

March 9, 1937.

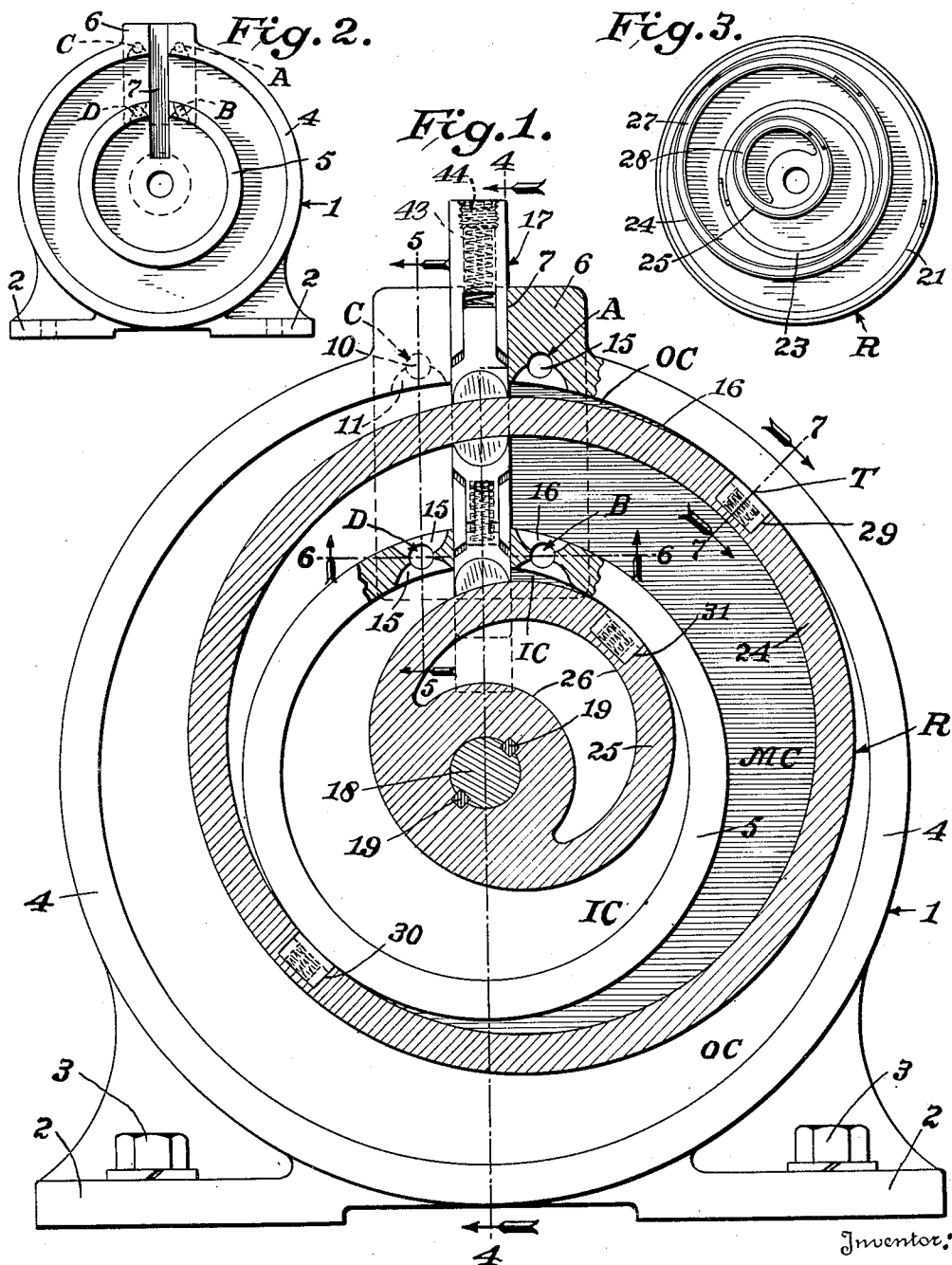
E. F. FOX

2,073,101

ROTARY PRIME MOVER

Filed Dec. 15, 1934

3 Sheets-Sheet 1



Inventor:

Eston F. Fox,
Parker Cook

By

Attorney.

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E. F. FOX

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Fig. 4.

