No. 725,615. PATENTED APR. 14, 1903.

J. F. COOLEY.

ROTARY FLUID ENGINE.

APPLICATION FILED JAN. 12, 1903.

NO MODEL. 3 SHEETS—SHEET 1.

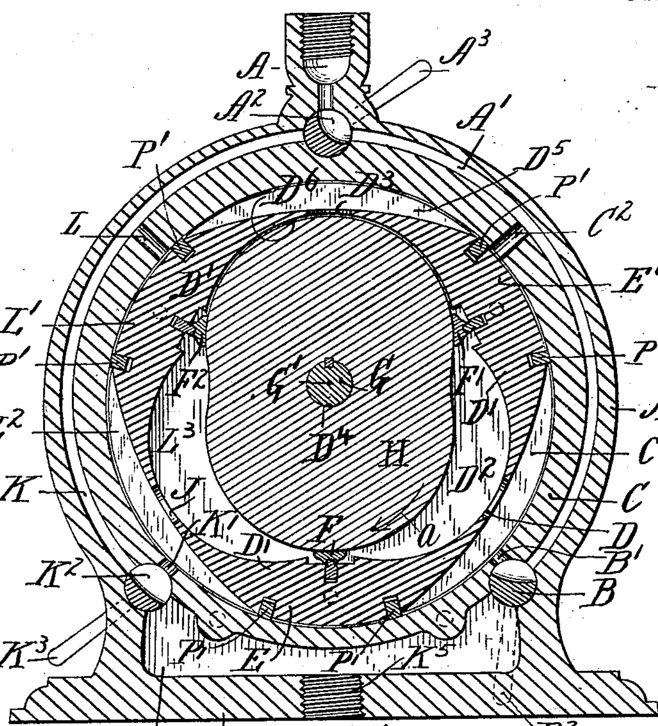

Fig. 1.

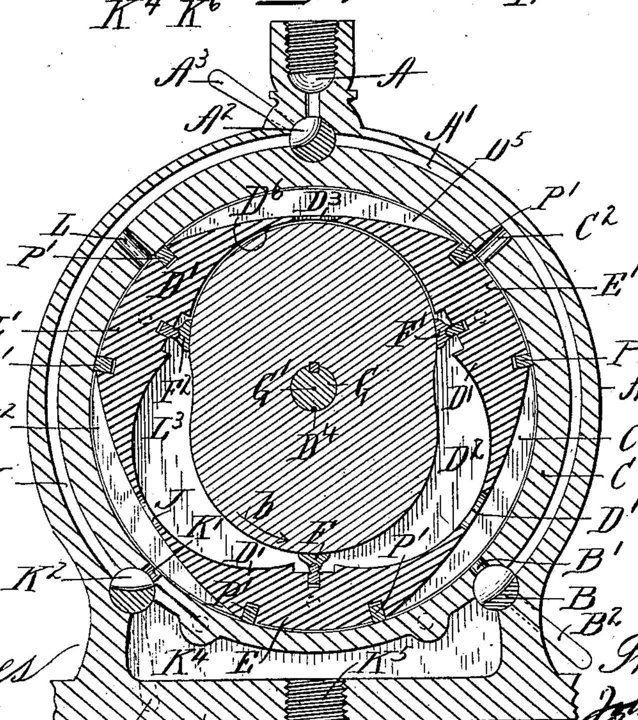

Fig. 2.

Witnesses

A. L. Numa

C. A. Stewart

Inventor.

John F. Cooley

By J. S. Rusk

atty

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

No. 725,615. PATENTED APR. 14, 1903.

J. F. COOLEY.

ROTARY FLUID ENGINE.

APPLICATION FILED JAN. 12, 1903.

NO MODEL. 3 SHEETS—SHEET 2.

