T. E. MARTIN.

ROTARY ENGINE.

APPLICATION FILED AUG. 30, 1912.

1,187,462.

Patented June 13, 1916.

3 SHEETS—SHEET 1.

Fig. 3.

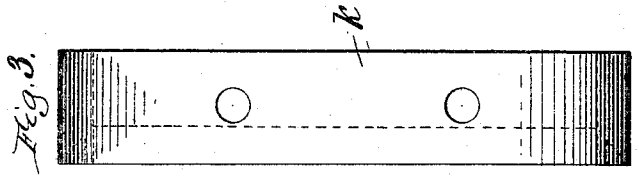


Fig. 2.

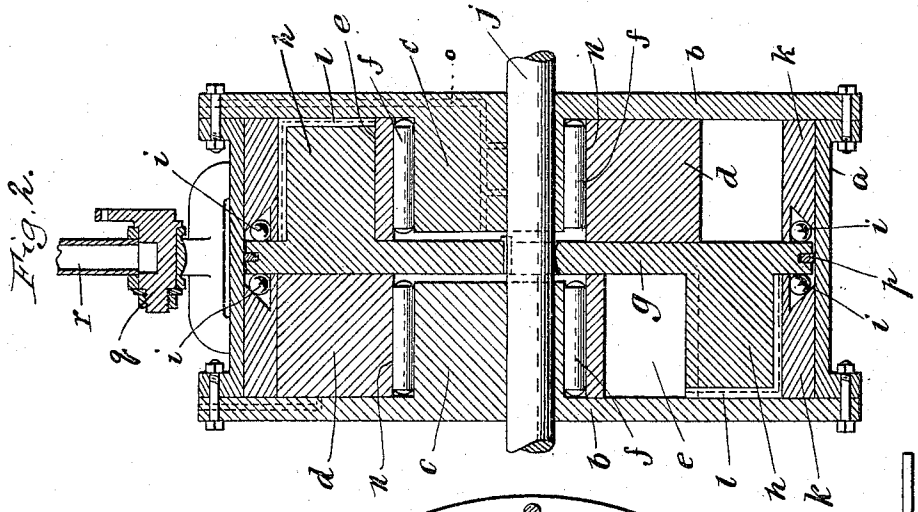


Fig. 4.

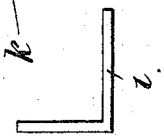


Fig. 1.

Witnesses:
E. M. Schweiger.
Jacob Obrist, Jr.

Thomas E. Martin, Inventor.
By Emil Neubart
Attorney

THE COLUMBIA PLANOGRAPH CO., WASHINGTON, D. C.

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Fig. 6.

