

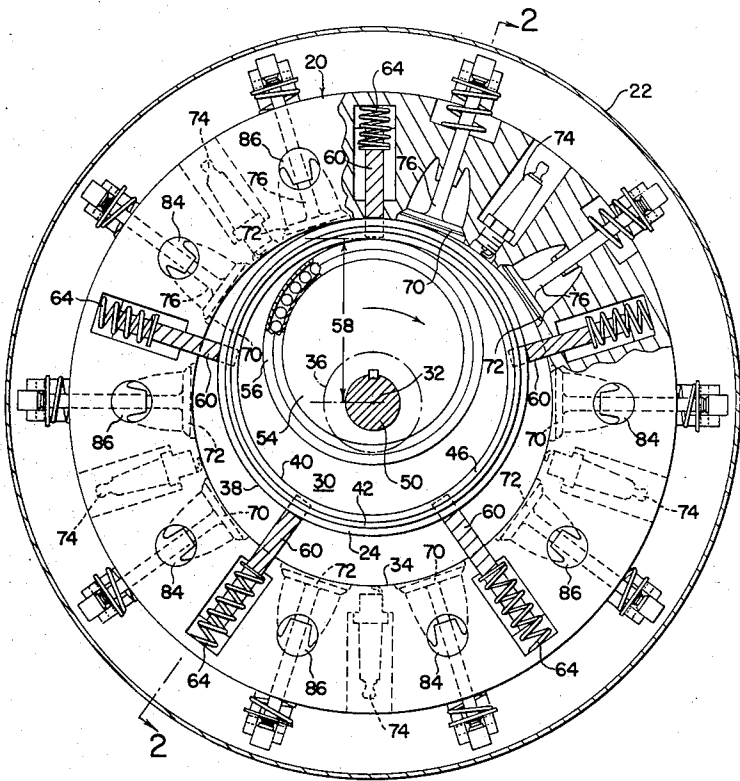
[54] **ROTARY ENGINE**
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Cleveland, Ohio
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[52] **U.S. Cl.**..... **123/8.45; 418/61 R**
[51] **Int. Cl.²**..... **F02B 53/00**
[58] **Field of Search**..... **123/8.45; 418/248, 249,**
418/250, 251, 61 R, 63, 65, 66

[56] **References Cited**

UNITED STATES PATENTS			
822,700	6/1906	Steele.....	418/61 R
1,575,860	3/1926	Monk.....	123/8.45
1,996,620	4/1935	Ketterer.....	418/65 X
2,005,141	6/1935	Gutzwiller.....	418/249 X
2,015,027	9/1935	Finley.....	418/61 R X
3,220,388	11/1965	Trotter.....	418/63 X
3,316,887	5/1967	Melvin.....	418/61 R X
3,539,280	11/1970	Ravera.....	418/248 X

3,809,024 5/1974 Abbey..... 123/8.45
FOREIGN PATENTS OR APPLICATIONS
520,016 4/1940 United Kingdom..... 418/248
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[57] **ABSTRACT**
The present invention is a new rotary engine consisting of a stator with a cylindrical cavity, a hollow cylindrical rotor located within the cylindrical cavity of the stator, a power shaft along the axis of the stator and an eccentric mounted on the power shaft. A plurality of spaced vanes are mounted in the stator for reciprocal movement with respect to the stator to provide working chambers between adjacent vanes, the stator, and the rotor so that rolling movement of the rotor around the interior of the stator in response to combustion of explosive charges in the chambers causes the eccentric to roll around the inner surface of the rotor and thereby rotate the power shaft.
14 Claims, 12 Drawing Figures



