S. W. BALCH.

ROTARY ENGINE.

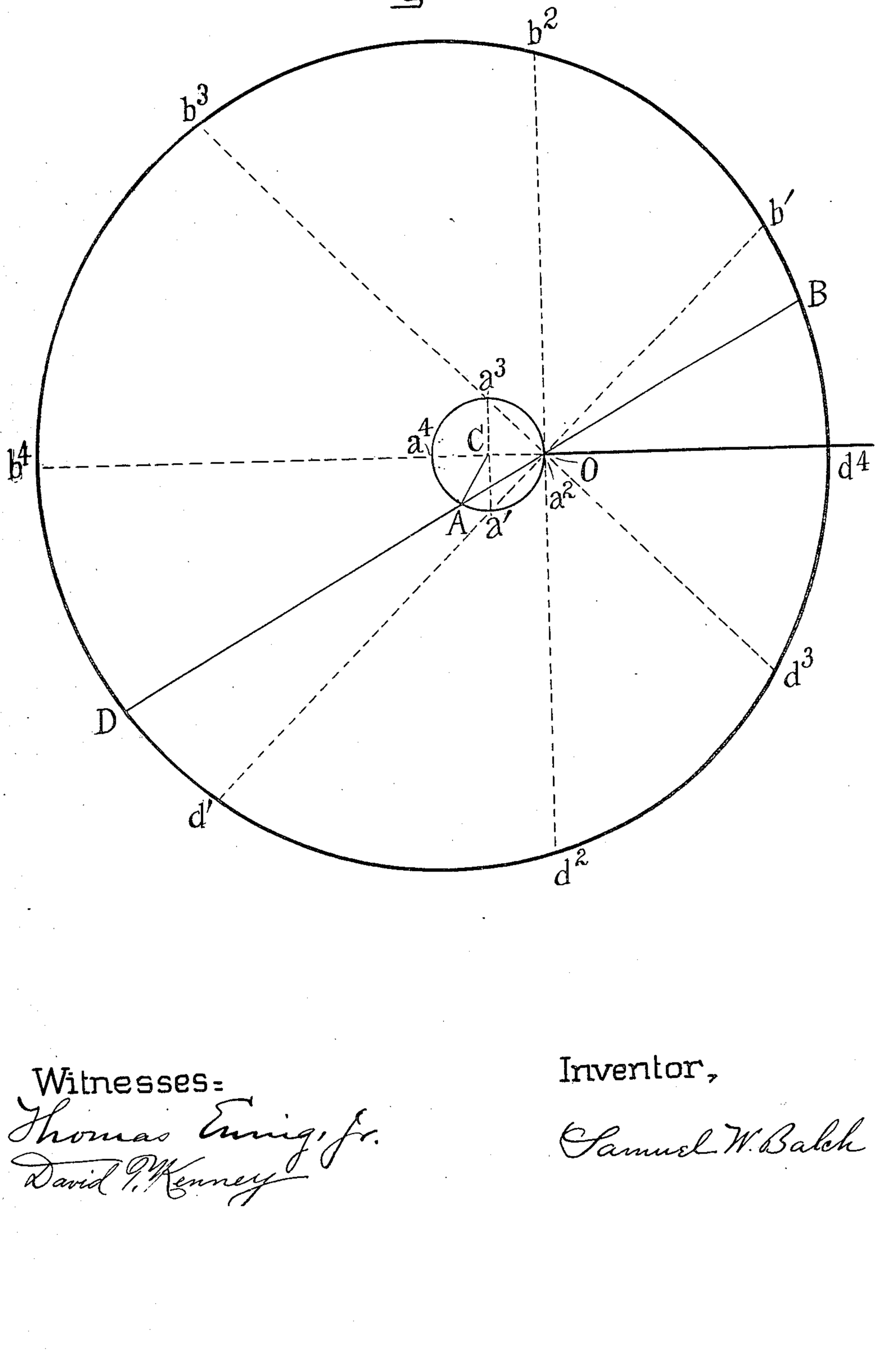
APPLICATION FILED MAY 6, 1907.