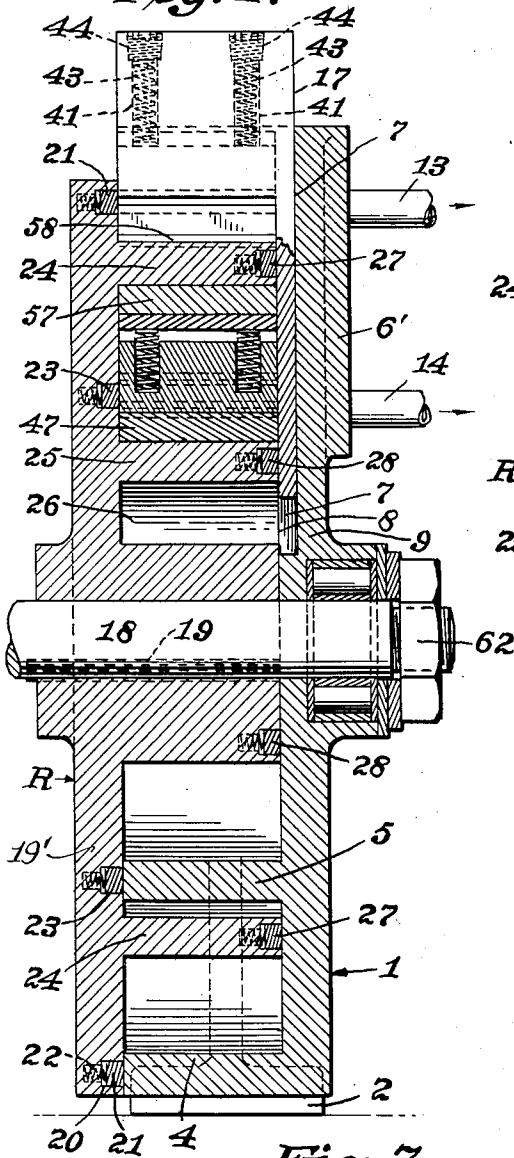


Fig. 5.

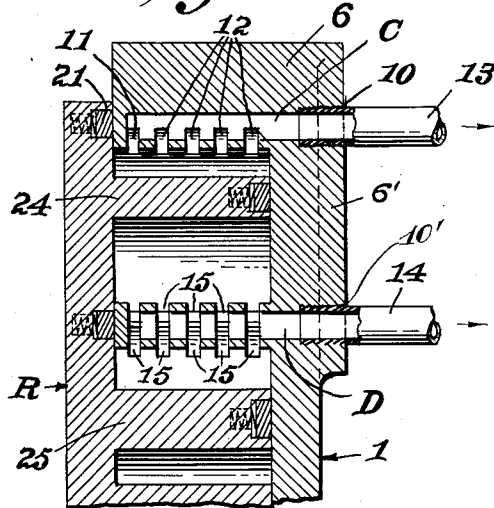


Fig. 6.

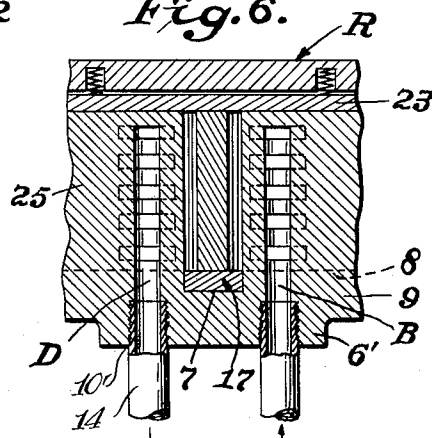


Fig. 8.

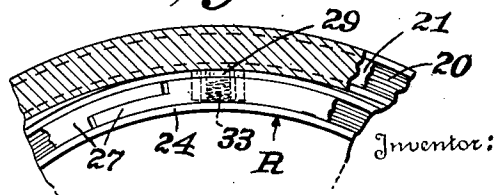
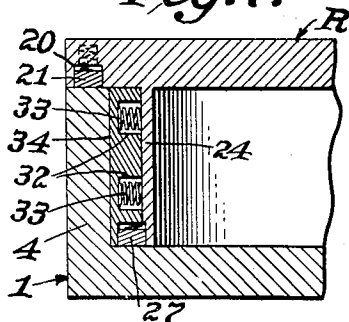


Fig. 7.



By *Eston F. Fox,*
Parker Cook

Attorney.

March 9, 1937.