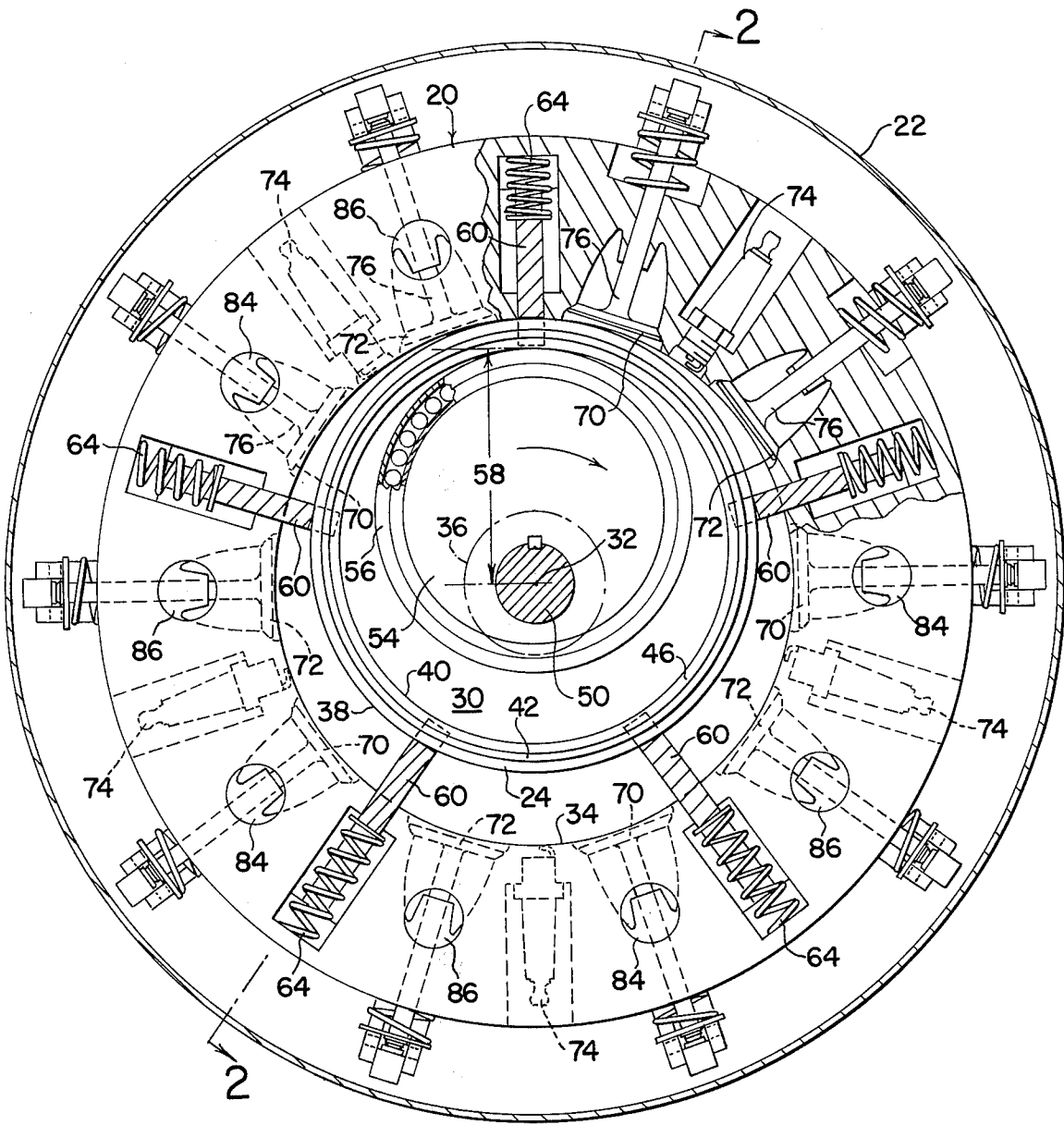


FIG. 1

FIG. 2

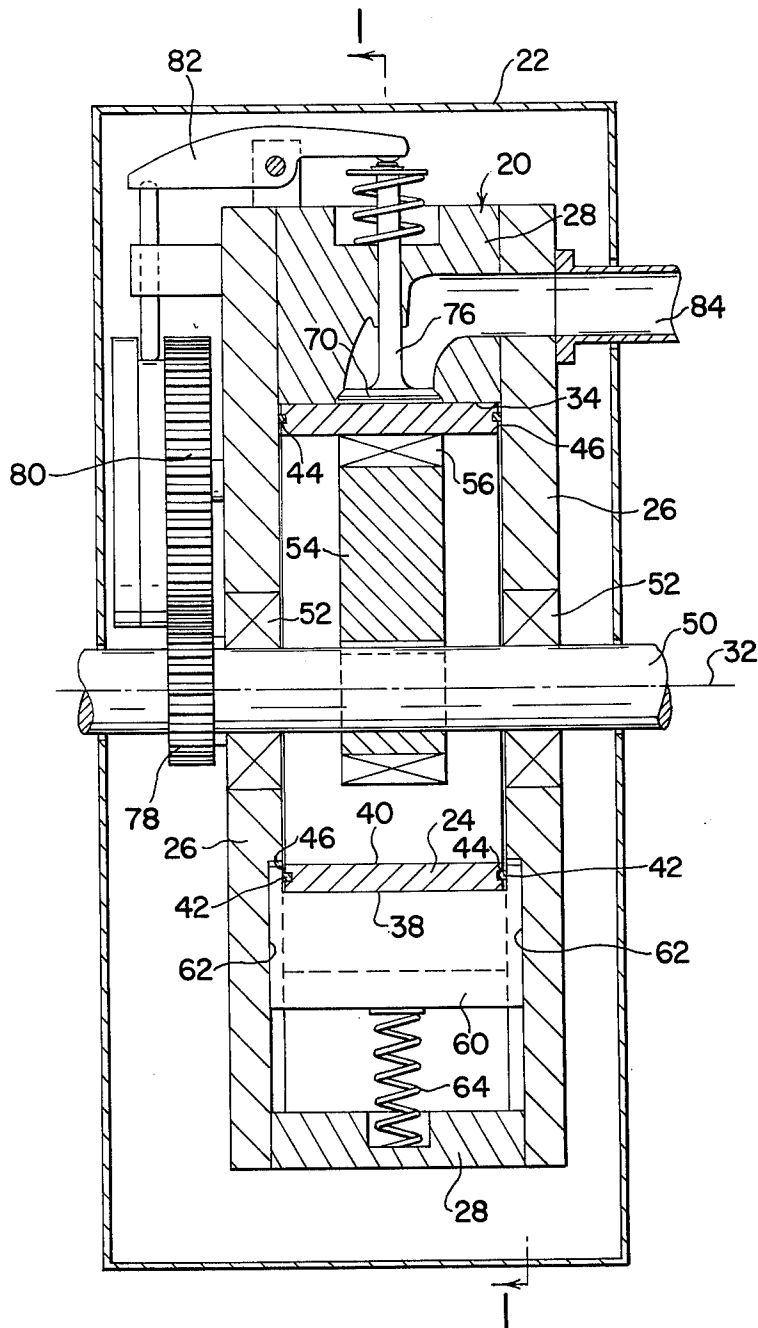


FIG. 3

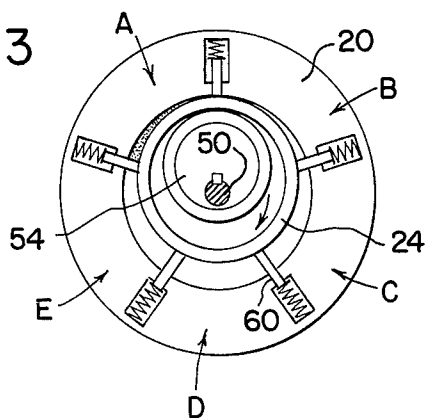
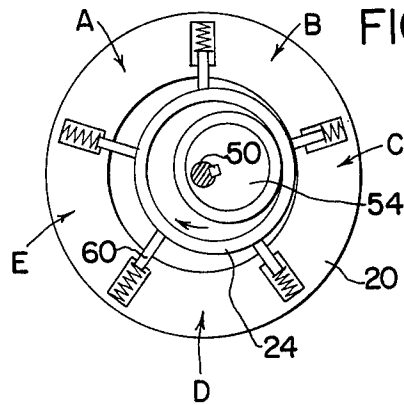
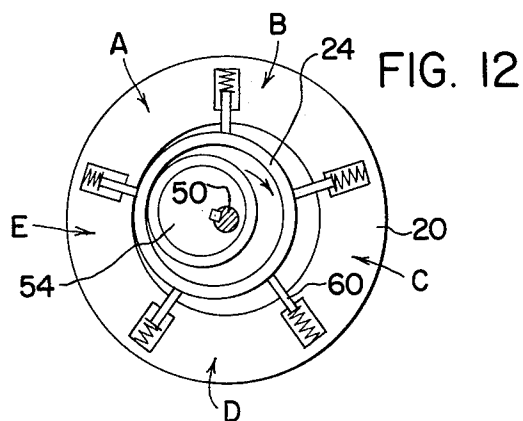
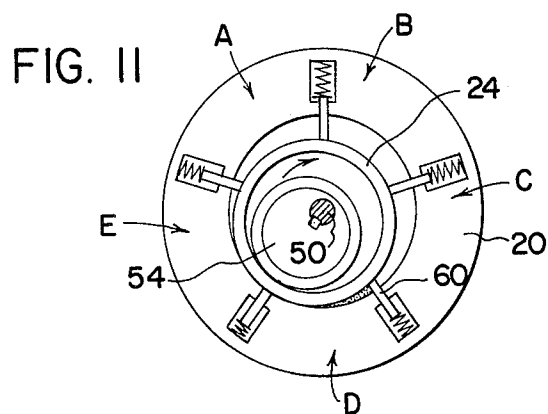
