R. GRAF.

ROTARY FLUID POWER DEVICE.

APPLICATION FILED JAN. 24, 1910. RENEWED MAR. 15, 1912.

1,042,215. Patented Oct. 22, 1912.

3 SHEETS—SHEET 1.

Fig. 1

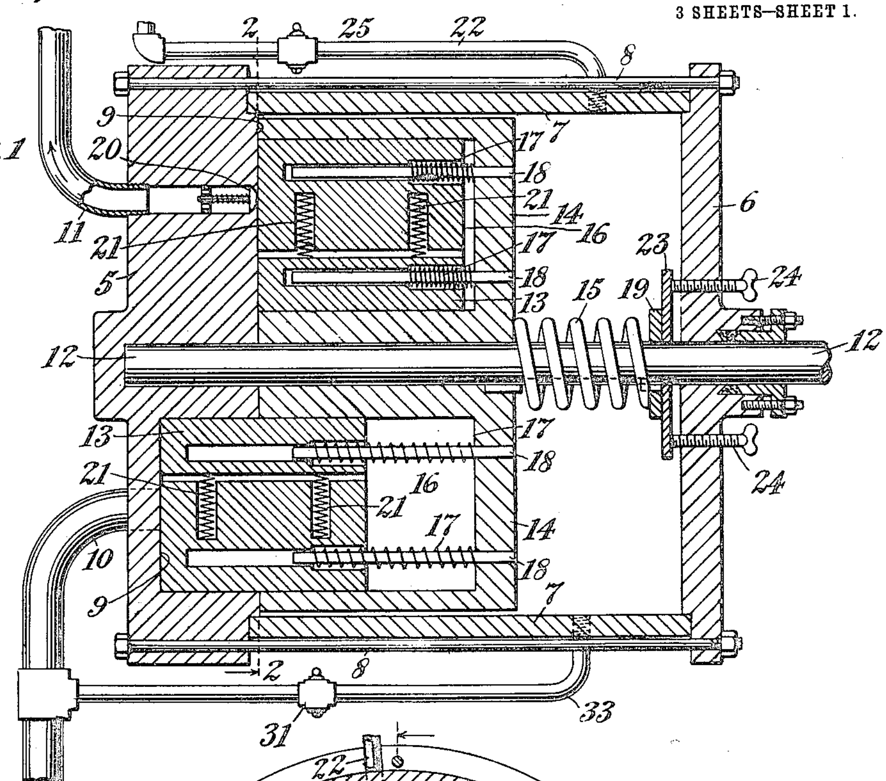
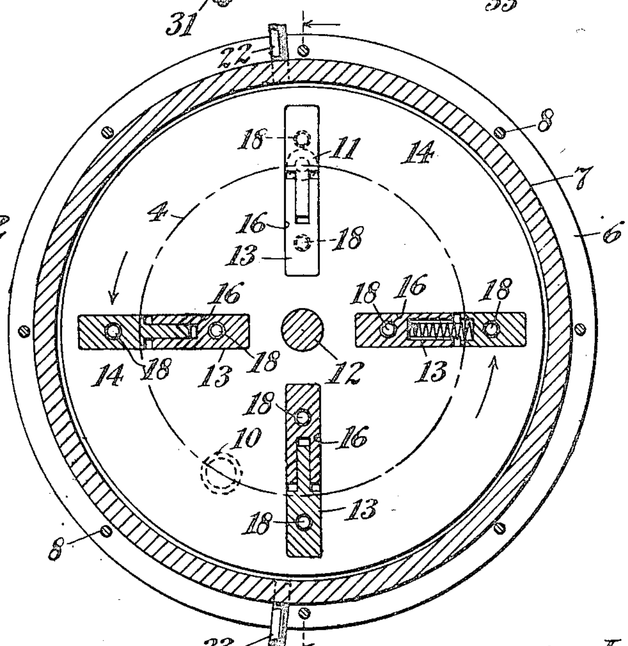



Fig. 2

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3 SHEETS—SHEET 2.