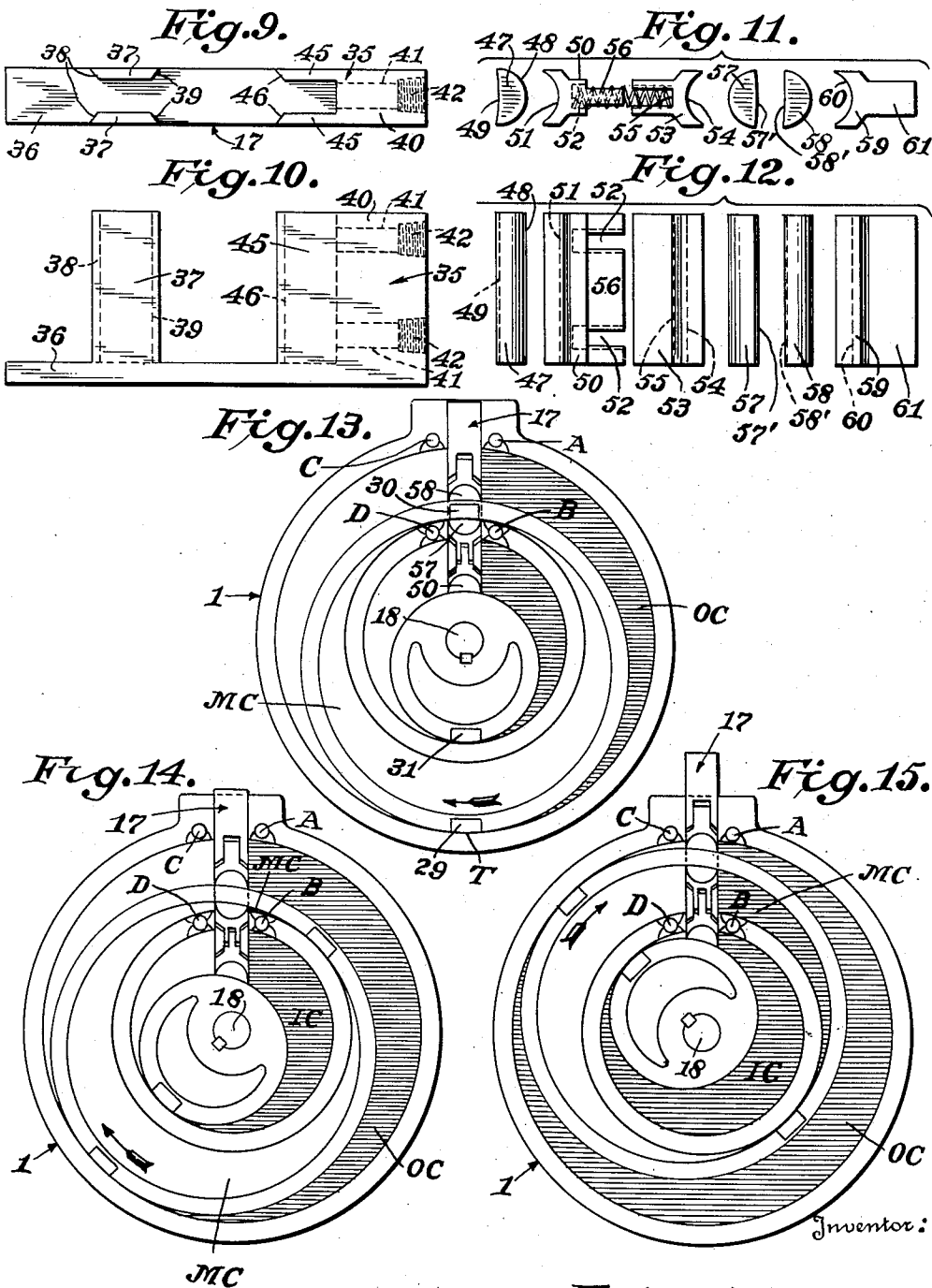
E. F. FOX

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ROTARY PRIME MOVER

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3 Sheets-Sheet 3



Eston F. Fox,

By

Parker Cook,

Attorney.

UNITED STATES PATENT OFFICE

2,073,101

ROTARY PRIME MOVER

Eston F. Fox, Hagerstown, Md.

Application December 15, 1934, Serial No. 757,723

8 Claims. (Cl. 121—68)

My invention relates to new and useful improvements in prime movers or pumps, and has for an object to provide a machine which includes a stator and a rotor, the rotary movement of which latter may be caused either by fluid pressure, that is, compressed air or steam, or the rotor may be mechanically driven by a belt or by gears when the device is used as a pressure or suction pump.

At the outset, it might be mentioned that for the sake of clearness of description and illustration, I have set forth the invention as being descriptive of a prime mover, but it will be readily understood by those skilled in the art that by the changing of a few mechanical details, such as possibly the arrangement of the ports, the invention is just as well adapted for use as a pump and the same, when so used, has proved highly efficient by actual test.

