C. F. PAUL, Jr.

ROTARY ENGINE.

APPLICATION FILED DEC. 21, 1908.

973,064.

Patented Oct. 18, 1910.

2 SHEETS—SHEET 1.

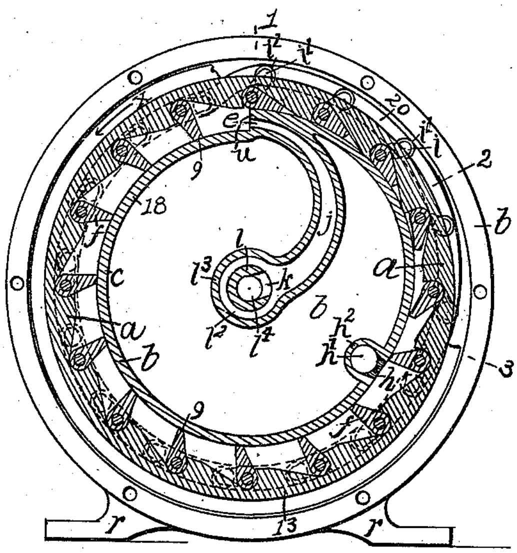

Fig. 1

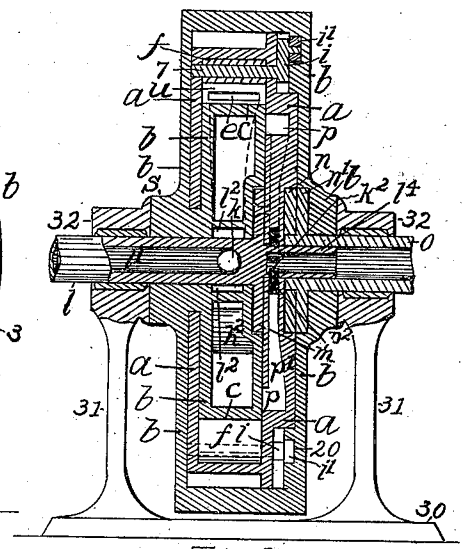

Fig. 2

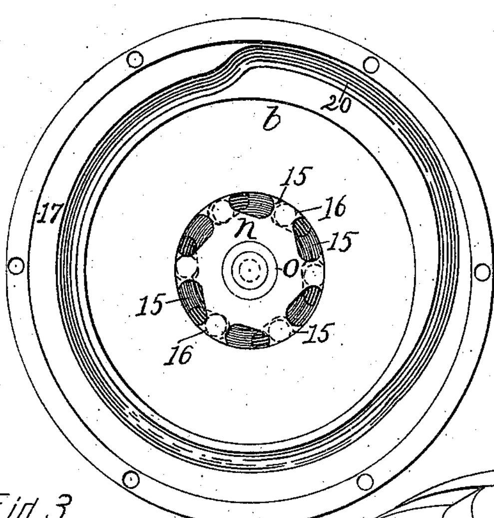

Fig. 3

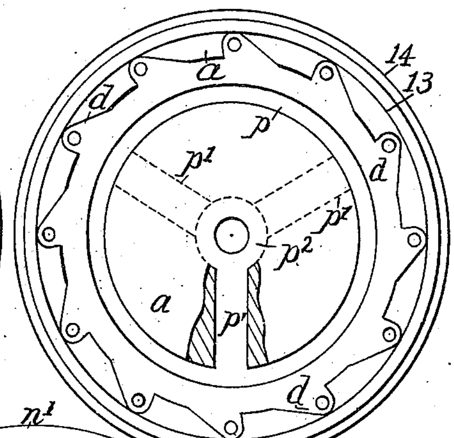

Fig. 4

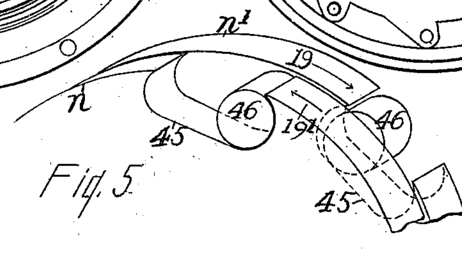

Fig. 5

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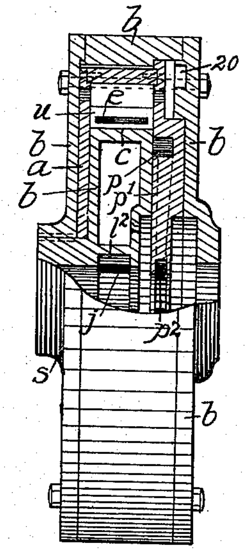