*Fig. 3*

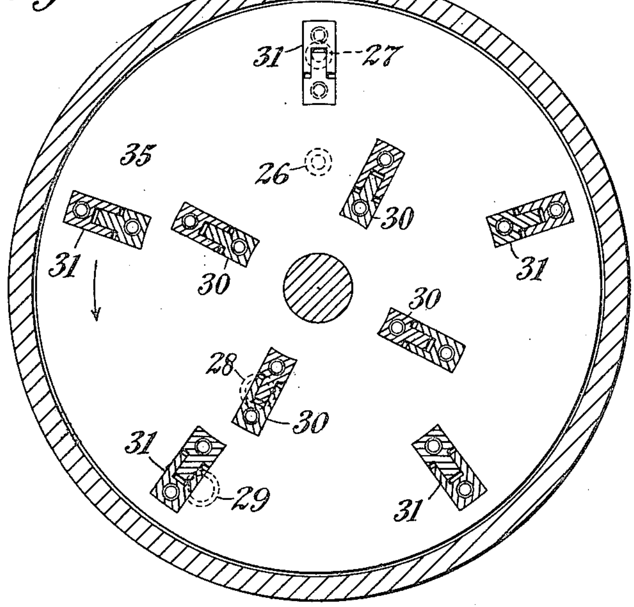
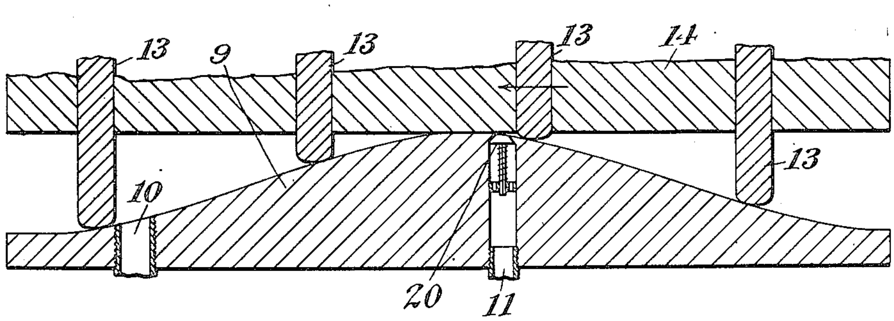