Heretofore, in prime movers or pumps of a rotary type, there have been certain disadvantages apparently inherent with the structure, one of these disadvantages being the difficulty in providing an efficient seal at the points throughout the cycle where the eccentric ring contacts are tangent to the stationary ring or what might be termed the chamber wall. Another disadvantage has been to provide an abutment that will prove to be air-tight or pressure-tight in conjunction with the rotating eccentric ring. Still another inherent disadvantage is that the motor has been low in efficiency due to the friction loss inherent to the organization of the moving parts. Finally, in most motors of this type with which I am familiar, there has been no means provided for an overlapping of power impulses similar to a multiple cylinder engine.

One of the principal objects, therefore, of the present invention is to provide a prime mover having a plurality of stationary concentric rings in the stator which, in reality, form a part of the chamber walls and a plurality of eccentric rings in the rotor which form another part of the chamber walls, and to so arrange the ports, that is, the inlet and exhaust ports, that fluid pressure may be admitted to simultaneously work in what might be termed two chambers. Then, before the rotor has advanced through one revolution or completed its cycle, further fluid pressure may be admitted to a third chamber. Thus, there is a continuous application of fluid pressure to the chambers, so that there is no dead center in the prime mover.

Still another object of the invention is to provide a prime mover of exceedingly simple struc-

ture consisting of but essentially two moving parts, that is, the rotor with its eccentric rings and what I term a sliding abutment operated, in turn, by the rotation of the eccentrically mounted rings, which abutment is provided with novel means for preventing leakage of the fluid pressure from one chamber to the other, either on its initial inlet of the fluid pressure or when under compression, if the prime mover is utilized as a pressure or as a vacuum pump.

Still another object of the invention is to provide a novel sliding abutment, which is operated through the rotation of the eccentric rings, and this abutment provides a fluid-tight seal between the revolving eccentric rings and is so formed as to always be seal-tight even after long continuous use, inasmuch as what I term the shoes are constantly under spring pressure. Even though they wear, this will be on an arc commensurate with the arc of the rings, thus providing a long life for the machine.

Still another object of the invention is to provide a mechanical structure, now about to be described in detail, that has numerous adaptations with but slight changes, so that it may either act as a driver or as a driven element and in both instances function with great efficiency.

With these and other objects in view, the invention consists in certain new and novel features and combination of parts, as will be hereinafter more fully explained and pointed out in the claims.

Referring now to the drawings showing one of the preferred embodiments,

Fig. 1 is a vertical section of the prime mover taken just inside the plate of the rotor and with the rotor advanced 45° from what I term the zero position;

Fig. 2 is a detail inside elevation of the stator on a reduced scale;

Fig. 3 is a similar view of the rotor;

Fig. 4 is a transverse sectional view taken on the line 4—4 of Fig. 1;

Fig. 5 is a fragmental detail sectional view taken on the line 5—5 of Fig. 1;

Fig. 6 is a fragmental detail sectional view taken on the line 6—6 of Fig. 1;

Fig. 7 is a fragmental detail sectional view taken on the line 7—7 of Fig. 1;

Fig. 8 is a fragmental detail sectional plan view of the parts shown in Fig. 7;

Fig. 9 is a detail plan view of the abutment strip with its component parts;

Fig. 10 is a side elevation thereof;

Fig. 11 is an exploded plan view of the adjust-

able elements composing the abutment member; Fig. 12 is a side elevation of the elements of Fig. 11;

Figs. 13, 14, and 15 are diagrammatic views 5 showing progressive positions throughout the cycle of the rotor.

Referring now more specifically to the several views, and for the moment to Fig. 1, there is shown a casing or stator 1 which is preferably 10 a casting, having the outstanding feet 2 which may be bolted, as at 3, to a fixed or mobile foundation. The casing 1, of course, may be of any diameter, depending upon the size of the prime mover desired. The casing is circular and has 15 the outer ring or wall 4, the thickness of which, of course, being such as to withstand the fluid pressure to which the prime mover will be subjected.

Preferably formed integral with the casing 20 and spaced from the ring or wall 4 is a second circular wall or ring 5 formed concentrically with the wall 4.

At the top of the casing, there is provided the upwardly extending lug 6, which is milled or cut-out, as at 7, to a depth slightly below the inner 25 face 8 of the rear wall 9 of the casing for the reception of a sliding abutment. This lug 6 also extends slightly outwardly from the rear wall of the casing, as at 6', and is drilled or bored 30 to form the inlet and exhaust ports to the chambers, as will now be described in detail.

In Fig. 1 may be seen two inlet ports A and B, which are formed in the rings 4 and 5, respectively.

