June 9, 1936. J. L. KEMPTHORNE 2,043,544

ROTARY ENGINE

Filed Oct. 7, 1933 4 Sheets-Sheet 1

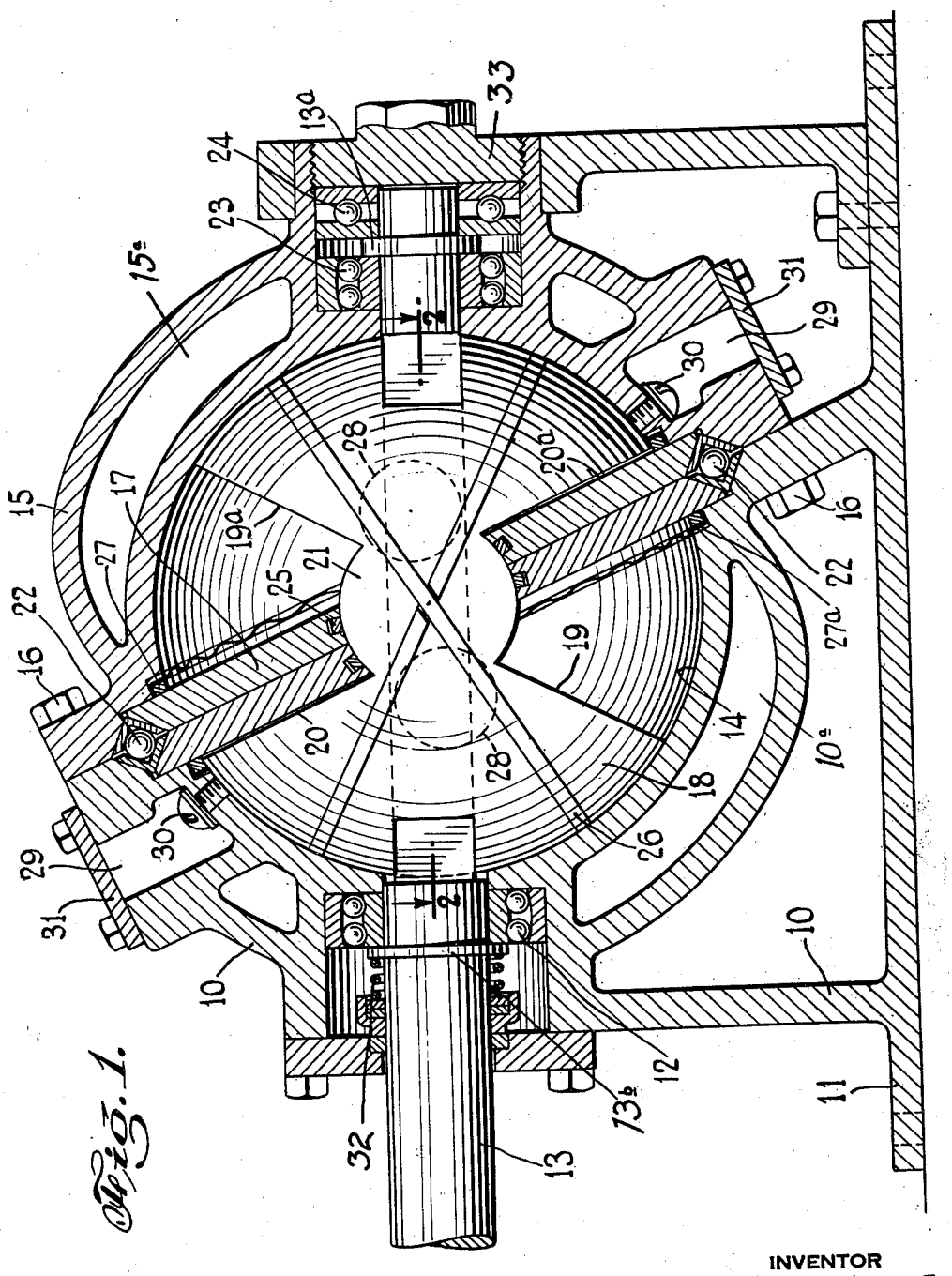


Fig. 1.

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Fig. 3.