*Fig. 4*

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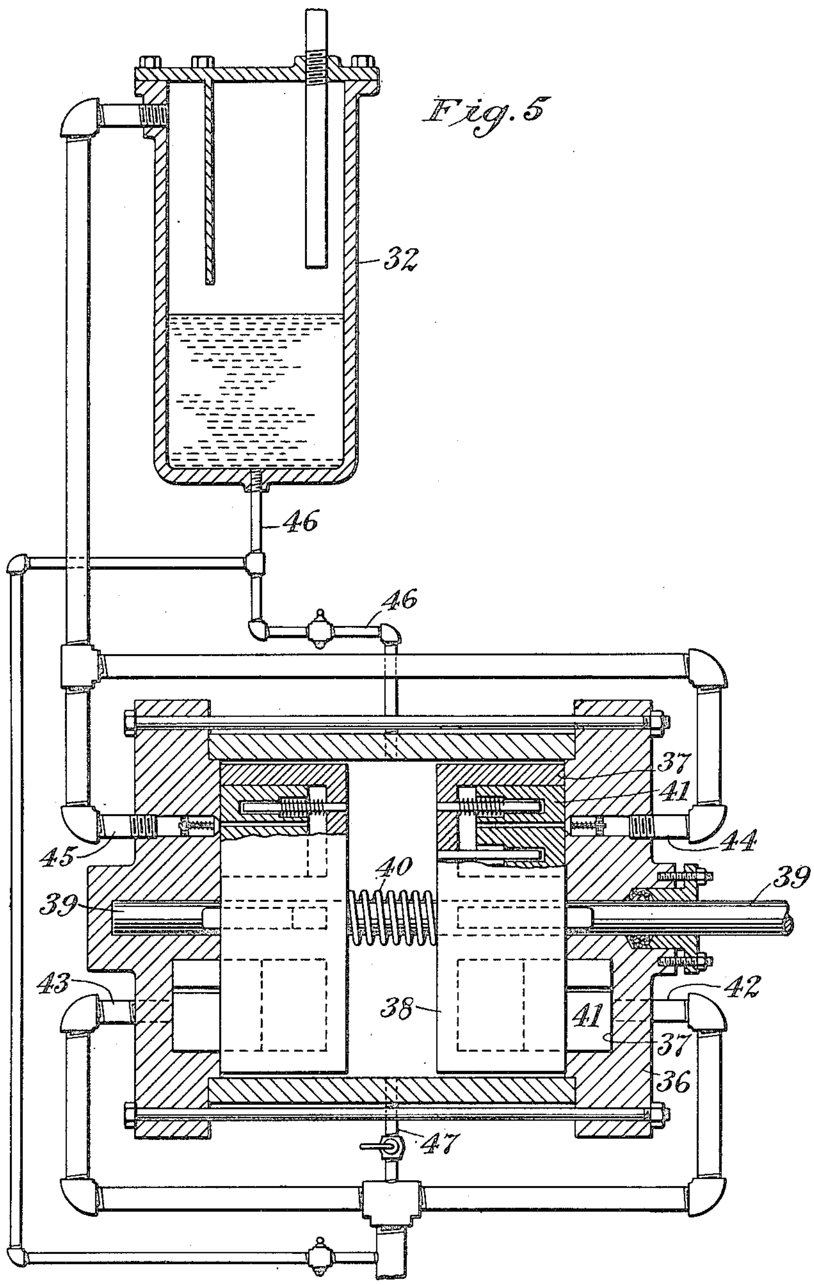
3 SHEETS—SHEET 3.

Fig. 5

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# UNITED STATES PATENT OFFICE.

RICHARD GRAF, OF NEW YORK, N. Y., ASSIGNOR, BY DIRECT AND MESNE ASSIGNMENTS, OF TWO-THIRDS TO WALTER E. SAVAGE, ONE-NINTH TO ALFRED MACKAY, AND ONE-NINTH TO R. GORDON MACKAY, ALL OF BROOKLYN, NEW YORK, AND ONE-NINETIETH TO BENJAMIN C. WICKES, OF AUBURN, NEW YORK.

## ROTARY FLUID-POWER DEVICE.

1,042,215. Specification of Letters Patent. Patented Oct. 22, 1912.

Application filed January 24, 1910, Serial No. 539,678. Renewed March 15, 1912. Serial No. 684,008.

*To all whom it may concern*

Be it known that I, RICHARD GRAF, a citizen of the United States, residing in the borough of Brooklyn, city of New York, in the county of Kings and State of New York, have invented certain new and useful Improvements in Rotary Fluid-Power Devices, of which the following is a specification, reference being had therein to the accompanying drawings, forming part thereof.

My invention relates generally to fluid circulating, compressing and motor apparatus of the rotary type, although the means embodying my invention and hereinafter described have been particularly designed for use as a fluid compressor for refrigerating purposes.

My invention has for its general objects simplicity, efficiency, compactness, reliability and durability.

More particularly, one of the objects of my invention is to do away with the necessity for clearance between the relatively movable parts of a compression chamber or chambers, thereby permitting the complete expulsion of all fluid during each cycle of operation or working movement.

Another object of my invention is the automatic relief of compression in an emergency so as to prevent explosions or breakage under conditions of abnormal pressure.

Another object of my invention is the reduction to a minimum of the leakage of compressed or pumped or motive fluid.

Another object of my invention is high speed of operation.