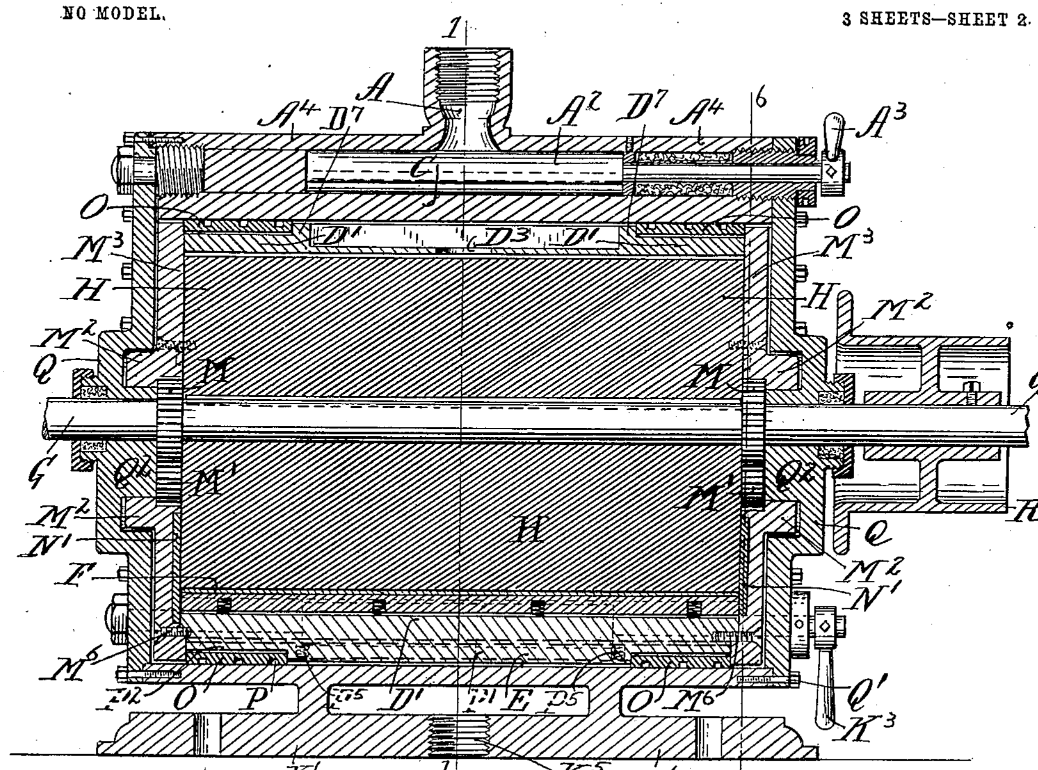

Fig. 3.

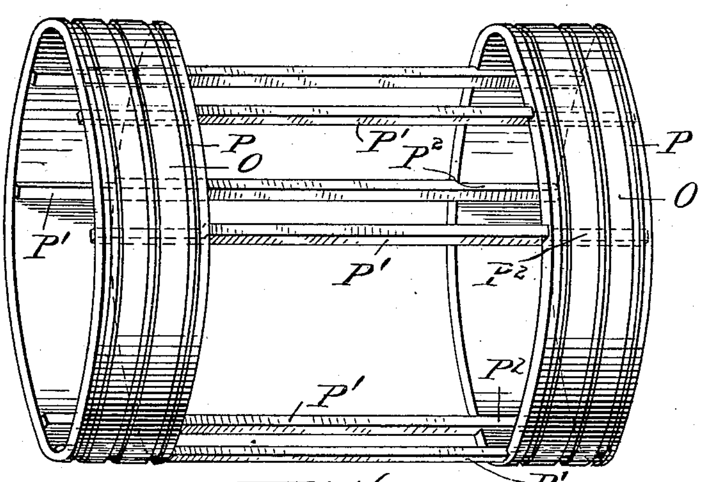

Fig. 4.

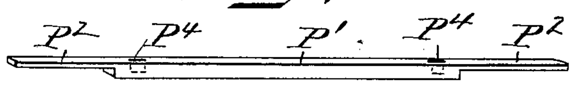

Fig. 5.

Witnesses:
A. L. Kuss[illegible]
C. A. Stewart

Inventor:
John F. Cooley
By J. H. Rusk
Atty

No. 725,615. PATENTED APR. 14, 1903.

J. F. COOLEY.

ROTARY FLUID ENGINE.

APPLICATION FILED JAN. 12, 1903.

NO MODEL. 3 SHEETS—SHEET 3.

