B. F. AUGUSTINE.

ROTARY ENGINE.

APPLICATION FILED FEB. 15, 1911.

1,009,213.

Patented Nov. 21, 1911.

8 SHEETS-SHEET 1.

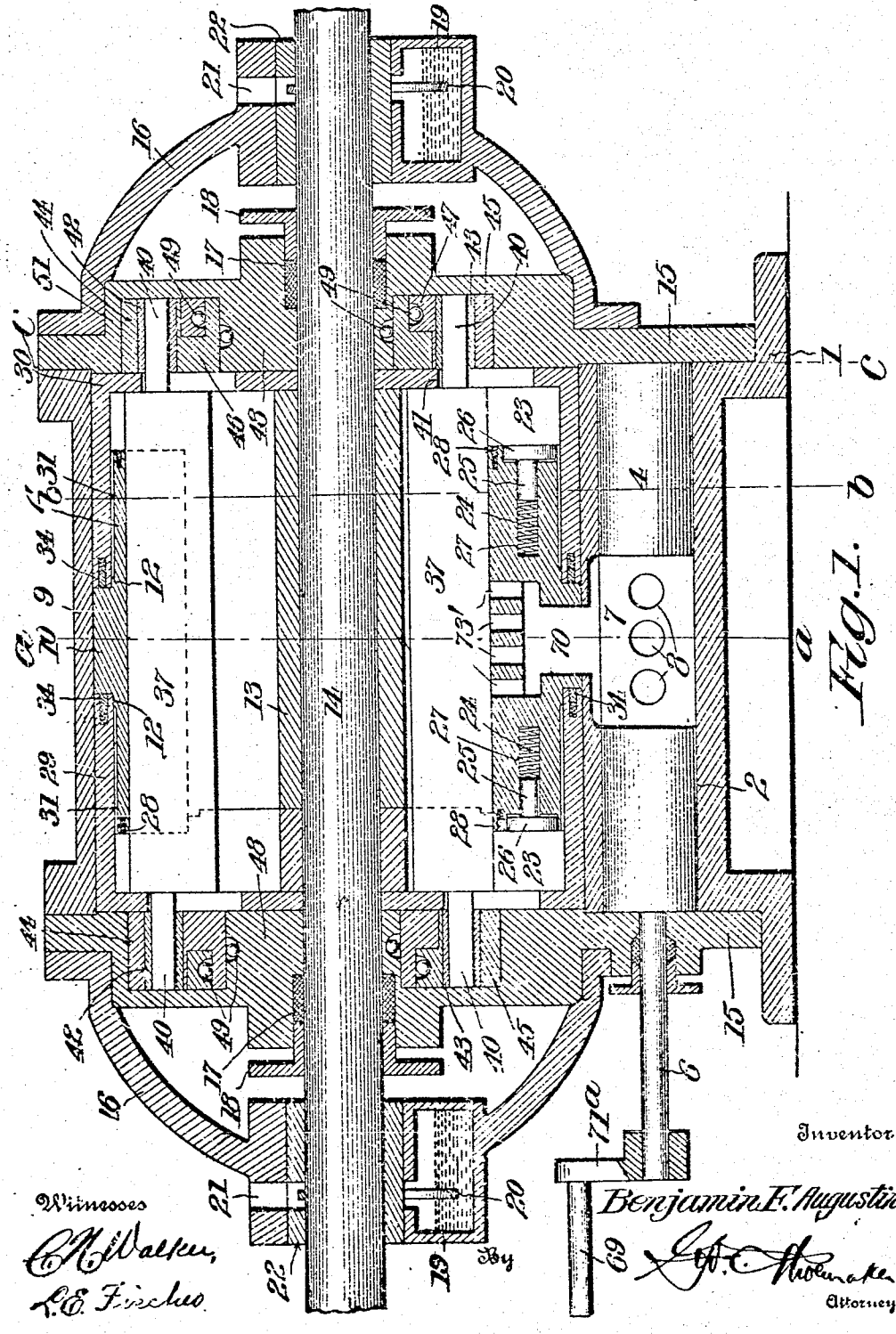

Fig. 1.

Witnesses

C. M. Walker,

L. E. Fischer.

Inventor

Benjamin F. Augustine

By

Attorney

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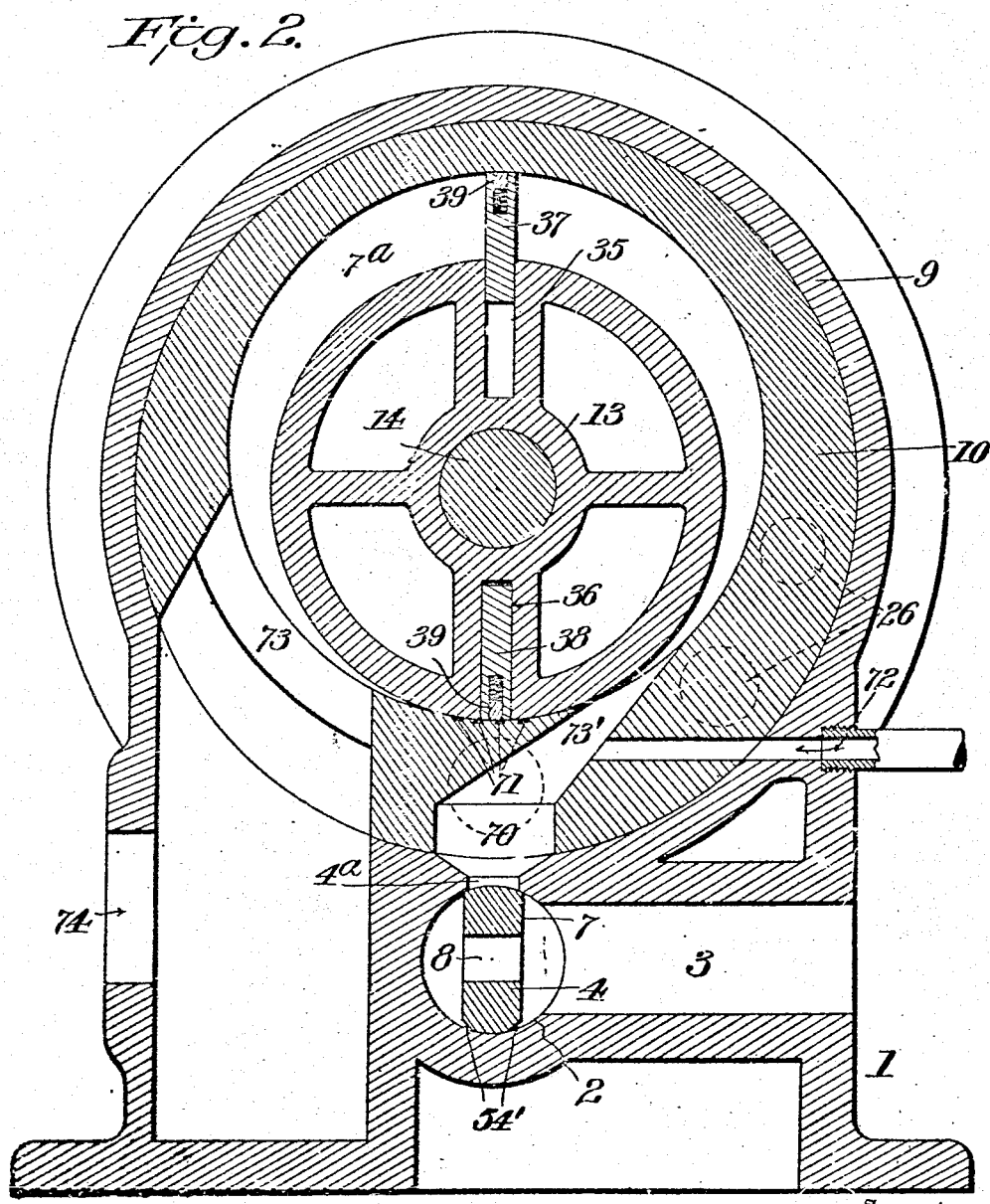
8 SHEETS—SHEET 2.

Fig. 2.



Inventor

Benjamin F. Augustine

Witnesses

C. N. Warren.

L. E. Fischer.

By

Attorney

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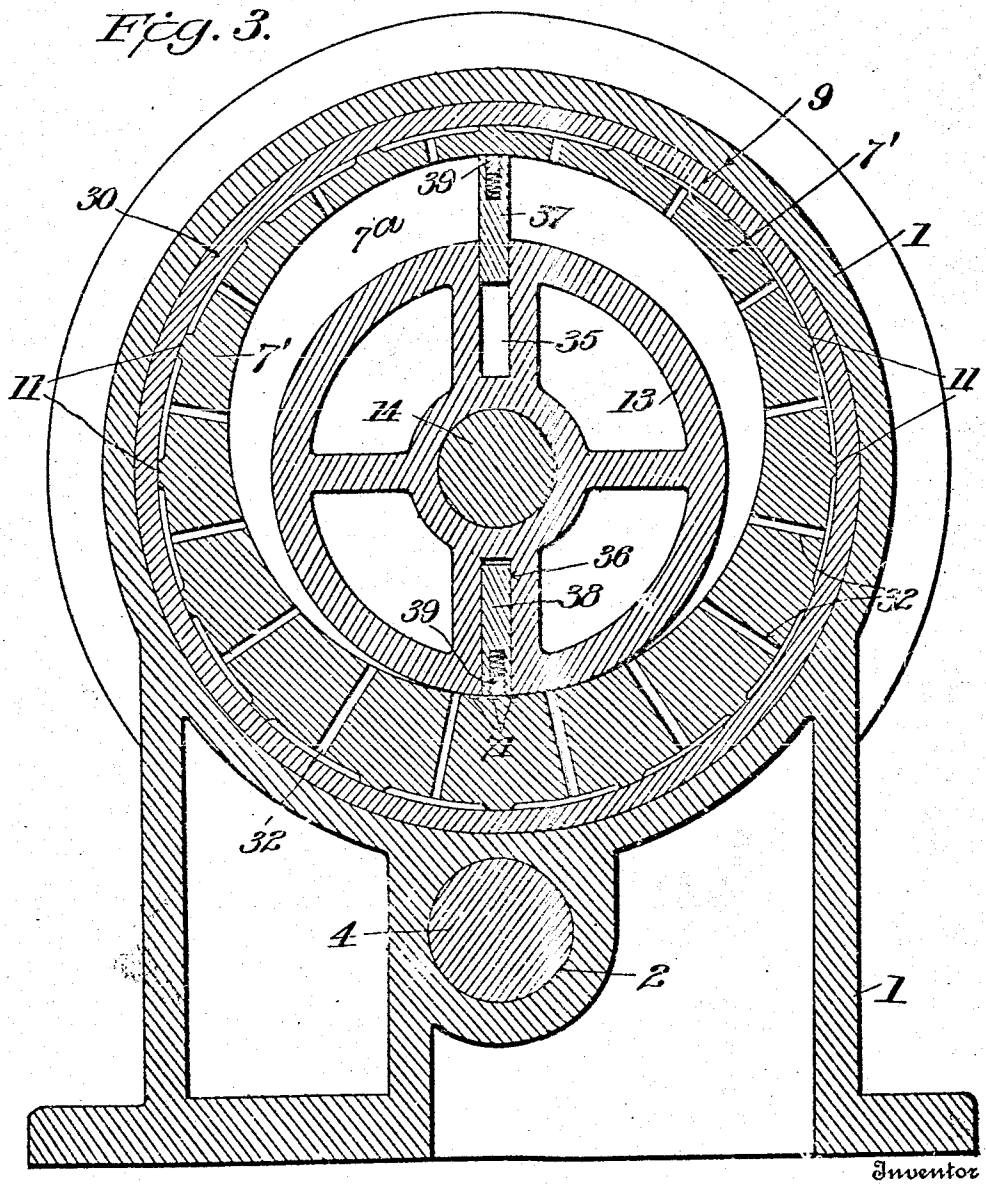
3 SHEETS—SHEET 3.