Another object of my invention is the balancing of the pressures on the moving parts and an adjustment of opposing pressures.

Other objects and advantages of my invention will appear from the following description.

I shall now describe my invention with reference to the accompanying drawings and shall thereafter point out my invention in claims.

Figure 1 is a vertical central longitudinal section of a complete device embodying my invention. Fig. 2 is a vertical transverse section of the same, taken on the line 2—2, Fig. 1, looking toward the right. Fig. 3 is a view similar to Fig. 2 of a modified embodiment of my invention. Fig. 4 is a development of the compression chamber of the construction shown in Figs. 1 and 2, on a section cut on a circle concentric with the axis of the shaft and passing through the inlet and outlet ports, and indicated at 4 in Fig. 2. Fig. 5 is a longitudinal vertical section, but with rotating inner heads and partitions partly in elevation, of another modified construction.

I have shown my invention as embodied in compressors and shall describe it as thus embodied, although it will be understood that it comprehends service as a pump or meter, or by reversal of operation as a motor, or other evident embodiments.

In the embodiment of my invention illustrated in Figs. 1, 2 and 4 of the drawings, I employ a cylindrical casing comprising a cylindrical wall 7, a front circular head 5 having the compression chamber therein and a rear circular plate 6, the parts fitted together in a fluid-tight manner and held together by clamping bolts 8, extending exteriorly of the casing through holes provided in the end plates.

An annular cam-face 9 is formed on the inner face of the front plate 5 and forms one end wall of the compression chamber, the configuration of this cam being particularly shown in the development, Fig. 4. A fluid inlet 10 enters the chamber at a part of the cam near the outer end of the casing, and an outlet 11 leaves the chamber in immediate proximity to the part of the cam farthest from the outer end of the casing, as shown in Figs. 1 and 4. A driving shaft 12 extends longitudinally through the casing coaxially therewith and with the end cam 9, and extends exteriorly of the casing through a tight joint in the rear plate 6 for the application of power from any suitable source.

Coacting with the cam-face 9 are a plurality of axially movable partitions 13, shown as four in number, which serve as radial partitions for the compression chamber and are carried by a rotary inner head 14, which forms the inner end wall of the compression chamber, is cylindrical in shape, and is preferably of slightly smaller outer diameter than the inner wall of the casing, to allow for expansion of the inner head when heated in the compressing operation. To impart rotation to the inner head 14, this head is splined to the driving shaft 12, as shown, so as to rotate with but be free to move longitudinally thereon, and a helical thrust spring 15, surrounding the driving shaft behind the inner head 14, bears against the inner head and holds it up against the raised part of the cam-face and the annular walls of the front plate inside of and outside of the cam-face, which are flush with the raised or extreme inner part of the cam-face and constitute annular sealing surfaces or bearing faces which contact with the opposed annular sealing surfaces or bearing faces on the inner head 14, forming concentric continuations with the plane face thereof opposite to the cam-face 9, so as to make a fluid-tight joint at this place, but to hold it tight with a yielding pressure, such as will accommodate expansion due to heating of the parts and will yield to prevent explosion or other breakage. Axial and radial partition-receiving slots 16, somewhat deeper than the lengths of the partitions 13, are formed in the front face of the head 14 for the reception of the partitions 13, and guide-rods 18 are secured in the inner rotating head and extend into bores in the partitions and serve to guide and hold in position helical thrust springs 17 surrounding the guide-rods 18, and which bear axially in the slots 16 behind the partitions 13 and hold the partitions out to their work against the cam 9.

