

[54] **ROTARY INTERNAL COMBUSTION ENGINE**[76] Inventor: **Kenneth D. Sauder**, 1861 Brentwood Drive, Clearwater, Fla. 33516[22] Filed: **June 15, 1971**[21] Appl. No.: **153,435****Related U.S. Application Data**

[63] Continuation-in-part of Ser. No. 883,728, Dec. 10, 1969, abandoned.

[52] U.S. Cl.**123/8.07, 123/8.15, 123/8.41, 123/8.25**[51] Int. Cl.**F02b 53/00**

[58] Field of Search.....123/8.07, 8.05, 8.13, 8.15, 123/8.19, 8.23, 8.25, 8.29, 8.41, 8.43, 8.01, 8.03

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Primary Examiner—Clarence R. Gordon

Attorney—Stefan M. Stein

[57] **ABSTRACT**

A rotary internal combustion engine including a plurality of segregated chambers arranged in communicating relation with one another such that compression, combustion and expansion of the gases used to rotate the engine may take place in succession, step-like manner. Each of the chambers have mounted therein a rotary pump which may be in the form of a pair of multi-lobed intermeshing rotors mounted on two parallel drive shafts. Alternately, the rotary pumps may be in the form of a single rotor mounted on a single drive shaft which extends through each of the successively arranged chambers so as to position the rotor in movable working relation with the interior of the cylinder.