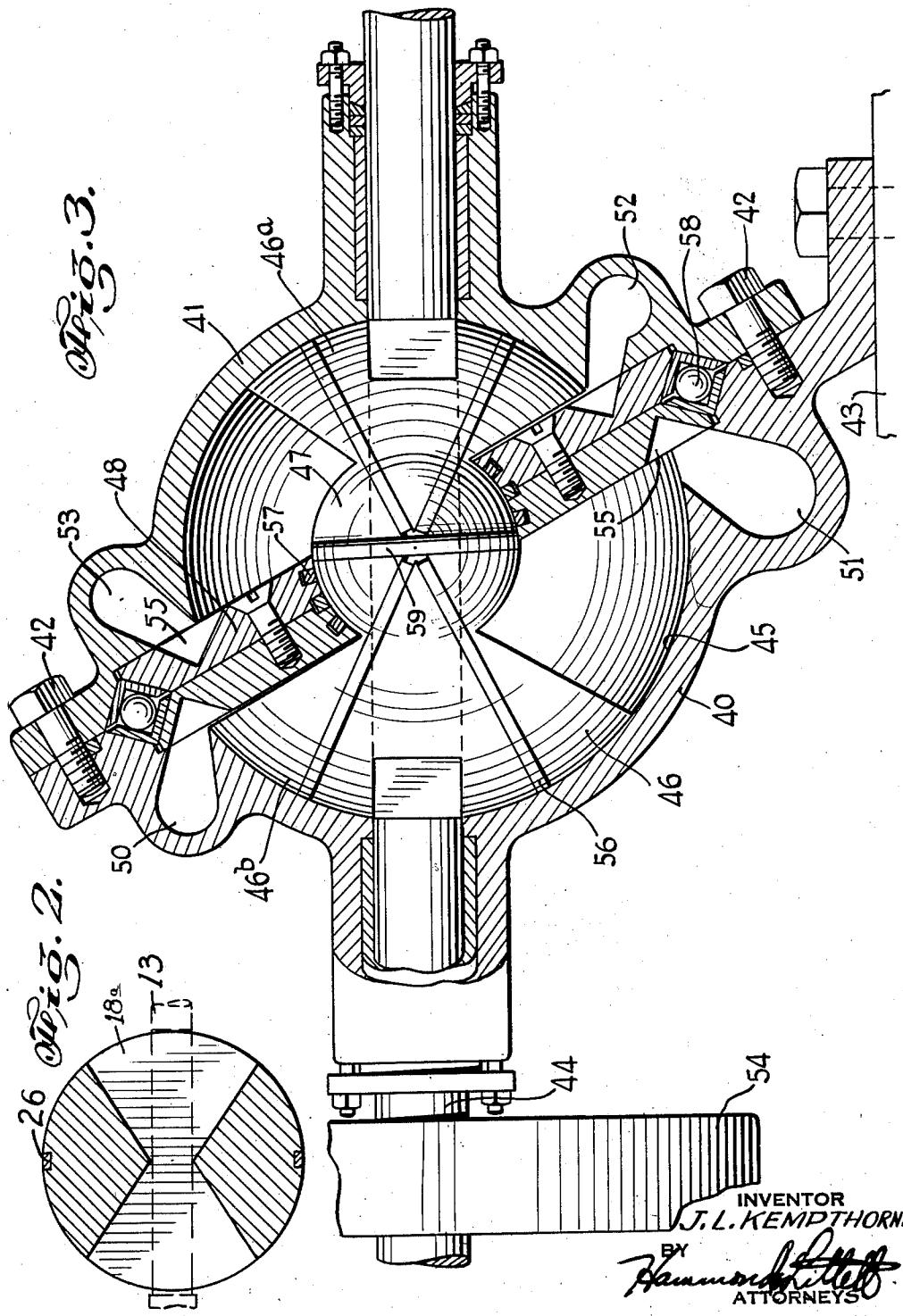


Fig. 2.