Fluid enters through the inlet 10 into the chamber formed between the two adjacent partitions 13 immediately in front and rear of the inlet port, and between the cam 9 and the rotary inner head 14, and as the inner head 14 is rotated by the driving shaft 12, the partitions are carried around until the rear partition is in front of the inlet port and the fluid is trapped into this space, which is now of maximum dimensions and capacity. As the rotation continues, the partitions are moved back into their slots in the inner head 14 by the cam 9, and the chamber or space in which the fluid is trapped grows continually smaller due to the rise of the cam, and the fluid, having no escape, is compressed in the diminishing space. After the front partition passes the outlet port, the compressed fluid begins to escape through the outlet 11, and since the inner head 14 rotates in contact with the cam at and beyond the edge of this outlet, all of the compressed fluid is forced out at the outlet, a check valve 20 being provided flush with the face of the cam to prevent the return of any compressed fluid, rotational shifting of the check valve being prevented in any convenient manner, for example, by a squared valve stem, as indicated in the drawings. By thus causing actual contact of the opposed walls of the compression chamber, I eliminate all clearance and insure that no compressed fluid will be left in the chamber after a partition has passed the outlet port. After the partition in advance passes the outlet 11 and starts outward on the cam, being pushed out against the cam all the time by the springs 17, the chamber begins to grow again and a substantial vacuum is formed in the chamber. When it reaches the inlet port again, more fluid is forced into this vacuum space which has again resumed its original size, and the same operation is repeated.

It is to be noted that the inlet port 10, by reason of its location at the depressed portion of cam-face 9, is in communication with the chamber or space formed between two adjacent partitions 13 until such growing chamber or space has reached its maximum capacity, the partitions 13 being so spaced that at all times one or another of the partitions is located between the inlet and the raised portion of the cam-face 9.

As indicated in Fig. 2, the outlet port is more than 180 degrees beyond the inlet port so that at high compression there are three partitions between the outlet and the inlet in a backward direction while in advance of the outlet tightness is assured by the actual contact of the cam-face and inner rotating head, thereby reducing to a minimum any leakage to the inlet port. To insure tight joints between the partitions and the inner and outer cylindrical walls of the chamber, to compensate for wear and to permit expansion by heat without binding, the partitions are spreadable radially by being divided longitudinally into two or more parts, which are joined by a tongue and groove connection, as shown, and thrust springs 21, seated in bores provided at this connection as shown in Fig. 1, tend to spread the parts and make their lateral contact with the walls fluid tight.

As a safety device for preventing the compression from becoming too high or higher than desired, and to permit expansion from heating of parts without binding, I have provided the spring 15 yieldingly holding the rotary inner head 14 to its work, as above stated. I also provide means for applying balancing or counter pressure behind the inner head 14 to relieve the pressure upon the spring 15, and means for adjusting this counter pressure to any desired limit, so that under any pressure from the compression chamber greater than the balancing or counter pressure, the head will give way and the compressor become temporarily inoperative. A conduit 22 leads from the high pressure side of the apparatus, preferably from an oil separator 32, as shown in Fig.

5, to the space in the casing behind the head 14, and admits compressed fluid to this space to create pressure against the inner rotating head in opposition to the pressure of the fluid being compressed. The tension of the spring 15 may be adjusted by screws 24, bearing against an adjusting plate 23, which in turn bears against a sliding thrust collar 19, splined to the driving shaft 12 and bearing directly against the spring 15. When the counter pressure, consisting of the sum of the pressure of the compressed fluid admitted through the conduit 22 and of the spring 15, is as great as desired, the admission of further compressed fluid through the conduit 22 may be stopped by closing a cock 25 in the conduit 22, and the counter pressure remains constant. As soon as the chamber pressure exceeds this counter pressure, the spring 15 yields and the head 14 is forced back on the shaft 12 and spins idly around, the compressed fluid then passing over the raised or extreme inner part of the cam-face 9 from the delivery to the inlet side of the apparatus, a short circuit or by-pass thus being provided from the compression chamber to the vacuum chamber. When the chamber pressure again falls below the counter pressure, the disk is again forced back to operative position. By these means, automatic regulation is effected and an absolute and automatic safeguard is afforded against damage resulting from careless or ignorant operation of the compressor.