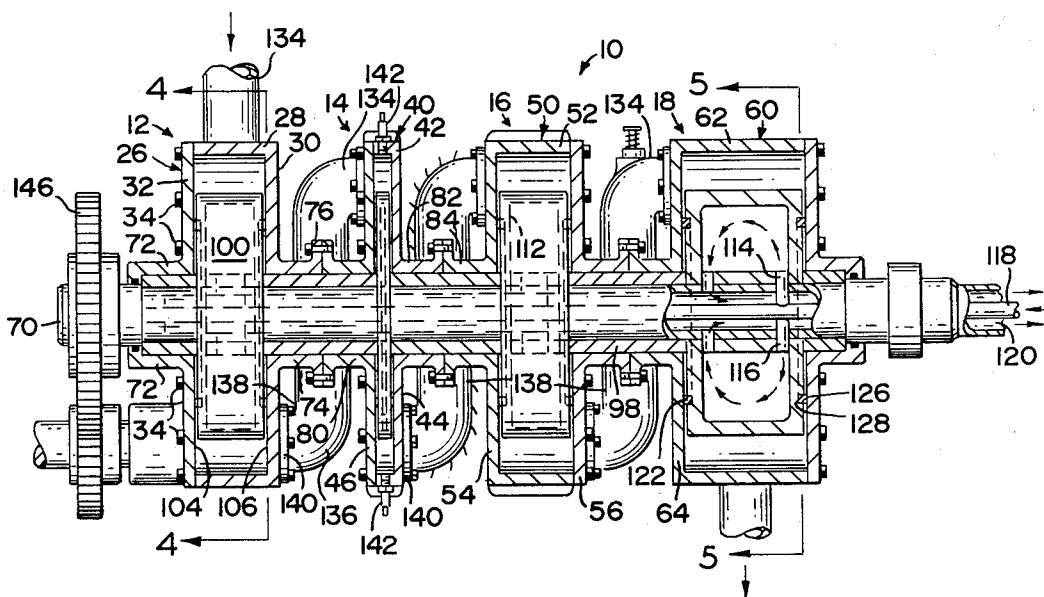
9 Claims, 10 Drawing Figures

FIG. 1

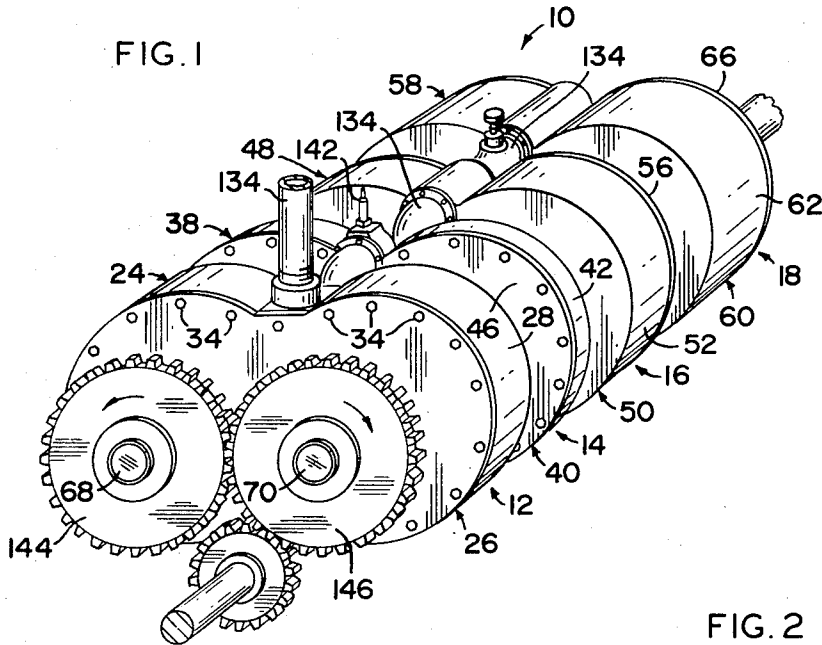
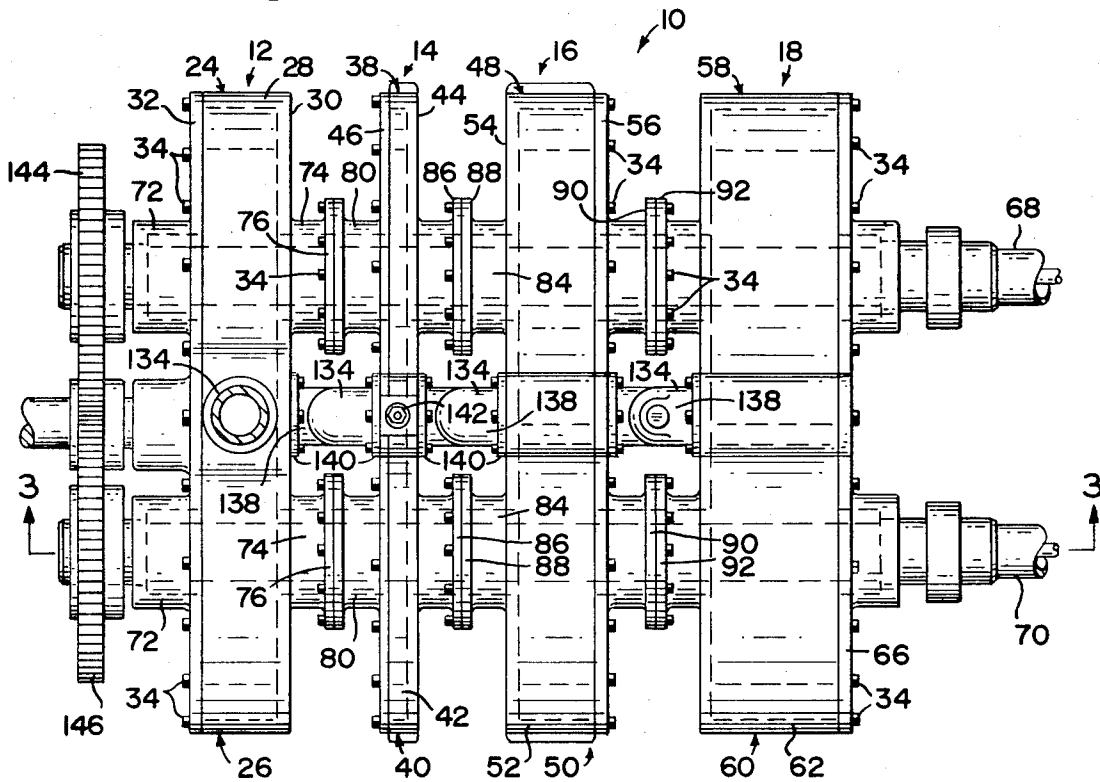


FIG. 2



INVENTOR.
KENNETH D. SAUDER

BY

Stefan M. Stein
ATTORNEY.

