# United States Patent [19]

**Lay**

[11] **3,902,464**

[45] **Sept. 2, 1975**


[54] **ROTARY INTERNAL COMBUSTION ENGINE**


[76] Inventor: **Joachim E. Lay,** 1749 Ridgewood, East Lansing, Mich. 48823



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[21] Appl. No.: **413,626**

[52] **U.S. Cl.** ..... **123/8.07;** 123/8.45; 418/60; 418/246

[51] **Int. Cl.²** ..... **F02B 53/06**

[58] **Field of Search** ..... 123/8.07, 8.45; 418/60, 418/244, 246



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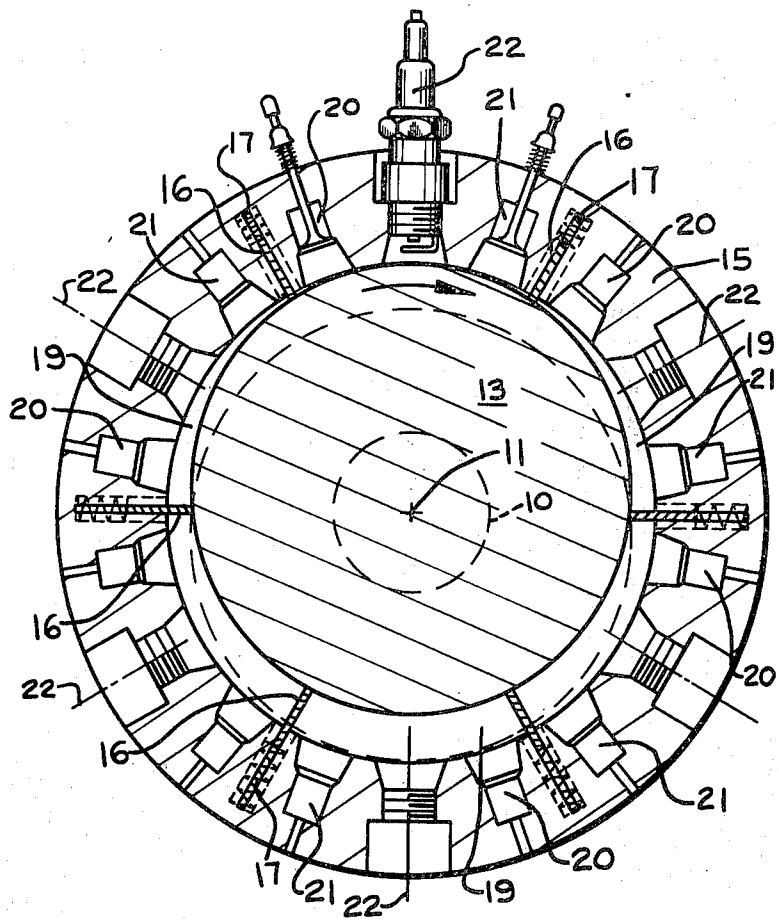
*Primary Examiner*—William L. Freeh
*Assistant Examiner*—Michael Koczo, Jr.
*Attorney, Agent, or Firm*—Miller, Morriss, Pappas & McLeod



[57] **ABSTRACT**

A sliding abutment rotary internal combustion engine with dual eccentric identically shaped rotors on a common shaft is described. The angle of eccentricity of the first rotor from the second rotor is 180° such that when the first rotor is inletting and then compressing a fuel-air mixture through a first 360° of rotation of the shaft, the second rotor is providing power by the combustion of a fuel-air mixture and then exhausting the combustion products through the second 360° of rotation of the shaft. A complete engine cycle is completed in 720° of shaft rotation. Valved conduit means are used for fuel-air inlet and combustion products exhaust to chambers formed by sliding abutment, engine housing and rotor. Particularly preferred valve actuating means for the rotary engine are described.