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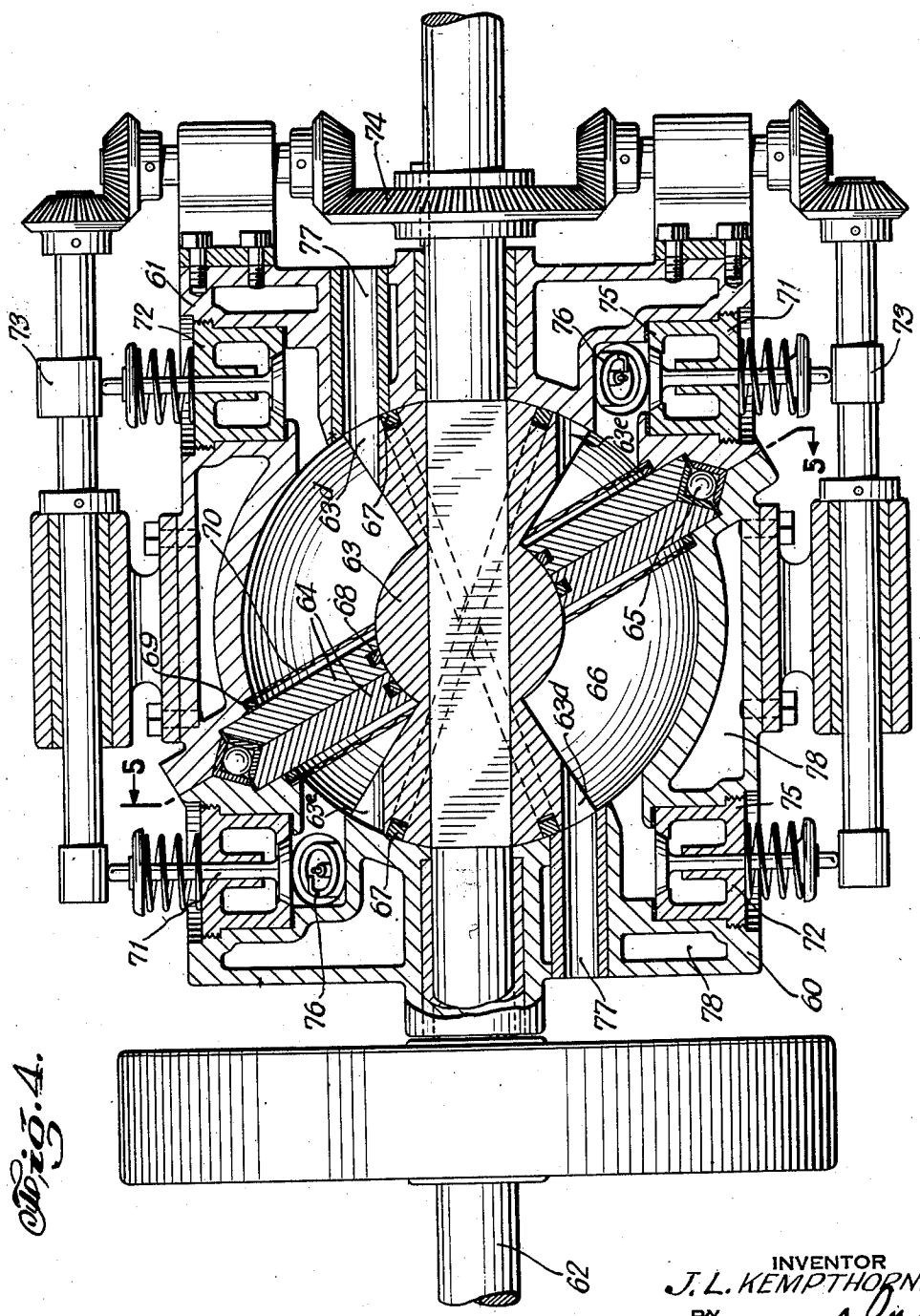