FIG. 3

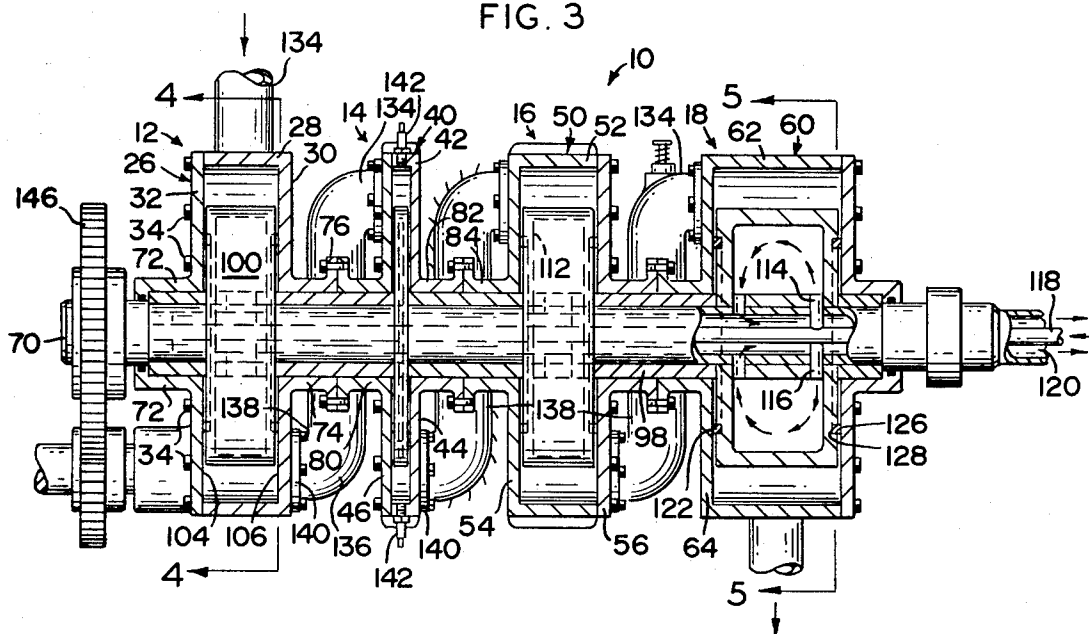


FIG. 4

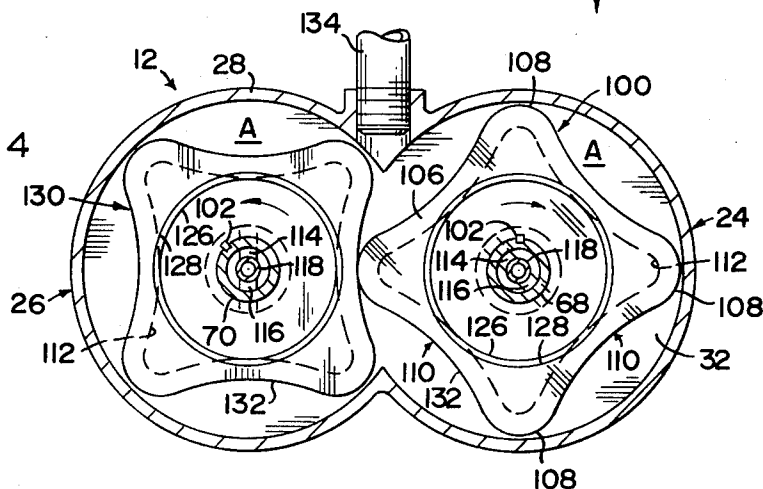
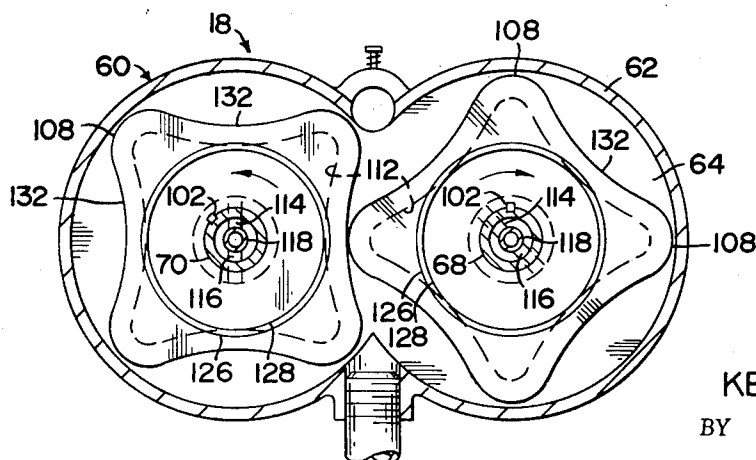


FIG. 5



INVENTOR.
KENNETH D. SAUDER

BY *Stefan M. Stein*
ATTORNEY.

FIG. 6

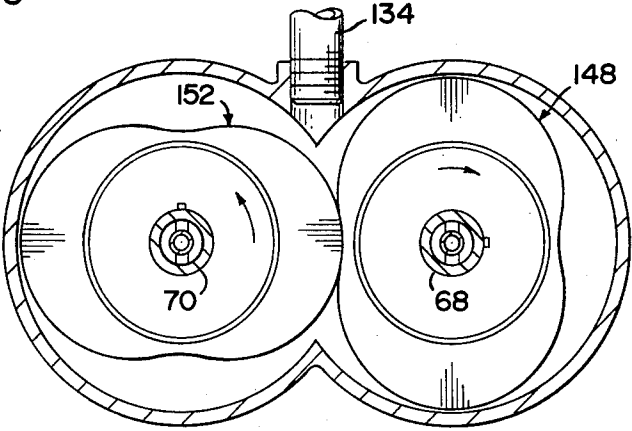


FIG. 7

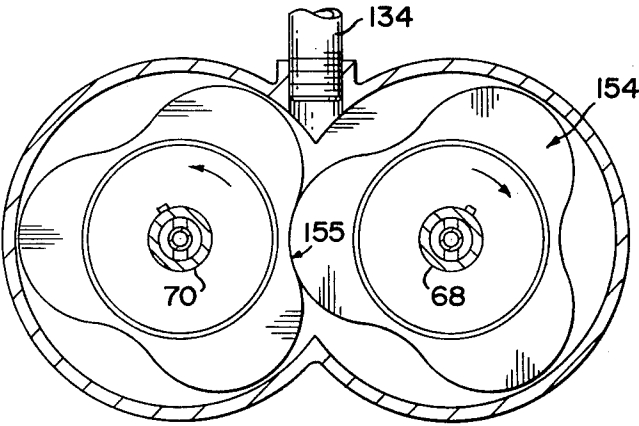
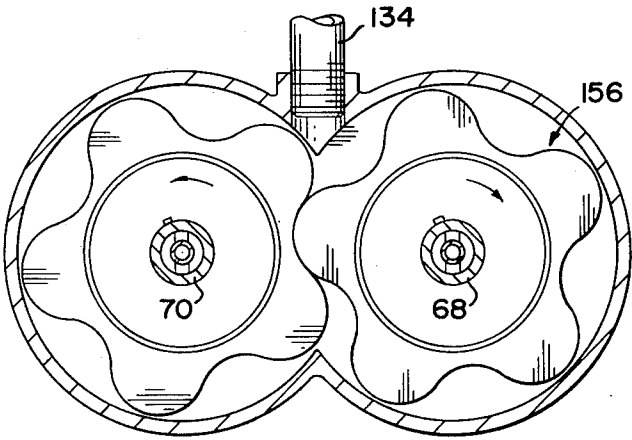


FIG. 8



INVENTOR.
KENNETH D. SAUDER
BY *Stefan M. Stein*
ATTORNEY.