**9 Claims, 29 Drawing Figures**



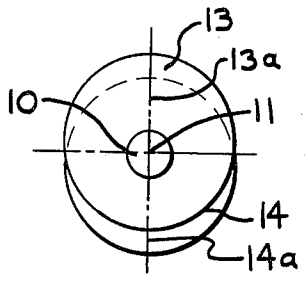



FIG. 1

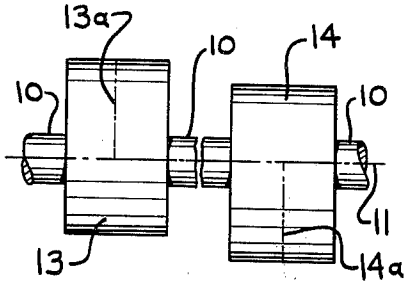



FIG. 1A

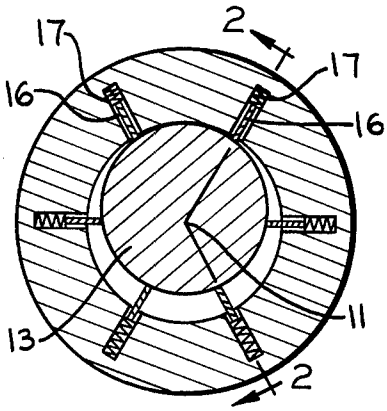



FIG. 2A

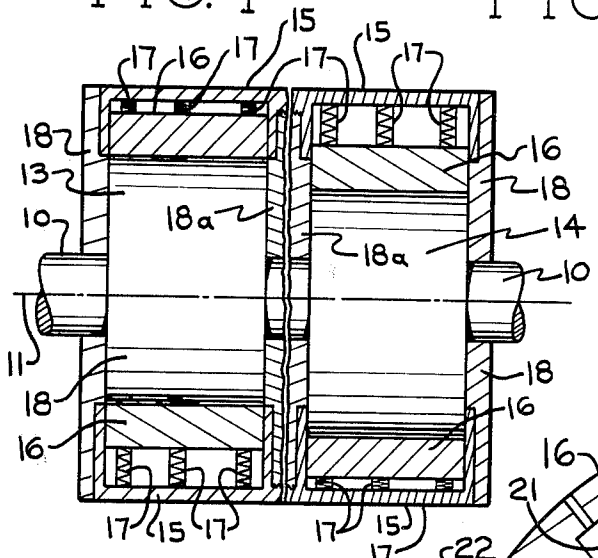



FIG. 2

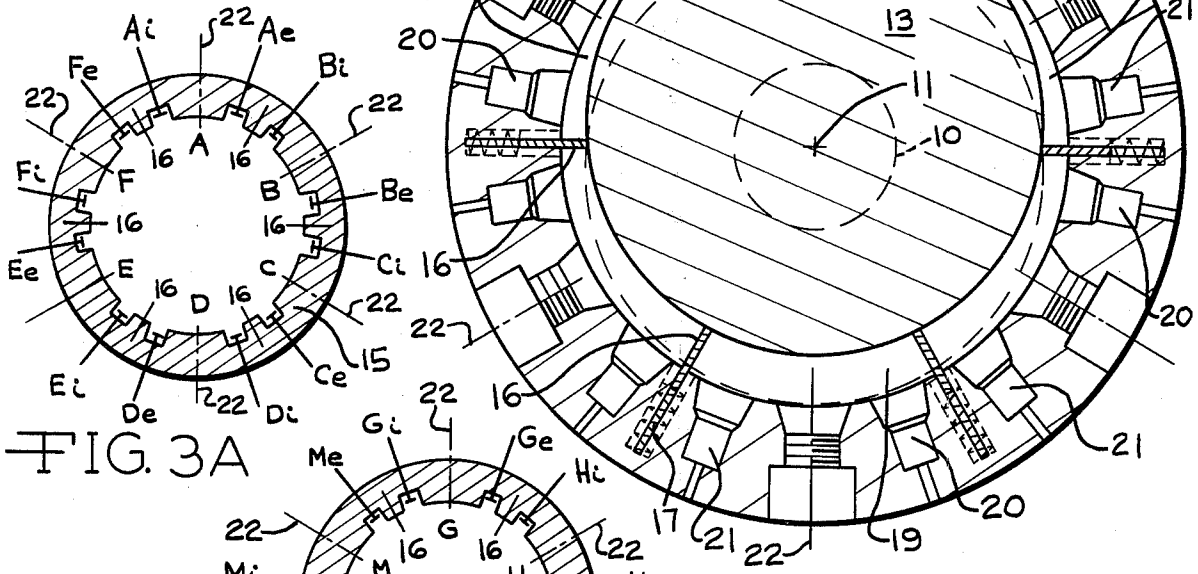



FIG. 3




FIG. 3A

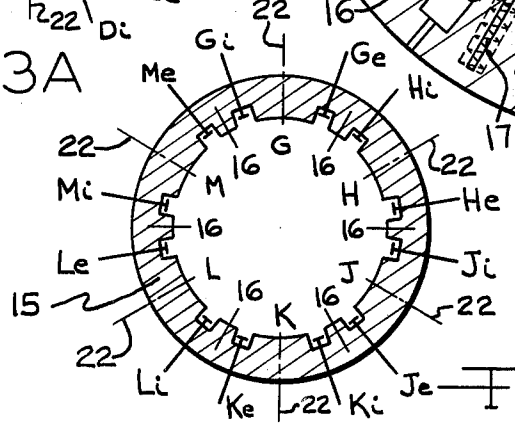



FIG. 3B

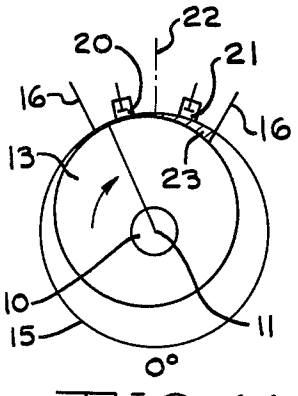



FIG. 4A

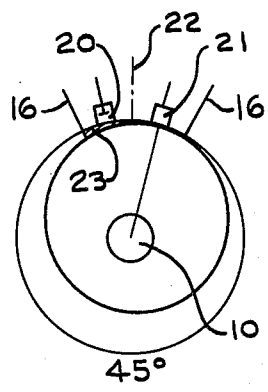



FIG. 4B

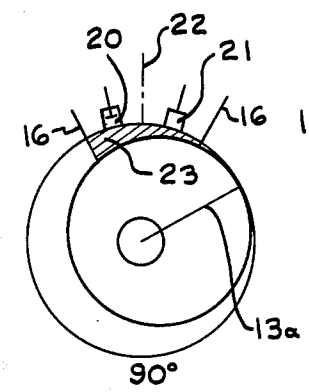