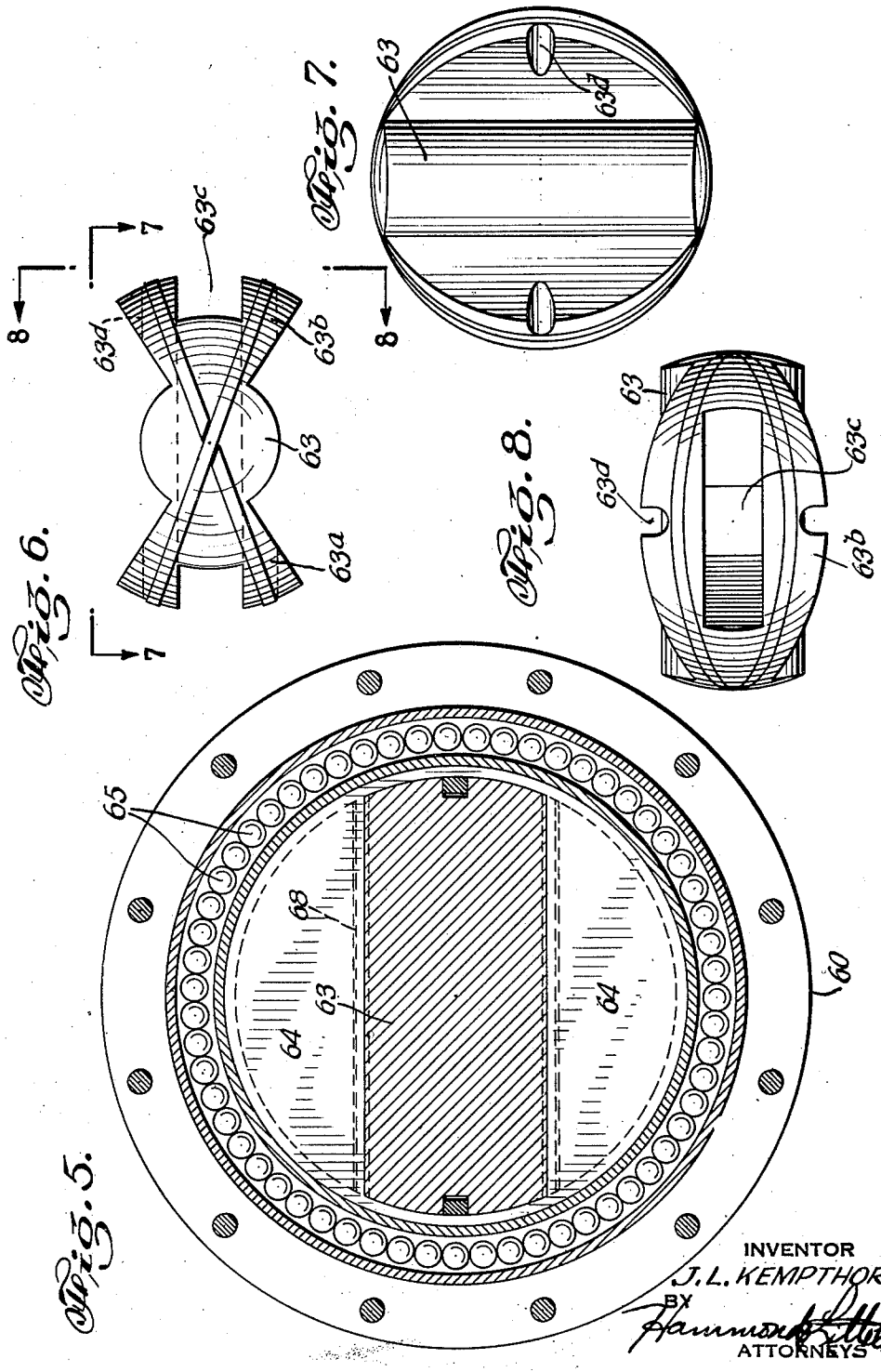
Fig. 4.

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ROTARY ENGINE

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UNITED STATES PATENT OFFICE

2,043,544

ROTARY ENGINE

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Application October 7, 1933, Serial No. 692,566

12 Claims. (Cl. 103—142)

This invention relates to improvements in motors, pumps and compressors and more particularly relates to an improved positive displacement rotary motor or engine of the four chamber type.

In previous applications and patents, I have described a positive displacement rotary engine having a hemi-spherical segment rotating in a cooperating chamber which was closed by an abutment at an angle to the driving shaft. Such engines have been found to have very distinct operating advantages over other well known forms of engines and compressors and are particularly efficient when used as pumps for liquids, compressors for gases or when operating as clutch or brake mechanisms.

I have now discovered that if two units are mounted in a full spherical casing, I can not only double the size of the unit but I can counterbalance forces thereby eliminating stresses due to compression and can make the unit extremely efficient with the material reduction of friction losses. Making the unit of multiple chambers, also makes possible the operation of the device as an internal combustion engine either of two cycle or four cycle type or I can also operate the device as a compound steam engine, or as a steam pump using one series of chambers for suitable pumping or compressing liquids or gases.

It is one of the principal objects of my invention to provide a full spherical chamber having a multiple spherical segment dividing the chamber into two parts, in each of which operates a hemispherical segment to alternately draw in, compress and discharge gases, liquids and the like.

Another object of my invention is to provide an engine of the positive displacement rotary type in which the rotor member has segmental portions of different radii and the casing in which the segmental portions operate have chambers of similarly different radii, such chambers being adapted for compounding or proportionating as desired.

A further and more detailed object of my invention is to provide a positive displacement rotary engine, with multiple chambers having ignition devices whereby it may be operated as an internal combustion engine, each chamber having suitable ports and timing mechanism for either two cycle or four cycle operation.

A further object of my invention is to provide improved sealing means for sealing the respective chambers against pressure loss and particularly sealing the central abutment plates which are rotated integral with the rotor.

Another object of my invention is to provide centering means for centering the rotor within the chamber to prevent undue thrust on any wall and to maintain the sealing means at the desired efficiency.