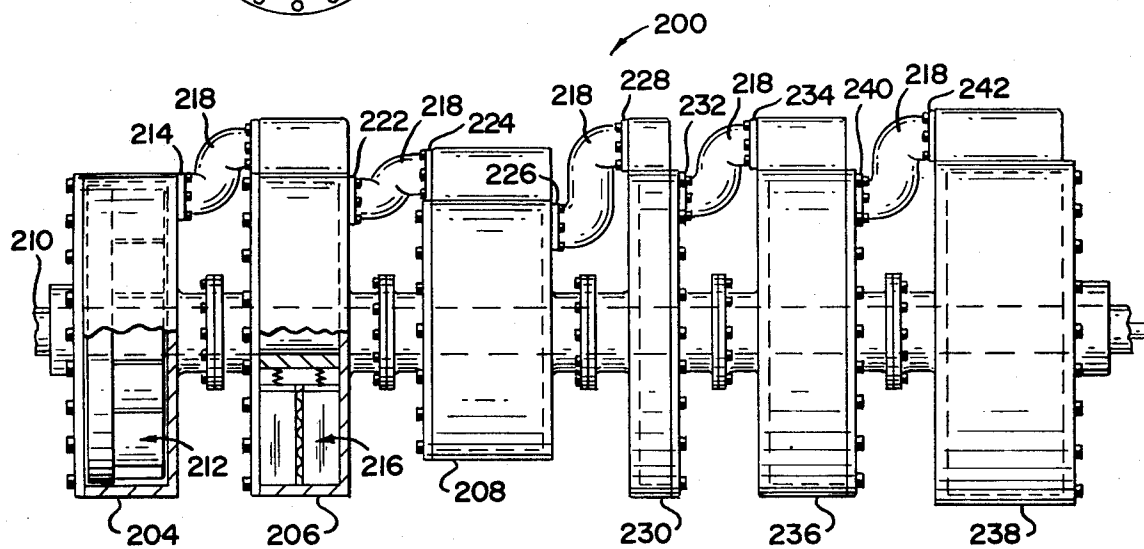
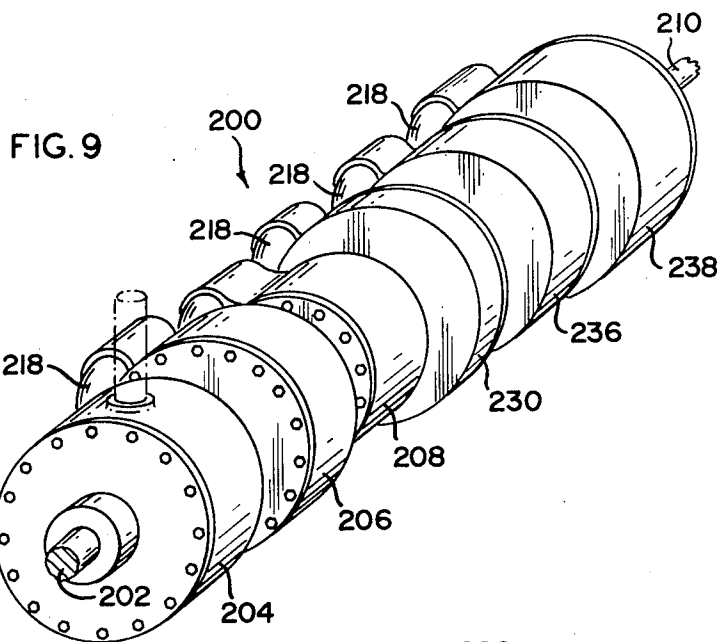


FIG. 10

ROTARY INTERNAL COMBUSTION ENGINE

This application is a continuation-in-part application of presently co-pending application Ser. No. 883,728 filed Dec. 10, 1969 now abandoned in the name of Kenneth D. Sauder.

BACKGROUND OF THE INVENTION

This invention relates generally to internal combustion engines and more particularly to rotary internal combustion engines of the type which have intermeshing rotors.

Many attempts have been made in the past to construct a rotary internal combustion engine to take advantage of the known and theoretical benefits of such an engine as compared to the internal combustion reciprocating piston type engine or a gas turbine engine. Among the advantages of a rotary engine would be the efficiency of the engine over a wide range of speeds so that the engine can be built for any desired speed without the necessity of introducing expensive and heavy power consuming gears or electric gears as are usually necessary with turbines.

Other advantages of the rotary engines over the reciprocating engine are a simple construction with fewer parts and less cost, no valve-gear problems, high output from a smaller and therefore lighter engine.

Of the hundreds of rotary combustion engines which have been proposed that substitute a rotary member for the reciprocating piston, one of the most successful designs to date is known as the Wankel engine. In a modern version of the Wankel rotating combustion engine the stator is in the shape of a two-lobed epitrochoid and the rotor is a trochoid. This symmetrical trochoid rotor revolves on a large bearing on the crank arm of the crankshaft which is an eccentric on the driveshaft. The three tips of the trochoid rotor have tip seals. An internal gear on the rotor, concentric with the rotor bearing, constrains the rotor to a planetary motion about a sun gear, concentric with the crank shaft. There are distinct intake, compression, combustion-expansion and exhaust processes as in a four stroke cycle.

Since the rotor has three sealed sections, corresponding to three cylinders, there are three power strokes per rotor revolution or one power stroke per shaft revolution. As the rotor turns, the intake volume of at least one of the chambers is increasing and therefore a fuel-air mixture can be inducted. As the rotor continues the intake port is covered and the volume is decreasing with consequent compression, when near the minimum contained volume, ignition takes place and continued revolvment allows for an increase in volume with the consequent expansion of the gases. Eventually the exhaust port is uncovered and then again the intake port. The pressures of combustion and expansion are transmitted through the rotor and bearing to the eccentric and because of the eccentricity, a torque is exerted on the drive shaft.