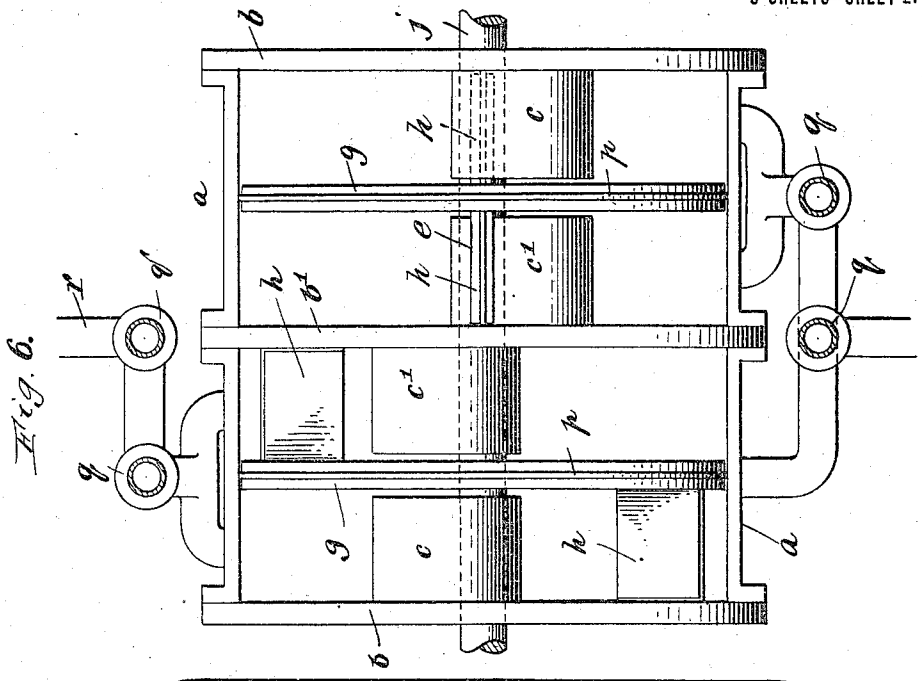
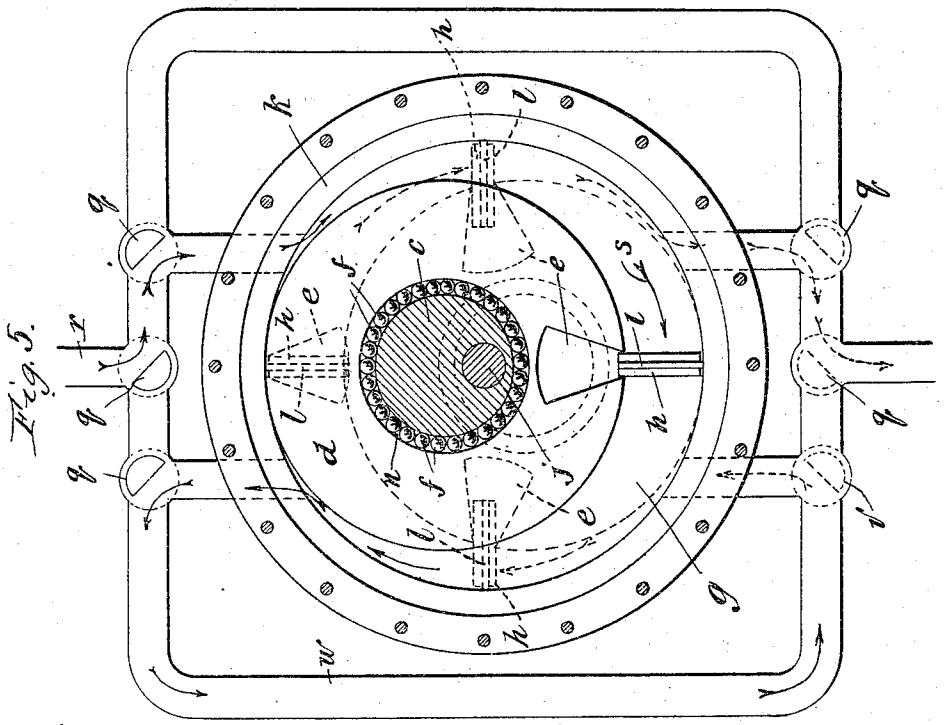


Fig. 5.



Witnesses:
E. M. Schweiger.
Jacob Obst Jr.

Thomas E. Martin, Inventor.
By Emil Neuhardt
Attorney

THE COLUMBIA PLANOGRAPH CO., WASHINGTON, D. C.

T. E. MARTIN.

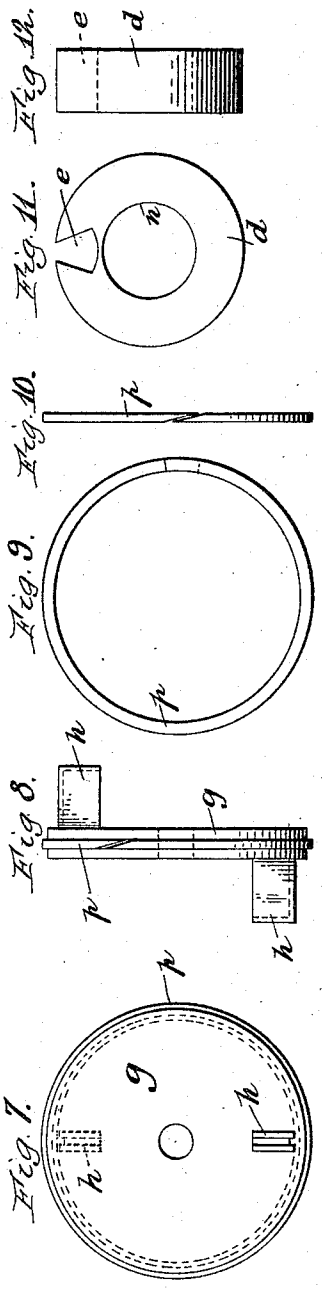
ROTARY ENGINE.