Fig. 3.



Inventor

Benjamin F. Augustine

By G. C. Thomas

Attorney

Witnesses

C. M. Walker.

L. E. Fischer.

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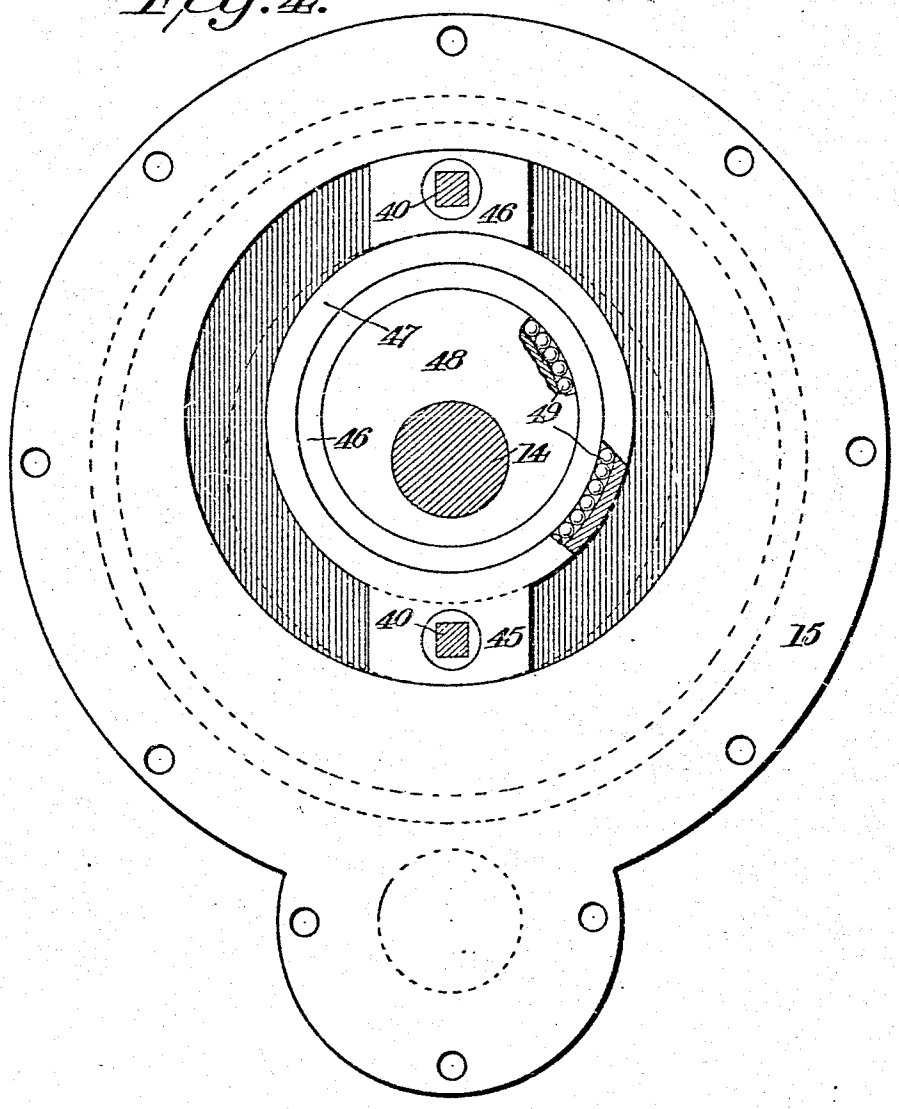
8 SHEETS—SHEET 4.

Fig. 4.



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L. E. Fischer.

Inventor

Benjamin F. Augustine.

By

Attorney

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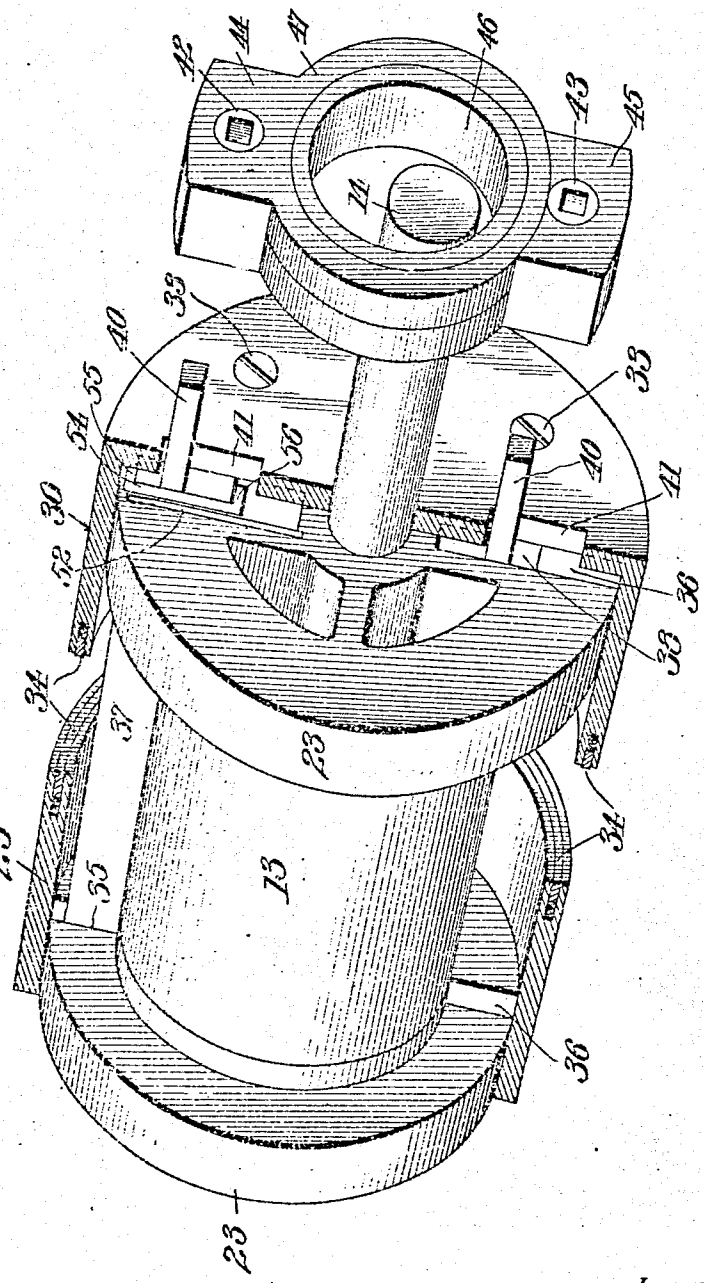
8 SHEETS—SHEET 5.

Fig. 5.



WITNESSES:

C. M. Walker.

C. E. Fischer.

INVENTOR

Benjamin F. Augustine

BY

Attorney

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8 SHEETS—SHEET 6.

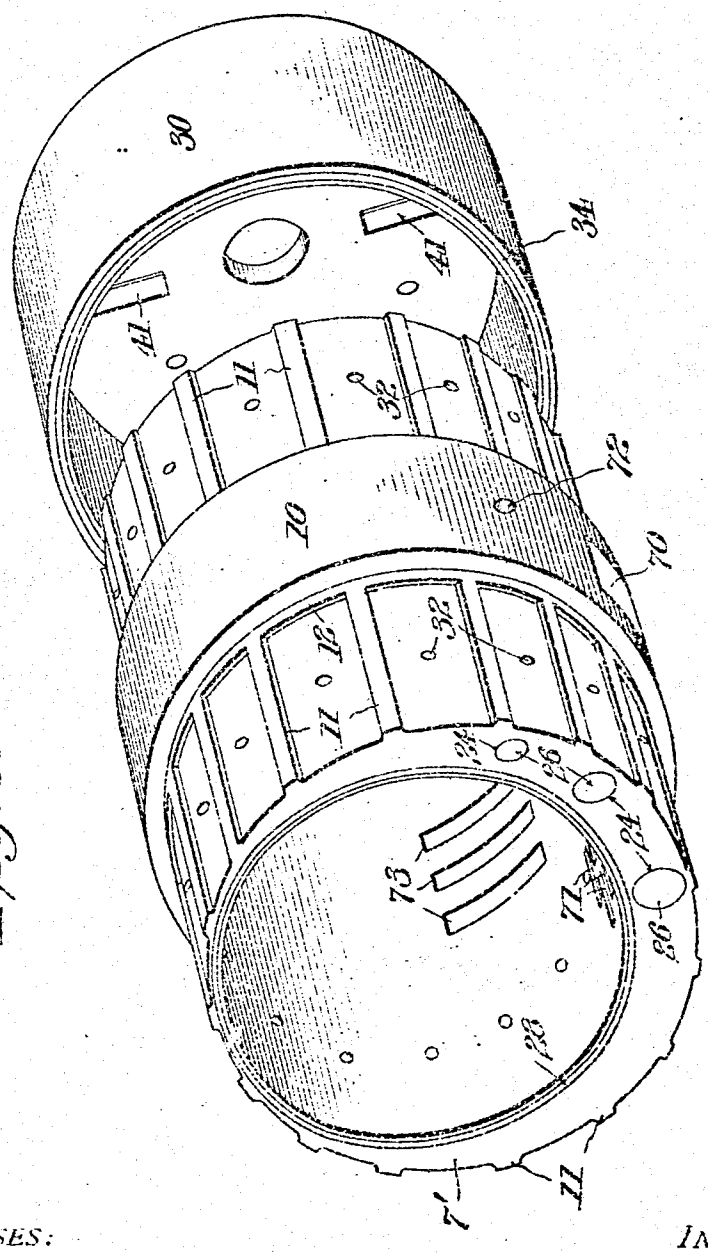

Fig. 6.