Even with the Wankel engine the major problem is that it is very difficult to construct an efficient rotary engine, a rotary pump or a rotary compressor for reasonably high speeds because the sliding vanes, being subjected to the action of centripetal force, progressively increase their pressure on the peripheral walls of the casing in which the vanes move, thereby lowering, prohibitively the efficiency of such machines.

Moreover, such an increased friction results in an abnormally rapid wear of the rubbing surfaces so that these surfaces become rough, still further increasing the friction and developing considerable leakage past the blades until the engine becomes unsuitable for normal operation completely.

Other disadvantages of the prior art rotary internal combustion engines are higher fuel consumption due to lower compression ratios and the seal and sparkplug lives are shorter than with reciprocating engines.

The objects of this invention, which are made apparent from the description herein, are efficiently obtained by providing a rotary internal combustion engine which comprises a plurality of successively positioned cylinders arranged in segregated but communicating relation to one another, whereby compression, combustion and expansion of gases passing through the engine takes place in successive stages.

In one embodiment of the present invention, each of the compression, combustion and expansion stages takes place in successive fashion, relative to one another, within one or more cylinders which comprise each stage. More specifically each cylinder may include parallel, side abutting cylinder pairs in which are disposed rotary pumps. In this particular instance each pump comprises multi-lobed, intermeshing rotors. Two parallel drive shafts are disposed through the parallel side abutting cylinders. Upon each shaft is mounted one of each of the multi-lobed, intermeshing rotors and each shaft with its respective rotors are rotatably mounted within the spaced, parallel side abutting cylinder pairs. Each of said cylinders are provided with communication tubes between the adjacent cylinders, and the parallel shafts are connected to a common shaft. An important feature of the present invention is that both the compression and expansion stages take place in a step-like manner in that treatment of the gases in each stage occurs successively in each of the chambers comprising the particular stage. Since each of the cylinders are in fact separated from one another it is important to note that the ignition stage is entirely separated from the compression and expansion stages. This allows ignition to take place after maximum compression has been obtained in the one or more cylinders comprising the first stage and before expansion begins in the one or more cylinders comprising the expansion and power stage.

Accordingly as the rotors turn, fuel mixture is drawn into the first cylinder compressed and forced into the second cylinder where ignition takes place. Because of the decreases volume of the second cylinder the mixture is further compressed. This compressed gas is then ignited by a sparking means and allowed to expand into a larger volume chamber housing the power rotor. The still expanding gas then flows into the final expansion chamber and drives a second power rotor housed therein. The shafts connecting the rotors are supported by anti-friction bearings and cooled internally by water or engine oil or the like.

Another embodiment of the present invention comprises a plurality of successively arranged chambers each housing a rotary pump means having any desired structure capable of performing the intended function on the gas passing through the engine. Each of the pumps are mounted on a common shaft extending sub-

stantially through the center of each of the cylinders. The pumps are of course mounted on the shaft in working, cooperative relation with the interior surfaces of the cylinders. The cylinders comprising each of the various stages are separated so as to provide the combustion stage being completely separated from both the compression and expansion stages thereby allowing combustion to take place at maximum compression after the gases have passed through the one or more cylinders comprising the compression stage and before expansion begins in the one or more cylinders comprising the expansion stage. In this particular embodiment the compression and the expansion stages each comprise a plurality of cylinders such that both compression and expansion take place in a step-like manner in each cylinder comprising the various stages. As set forth above, said each of the cylinders are completely separated except for respective intake and output vents arranged in communicating relation between the adjacently positioned cylinders, the ignition stage of the cycle is completely separated from both the compression stage and the expansion stage. This allows ignition to take place at maximum compression after the gases pass through the plurality of cylinders comprising the compression stage and also allows ignition to take place while the gas is maintained under maximum compression and before expansion begins in the plurality of cylinders comprising the expansion stage of the cycle. More specifically, a combustible fuel mixture is drawn into the first cylinder which houses a rotary pump in the form of a centrifugal pump. Accordingly, the air is drawn in along the central axis of the cylinder, compressed and delivered to the second and succeeding one or more cylinders comprising the compression stage, thereby causing the gas to be compressed in the stages as described above. After complete compression has been accomplished, the gas passes immediately into the combustion cylinder where, because of the decreased volume of this cylinder, the mixture is further compressed and the gas mixture is ignited at maximum compression. After ignition the gas passes into the first of a plurality of chambers comprising the expansion and power stages of the cycle. It should be noted that the number and size of the cylinders comprising the expansion stage should allow for sufficient volume to accommodate the gas passing through the preceding portion of the engine. In particular the volume of the expansion stage should be equal to or greater than the volume in the compression stage of the engine. In both of the embodiments described above, the speed of the engine could be throttled controlled and the gas mixture would come from a standard carburetor. A distributor would not be needed and the ignition could be advanced or retarded depending upon the speed of the motor. Advancing or retarding of the ignition would be accomplished by utilizing a series of glow plugs about the periphery and then selectively utilizing one or another of the plugs as desired.

The invention accordingly comprises the features of construction, combination of elements, and arrangements of parts which will be exemplified in the construction hereinafter set forth and the scope of the invention will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the follow-

ing detailed description taken in connection with the accompanying drawings in which:

FIG. 1 is a perspective view of the present invention.

FIG. 2 is a top view of the present invention.

FIG. 3 is a cross-section of one shaft of FIG. 2 along line 3—3.