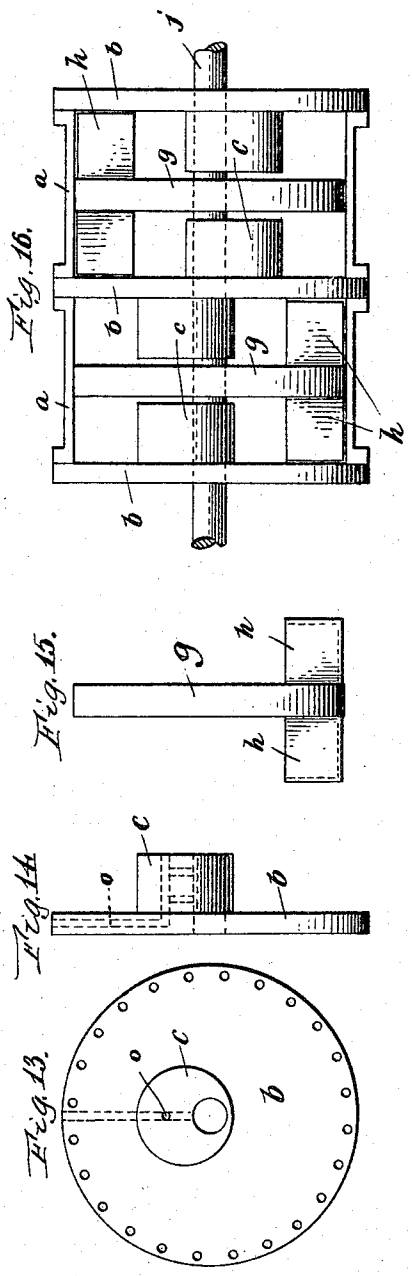
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3 SHEETS—SHEET 3.





Witnesses:
C. M. Schweiger.
Jacob Obrist Jr.

Thomas E. Martin, Inventor
By Emil Neubart
Attorney

THE COLUMBIA PLANOGRAPH CO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

THOMAS E. MARTIN, OF BUFFALO, NEW YORK, ASSIGNOR TO SARAH CAMPBELL, OF HARBOUR CREEK, PENNSYLVANIA.

ROTARY ENGINE.

1,187,462. Specification of Letters Patent. Patented June 13, 1916.

Application filed August 30, 1912. Serial No. 717,945.

To all whom it may concern:

Be it known that I, THOMAS E. MARTIN, a citizen of the United States, residing at Buffalo, in the county of Erie and State of New York, have invented certain new and useful Improvements in Rotary Engines, of which the following is a specification.

My invention relates to rotary engines and it has for its object the production of a simple and inexpensive engine which may be readily reversed, and the novel features of which may be embodied in a simple, double, triple or quadruple expansion engine which is almost perfectly balanced and in which internal friction is reduced to the minimum.

A further object of my invention is the production of an improved engine of this type in which the construction provides for maximum leverage, due to the increased diameter of the cylinder employed over those now in use having a given size piston, and in which the several operating parts will rotate easily and noiselessly during their working operations.

A further object of my invention is the production of an engine of such construction that rotary engines of larger size may be built than heretofore possible, due to the elimination of all lateral thrust on the engine shaft.

A further object of my invention is the production of an engine of this type in which the construction provides for maximum leverage due to the possible increase in the diameter of the cylinder and of the piston over those now in use, such increase being permitted by reason of the eliminations of side thrust.

A still further object of my invention is the provision of a new and improved construction permitting the employment of anti-friction bearings to assure durability in use, ease of operation and the elimination of friction not otherwise possible to eliminate.

Still further objects are the provision of fixed piston blades whereby maximum blade exposure is assured and by means of which the usual friction between the piston blades and their co-acting parts is almost entirely eliminated, also whereby a greater average exposure of the blades is obtained at all times during the rotation of the rotor; to so construct the piston blades that friction thereon is reduced to the minimum and so that the amount of blade exposure or variation of load causes no perceptible variation in the frictional contact of said blades; and to otherwise improve on rotary engines now in use.

With these objects in view the invention consists in the novel features of construction and in the arrangement and combination of parts to be hereinafter described and particularly pointed out in the subjoined claims.

