No. 613,682. Patented Nov. 8, 1898.

F. G. HUBBARD.

ROTARY ENGINE.

(Application filed Aug. 20, 1897.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.

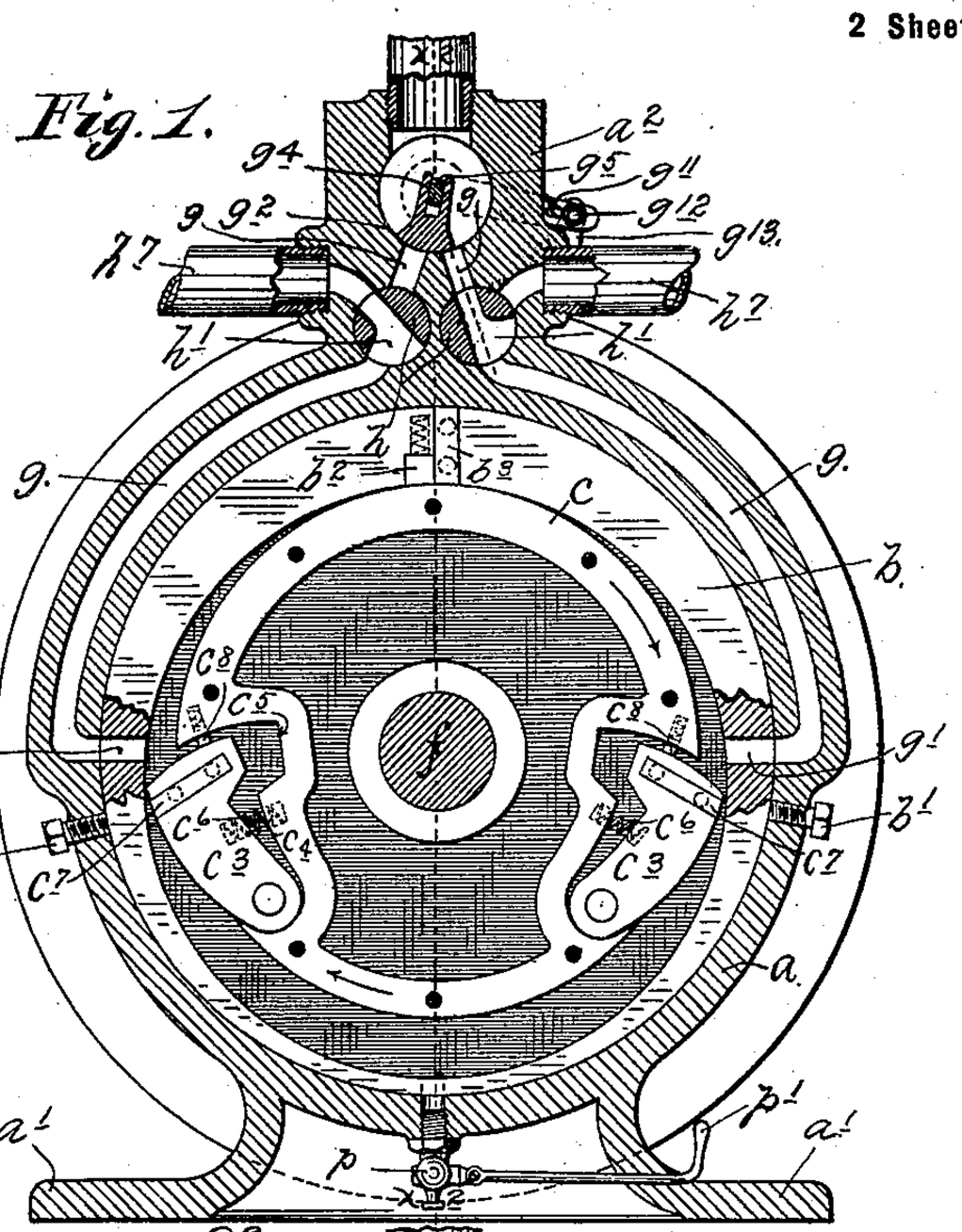
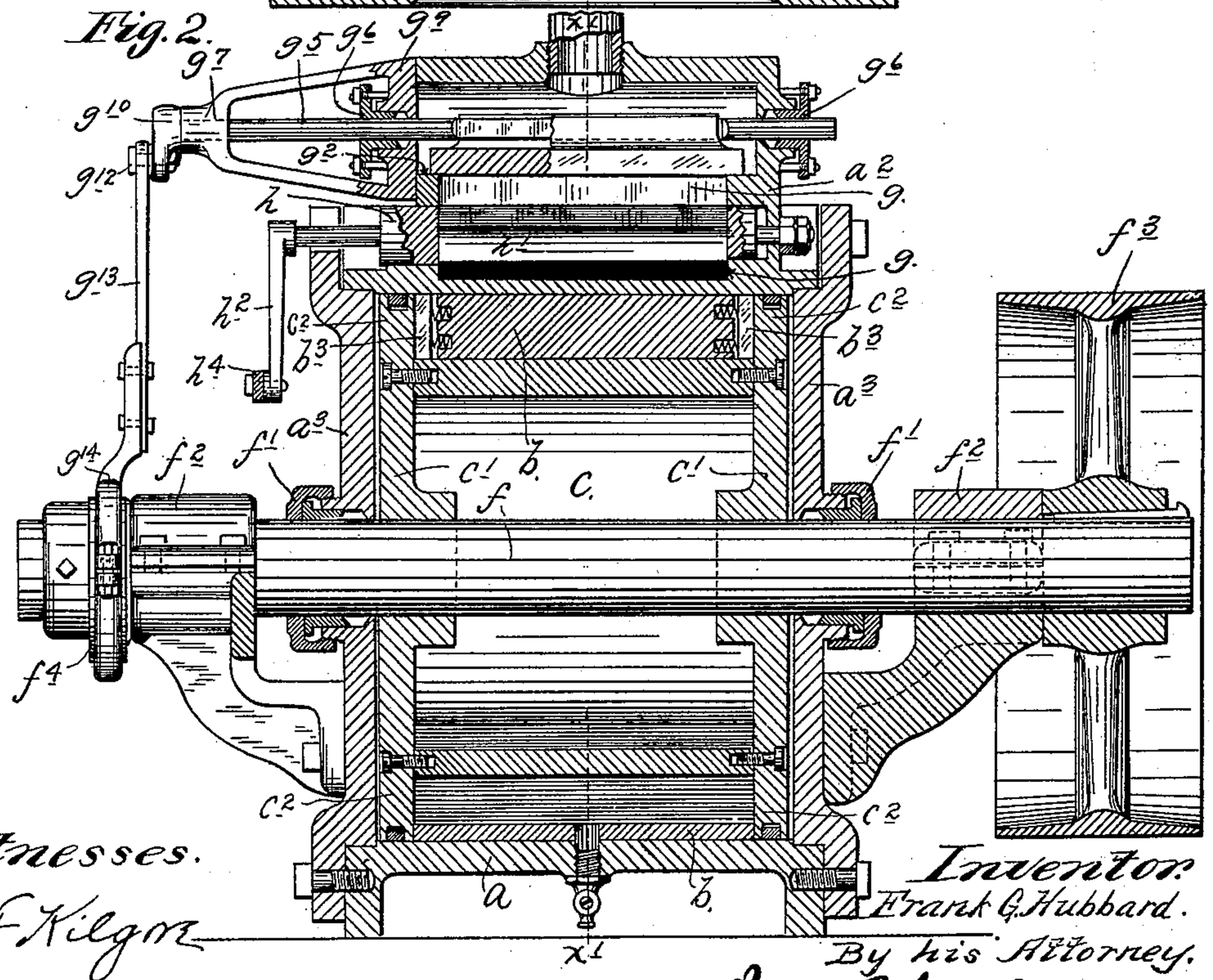