FIG. 4 is a cross-sectional view along line 4—4 of FIG. 3.

FIG. 5 is a cross-sectional view along line 5—5 of FIG. 3.

FIG. 6 is a view of an alternative rotor design.

FIG. 7 is a view of an alternative rotor design.

FIG. 8 is a view of an alternative rotor design.

FIG. 9 is a perspective view of another embodiment of the present invention showing the plurality of successively arranged cylinders each housing a rotary pump which is mounted on a single common shaft extending through each of the cylinders.

FIG. 10 is a side sectional view of the embodiment shown in FIG. 9.

Similar reference characters refer to similar parts throughout the several views of the drawings.

Referring to the embodiments of FIG. 3, the internal combustion rotary engine 10 comprises a compression stage comprising first compression cylinder 12, as shown in FIG. 4, including two sidewise abutting cylinder lobes 24 and 26. Lobes 24 and 26 have a substantially cylindrical side wall 28 with an integral front wall 30 and a removable rear wall or head 32. Head or rear wall 32 is secured and sealed by fastening devices 34 to cylinder side wall 28.

A second compression cylinder 14 comprises the ignition stage and as can be seen is separated from each of the cylinders comprising both the compression and expansion stages. Cylinder 14 is provided in a spaced and parallel relation with cylinder 12 and also consists of two cylinder lobes 38 and 40. Lobes 38 and 40 have a substantially cylindrical side wall 42 with an integral front wall 44 and a removable rear wall 46. Rear wall 46 is secured and sealed by fastening devices 34 to cylinder side wall 42.

A power and expansion cylinder 16 is provided in a spaced and parallel relation with cylinder 14 and it similarly consists of two cylinder lobes 48 and 50. Lobes 48 and 50 have a substantially cylindrical side wall 52 with an integral rear wall 54 and a removable front wall 56. Front wall 56 is secured and sealed by fastening devices 34 to cylinder side wall 52.

Attached parallel to and spaced from power cylinder 16 is a second expansion cylinder 18 which also has two cylinder lobes 58 and 60. Lobes 58 and 60 have a substantially cylindrical side wall 62 with an integral rear wall 64 and a removable front wall 66. Front wall 66 is secured and sealed by fastening devices 34 to cylinder side wall 62.

A first shaft 68 is rotatably disposed through lobes 24, 38, 48 and 58 of cylinder housings 12, 14, 16 and 18 respectively. Rear wall 32 has an integral cylindrical cap 72 for covering and supporting shaft 68. Front wall 30 has a cylindrical bushing 74 with radial flange 76. Radial flange 76 abuts and is fastened to radial flange of cylindrical bushing 80 by fastening devices 34. Cylindrical bushing 80 is an integral extension of rear wall 46. In a similar manner to the above, front wall 44 has a cylindrical bushing which is connected to cylin-

drical bushing 84 of rear wall 54, by radially abutting flanges 86 and 88 with fasteners 34. Similarly, lobes 48 and 58 are connected together with fasteners 34 about shaft 68 by radial flanges 90 and 92.

A bearing liner 98 is provided within the cylindrical bushings which engage about the shaft 68 between the various lobes. The shaft 68 is preferably supported from the bushing 98 by any suitable means known in the art such as utilizing an anti-friction bearing (not shown) which would include an outer race disposed on the cylindrical bushing, an inner race disposed on the shaft and a plurality of ball bearings disposed within the above two races so as to rotatably support the shaft 68 from the bearing liner.

A second shaft 70 is rotatably disposed through lobes 26, 40, 50 and 60 of cylinder housings 12, 14, 16 and 18 respectively and is parallel and spaced from shaft 68. The lobes 24, 38, 48 and 58 are arranged about shaft 68 and connected to each other by cylindrical sleeves and radial abutting flanges in the manner described for shaft 68. Likewise, shaft 70 is supported from its bushings by a suitable anti-friction bearing and the entire unit is sealed by proper, standard, gaskets to prevent leakage.

Referring now to FIG. 4, a rotor 100 is shown disposed in lobe 24 of housing 12. Rotor 100 is keyed 102 or otherwise fixedly secured to the shaft 68. The rotor 100 includes a pair of spaced parallel side walls 104 and 106 which rotate in close tolerance but not touching cylinder front and rear wall 30 and 32 respectively. Rotor 100 of FIG. 4 is of a generally square configuration with each of the four corners 108 being rounded cusps. A straight line drawn between two opposing rounded cusps 108 would be slightly less than the diameter of lobe 24 by an amount of approximately eight-thousandths thousandths of an inch or a minimum distance needed so that at operating temperatures the rotors would be near but not touching either the cylinder side walls or the adjacent rotors. Between cusps 108 the side of rotor 100 incurvates. The incurvature 110 of rotor 100 describes a curve similar in shape to the incurvature in a gear tooth designed so that the opposing cusps approximate but do not touch each other. The interior of rotor 100 is provided with an annular cooling chamber 112 within which a cooling liquid, such as water or oil or the like, is adapted to circulate. The cooling solution is transported in and out of cooling chambers 112 through channels 114 and 116 which communicates respectively with ingress and egress sleeves concentrically situated within axle 68. The annular sealing ring 122 is mounted in annular groove 124 formed on rotor side wall 104 and a second annular sealing ring 126 is mounted in an annular groove 128 located on rotor side wall 106. The cooling fluid flows thru passage 118, enters rotor 10 through channel 116, circulates around annular cooling chamber 112 and is forced out channel 114 from whence it is carried out of the engine through sleeve 120.