913,255.

Patented Feb. 23, 1909.

4 SHEETS—SHEET 1.

Fig. 1.



Witnesses:

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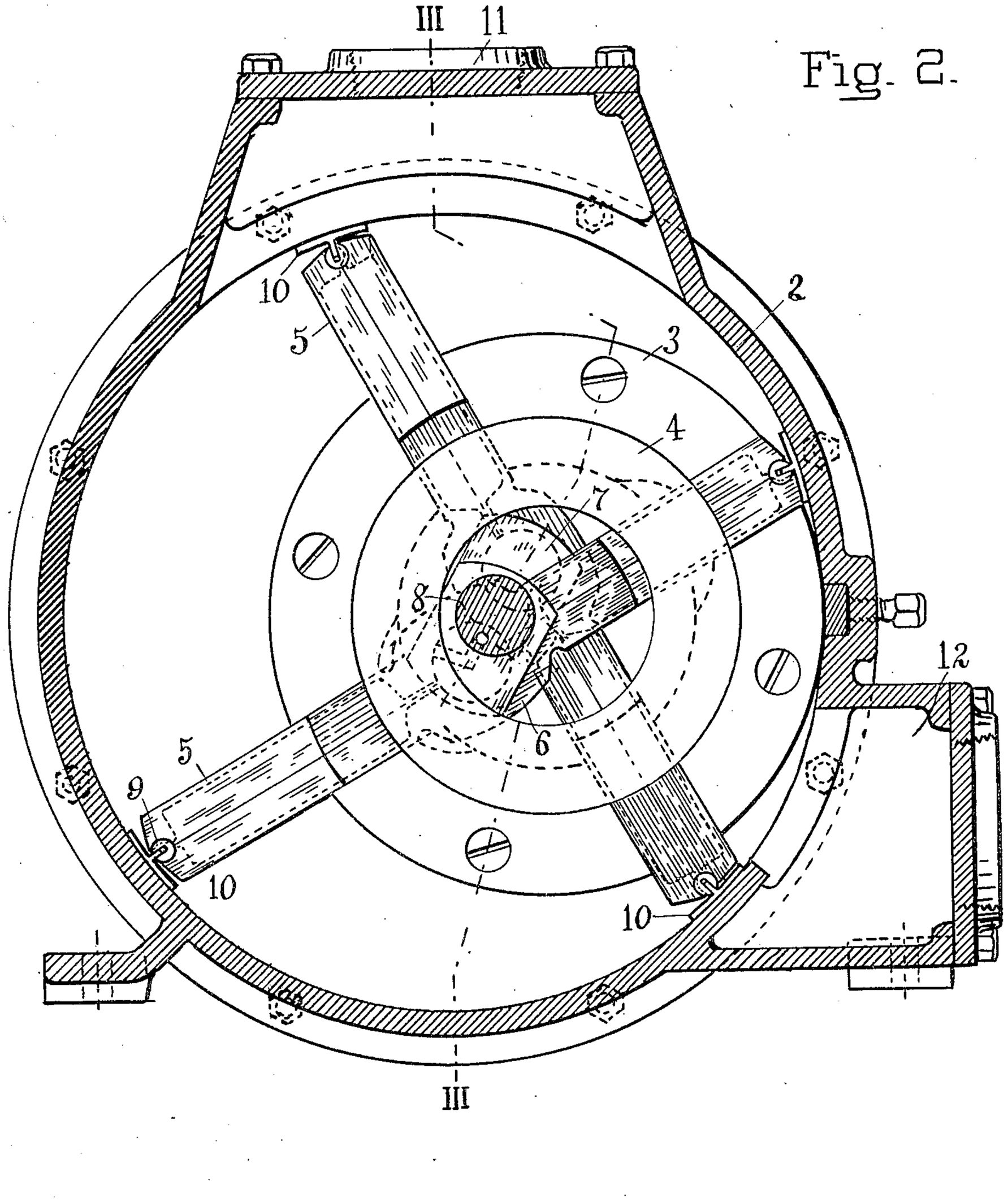
4 SHEETS—SHEET 2.