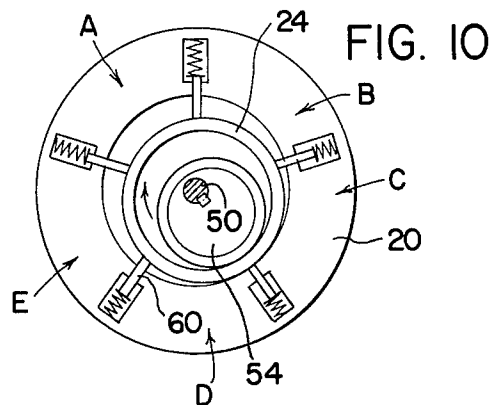
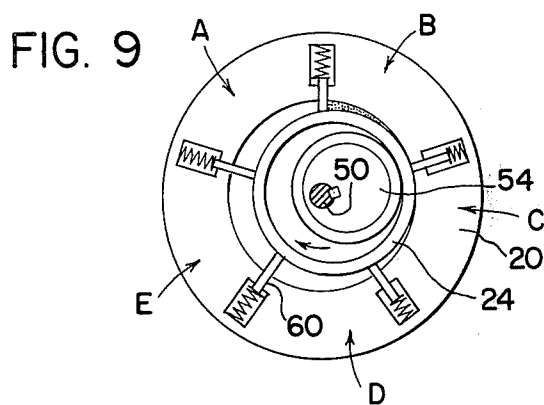
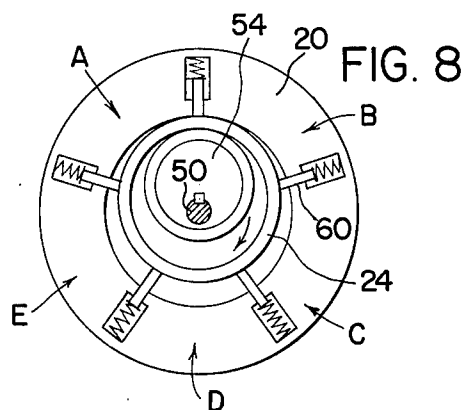
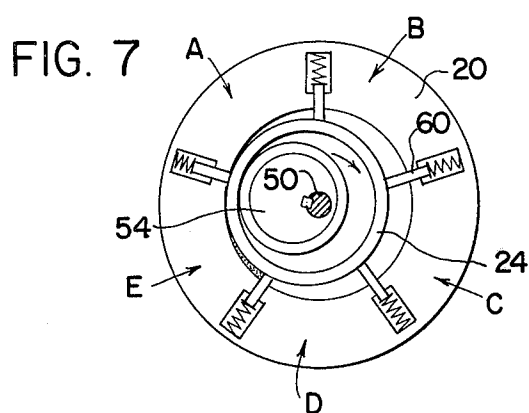
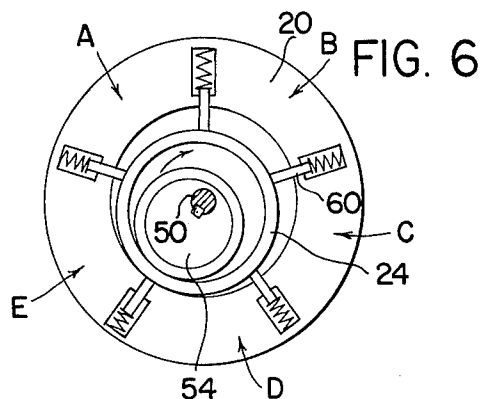
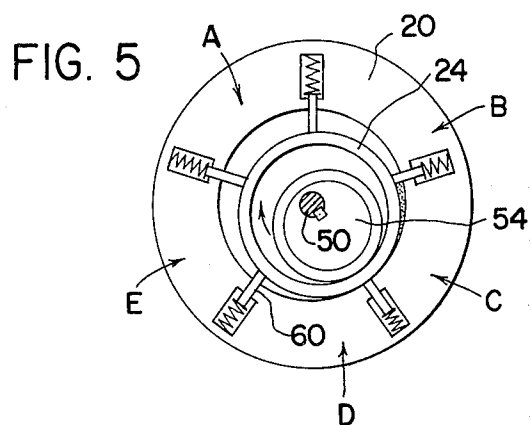