Fig. 2.



Witnesses.

C. F. Kilgore

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Fig. 3.

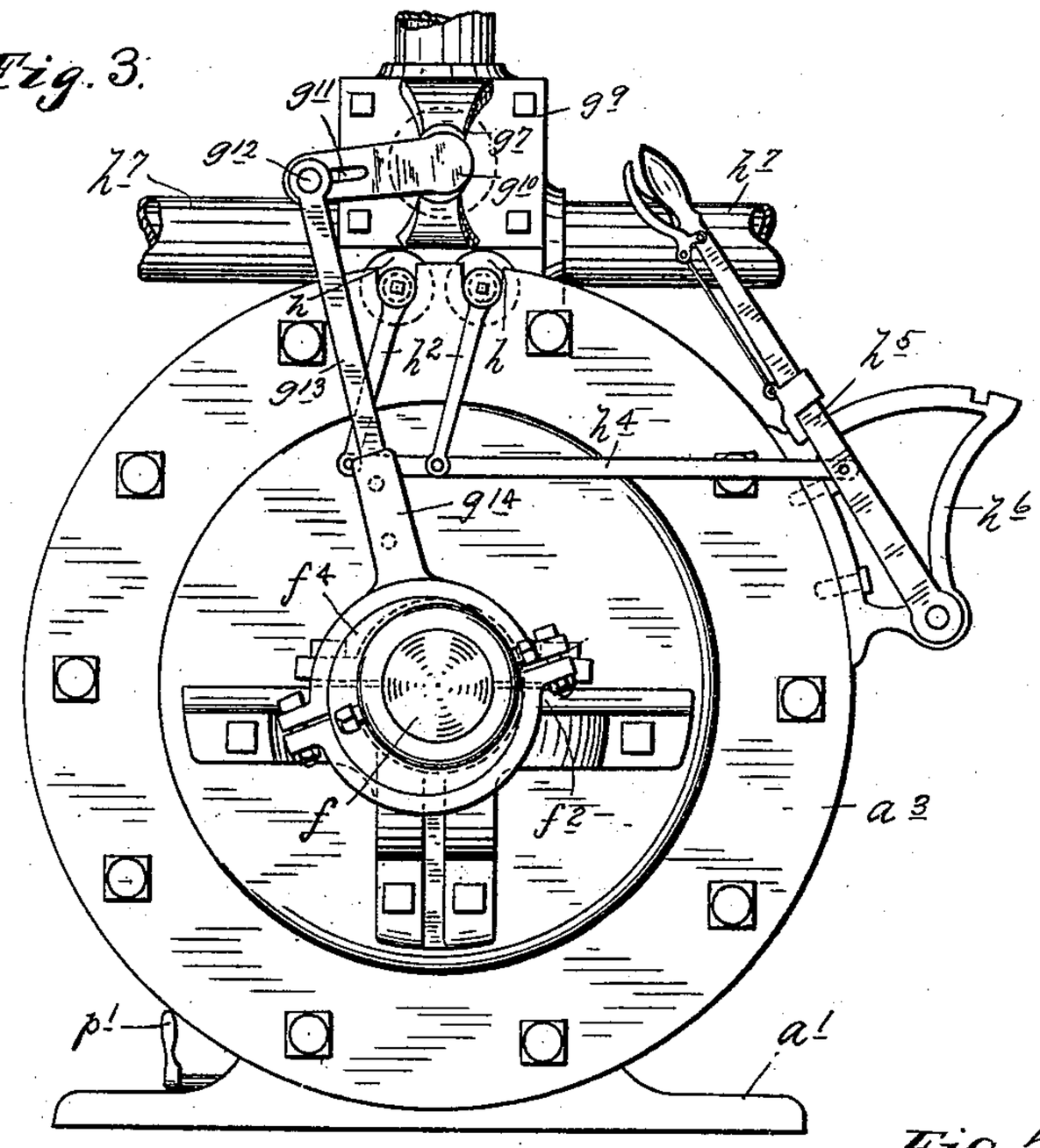


Fig. 5.

Fig. 6.