Fig. 2.



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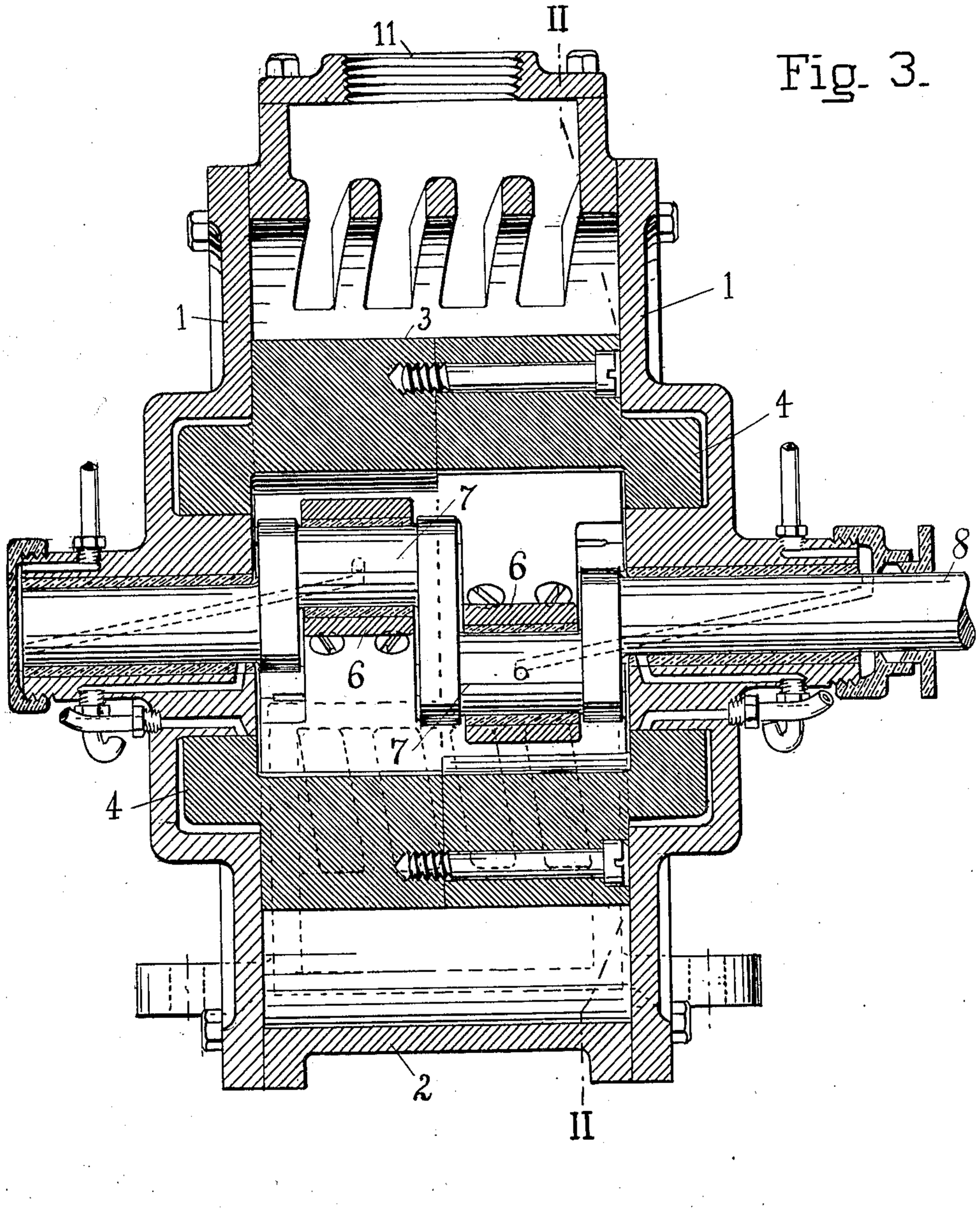
4 SHEETS—SHEET 3.