FIG. 4





ROTARY ENGINE

BACKGROUND OF THE INVENTION

Many designs for rotary engines have been proposed. Representative prior art rotary engines are shown, for example, in U.S. Pat. Nos. 2,907,307; 2,005,141; 1,974,761; 1,305,451; 3,624,740; and 3,194,220.

SUMMARY OF THE INVENTION

The present invention is a new rotary engine. This rotary engine. This rotary engine comprises: a stator having spaced end walls and a peripheral wall interconnecting the end walls to form a cylindrical cavity having an axis, the inner surface of the peripheral wall having a substantially circular profile; a hollow cylindrical rotor having an outer and inner surface, each having a substantially circular profile, and supported in the cavity for rolling motion with respect to the inner surface of the stator about an axis spaced from but parallel to the stator axis; the rotor having an internal diameter such that the stator axis is located inside the inner surface of the rotor and an external diameter that is less than the diameter of the inner surface of the stator; means for sealing the outer surface of the rotor with respect to its inner surface; an eccentric mounted within the inner surface of the rotor for rotation about the stator axis and in rolling contact with the inner surface of the rotor, whereby in operation the rotor axis describes a substantially circular path around the stator axis; a plurality of spaced vanes mounted in the stator in sealing relationship with the end walls for reciprocal movement with respect to the inner surface of the stator; means for holding the vanes in sealing engagement with the outer surface of the rotor; whereby at least two chambers, at least one of which is a working chamber, are defined by adjacent vanes, the outer surface of the rotor, the inner surface of the stator, and the end walls of the stator; the stator having an intake port for admitting fuel to the working chamber and an exhaust port for discharging exhaust products from such chamber.

In the operation of the engine, ignition of the fuel causes the rotor to roll around the inner surface of the peripheral wall of the cylindrical cavity of the stator. This rolling movement of the rotor causes the eccentric, which is in rolling contact with the inner surface of the rotor, to revolve around the axis of the stator describing the path traced by the axis of the rotor and thereby rotate the power shaft.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross sectional view through the rotary engine of this invention;

FIG. 2 is a sectional view taken along the line 2—2 of FIG. 1; and

FIGS. 3—12 are schematic views illustrating the cycle of the rotary engine of this invention through two revolutions.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Reference will now be made in detail to the present preferred embodiments of the invention, an example of which is illustrated in the accompanying drawings.

As shown in FIGS. 1 and 2, the rotary engine of this invention consists generally of a stator 20 located within a housing 22 and a rotor 24 rotatably supported within stator 20.