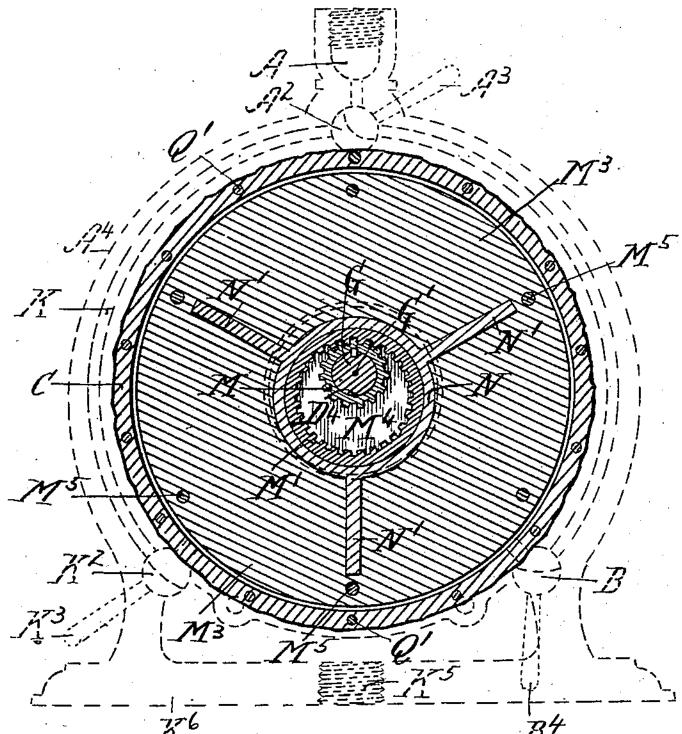

Fig. 6.

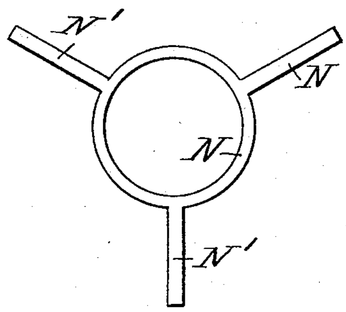

Fig. 7.

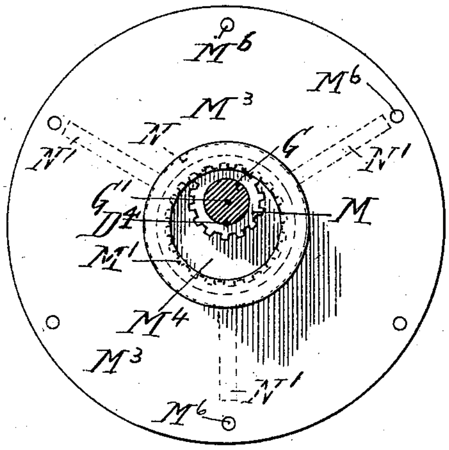

Fig. 8.

Witnesses:

A. L. Munson

C. A. Stewart

Inventor:

John F. Cooley

By J. S. Rusk atty

UNITED STATES PATENT OFFICE.

JOHN FRANCIS COOLEY, OF BOSTON, MASSACHUSETTS, ASSIGNOR, BY DIRECT AND MESNE ASSIGNMENTS, TO COOLEY EPICYCLOIDAL ENGINE DEVELOPMENT COMPANY, OF JERSEY CITY, NEW JERSEY, AND BOSTON, MASSACHUSETTS, A CORPORATION OF NEW JERSEY, AND COOLEY EPICYCLOIDAL ENGINE COMPANY, A CORPORATION OF NEW JERSEY.

ROTARY FLUID-ENGINE.

SPECIFICATION forming part of Letters Patent No. 725,615, dated April 14, 1903.

Application filed January 12, 1903. Serial No. 138,632. (No model.)

To all whom it may concern:

Be it known that I, JOHN FRANCIS COOLEY, of Boston, (Allston,) in the county of Suffolk and State of Massachusetts, have invented certain new and useful Improvements in Rotary Fluid-Engines, of which the following is a specification.

This my invention in its broad scope relates to the solution of the problem of the construction of rotary fluid-engines for propelling or being propelled by fluids—in other words, a rotary fluid-engine which may be operated by external devices to produce pressure in a fluid medium and, conversely, which operate in consequence of pressure in a fluid medium to give motion to external devices.