Fig. 6

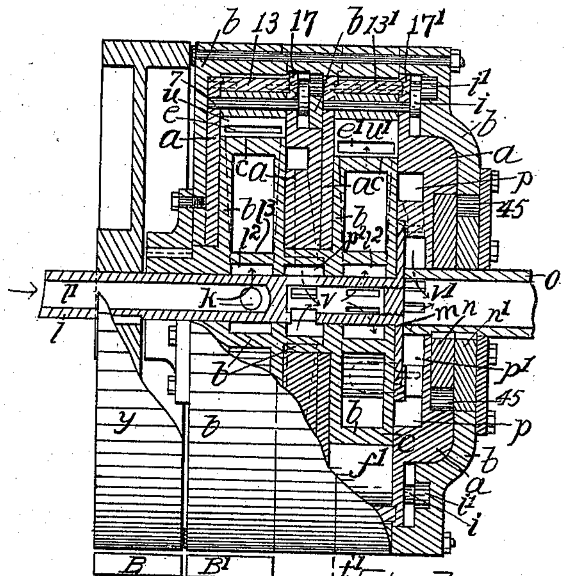

Fig. 7

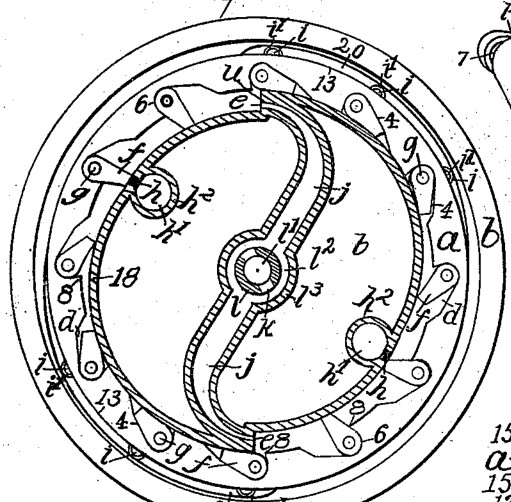

Fig. 8

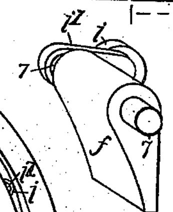

Fig. 9

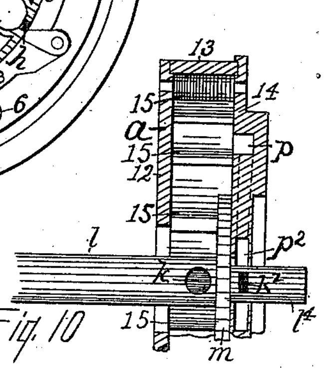

Fig. 10

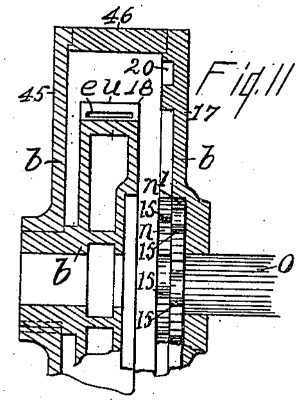

Fig. 11

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ROTARY ENGINE.

973,064. Specification of Letters Patent. Patented Oct. 18, 1910.

Application filed December 21, 1908. Serial No. 468,667.

To all whom it may concern:

Be it known that I, CHRISTIAN F. PAUL, Jr., a citizen of the United States, and resident of Peekskill, in the county of Westchester and State of New York, have invented certain new and useful Improvements in Rotary Engines, of which the following is a specification.