In accordance with the invention, stator 20 comprises a pair of spaced end walls 26 and a peripheral wall 28 interconnecting end walls 26 to form a cylindrical cavity 30 having an axis 32. As best shown in FIG. 1, the inner surface 34 of peripheral wall 28 has a substantially circular profile.

In accordance with the invention and as best shown in FIG. 1, rotor 24 is a hollow cylinder supported in stator cavity 30 for rolling motion around the inner surface 34 of the stator about an axis 36 spaced from, but parallel to, stator axis 32. The outer surface 38 of rotor 24 has a substantially circular profile and a diameter less than the diameter of the circular inner surface 34 of stator 20.

Preferably, and as more fully described below, the diameter of outer surface 38 is at least about 70%, and more preferably from about 75 to about 95%, of the diameter of stator cavity 30. Further, and as best seen in FIG. 1, the inner surface of hollow rotor 24 also has a substantially circular profile and a diameter that permits the stator axis 32 to be located inside the inner surface 40 of the rotor.

In accordance with the invention, means are provided for sealing the outer surface 38 of rotor 24 with respect to its inner surface 40. As embodied, and as best shown in FIG. 2, this means comprises an annular sealing ring 42 journaled in a groove 44 extending around the outer edges 46 of both sides of rotor 24. These sealing rings 42 are biased against end walls 26 of stator 20 to movably seal the volume inside of rotor 24 from the volume between rotor 24 and stator 20. Inside of rotor 24 and along stator axis 32 is mounted a power shaft 50 that is journaled in bearings 52 in end walls 26 and extends out through housing 22.

In accordance with the invention, an eccentric 54 is mounted on power shaft 50 for rotation about stator axis 32. Eccentric 54 supports rotor 24 in stator cavity 30 and is in rolling contact with the inner surface 40 of the rotor, so that as eccentric 54 rotates about stator axis 32 responsive to rolling movement of rotor 24 within stator cavity 30, the axis of rotor 24 describes a substantially circular path, as shown in FIG. 1, around stator axis 32.

To provide for rolling contact between eccentric 54 and the inner surface of rotor 24, a low friction bearing 56 is rollably mounted around the outer surface of eccentric 54.

In accordance with a preferred embodiment of the invention, and as more fully described below in connection with the operation of the rotary engine, the radial length 58 of eccentric 54 from stator axis 32 plus the distance between the inner surface 40 and outer surface 38 of rotor 24 is essentially equal to, but slightly less than, the radius of the circular inner surface 34 of stator peripheral wall 28 to provide for maximum compression and exhaust of the explosive charge in the engine.

To provide working chambers capable of containing an explosive charge for compression by the rotary motion of rotor 24, a plurality of vanes 60 are slidably mounted in the peripheral wall 28 of stator 20 for reciprocal movement with respect to the inner surface 34 of the stator. Preferably, and as best shown in FIG. 1, vanes 60 reciprocate in a substantially radial direction with respect to stator axis 32 and move in sealing relationship with end walls 26 of the stator.

In accordance with the invention, means are provided for guiding and supporting vanes 60 during such

reciprocal movement. As embodied, and as best shown in FIG. 2, this guide means comprises slots 62 in end walls 26 that extend in a radial direction over the length of travel of the vanes.

In addition, vanes 60 are biased into sealing engagement with the outer surface 38 of rotor 24 regardless of its relative position within stator cavity 30, and means are provided for holding these vanes in sealing engagement with the rotor. As embodied, and as shown in FIG. 1, this means can include springs 64 as well as the pressure of the compressed gas in the working chambers. Thus, vanes 60 provide a plurality of circumferentially spaced working chambers around the inner surface of stator 20, each working chamber being defined by adjacent vanes 60, the outer surface 38 of rotor 24, and the inner surface 34 and the end walls 26 of stator 20.

For each working chamber there is also provided an intake port 70 for admitting fuel to the working chamber and an exhaust port 72 for discharging exhaust products from each chamber. Optionally, ignition means, such as a spark plug 74, can be provided for each working chamber depending on the type of fuel being used, as is well known to those skilled in the art.

In accordance with a preferred embodiment of the invention, intake and exhaust ports 70, 72 are provided with suitable valves 76 for opening and closing such ports and means are provided for controlling operation of these valves. As shown in FIG. 2, the means for controlling the valves includes a cam-drive gear 78 affixed to power shaft 50. Cam-drive gear 78 drives suitable cam gears 80 which, in turn, actuate the movement of valves 76 through lever arm 82.

An intake manifold 84 provides the necessary access for the combustion mixture to intake port 70 and a similar exhaust manifold 86 connected to exhaust port 72 provides for the necessary discharge of exhaust gases following combustion.

While the rotary engine, shown in the drawings, consists of five vanes 60 and five working chambers with the necessary intake, exhaust and ignition means for each chamber, it can be readily understood by those skilled in the art that any number of working chambers can be provided without departing from the scope of this invention. Preferably, the rotary engine has at least three vanes to provide at least three working chambers and, as more fully described below, it is preferred to use an odd number of working chambers.

For purposes of illustration, the rotary engine of this invention will now be described as it relates to a typical four-cycle gasoline engine operation of combustion, exhaust, intake and compression. But, it should be understood that the invention can also be used in a two-cycle mode without departing from the scope of the invention.