I found that when a point was revolving around and at a set distance from an axis at a given rate of motion upon a plane which revolved in like direction around an axis slightly offset from the axis of revolution of the point and with a comparative rate of revolution of the plane to the point, as two to one, three to two, four to three, &c., then the point delineated and circumscribed upon the plane, epicycloidal, or hypocycloidal forms, which might also be produced by the circle and point-bearing disk of cyclometry. I notice that the movement of two to one produced the well-known cardioid, the three to two a nephroid, &c., and I also found that the cardioid has two such points revolving around the same axis, which would describe the same epicycloidal curvilinear form at the same time, and that the described bicuspid form (or nephroid) had three such points, the tricuspid had four, &c., and that if another circumscribed epicycloidal form was described whose cusps corresponded to these points upon these forms then the opposing lines or their axial and longitudinal extensions forming surfaces (which would be a condition of practice) would form partitioned spaces between their opposing surfaces which presented conditions which if inclosing a fluid under pressure on either side of a straight line drawn through the two axes (supposing the ends to be properly closed by suitable end plates preferably identified with one of the moving parts and in close moving contact with the other) then the fluid-pressure would cause a rotary movement of the first epicycloidal form, and the corresponding relative movement of the first epicycloidal form and the corresponding relative movement of the second epicycloidal form would follow, and if the first form was caused to move the second would follow and a pressure be exerted upon the fluid contained between the two forms, and between the partitions and the rate of the relative progression of the second form would be in the same ratio as the aforesaid generating-point would bear to the plane in producing the first form, which would be the epicycloidal form of the cardioid, bicuspid, tricuspid, &c., of this engine, and upon this I base my invention. In practice it substantially consists of the combined correlative construction and function of two preferably cylindroid parts—a piston-cam and a spacer-abutment—of equal length one within the other, suitably bounded by parallel planes, each part rotating in the same direction, one in moving contact with the other at points having common radial and mutually-equal cyclic distances moving at a relatively constant rate of speed differing by unity, each upon an axis which is independent of the other and at a slight predetermined distance or offset therefrom, but parallel therewith and of unchanging location, secured by suitably-attached axles or bearing-surfaces in fixed bearings, wherein the lateral opposing surfaces of one of the parts (the piston) is described by the said points of the other, producing circumscribed epicycloidal or hypocycloidal forms or modifications thereof, one piece (the spacer) possessing, numerically, one more bearing-point than the number of piston rises and a means for fluid entrance and exit to and from the spaces so formed. The part with the bearing-points would perform the function of partitioning and spacing device, determining by the distance between its points which bear and move upon the opposing lateral surfaces of the other part the peripheral extent over which and by its relative movement the direction from which mutual surface abutment exists with reference to any therein inclosed fluid. This piece herein is called a "spacer," because it spaces off the peripheral surfaces of the piston. The other piece, whose lateral surfaces oppose the spacer and support the moving contact of the cusps thereof, is herein called a "piston." The spacer is preferably cylindroid, but may be otherwise constructed—as, for instance, by radial partitions connected together and moving within the limits of the cusps or bearing-points and performing their functions in contact with cylinders whose centers are concentric with the axis of rotation of the partitions; but the lateral surfaces of the piston upon which the cusps or partitions contiguously move must be of epicycloidal or hypocycloidal generation, and to it or from it power should be transmitted, preferably, through one or two suitably axial extensions. It is also preferable to close the ends of the moving parts by identifying suitable disks with and at each end of one of the moving parts, so that they may revolve therewith in close moving contact with the other moving part, and when the disks are so identified with one of the parts, especially when that part is the spacer, it is preferable to provide bearing-surfaces on the disk for the support of the spacer, making and providing a central opening in the disk large enough to allow the movement of the shaft therein.

My invention consists of certain novel features hereinafter described, and particularly pointed out in the claims.

In the accompanying drawings, which illustrate a construction embodying my invention, Figure 1 is a cross-sectional view through the engine on the line 1 1, Fig. 3, and showing the interior mechanism of the engine and the steam-channels and valves controlling the entrance and exit of fluid. Fig. 2 is a similar view with the valves reversed for the operation of the engine in the reverse direction. Fig. 3 is a longitudinal central sectional view through the engine. Fig. 4 is a perspective view of the spacer-packing hereinafter described. Fig. 5 is a detail view of one of the packing-strips for the spacer. Fig. 6 is a cross-sectional view on the line 6 6, Fig. 3, looking in the direction of the arrow. Fig. 7 is a detail view of the wearing-ring with radial wearing projections for the end disks. Fig. 8 is an end view of one of the spacer-disks and gearing with one of the cylinder-heads removed.

Like letters of reference refer to like parts throughout the several views.