WITNESSES:

C. A. Wackes.

L. E. Fischer.

INVENTOR

Benjamin F. Augustine

BY

Attorney

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8 SHEETS—SHEET 7.

Fig. 7.

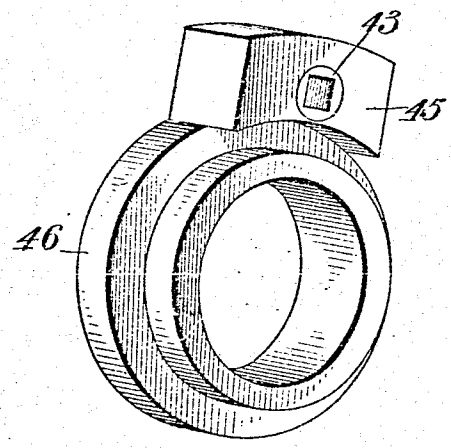


Fig. 8.

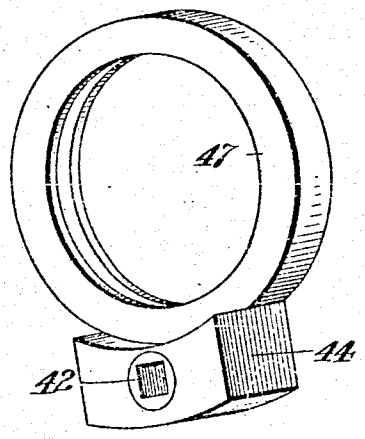


Fig. 9.

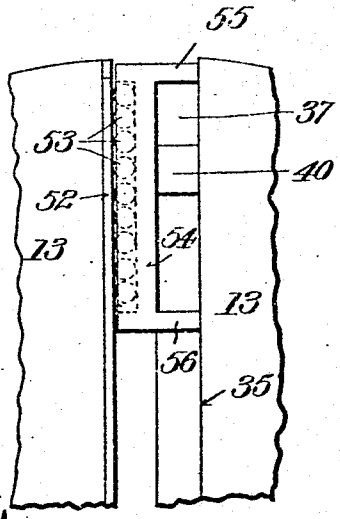
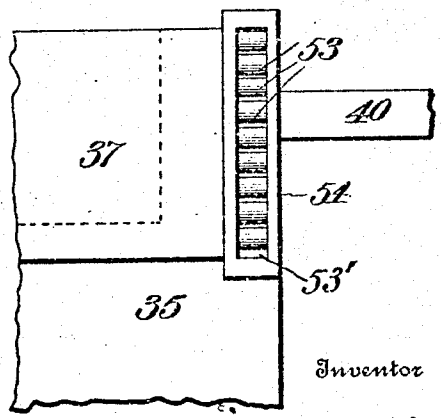


Fig. 10.



Witnesses

C. M. Walker.

P. E. Fischer.

Inventor

Benjamin F. Augustine.

By J. F. Stevens

Attorney

B. F. AUGUSTINE.

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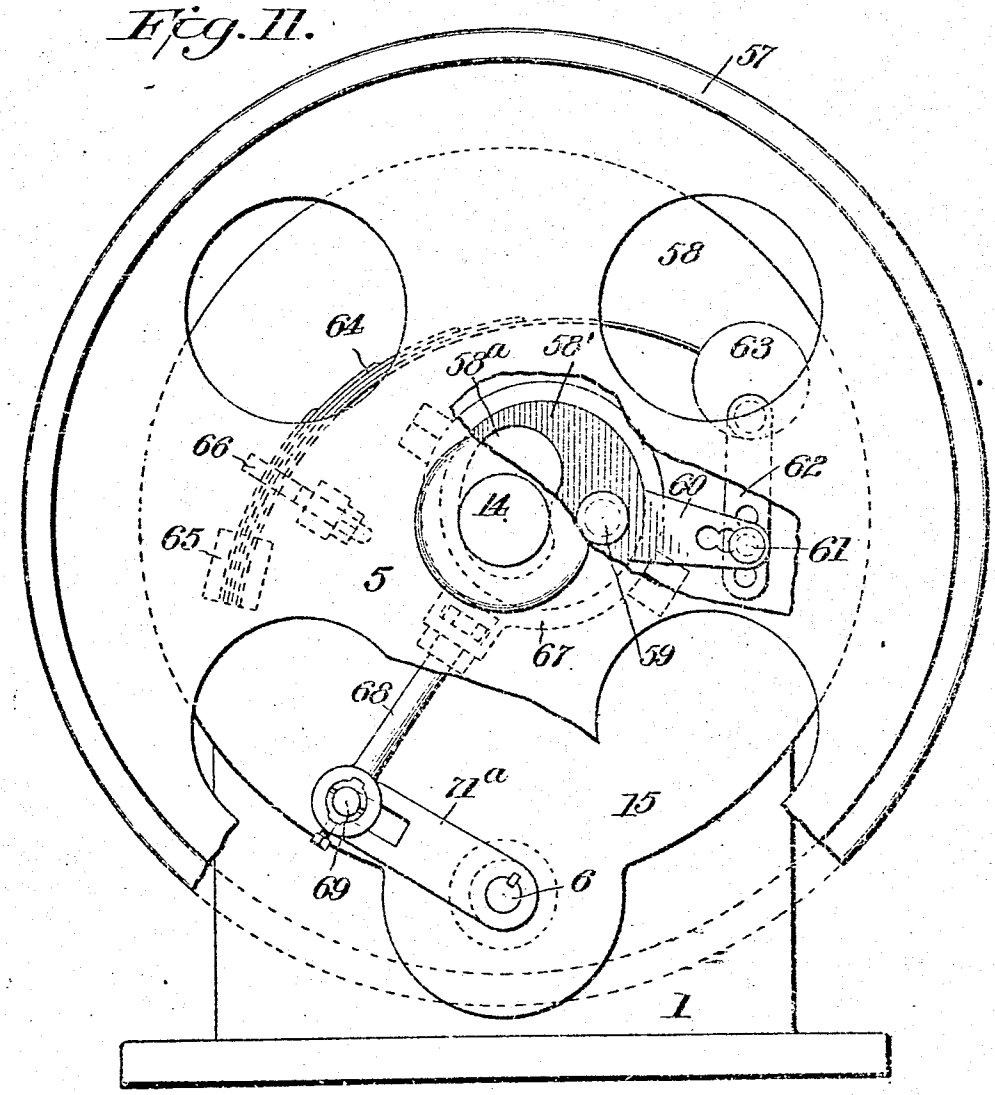
APPLICATION FILED FEB. 15, 1911.

1,009,213.

Patented Nov. 21, 1911.

8 SHEETS—SHEET 8.

Fig. 11.



WITNESSES:

C. H. Walker

L. E. Fischer.

INVENTOR

Benjamin F. Augustine.

BY

Attorney

UNITED STATES PATENT OFFICE.

BENJAMIN F. AUGUSTINE, OF BUFFALO, NEW YORK.

ROTARY ENGINE.

1,009,213. Specification of Letters Patent. Patented Nov. 21, 1911.

Application filed February 15, 1911. Serial No. 608,702.

To all whom it may concern:

Be it known that I, BENJAMIN F. AUGUSTINE, 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.

This invention relates to rotary devices, such as rotary engines or the like.

One object is to provide a rotary engine embodying such characteristics as to provide for an efficient balancing of the pistons and other parts of the engine.

Another object resides in the provision of a rotary engine whose parts are so formed and constructed that the abutment has an area of fluid pressure on one side substantially commensurate with the lateral fluid pressure on the rotating carrier, together with devices whereby the fluid pressure on the abutment may be utilized to counterbalance the carrier.

A still further object is to provide a rotary, steam, gas, air, combustion, or other fluid operating engine embodying a novel organized mechanism designed to overcome unnecessary vibration, noise, undue wear of parts and leakage.

A still further object is to provide two fixed contacting members and a movable member mounted within the innermost fixed member with means constructed and arranged whereby pressure may be transferred between the fixed members and utilized to balance the movable member.

It is still further designed to provide a novel means for supporting and balancing the operating pistons whereby the pistons are held in proper operative position and the centrifugal force acting on the pistons incident to the rotation thereof is effectually overcome.

With the above and other objects in view, the present invention consists in the construction and arrangement of parts hereinafter more fully described, illustrated in the accompanying drawings and particularly pointed out in the appended claims, it being understood that changes may be made in the form, proportion, size and minor details without departing from the spirit or sacrificing any of the advantages of the invention.

In the drawings: Figure 1 is a longitudinal sectional view of the engine. Fig. 2 is a transverse sectional view on the line *a*—*a* of Fig. 1. Fig. 3 is a transverse sectional view on the line *b*—*b* of Fig. 1. Fig. 4 is a transverse sectional view on the line *c*—*c* of Fig. 1. Fig. 5 is a detail perspective view of the rotary carrier with the telescoping caps applied thereto and shown in section and with the piston carrying and balancing means shown ready for application to the pistons. Fig. 6 is a detail perspective view of the abutment illustrating one of the telescoping caps ready to be positioned thereon. Fig. 7 is a detail perspective view of one of the cam rings forming part of the piston supporting and balancing means. Fig. 8 is a detail perspective view of the other cam ring that forms part of the piston supporting and balancing means. Fig. 9 is a detail fragmentary view of the anti-friction means associated with the pistons. Fig. 10 is a fragmentary view illustrating a face view of one of the parts of the anti-friction bearing retaining elements. Fig. 11 is a view of the centrifugal governor, a part being broken away.