This invention relates to rotating engines of the type of turbine engines; and its object is the embodiment of features that will yield the highest efficiency from the steam pressure, that may be adaptable as a rotary, or as a turbine engine, and that may be used to develop motion in only one direction, or as a reversible engine without the shifting of valves. These objects are attained by the means set forth in these specifications and the accompanying drawings, in which—

Figure 1 is a transverse section of the main parts of the engine. Fig. 2 is a vertical longitudinal section of the engine. Fig. 3 is a plan of the cam plate. Fig. 4 is a plan of the blade ring and the exhaust plate. Fig. 5 is a detail relating to a reversing clutch. Fig. 6, Sheet 2, is an edge elevation of the engine partly in cross section. Fig. 7 is a partial sectional view showing the elements of the engine extended to use the steam expansively. Fig. 8 shows in plan how the steam intakes in the engine may be multiplied in developing the turbine features of the engine. Fig. 9 represents one of the steam blades in perspective. Fig. 10 represents the internal rotating parts of the engine in partial cross-section, and Fig. 11 is a like view of what may be either the stationary parts, or the reversing element of the engine.

As will be apparent from a view of Fig. 6, an end view of this engine will present only a plain disk surface with a central hub through which the main shaft projects as in Fig. 2 where the shaft is shown as supported in standards or without attachments as in Fig. 7, it depending upon the use to which the engine is to be applied.

The engine consists of two particular parts *a b*, Figs. 1 2 6 8 10 11, the part *a* constituting the interior revolving head, and the part *b* either the exterior revolving element as in Figs. 2 6 8 11, or a stationary element as in Fig. 1. The part *b*, shown separately in Fig. 11 is made up of a front plate 15, a cam plate 17, and a steam head 18. The part *a* is shown separately in Fig. 10, and comprises a front plate 12, a blade ring 13, and an exhaust plate 14. Each of these parts *a* and *b* are shown with the shafts that operate with them. By means of a flange *m* on the shaft *l*, Fig. 10, the shaft and the parts *a* are secured and revolve together. The shaft *o*, Fig. 11, is not secured to the part *b*, but is actuated by both the parts *a* and *b* through the clutches on the end of the shaft. The relation of the two parts to each other is plainly shown in Fig. 2, where each, for clearness, is represented as constituting one piece of metal, showing how they are interlapped and operate together.

The periphery *c* of the steam head 18, Fig. 1, is concentric with the center of the head for two thirds of its length. A segmetal portion from the point 1 to 2 is concentric with the greater length but with a longer radius. At the point 1 these concentric flanges are joined abruptly forming the steam breast *u*, and the ends of the flanges from 2 to 3 are joined by a section of flange eccentric to the head's center. This expanded portion of the steam head from 1 to 2 conforms to the inner faces of the blade ring 13.

Pockets *d* in the blade ring 13, see particularly Fig. 8, have swinging blades *f* hinged therein upon pivots or trunnions *g*, the pockets being of a shape and size to admit of the folding therein of the blades, as at 4, Figs. 1 and 8. The pockets are curved at their inner extremities to receive the rounded ends of the blades *f*, shown in Figs. 1 2 8 9. Adjacent to the blades the pockets terminate in abutments 8 against which the blades lodge when in action, and the abutments are adapted to just admit of the points of the blades engaging with the periphery of the steam head, as at 9.

As the blade ring revolves in the direction of the arrow *x* it will be apparent that the blades *f*, Fig. 1, in passing the point 1 will drop by gravity to the position shown at 9, and that with steam pressure upon them from the port *e* they will remain in that position until the exhaust port *h* is passed, when the eccentric path from 3 to 2 will gradually lift the blades *f* into their respective pockets, and that they will be entirely housed therein as at 4 during their passage from the point 2 to the point 1. But to insure and to assist the blades *f* in assuming the varying positions shown the blades are provided with crank-levers *i*, see Fig. 9, upon the ends of which are friction rollers i^1. These rollers are adapted to travel in a cam-groove 20 in the cam plate 17, Figs. 1 2 3 6 8 11. The groove is so shaped as to impart the exact movement to the blades that would be produced by their movement upon the surface of the steam head. This not only insures the prompt and proper action of the blades, but also relieves the friction that would occur were the surface of the steam head required to effect the movement of the blades.

A shaft *l*, Figs. 1 2 10, extends partly through the hub *s* of the part *b*, and into the shaft *o*, as at l^4, Fig. 2. The shaft is hollow to a point coincident with the steam chamber l^2, where a port *k* through the shaft communicates with the steam chamber. The shaft serves as a steam conduit to the engine. The steam chamber is made annular by the introduction of the shaft through the hollow hub l^2, Fig. 1. From the chamber a passage *j* carries the steam to the entry port *e*. From the port *e* the steam impinges against the blades *f*, driving them forward, or, if the parts *a* are held stationary it will be the steam head that will be set in motion. In Fig. 1 the blades are represented as moving two-thirds the length of their travel before the steam escapes through the exhaust port *h* into the outlet h^1.