FIG. 4C

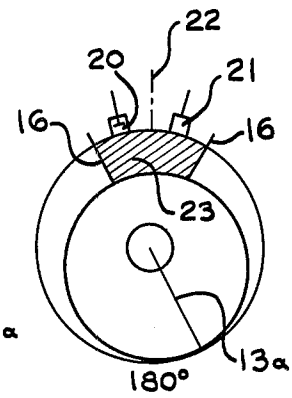



FIG. 4D

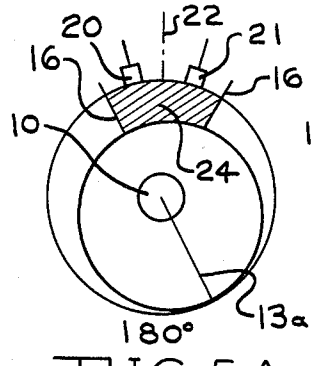



FIG. 5A

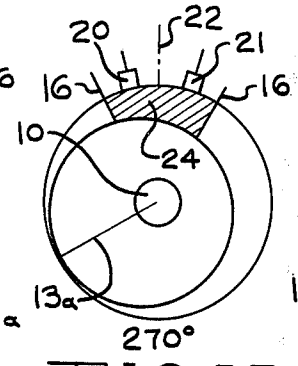



FIG. 5B

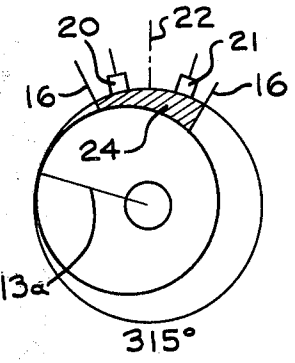



FIG. 5C

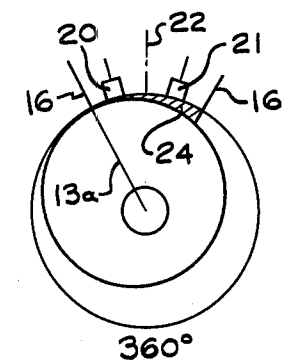



FIG. 5D

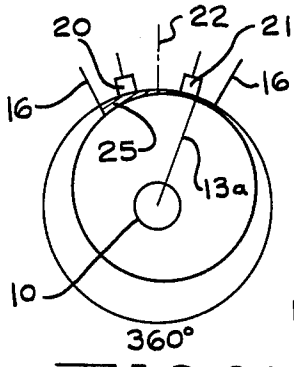



FIG. 6A

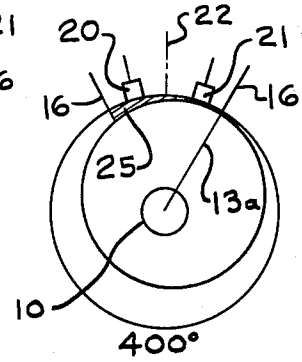



FIG. 6B

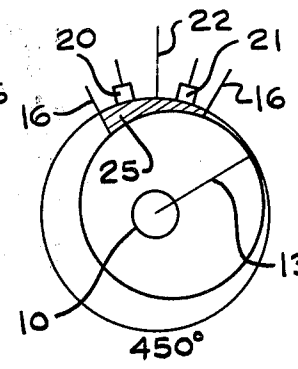



FIG. 6C

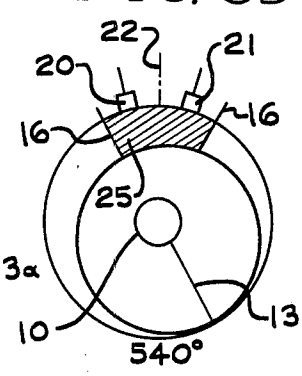



FIG. 6D