Fig. 3.



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4 SHEETS—SHEET 4.

Fig. 4.

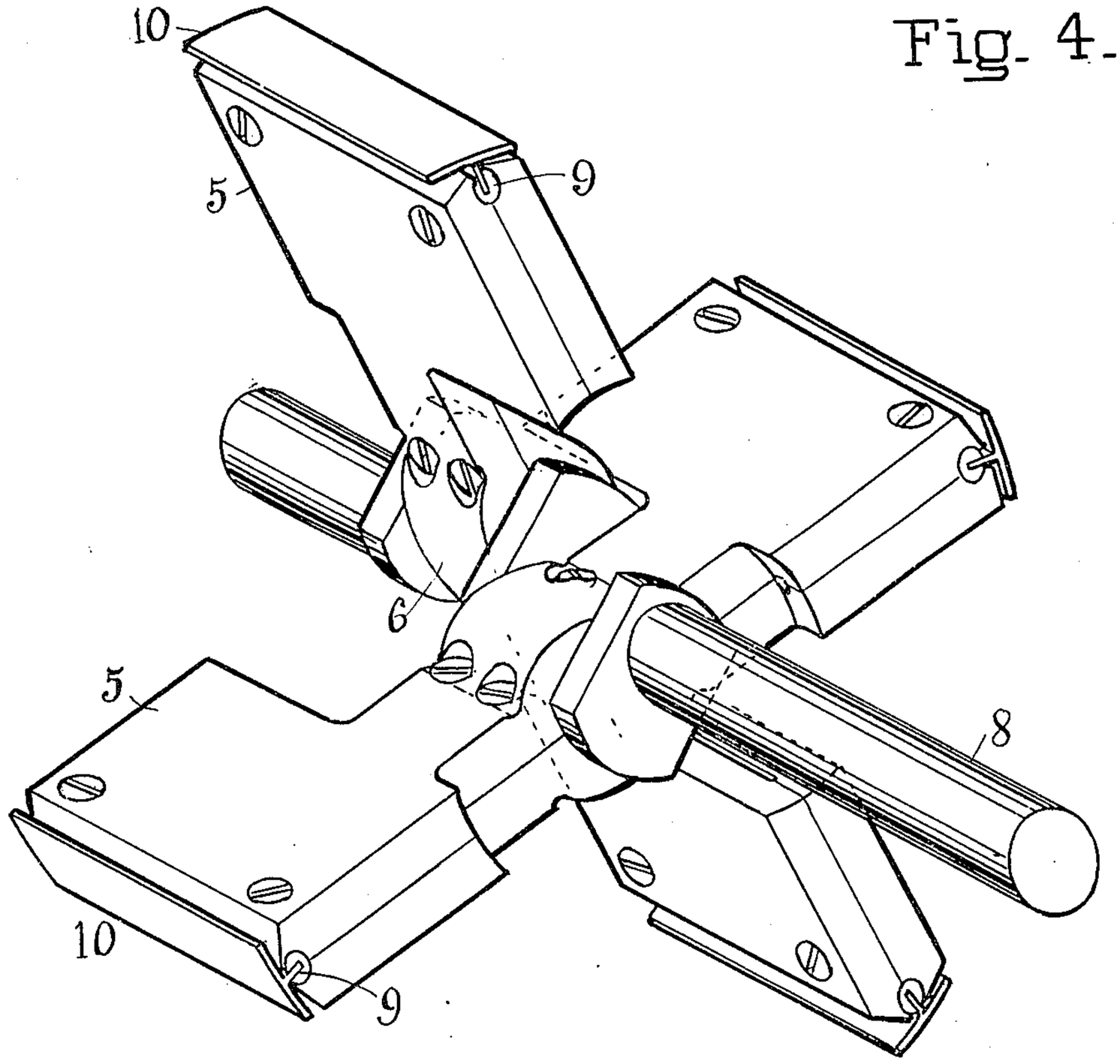
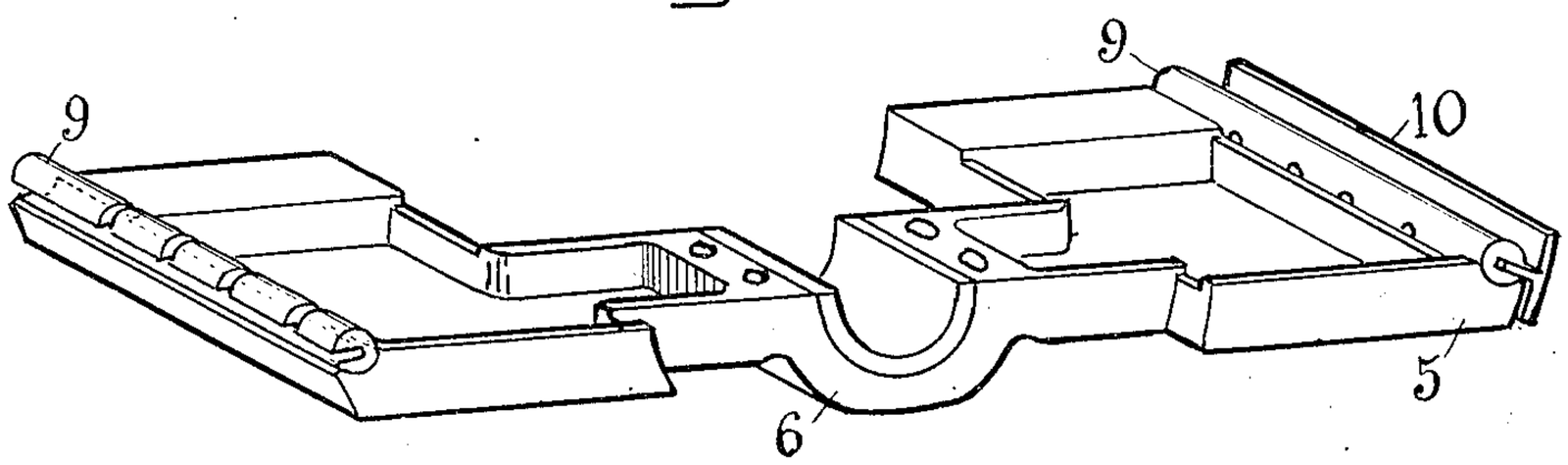