Further objects and advantages of my invention will appear from the following description of preferred forms of embodiment thereof and in which;

Figure 1 is a substantially central vertical section through a four chamber, positive displacement rotary engine, with the rotor in elevation,

Figure 2 is a horizontal section through the center of the engine of Figure 1 and taken substantially on the line 2—2 of Figure 1,

Figure 3 is a vertical section substantially like Figure 1, but showing a four chamber rotary engine having different sized chambers and segments,

Figure 4 is a vertical section through a modified form of engine adapted for four cycle internal combustion operation,

Figure 5 is a central section taken on the line 5—5 of Figure 4,

Figure 6 is a side view of the segmental rotor of Figure 4,

Figure 7 is a top plan view of the rotor taken along the line 7—7 of Figure 6, and,

Figure 8 is an end view of the rotor of Figure 6 taken from the line 8—8 of Figure 6,

One form of my improved engine having four chambers, and one which is substantially full spherical in shape is shown in Figures 1, 2 and 3. It includes a casing 10 mounted on a base 11, and containing a bearing 12 in which the operating shaft 13 is journaled. The casing 10 is provided with a hemispherical internal surface forming chamber 14 and is closed by a cap 15 having a similar hemispherical internal chamber which completes the motor. The cap 15 may be bolted to the fixed casing 10 by suitable bolts 16 and both the casing and cap may have water cooling passages 10a and 15a respectively.

In order to divide the spherical chamber into two parts an abutment plate 17 is provided, the plane of the plate being at an angle to the axis of the shaft 13, for the purpose to be hereinafter described. The plate is preferably a composite one and may be joined by any desired means. A ball race 22 is provided for the abutment which may be suitably carried within the confines of the casing and cap so that the set angular position of the abutment with respect to the shaft will not change. The plates 17 are sealed by the central sealing blades 25 and other sealing rings 27

held against the plates 17 by a wavy ring 27a are provided for sealing the side.

The rotary element 18 is a double segment of a hemisphere having converging faces 19 and 20 on one segment and 19a and 20a on the other segment. These faces are complementary to the faces of the abutment 17 and are adapted to close with respect thereto. The two segments, are preferably integral and connected by a substantially cylindrical center bearing portion 21 which is mounted within the plates 17. Sealing rings 26 are preferably used to seal the segment with respect to the casing and to the cover.

The shaft 13 is provided with a square or other polygonal shape projection into the cylindrical center 21 of the rotary element 18 which has a suitable longitudinal slot so that the segments of the rotary element 18 and the plates 17 will rotate integrally with the shaft. A second bearing 23 is provided for the opposite end of the driving shaft 13, and a thrust bearing 24 may be provided for adjustment in cooperation with the shoulder 13a on the shaft. A spring 32 cooperates with a similar shoulder 13b to force the shaft against the centering nut 33. The segment may thereby be directly centered in the chamber. Oil passages may be provided if and where necessary as through the center of the shaft.

Intake ports 28 are provided in the sides of the casing and cover and the exhaust is out through the conduits 29 which are controlled by suitable feather valves 30 to which connections are made through headers 31.

In operation the shaft causes the rotation of the segments or rotor 18 together with central plates 17 in their particular holding member. As the rotor 18 is at an angle to the shaft 13 and as the rotor must follow the course of the spherical chamber in the casing, the rotor rotates and oscillates. The converging faces 19 and 20 change with respect to the abutment, the converging faces 19 and 19a of the opposite segments drawing closer to the plates 17 while the opposite faces 20 and 20a gradually move away from the plates. In half a revolution, the converging faces 19 and 19a assume the position previously occupied by the converging faces 20 and 20a, thus causing an expansion by the movement of the plates 20 and 20a away from the plates and a compression due to the closing of the chambers left by the plate and faces 19 and 19a as shown in Figure 1. A slot 18a in the rotor 18, more clearly shown in Figure 2 permits this oscillation as previously described.

With such an engine, it is possible to double the capacity of the single segment type and at the same time, balance the thrusts so that there is a much lower friction loss. The engine occupies relatively little more space and is equally as easy to construct and assemble. The water cooling is easily accomplished and the size of the chambers may be varied according to specific needs.

The engine of Figure 3 is slightly modified from the form shown in Figures 1 and 2. It is primarily adapted for compression in two stages by varying the size of the segments and is also adapted to the pumping of fluids by steam or similar fluids under pressure by similarly changing the size of the segments. This structure includes the casing 40 having the hemispherical chamber 45 which is completed by the hemispherical chamber in the cap 41 suitably bolted at 42 to the casing 40. It is to be understood that the casing 40 is mounted on a suitable base or support 43 as desired and is provided with a suitable shaft 44 which extends through the spherical chamber 45 as shown by the dotted lines. The shaft has a polygonal shaped driving connection with the rotor 46 as previously described.

The rotor 46 comprises a plurality of spherical segments having converging faces but preferably integrally formed to make a complete unit. One of the segments 46a is preferably smaller than the other segment 46b and the radius of the spherical chamber within the cap 41 is also less than the radius of the casing 45. The segments 46a and 46b are itegrally joined at 47 by a substantially cylindrical bearing which extends throughout the segments and has rounded ends to cooperate with the chamber. A sealing ring 59 seals each end of the segment.