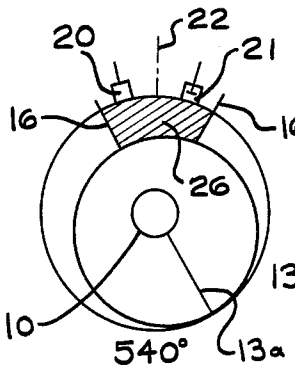



FIG. 7A

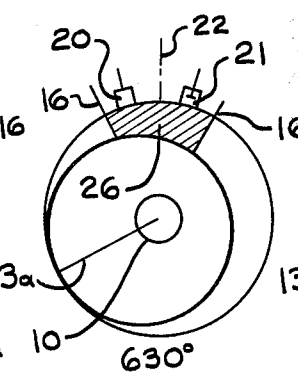



FIG. 7B

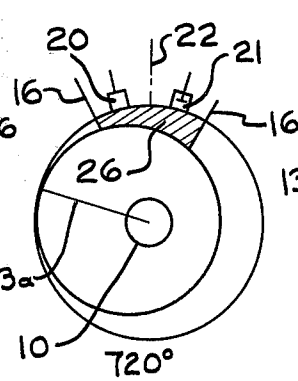



FIG. 7C

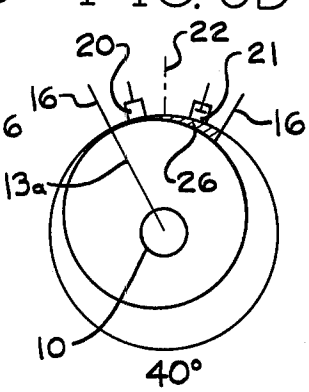



FIG. 7D

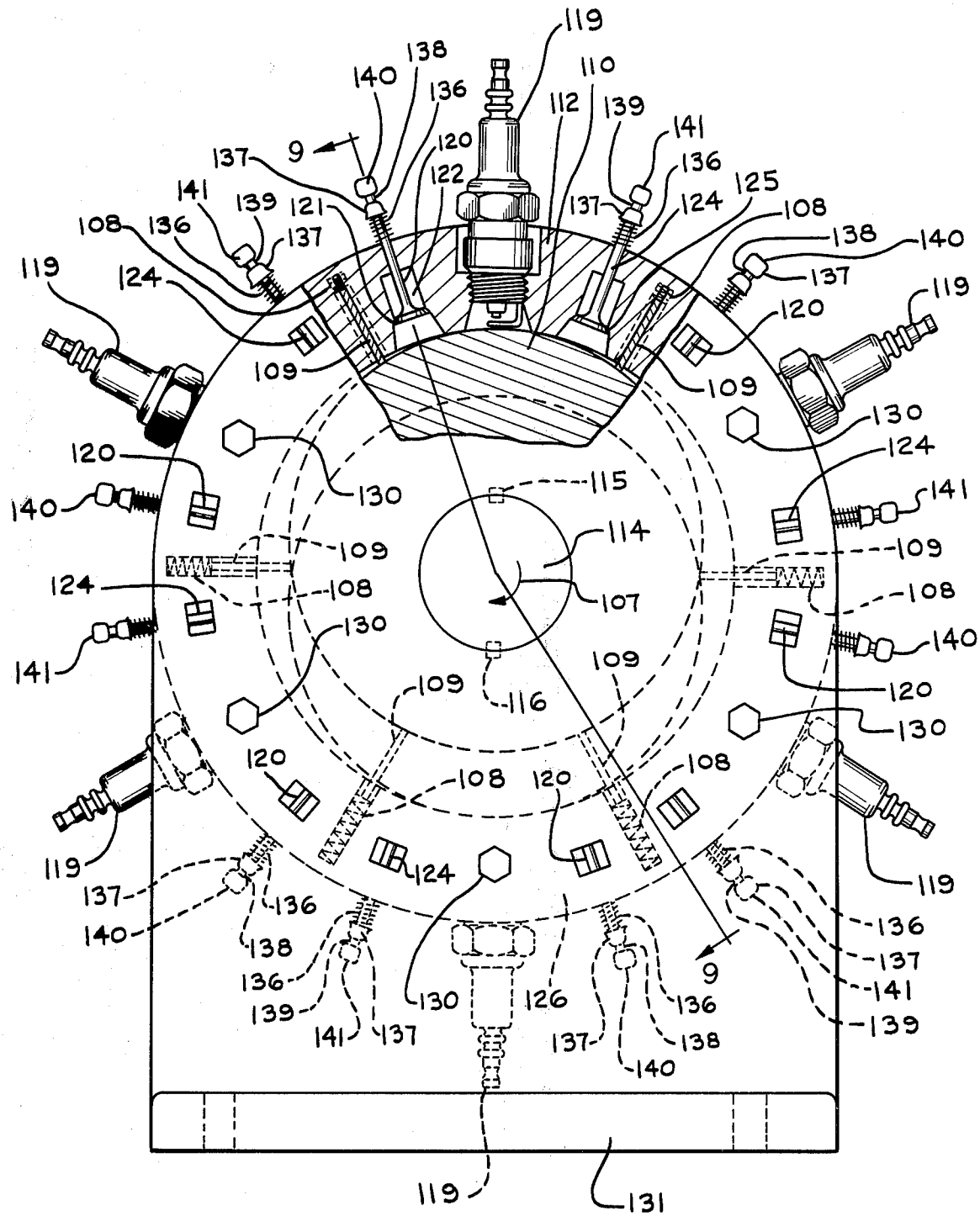

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FIG. 8

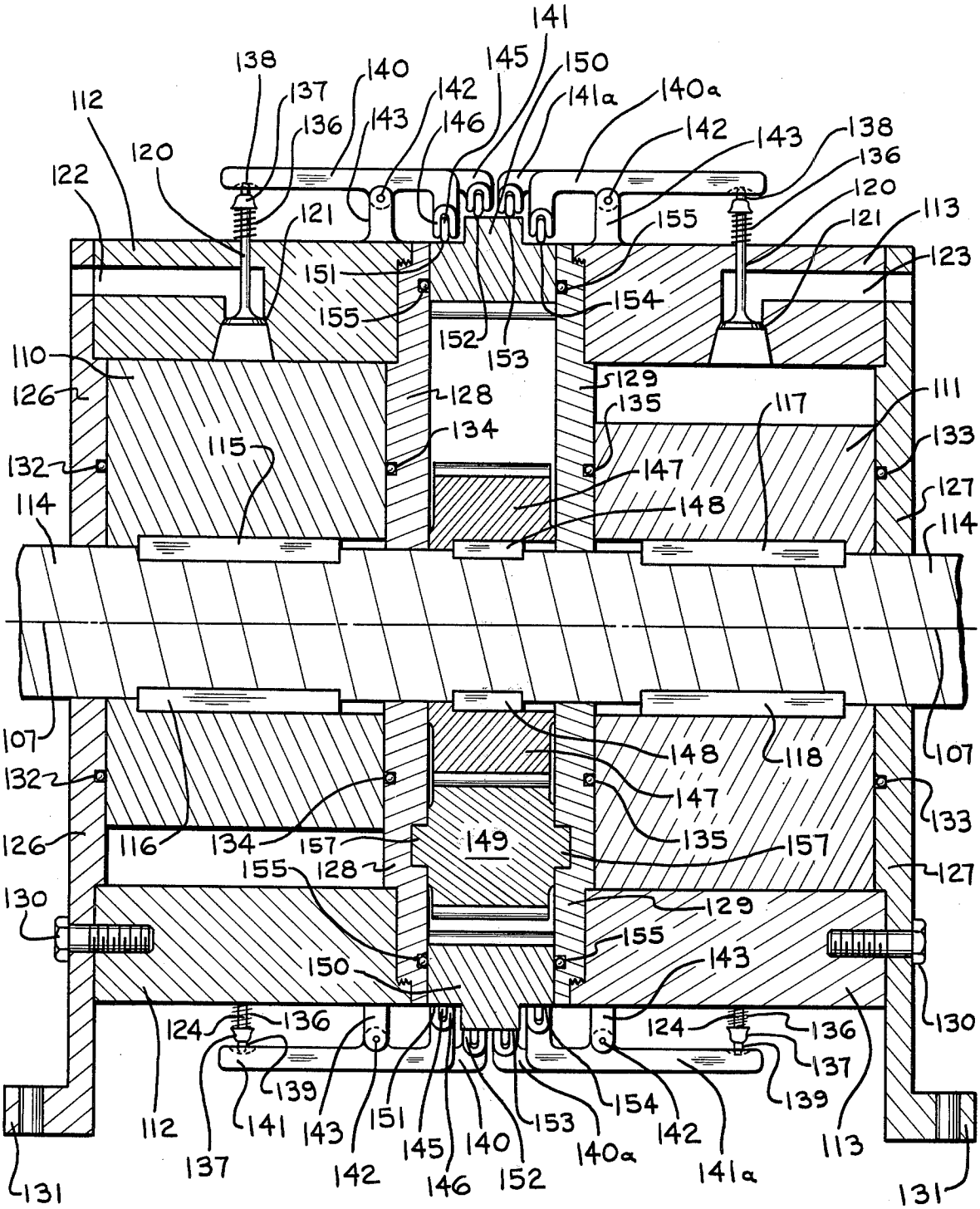

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FIG. 9

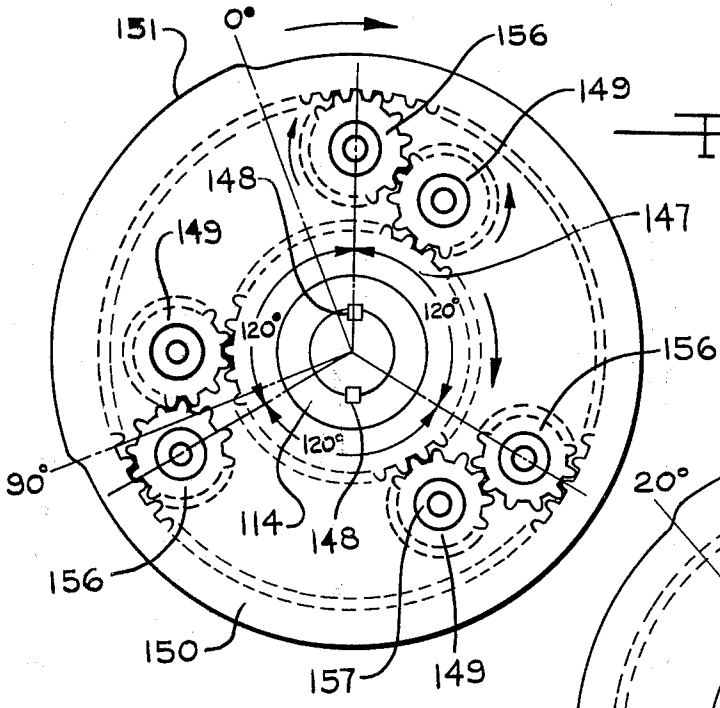
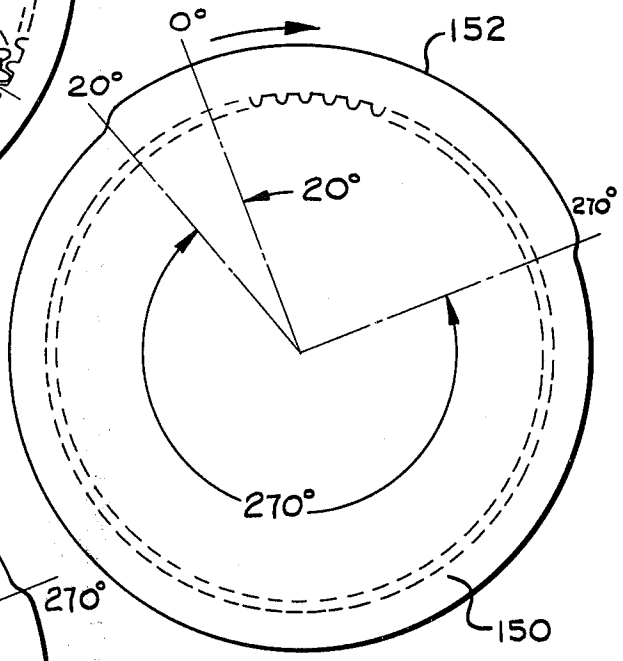