Referring again to FIG. 4, cylinder 12 is shown with a second rotor 130 disposed within lobe 26. Rotor 130 is similar in every detail to rotor 100 and is similarly mounted on shaft 70 so as to rotate within lobe 26. The rotors 100 and 130 are spaced relative to each other such that as they rotate in the direction indicated by the

arrows, the relative position of one rotor will always be rotated 90° from the relative position of the other rotor. The rotors are arranged such that there will exist, continuously as the rotors rotate, points of proximate rolling contact between cylindrical side walls 28 and cusps 108 and between the two rotor surfaces 132 where the surfaces abut. Therefore, as is seen by FIGS. 4 and 5, there will be defined within the cylinders at any given instant a number of distinct chambers A which travel about the cylinders.

Cylinder 12 is provided with an intake port 134 located at the top junction of lobes 24 and 26. Intake port 134 is adapted to be connected to a carburetor or other fuel mixing means. Cylinder 12 is also provided with an exhaust port at the bottom junction of lobes 24 and 26. Cylinders 14, 16 and 18 are similarly each equipped with an intake port 134 and an exhaust port 136 as illustrated in FIG. 3. The exhaust port 136 of cylinder 12 is connected to the intake port 134 of cylinder 14 by a connecting pipe 138. The connecting pipe 138 is of generally tubular construction with approximately a 90° bend at each end. Connecting pipe 138 has a radial flange 140 at each end and this flange is sealed to cylinder side walls 30 and 40 by suitable fasteners 34. The same tubular connection is made between each of the intake-exhaust port pairs of the adjacently located cylinders.

Placed about the periphery of cylinder 14 are ignition means 142 which may be standard glow or spark plugs. The ignition means are adapted to be connected to a suitable circuit making or breaking means (not shown) such as to obtain the desired ignition of the compressed fuel mixture. It should be noted that the exact placement of ignition means 142 will depend upon the fuel and the revolutions per minute of the rotors. Ignition means 142 could be placed on the connecting pipe 138 immediately after cylinder 14 or peripherally about cylinder side wall 42.

In operation of this embodiment of the subject rotary internal combustion engine the fuel mixture is drawn into the intake port 134 of compressor 12 by virtue of the suction created by rotors 100 as they rotate in their indicated directions.

The rotating chambers A, containing a metered amount of fuel mixture are moved about cylinder lobes 24 and 26 to exhaust port 136. The fuel mixture carried in chambers A will be forced into the rotating chambers of cylinder 14 which is of substantially smaller volume than the chambers of cylinder 12. Since the same quantity of fuel mixture travels about chambers A of cylinder 14, the pressure within these chambers is substantially greater. As each compressed fuel mixture chamber approaches exhaust 136, of cylinder 14, ignition is caused. The rapid expansion and high pressure caused by the burning fuel mixtures forces the power rotors in cylinder 16 around in a power stroke. The volume of the power rotor chambers are larger to accommodate the expanded gases. The gases further expand into a second power rotor cylinder 18 with a still larger chamber volume. The gases are then vented to the atmosphere. The rotation of the power rotor members is so timed with respect to the rotation of the compressor rotor members the rotor lobe rounded corner 108 will just be passing the intake port 134 of cylinder 16 at the time the rotor lobe of cylinder 14 is in a sub-

stantially exhaust port closing position with respect to exhaust port 136 of cylinder 14.

Shafts 68 and 70 each have a spur gear 144 and 146 attached to the ends thereof. The spur gears are keyed to the shafts in a conventional manner. The two gears are in constant mesh with each other and are of the same diameter so that the two shafts 68 and 70 will rotate at an equal speed. The spur gears may be connected to a drive shaft by any suitable method so that the rotational power of the engine can be utilized.

Relief valve 160 is provided on the communication pipes to provide a means to draw in addition air into the system if the internal pressure drops beneath the ambient pressure the check valve will open to equalize the internal pressure.

In addition, it is contemplated that, additional sets of larger rotors could be added to create more stages of compression and therefore higher compression ratios and increased efficiency may be achieved before the gas mixture readies the combustion rotor.

In alternative embodiments of the above invention, different shaped rotor lobes may be utilized. Referring to FIGS. 6-8, different rotor shapes are illustrated. FIG. 6 shows a two lobe rotor 148 in which the incurvature between the lobes is the radius of curvature of the abutting cylinder 152. FIG. 7 discloses a three lobed rotor 154 again with an incurvature 155. FIG. 8 shows a five lobed rotor 155 with its corresponding incurvature. It is within the contemplation of this invention that other multi-lobed rotors be used in this engine such as six, seven and etc., description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