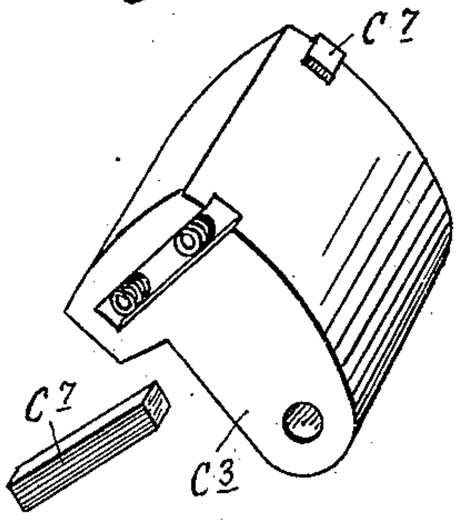
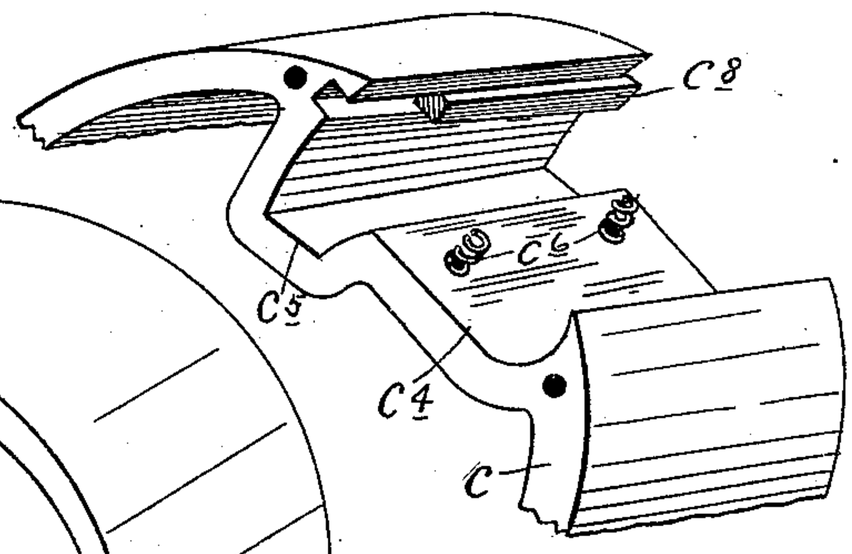
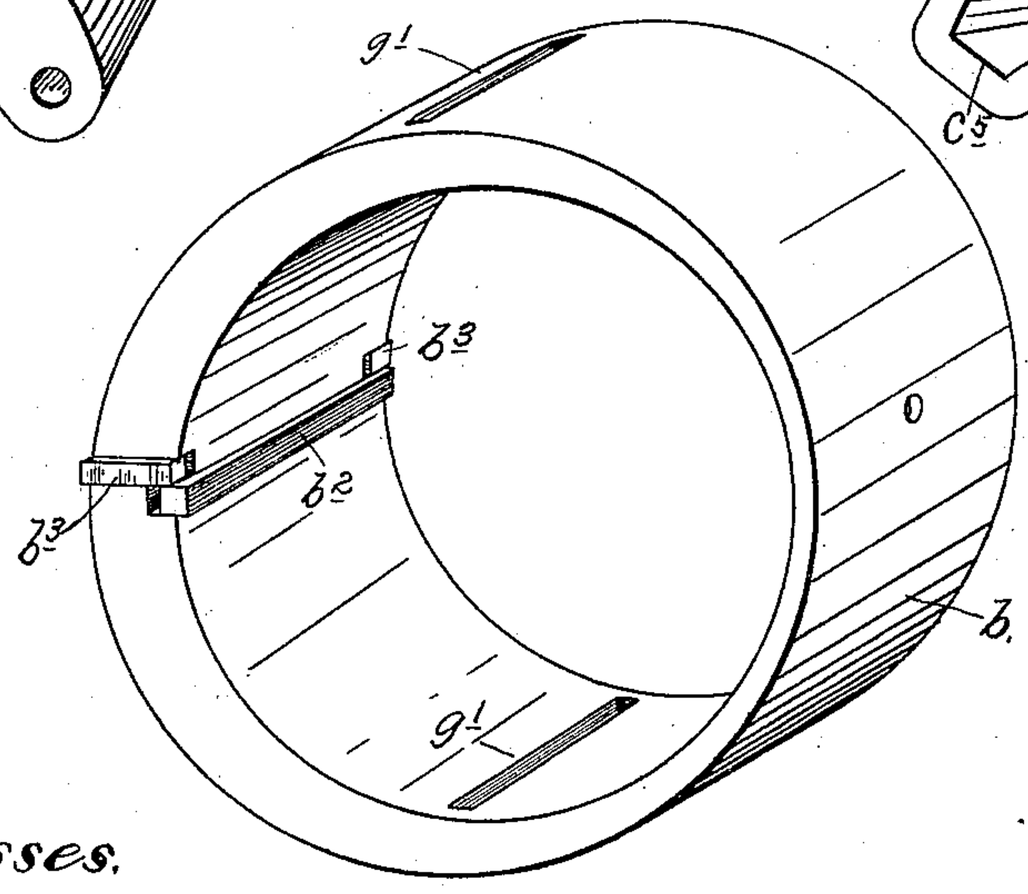


Fig. 4.





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UNITED STATES PATENT OFFICE.

FRANK G. HUBBARD, OF MINNEAPOLIS, MINNESOTA, ASSIGNOR OF ONE-HALF TO ELIAS ANDERSON, OF SAME PLACE.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 613,682, dated November 8, 1898.

Application filed August 20, 1897. Serial No. 648,889. (No model.)

To all whom it may concern:

Be it known that I, FRANK G. HUBBARD, a citizen of the United States, residing at Minneapolis, in the county of Hennepin and State of Minnesota, have invented certain new and useful Improvements in Rotary Engines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention has for its object to provide an efficient and durable rotary engine.