Referring to FIGS. 3-12, FIG. 3 shows the beginning of the power stroke after firing of the explosive charge in working chamber A. At firing, the intake and exhaust ports are closed. FIG. 4 shows the continuing power stroke and the resulting clockwise rotation of eccentric 54 and power shaft 50.

FIG. 5 shows the end of the power stroke of working chamber A and the start of the exhaust stroke in which the exhaust port is open and the intake port is closed. FIG. 6 shows the continuing exhaust stroke, and by the time the rotor reaches the position shown in FIG. 7, exhaust is nearly complete. The exhaust port then closes, and the intake port opens so that when the rotor

reaches the position shown in FIG. 8 the intake of a combustible mixture into chamber A has begun.

FIG. 9 shows continuing intake of combustible mixture, and FIG. 10 shows the completion of the intake stroke at which point the intake port closes and the compression stroke on the combustible mixture in working chamber A begins. With the rotor in a position shown in FIG. 11 the compression stroke continues and FIG. 12 is near the end of the compression stroke, the combustible fuel will then be ignited as shown in FIG. 3, and the cycle repeated.

Exactly the same sequence is taking place in the other five working chambers of the rotary engine, illustrated in FIGS. 3-12. To facilitate this understanding, the other working chambers have all been stippled at the point where ignition occurs in each chamber. Thus, for example, when working chamber A is at the end of its power stroke, as shown in FIG. 5, working chamber C is firing. Then, when working chamber C is at the end of its power stroke and working chamber A is near the end of its exhaust stroke, as shown in FIG. 7, working chamber E is fired.

Following through the cycle, it can be seen, then, that working chamber B is fired, as shown in FIG. 9, when working chamber A is on the intake stroke. Finally, the last working chamber D is fired during the compression stroke of working chamber A, as shown in FIG. 11, and then working chamber A is fired again repeating the cycle. It can, thus, be seen that the rotor makes two complete revolutions between the firing of each chamber to provide for the necessary intake, compression, combustion, and exhaust operations of the four-cycle engine.

In view of the simplicity of the rotary engine of the present invention, it is not necessary to use highly sophisticated designs and complex construction techniques. The stator can conveniently be made from a bored cast iron or aluminum block with end walls covering both ends. The rotor can be a hollow metal cylinder of the appropriate diameter.

The power shaft can be a solid rod. The eccentric may take many forms, but preferably it will not occupy the entire space defined by the inner surface of the rotor, but will leave more than half that space open. By having a substantial amount of the space defined by the inner surface of the rotor open, it is possible to pass a cooling fluid or gas through the center of the rotor to achieve extremely effective engine cooling, because the outer surface of the rotor forms portions of the working chambers of the engine.

Ideally, the eccentric will also be designed in a shape whereby the bulk of its weight is located on the side of the rotor that is farthest from the inner wall of the stator and closest to the stator axis so that this imbalance of weight in the design of the eccentric can serve to counterbalance the eccentricity of the path that is followed by the rotor and eccentric about the stator axis.

It is of the essence of the present invention, that the eccentric be mounted within the inner surface of the rotor in a manner whereby the eccentric is in rolling contact with the inner surface of the rotor. The eccentric may contact the inner surface of the rotor at one or more points but at each of these points, the eccentric should be in rolling contact with the inner surface of the rotor. Roller bearings mounted on the eccentric can serve to provide such rolling contact.

Any kind of frictional or sliding contact can defeat some of the prime advantages of the present invention.

Frictional or sliding contact between the eccentric and inner surface of the rotor will cause the rotor to rotate within the stator in excess of its normal rotational movement and to rub or slide against the sealing vanes, causing rapid and unacceptable wear and attrition of the vanes.

As embodied in the present invention, the vanes themselves can be made from simple machined flat pieces of metal, and the operating end or sealing end of the vanes can be notched or cut back to fit over the outer surface of the rotor and yet extend towards the center of the engine past the outer surface of the rotor in the portion of the vanes that is carried in slots in the end walls of the stator. This overhang or extension of the sealing vanes past the outer surface of the rotor within the end walls of the stator enhances the sealing effectiveness of the vanes in sealing adjacent chambers of the engine at the end walls.

Valves, spark plugs, cams, and carburetors for the engine may all be selected from a wide variety of such devices that are conventional and readily available.

An outstanding feature of the rotary engine of this invention is the large cubic inch displacement that can be obtained with a relatively small engine. For example, a rotary engine having a stator with an internal radius of 2.5 inches, a rotor having an external radius of 1.875 inches, and a width of 2 inches, would have a cubic inch displacement of about 28 cubic inches. This very small engine would generate about 30 horsepower at 4000-6000 r.p.m.

In the drawings of the present invention all chambers are used for firing. This is very desirable for uniform heating of the engine. However, to assist in taking the heat out of the engine, the engine can be designed so that some of its chambers are used for cooling only. For example, alternating chambers can have a continuous flow of air passing through the chamber. This helps to cool the engine, and at least part of the heated cooling air can then be conveniently used in the combustion mixture.