When this engine is operated as a motor by fluid under pressure, motive fluid for operating the engine enters through the opening A and passes through the valve A^2, controlled by the handle A^3, into the passage A', formed by the shell A^4 and cylinder C, and from said passage motive fluid passes through the valve B, controlled by the handle B^2, through the port B' in the cylinder C into the space C', then through the opening D in the spacer D' into the space D^2. The motive fluid is now under pressure in the spaces D^2 and C' and mutually repels the surfaces of the cylinder C between the projections E and E' on the spacer D' on one side and the piston H between the equidistant wearing rocking shoes F and F' in the other direction, the resultant of which pressure passes below the axis of revolution G' of the piston H and propels the piston in the direction indicated by the arrow *a*. The axis G' of revolution of the piston H is parallel, but eccentric, to the axis of the bore of the cylinder C which coincides with the axis D^4 of revolution of the spacer D'. The equidistant wearing rocking shoes F F' F^2, located in the spacer D', form bearing-points and are in contact with the piston in all forms and positions of the moving parts of this invention, and the spaces between the strips form separate equal cylinders. At the same time that the movement of the piston takes place in Fig. 1 the spacer also revolves at a rate which, reckoned in complete revolutions of the spacer and piston, may be expressed in integral numbers, as two to three, and the fluid under pressure operating within the space D^2 continues to so propel the piston until its movement, together with the correlative movement of the spacer D', brings their line of mutual repulsion to correspond to a line through the centers D^4 and G' of the spacer D' and piston H. In the meantime, by the correlative movement of the parts, the external spacer projection E' has passed the port C^2, allowing the fluid to enter the space D^5, then through the opening D^3 into the space D^6, causing the mutual repulsion of the surfaces, which in that position of the parts also causes a rotary tendency of the piston, due to the deflection of the line of mutual repulsion from a line corresponding with the centers of the piston and spacer, due to their relative change of position, and so on in order, thus keeping up the motion of the engine. When the spacer projection E has reached a point in its revolution at which it passes the port K', then the fluid under pressure in the spaces D^2 and C' exhausts through the port K', through the valve K^2, controlled by the handle K^3, into the chamber K^4 and out through the exhaust-opening K^5. L is an additional port to allow free relief of any remaining fluid contained in the spaces after having exhausted the fluid-pressure through the port K'. In the revolution of the engine when the spacer projection L' has passed the port C^2 in continued revolution the motive fluid will enter the space L^2 through the port C^2 and opening J into the space L^3, and the operation continues as previously described.

When it is desired to operate the engine in the reverse direction from that described in Fig. 1, the valves A^2, B, and K^2 are turned, by means of their respective handles A^3, B^2, and K^3, to the direction indicated in Fig. 2, when the engine will operate reversely, as indicated by arrow *b*, to that described for Fig. 1 upon the admission of steam or other motive fluid, and the valves A^2 and K^2 act as inlet-valves and the valve B as the exhaust-valve. When the valve B in Fig. 1 and the valve K^2 in Fig. 2 shall have been so turned as to close their respective ports B′ and K′, limiting the entrance of motive fluid to the port C^2 in Fig. 1 and the port L in Fig. 2, then the passing of the spacer projections across said ports will produce a cut-off of the motive-fluid entrance as regards the spaces C′ and D^2 in Fig. 1 and L^2 and L^3 in Fig. 2, and the motive force of the expansion of the contained fluids will propel the engine until the said spaces D^2 and L^3 are exhausted through the exhaust-ports in each case. This condition of cut-off and expansion occurs in consecutive order, as the spacer projections consecutively close the said ports C^2 and L from the fluid-passage A′ in Fig. 1 and the fluid-passage K in Fig. 2.

The pinion M on the shaft G of the piston H and the internal gears M′, cut in the openings M^4 in the disks M^3, secured to the spacer D′, intermesh and operate at the same correlative speed ratio as the piston and spacer of the engine. The wearing-rings N are provided with radial projections N′ (shown in Figs. 6 and 7) and located in the two opposite end disks M^3, as shown in Fig. 3. On the outer ends of the engine are located the cylinder-heads Q, secured by bolts Q′ and through which projects the shaft G of the piston H, and these cylinder-heads have also inwardly-projecting hubs Q^2, which form a bearing for the hubs M^2 on the end disks M^3 of the spacer D′ and also for the shaft G, mounted eccentrically to the axis of the bore of the cylinder and to the axis of rotation of the spacer. The disks M^3 are secured to the spacer D′ by suitable bolts M^5, which pass through the openings M^6 in said disks M^3.