In the drawings, Figure 1 is a sectional end elevation of a simple expansion engine with the disk portion of one of its heads removed and parts broken away to better illustrate the arrangement for admission and exhaust of steam. Fig. 2 is a vertical longitudinal section taken on line 2—2, Fig. 1. Fig. 3 is a side elevation of one of the cylinder rings or liners. Fig. 4 is a face view of one of the metallic packings with which the piston blades are equipped. Fig. 5 is an end elevation of a double expansion engine having the disk portion of one of its heads removed and showing the valve controlled inlets and exhausts in diagrammatic form. Fig. 6 is a diagrammatic side view of a double expansion engine showing the relative position of the pistons with their fixed piston blades, the heads and parallel divisional wall of the casing, and the fixed eccentrics on said heads and divisional wall. Fig. 7 is a face view of the piston with its fixed piston blades. Fig. 8 is an edge view of the same. Fig. 9 is a face view of the packing ring applied to the peripheral edge of the piston. Fig. 10 is an edge view of said packing ring. Fig. 11 is a face view of one of the annuli forming the inner movable wall of the steam space within the engine casing. Fig. 12 is an edge view of one of said annuli. Fig. 13 is an inner face view of one of the cylinder heads. Fig. 14 is an edge view of the same. Fig. 15 is an edge view of a piston, such as used in a multiple expansion engine. Fig. 16 is a diagrammatic side view of a double expansion engine showing the relative positions of the pistons and the heads and divisional wall of the casing with their eccentrics, the pistons being of the type shown in Fig. 12 in which the piston blades of one piston are at points diametrically opposite those of the other.

Referring now to the drawings in detail, similar letters of reference refer to similar parts in the several figures.

The reference letter *a* designates the cylinder or casing having the usual heads *b*, each of which is provided with a short inwardly-directed eccentric or eccentrically arranged boss *c*, said heads being secured to flanges formed on the cylinder portion of the casing by means of bolts, or in any other approved manner, to make the casing steam tight.

j designates the engine shaft, the axis of which is coincident with that of the casing but eccentric to the bosses *c*, as clearly shown in Figs. 1, 2 and 5.

d designates rotatable annuli, each being provided with an axial bore *n* to receive the eccentric bosses *c*, on which they are rotatably mounted. In order to reduce friction at these points anti-friction bearings *f* are interposed between the two, each of said bearings preferably comprising an annular series of anti-friction rollers, which assure free relative movement of the annuli on the eccentrically arranged bosses *c*. Each of the annuli has a fan shaped blade-receiving slot *e* extending inwardly from its periphery, the slot of one annulus being arranged at a point diametrically opposite that of the other and the fan shaped slot being so arranged in each rotatable annulus that it is narrowest at the periphery of the annulus and gradually widens inwardly toward its axis, as clearly shown in Figs. 1 and 5.

Arranged centrally within the casing is a piston *g*, which is keyed to the engine shaft *j* so that it will rotate therewith yet permit said shaft to be deflected at either or both ends when its bearings become worn, without causing said piston to move out of true position. For this purpose the bore of the piston is made a trifle larger than the shaft, preferably flaring or rounded in opposite directions with the point of greatest restriction in a plane medially between the opposite side faces of the piston. Said piston is provided with fixed piston blades *h*, by preference one projecting from each side and in a simple expansion engine, one of said blades is preferably at a point diametrically opposite the other.

The piston blades *h* are located near the marginal portion of the piston, which is itself of a size to snugly fit the cylindrical wall of the casing; it preferably having an annular groove into which is fitted a metallic packing ring *p*, so that the two parts of the cylinder which are separated by the piston are steam tight from each other. With the piston arranged centrally between the heads of the casing, the annuli *d* occupy positions on opposite sides of said piston.

By reason of the annuli *d* being mounted directly upon fixed bosses extending inwardly from the heads *b* of the casing and the piston co-acting therewith through the piston blades *h* as intermediaries, all lateral thrust on the engine shaft invariably found in engines of this type is entirely eliminated. For this reason and also for the reason that the piston is retained in perfect vertical position by suitable bearings at its marginal portion, the rotatable member can be made of considerably greater diameter than heretofore possible, since in engines of this type now in use or known, it is found that the lateral thrust on the engine shaft increases in proportion to the increase in size of piston, or rotor, as the case may be, until the thrust becomes so great as to render the engine inoperative. For this reason, rotary engines are limited in size, which it is one of the prime objects of my invention to overcome.