35 Likewise opposite the inlet A is the exhaust port C formed in the ring 4, and opposite the inlet B is the exhaust port D formed in the ring 5. As the structural formation of the inlet and outlet ports is the same, and Fig. 5 shows in detail 40 the manner in which the exhaust ports are formed, reference is now made to these ports C and D.

As may be seen in Fig. 5, the exhaust port C, for instance, is bored, as at 10, through the lug 6 45 and extends nearly through the ring 4, terminating at one of the cut-out or milled portions 11. It will be noticed that there are additional milled portions 12 which register with the bore 10, so that, as will be explained, the fluid pressure may 50 escape through these milled portions 12 of the exhaust port and out through the bore 10 where there may be an extension pipe 13, if desired. In the same manner, there may be seen in Fig. 5 55 the exhaust port D consisting of the bore 10' and extension pipe 14, but in this instance the milled portions 15 extend on both sides of the ring 5 (see Fig. 1), so that the fluid pressure may escape from either side of the ring 5, the purpose of which will be hereinafter explained.

60 In the same way are formed the inlets A and B, that is, the bores 15 and 16 may be seen and the milled portions (Figs. 1 and 6) extend inwardly from the opposite sides of the ring to the bore 16. In other words, the inlet port A is similar to the exhaust port C while the inlet port 65 B is similar to the exhaust port D, the inlet ports A and B, however, being to the right of what I term the abutment 17, which will shortly be described in detail, and the exhaust ports 70 being to the left of the abutment with reference to Fig. 1.

As far as the stator is concerned, therefore, there is the circular casing with the two concentric rings 4 and 5, the ring 4 having an inlet port A 75 and an outlet port C and the ring 5 also provided

with an inlet port B and an outlet D, while spaced between these ports is the groove or track 7 for the reception of the sliding abutment 17.

Having described the structure of the stator, reference will now be made to the rotor and its 5 construction.

Description of the rotor

Referring now for the moment to Figs. 1 and 3, there will be seen the rotor R which includes 10 the shaft 18, which may be keyed, as at 19, (Fig. 1), to the plate 19' of the rotor R, this plate being of the same outside diameter as the stator. On the inner face of the plate of the rotor, there is 15 cut a suitable groove 20, so that a packing ring 21 may be inserted therein, while in the bottom of the groove holes may be drilled for the reception of small coil springs 22 see Fig. 7. Thus, this packing ring will bear tightly against the 20 outer face of the wall 4 (Fig. 2) when the rotor is in position to prevent any leakage from between the stator and rotor.

In the same manner, another ring 23 spaced inwardly from the periphery of the plate of the 25 rotor is provided, so that this ring will contact on its face with the concentric ring 5 of the stator and both rings 4 and 5 are sealed against leakage.

Now on the inner surface of the plate of the 30 rotor are two preferably integral eccentric rings 24 and 25, the ring 25 being in the nature of a circular plate but cut-out, as at 26, for the purpose of lightness, and the center of these two rings being struck from a point slightly remote, 35 eccentric, from the central axis of the shaft 18 and the axis of the stator rings.

So that these eccentric rings will also be leak-proof or pressure-tight, I have provided the packing rings 27 and 28, these packing rings being in 40 the side faces of the rotor rings (Fig. 3), and these rings, in turn, bearing against the inner rear wall of the stator. Thus, with these four packing rings, the air or fluid pressure will be sealed against leakage, that is, between the side 45 faces of these concentric and eccentric rings.

Also in a motor of prime mover of this kind, it is necessary to provide seals on the outer peripheries of the eccentric rings, so that at the point of tangency with the concentric rings the 50 air or fluid pressure will be prevented from escaping.

Thus, it will be noticed from Fig. 1 that there are shown the seals 29 and 30 which are spaced at opposite points in the outer eccentric ring 24 55 and the further seal 31 in the inner eccentric ring 25. These seals, for example, (see Fig. 7), are spring-pressed, which is accomplished by milling out the spaces 32, in which spaces are placed the springs 33 to hold the small plate or seal proper 34 (Fig. 7) under tension to thus 60 form a tight contact with the concentric ring throughout its rotary movement, and it will be noticed that these seals are positioned at the point of tangency with the stationary or concentric rings. 65

It will be seen, as far as the description has proceeded, that there is a tight seal where the concentric rings of the stator bear against the inner face of the rotor and also between the 70 rings of the rotor where they bear against the inner face plate of the stator, and furthermore sealing means is provided between the respective rings at their points of tangency.