Referring now more particularly to the accompanying drawings the reference character 1 indicates a base provided with a valve chamber 2 with which communicates a steam inlet 3, there being an automatically balanced valve 4 disposed in said chamber and operable according to the varying load under the influence of the centrifugal governor mechanism, indicated generally by the reference character 5, said valve having a stem 6 which has connection with the governor mechanism hereinafter more fully described. This valve 4 is preferably cylindrical in cross-section and reduced intermediate its ends to provide a flat portion 7 having a plurality of apertures 8 through which the steam may pass to the rear of the chamber 2 or to the side of the valve opposite that toward which the steam enters the valve chamber through the inlet 3 and by virtue of the steam expanding upon opposite sides of the valve 4 the latter is balanced because the force of the incoming steam against the piston is counterbalanced by the steam behind the valve intermediate the ends of the latter. Thus the valve practically divides the valve chamber 2 into separate steam compartments, and by reason of the lower edge of the valve being reduced or tapered, as at 54′ the steam upon opposite sides thereof will expand beneath the valve and lift

it toward the mouth 4^a of the port 70 to force the upper edge of the same into tight engagement with the mouth 4^a and positively cut off the supply of steam to the valve chamber 2 to the steam cylinder 9 disposed on the base 1 and having communication with the valve chamber 2 by way of said port 70.

Disposed in the steam cylinder 9 is rigidly mounted an abutment 7', which is cylindrical in shape and is provided with a cylindrical chamber 7^a located eccentrically therein, thus forming in effect a member cam shaped in cross section and which has its thickened portion preferably at the lower side of the casing. This abutment has peculiar exterior formation, by virtue of which, it has comparatively small surface contact with the interior of the casing, there being an external, annular outstanding, ring-like enlargement 10 which is the only part of the abutment which contacts with the casing, the external portions of the abutment upon opposite sides of the annular enlargement 10 being reduced and provided with spaced ribs 11 disposed longitudinally of the abutment and leading from the ends thereof to corresponding rings 12 adjacent opposite sides of said enlargement. On the interior of the abutment at its thickened portion between the inlet port 70 and the exhaust port 73, are staggered grooves 71 that become filled with oil and other foreign matter and form a seal to prevent the escape and waste of the operating fluid.

The numeral 13 indicates a rotary piston carrier rigidly secured on the power shaft 14 to rotate therewith. Said shaft is centrally journaled through the heads 15 and end sections 16 of the cylinder.

17 indicates stuffing boxes formed preferably on the heads 15 with which coöperate packing glands 18.

19 indicates lubricating wells and in each of which and supported on the power shaft, is a ring or other suitable element 20 adapted to feed the lubricant from the bottom of the wells 19 to the power shaft automatically, the rings being let down through the opening 21 in the top of the wells 19 and disposed in alinemer with the bores 22 of the wells to receive the power shaft 14.

The piston carrier is eccentrically disposed within the cylindrical chamber in said abutment and has its outer wall or surface in running contact with the wall of the chamber. Said carrier has flanged ends 23 adapted to overlap the ends of the abutment. The carrier is formed in sections so that it may be disposed in the abutment even though the flanges 20 be integral with the body of the carrier. I provide a plurality of bores 24 in the ends of the abutment which are adapted to receive the stems 25 of the packing blocks 26, helical or other springs or pressure exerting means 27 being confined within the bores and engaging said stems at the ends of the latter to force the packing blocks normally against the inner faces of the end flanges of the piston carrier, the packing 28 forming a steam tight joint between the abutment and the flanged ends of the carrier. It will be noted that the stems 25 are preferably of a diameter substantially the same as the diameter of the bores and that the springs 27 are of substantially the same diameter as the stems, and these sizes and this arrangement of these elements have been adopted for the purpose of insuring an even pressure upon the packing blocks by the pressure exerting means so as to prevent tilting of the packing blocks and insuring an even bearing surface. Sleeves or flanged disks 29 and 30, hereinafter referred to as "caps", telescope the ribbed ends of the abutment for coöperation with the ribs 11 and with the enlargement 10 to form chambers 31 (see F.g. 1) between the ribs to provide for steam cushioning or balancing of the piston carrier. These chambers 31 are connected with the steam chamber 7^a by a series of ports 32. The operating fluid in the chamber 7^a will pass through the ports 32 into the chambers 31 and create a pressure on the caps. The inner ends of the caps 29 and 30 have running joint connections with the respective rings 12 and are fixed to the ends of the rotary piston carrier through the instrumentality of screws or other suitable fastenings 33. In order to prevent leakage between the inner ends of said caps and the sides of the enlargement 10 of the abutment I provide the inner ends of the caps with packing 34.

Formed in the piston carrier are radial piston guide-ways 35 and 36 in which are mounted the radial pistons 37 and 38, respectively, which slide relative to the carrier as the carrier rotates. Each piston carries packing 39 in its outer edge and which is adapted to bear against the inner wall of the abutment and against the pistons the steam impinges to drive the piston carrier and pistons and consequently operate the engine as will be hereinafter more fully explained.

The piston blades 37 and 38 each have projections 40 at their ends that project through the slotted openings 41 of the caps 29 and 30 and which are preferably rectangular in cross section for engagement in the similarly formed openings in the bearings 42 and 43 loosely mounted in the lugs 44 and 45 of the rings 46 and 47, respectively. These rings are mounted on fixed eccentric bearing hubs 48 on the heads 15 of the cylinder. These eccentric bearings form means for supporting or holding the pistons in running contact with the wall of the chamber 7^a as the carrier rotates. If desired, balls, roller or other bearing elements are preferably dis-

posed between the hubs 48 and the innermost ring and also between the rings as clearly shown in Figs. 1 and 4.

In order to counterbalance the centrifugal force acting on one piston by the centrifugal force acting on the other piston the rings 46 and 47 are mounted upon each other with the innermost ring loose on the corresponding eccentric hub 48 and the outermost ring loose on the innermost ring, so that both rings are permitted to move or oscillate slightly on said eccentric mountings and also with relation to each other so as to permit the pistons to slide radially relative to the carrier as the carrier rotates. Moreover, by reason of these rings, the distance between the bearings 42 and 43 of said lugs is equal at all times across the axis of the cylindrical bore, thereby insuring not only an efficient balance of the pistons but obviating undue wear on the piston supporting and balancing means. These rings, therefore, perform more than one function, in that they support the pistons in their guideways so that they slide relative to the carrier in the guide-ways and also balance the pistons. By virtue of these characteristics the cam rings may be termed "combined piston supporting and balancing means."

The structure of the rings 46 and 47 is peculiar, one ring fitting within the other, the ring 46 having one side reduced and upon which reduced portion the companion ring 47 is mounted, whereby they overlap circumferentially and interengage with relation to each other, the lugs 44 and 45 of the rings being of a thickness equal to the thickness of both rings when assembled and having their inner overhanging ends curved to conform to the curvature of the rings with their outer ends curved to conform to the curvature of the outer flanged wall 51 of the heads 15 whereby the lugs 44 and 45 have movement in the space between the outer circumference of the rings and the inner circumference of the flanges 51 of the heads.

To facilitate an efficient sliding movement of the pistons in their guideways and to reduce friction to a minimum, one side of each guide-way may be milled out to provide a shoulder to receive the wear plate 52 (see Figs. 9 and 10) against which the rollers or other bearings 53 of the roller bearing retainer 54 travel, one of which retainers is slipped over each end of each piston 37—38, the flanges 55 and 56 fitting over the outer and inner longitudinal edges of the pistons. The roller bearings 53 are held against lengthwise movement from the retainer 54 and plate 52 by virtue of the fact that their ends bear against the sides of the slots 53′ of the retainers.

The centrifugal governor 5 hereinbefore referred to is constructed preferably of a disk 57, which may have openings 58 to lighten the same if desired, and is fixedly mounted upon the power shaft 14. This disk has a cam 58′ pivoted thereon off from the center thereof by means of a suitable pivot 59, the arm 60 of the eccentric cam 58′ having adjustable pivotal connection at 61 with a link 62 pivoted to the weight 63 secured to the outer end of the leaf spring 64, fixedly secured at one end, as at 65, to the disk 57, there being a suitable tensioning means 66 for the spring 64. The cam 58 has the cam slot 58ª which embraces the power shaft 14 and the strap 67 of the eccentric cam 58′ has link connection 68 with a shaft 69 to which latter is connected the crank 71ª which connects with the stem 6 of the valve 4. This governor mechanism is designed for the purpose of automatically regulating the valve 4 to supply the operating fluid to the engine according to the varying loads. Obviously any other governor mechanism may be employed.

In the operation of the engine the fluid enters the inlet 3 and passes through the openings 8 in the flat intermediate portion 9 of the valve 4, and in the event that the engine be at rest and the rotary carrier off center with the valve 4 in closed position, steam may be supplied to the inlet port 70 through a by-pass 72 and permitted to enter the steam cylinder to start the engine. Whether the steam enters the port 70 by way of the inlet 3 or the by-pass 72, it passes upwardly in the port 70 and out of the upper end of the latter through the spaced orifices 73′, by virtue of which latter, the steam is spread, and passes into the cylinder and expands and impinges against the corresponding piston, causing the rotary carrier and the power shaft 14 to rotate. As the steam expands and impinges against the corresponding piston, the rotary piston carrier is caused to rotate, as stated, with the steam passing out of the steam cylinder by way of the exhaust ports 73—74 as the driven piston passes the exhaust ports and when the rotary carrier reaches a predetermined speed the centrifugal governor acts upon the automatically balanced valve 4 to regulate the supply of steam to the steam cylinder according to the varying load.