Lying in contact with the cylindrical wall of the casing and located between said piston and the heads of the casing are liners *k*, the edges thereof facing said piston being beveled to form raceways for two annular series of anti-friction balls *i*, said balls being in contact with the liners and the opposite sides of the marginal portion of said piston, so that the latter is retained in true parallelism with the heads of the casing. For this reason, the piston cannot be deflected laterally toward either head, and since the manner of attaching the piston to the shaft is such that the shaft may be deflected from its axial line when its bearings become worn, without imparting such action to the piston, the latter will at all times have perfect freedom in action and by reason of its marginal portion being guided between anti-friction bearings, frictional contact between the piston blades and the heads of the casing is reduced to the minimum. The manner in which the piston may be secured to the shaft to accomplish the results just described may vary, but, as stated, I preferably provide the wall of the axial bore of said piston with a convex or similar surface and key the piston to the shaft so that when the piston is rotated the shaft must rotate with it although it may be deflected from its true axis by rocking on the convex surface of said piston bore. This connection of the piston and shaft may well be termed a "non-rigid connection" since it compels one to turn with the other yet allows one a certain independent movement impossible to obtain when the parts are rigidly connected.

From the foregoing it will be understood that the annuli are eccentric to the piston and that the latter is concentric with the cylinder. This permits the employment of annuli of comparatively small diameter, the resultant of which is a comparatively large steam chamber between the annuli and the

surrounding cylindrical wall of the casing, this being particularly true by reason of the fact that the piston blades are fixed to the piston and travel in a circular path concentric to the shaft *j*.

The annuli fit snugly between the piston and the heads of the casing and the piston blades *h* of the piston are entered or partially entered in the fan-shaped blade-receiving slots thereof, depending on the position said slots are in with respect to the axis of the piston. As shown in Fig. 1, each of the annuli lies in contact with one of the liners *k* at one point on the inner circumferential surface of the latter and gradually recede from said point in opposite directions to a point diametrically opposite where it is farthest from its co-acting liner, thus providing a crescent-shaped steam chamber at each side of the piston whose confining walls are the piston, the heads of the casing, the liners *k* and the annuli *d;* the latter acting as movable inner walls for said steam chambers. The points at which the annuli *d* contact with the liners *k* serve as barriers against the backward flow of steam confined in the steam chamber and therefore compels the steam in each chamber to act against only one side of the piston blade in said chamber, so as to cause rotation in the desired direction.

By reason of the piston blades *h* of the piston being entered or partially entered in the blade-receiving slots of the annuli, said slots gradually move from the outer ends of said blades during one-half revolution of said annuli and gradually move over said blades during the other half revolution, but at no time are said blades entirely free of said slots. When the blade-receiving slot of each annulus reaches the point nearest its corresponding liner *k*, the co-acting piston blade is entirely within its receiving slot and as said slot gradually recedes from said liner during its travel to a diametrically opposite point where it is farthest from said liner, its co-acting piston blade becomes gradually exposed until it reaches its point of greatest exposure, at which time only sufficient of the blade remains in its receiving slot to retain said blade in such position that during the next half revolution of the annulus the said slot will gradually pass over said blade until the latter again reaches its point of least exposure, or more particularly, until said blade is fully confined within its receiving slot.

It is to be noted that only sufficient of each piston blade is retained in its receiving slot during greatest exposure of the blade to compel its co-acting annulus to rotate with the piston, and by reason of said slots being gradually widened inward the piston blades are in contact with the walls of said slots only at the narrow outer ends thereof, thus reducing friction to the minimum and insuring freedom in action, and consequently greater power. The blade-receiving slots are also widened inwardly for the reason that when they travel from the point of least piston-blade exposure to the point of greatest exposure, one side wall of each slot gradually moves toward the adjacent side of its co-acting piston blade *h*, and when traveling from the point of greatest piston blade exposure to that of least exposure, the opposite wall moves toward the adjacent side of its co-acting piston blade, as clearly shown in Fig. 5. It is apparent therefore that clearance must be provided in the blade-receiving slots to prevent cramping of the piston blades. It, however, is not necessary that the piston blades touch the side walls of their receiving slots except at the narrowest points thereof; in fact, as heretofore stated, it is the intention that they be in contact only at the narrow outer end portions of said slots so as to eliminate all friction possible.