FIG. 10

FIG. 10A



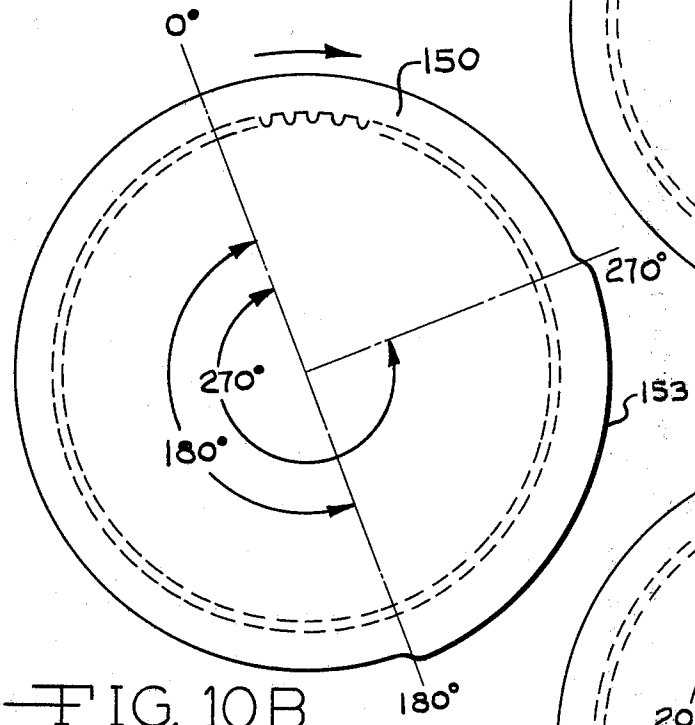




FIG. 10B

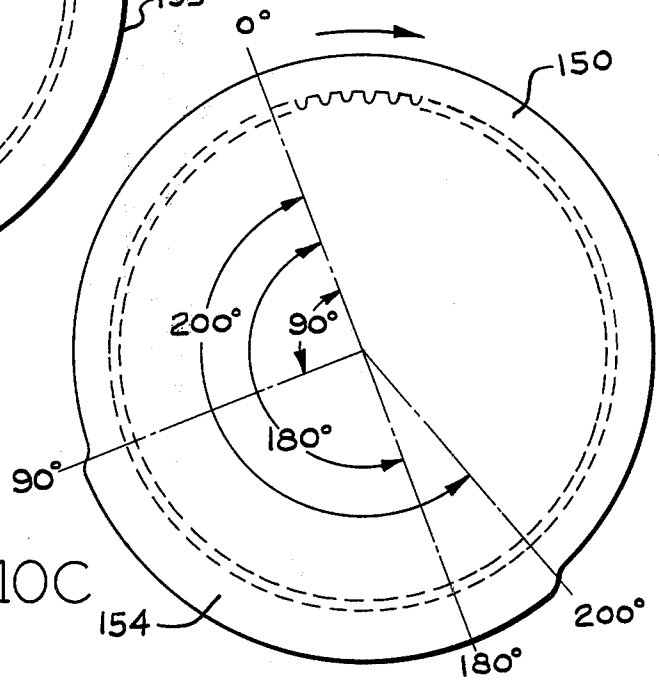



FIG. 10C

# ROTARY INTERNAL COMBUSTION ENGINE

## SUMMARY OF THE INVENTION

The present invention relates to a sliding abutment rotary internal combustion engine wherein spaced apart, dual eccentric rotors are provided on a common shaft such that while one rotor is inletting and then compressing a fuel-air mixture through a first 360° of rotation of the shaft, the other rotor is providing fuel-air combustion and then combustion products exhaust through the second 360° of rotation of the shaft. Chambers formed by the rotors, abutment and engine housing are fired in sequence around the first rotor housing and then in sequence around the second rotor housing through 720° of rotation of the shaft.

## PRIOR ART

A rotary internal combustion engine has inherent advantages over a reciprocating internal combustion engine, mainly because the energy released by the combustion can be converted directly into rotational motion of the shaft mounting the rotor. In fact, the idea of a rotary engine goes back several centuries and actually pre-dates the invention of the reciprocating engine. However, the quest for a rotary engine which is simple and inexpensive to produce has met with limited success so far, and only in a few cases such as the Wankel engine have such engines been mass produced. Although many rotary engines have been conceived (the literature abounds with ingenious and complicated designs for rotary combustion engines), they generally are difficult and expensive to produce.

Sliding abutment rotary combustion engines are well known to the prior art. For instance, they are shown in U.S. Pat. Nos. 2,155,775; 2,409,141; 3,155,081; and 3,280,804. In these rotary engines, equally spaced cam lobes on the rotor move the sliding abutments. In others, such as shown in U.S. Pat. Nos. 3,164,139 and 3,539,280, a single eccentric rotor is described. In all of these rotary engines there is no valving for the exhaust, since the fuel-air mixture moves the rotor into the position of ignition and then exhausts within 360° of rotation of the rotor. In order to balance these engines, the rotor must be counterbalanced opposite the eccentricity, usually by another balancing eccentricity on the same rotor.

U.S. Pat. No. 2,155,775 describes a dual rotor unit where both rotors are fired simultaneously 180° apart and repeatedly during 360° of revolution of the rotor shaft. A complex air injection system is provided wherein compressed air is channeled to the chamber where the firing is to take place from three other chambers provided on each rotor. Balance is achieved by using dual rotors on the same shaft; however, the engine would be difficult and expensive to manufacture. U.S. Pat. No. 2,409,141 also describes a single rotor with compressed air injection from opposite chambers with dual sequenced firing.

U.S. Pat. No. 3,155,081 shows multiple sequenced firing in 360° of rotor shaft rotation of the rotor. A lever is compressed onto the surface of a balanced rotor to compress the fuel-air mixture prior to firing. U.S. Pat. No. 3,280,804 shows multiple sequenced firing in 360° of rotor shaft rotation wherein air-fuel mixture ignition system is provided in the rotor itself. The compressed air-fuel mixture is provided inside the rotor by means of ports and the fired mixture is ported onto the surface of the rotor adjacent two opposing lobes. U.S. Pat. No. 3,539,280 also shows multiple sequenced firing through 360° of rotation the use of a central air inlet and usually fuel exhaust through an eccentric rotor.



Scientific American, Volume 220, No. 2, February 1969 (pages 90 to 99) describes a number of rotary engines. Further, Alternatives to the Internal Combustion Engine (1972) by R. U. Axres and R. P. McKenna pages 119 to 120 describes recent developments in such engines. All are similar to the engines described above in that the cycles of fuel inlet, compression combustion and exhaust are completed at least once in 360° of rotor shaft rotation. These rotary engines are also difficult and expensive to build even when conventional valves are used. Further, means for fuel-air inlet or fuel-air compression is usually either complex or uncertain in operation. The engine rotors are difficult to balance and build and the rotors at high revolutions tend to overrun their safe limits because of their momentum.