The exhaust outlet is through the exhaust plate 14 and the shafts *l* and *o*. A plan of the exhaust plate, which carries the blade ring, is shown in Fig. 4. A groove *p*, Figs. 2 4 6 11 coincides with the ports h^1, Fig. 1, and is connected with a central chamber p^2 by passages p^4. The shaft extension l^4 is bored out and has ports k^2 opening to the chamber p^1. This shaft extension enters the hollow shaft *o*, and thus the shaft upon one end of the engine becomes the steam inlet, and the shaft upon the other end becomes the exhaust outlet.

In the operation of the engine as shown in Figs. 1 2 the steam jet from the port *e* does effective work against one blade only until the following blade drops into position to receive the jet, and the steam between any pair of blades after the first blade does no work. That is obvious. But each space, until the exhaust port is reached, is filled with steam, and the steam in conjunction with the water of condensation that will occur, affords a steam and water packing against any leaks that may be the result of wear of parts or of indifferent fitting, and there will be practically no loss of steam from the active chamber by reason of leakage. Similarly, the numerous joints between the point 1 backward to the exhaust port *h* will encounter water from condensation that will effectually prevent the loss of steam from the reaction of steam from the first chamber toward the blades that are folded up in their respective pockets. The number of steam jets, however, may be varied to suit the diameter of the engine. Two steam ports are shown in Fig. 8, and the number of ports need be limited only by the space required to obtain the proper action of the blades. In Fig. 8 the exhaust is shown to take place upon the passage of a blade just after the action of the steam against it ceases. In this construction the advantages of steam and water packing disappear except upon the folded blades, and such an engine will require the maintenance of steam tight joints, more than in the construction previously described.

That this engine is susceptible of compounding is shown in Fig. 7, in which that portion of the engine indicated by the line *t* is similar in construction to that shown in Fig. 2. To the right of that is substantially another engine, but using the steam from the first engine, and made on a larger scale as to the area of the blades, as at *f*, and the steam breasts *u* u^1, the ports p^1 and the connecting passages. The steam inlet port e^1 is also larger than the port *e*. The parts *a* of both engines are united and act as a single element, and the parts *b* are united and they act as a single element, the two having the same relations to each other as in the single engine. The end *t* of the engine is the high pressure side and the end t^1 is the low pressure side; the steam passing from the high pressure side through the exhaust plate 17 to the exhaust outlet *v* and thence through the passage in the direction of the arrows through the steam head to the inlet port e^1. After doing its work it is exhausted through the second exhaust plate 17^1, and thence out through the shaft *o* by the path indicated by the arrows v^1.

The inlet ports and the area of the blades are greater in the last engine than in the first, as shown by the difference in areas between the inlet breasts *u* u^1 and the blade f^1. The exhaust ports of the second engine are likewise of greater area than in the side *t* of the engine. Except as to these differences the construction in the compound side is similar to that of the high pressure side. The lengthening of the engine, by adding to its number of parts appears to involve changes in the inner ends of the shafts and the application of the clutches *n* n^2 hereinafter described, but as a matter of fact they may be the same as in Figs. 1 and 2, which are somewhat departed from only to indicate the susceptibility of the construction to modifications that in themselves do not affect the combination and its operation as a whole.

A balance wheel *y* is shown as keyed fast upon the shaft l. The wheel turns with the shaft l and the parts a, and through the clutch n rotates the shaft o in a forward direction. The parts b are not secured to either shaft but moves in a reverse direction from the parts a and causes the shaft o to move with it through the clutch n^1.

The clutches n n^1 are of a well known form, and are made plain by the enlarged detail Fig. 5. The disks n n^1 are oppositely notched as at 15, Figs. 3 5 7 11, to receive rollers 16, Fig. 5. When the roller in the plate n lies in the position shown, in the deepest part of the socket 15, and the inclosing plate, as b, Fig. 3, is moving in an opposite direction to the arrow 19^1, the clutch offers no resistance to the plate b; but when the plate b moves with the arrow the roller will rise on the inclined bottom of the socket, as shown in the disk n^1, and will engage with the surrounding plate, and the plate and disk will move together. The parts a engage the disk n, and the parts b engage the disk n^1.