Lastly, it is necessary to provide a pressure- 75

proof sealing means between the eccentric rings and the sliding abutment 17, which abutment is operated by the inner and outer eccentric rings, and this is accomplished in the following manner.

Description of the abutment

Referring now for the moment to Figs. 9 to 12, inclusive, there will be seen the several parts that make up the abutment 17. In Fig. 9, there is shown what I term the cage 35 having the base portion 36 and two upstanding walls 37 which are beveled, as at 38, and also on their opposite edges, as at 39. There is also the rear upstanding wall 40 which is bored longitudinally, as at 41, and these bores may be internally threaded, as at 42, so that small springs 43 (Fig. 1) may be placed within the bores and held in place by retaining screws 44.

To the left of the wall 40 (Fig. 9), there may also be seen the opposite upstanding walls 45 which are beveled at their forward edges, as at 46, these walls 45, in reality, forming a small pocket, through the rear wall of which extend the bores 41.

Referring now for the moment to Figs. 11 and 12, there may be seen the several shoes and carriers, and describing these from the left there may first be seen the shoe 47 which may be of cast iron and which will form a good mechanical seal with the ring 25. It will be noticed that the shoe might be termed half round, that is, the rear surface is convex, as at 48, while the forward or front surface 49 is slightly concave, the arc of the concavity being similar to the arc of the inner eccentric ring 25.

This shoe 47 fits within the carrier 50, the forward face of which is also concave, as at 51, so that the shoe 47 may fit snugly within the same and still slightly rotate to change its position, according to the shifting position of the inner eccentric ring during its rotation. This carrier 50 is also bored in its tongue 56, as at 52, so that springs may be placed therein which, in turn, will bear against the opposite carrier 53, which is also formed with a concave front surface 54 and is slotted at its rear, as at 55, to receive the tongue 56 of the carrier 50.

Still progressing from left to right, there is seen a further shoe 57, which is somewhat similar to the shoe 47 but is oppositely positioned, and likewise there may be seen another shoe 58, which is similar to the shoe 47 in both its position and construction, and this, in turn, fits within a carrier 59, which is cut-out, as at 60, and has the rearwardly extending tongue 61, which latter fits between the walls 45 of the cage 35.

It might be mentioned that there is a slight difference in the faces of the shoes 57 and 58 from that of the shoe 47, and that is, the face 57' of the shoe 57 is slightly convex rather than concave or, in other words, is struck on an arc commensurate with the arc of the inner surface of the first eccentric ring 24. In the same way, the face 58' of the shoe 58 is struck on an arc such that it will contact throughout its width at all times with the outer surface of the first eccentric ring 24.

It will be understood that as the rotor makes its revolutions, the abutment will travel inwardly and outwardly, (Fig. 1), and that as the eccentric rings rotate and approach and diverge from the concentric rings, the shoes in the abutment will oscillate and at all times bear tightly

against the inner and outer faces of the first eccentric ring and against the outer face of the inner eccentric ring, thus providing a tight seal at all times between the sliding abutment and the eccentric rings.

By providing the cage and carriers, it will be seen that the shoes not only lie flush throughout their width with the eccentric rings but as they wear, the wear will be taken care of as the shoes are under spring tension, thus assuring a long and serviceable life to the abutment. The width of the abutment, of course, is such that when in its groove it will bear tightly against the inner face of the plate of the rotor and against the packing rings 21 and 23 of the rotor.

Having described the physical characteristics of both the rotor, with its eccentric rings, and the stator, with its concentric rings, together with the position of the ports, as well as the manner of sealing the rings with respect to each other and with respect to the rotor plate, and having described in detail the abutment 17 a brief description of the operation of the device in toto follows.

It will be understood that when the rotor and the stator are assembled, means in the way of washers and a nut are provided, as at 62, for holding the rotor plate 19' tightly against the stator. For the purpose of illustration, it will be supposed that compressed air from a storage tank (not shown) will be connected with the inlets A and B.

Also for the purpose of clearness of illustration, presume that in Fig. 1 the rotor has been revolved from what I term a zero position to the position shown in Fig. 1, that is, its having revolved about 45°.

It will be noticed that the eccentric ring 24 is tangent at the point marked "T" to the concentric ring 4, so that the seal 29 in the rotor tightly contacts the ring 4 at this point. It will also be noticed that the inlet port A is now open so that the compressed air may occupy the now relatively small chamber or space OC that exists between the two rings and to the rear of the seal 29. The rear of the chamber is, of course, one of the side walls of the abutment 17.