It is therefore an object of the present invention to provide a rotary engine which is simple and inexpensive to build. Further still, it is an object of the present invention to provide an engine with positive fuel-air compression and wherein the fuel-air mixture is inletted directly into each firing chamber. Further still, it is an object of the present invention to provide an engine which has positive and easily regulated fuel inlet and combustion exhaust. Further still, it is an object of the present invention to provide an engine where the rotor has less of a tendency to overrun the safe revolution limit. Also provided is a unique and simplified valve actuating means which accomplishes fuel-air inlet and exhaust outlet. These and other objects will become increasingly apparent to those skilled in the art and in particular by reference to the drawings.

## IN THE DRAWINGS

FIGS. **1** and **1***a*, in front and side views respectively, schematically illustrate a shaft with two eccentrically mounted rotors with their maximum eccentricity 180° apart.

FIGS. **2** and **2***a*, in a cross-section front and side view respectively, schematically illustrate the shaft and dual rotors mounted in a housing which has sliding abutments contacting the rotors.

FIG. **3**, in a cross-sectional view of one rotor within its housing, schematically illustrates an assembled individual chamber or compartment with a spark plug and valves.

FIGS. **3***a* and **3***b* show the housing of each rotor being divided into separate compartments, labeled compartment A, compartment B, . . . compartment M. The intake and exhaust valves in each compartment are labeled respectively as $A_i$, $A_e$, $B_i$, $B_e$, . . . $M_i$, $M_e$.

FIGS. **4** through **7**, schematically illustrate the two complete revolutions of one of the dual rotors to produce the engine cycle wherein FIG. **4** shows fuel-air intake, FIG. **5** compression, FIG. **6** combustion and FIG. **7** exhaust.

FIG. **8**, in an end view with a partial section of one compartment, illustrates the preferred rotary internal combustion engine of the present invention and particularly illustrates the details of the mounting of the valve means in the housing.

FIG. 9, in a cross-sectional view of the engine of FIG. 8 along line 8—8, illustrates the valve actuating means mounted between the rotors on the crankshaft and particularly illustrates four cam surfaces on a ring gear.

FIG. 10 is a cross-section view of the ring gear, particularly illustrates the planetary gearing to reduce the rate of rotation of the valve actuating ring gear to one-half that of the crankshaft and rotors. It also shows the profile of one cam surface, which actuates the intake valves $A_i$, $B_i$, $C_i$, $D_i$, $E_i$, and $F_i$.

FIG. 10*a* shows the profile and position of the cam surface, which actuates the exhaust valves $A_e$, $B_e$, $C_e$, $D_e$, $E_e$, and $F_e$.

FIG. 10*b* shows the profile and position of the cam surface, which actuates the intake valves $K_i$, $L_i$, $M_i$, $G_1$, $H_i$, and $J_i$.

FIG. 10*c* shows the profile and position of the cam surface, which actuates the exhaust valves $K_e$, $L_e$, $M_e$, $G_e$, $H_e$, and $J_e$.

## GENERAL DESCRIPTION

The present invention relates to the design of a rotary internal combustion engine using an eccentric rotor and sliding abutment to form chambers for compression and then combustion with valve and conduit means for fuel-air intake and products exhaust comprising two identically shaped rotors eccentrically mounted on a common shaft with the maximum eccentricity spaced 180° from each other; sliding abutment resiliently mounted in each of the housings for continuous contact with the rotors throughout the revolution of the shaft so as to form sealed compression and then combustion chambers with the rotors; and fuel-air ignition means in each compression combustion chamber wherein during operation each of the chambers on one of the rotors is providing in sequence a fuel-air mixture through the inlet valve conduit means and then fuel-air compression through 360° of rotation while the other of the rotors is providing in sequence fuel-air combustion and then combustion products exhaust through the exhaust valve means through a second 360° of rotation.

The method of providing rotation of a shaft in a rotary internal combustion engine housing with two spaced apart identically shaped rotors mounted eccentrically on the longitudinal axis of the shaft such that the radius of eccentricity from the longitudinal axis of one rotor is 180° from the same radius of the other rotor, with valved conduit means for fuel air inlet and combustion products exhaust outlet and with at least one sliding abutment forming a sealed compression and combustion chamber between each rotor and its housing which comprises: providing a fuel-air mixture through the valved conduit fuel inlet means to each chamber on the first rotor in sequence through 360° of rotation as the radius of maximum eccentricity passes each inlet at a trailing surface of the rotor and then to the second rotor in the same sequence through 360° of rotation; compressing the fuel-air mixture between the first rotor, abutment and housing in sequence through the 360° of shaft rotation in step (a) using the power produced by the simultaneous combustion of a compressed fuel-air mixture between the second rotor, abutment and housing; igniting the compressed fuel-air mixture between the first rotor, abutment and housing on the trailing surface of the rotor thereby providing the power for rotating the shaft a second 360° to compress fuel-air mixture in the compartment formed by the second rotor, abutment and housing; and exhausting the combustion products from the leading surface of the first rotor upon completion of the second 360° of rotation, wherein each of the chambers on one of the first rotor is provided in sequence with a fuel-air mixture through the inlet valved conduit means and then fuel-air compression while the second rotor is providing in sequence fuel-air combustion and then combustion products exhaust through the valved conduit means for a total of 720° of rotation of the shaft.

The rotary engine is illustrated in FIGS. 1 to 3 and consists of a shaft **10** having a longitudinal axis of rotation **11** with two eccentrically mounted rotors **13** and **14** provided in a cylindrical casing or housing **15** (FIG. 2) in which it rotates. The two rotors, **13** and **14** and the crankshaft, **10**, are shown in FIGS. 1 and 1*a* with the radii of maximum eccentricity **13***a* and **14***a* 180° apart. The assembled engine, with the casing **15** and end plates **18** and **18***a* included, is schematically shown in FIGS. **2**, **2***a* and **3**. The broken lines show the rotor **14**.

The relative positions of each rotor **13** and **14** in the casing **15** is shown in FIGS. **2** and **3**. Inside each of the casings **15** are sliding abutments **16**, held by springs **17** against the rotors **13** and **14**. As shown, there are six abutments **16** per rotor **13** and **14**, thus forming six separate compartments or chambers which are spaced 60° apart.

Each compartment **19** contains air-fuel inlet and exhaust valve means, preferably a conventional intake valve **20** and an exhaust valve **21**. A spark plug **22** as shown in FIG. **3** can be used or other igniting means such as glow plugs or heated tubes (not shown) can be used instead. The valves **20** and **21** are located adjacent to the abutments **16**. As shown particularly in FIGS. 3*a* and 3*b*, the valves **20** and **21** are lettered A to M in the firing sequence with subscripts (*i*) for intake and (*e*) for exhaust.