Fig. 5.



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UNITED STATES PATENT OFFICE.

SAMUEL W. BALCH, OF MONTCLAIR, NEW JERSEY.

ROTARY ENGINE.

No. 913,255. Specification of Letters Patent. Patented Feb. 23, 1909.

Application filed May 6, 1907. Serial No. 372,033.

To all whom it may concern:

Be it known that I, SAMUEL W. BALCH, a citizen of the United States of America, and a resident of Montclair, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Rotary Engines, of which the following is a specification.

The mechanism involved in these improvements is equally applicable as a pump and as an engine without modifications affecting the main principles of construction as herein detailed.

More particularly, this invention relates to improvements in rotary pumps and engines wherein a cylindrical drum rotates on its axis within an oval casing with inlets and outlets, the drum occupying an eccentric position within the casing with its convex surface in contact with the oval wall of the casing so as to form within the casing a crescent-shaped chamber, and in which blades are mounted to slide diametrically in the drum and form traveling partition walls or pistons in the chamber.

The object of this invention is to provide a mechanism of the general character above indicated, of compact design and large capacity, which will operate with little friction, in which the speed of shaft rotation is double that of the blades whereby direct coupling to high-speed dynamo-electric machines may be made, in which parts are self compensating for wear and any irregularities in the contour of the oval wall of the casing, and in which the parts are in balance.

In the accompanying four sheets of drawings which form a part of this application, Figure 1 is a geometrical diagram illustrative of mechanical principles involved in the invention. Fig. 2 illustrates in section taken at right angles to the shaft axis on the line II—II of Fig. 3, an embodiment of the invention which has been made with especial reference to its employment as a vacuum pump. Fig. 3 is a vertical longitudinal section through the pump on the line III—III of Fig. 2. Fig. 4 is a perspective view of the shaft and blades connected therewith. Fig. 5 is a perspective view of the piece forming one side of one of the pairs of blades.