In some instances I may omit the counter-pressure conduit 22, supplying compressed fluid behind the head 14, and rely entirely upon the spring 15, which will then be of the required stiffness and adjusted to maintain the desired delivery pressure at the outlet 11.

In the operation of the compressor a considerable quantity of lubricating oil is used to seal the joints and lubricate the parts. Oil is supplied with the fluid to be compressed in the usual manner and is collected in the oil collector 32 (Fig. 5) in the usual manner. A considerable quantity of oil is usually maintained in the casing between the inner rotary head 14 and the rear plate 6, and may be readily supplied through the counter-pressure supplying pipe 22, which runs from the oil collector to this part of the casing, and may be drained from the casing when desired through a pipe 33, having a cock 34 therein and running from the casing to the inlet pipe 10.

My compressor may readily be increased in capacity by providing two concentric compression chambers, as shown in Fig. 3. In this construction there are two outlet ports 26 and 27, radially alined, and two inlet ports 28 and 29 also radially alined, the relative position of these ports being indicated in dotted lines. The inner chamber has four inner partitions 30, and the outer chamber has five partitions 31. The inner cam-face is as shown in the drawings heretofore described. The outer cam-face would be of the same construction, but of larger diameter, forming with the inner rotating head 35 an annular chamber of inner and outer diameter corresponding to the inner and outer diameter of the outer partitions 31. The outer partitions 31 are so arranged relatively to the inner partitions as to act successively, and consequently the compression occurs at shorter intervals than in the single chamber system. The connections of the two chambers are not shown. Obviously they could be connected as desired.

My compressor may readily be duplicated with the parts in reversed position, as shown in Fig. 5. Here the casing has been lengthened, the rear plate has been replaced by a rear head 36 having a cam-face 37 therein, in all respects a reversal of the outer head heretofore described. A second inner head 38 is splined to the driving shaft 39, and a common thrust spring 40 yieldingly presses each inner head outward to seal the compression chambers. The partitions 41 of the second chamber may be similarly, but oppositely, arranged to those of the first chamber and the inlets 42 and 43 joined and the outlets 44 and 45 joined. The outlets are shown as leading to an oil separator 32, above referred to, from which the counter-pressure and oil feeding pipe 46 leads to the casing, while an oil drawing pipe 47 leads from the casing to the inlet.

It is obvious that various modifications may be made in the constructions shown and above particularly described within the principle and scope of my invention.

I claim:

1. A rotary power device comprising two heads, one of which is rotary relatively to the other each having concentric opposed annular sealing surfaces, one of these heads having an annular cam-face concentric with and between the annular sealing surfaces and the other head having an annular face between the sealing surfaces and opposite to the cam-face and forming a chamber therewith, an inlet and an outlet for the chamber, a movable partition coöperative with the cam-face and carried by the head having the annular face opposite to the cam-face, and means for pressing together the opposed sealing surfaces of the two heads.

2. A rotary fluid power device having an annular chamber, an inlet and an outlet for the chamber, longitudinally movable partitions in the chamber, one of the end walls of the chamber being shaped to approach to and recede from the other end wall thereof and arranged as a cam to actuate the partitions, means for causing relative rotary movement between the cam-shaped end wall and the partitions, the end

walls of the chamber being mounted to yield apart and means for yieldingly pressing together the end walls of the chamber.

3. A rotary fluid power device comprising a casing with an end wall the inner face of which is a cam, a part within the casing having a face opposite the cam-face and forming with the casing a fluid chamber, yielding means for holding the inner part in operative position, an inlet and an outlet for the chamber, means for causing relative rotary movement between the casing and inner part, a plurality of axially reciprocative partitions carried by the inner part and coöperative with the cam-face, the partitions being actuated in one direction by the cam-face, and resilient means adapted to actuate the partitions in the other direction and also adapted to continuously hold them in yielding engagement with the cam-face.