To this end my invention consists of the novel devices and combinations of devices hereinafter described, and defined in the claims.

The invention is illustrated in the accompanying drawings, wherein, like notations referring to like parts throughout the several views—

Figure 1 is a central vertical section crosswise of the shaft or on the line x' x' of Fig. 2. Fig. 2 is a longitudinal vertical section on the line x^2 x^2 of Figs. 1 and 3. Fig. 3 is a left end elevation with respect to Fig. 2. Fig. 4 is a perspective view showing the bushing-abutment removed. Fig. 5 is a detail in perspective showing one of the wing-seats in the piston. Fig. 6 is a perspective view of one of the wings removed with some portions pulled apart.

The main casting is made up of the cylinder or body portion a, with foot-flanges a' and the chest portion a^2 formed integral with each other. To the body portion a are bolted the heads a^3 to complete the cylinder. To the bore of the cylinder-casting a is fitted a bushing b, adapted to be driven into place and be secured therein by set-screws b' or other suitable means. It is of the utmost importance to note that this bushing b is formed by two eccentric true cylindrical surfaces. The said bushing b is provided with a radially-movable spring-seated packing-strip b^2 and laterally-movable spring-seated packing-strips b^3 directly opposite each other in its end walls and directly adjacent to the radial packing-strip b^2. The said abutment-bushing b is of less length than the bore of the cylinder-casting a and is disposed therein at equal distances from the heads a^3 of the cylinder. The piston is made up of the cylindrical or body portion c and the heads c' bolted thereto. The heads c' are of greater diameter than the body portion c of the piston, thereby affording piston-flanges c^2, which embrace the end walls of the abutment b when the parts are in working position. The piston-heads c' are keyed or otherwise made fast to the main shaft f. The said shaft f passes out through suitable stuffing-boxes f' and is mounted in suitable bearings f^2, which, as shown, have their fixed members made fast to the cylinder-heads a^3. The said shaft f is shown as provided at one end with a pulley f^3 for the transmission of power and at the other with an eccentric f^4 as part of the valve-gear, which will later be described.

In virtue of the described construction of the bushing b said bushing is caused to act as a continuous abutment, against which the steam reacts in propelling the piston, as it would were an abrupt abutment used; but with this construction the propelling blades or wings always act against a true cylindrical surface, so that they cannot possibly pound, no matter how high speed may be attained. Furthermore, as the pounding action is reduced the friction and wear on the piston itself and on the propelling wings or blades is correspondingly reduced, and, again, the bushing when worn may be replaced by another, or removed, trued up, and replaced in working position.

The shaft f, the piston c c', and the bore of the cylinder-casting a are concentric. The bore of the abutment-bushing b is formed on a true circle, but is turned from a center eccentric to the periphery of the abutment. Hence when the parts are in working position the effect is to afford an abutment b, which is eccentric to the piston. When in proper position in the cylinder-casting a, the said abutment b is located with the thickest part of its eccentric wall directly under the center of the valve-chest part a^2 of the main casting, as clearly shown in Fig. 1. With the parts disposed as above described it is obvious that the piston-flanges c^2 will be packed by the laterally-movable spring packing-strip b^3 and that the body portion c of the piston will be packed to afford a division between

the live fluid and the exhaust by the radially-movable packing-strip b^2 in the abutment. The body portion c of the piston has pivoted thereto hook-shaped wings c^3, which work in seats of corresponding shape countersunk in the periphery of the body of the piston and formed in two steps, as shown at c^4 c^5. The said blades or wings c^3 are pivoted to close toward each other for the purposes of affording a reversing engine, as will later more fully appear. The said wings or blades c^3 are of proper shape to afford a continuation of the periphery of the piston-body c when in their closed position. The said blades c^3 are subject to the action of light springs c^6, reacting against the seat-steps c^4 and tending to throw the said blades outward for a limited distance, which need only be sufficient to expose the heads of the said wings to the action of the live fluid. The sides of said wings or blades c^2 are provided with laterally-movable spring-seated packing-strips c^7, which bear against the piston-heads c'. The radial walls of the seat-steps c^5 are provided with spring-seated packing-strips c^8, which bear against the heads of the wings or blades c^3 and serve to prevent the fluid from passing under the said wings.