The invention is based on the proposition that if a line is revolved about a fixed point in the circumference of a circle the angular velocity of the line will be one-half the angular velocity with which the second point of intersection of the line traverses the circumference. This follows from the proposition in geometry that an angle inscribed in a circle is equal to one-half of the arc included between the sides of the angle. For, let D A B be a line and O a fixed point in the circumference of the circle A a' a^2 a^3 a^4 about which the line is revolved, and let d' a' b' be any other position of this line, then will the angle A O a' formed by the two positions of the line be one-half the measure of the arc A a'. If A B and A D are equal and opposite branches of the line and of fixed length, with the middle point A tracking in the circumference, then other positions of the branch A B illustrated in the diagram are a' b', a^2 b^2, a^3 b^3, a^4 b^4, and other positions of the branch A D are a' d', a^2 d^2, a^3 d^3, a^4 d^4. These positions of the branch A D may also be regarded as positions of the branch A B after it has revolved angularly through half of a revolution and the point of intersection is making a second revolution. Hence the branches A B and A D sweep over the same area and the ends B and D follow the same curve. The curve is symmetrical only about the axis b^4 d^4. Its points of sharpest curvature are in the quadrants b^2 d^4 and d^2 d^4. The flattest point of the curve is at d^4. At the position a^2 b^2 the line is tangent to the circle and the points a^2 and O come together.

In the apparatus a casing, consisting of flat parallel heads 1 1 and an oval cylinder 2 the interior of which is a parallel to the curve of the diagram, contains a hollow cylindrical drum 3. This drum is provided with hollow trunnions 4 4 which are journaled in annular grooves in the heads so that the drum is free to rotate about its axis. The annular grooves are eccentrically positioned in the heads so that the drum will lie in contact with the wall of the cylinder and form with the casing a crescent-shaped chamber. Channels are cut exactly diametrical through the drum and at right angles to each other, and blades 5 5 are mounted in the channels. Midway of the ends of each pair of blades is a crank-box 6 which is engaged by a crank 7 of a crank-shaft 8. The crank-shaft is journaled in the heads of the casing with its axis eccentric to the axis of the drum by an amount exactly equal to the throw of the cranks so that the axis of each crank in the course of its revolution is brought into coincidence with the axis of the drum. With two pairs of blades as shown, the ends of the

channels cut the periphery of the drum at ninety degrees spacing. The cranks, of which there is one for each pair of blades, are spaced exactly double that of the ends of the channels, that is one hundred and eighty degrees with the structure as illustrated.

In order to make a close fit between the ends of the blades and the cylinder wall, longitudinally grooved rock-shafts 9 9 are mounted at the ends of the blades. Shoes 10 10 adapted to contact with the curved wall of the casing have tongues which engage the grooves in the rock-shafts and slide freely in these grooves so that the shoes will be pressed out against the wall by centrifugal force. The casing is provided with ports, the larger of which 11 serves as an inlet if the apparatus is used as a pump and as an exhaust if it is used as an engine. The smaller of the ports 12 is the outlet if the apparatus is used as a pump and the intake if used as an engine.

Comparing the apparatus with the diagram, the axis of the drum is the fixed point O through which pass and around which revolve the middle lines of the blades either of which may be taken as the line D B. The center C is the axis of the crank-shaft about which revolves the point A which is the axis of the crank-box of either pair of blades and of the crank journaled therein.