As above noted, the piston carrier is counterbalanced throughout its entire rotation through the connection of the chambers 31 on the outer side of the abutment with the chamber 7ª wherein the operating fluid is expanded to rotate the carrier. The pressure of the operating fluid creates a rotating force operating upon the carrier to rotate the same and also non-rotating forces which act laterally upon the carrier and also laterally against the outer wall of the chamber 7ª. These lateral forces of the outer wall of the chamber 7ª are, of course, im-

material. The lateral forces, however, operating upon the rotating carrier will force the same against the supporting bearings therefor, thereby creating great friction and wear and loss of power. It is these lateral forces against the rotating carrier which it is desired to counterbalance so that the carrier may rotate freely and with little or no friction in the cylinder. This complete counterbalancing of the lateral or non-rotating forces on the carrier is brought about in the following manner. In the rapid rotation of the piston carrier, the centrifugal force acting upon the operating fluid will carry the lubricant therein and a certain part of the water of condensation to the outer wall of the chamber 7ª and through the ports 32 formed in the abutment to the chambers 31. Thus, a portion of the operating fluid is transferred to the outer face of the abutment and is forced against the caps in a lateral direction opposite to the lateral forces of the operating fluid acting upon the piston carrier in the chamber 7ª. The caps, as above noted, are connected with the rotating piston carrier, and therefore, this lateral force on the caps will offset or counterbalance the lateral force on the carrier, provided of course, that the area of the surface on the caps exposed to the lateral force of the operating fluid, is substantially equal to the area of the outer surface of the piston carrier which is exposed to the lateral force of the operating fluid in the chamber 7ª. These chambers 31 are so constructed that the surface areas, above referred to, are substantially equal, and therefore, these parts constitute devices for utilizing a portion of the operating fluid for creating an opposing force on the piston carrier which is substantially equal to the lateral or non-rotating force of the operating fluid on the piston carrier. When a radial piston has just passed the inlet port, the surface area on the rotating carrier exposed to the steam or fluid pressure is comparatively small. This surface area gradually increases with the rotation of the piston carrier. The chambers 31 are arranged in succession circumferentially about the abutment and as the radial pistons rotate with the carrier, first one port 32 and then another will be uncovered and thereby the area on the caps exposed to the pressure of the operating fluid will be increased in substantially the same increments and simultaneously with the increased area on the piston carrier which is exposed to the pressure of the operating fluid. Therefore, during the entire rotation of the piston carrier, the area of the surface on the caps exposed to the fluid pressure will be substantially equal to that on the carrier exposed to the operating fluid pressure. Furthermore, when the operating fluid first enters the chamber 7ª, the pressure on the carrier is, of course, much greater than after said operating fluid has expanded and its active force substantially spent. By my improved construction, however, wherein a portion of the operating fluid is utilized to effect a counterbalancing of the rotating carrier, the counterbalancing force on the caps would always equal, for each unit area, the lateral or non-rotating force on the rotating carrier. These lateral forces of the operating fluid on the rotating carrier not only cause friction and wear and thereby loss of power but also tend to lift the rotating carrier in its bearings away from the abutment at the point of running contact, thereby causing a leak of the operating fluid and a further loss of power. By my construction, however, wherein the caps are connected to the rotating carrier in such a manner that the abutment at the point of running contact is embraced at the inner side by the rotating carrier and at the outer side by a cap and by the further providing of the cap at this point with an opposing force substantially equal to the non-rotating force on the carrier, through the chambers 31 and ports 32, above referred to, the rotating carrier is held in perfect running contact with the wall of the chamber 7ª. In other words, the wall of the chamber and the carrier may be ground so as to have a perfect running fit and through the aid of the caps contacting with the outer face of the abutment, said rotating carrier will be held in the same predetermined position, regardless of the varying fluid pressure on the rotating carrier and regardless of the fact that there is necessarily a slight side play in the bearings of the rotating carrier. Furthermore, the accumulation of the lubricant in the chambers 31 forms in effect a lubricant support for the caps, which causes the caps to run freely and smoothly on the abutment, and through the counterbalancing of the non-rotating forces, causes the piston carrier to practically float in the cylinder in perfect peripheral balance with no lateral or non-rotating strains thereon.

By my improved structure I provide a highly efficient and durable rotary engine and one that is not limited to the use of steam as a driving medium but one operable under the influence of gas, air, combustion, or other operating fluid.

What is claimed is:

1. In a rotary engine, a cylinder, flanged heads secured to the ends of the cylinder and each provided with an eccentric hub, a power shaft journaled through the eccentric hubs of the heads, a rotatable piston carrier secured to the shaft and provided with piston guide-ways, a piston slidably mounted in each guide-way, each piston having longitudinally projecting stems at opposite

ends, rings mounted on the eccentric hub of each flanged head, said rings overlapping each other and having movement one on the other with the innermost ring movable on the corresponding eccentric hub, each ring having a lug provided with a bearing to receive the corresponding stem of the corresponding piston to support and balance the pistons, a valve, and means for operating the valve to supply the operating fluid to the cylinder according to the varying loads.

2. In a rotary engine, a cylinder, flanged heads secured to the ends of the cylinder and each provided with an eccentric hub, a power shaft journaled through the eccentric hubs of the heads, a rotatable piston carrier secured to the shaft and provided with piston guide-ways, a piston slidably mounted in each guide-way, each piston having longitudinally projecting stems at opposite ends, rings mounted on the eccentric hub of each flanged head, each ring having a lug provided with a bearing to receive the corresponding stem of the corresponding piston to support and balance the pistons, a valve, and means for operating the valve to supply the operating fluid according to the varying loads.

3. In a rotary engine, a cylinder, heads secured to the ends of the cylinder and each provided with an eccentric hub, a power shaft journaled through the eccentric hubs of the heads, a rotatable piston carrier secured to the shaft and provided with piston guide-ways, a piston slidably mounted in each guide-way, each piston having longitudinally projecting stems at opposite ends, rings mounted on the eccentric hub of each head, said rings circumferentially overlapping each other and having movement one on the other with the innermost ring movable on the corresponding eccentric hub, each ring having a lug provided with a bearing to receive the corresponding stem of the corresponding piston to support and balance the pistons, a valve chamber having communication with the cylinder, a valve mounted in the valve chamber, and a governor mechanism having connection with the valve to operate the latter automatically to supply the operating fluid according to the varying loads.

4. In a rotary engine, a cylinder, flanged disk heads secured to the ends of the cylinder and each provided with an eccentric hub, a power shaft journaled through the eccentric hubs of the heads, a rotatable piston carrier secured to the shaft and provided with piston guideways, a piston slidably mounted in each guide-way, each piston having longitudinally projecting stems at opposite ends, rings mounted on the eccentric hub of each flanged head, said rings circumferentially interengaging and having movement one on the other with the innermost ring movable on the corresponding eccentric hub, each ring having a lug provided with a bearing to receive the corresponding stem of the corresponding piston to support and balance the pistons, the upper ends of said lugs being curved to correspond with the curvature of the flanges of said heads and oscillating against said flanges, the lugs being of a thickness equal to the thickness of both rings and having their inner ends curved to correspond with the curvature of the outer circumference of the corresponding rings, said lugs oscillating between the flanges of the heads and the circumference of the rings, a valve, and means for operating the valve to supply the operating fluid according to the varying loads.

5. In a rotary engine, a cylinder, flanged disk heads secured to the ends of the cylinder, a power shaft journaled eccentrically through the heads, a rotatable piston carrier secured to the shaft and provided with piston guide-ways, a piston slidably mounted in each guide-way, means operable within the flanges of the heads and contacting with the flanges and operatively connected to the pistons to support and balance the latter, a valve, and means operatively connected with the valve to supply the operating fluid according to the varying loads.

6. In a rotary engine, a cylinder, heads secured to the ends of the cylinder, a power shaft journaled eccentrically through the heads, a rotatable piston carrier secured to the shaft and provided with piston guide-ways, a piston slidably mounted in each guide-way, rings having oscillatory movement with relation to and upon each other and connected to the pistons to operate the same, said rings having interengaging parts to counterbalance the pistons.

7. In a rotary engine, a cylinder, heads secured to the ends of the cylinder, a power shaft journaled eccentrically through the heads, a rotatable piston carrier secured to the shaft and provided with piston guide-ways, a piston slidably mounted in each guide-way, combined piston supporting and balancing means disposed at the ends of the pistons and having operative connection therewith, a valve, and means for operating the valve.

8. In a rotary engine, a cylinder, an abutment rigidly mounted in the cylinder, heads secured to the ends of the cylinder, a power shaft journaled eccentrically through the heads, a rotatable piston carrier secured to the shaft and provided with piston guide-ways, a piston slidably mounted in each guide-way, counterbalancing means having common operative connections with the pistons to support and balance the latter, said counterbalancing means having oscilla-

tory movement, a valve, and means operatively connected with the valve to operate the latter automatically.

9. In a rotary engine, a cylinder, an abutment rigidly mounted in the cylinder, heads secured to the ends of the cylinder, a power shaft journaled eccentrically through the heads, a rotatable piston carrier secured to the shaft and provided with piston guide-ways, a piston slidably mounted in each guide-way, counterbalancing means disposed adjacent said heads and having operative connection with the pistons to support and balance the latter, a valve, and means operatively connected with the valve to operate the latter automatically.

10. In a rotary engine, a cylinder, an abutment fixedly secured in the cylinder and having its ends reduced, heads secured to the ends of the cylinder, caps telescoping the reduced ends of the abutment and provided with slotted openings, a rotatable piston carrier secured to said shaft and provided with piston guide-ways, a piston slidably mounted in each guide-way with portions of each piston projecting through said slotted openings of the caps, counterbalancing means for the pistons interposed between the heads and said caps and operatively connected to the projecting parts of the pistons, a valve and means for operating the valve, to supply the operating fluid to the cylinder according to the varying loads.

11. In a rotary engine, a cylinder, an abutment fixedly mounted in the cylinder and having its ends reduced, a power shaft journaled eccentrically through the heads, caps confined within the cylinder and telescoping with the reduced ends of the abutment and provided with slotted openings, a rotatable piston carrier secured to the shaft and provided with piston guide-ways, a piston slidably mounted in each guide-way, each piston having parts projecting through the openings of said caps, means mounted between each head and the adjacent cap and operatively connected to the projecting parts of the pistons to balance the latter, a valve, and means for operating the valve to supply the operating fluid to the cylinder.

12. In a rotary engine, a cylinder, an abutment rigidly mounted in the cylinder, caps telescoping with the ends of the abutment, heads secured to the cylinder in spaced relation to said caps, a power shaft journaled eccentrically through the heads and caps, a rotatable piston carrier secured to the shaft and provided with piston guideways, a piston slidably mounted in each guide-way, means operable between each head and the adjacent cap and having operative connection with the pistons to support and balance the latter during the centrifugal force developed incident to operation of the rotatable piston carrier, a valve, and means for operating the valve to supply the operating fluid to the cylinder.