The drawings of the invention also show essentially uniform spacing between vanes. Although this is certainly a desirable design, other designs are possible, and an uneven spacing between the vanes may be desirable for optimum engine operation in certain cases.

The vanes may be biased against the rotor by spring action, pneumatic force, or any other force. In the preferred practice of the invention, pneumatic pressure is at least partially used to bias the vanes against the rotor. This pneumatic action causes greater pressure on the vanes against the rotor in the power and compression cycles and less pressure on the vanes in the intake and exhaust cycles.

Thus, in accordance with the present invention, when the most severe sealing requirement exists during the compression and power cycles, because it is then that the highest pressures are encountered, the greatest pneumatic force to press the vanes against the outer surface of the rotor is exerted. Conversely, when the least severe sealing is required, namely, during the intake and exhaust cycles, the pressure exerted on the vanes against the rotor is lowest. Thus, adequate and appropriate sealing is maintained at each point in the rotational cycle.

The vanes divide sections of the engine into chambers. There must be at least two vanes, but three or more vanes are preferred, and there is no theoretical

upper limit to the number of vanes that can be used with the rotary engine of this invention.

Although an even number of combustion chambers can be used, the use of an odd number of combustion chambers is preferred, because a full cycle on two revolutions of the rotor is obtained with an odd number of chambers. If an even number of combustion chambers is used, the timing and chamber firing sequence is more complex.

As a general rule, it has been found that with a given stator and rotor, the compression ratios of the engine are a function of the spacing between the vanes. The narrower the spacing between the vanes, the higher the compression ratios that are possible. Thus, if higher compression ratios are desired, narrower spacings can be used.

For example, by combining a high compression ratio with adequate direct cooling in the chamber, it is possible to have a narrow combustion chamber between two vanes where a high compression combustion takes place. The chamber directly following this combustion chamber can be a relatively broad chamber with a continuous flow of air for cooling.

The relative diameters of the inside of the stator and the outside of the rotor are also important. In the broad concept of the invention any inside diameter of the stator can be used. The outside diameter of the rotor is, however, limited by the inside diameter of the stator, but the outside diameter of the rotor can be almost as large as the inside diameter of the stator.

The minimum outside diameter of the rotor is limited to a value slightly larger than the inside radius of the stator. In the preferred rotary engine, the outside diameter of the rotor is at least about 70 percent and more preferably from about 75 to about 95% of the inside diameter of the stator.

The relative diameters of the rotor and the inner surface of the stator have a direct bearing upon the compression ratios that can be obtained. As a general proposition, in an engine containing three or more combustion chambers, the compression ratio increases as the difference between the diameter of the rotor and the diameter of the inner surface of the stator decreases.

The eccentric is mounted on the power shaft (which is concentric with the stator axis); and is contained within the space defined by the inner surface of the rotor. The eccentric must be of such a size and shape that it allows the rotor to roll around or near the circumference of the inner surface of the stator. As the rotor rolls around the inner surface of the stator, the eccentric rolls on the inner surface of the rotor at the points of contact between the inner surface of the rotor and the rollers or low-friction bearings on the eccentric.

As noted previously, the eccentric may have a wide variety of designs. In the drawings, the eccentric is depicted as a solid circular disc with a roller bearing around the outside of the entire disc. The eccentric could also be a narrow extended arm having rolling contact with the inner surface of the rotor adjacent the portion of the rotor that is closest to the inner surface of the stator with a counterweight portion on the other side of the stator axis. The counter-weight portion also preferably is in rolling contact with the inner surface of the rotor. Various other shapes could also be devised to provide for counter-balancing the eccentric.

The rotary engine of the present invention has many attributes that make it an extremely useful power source.

One of the important features of the rotary engine is its ease of construction. All major parts of the present engine can easily be made on conventional lathes and boring and milling machines. Moreover, the simplicity of the rotor design makes side sealing of the rotor easy to accomplish. No gears are required to transfer the energy to the power shaft or to ensure that the engine remains in phase, as is required in the well-known Wankel rotary engine. In the present design, the engine power shaft is directly driven by the eccentric.

In the rotary engine of this invention, combustion can take place at any portion of the inner surface of the cylindrical cavity of the stator. As a result, the heat generated is distributed evenly throughout the engine and thermal distortions can be minimized.

Another important advantage of the present rotary engine is that the power shaft rotates once per revolution of the rotor. Thus, the engine is capable of operating at very high rotor revolutions per minute. This characteristic is important, because high revolutions per minute of the rotor are required for maximum power output. Engines that have high shaft revolutions per revolution of the rotor, such as the Wankel engine which has three shaft revolutions per rotor revolution, require special and expensive gearing to permit practical power take off from the shaft.

In the rotary engine of the present invention, the number of firings per rotor revolution is dependent upon the number of combustion chambers. As a rule, the number of firings per revolution of the rotor are half the number of combustion chambers. Thus, in the course of two revolutions all combustion chambers will fire. Most convenient for purposes of firing design are those versions of this invention in which the engine has an odd number of chambers. With an odd number of chambers, the firing sequence is repeated every two revolutions. Whereas, with an even number of revolutions, it may be necessary to skip or omit certain firings.