In a like manner, it will be seen that the fluid pressure through the inlet B will occupy the chamber IC formed between the inner eccentric ring and its adjacent concentric ring, so that these two chambers always operate in unison. Now the fluid pressure will cause the rotor to move and I have shown a further position in the cycle in Fig. 13. In this instance, the rotor has traveled 135° from its position of Fig. 1 and it will now be noticed that the outer eccentric ring is tangent to the inner concentric ring at a point in line with the abutment and is also tangent at a point diametrically opposite the abutment to the outer concentric ring, while the inner eccentric ring is tangent to the inner concentric ring at a point diametrically opposite the abutment. It will also be noticed that the chambers OC and IC have now enlarged a considerable amount.

In Fig. 14, I have shown a further position in the cycle, and considering now what I term the middle chamber, referred to as MC, that is, the space between the outer eccentric ring, the inner concentric ring, and the abutment 18, it will be remembered that the inlet port B feeds to both sides of the inner concentric ring 5, so that fluid pressure will now be admitted to this newly formed MC chamber to apply an over-

lapping power impulse before the rotor has finished one complete cycle.

Referring for the moment to Fig. 15, it will be seen that the rotor having advanced to this position, fluid pressure is now being admitted to what I term the outer chamber OC, the inner chamber IC, as well as the middle chamber MC.

Referring to the exhaust side of the motor, (Fig. 13), and considering the exhaust cycle rather than the intake, and considering first the rotor in the position as shown in Fig. 1, that is, in the position described as the intake, it will be seen that as the rotor revolves, the air or steam in the OC chamber, as well as the MC chamber and in advance of the seals 29 and 30, respectively, will be compressed or driven out or may escape through the exhaust ports C and D. Likewise, when the rotor has made a half revolution as to the position shown in Fig. 13, the exhaust port D opens, so that the spent fluid pressure in the middle chamber MC may escape through this port. When the rotor reaches the position as shown in Fig. 14, the exhaust port C is still open as well as the exhaust port D both from the middle and intermediate chamber, so that the now spent fluid pressure is at this time exhausting from all three chambers and, at the same time, it will be noticed that the inlet ports are open to all three of the chambers on the inlet side of the motor.

It will also be noticed that in some positions, that is, in the position as shown in Fig. 14, for instance, that the exhaust port D will be open in the middle chamber, i. e., on the exhaust side of the abutment and will also be open to the inner chamber on the exhaust side, so that the exhaust from the middle chamber and the exhaust from the inner chamber are open to each other but the pressure will soon equalize and escape through the port D.

It will further be noticed that in the cycle of the rotor, the sliding abutment moves inwardly and outwardly with the eccentric movement of the inner and outer rings, but at all times forms a tight seal with the rings and forms what might be termed the rear wall of the chambers on the inlet side and the front wall of the chambers on the exhaust side. In Fig. 1, the dotted line of the track for the abutment shows the innermost limit of the abutment. In Fig. 13, the abutment is shown in its innermost position and in Fig. 15, it is approaching its outermost position.

As will be seen, I refer to chambers on the expansion and exhaust sides of the motor and also outlet ports on the exhaust side and the inlet ports on the expansion side, but in reality during different positions of the eccentric rings, the chambers will extend practically from one side of the abutment around to the opposite side thereof, as these chambers, of course, change their shape and size during the orbital movement of these rings.

From the foregoing, it will be seen that I have provided a rotary type prime mover consisting primarily of three chambers, two of which operate in the same phase and the third of which provides overlapping power, so that force at all times is applied to the rotor.

It will be understood that if it were desired to use the motor as a pump, it would only be necessary to drive the rotor with a belt or with gears and possibly change the arrangement of the ports slightly, so that instead of the air being

exhausted it will be compressed and stored in a storage tank. In the same way, it is within the scope of the invention to so drive the motor that it might act as a vacuum pump (on the expansion side) to evacuate a chamber or vessel.

Finally, it will be noticed that by providing the several chambers, there is a continuous fluid pressure power application to the rotor throughout its cycle.

Many slight changes are possible in the construction hereinbefore set forth without in any manner departing from the spirit of the invention.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. A prime mover including a stator and a rotor, a shaft concentrically mounted in the rotor and keyed thereto, the stator having a plurality of concentric rings and the rotor having a plurality of eccentric rings and the eccentric rings respectively tangent to the concentric rings throughout their entire rotary movement to form expansion and exhaust chambers, a sliding abutment mounted in a groove in the stator and extending to the inner eccentric ring and operated by the movement of the eccentric rings, said abutment also forming a means for dividing the space between the rings into expansion and exhaust chambers, and inlet and outlet ports formed in the concentric rings and on opposite sides of said abutment for providing inlets to the expansion chambers and outlets from the exhaust chambers and one of said inlet ports extending to the inner and middle chambers.