A plurality of plates 48 serve as abutments for the converging faces of the rotor 46 and divide the hemispherical chamber into the respective parts. These plates rotate with the rotor as a unit, and the ball race 58 is provided to reduce the friction during rotation. For convenience the left hand chamber is shown to be of the larger diameter and is thus the low pressure side, the right hand side is of the small diameter and is therefore the high pressure side. In the low pressure side the ports are shown at 50 and 51 and on the high pressure side the ports are indicated at 52 and 53. It will be obvious that inlet and outlet designations will vary depending on whether the unit is run as a pump, motor or compressor.

The operation of this unit as a compressor driven by the flywheel 54 is similar to that of the first form shown in Figures 1 and 2.

The converging faces of the respective segments change their relative position in that the converging faces which are away from the plate 48 alternately close against the plate and the converging faces that are in substantial contact as shown in Figure 3 alternately move away to the opposite position. Therefore, while diametrically opposite faces of the segments are compressing the gases against the plate and discharging them out of the outlet, the other faces of the segment are under a partial vacuum or reduced pressure and drawing in a fresh charge. The cut away portions 55 allow free movement of the gases into ports 51. On the high pressure side the suction and compression is similar to that on the low pressure side and if the fluids are conveyed into the inlet of the high pressure chamber from the discharge of the low pressure side, the same rotor will work simultaneously on the higher pressure gases as well as the lower pressure gases, but due to the reduced radius of the high pressure side the volume will be smaller and the work done will be approximately the same in both chambers. The displacement of the first stage may be varied with the displacement of the second stage for any desired conditions.

If it is desired that the unit be used as a steam engine the steam can be introduced into the high pressure side and thence into the low pressure, high volume side which will cause the rotation of the segment. If other fluids such as water, oil, etc., are introduced into one side while the other side is used as a prime mover, the unit will operate as an efficient pump. Furthermore, by the addition of an ignition device it would operate successfully, as a two cycle-internal combustion engine.

Suitable bushings, gaskets, etc., may be used in order to properly seal the various parts and the segments may be effectively sealed by a plurality

of semi-circular rings 66 on different radii of the segments and the internal blades 67 carried by the plates 48.

A modified form of construction of the four-chamber rotary engine is shown in Figures 4 to 9 inclusive, in which the engine has been provided with valves and ignition means for operation as an internal combustion engine of the four cycle type. More particularly shown in Figure 4 the casing is indicated at 60 and 61, the two parts being suitably bolted together and preferably at an angle to the shaft 62 on which the rotor 63 is mounted. In the plane of the joint of the two parts of the casing 60 and 61 are a pair of abutment plates 64 which operate in a suitable ball race 65, the plates 64 being in contact with the cylindrical shaped center of the rotor 63.

The shape of the rotor 63 is shown in Figures 6, 7 and 8 in greater detail, the end portions 63a and 63b of the rotor being segments of a hemisphere and provided with suitable slots 63c in which the shaft 62 oscillates. The slot 63c is wedge-shaped as shown in Figure 8, being flat at the top and bottom. This is necessary for inasmuch as the rotor 63 rotates within the chamber 66 in the casing, it is forced to rotate at the angle at which the abutment plates 64 are set.

Suitable rings 67 are used to seal the outer portion of the rotor to the casing, and sealing plates 68 seal the central part of the rotor 63 to the plates 64. Still other rings 69 backed up by a wavy ring 70 or other means seal the chamber 66 with respect to the plates 64. This or some other form of seal is desirable to maintain pressure tight condition during the rotation and oscillation of the rotor 63. As in the previous forms of construction the surfaces of the segmental ends 63a and 63b come into contact with the plates on opposite ends causing alternately a suction and a compression similar to the operation of the typical reciprocating engine.

In order to adapt this type of rotary, positive displacement engine to operation as an internal combustion engine I have provided a series of valves for example, of the poppet type indicated at 71 and 72, the valves 71 and 72 being oppositely disposed for the different chambers in the casing and being operated by a similar cam mechanism 73 driven in a desired manner from the shaft 62 through the intermediary of gears 74. As a constructional detail, I have chosen to mount the valves in cages 75 although it is obvious that such cages are not an essential part of the engine.

The connection of the valves to suitable exhaust manifolds and to suitable intake manifolds has not been shown as it is believed to be clearly known in the art. Similarly the numerous water ports 78 are to be understood to be in suitable communication with each other so that the device may be properly water cooled.

Ignition devices 76 are provided in opposite chambers and scavenging ports 77 which are normally closed by the rotor 63 are provided. The rotor is cut away at 63d to cooperate with the scavenging ports, and is also cut away at 63e to cooperate with the ignition chamber for effective timing and complete combustion.