13. In a rotary engine, a cylinder, an abutment rigidly mounted in the cylinder, caps telescoping with the ends of the abutment and provided with openings, heads secured to the cylinder, a power shaft journaled eccentrically through the heads and caps, a rotatable piston carrier secured to the shaft and provided with piston guide-ways, a piston slidably mounted in each guide-way and having parts projecting through said openings of the caps, said heads having eccentric hubs, inter-engaging rings movably mounted on said eccentric hubs and having operative connection with the projecting parts of the pistons to counterbalance the latter during operation of the piston carrier, a valve, means for operating the valve automatically, and a by-pass to supply the operating fluid to the cylinder independently of the valve operating means.

14. In a rotary engine, a cylinder, heads secured to the ends of the cylinder, a power shaft journaled through the heads, a rotatable piston carrier secured to the shaft and provided with piston guide-ways, a piston mounted in each guide-way to slide relative to the carrier, inter-engaging rings connected to the pistons for counterbalancing the pistons during the operation of the piston carrier, a fluid inlet, a valve interposed between the inlet and the cylinder, and means for operating the valve to supply the operating fluid to the cylinder.

15. The combination with a cylinder, a fixed member within said cylinder, a rotatable member within said fixed member, sliding pistons mounted for radial movement on said rotatable member, means for supplying an operating fluid between said members to operate the rotatable member, of a fluid pressure means to oppose and counterbalance the non-rotating forces of the operating fluid on said rotatable member, and means operatively connecting the pistons together to overcome the centrifugal force incident to rotation of the rotatable member and thereby counterbalance the pistons.

16. In a rotary engine, a cylinder, an abutment rigidly mounted in the cylinder, caps telescoping with the ends of the abutment and provided with radial openings, heads secured to the cylinder in spaced relation to said caps, a power shaft journaled eccentrically through the heads, a rotatable piston carrier secured to the shaft and provided with radially directed piston guide-ways, a piston slidably mounted in each guide-way, means interposed between each head and the adjacent cap and having operative connection with the pistons through said openings of the caps to counterbalance the pistons, a steam inlet for the cylinder, a valve interposed between the inlet and the

cylinder to govern the supply of operating fluid to the cylinder, and means for governing the operation of the valve.

17. In a rotary engine, a cylinder, an abutment rigidly mounted in the cylinder, caps telescoping with the ends of abutment and provided with radial openings, heads secured to ends of the cylinder in spaced relation to said caps, a power shaft journaled eccentrically through the heads and caps, a rotatable piston carrier secured to the shaft and provided with radial piston guide-ways, a piston slidably mounted in each guide-way, means for securing said caps to the ends of the said piston carrier, means constructed and arranged and interposed between each head and the adjacent cap and having operative connection with said pistons through the openings of the caps to counterbalance the pistons during operation thereof incident to operation of the piston carrier, and means for supplying operating fluid to the cylinder according to the varying loads.

18. In a rotary engine, a cylinder, an abutment in the cylinder, caps telescoping with the ends of the abutment, the exterior of the abutment being constructed to provide fluid receiving chambers between the caps and the abutment, said abutment having ports leading into said chambers, heads secured to the cylinder, a power shaft journaled through the heads, a rotary piston carrier secured to the shaft and provided with piston guide-ways, pistons slidable in the guide-ways, means for counterbalancing the pistons, means for connecting the caps to the piston carrier and means for supplying operating fluid to the cylinder to drive the piston carrier.

19. In a rotary engine, a cylinder, an abutment in the cylinder, caps telescoping with the ends of the abutment, the exterior of the abutment being constructed to provide fluid receiving chambers between the caps and the abutment, said abutment having ports leading into said chambers, heads secured to the cylinder, a power shaft journaled through the heads, a rotatable piston carrier secured to the shaft and provided with piston guide-ways, pistons slidable in the guide-ways, means for connecting the pistons whereby one piston counterbalances the other, and means for supplying an operating fluid to the cylinder.

20. In a rotary engine, a cylinder, an abutment fixedly mounted in the cylinder, a rotary piston carrier journaled in the cylinder and provided with piston guide-ways, pistons mounted in the piston carrier and slidable relatively thereto, means for counterbalancing the pistons, means for supplying operating fluid to the cylinder to operate the carrier, and means constructed and arranged to utilize a portion of the operating fluid to equalize the non-rotating force of the operating fluid on the rotatable carrier to counterbalance the same.

21. In a rotary engine, a cylinder, an abutment fixed in the cylinder and reduced at its ends and at its reduced ends provided with ribs, caps fitting over the reduced ends of the abutment and coöperating with the ribs to provide fluid receiving chambers, the abutment having ports leading into the chambers, a rotatable piston carrier journaled in the cylinder and connected to the caps, pistons mounted in the carrier to slide relatively thereto, and means for supplying operating fluid to the cylinder according to the varying loads, a portion of the operating fluid entering said chambers through the ports of the abutment, for equalizing the lateral force of the operating fluid on the piston carrier to counterbalance the same.

22. The combination with two fixed members having circumferential contact with each other, a movable member within the innermost fixed member and means for supplying an operating fluid between the innermost member and the movable member to operate the latter, of means constructed and arranged to utilize a portion of the operating fluid to counterbalance the movable member.

23. The combination with two fixed members having circumferential contact with each other, a movable member within the innermost fixed member, said movable member having pistons mounted therein, and means for supplying an operating fluid between the innermost fixed member and the movable member to operate the latter, of means constructed and arranged to utilize a portion of the operating fluid to counterbalance the movable member, and means for counterbalancing the pistons.

24. The combination with two fixed members having circumferential contact with each other, a movable member within the innermost fixed member, said movable member having pistons mounted therein, and means for supplying an operating fluid between the innermost fixed member and the movable member, of means constructed and arranged to utilize a portion of the operating fluid to counterbalance the movable member, and sets of interengaging rings eccentrically mounted adjacent said members to counterbalance the pistons.

25. The combination with two fixed members having circumferential contact with each other, a movable member within the innermost fixed member, said movable member having pistons mounted therein to slide relative to the movable member, and means for supplying an operating fluid between the innermost fixed member and the movable member, of means constructed and arranged to utilize a portion of the operating fluid to

counterbalance the movable member, and means constructed and arranged adjacent said members to counterbalance the pistons.

26. The combination with fixed members having circumferential contact with each other, a rotatable member within the innermost fixed member provided with pistons slidable relative thereto and means for supplying an operating fluid between the innermost fixed member and the rotatable member, of means constructed and arranged to utilize a portion of the operating fluid to counterbalance the rotatable member, and means constructed and arranged adjacent said members for connecting said pistons together to counterbalance them against the centrifugal action incident to rotation of the rotatable member.

27. In a rotary engine, a cylinder, an abutment rigidly mounted in the cylinder, and having its ends reduced, heads secured to the ends of the cylinder, a power shaft journaled through the heads, a rotatable piston carrier fixed to the shaft within the cylinder, pistons mounted in the carrier, to slide relative thereto, caps fixed to the piston carrier and telescoping with the reduced ends of the abutment to form fluid receiving chambers, means for supplying an operating fluid to the rotatable carrier, means to convey a portion of the operating fluid to said chambers to create an opposing force on the caps to equalize the lateral force of the operating fluid on said rotatable carrier, a valve, and means for operating the valve.

28. In a rotary engine, a cylinder, an abutment rigidly mounted in the cylinder and having its ends reduced, heads secured to the ends of the cylinder, a power shaft journaled through the heads, a rotatable piston carrier fixed to the shaft within the cylinder, pistons mounted in the carrier to slide relative thereto, caps fixed to the piston carrier and telescoping with the reduced ends of the abutment to form fluid receiving chambers, and means to transfer a portion of the operating fluid to oppose the non-rotating force of the operating fluid against the rotatable carrier to counterbalance the piston carrier, means constructed and arranged between each head and the adjacent cap and having operative connection with the pistons to counterbalance the latter, a valve, and means for operating the valve.

29. The combination with two fixed members having circumferential contact with each other, a movable member within the innermost fixed member and means for supplying an operating fluid between the movable member and the innermost fixed member, of means constructed and arranged to transfer a portion of the operating fluid on the outer side of the innermost fixed member and means to utilize the transferred fluid to oppose the non-rotating force of the operating fluid to counterbalance the movable member.

30. The combination with a cylinder, a fixed member, a movable member, and means to supply an operating fluid between said members, of means arranged to transfer a portion of the operating fluid to the outer side of the fixed member, and means for utilizing the transferred fluid on the outside of the fixed member to counterbalance the movable member, the utilizing means including a movable member connected to said first named movable member.

31. The combination with a cylinder, a fixed member, a rotary member, the rotary member having radially slidable pistons and means to supply an operating fluid between said members, of means constructed and arranged to transfer a portion of the operating fluid to the outer side of the fixed member, and means for utilizing the transferred fluid on the outside of the fixed member to counterbalance the rotary member, the utilizing means including a movable member, and means constructed and arranged to operatively connect the pistons to counterbalance the latter during operation of the rotary member under the influence of the operating fluid.

32. The combination with a cylinder, a fixed member, a rotatable member, the rotatable member having radially slidable pistons and means to supply an operating fluid between said members, of means constructed and arranged to transfer a portion of the operating fluid to the outer side of the fixed member, and means for utilizing said transferred portion of the operating fluid on the outside of the fixed member to counterbalance the rotatable member, the utilizing means including a movable member, and means connecting the pistons whereby one piston counterbalances the other during operation of the rotatable member under the influence of said operating fluid.

33. In a rotary engine, a cylinder, an abutment fixed in the cylinder and having its ends reduced, heads secured to the ends of the cylinder, a power shaft journaled in said heads, a rotary piston carrier secured to said shaft and provided with piston guide-ways, pistons slidably mounted in the guide-ways, the abutment having ports at its reduced ends, caps secured over the reduced ends of the abutment to provide fluid receiving chambers at opposite ends of the abutment which fluid enters the chamber by way of said ports and which counterbalances the piston carrier, said caps having openings and the pistons having parts projecting through the openings, and means mounted adjacent the heads of the cylinders and operatively connected to the projecting por-

tions of the pistons to counterbalance the latter during rotation of the piston carrier, a valve and means for operating the valve.