As shown in Fig. 4, the rings O, having channels P, are located in each end of the spacer, as shown in Fig. 3, between the lugs D^7 and end disks M^3, and are made to run closely contiguous to the cylinder C and closely to the lateral limitations (lugs D^7 and disks M^3) in the ends of the spacer, being free of contact with the spacer except at such lateral limitations, maintaining practically fluid-tight conditions as regards leakage at the ends of the spacer. The parallel strips P′ are located, as shown in Fig. 1, in the extremities E, E′, and L′ of the spacer, being free to move radially within their limitations and closely contiguous to the sides of their channels in the spacer, but in contact with the cylinder C, and maintained in a constant condition of such contact by the springs P^5, located in the recesses P^4, as shown in Figs. 3 and 5, maintaining a practically fluid-tight condition as regards leakage around the outside of the spacer from space to space. The parallel packing-strips P′ have reduced ends P^2, which are projected under the rings O, which limit their outward radial motion in contact with the bore of the cylinder. The object of the channels P in the rings O is to allow any fluid which leaks by on the entrance side to circulate freely to the other side of the ring and balance the pressure thereon. The rings O and strips P′ may be of cast-iron, steel, or any other desirable material.

R is a suitable pulley fixed fast on the shaft G.

Having thus described the nature of my invention and set forth a construction embodying the same, what I claim as new, and desire to secure by Letters Patent of the United States, is—

1. In a rotary fluid-engine, a cylinder having an internal bore, a rotary cam-piston therein whose axis is parallel to the axis of said bore and mounted on a shaft eccentric to said bore, cylinder-heads provided with eccentric bearing for said piston-shaft, a like directionally-rotating spacer between said piston and said bore in continuous contact at radially-coincident and equiangularly-spaced intervals with both bore and piston, both piston and spacer rotating in the same direction at relatively constant but different rates of speed, concentric bearings for the spacer, disks provided with bearing-surfaces for supporting said spacer, entrance and exit ports for the fluids in said cylinder, and intermeshing gearings on said piston-shaft and spacer.

2. In a rotary fluid-engine, a cylinder having an internal bore, a rotary cam-piston therein whose axis is parallel to the axis of said bore and mounted on a shaft eccentric to said bore, cylinder-heads provided with eccentric bearings for said piston-shaft, a like directionally-rotating spacer between said piston and said bore in continuous contact at radially-coincident and equiangularly-spaced intervals with both bore and piston, both piston and spacer rotating in the same direction at relatively constant but different rates of speed, concentric bearings for said spacer, disks provided with bearing-surfaces for supporting said spacer upon said concentric bearings, entrance and exit ports in the cylinder controlled by said spacer for admitting and exhausting fluids to and from the piston between said contact-points, and intermeshing gearing on said piston-shaft and spacer.

3. In a rotary fluid-engine, a cylinder having an internal bore, a rotary cam-piston therein whose axis is parallel to the axis of said bore, a like directionally-rotating spacer between said piston and said bore in continuous contact at radially-coincident and equiangularly-spaced intervals with both bore and piston, both piston and spacer rotating in the same direction at relatively constant but different rates of speed, entrance and exit ports

for fluids, and intermeshing gearing on said piston-shaft and spacer.

4. In a rotary fluid-engine, a cylinder having an internal bore, a rotary cam-piston therein whose axis is parallel to the axis of said bore, a like directionally-rotating spacer between said piston and said bore in continuous contact at radially-coincident and equiangularly-spaced intervals with both bore and piston, entrance and exit ports for fluids, and reversible valves for controlling the admission and exhaust of fluids to and from the engine.

5. In a rotary fluid-engine, a packing-ring provided on its outer periphery with fluid-circulation channels for equalizing the pressure on said ring.

6. In a rotary fluid-engine, a cylinder having an internal bore, a rotary cam-piston therein whose axis is parallel to the axis of said bore, a like directionally-rotating spacer between said piston and said bore in continuous contact at radially-coincident and equiangularly-spaced intervals with both bore and piston, entrance and exit ports for fluids, and packing-rings around said spacer at opposite ends and provided with fluid-circulation channels on their outer peripheries for the purpose of equalizing the pressure on said ring.

7. In a rotary fluid-engine, a cylinder having an internal bore, a rotary cam-piston therein whose axis is parallel to the axis of said bore, a like directionally-rotating spacer between said piston and said bore in continuous contact at radially-coincident and equiangularly-spaced intervals with both bore and piston, entrance and exit ports for fluids, packing-rings around said spacer at opposite ends and provided with fluid-circulation channels on their outer peripheries for the purpose of equalizing the pressure on said ring, and parallel strips located in the outer periphery of said spacer and in contact at their outer ends with the inner periphery of said rings.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 7th day of January, A. D. 1903.

JOHN FRANCIS COOLEY.

Witnesses:
GEORGE H. BLOOD,
A. P. TEELE.