4. A rotary power device comprising two heads, one of which is rotary relatively to the other each having concentric opposed annular sealing surfaces, one of these heads having an annular cam-face concentric with and between the annular sealing surfaces and the other head having an annular face between the sealing surfaces and opposite to the cam-face and forming a chamber therewith, an inlet and an outlet for the chamber, a movable partition coöperative with the cam-face and carried by the head having the annular face opposite to the cam-face, and resilient means for pressing together the heads to thereby cause yielding engagement of the opposed sealing surfaces.

5. A rotary fluid power device comprising a casing with an end wall the inner face of which is a cam, a part within the casing having a face opposite the cam-face and forming with the casing a fluid chamber, yielding means for holding the inner part in operative position, an inlet and an outlet for the chamber, means for causing relative rotary movement between the casing and inner part, and a plurality of axially reciprocative partitions carried by the inner part and coöperative with the cam-face.

6. A rotary fluid power device comprising a casing with an end wall, the inner face of which is a cam, a part within the casing having a face opposite the cam-face and forming with the casing a fluid chamber of annular form, an inlet and an outlet for the chamber, a shaft co-axial with the cam-face and carrying the inner part, the inner part being connected to the shaft so as to rotate therewith but to move axially thereon, yielding means for holding the inner part in operative position, and a plurality of axially reciprocative partitions carried by the inner part and coöperative with the cam-face.

7. A rotary fluid power device comprising a casing with an end wall the inner face of which is a cam, a part within the casing having a face opposite the cam-face and forming with the casing a fluid chamber of annular form, an inlet and an outlet for the chamber, a shaft co-axial with the cam-face and carrying the inner part, the inner part being connected to the shaft so as to rotate therewith but to move axially thereon, yielding means for holding the inner part in operative position, a plurality of axially reciprocative partitions carried by the inner part and abutting against the cam-face, and means to hold the partitions against the cam-face as the shaft and inner part are rotated.

8. A rotary fluid power device comprising an outer part with an end wall the inner face of which is a gradually rising and gradually falling cam, an inner part having a face opposite the cam-face and forming with the outer part a fluid chamber, an inlet for the chamber communicating therewith at the depressed portion of the cam-face and an outlet for the chamber communicating therewith at the raised portion of the cam-face, the highest portion of the cam-face forming a seal between the outlet and the inlet at a point in advance of the inlet and beyond the outlet, means for causing relative rotary movement between the outer part and the inner part, and a plurality of axially reciprocative partitions carried by the inner part and coöperative with the cam-face and so spaced that at all times one or another of the partitions is located between the seal and the inlet in advance of the inlet and beyond the outlet.

9. A rotary fluid power device comprising a casing with an end wall, the inner face of which is a cam, a part within the casing having a face opposite the cam-face and forming with the casing a fluid chamber of annular form, an inlet and an outlet for the chamber, a shaft co-axial with the cam-face and carrying the inner part, the inner part being connected to the shaft so as to rotate therewith but to move axially thereon, yielding means for holding the inner part in operative position, means for adjusting the yielding means to vary the force with which the inner part is held in operative position, and a plurality of axially reciprocative partitions carried by the inner part and coöperative with the cam-face.

10. A rotary fluid power device comprising a casing with an end wall the inner face of which is a cam, a part within the casing having a face opposite the cam-face and forming with the casing a fluid chamber, yielding means for holding the inner part in operative position, an inlet and an outlet for the chamber, means for causing relative rotary movement between the casing and inner part, a plurality of axially reciprocative partitions carried by the inner

part and coöperative with the cam-face and divided longitudinally into a plurality of parts, and means for radially spreading the partition parts.

11. A rotary fluid power device comprising a casing with an end wall, the inner face of which is a cam, a part within the casing having a face opposite the cam-face and forming with the casing a fluid chamber of annular form, an inlet and an outlet for the chamber, a shaft co-axial with the cam-face and carrying the inner part, the inner part being connected to the shaft so as to rotate therewith but to move axially thereon, yielding means for holding the inner part in operative position, a plurality of axially reciprocative partitions carried by the inner part and abutting against the cam-face and divided longitudinally into a plurality of parts, and resilient means for radially spreading the parts.