34. The combination with a cylinder, a fixed member, a movable member, and means for supplying an operating fluid between said members, of means constructed and arranged to transfer a portion of the operating fluid to the outside of the fixed member at the ends only of the latter, and means for utilizing the fluid on the outside of the fixed member to counterbalance the movable member.

35. The combination with a cylinder, a fixed member, a movable member, and means for supplying an operating fluid between said members, of means constructed and arranged to transfer a portion of the operating fluid to the outside of the fixed member at each end of the latter, and means to utilize the transferred fluid on the outside of the fixed member at the ends thereof to counterbalance the movable member, the utilizing means at one end being independent of the utilizing means at the opposite end.

36. The combination with a cylinder, a fixed member, a rotatable member, and means for supplying an operating fluid between said members, of means constructed and arranged to transfer a portion of the operating fluid to the outside of the fixed member at each end of the latter and means to utilize the transferred portion of the operating fluid on the outside of the fixed member at its ends only to counterbalance the rotatable member, parts of said utilizing means being carried by the rotatable member for rotation therewith.

37. The combination with a cylinder, a fixed member, a movable member within the fixed member and means for supplying an operating fluid between said members, of means composed of parts carried by the fixed and movable members to provide chambers on the outside of the fixed member to receive a portion of the operating fluid on the outside of the fixed member to counterbalance the movable member.

38. The combination with a cylinder, a fixed member, a movable member within the fixed member and means for supplying an operating fluid between said members, of means constructed and arranged to transfer a portion of the operating fluid to the outside of the fixed member, and means to utilize the transferred operating fluid on the outside of the fixed member and exteriorly of the movable member to counterbalance the movable member.

39. The combination with a cylinder, a fixed member, a movable member, and means for supplying an operating fluid between the members, of means constructed and arranged to transfer a portion of the operating fluid to the outside of the fixed member and means to utilize the transferred operating fluid to oppose the non-rotating forces of the operating fluid on the movable member to counterbalance the same, said utilizing means including a floating member.

40. The combination with a cylinder, a fixed member, a movable member, and means for supplying an operating fluid between said members, of means constructed and arranged to transfer a portion of the operating fluid to the outside of the fixed member, and means to utilize the transferred operating fluid to balance the movable member, said utilizing means including a floating member carried by the movable member.

41. The combination with a cylinder, a fixed member within said cylinder, a movable member within said fixed member, and means for supplying an operating fluid between said members to operate the movable member, of means to transfer a portion of the operating fluid to the outer side of said fixed member, and means operated by the transferred fluid to counterbalance the movable member.

42. The combination with a cylinder, a fixed member within said cylinder, a movable member within said fixed member, and means for supplying an operating fluid between said members to operate the movable member, of means to transfer a portion of the operating fluid to the outer side of the fixed member, and means for utilizing the transferred portion of the operating fluid on the outer side of the fixed member for creating an opposing force on the movable member substantially equal to the lateral force of the operating fluid on the movable member.

43. In a rotary engine, in combination, a cylinder, a rotatable piston carrier mounted in the cylinder, pistons carried by the carrier, means for supplying an operating fluid between the carrier and cylinder to operate the carrier, and means constructed and arranged to receive a portion of the fluid delivered between the carrier and cylinder, and devices for utilizing the same to counterbalance the carrier.

44. In a rotary engine, in combination, a cylinder, an abutment fixedly mounted in the cylinder, a rotatable carrier journaled in the cylinder and having a flange at each end adapted to overlap the sides of the abutment, means for supplying operating fluid between the carrier and the abutment to operate the carrier, and means constructed and arranged to transfer a portion of the operating fluid to the outside of the abutment, and means to utilize the transferred portion of the operating fluid on the outer side of the abutment between the latter and the cylinder to counterbalance the rotatable piston carrier.

45. In a rotary engine, in combination, a cylinder, an abutment within the cylinder, a

rotatable carrier journaled in the cylinder, and located within said abutment, means for supplying an operating fluid between the abutment and carrier to operate the latter, and means constructed and arranged to transfer a portion of the operating fluid to the outside of the abutment for action against the ends of the carrier to overcome end thrust on the latter.

46. In a rotary engine, in combination, a cylinder, a fixed member, a rotatable carrier journaled in the cylinder, and located within the fixed member, means for supplying an operating fluid between the cylinder and carrier to operate the latter, and means constructed and arranged to transfer a portion of the operating fluid to the outer side of the fixed member, and means to utilize the transferred fluid to provide for a peripheral balance of the movable member.

47. In a rotary engine, in combination, a cylinder, a rotatable piston carrier journaled in the cylinder, pistons carried by the carrier, means for supplying an operating fluid between the cylinder and the rotatable carrier to operate the latter, and means constructed and arranged to receive a portion of the operating fluid, and devices for utilizing the same to counterbalance the carrier during the entire rotation of the carrier.

48. In a rotary engine, in combination, a cylinder, a power shaft journaled in the cylinder, a rotatable piston carrier secured to the shaft, pistons carried by the carrier, a valve, means for operating the valve to supply the operating fluid to the cylinder to drive the carrier, and a set of rings operatively connected to the pistons at each end of the carrier, said rings having interengaging parts whereby one piston balances the other in all parts of the revolution of the carrier.

49. In a rotary engine, in combination, a cylinder, a power shaft journaled in the cylinder, a rotatable piston carrier secured to the shaft, pistons carried by the carrier, devices operatively connected to the pistons to hold the pistons in constant running joint with the cylinder wall, and means for connecting the devices whereby one of the pistons balances the other during all parts of the rotation of the carrier.

59. In a rotary engine, in combination, a cylinder, a power shaft journaled in the cylinder, a rotatable piston carrier secured to the shaft, pistons carried by the carrier, a valve, means for operating the valve to supply the operating fluid to the cylinder to drive the carrier, means constructed and arranged and operatively connected to the pistons to balance the latter, one piston balancing the other in all parts of the revolution of the carrier with the pistons having a constant running joint with the cylinder wall, and means constructed and arranged to transfer a portion of the operating fluid from between the carrier and cylinder for coöperating with the operating fluid between the carrier and cylinder to oppose the non-rotating force of the fluid on the piston carrier to effect a balancing action upon the carrier.

51. In a rotary engine, in combination, a cylinder, a power shaft journaled in the cylinder, a rotatable piston carrier secured to the shaft, pistons carried by the carrier, a valve, means for operating the valve to supply the operating fluid to the cylinder to drive the carrier, means constructed and arranged and operatively connected to the pistons to balance the latter, one piston balancing the other in all parts of the revolution of the carrier with the pistons having a constant running joint with the cylinder wall, means constructed and arranged to transfer a portion of the operating fluid from between the carrier and cylinder exteriorly of the carrier, and means for utilizing the transferred operating fluid to counterbalance the rotatable piston carrier.

52. In a rotary engine, a cylinder, an abutment, a rotary carrier journaled in the cylinder and located in said abutment, pistons carried by the carrier, means constructed and arranged to supply an operating fluid to the cylinder to rotate the carrier, and means constructed and arranged to transfer a portion of the operating fluid to the outer side of the abutment, said carrier having means operated upon by the transferred fluid to provide for a peripheral balance of the carrier.

53. In a rotary engine, in combination, a cylinder, a carrier journaled in the cylinder, pistons carried by the carrier, means to supply the operating fluid to the cylinder to operate the carrier, a floating member secured to the carrier and operated thereby, and means coöperating with the floating member to counterbalance the latter.

54. The combination with a cylinder, a fixed member, a movable member with means for supplying an operating fluid between said members to operate the movable member, of floating members having direct connection with the movable member, and means constructed and arranged whereby the movable and floating members are counterbalanced one by the other.

55. The combination of a cylinder, a fixed member, a rotatable member within the fixed member, a movable member connected to the rotatable member and having a running contact with the fixed member, means for supplying an operating fluid between said members for operating the rotatable member, and means for receiving the lubricant separated from the operating fluid by centrifugal force and applying the same to the running contact between the movable mem-

ber and the fixed member whereby the movable members are caused to float on the fixed member.

56. The combination of a cylinder, a fixed member located in the cylinder, and having a cylindrical chamber disposed eccentrically to the cylinder, a rotatable cylindrical carrier in said chamber, having its outer surface in contact with the wall of the chamber, pistons mounted on said carrier and movable radially relative thereto, a movable member connected to the carrier and having running contact with the outer face of the fixed member, means for supplying said chamber with an operating fluid, and means for receiving the lubricant separated from the operating fluid by centrifugal force and applying the same to the running contact between the movable member and the fixed member, whereby the movable member is supported on the fixed member, and the rotatable carrier caused to float in said chamber.

57. The combination of a cylinder, a fixed member located in the cylinder, and having a cylindrical chamber disposed eccentrically to the cylinder, said fixed member having contact centrally thereof with the walls of the cylinder and at each end thereof spaced from the walls of the cylinder, a shaft centrally of the cylinder, a cylindrical carrier mounted on the shaft and having its outer wall in contact with the wall of the chamber, pistons mounted on the carrier and movable radially relative thereto, movable members located at each end of the fixed member, and in the space between the fixed member and the cylinder, said movable members having running contact with the fixed member, means for connecting the movable members with the carrier, means for supplying said chamber with an operating fluid, and means for receiving the lubricant separated from the operating fluid by centrifugal force, and applying the same to the running contact between the movable members and the fixed members, whereby the movable members are supported and the carrier caused to float in said chamber.

58. The combination of a fixed member, a rotatable member within the fixed member, caps connected to said rotatable member and having running contact with the fixed member, means for supplying an operating fluid between said members for operating the rotatable member, said fixed member having pockets formed in its face contacting with the caps and having passages leading to said pockets whereby the lubricant in the operating fluid may be caused by centrifugal force to accumulate in said pockets and provide a support on which the caps and rotating member float.

59. The combination of a cylinder, a rotatable member within said cylinder, means for supplying an operating fluid to the rotatable member for rotating the same, and fluid pressure means for providing said rotatable member with an opposing force substantially equal to the non-rotating force of the operating fluid against said rotatable member to counterbalance the same during the entire rotation of the rotatable member.