The embodiments shown in FIG. 9 and 10 comprises a rotary internal combustion engine generally indicated at 200 and including a plurality of cylinders arranged in successive, end-line fashion and each housing a rotary pump which is mounted on a central shaft extending through the substantial center of each of the cylinders. In the specific structural arrangement shown the engine comprises one or more cylinders making up the compression, ignition and expansion stages of the engine cycle. More specifically, cylinders 204, 206 and 208 comprise the compression stages and while this particular embodiment shows three such cylinders, each stage could have more or less cylinders than that shown. A fuel mixture enters along the central axis at 210 into cylinder 204. A centrifugal pump generally indicated as 212 is mounted within cylinder 204 and affixed to shaft 202 in working relation to the interior of the cylinder. By virtue of this arrangement the fuel mixture is drawn in, compressed and passed out through outlet 214. The compressed gas passes into a second compression cylinder 206 having a rotary pump 216 of a conventional or predetermined structure which is fixedly mounted on shaft 210. Communication of the treated gases or fuel mixture between cylinders is accomplished by virtue of connection pipes 218. It should be noted that for proper reaction of the fuel mixture within the individual cylinder the intakes and outlets of the various individual cylinders must be spaced at least one quarter revolution from one another. After further compression in cylinder 206 the gas passes from outlet 222 through connection pipe 218 into intake 224 of cylinder 208. Here the gas is additionally compressed

by virtue of a rotary pump arranged within cylinder 208 and also connected to central shaft 210. Finally, after the compression of the gas is at its maximum point it is passed out of outlet 226 through connection pipe 218 into inlet 228 of ignition cylinder 230. In this particular embodiment the cylinder 230 is the only cylinder in the ignition stage and differs from the compression and expansion stages by virtue of the fact that a plurality of cylinders may comprise each of the compression and expansion stages. It is again emphasized that each of the cylinders are segregated from one another and are arranged in communicating relation only by virtue of the connecting pipes 218. Accordingly, combustion cylinder 230 is separated from cylinders 204, 206 and 208 comprising the compression stage and thereby allows ignition of the fuel mixture to take place only after maximum compression has been reached in this previous compression stage. Upon ignition, expansion begins only after the gas passes from outlet 232 into intake 234 of cylinder 236 which comprises the first cylinder of the expansion and power stage. A predetermined amount of expansion is permitted dependent upon the volume and capacity of cylinder 236. The expanding gas next passes to a second expansion chamber 238 by virtue of it passing from outlet 240 through connecting pipe 218 and into intake 242. It should be noted that additional cylinders in both the compression and expansion stages could be added as long as the total volume passing through the compression stage is proportioned to the volume passing through the expansion stage. Gearing and other power takeoff apparatus could be essentially equivalent to that described above with particular reference to the embodiment of FIGS. 1-3.

It will thus be seen that the objects made apparent from the preceding description are efficiently attained and, since certain changes may be made in the above construction without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention, which, as a matter of language, might be said to fall therebetween.

Now that the invention has been described:

What is claimed is:

1. A rotary internal combustion engine of the type having compression, combustion and expansion stages, said engine comprising: said compression stage including a plurality of cylinders arranged in successive, step-like arrangement to one another, said combustion stage comprising at least one cylinder arranged and successively related to said compression stage, said expansion stage including a plurality of cylinders arranged in successive, step-like relation to the cylinders of said compression and combustion stages; each of said cylinders of each of said stages arranged in segregated relation to one another, whereby treatment of gases in each cylinder is independent of gas treatment in the remaining cylinders, said combustion cylinder arranged in segregated, communicating relation with cylinders of the compression and expansion stages such that com-

bustion occurs at maximum compression after transfer of gases from said compression stage and prior to gases entering the expansion stage; rotary pump means movably arranged within each of the cylinders of each stage and each rotary pump means affixedly mounted on shaft means corporating with each of said cylinders.

2. A rotary internal combustion engine as in claim 1 wherein each of said cylinders comprising each of said stages are arranged in successive, end-line relation, communication means interconnected between adjacently located cylinders such that gases pass from one cylinder to another upon treatment in each of said cylinders.

3. A rotary internal combustion engine as in claim 2 each cylinder comprising an intake and an exhaust vent positioned in spaced relation to one another a distance of at least one fourth revolution of the respective cylinders on which the vents are mounted.

4. A rotary internal combustion engine as in claim 1 wherein said shaft means comprises a single shaft extending through each of said cylinders of each of said stages, each rotary pump means of each cylinder fixedly attached to said shaft in working relation to their respective cylinders.

5. A rotary internal combustion engine as in claim 1 wherein said shaft means includes a pair of shafts rotatably mounted in each of said cylinders, said rotary pump means comprising a plurality of rotor pairs, each cylinder having a rotor pair mounted therein on said pair of shafts respectively, each of said rotors comprising said rotor pair being multi-lobed and adapted to approximately intermesh with one another, communication means interconnected between said successively arranged cylinders whereby gases are transported

between said successive cylinders, an intake vent provided in said wall of each of said cylinders whereby said gases are introduced into said cylinders, an exhaust vent connected to each of said cylinders whereby treated gases are exhausted from each of said cylinders, ignition means provided on said combustion stage whereby said gases are ignited, gear means provided whereby the rotation of said two shafts are synchronized.

6. The rotary internal combustion engine as in claim 5 wherein said multi-lobed rotors are four rounded cusps and further wherein between said cusps of said rotor is concave.

7. A rotary internal combustion engine as in claim 5 wherein said rotor has at least two rounded cusps and further wherein a concavity exists in said rotor between said rounded cusps.

8. A rotary internal combustion engine as in claim 5 wherein said cylinders each comprise at least two sidewise abutting and communicating cylinder pairs in which said shafts are rotatably mounted in spaced, fixed and parallel relationship and further wherein the displacement volume defined by the space between said cylinder pairs and said rotors are substantially smaller in at least one of said sidewise abutting cylinders.

9. A rotary internal combustion engine as in claim 1 wherein said compression stage comprises at least three cylinders, said ignition stage comprises one cylinder and said expansion stage comprises three cylinders; all of said cylinders of said stages being arranged in successive, segregated relation to one another such that gas passing through said engine is treated in a step-like fashion.

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