By reason of the fact that the piston blades are not retained by the annuli, as in rotary engines heretofore known, it is possible to obtain nearly double the amount of piston blade exposure and proportionately increased power than otherwise, due to the fact that the annuli may be of much smaller diameter relative to the casing than in any other motor having a casing of the same size, which consequently results in greater power. Moreover, by having the piston blades fixed to a rotatable member eccentric to the slotted annulus or annuli, as the case may be, it is not necessary that the blades be entered in their receiving slots farther than necessary to retain contact with the walls of said slots near their outer portions when said blades are passing through the widest portion of the steam chamber; whereas in engines in which the force of the power medium must be entirely imparted to the side walls of the piston guides or slots instead of to a separate member having the piston blades integral or fixed thereto, as in this invention, one-half of the depth of the piston blade must be retained in the guide slots to provide the proper bearing for them and also to reduce cramping or binding of the blades in the slots to a workable condition; consequently, to provide a piston exposure of a given depth now requires nearly double the depth of slot and necessarily a larger member to receive the same, which would greatly reduce the diameter of the steam chamber and cause proportionate reduction in power.

The heads *b* of the casing are provided with oil ducts *o* which lead to the annuli *d* and piston *b* so as to properly lubricate the same.

r designates a pipe through which steam

is admitted to the casing *a*, and a portion of which is used as an exhaust. This pipe is provided with valves *q* which are adapted to control the admission of the steam to either end of the crescent-shaped steam chamber, and also the exhaust therefrom, thus enabling the engine to be reversed when desired, the exhaust escaping through pipes *t* connected to the pipe *r*. The arrows *s* shown in Fig. 1, indicate the direction of rotation of the piston with its piston blades and the annuli, the rotation in such direction being caused by the admission of steam at one end of the crescent-shaped steam chamber, but when the steam is admitted at the other end of said chamber, a reverse action of the engine takes place; that is to say, the valves *q* are used interchangeably as inlet and exhaust valves, depending on the direction of rotation of the engine shaft.

In order that a steam tight joint is obtained between the two contiguous edges of the piston blades and the inner surface of the liners *k* and inner surfaces of the heads *b* of the casing, each piston blade is grooved to receive packing strips *l* shown in Figs. 1, 2 and 4.

In Figs. 5 and 6, the cylinder or casing is divided centrally between its heads by an intermediate wall b^1 and has a piston spaced centrally between said intermediate wall and each of the end heads of the casing so as to provide a double expansion engine. This principle of multiple expansion may be carried out to a greater extent, if desired; that is to say, it may be increased to provide a triple or quadruple expansion engine by increasing the number of intermediate walls. In a double expansion engine, such as shown in Figs. 5 and 6 the eccentric bosses *c* in one-half of the casing are arranged opposite to those in the other half. The intermediate wall or head b^1 has two eccentric bosses c^1 formed thereon which project from opposite faces and are arranged with their throw in diametrically opposite directions, the eccentric boss of one end head being alined with one of the eccentric bosses on the intermediate wall while the eccentric boss of the other end head is alined with the other eccentric boss of said intermediate wall. The annuli *d* are therefore oppositely arranged at opposite ends of the casing, as clearly shown in full and dotted lines in Fig. 5. In this instance two sets of valves *q* are provided for the casing, one set being adapted to provide means for regulating the admission and exhaust of the steam to and from one-half of the casing, and the other to regulate the admission and exhaust to and from the other half of the casing. The steam enters the pipe *r*, passes into the casing at one end of one of the crescent-shaped steam chambers, acts against the piston blades *h* and exhausts through the valved outlet at the other end of said crescent-shaped steam chamber, being directed from said valved outlet by a pipe *w* to a valved inlet *v* opening into the other half of the casing at one end of the crescent-shaped steam chambers therein. The steam entering said last-mentioned steam chamber acts against the piston blades *h* traveling therethrough and exhausts through the outlet at the other end of the same, as clearly shown in Fig. 5.

In the modification shown in Figs. 15 and 16, the piston blades project from the pistons *g* at opposite sides thereof in longitudinal alinement and when thus employed in a multiple expansion engine, the pistons are so related that the blades of one are in planes diametrically opposite those of the other, thus equalizing the force or pressure applied to the engine shaft in the same manner as though the blades were arranged, as shown in Fig. 6.