The rotor 63 will initially draw in a charge of combustible mixture which will, during the continued rotation of the rotor, be compressed until the position of firing is attained at which time a suitable distributor (not shown) will operate the particular ignition device and the burning of the gases will then in turn cause a further rotation of the rotor. At a suitable point the segment will come into position adjacent the scavenging port which will facilitate the discharge of the exhaust gases. The operation of the internal combustion engine is well known and the construction shown in Figure 4 is adapted for four-cycle operation. It is of course to be understood that it would operate satisfactorily as a two-cycle engine if the valves were eliminated and suitable connections made from the compression of the intake to the firing chamber.

One of the principal advantages of the rotary type engine as disclosed herein is that there are no unbalanced forces and no reciprocating parts. The engine is extremely simple in construction and will operate with the maximum efficiency. It may be very effectively sealed and it is adapted to run with the minimum of friction due to the ball bearings in the race 65.

It will thus be seen that I have developed a four chamber full spherical type engine adapted for operation as a pump, engine or compressor, and one which is highly efficient and of extremely reduced size. The valves and porting can be adjusted and timed to suit any desired condition and the balancing of thrust on each side of the central plates makes the operation smooth and uniform.

While I have shown preferred forms of embodiment of my device, I am aware that modifications may be made thereto and I therefore desire a broad interpretation of my invention within the scope and spirit of the disclosure herein and of the claims appended hereinafter.

I claim:

1. A rotary engine of the positive displacement type which includes a spherical casing, a rotor mounted in said casing and an abutment having opposite sides, said casing having ports therein, means to rotate said rotor, said rotor having two pairs of mutually converging faces, each of said pairs of faces cooperating with the respective sides of said abutment, means to oscillate said rotor as it rotates, the plane of said abutment being at a constant angle with respect to the axis of rotation of said rotor whereby alternate faces of each pair of faces of said rotor closely approach said abutment during rotation.

2. A rotary engine of the positive displacement type which includes a spherical casing, a rotor mounted in said casing and an abutment having opposite sides, said casing having ports therein, means to rotate said rotor, said rotor having two pairs of mutually converging faces, each of said pairs of faces cooperating with the respective sides of said abutment, and forming a plurality of chambers, means to oscillate said rotor as it rotates, the plane of said abutment being at a constant angle with respect to the axis of rotation of said rotor whereby diametrically opposite faces of each pair of faces of said rotor alternately move nearly into and away from contact with said abutment during rotation to draw in, compress and exhaust fluids.

3. A rotary engine of the class described comprising a substantially spherical casing, a rotatable member in said casing, said rotatable member including a plurality of separate spherical sector portions having the part spherical surfaces thereof cooperating with said casing, means to rotate said rotatable member, and a transverse abutment dividing the casing into separate sections each of said sections having a sector portion of the rotatable member, said abutment being rotatable in a fixed plane at an angle with

respect to the driving means, the side faces of the sector portions of said rotor being flat and alternately forming and closing chambers with respect to the abutment for the intake and exhaust of fluids, and separate fluid control means extending to the respective sections of said casing whereby said engine may operate on separate substances.

4. A rotary engine of the class described comprising a substantially spherical casing, a rotatable member in said casing, said rotatable member including a plurality of separate spherical sector portions having the part spherical surfaces thereof cooperating with said casing, means to rotate said rotatable member, said rotatable member being slotted to receive the rotating means, and a transverse abutment dividing the casing into separate sections each of said sections having a sector portion of the rotatable member, said abutment being rotatable in a fixed plane at an angle with respect to the driving means, the side faces of the sector portions of said rotor alternately forming and closing chambers with respect to the abutment for the intake and exhaust of fluids and separate fluid control means extending to the respective sections of said casing, whereby said engine may operate on separate substances and means to admit a power actuating substance into one section to pump a fluid in the opposite section.

5. A proportionating mechanism of the class described comprising a substantially spherical casing, a rotatable member in said casing, said rotatable member including a plurality of separate spherical sector portions having the part spherical surfaces thereof cooperating with said casing, means to rotate said rotatable member, said rotatable member being slotted to receive the rotating means, and a transverse abutment dividing the casing into separate sections each of said sections having a sector portion of the rotatable member, said abutment being rotatable in a fixed plane at an angle with respect to the driving means, the abutment and spherical casing forcing said rotor to oscillate as it rotates, the side faces of the sector portions of said rotor alternately forming and closing chambers with respect to the abutment for the intake and exhaust of fluids, and separate fluid control means extending to the respective sections of said casing, whereby said mechanism may operate on separate substances.