2. A prime mover including a stator and a rotor, a concentric shaft keyed to the rotor, the stator having a plurality of concentric rings and the rotor having a plurality of eccentric rings, the eccentric rings respectively being tangent to the concentric rings at a point throughout the entire rotary movement of the rotor to thereby form increasing and diminishing expansion and exhaust chambers, the stator being provided with a vertical groove, a sliding abutment mounted in the groove of the stator through which abutment said eccentric rings pass and the movement of the eccentric rings actuating the sliding abutment, said abutment also forming certain walls of the expansion and exhaust chambers, inlet ports one leading to the outer chamber and the other leading to the inner and middle chambers formed in the concentric rings at one side of the abutment and outlet ports formed in the concentric rings at the other side of the abutment, and the movement of the eccentric rings of the rotor properly opening and closing the said inlet and outlet ports.

3. A prime mover consisting of a stator and a rotor, the stator having two concentric rings and the rotor having two eccentrically positioned rings, the eccentric rings tangent throughout their orbital movement to the said concentric rings to thereby form chambers, a sliding abutment in the stator through which one of the eccentric rings passes and against which the other eccentric ring bears, inlet ports in the concentric rings at one side of the abutment, one of said ports leading to the outer chamber and the other of said ports leading to the inner and middle chambers, and outlet ports in the concentric rings at the other side of the abutment, one of said outlet ports leading from the outer chamber and the other of said outlet ports leading from the inner and middle chambers, sealing

means positioned on the periphery of the eccentric rings at their point of tangency with the concentric rings, a further sealing means on one of the eccentric rings at its point of tangency with the inner concentric ring, and likewise sealing means on the abutment for contact with the eccentric rings whereby the eccentric rings are sealed with respect to the concentric rings and to the abutment.

10 4. A prime mover including a stator and a rotor, a plurality of concentric rings and a plurality of eccentric rings, the eccentric rings being tangent to the concentric rings to thereby form chambers, a radial track in the stator, a sliding abutment through which one of the eccentric rings passes and against which the other of the eccentric rings abuts, said abutment provided with arcuate rockable shoes adapted to rock in either direction to thereby form a tight seal with the eccentric rings regardless of their position in the cycle, and said stator provided with inlet and outlet ports that are opened and closed by the rotation of one of said eccentric rings, one of the said inlet ports communicating only with the outer chamber and another of the said inlet ports communicating with the inner and middle chambers.

30 5. A prime mover including a stator and a rotor, concentric rings on the stator, eccentric rings on the rotor and the eccentric rings tangent to the concentric rings to thereby provide an inner chamber, a middle chamber, and an outer chamber and the outer and inner chambers operating in synchronism, inlet ports extending into all of said chambers, the ports for the inner and middle chamber being formed in a concentric ring and outlet ports extending from said chambers, the inlet ports to the outer and inner chambers opening before the opening of the port to the middle chamber, and the one inlet port extending only to the outer chamber and

another inlet port extending to the inner and middle chambers.

6. A prime mover including a rotor and a stator, concentric rings on the stator and eccentric rings on the rotor and the eccentric rings tangent to the concentric rings to thereby provide inner, middle, and outer chambers, a radial track extending from the center of the stator to its outer periphery, a box-like sliding abutment movable in said track one end of which contacts with the inner eccentric ring while the outer eccentric ring passes through said abutment, rockable spring-pressed shoes adapted to rock in either direction formed in the abutment to bear at all times against said eccentric rings to seal the same throughout their revolution, and further seals on the eccentric rings at their point of tangency with the concentric rings to thereby seal the rings with respect to each other.

7. In a prime mover, a unitary sliding abutment consisting of a cage, a carrier in said cage, the forward end of the carrier being arcuate and a shoe having an arcuate rear face fitting within said carrier, spring means in the cage for forcing the shoe outwardly, further oppositely positioned shoes in said cage, and a spring-pressed carrier between said shoes to thereby force said last-mentioned shoes outwardly with respect to each other.

8. In a sliding abutment for a prime mover, a cage, a carrier near one end of said cage, the said carrier having a concave face, a shoe having a concave inner face fitting within said carrier, a further carrier and an oppositely positioned shoe and means between the two shoes for forcing the same outwardly from each other, and a further carrier and shoe and means for forcing the last-mentioned carrier and shoe toward one of the aforementioned shoes and the abutment adapted to slide in a track of substantially the same width and be removable as a unit.

ESTON F. FOX.