The operation of the rotary engine can be understood by reference to the events taking place in one of the compartments **19** of FIG. **3** as shown in FIGS. **4** to **7** for one rotor. In FIG. 4*a*, the rotor **13** is in the position shown at the beginning of the sequence of operations, just as it sweeps past the intake valve **20**. The radius of eccentricity **13***a* of the rotor **13** from the longitudinal axis **11** along the shaft **10** compresses the abutment **16**, while at the same time, the valves **20** and **21** are open. Consider the sweep as it reaches the intake valve to be the 0° of shaft **10** rotation with the intake valve **20** open. A fresh charge of fuel and air is about to be swept into the chamber **19** on the trailing side of the rotor **13**, while on the leading side of the rotor **13**, discharge of the exhaust gases is being completed through the still open exhaust valve **21**. The intake process takes place as the shaft **10** rotates from 0° to 180°. At this point (one-half a revolution of the crankshaft **10**), the fuel-air intake is completed, the intake valve **20** closes, and the fuel compression process begins. The shaded area in FIGS. 4*a* to 4*d* denotes the volume of air-fuel mixture **23** drawn in.

From 180° to 360° of shaft **10** rotation, fuel-air compression takes place, with both intake and exhaust valves **20** and **21** being closed. This is shown in FIGS. 5*a* to 5*d*, where the shaded area **24** (representing the volume of trapped fuel and air), becomes smaller and smaller. The compression process **24** continues past 360°, and at 400° of shaft **10** rotation, the spark plug **22**

fires, whereupon the gas expansion 25 or power stroke begins. This is shown in FIGS. 6*a* to 6*d*. The gas expansion 25 is completed at 540°.

At 540°, the exhaust valve 21 opens, and discharge of the exhaust gases 26 begins. Exhaust proceeds from 540° of shaft 10 rotation, through 720°, to 40° (new cycle position). At 720° of shaft 10 rotation (2 revolutions), the intake valve 20 opens to begin a new cycle, while the exhaust valve 21 stays open to 40° to allow full rejection of the exhaust gases 26. The exhaust process is shown in FIGS. 7*a* to 7*d*.

From the above description of the events shown in FIGS. 4 to 7 it is seen that an entire cycle, comprising intake, compression, combustion-expansion, and exhaust, takes place in two revolutions of the shaft 10. For this reason, two rotors 13 and 14, mounted with the radii of 13*a* and 14*a* eccentricity 180° apart on a shaft 10, are specified per engine.

For an engine which basically makes use of two rotors 13 and 14, the firing sequence follows the order of rotation of one rotor 13 and then the other rotor 14. That is, during a given revolution of the crankshaft 10, all the chambers 19 surrounding the first rotor 13 fire one after the other through 360°, while the chambers 19 surrounding the second rotor 14 perform their tasks of intake and compression. During the next revolution through 360°, all the chambers 19 surrounding the second rotor 14 fire one after the other, while the chambers 19 surrounding the first rotor 13 perform their tasks of intake and compression. A power stroke occurs at every 60° of crankshaft 10 rotation in the preferred engine. The engine shown in FIGS. 1 to 7 is thus like a twelve cylinder reciprocating piston engine as to the number of firing chambers. The twelve chambers 19 assures a uniform torque output and a smooth operation of the engine.

## SPECIFIC DESCRIPTION

FIGS. 8, 9 and 10 show a preferred rotary engine, such as illustrated in FIG. 3, in considerably more detail. The eccentric rotors 110 and 111 are each confined in cylindrically cross-sectioned housings 112 and 113. Six (6) sliding abutments 109 with springs 108 are provided in each of the housings 112 and 113. The rotors 110 and 111 are mounted on a shaft 114 held in position by keys 115, 116, 117 and 118, mounted in key ways between the rotors 110 and 111 and shaft 114. The construction engine in the two housings 112 and 113 is identical except that the radii of eccentricity of the rotors 110 and 111 are 180° around the central axis 107 of the shaft 114. Six spark plugs 119 are mounted through the housing 112 and correspondingly through housing 113 (not shown). Six tapered head intake valves 120 are mounted in each of the housings 112 and 113 on one side of each of the spark plugs 119 so as to open towards the center 107 of the shaft 114 and to close on seats 121 in conduits 122 and 123. Six tapered head exhaust valves 124 are mounted in the housings 112 and 113 on the other side of the spark plugs 119 so as to open towards the center 107 of the shaft 114 and to close on seats 125. The housings 112 and 113 are closed by end plates 126, 127, 128 and 129 using bolts 130. The engine has mounting plates 131. Ball bearings 132, 133, 134 and 135 (FIG. 9) are provided in recesses in the inside of end plates 126, 127, 128 and 129 in contact with the sides of the rotors 110 and 111.

All of the valves 120 and 124 are provided with identical compressed, coil springs 136 and keepers 137 such that end portions 138 and 139 of the valves 120 and 124 respectively are exposed. The valve ends 138 and 139 are acutated by rocker arms or levers 140 and 141 pivotally mounted at 142 on the housing 112 by fork mounts 143. Corresponding rocker arms 140*a* and 141*a* are mounted on housing 113. The ends of the rocker arms are forked for rollers 145, mounted on pins 146. The roller 145 and arms 140 and 141 are actuated by cam surfaces 151, 152, 153, and 154 on a ring gear 150.

The ring gear 150 is positioned between the rotors 110 and 111 and supported by opposing inside rotor closing plates 128 and 129 mounted on the housings 112 and 113 respectively. The outsides of the plates 128 and 129 support a planetary gear mechanism for driving the ring gear 150 as particularly shown in FIGS. 9 and 10.

A central driving gear 147 is mounted on the shaft 114 by key 148. The sides of the gear 147 bear on the outside of the plates 128 and 129. Three planetary driven gears 149 are rotatably mounted on the plates 128 and 129 in contact with the gear 147 on a shaft 157 which is recessed into plates 128 and 129 so as to be 120° apart. The planetary gears 156 are in contact with the gears 149 and the inside of the ring gear 150 and are also spaced 120° apart. Ball bearings 155 are recessed into the end plates 128 and 129 for sliding contact with the sides of the ring gear 150.