6. An engine of the class described comprising a spherical walled casing, an abutment plate in the casing dividing the casing into two substantially hemispherical sections, a rotor projecting through said abutment plate and having end elements of substantially spherical sector shape on either side of the plate, and in the respective sections, means to rotate said rotor, said rotor driving said abutment plate, means to maintain the abutment plate at a constant fixed angle to said rotating means, said rotor oscillating in following the casing and abutment plate, the segmental faces of the end elements alternately withdrawing from and approaching the abutment plate for the intake and exhaust of fluids in the respective sections of the casing and means to control the fluid flow into the respective sections.

7. A compound engine of the class described comprising a spherical walled casing, an abutment plate in the casing dividing the casing into two substantially hemispherical sections, a rotor projecting through said abutment plate and having end elements of substantially spherical sector shape on either side of the plate and in the respective sections, means to rotate said rotor, said rotor driving said abutment plate, means to maintain the abutment plate at a constant fixed angle to said rotating means, said rotor oscillating in following the casing and abutment plate, the segmental faces of the end elements alternately withdrawing from and approaching the abutment plate for the intake and exhaust of fluids in the respective sections of the casing and means to control the fluid flow into the respective sections, said casing sections being of different radii and means to transfer fluids from one section to the other section for compound operation.

8. A fluid operated pump of the class described comprising a spherical walled casing, an abutment plate in the casing dividing the casing into two substantially hemispherical sections, a rotor projecting through said abutment plate and having end elements of substantially spherical sector shape on either side of the plate and in the respective sections, means to rotate said rotor, said rotor driving said abutment plate, means to maintain the abutment plate at a constant fixed angle to said rotating means, said rotor oscillating in following the casing and abutment plate, the segmental faces of the end elements alternately withdrawing from and approaching the abutment plate for the intake and exhaust of fluids in the respective sections of the casing and means to control the fluid flow into the respective sections, said casing sections being of different radii, means to introduce a power actuating fluid into one section as a prime mover and means to introduce a pumpable fluid in the other section whereby said power actuating fluid will pump the pumpable fluid.

9. A proportionating device of the class described comprising a spherical walled casing, an abutment plate in the casing dividing the casing into two substantially hemispherical sections, a rotor projecting through said abutment plate and having end elements of substantially spherical sector shape on either side of the plate and in the respective sections, means to rotate said rotor, said rotor driving said abutment plate, means to maintain the abutment plate at a constant fixed angle to said rotating means, said rotor oscillating in following the casing and abutment plate, the segmental faces of the end elements alternately withdrawing from and approaching the abutment plate for the intake and exhaust of fluids in the respective sections of the casing and means to control the fluid flow into the respective sections, said casing sections being of different radii.

10. In a rotary engine of the positive displacement type a substantially spherical casing, a shaft passing through said casing, a rotor positively rotated by and freely oscillating on said shaft, an abutment having opposite side faces at a fixed angle to said shaft and mounted for rotation with said rotor, said rotor having spherical sector shape end pieces movable in the spherical casing the double converging faces of said end pieces alternately forming and closing chambers with the respective faces of the abutment, and valve means to control the intake and exhaust to said chambers.

11. An air compressor of the class described comprising a substantially spherical casing, a transverse abutment plate in said casing and dividing the casing into two separate gas-tight sections, a rotary element including two double

lobed spherical sectors and a central substantially cylindrical portion, said abutment cooperating with and tightly fitting the central cylindrical section of the rotor, means to maintain the abutment plate at a fixed angle to the axis of revolution of the rotor, means to rotate the rotor, said rotor being slotted to be freely oscillatable on said rotating means, the respective sector shaped lobes of the rotor leaving unfilled spaces in the respective sections of the casing, said sector shaped lobes alternately drawing in air and discharging air from the respective sections, antifriction means surrounding the abutment and means to control the inflow and exhaust of air from said compressor.

12. A compound liquid pump of the class described including a spherical casing and a transverse abutment plate dividing said casing into two sections, means to seal said abutment plate, whereby each section is liquid tight, a one piece double lobed rotor, the lobes of which are sectors of a sphere of the same radius as the casing, said rotor projecting through the abutment plate and the respective lobes substantially filling the respective sections of the casing, said rotor having a polygonal shaped opening and a double wedge shaped slot through which slot rotor drive means project whereby said rotor may oscillate with respect to said abutment plate as it rotates, liquid connections with the respective sections, and said drive means rotating said rotor to alternately draw in and discharge liquid in the chamber formed by the respective faces of the rotor and the abutment plate, said abutment plate being rotatable at a fixed angle with respect to the axis of rotation of the rotor.

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