60. The combination with a cylinder, a fixed member within said cylinder, a movable member within said fixed member, and means for supplying an operating fluid between said members to operate the movable member, of a fluid pressure means for providing said movable member with an opposing force substantially equal to the lateral force of the operating fluid against said movable member to counterbalance the same during the entire rotation of the movable member.

61. The combination with a cylinder, a fixed member within said cylinder, a rotatable member within said fixed member, and means for supplying an operating fluid between said members to operate the rotatable member, of a fluid pressure means for providing said rotatable member with an opposing force substantially equal to the non-rotating force of the operating fluid against said rotatable member to counterbalance the same during the entire rotation of the rotatable member.

62. The combination of a cylinder, a rotatable member within said cylinder, means for supplying an operating fluid to the rotatable member for rotating the same, and means for utilizing a portion of the operating fluid to create an opposing force on said rotatable member substantially equal to the non-rotating force of the operating fluid against said rotatable member to counterbalance the same.

63. The combination with a cylinder, a fixed member within said cylinder, a rotatable member within said fixed member, means for supplying an operating fluid between said members for operating the rotatable member, and means for utilizing a portion of the operating fluid to create an opposing force on said rotatable member substantially equal to the non-rotating force of the operating fluid against the rotatable member to counterbalance the same.

64. The combination of a cylinder, a fixed member within the cylinder, a rotatable member within the fixed member, means for supplying an operating fluid between said members for operating the rotatable member, caps located at the outside of said fixed member and connected to the rotatable member, and fluid pressure means acting on said caps for providing a peripheral balance for said rotatable member.

65. The combination of a cylinder, a shaft located centrally of the cylinder, said cyl-

inder having a cylindrical chamber disposed eccentrically to the shaft, a cylindrical carrier mounted on the shaft and located in said chamber with its outer wall in contact with the wall of the chamber, radially disposed pistons mounted on the carrier, means for supplying a fluid to said chamber, and means for providing the carrier with an opposing force substantially equal to the lateral force of the fluid against the carrier, to counterbalance the same.

66. The combination of a cylinder, a shaft located centrally of the cylinder, said cylinder having a cylindrical chamber disposed eccentrically to the shaft, a rotatable cylindrical carrier mounted on the shaft and located in said chamber, with its outer wall in contact with the wall of the chamber, pistons mounted on the carrier and movable radially relative thereto, means for holding the pistons in contact with the walls of the chamber as the carrier rotates, means for counterbalancing one piston by the other, means for supplying said chamber with a fluid, and means for providing the carrier with an opposing force substantially equal to the lateral force of the fluid against the carrier, to counterbalance the same.

67. The combination of a cylinder, a shaft located centrally of the cylinder, said cylinder having a cylindrical chamber disposed eccentrically to the shaft, a rotatable cylindrical carrier mounted on the shaft and located in the chamber with its outer wall in contact with the wall of the chamber, pistons mounted on the carrier and movable radially relative thereto, stationary eccentric bearings, rings coöperating with the bearings and connected to the pistons for holding the pistons in contact with the wall of the chamber as the carrier rotates, means for connecting the rings whereby one piston counterbalances the other, means for supplying said chamber with a fluid, means for providing the carrier with an opposing force substantially equal to the lateral force of the fluid against the carrier, to counterbalance the same.

68. The combination of a cylinder, a shaft located centrally of the cylinder, a fixed abutment within the cylinder and having a cylindrical chamber disposed eccentrically to the shaft, a cylindrical carrier mounted on the shaft and located in said chamber with its outer wall in contact with the wall of the chamber, radially disposed pistons mounted on the carrier and slidable relative thereto, means for supplying an operating fluid to the chamber, and means for providing the carrier with an opposing force substantially equal to the lateral force of the operating fluid against the carrier, to counterbalance the same.

69. The combination of a cylinder, a shaft located centrally of the cylinder, an abutment within the cylinder having a cylindrical chamber disposed eccentrically to the shaft, a rotatable cylindrical carrier mounted on the shaft and located in said chamber with its outer wall in contact with the wall of the chamber, pistons mounted on the carrier, and movable radially relative thereto, means for holding the pistons in contact with the wall of the chamber as the carrier rotates, means for counterbalancing one piston by the other, means for supplying said chamber with an operating fluid, and means for providing the carrier with an opposing force substantially equal to the lateral force of the fluid against the carrier, to counterbalance the same.

70. The combination of a cylinder, a shaft located centrally of the cylinder, a fixed abutment within the cylinder and having a cylindrical chamber disposed eccentrically to the shaft, a rotatable cylindrical carrier mounted on the shaft and located in the chamber with its outer wall in contact with the wall of the chamber, pistons mounted on the carrier and movable radially relative thereto, stationary eccentric bearings, rings coöperating with the bearings and connected with the pistons for holding the same in contact with the wall of the chamber as the carrier rotates, means for connecting the rings whereby one piston counterbalances the other, means for supplying the chamber with an operating fluid, and means for providing the carrier with an opposing force substantially equal to the lateral force of the operating fluid against the carrier, to counterbalance the same.

71. The combination of a cylinder, a shaft located centrally of the cylinder, said cylinder having a cylindrical chamber disposed eccentrically to the shaft, a rotatable cylindrical carrier mounted on the shaft and located in said chamber, with its outer wall in contact with the wall of the chamber, pistons mounted on the carrier and movable radially relative thereto, means for holding the pistons in contact with the walls of the chamber as the carrier rotates, means for counterbalancing one piston by the other, means for supplying said chamber with a fluid, and means for utilizing a portion of the operating fluid, for providing the rotatable carrier with an opposing force substantially equal to the lateral force of the operating fluid on the carrier to counterbalance the same.

72. The combination of a cylinder, a shaft located centrally of the cylinder, said cylinder having a cylindrical chamber disposed eccentrically to the shaft, a rotatable cylindrical carrier mounted on the shaft and located in the chamber with its outer wall in contact with the wall of the chamber, pistons mounted on the carrier and movable radially relative thereto, stationary eccen-

tric bearings, rings coöperating with the bearings and connected to the pistons for holding the pistons in contact with the wall of the chamber as the carrier rotates, means for connecting the ring whereby one piston counterbalances the other, means for supplying said chamber with a fluid, and means for utilizing a portion of the operating fluid, for providing the rotatable carrier with an opposing force substantially equal to the lateral force of the operating fluid on the carrier to counterbalance the same.

73. The combination of a cylinder, a shaft located centrally of the cylinder, an abutment within the cylinder having a cylindrical chamber disposed eccentrically to the shaft, a rotatable cylindrical carrier mounted on the shaft and located in said chamber with its outer wall in contact with the wall of the chamber, pistons mounted on the carrier, and movable radially relative thereto, means for holding the pistons in contact with the wall of the chamber as the carrier rotates, means for counterbalancing one piston by the other, means for supplying said chamber with an operating fluid, and means for utilizing a portion of the operating fluid, for providing the rotatable carrier with an opposing force substantially equal to the lateral force of the operating fluid on the carrier to counterbalance the same.

74. The combination of a fixed member having a cylindrical chamber located eccentrically thereof, a cylindrical carrier within said chamber having its outer surface in running contact with the wall of said chamber, radial pistons carried by said carrier, means for supplying an operating fluid to said chamber for rotating the carrier, and fluid pressure means for holding said rotating carrier in a proper running contact with the wall of the chamber.

75. The combination of a fixed member having a cylindrical chamber located eccentrically thereof, a cylindrical carrier within said chamber having its outer surface in running contact with the wall of said chamber, radial pistons carried by said carrier, means for supplying an operating fluid to said chamber for rotating the carrier, and fluid pressure means for holding said rotating carrier in a proper running contact with the wall of the chamber, the wall of said chamber contacting with the rotary carrier and having formed therein a plurality of staggered grooves extending longitudinally of the chamber.

76. The combination with a cylinder, a fixed member within the cylinder, said fixed member having a cylindrical chamber formed therein, a rotatable cylindrical carrier within said chamber and having its outer wall in running contact with the inner wall of said chamber, radial pistons carried by said carrier, means for supplying an operating fluid to said chamber for rotating the carrier, a movable member connected to the carrier, and means for directing a portion of the operating fluid against said movable member at a point to create a force on the rotatable carrier opposite the lateral forces thereon by the operating fluid whereby said carrier is held in proper running contact with the wall of the chamber.

77. The combination with a cylinder, a fixed member within the cylinder, said fixed member having a cylindrical chamber formed therein, a rotating cylindrical carrier rotated within said chamber and having its outer surface in running contact with the inner wall of the cylindrical chamber, radial pistons carried by said carrier, means for supplying an operating fluid to said chamber for rotating said carrier, and fluid pressure means for holding said rotating carrier in proper running contact with the wall of the chamber.

78. The combination of a fixed member having a cylindrical chamber located therein, a rotatable piston carrier within said chamber having its outer surface in running contact with the wall of said chamber, pistons carried by the carrier, means for supplying an operating fluid to said chamber for rotating the carrier, and members connected to the carrier and rotatable against the outer wall of said fixed member whereby at the point of running contact the fixed member is embraced between said carrier and said rotatable members to maintain said rotatable carrier in constant running contact with the inner wall of said cylinder to create a seal between the carrier and the inner wall of the cylinder and between the outer wall of said fixed member and said members.

79. The combination of a fixed member having a cylindrical chamber therein, a piston carrier eccentrically mounted in said chamber, oppositely disposed pistons mounted on said carrier and movable radially relative thereto, and means for holding the pistons in contact with the wall of the chamber as the carrier rotates and allow the pistons to move radially relative to each other, said means including devices for connecting one piston to the other, whereby the centrifugal force acting on the pistons are counterbalanced one by the other.

80. The combination of a fixed member having a cylindrical chamber therein, a piston carrier eccentrically mounted in said chamber, oppositely disposed pistons mounted on said carrier and movable radially relatively thereto, and means for holding the pistons in contact with the wall of said chamber as the carrier rotates and allow the pistons to move radially relative to each other, said

means including devices for connecting one piston to the other, whereby the centrifugal force acting on the pistons are counterbalanced one by the other, said devices being so constructed as to allow an angular movement of the holding means for one piston relative to the other.

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

BENJAMIN F. AUGUSTINE.

Witnesses:
JOHN H. SIGGERS,
GEO. C. SHOEMAKER.