The operation of the device is as follows: Steam entering the casing at one end of the crescent-shaped steam chamber causes it to act against the exposed piston blades and causes the piston *g* and annuli *d* to rotate, said annuli rotating on different centers than the piston and consequently in their revolutions have their blade-receiving slots passing over the piston blades owing to the outer edges of the latter and the periphery of the annuli reaching a common point, at which both are in perfect longitudinal alinement and in contact with the two liners *k*. As the rotation of the parts is continued the annuli gradually move away from the outer edges of the piston blades and cause the latter to be exposed to the action of the steam entering the casing. The steam behind the piston blades escapes through the exhaust prior to the pistons reaching their points of least exposure. By reason of the piston blades traveling in a circular path whose axis is eccentric to that of the annuli receiving them, maximum blade exposure is obtained when each blade passes through the widest portion of the steam chamber without in any manner changing its position with reference to the axis of the piston and consequently the blade exposure is nearly double in an engine of given diameter than can be obtained in engines as now constructed or known; and, by reason of the construction hereinbefore described, friction is reduced to the minimum, a very simple construction provided, and the steam used economically and expanded to the utmost limit while performing its function in rotating the engine.

It is to be understood that the construction and combination of elements constituting my improved engine may be utilized in rotary pumps and fans, and, if desired, as a power producer in which water or other

elastic fluids may be substituted for that of steam, and also that various modifications and changes in construction may be resorted to without departing from the spirit of my invention or sacrificing any of the advantages thereof.

Having thus described my invention, what I claim is,—

1. A rotary engine comprising a casing, a rotatable element within said casing having a piston blade fixed thereon, and an annulus within the casing separate from and eccentric to said rotatable element and having a blade-receiving slot co-acting with said piston blade.

2. A rotary engine comprising a casing, a rotatable element within said casing having a piston blade fixed thereon, and a rotatable annulus separate from and eccentric to said rotatable element and having a blade-receiving slot co-acting with the blade of said rotatable element and being widened inwardly from its periphery.

3. A rotary engine comprising a cylinder or casing, a piston arranged within said casing and spaced from opposite ends thereof, said piston having piston blades projecting from opposite sides, and a rotatable annulus between said piston and each end of the casing, each annulus being provided with a blade-receiving slot adapted to receive its coöperating piston blade as its periphery is brought toward the outer edge of said piston blade.

4. A rotary engine comprising a casing, a shaft, a rotary element rotatable with said shaft and having piston blades projecting from opposite sides thereof, said piston blades traveling in a circular path concentric with said casing, and annuli arranged to have their peripheries traveling in a circular path eccentric to said piston blades, said annuli co-acting with said rotary element and each having a blade-receiving slot extending inward from its periphery to receive one of said piston blades.

5. A rotary engine comprising a cylindrical casing having end heads provided with eccentric inwardly-directed bosses, an annulus mounted concentrically on each of said bosses and each having a radial blade-receiving slot formed therein, and a piston interposed between said annuli and arranged concentric with said casing, said piston having fixed piston blades on opposite sides adapted to co-act with the radial blade-receiving slots of said annuli.

6. A rotary engine comprising a cylindrical casing having end heads provided with eccentric inwardly-directed bosses, an annulus mounted concentrically on each of said bosses and each having a radial blade-receiving slot formed therein, anti-friction bearings between said annuli and said concentric bosses, an engine shaft passing axially through said casing, a piston interposed between said eccentric bosses and being secured to said shaft, said piston having fixed piston blades projecting from opposite sides adapted to enter said radial blade-receiving slots, and means for introducing and exhausting steam to and from said casing so as to act against said piston blades.

7. In a rotary engine, the combination of a casing having a cylindrical portion inclosed at the ends with heads provided with inwardly-extending eccentric bosses, an engine shaft extending eccentrically through said bosses and axially through said heads, a piston secured to said shaft between said eccentric bosses and having piston blades fixed thereon and arranged at opposite sides thereof, said piston blades being at diametrically opposite points, annuli concentrically mounted on said eccentric bosses to provide crescent-shaped steam chambers within said casing and having blade-receiving slots to receive said piston blades, an inlet opening into said steam chamber at one end, and an outlet opening thereinto at its other end.

