluid to the cylinders and the exhaust therefrom, substantially as described.

57. In a rotary motor, in combination, a body; two flat rings fitted in a circular groove therein with an annular space between them; a disk adapted to rotate concentrically to the annular space and with its face arranged against the outer faces of the rings, constituting with the adjacent faces of the flat rings and the inner wall of the groove of the body an annular cylinder; means as springs, for holding the rings against the side of the disk; pistons fitted to slide in the annular cylinder and carried by the disk; rotary valves fitted to rock in circular recesses formed in the adjacent faces of the rings and formed to permit the piston to pass by them; and means for rocking the valves in unison with the movement of the pistons, substantially as described.

58. In a rotary motor, in combination, a body or casing provided with a circular groove forming an annular cylinder; a shaft fitted to rotate in central bearings in the body; a disk secured to the shaft with its side covering the opening of the circular

groove, and having intake-passages extending from its central part to ports in its face opening into the cylinder, and passages extending from its periphery to exhaust-ports in its face; pistons secured to the face of the disk and extending into and fitted to slide in the annular cylinder; a steam chamber or chest at the central part of the body into which the intake-passages open; an exhaust-chamber surrounding the periphery of the disk into which the exhaust-passages open; valves fitted to rock in circular recesses formed in the annular cylinder to constitute abutments therein and constructed to permit of the passage of the pistons through them, and means for rocking the valves to cause them to work in unison with the pistons, substantially as described.

59. In a rotary motor, in combination, a body having two internal circular grooves; a disk fitted to rotate between the grooves with its sides covering the openings of the same, thus forming two annular cylinders; pistons secured to and diametrically arranged on the sides of the disk and formed to slide through the annular cylinders; a central shaft having bearings in the body and to which the disk is secured; valves fitted to rotate in the annular cylinders, adapted to act as abutments and formed to permit the pistons to pass by them, and having operating-stems extending through the body, means, as cams and levers, imparting motion from the central shaft to the stems of the valves; a steam chamber or chest in the body at the central parts of the two sides of the disk, and an exhaust-chamber surrounding the periphery of the disk, and two sets of ports in the sides of the disk, one of each at the opposite ends of the pistons, and opening into the annular cylinders, and passages connecting the one set of ports with the central steam-chest and the other set of ports with the exhaust-chamber, substantially as described.

60. In a rotary motor, in combination, an annular cylinder; a rotating disk arranged to form one of the side walls of the cylinder; a piston connected to the disk and fitted to slide or travel around the cylinder; and a valve comprising a body portion seated to rotate in a cylindrical recess formed in the other side wall of the annular cylinder, a segmental part fitted to slide longitudinally on the body portion and adapted to extend athwart the annular cylinder and to rock into the circular recesses formed in the cylindrical walls thereof; and means for rocking the valve, substantially as described.

61. In a fluid-pressure motor, a pressure-chamber, a piston adapted to travel therein, and movable valves for inclosing portions of said chamber and adapted to be forced into steam-tight contact with the walls of said chamber by the action of the pressure fluid, and to be released from such pressure be-

fore any movement of the valves takes place, substantially as described.

62. In a rotary motor, an annular pressure-chamber, a piston adapted to travel therein, and rotating valves for inclosing portions of said chamber and adapted to be forced into steam-tight contact with the walls of said chamber by the action of the pressure fluid and to be released from such pressure before any movement of the valves takes place, substantially as described.

63. In a rotary motor, an annular pressure-chamber, a piston adapted to travel therein, and movable valves for inclosing portions of said chamber and composed of a plurality of members, one within the other, and having reciprocal movements so as to reduce the amount of throw of a single part, substantially as described.

64. In a rotary motor, an annular pressure-chamber, a piston adapted to travel therein, and movable valves for inclosing portions of said chamber and composed of a plurality of members having reciprocal movements so as to reduce the amount of throw of a single part, said valves being adapted to be forced into steam-tight contact with the walls of said chamber by the action of the pressure fluid and to be released from such pressure before any movement of the valves takes place, substantially as described.

65. In a rotary motor, an annular pressure-chamber, a piston adapted to travel therein, and movable valves for inclosing portions of said chamber and composed of a plurality of rotating members, one within the other, and having reciprocal movements around a common center so as to reduce the amount of throw of a single part, substantially as described.

66. In a rotary motor, an annular pressure-chamber, a piston adapted to travel therein, and movable valves for inclosing portions of said chamber and composed of a plurality of rotating members, one within the other, and having reciprocal movements around a common center so as to reduce the amount of throw of a single part, said valves being adapted to be forced into steam-tight contact with the walls of said chamber by the action of the pressure fluid, substantially as described.

67. In a rotary motor, the combination of a pair of annular pressure-chambers, a piston-carrier between said chambers and a plurality of pistons on said carrier adapted to travel in said chambers, annular sections adjustable in a direction toward and away from the piston-carrier and between which the pistons move, said chambers being so proportioned as to maintain equal pressures on each side of said carrier and the pistons being so arranged on the carrier as to balance one another and prevent excessive wear on the moving parts, substantially as described.

68. In a rotary motor, the combination of a pair of annular pressure-chambers, a piston-carrier between said chambers and a plurality of pistons on said carrier adapted to travel in said chambers, movable annular sections lying one within the other and between which the pistons move, the said sections being in frictional contact with said pistons and forming part of the walls of said chamber, said chambers being so arranged as to maintain equal pressures on each side of said carrier and the pistons being so arranged on the carrier as to balance one another and prevent excessive wear on the moving parts, substantially as described.

69. In a rotary motor, the combination of a pair of annular pressure-chambers, a piston-carrier between said chambers and a plurality of pistons on said carrier adapted to travel in said chambers, said chambers being so proportioned as to maintain equal pressure on each side of said carrier and the pistons being so arranged on the carrier as to balance one another and prevent excessive wear on the moving parts, a plurality of movable partitions adapted to inclose portions of the annular chambers and by which the pistons are permitted to pass, and means for moving said partitions and delivering the pressure fluid so that the pressure-chamber constitutes at all times, except when a piston is passing a partition, the space in the annular chamber between said piston and the second partition behind it, substantially as described.

70. In a rotary fluid-pressure motor, the combination with an annular fluid-chamber, a piston adapted to travel therein, movable valves in said chamber and a by-pass connecting both sides of said valves during the entire period of their movement so as to equalize the pressure thereon, substantially as described.

71. In a rotary fluid-pressure motor, the combination with an annular fluid-chamber, a piston adapted to travel therein, movable valves or partitions for inclosing portions of said chamber and by which said piston is adapted to pass, and a by-pass connecting the opposite sides of said valves during the entire period of their movement so as to equalize the pressure thereon, substantially as described.

72. In a rotary fluid-pressure motor, the combination with an annular fluid-chamber, a piston-carrier adjacent thereto, a piston on said carrier and adapted to travel in said chamber, a movable valve in said chamber, and a by-pass in said piston-carrier communicating with both sides of said valve during the entire period of its movement so as to equalize the pressure thereon, substantially as described.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

DANIEL F. SMITH.

Witnesses:

WM. E. McREYNOLDS,  
ADOLPH F. DINSE.