It has already been noted that the eccentric abutment b is positioned with the thickest part of its wall directly under the center of the chest part of the main casting in position to cause its packing-strips b^2 and b^3, in coöperation with the piston-flanges c^2, to effect a division between the working and the exhaust sides of the fluid-compartment in the cylinder. The cylinder-casting is shown as provided with peripheral ports g, which lead to ports g' in the bushing or abutment b at diametrically opposite points, as shown in Fig. 1. The cylinder-casting ports g extend to the valve-seat g^2 through openings controlled by reversing-valves h, having ports h'. In the valve-chest g^3 is mounted a rock-valve g^4, working on the seat g^2 and controlling the admission through the particular member of the ports g left open by the reversing-valves h. The said rock-valve g^4 is provided with an extended stem g^5, which passes out through suitable stuffing-boxes g^6. One end of said valve-stem g^5 is mounted in a suitable bearing g^7, which is formed integral with the removable end cap g^9 of the valve-chest g^8. The outer end of said valve-stem g^5 is provided with a crank-arm g^{10}, having a slot g^{11}. In the said slot is mounted an adjustable pin g^{12}, to which is applied the outer end of a rod g^{13}, made fast at its inner end to an eccentric-strap g^{14}, mounted on the eccentric f^4 of the main shaft f. Through these connections the proper motion is imparted to the rock-valve g^4. The reversing-valves h are provided at one end with crank-arms h^2. Said crank-arms h^2 are pivoted to a rod or link h^4, which in turn is connected to a reversing-lever h^5, pivoted to a lock-segment h^6, made fast to the cylinder-casting, as clearly shown in Fig. 3. By these reversing connections the said reversing-valves h may be turned so as to cause their ports h' to register, one with a port g, leading to the valve-chest g^3, and the other with one of the exhaust ports and pipes marked with the common reference-letter h^7. Hence either of the cylinder-ports g may be used for admission and the other for exhaust, according to the direction in which it is desired to run the engine. If the parts are in the position shown in the drawings, the engine-piston will turn in the direction shown by the arrow in Fig. 1. When so running, the right-hand cylinder-port g will serve to permit the admission of the fluid under the control of the rock-valve g^4 and the left-hand cylinder-port g will permit the exhaust. To reverse the engine, it is only necessary to shift the reversing-lever h^5 to the outer notch of the lock-segment, and when that is done the left-hand cylinder-port g will serve for admission and the right-hand port g for exhaust. When either of the piston-blades c^3 is doing the work under the live pressure, the other blade is idle, and in its travel through the exhaust-chamber of the cylinder will be held in its closed position under the pressure of the exhaust fluid. In Fig. 1 of the drawings the parts are shown as they would appear when the engine is idle or with the fluid-supply cut off at the throttle. The cylinder is shown as provided with a suitable waste-cock p, provided with a hand-lever p'.

From the foregoing statements it will be seen that I have provided a rotary engine of simple construction which may be run in either direction at will. It will also be seen that I have provided packings well adapted to maintain the required tight joints between the parts packed.

The chief feature of my invention is in the provision of the eccentric bushing b to serve as an abutment for coöperation with the piston-blades c^3. By this feature I am able to provide a perfectly true curvilinear surface for the blade-heads c^3 to act against under the fluid-pressure and am able to maintain a tight joint between the said coöperating parts. As the bushing-abutment may be readily replaced it is a simple and inexpensive matter to keep the engine in condition for maximum efficiency. Two or more of the said eccentric bushings b are supplied with each engine when sold, so there need be no loss of time in the working of the engine beyond that required to take out the old bushing and put in the new, which is at hand. This facility for repair or substitution of the abutment is a great advantage in a rotary engine. This is the part which most rapidly wears out under the action of the piston-blades.

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

1. In a rotary engine, the combination with a cylinder, piston and shaft, concentric with each other, of one or more propelling wings or blades on said piston, and a removable bushing tightly fitting the cylinder, which bushing

is formed with two eccentric true cylindrical surfaces, the inner of which affords an eccentric abutment for coöperation with the said propelling wing or blade, substantially as described.

2. In a rotary engine, the combination with a cylinder, piston and shaft, eccentric with each other, which piston is provided with one or more propelling wings or blades, and parallel peripheral side flanges between which said wings or blades work, of a removable bushing tightly fitting the cylinder, which bushing is formed with two eccentric true cylindrical surfaces, and works between said peripheral flanges, with its inner surface affording an eccentric abutment for coöperation with said propelling wings or blades, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

FRANK G. HUBBARD.

Witnesses:

JAS. F. WILLIAMSON,

F. D. MERCHANT.