8. A rotary engine comprising a cylindrical casing having end heads, annuli rotatably and eccentrically mounted with respect to said end heads and bearing at one point against the internal surface of said casing to provide crescent-shaped steam chambers, each of said annuli having a blade-receiving slot, a rotatable element carrying piston blades traveling in a circular path concentric to said casing and co-acting with said annuli, said blade-receiving slots being adapted to receive said piston blades as the two approach the point at which said annuli contact with said casing, an inlet opening into one end of each of said steam chambers, and an outlet opening into the other end thereof.

9. A rotary engine comprising a cylindrical casing having end heads, a shaft extending axially through said casing, a piston secured to said shaft and having fixed piston blades extending from opposite sides thereof at its marginal portion, liners facing the inner surface of the cylindrical portion of said casing and arranged at opposite sides of said piston, said liners having their edges beveled adjacent said piston, a series of anti-friction elements interposed between the beveled edges of said liners and said piston, and annuli at opposite sides of said piston surrounded by said liners and eccentrically mounted with respect to said piston, each of said annuli having a radial slot to receive its coöperating piston blade.

10. An engine comprising a cylindrical casing, a shaft extending axially therethrough, a piston secured to said shaft and having fixed piston blades projecting there-

from, anti-friction bearings co-acting with the marginal portions of said piston to prevent deflection thereof, and an annulus arranged eccentrically to said piston at each side thereof and provided with a blade-receiving slot adapted to receive a coöperating piston blade.

11. A rotary engine comprising a cylindrical casing having end heads provided with inwardly-directed eccentric bosses, a shaft extending axially through said casing and eccentrically through said bosses, a piston secured to said shaft between said eccentric bosses having fixed pistons extending from opposite sides at diametrically opposite points, annuli mounted on said eccentric bosses and providing two crescent-shaped steam chambers at opposite sides of said piston, said annuli having radial slots with the slot of one annulus diametrically opposite that of the other and each co-acting with one of said piston blades, and steam pipes connecting the opposite ends of said crescent-shaped steam chambers and adapted to be used interchangeably as a steam inlet or steam exhaust.

12. A rotary engine comprising a cylindrical casing, a shaft extending axially therethrough, a piston mounted on said shaft and having fixed piston blades extending from opposite sides thereof, and annuli eccentric to said piston arranged at opposite sides thereof and having blade-receiving slots gradually widening inwardly and adapted to receive said piston blades.

13. A rotary engine comprising a cylindrical casing, a shaft extending therethrough, an annulus rotatably mounted independent of said shaft and eccentrically with respect thereto, said annulus having a blade-receiving slot extending inward from its periphery, and a piston having a piston blade adapted to co-act with said blade-receiving slot, said piston being rotatable with said shaft.

14. A rotary engine comprising a cylindrical casing, a piston within said casing having piston blades fixed thereon extending from opposite sides thereof, eccentrically mounted elements at opposite sides of said piston, each in contact with the peripheral wall of the casing at one point to provide crescent-shaped steam chambers, said eccentric elements being in co-action with said piston blades and rotated thereby and being adapted to entirely receive said piston blades when the latter are moved to the point of contact of said eccentric elements with said casing.

15. In a rotary engine, a piston comprising a disk having flat piston blades extending from opposite sides thereof near its marginal portions, the piston blade at one side of said disk being diametrically opposite that on the other side thereof, opposite sides of each of said piston blades acting as working faces so that the piston may be reversed.

16. A rotary engine comprising a cylindrical casing, a shaft extending axially therethrough, a piston mounted concentrically on said shaft and having its peripheral edge in contact at all points with the inner peripheral surface of said casing, said piston having flat piston blades extending from opposite sides thereof, and rotatable annuli mounted eccentric with respect to said piston at opposite sides thereof to provide crescent-shaped steam chambers in which said flat piston blades travel, said annuli having blade-receiving slots adapted to receive said piston blades.

17. A rotary engine comprising a cylindrical casing, a shaft extending axially through said casing, an element mounted concentrically on said shaft and having fixed laterally extending piston blades thereon at diametrically opposite points, and an annulus at each side of said concentrically mounted element and having slots to receive said piston blades.

In testimony that I claim the invention above set forth I affix my signature in presence of two witnesses.

THOMAS E. MARTIN

Witnesses:
GEO. R. RIX,
ALICE M. VOGELMAN.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents. Washington, D. C."