12. A rotary fluid power device comprising a casing with an end wall, the inner face of which is a cam, a part within the casing having a face opposite the cam-face and forming with the casing a fluid chamber of annular form, an inlet and an outlet for the chamber, a shaft co-axial with the cam-face and carrying the inner part, the inner part being connected to the shaft so as to rotate therewith but to move axially thereon, a plurality of axially reciprocative partitions carried by the inner part and coöperative with the cam-face, resilient means for holding the inner part in operative position, and means for applying compressed fluid to create pressure against the inner rotating head in opposition to the pressure of the fluid being compressed.

13. A rotary fluid power device comprising a casing with an end wall the inner face of which is a cam, a part within the casing having a face opposite the cam-face and forming with the casing a fluid chamber of annular form and also forming within the casing a space behind such inner part, an inlet and an outlet for the chamber, a shaft co-axial with the cam-face and carrying the inner part, the inner part being connected to the shaft so as to rotate therewith but to move axially thereon, axially reciprocative partitions carried by the inner part and coöperative with the cam-face, resilient means for holding the inner part in operative position, and a conduit leading from the outlet to the space behind the inner part for supplying fluid under pressure behind such inner part.

14. A rotary fluid power device comprising a part having an annular cam-face, a part having a plane face opposite the cam-face, a chamber being formed between the two faces, yielding means for holding such parts in operative position, an inlet and an outlet for the chamber, means for causing relative rotary movement between the two parts, and an axially reciprocative partition carried by the part having the plane face and coöperative with the cam-face.

15. A rotary fluid power device comprising two relatively rotary heads arranged in juxtaposition, one of these heads having therein a groove with inner and outer peripheral walls of circular contour and forming a chamber between the heads, the bottom of the groove constituting an end wall of the chamber and forming a cam-face, such head also having two annular sealing surfaces concentric with the cam-face and located respectively inward and outward therefrom, such sealing surfaces being in a plane continuous with the highest portion of the cam-face, the other head having a plane face opposite the cam-face and constituting the other end wall of the chamber, such plane face having concentric continuations forming annular sealing faces opposed to the annular sealing faces of the head having the cam-face, an inlet and an outlet for the chamber, a movable partition carried by the part having the plane face and coöperative with the cam-face, and means for yieldingly pressing together the heads to thereby press together the opposed sealing surfaces.

16. A rotary fluid power device comprising two relatively rotary parts forming a chamber between them, one of such parts being provided with an annular cam-face within and forming an end of the chamber, a partition carried by the other part and coöperative with the cam-face, yielding means for holding the two parts in operative position, and means for causing relative rotary movement between the two parts.

17. A rotary fluid power device comprising two heads arranged in juxtaposition, one of these heads having therein a groove with inner and outer peripheral walls of circular contour integral with the grooved head and forming the side walls of the groove, the groove forming a chamber between the heads, the bottom of the groove constituting an end wall of the chamber and forming a cam-face, and movable partitions carried by the other head and coöperative with the cam-face, an inlet and an outlet for the chamber, and one of the heads being rotary relatively to the other.

18. A rotary power device comprising two juxtaposed heads, one of which is rotary relatively to the other, each head having two spaced annular concentric end surfaces opposed to and forming a seal with the corresponding end surfaces on the other head, one of these heads having an annular cam-face concentric with and between the annular sealing surfaces and the other head having an annular face concentric with and between the annular sealing surfaces and op-

posite to the cam-face, a chamber with inner and outer cylindrical walls being formed by the heads between the cam-face and the annular face opposite thereto, and a movable partition coöperative with the cam-face and carried by the head having the annular face opposite to the cam-face.

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

RICHARD GRAF.

Witnesses:
WM. ASHLEY KELLY,
BERNARD COWEN.