One very important advantage of this invention is that the engine can operate at very high compression ratios, which can be as high as the diesel range. Many other rotary engines cannot directly obtain such high compression ratios. As previously noted, in the present rotary engine the compression ratio is mainly dependent upon the relative outside diameter of the rotor in comparison to the internal diameter of the stator, and upon the spacing between vanes.

One of the most distinctive advantageous features of the present invention is the manner in which the rotary engine is separated into combustion chambers. Most engines containing vanes rely on a seal that is in sliding engagement with the outer surface of the rotor or the inner surface of the stator. In the present invention, however, the rotor rolls over the sealing vane at the position of full retraction of the vane into the stator. At this position, there is little or no sliding motion between the vane and the rotor.

This is an extremely important benefit of this invention, because at the point of full retraction of the vane into the stator the chamber pressures are at their highest. From the drawings, it can be seen that it is at relatively full retraction of the vane into the stator that the compression and power strokes occur. For these pneumatically actuated vanes, the rolling motion of the rotor over the vane is at a maximum at the same time that the pressure of the vane against the rotor is at a maximum. Wear is thereby minimized.

The above discussion should not be taken to indicate that there is no sliding motion between the vanes and the rotor. There, indeed, is some sliding motion. This sliding action is an approximately direct function of the differences in the outer diameter of the rotor and the inner diameter of the stator. As this difference increases, the amount of sliding action increases. In a representative engine of the present invention, the rotor makes about 10 to 15 revolutions in the time that the vanes slide completely once around the outer surface of the rotor. This is a small amount of sliding motion and does not cause substantial wear on the vanes, in contrast to the extensive wear experienced in the Wankel, and many other rotary engines, in which the vanes travel the entire length of the inner surface of the stator per revolution.

A very important point with regard to the sliding action that does occur is that such sliding action takes place at pressures during which the intake and scavenging strokes are taking place. Thus, there is a minimum of stress on the vanes when sliding does occur. In accordance with this invention, for pneumatically actuated vanes, the sliding motion between the rotor and the vanes is maximized when the pressure exerted by the vane against the rotor is minimized, and wear due to sliding is thereby also minimized.

These and other attributes of the engine of this invention make it a particularly desirable, compact, and highly efficient power source.

What is claimed is:

1. A rotary engine comprising:

- a stator having spaced end walls and a peripheral wall interconnecting the end walls to form a cylindrical cavity having an axis, the inner surface of the peripheral wall having a substantially circular profile;
- a hollow cylindrical rotor having an outer and inner surface, each having a substantially circular profile, and supported in the cavity for rolling motion with respect to the inner surface of the stator about an axis spaced from but parallel to the stator axis;
- the rotor having an internal diameter such that the stator axis is located inside the inner surface of the rotor and an external diameter that is less than the diameter of the inner surface of the stator;
- means for sealing the outer surface of the rotor with respect to its inner surface;
- an eccentric mounted within the inner surface of the rotor for rotation about the stator axis and having bearing means located on the periphery of the eccentric which are in rolling contact with the inner surface of the rotor, whereby in operation the rotor axis described a substantially circular path around the stator axis;
- a plurality of spaced vanes mounted in the stator in sealing relationship with the end walls for reciprocal movement with respect to the inner surface of the stator;
- means for holding the vanes in sealing engagement with the outer surface of the rotor;
- whereby at least two chambers, at least one of which is a working chamber and one of which is a non-working chamber, are defined by adjacent vanes, the outer surface of the rotor, the inner surface of the stator, and the end walls of the stator;
- the stator having an intake port for admitting fuel to the working chamber and an exhaust port for discharging exhaust products from such chamber.

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2. The rotary engine defined in claim 1 in which the external diameter of the rotor is at least about 70 percent of the diameter of the inner surface of the stator.

3. The rotary engine defined in claim 2 in which the external diameter of the rotor is 75 to 95 percent of the diameter of the inner surface of the stator.

4. The rotary engine as defined in claim 1 which has at least three vanes.

5. The rotary engine as defined in claim 1 which has an odd number of working chambers.

6. The rotary engine defined in claim 1 in which the vanes reciprocate substantially radially with respect to the stator axis.

7. The rotary engine defined in claim 1 in which the intake and exhaust ports are located in the peripheral wall of the stator.

8. The rotary engine defined in claim 1 in which the intake and exhaust ports have valves for opening and

closing such ports and means for controlling the operation of the valves.

9. The rotary engine defined in claim 1 which has ignition means for igniting fuel in each working chamber.

10. The rotary engine as defined in claim 1 in which the outer surface of the rotor is in rolling contact with the vane when the chamber pressure is near maximum.

11. The rotary engine defined in claim 1 in which the eccentric occupies substantially less than the space defined by the inner surface of the rotor.

12. The rotary engine defined in claim 1 including means in the end walls for guiding and supporting the vanes.

13. The rotary engine defined in claim 1 including a power shaft mounted to the eccentric along the stator axis.

14. The rotary engine defined in claim 1 in which the end walls are parallel to each other and perpendicular to the inner surface of the peripheral wall.

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