The four separate cam surfaces 151, 152, 153 and 154 on the outside of the ring gear 150 actuate the opening and closing of the valves 120 and 124 by means of rocker arms 140, 140*a*, 141 and 141*a* as shown in FIG. 9. Rollers 145 each ride on one cam surface 151 to 154 on ring gear 150. As the shaft 114 and ring gear 150 rotate, the rocker arms 140, 140*a*, 141 and 141*a* cause the valves 120 and 124 to open and close. Since the engine has 24 valves altogether, it is desirable to have a maximum number of valves 120 and 124 being driven from a given cam surface 151 to 154. From the planetary gear arrangement shown in FIG. 10, it can be seen that the ring gear 150 revolves in the same direction as the rotors 110 and 111. Also, because of the ratio of the diameter of the ring gear 150 to the central gear 147, the ring gear 150 rotates at half the angular speed of the shaft 114. Thus, a complete cycle of events is accomplished in two revolutions (720° ) of the shaft 114 and one revolution (360°) of the ring gear 150. This enables the profile of the cam surfaces 151 to 154 to be easily determined. For example, the intake process in chamber A takes place between 0° and 180° rotation of shaft 114. Since the ring gear 150 rotates at half the shaft speed, cam surface 151 will have a dwell (the raised portion corresponding to the opened valve position) from 0° to 90°. All the rollers actuating intake valves $A_i$, $B_i$, $C_i$, $D_1$, $E_i$, $F_i$ will ride on this surface. Cam surface 151 is shown in FIG. 10.

Similarly, the exhaust process in chamber A takes place between 540° and 40° of shaft 114 revolution, and therefore cam surface 152 will have a dwell from 270° to 20° as shown in FIG. 10*a*. All the rollers actuating exhaust valves $A_e$, $B_e$, $C_e$, $D_e$, $E_e$, $F_e$ will ride on this surface. Likewise, the profile of cam surface 153 actuating the intake valves $K_i$, $L_i$, $M_i$, $G_i$, $H_i$, $J_i$ is arrived at and shown in FIG. 10*b*, and the profile of cam surface

154 actuating exhaust valves $K_e$, $L_e$, $M_e$, $G_e$, $H_e$, $J_e$ is arrived at and shown in FIG. 10*c*.

As can readily be seen from the foregoing description, the preferred rotary engine operates with valving to control fuel-air inlet and exhaust products outlet. The valving shown by FIGS. 8 to 10 is preferred; however, it will be appreciated that other conventional valve actuating means or other valving means such as rotatable cylindrical ported internal sleeve valves in mating contact with the internal walls of the cylindrical housings 112 and 113 can be used as is well known to those skilled in the art.

I claim:

1. A four-cycle rotary internal combustion engine which comprises:

a. a shaft having spaced apart bearing surfaces separating two sections of the shaft around a longitudinal axis for journaled rotation of the shaft;

b. two spaced apart identically shaped rotors mounted on the sections of the shaft between the bearing surfaces and eccentrically mounted on crankshaft such that the radius of maximum eccentricity from the longitudinal axis for the shaft of one rotor is 180° from the other rotor;

c. dual housings mounting the shaft for journaled rotation of the rotors with spaced apart surfaces from the radii of maximum eccentricity of the rotor around the axis of rotation of the shaft;

d. at least two sliding abutments resiliently mounted in each of the housings for continuous contact with the rotor through 360° of revolution of the shaft so as to form sealed compartments with the rotors;

e. valved conduit means for air and fuel inlet and combustion products exhaust outlet in each of the compartments formed by the abutments and rotors, the valves extending to each compartment around the rotors having a head seating in the conduits in the housing for closure and having a shaft mounting the head and extending through and from the housing, with external compressed coil springs mounted on the shafts and housings to seat the valves;

f. means for actuating the valves at the extension of the shaft from the housing including cam actuated levers mounted on the housing so as to pivot and depress each valve shaft in sequence, wherein the camming of the levers is provided by four cam surfaces for independent inlet and outlet valve opening around each rotor which are mounted between the rotors and geared to the rotor shaft so as to rotate at one-half the rate of rotation of the rotor shaft and wherein the cam surface rotation is regulated by a driving gear mounted on the shaft and multiple driven gears rotatably mounted to drive a ring gear bearing the cam surfaces; and

g. openings to each of the compartments for fuel-air ignition means which are provided in each compartment wherein during operation of the engine one of the compartments on a first rotor provides in sequence fuel-air inlet through the fuel inlet valve means and then fuel-air compression through 360° of shaft rotation while the second rotor is providing in sequence fuel-air combustion and then combustion products exhaust through the exhaust valve means and then the sequence is reversed during two complete revolutions of each rotor.

2. The rotary engine of claim 1 wherein the surfaces in the housing are cylindrically shaped.

3. The rotary engine of claim 1 wherein the ignition means openings are adapted for spark plugs.

4. The rotary engine of claim 1 wherein the rotors have a cylindrical cross-section.

5. The rotary engine of claim 2 wherein there are six sliding abutments so as to provide six sealed compartments around each rotor.

6. The rotary engine of claim 1 wherein the driven gears are journaled by opposing outside portions of the housing.

7. In a rotary engine using two identically shaped rotors eccentrically mounted on a common shaft in two separate housings with the maximum eccentricity spaced 180° from each other; at least two sliding abutments resiliently mounted in each of the housings for continuous contact with the rotors throughout the revolution of the shaft so as to form sealed compression and then combustion chambers with the rotors; and fuel-air ignition means in each compression combustion chamber wherein during operation each of the chambers on one of the rotors is providing in sequence a fuel-air mixture through an inlet valved conduit means and then fuel-air compression through 360° of rotation while the other of the rotors is providing in sequence fuel-air combustion and then combustion products exhaust through an exhaust valved conduit means through a second 360° of rotation, wherein the inlet and exhaust valves have a shaft extending through and from the housing and wherein means for actuating the valves at the extension of the shaft from the housing is provided to open the valves the improvement which comprises:

a. means for actuating the valve shafts including cam actuated levers mounted on the housing so as to pivot and depress each valve shaft in sequence; and

b. four cam surfaces camming the levers for independent inlet and outlet valve opening around each rotor which are mounted between the rotors and geared to the shaft so as to rotate at one-half the rate of rotation of the rotor shaft, wherein the cam surface rotation is regulated by the rotation of the shaft by means which drive a ring bearing the cam surfaces.

8. The rotary engine of claim 7 wherein the cam surface rotation is regulated by a driving gear mounted on the shaft and multiple driven gears rotatably mounted to drive a ring gear bearing the cam surfaces.

9. The rotary engine of claim 7 wherein the driven gears are journaled by opposing outside portions of the housings.

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# UNITED STATES PATENT OFFICE

# CERTIFICATE OF CORRECTION

Patent No. 3,902,464 Dated September 2, 1975

Inventor(s) Joachim E. Lay

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 27, after "as" insert --with--.

Column 1, line 41, after "moves" insert --with--.

Column 3, line 1, after "a" insert --side--.

Column 3, line 48, insert a "hyphen" between fuel and air.

Column 8, line 13, Claim 5, change "Claim 2" to read --Claim 1--.

Signed and Sealed this

second Day of December 1975

[SEAL]

*Attest:*

RUTH C. MASON
*Attesting Officer*

C. MARSHALL DANN
*Commissioner of Patents and Trademarks*