In operating as a pump, power is applied to the crank-shaft, and being transmitted through the cranks to the blades, the drum is thereby driven at half the angular speed with which the shaft revolves, so that the blades and drum will be carried once around at each half revolution of the crank-shaft, the shaft and drum being thus geared together in two-to-one ratio. With each crank and pair of blades there is an exception to this transmission of power at the one point of revolution of the crank-shaft and the two points of revolution of each pair of blades when the axis of the crank-box coincides with the axis of the drum; but as this is at different times with the two pairs of blades the transmission is uninterrupted. The diametrical travel of the blades in the drum channels is positively controlled and exactly defined throughout the revolution independently of the wall of the cylinder. The wall of the cylinder is shaped to parallel generally the path of the ends of the blades as defined by the path of the axes of the rock-shafts, the telescoping action of the tongues of the shoes in the grooves in the rock-shafts being relied upon to take up any irregularities and to compensate for wear. The blades form moving partition walls or pistons across the crescent-shaped chamber to propel or be propelled by whatever fluid may be admitted thereto. Since the wall of the cylinder is not required to cam the blades in their diametrical movements through the drum, a much more oblique relation between the wall and blades than if the blades were cammed by the wall will not cause the parts to bind, and will allow of greater throw for the blades and greater capacity. The throw of the blades is wholly removed from the wall of the cylinder and is resisted by the cranks where there is an exact conformity between the rubbing surfaces, which is not possible between the shoes and the wall of the cylinder, and where relative surface travel is much slower with corresponding reduction in friction and avoidance of concentrated pressures at bearing points with consequent cutting or rapid wear. There is a balance through the cranks of the centrifugal forces in the blades since the cranks are symmetrically disposed with reference to the crank-shaft, the two pairs of blades being of equal weight with their centers of mass in the crank axes. Absolute rotary balance of the parts as a whole is secured by further proportioning the blades so that their centers of mass lie midway of their widths, and track with each other.

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

1. The combination of an oval cylinder and heads forming a casing, a cylindrical drum journaled in the heads so as to rotate on its axis within the casing and forming with the casing a crescent-shaped chamber, a crank-shaft with a plurality of cranks spaced equiangularly and journaled in the heads inside the drum journals so as to rotate within the drum, the shaft at one end projecting through the head, and blades journaled to the cranks and mounted to slide diametrically in the drum.

2. The combination of an oval cylinder and heads forming a casing, a cylindrical drum journaled in the heads so as to rotate on its axis within the casing and forming with the casing a crescent shaped chamber, a crank-shaft with two oppositely placed cranks and journaled in the heads inside the drum journals so as to rotate within the drum, the shaft at one end projecting through the head, and two pairs of blades journaled to the cranks and mounted to slide diametrically in the drum.

3. The combination of a casing, a cylindrical drum mounted to rotate on its axis within the casing and forming with the casing a crescent-shaped chamber, a pair of blades mounted to slide diametrically in the drum, means independent of the curved wall of the casing for determining the path of the ends of the blades, longitudinally grooved rock-shafts mounted in the ends of the blades, and tongued shoes mounted in the grooves in the rock-shafts.

4. The combination of an oval cylinder and heads forming a casing, a cylindrical drum journaled in the heads so as to rotate

on its axis within the casing and forming with the casing a crescent-shaped chamber, a crank-shaft with a plurality of cranks spaced equiangularly and journaled in the heads inside the drum journals so as to rotate within the drum, the shaft at one end projecting through the head, blades journaled to the cranks and mounted to slide diametrically in the drum, longitudinally grooved rock-shafts mounted in the ends of the blades, and tongued shoes mounted in the grooves of the rock-shaft.

5. The combination of an oval cylinder and heads forming a casing, a cylindrical drum journaled in the heads so as to rotate on its axis within the casing and forming with the casing a crescent-shaped chamber, a crank-shaft with two oppositely placed cranks and journaled in the heads inside the drum journals so as to rotate within the drum, the shaft at one end projecting through the head, two pairs of blades journaled to the cranks and mounted to slide diametrically in the drum, longitudinally grooved rock-shafts mounted in the ends of the blades, and tongued shoes mounted in the grooves of the rock-shafts.

Signed at New York, borough of Manhattan, N. Y., on the fourth day of May, 1907.

SAMUEL W. BALCH.

Witnesses:
THOMAS EWING, JR.,
GEORGE H. GILMAN.