If the element B, Fig. 7, represents a brake that may be put upon the balance wheel y, and B^1 a brake that may be brought to bear upon the body of the engine, then by manipulation of the brakes the engine becomes reversible, for hoisting, marine, and like purposes. As a reversible engine the shafts l and o require to be supported in some manner as shown in Fig. 2, in which shaft bearings 32 are attached to standards 31 upon a base 30. For a non-reversible engine base lugs such as r r, Fig. 1, are attached to the outer parts b.

While the Fig. 7 shows the engine as using the steam expansively only once, it discloses the possibility of its being further compounded so long as anything can be gained from the steam.

In general, this engine may be described, in its single form, as comprising two principal parts, namely, that shown in Fig. 10 as constituting an internal revolving element, and that in Fig. 11 as constituting an outer casing with an attached internal steam head, the casing inclosing the revolving elements and the revolving elements embracing the steam head. Obviously, when the engine is made for use as in Fig. 1, that is, with the outer casing a stationary element, the shaft of the engine would be one continuous shaft, and the clutch disks n n^1 would be omitted.

Having described my invention, what I claim and desire to secure by Letters Patent, is—

1. The combination in a rotative engine of two principal members, one comprising an outer casing inclosing a steam head forming annular chambers around the periphery of the head and on each side of the head, a hub for a hollow shaft and a steam chamber central of the steam head, a pair of reversing clutches in a part of one of the said side chambers, a hollow shaft secured in the said clutches, the first clutch adapted to engage with the said member, the said steam head having a diametrally enlarged surface, a steam port in said enlargement, and a cam groove in the side of the casing that contains the said reversing clutches; and a second member comprising a revolving element, a main shaft hollow at each end secured to said element, the member filling the space within the first member except the space traversed by the steam blades, steam blades trunnioned in the said member, pockets in the member within which the steam blades are foldable, levers on the steam blade trunnions, friction rollers on said levers to traverse the cam groove in the first member, the member having engagement with the second of the reversing clutches, a channel in the inner side of the member to coincide with the exhaust ports in the steam head, a central chamber connected with said channel, a port from said chamber into and out through the exhaust end of the shaft, the exhaust end of the shaft entering the large hollow shaft that carries the reversing clutches, the two members described united and operating together in the manner set forth.

2. The combination in a rotative engine of two principal members one comprising a stationary outer casing and an internal steam head operating as integral parts and mounted upon a main shaft, and an internal revolving member that embraces the said steam head, the steam head provided with a steam breast, a steam port in said steam breast, the steam breast extended rearward and being a part of the periphery of the head, the said internal revolving part provided with a multiplicity of steam blades, pockets for the steam blades in the internal periphery of the said internal revolving part, the steam blades foldable within said pockets, the steam blades suspended upon trunnions, levers upon one end of the trunnions, friction rollers on the ends of the levers, and a cam groove in the fixed member in which the said rollers move and actuate the steam blades, the steam blades after passing the steam breast retaining steam under pressure between them during the greater part of the revolution of the member before exhausting the steam through the eduction port.

3. The combination in a rotative engine of a duplication of internal steam heads and outer casings forming annular chambers, and a duplication of internal revolving members to occupy the said chambers within the first described members, as described, the internal members constituting steam heads, offsetting steam breasts on said heads,

steam ports in said steam heads, a shaft fast in one end of the first members, and a shaft fast in the corresponding end of the second members, extensions of each shaft out of said members for support in bearings, the shaftless end of the first members turning on the shaft of the second members, the shaft in the second members perforated for a steam inlet to steam passages within the first steam head, exhaust passages through the first blade carrier of the second members back to the shaft, through the shaft, and to the steam port in the succeeding steam head, and like passages through the succeeding blade carrier of the second members to and out through the shaft secured in the first members, the said second members provided with steam blades, pockets in said members to receive the steam blades as they pass over the steam breast, levers on the trunnions of the steam blades, rollers on said levers, and cam grooves in the first members within which said rollers travel and actuate the steam blades.

Signed at Peekskill in the county of Westchester and State of New York this fourteenth day of December A. D. 1908.

CHRISTIAN F. PAUL, Jr.

Witnesses:
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JOSEPH F. RAYMOND.