A rotor is mounted in a casing defining a cylindrical annular interior wall in sealing relationship with the periphery of the rotor. The rotor includes a peripheral cavity mounting a piston for radial movement towards and away from the opposed annular wall surface of the casing. An air-fuel mixture inlet port, a combustion chamber, and an outlet port for burnt gasses are circumferentially spaced about the interior annular wall so that the portion of the peripheral cavity on the rotor between the piston and the interior annular wall is successively placed into communication with the inlet port, combustion chamber, and outlet port as the rotor rotates. A cam arrangement connects the piston with a cam surface on the interior of the casing so that movements of the piston towards and away from the opposed interior annular wall are guided. A fresh air inlet in turn communicates with the peripheral cavity portion under the piston and includes a check valve so that outward movement of the piston draws in fresh air and inward movement compresses the air. The cavity is shaped such that complete inward movement of the piston exposes an outlet portion so that the compressed air can circulate around the piston. With this arrangement, the fuel-air inlet mixture is supercharged by the compressed air during a portion of the compression stroke of the piston and the burnt gasses are in turn purged by the fresh air during an exhaust stroke of the piston. The fresh air inlet also provides cooling for the piston and rotor.

6 Claims, 7 Drawing Figures
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ROTARY INTERNAL COMBUSTION ENGINE

This invention relates generally to rotary type internal combustion engines and more particularly to an improved rotary engine incorporating novel features providing for increased power and more complete combustion so that pollution effects are minimized.

BACKGROUND OF THE INVENTION

One of the principal advantages of rotary internal combustion engines over the reciprocating piston type is the relative smoothness and more simplified mechanical arrangement that can be realized in the overall operation. On the other hand, there tends to be less complete combustion resulting in more air pollution than is caused by an equivalent reciprocating type engine. Many of the known types of rotary engines operate on almost a "turbine" principle wherein good efficiency can only be realized for high rotor speeds. Such embodiments thus require gear reduction arrangements and there is lacking good torque control particularly at low speeds. Even in the reciprocating type engines there is a deficiency in proper torque control as a consequence of the use of crank shafts wherein the torque arm is relatively small thereby requiring fairly large capacity cylinders or "displacement" to generate sufficient power.

BRIEF DESCRIPTION OF THE PRESENT INVENTION

The present invention contemplates a vastly improved rotary type engine wherein various deficiencies noted above are substantially reduced.

More particularly, the present invention contemplates a rotor mounted within a cylindrical interior annular wall defined by a casing structure such that the peripheral surface of the rotor sealingly engages the interior annular wall. The rotor itself includes a peripheral cavity within which a piston is mounted for radial movement inwardly from and outwardly towards the annular wall. Cooperating cam means are provided for guiding movement of the piston to various positions throughout one complete rotation of the rotor.

In the preferred embodiment of the invention, there are provided a pair of such rotors mounted on parallel shafts each having an associated cooperating interior annular wall, the peripheral portions of the rotors closest to each other defining with common portions of the interior annular walls a combustion chamber. Fuel-air inlet means and burnt gas outlet means are provided at circumferentially spaced portions of the interior annular walls for communicating with the portions of the cavities between the pistons and interior annular walls as the peripheral cavities pass the inlet and outlet means when the rotors rotate. The rotor shafts are geared together for simultaneous rotation so that the rotors work together with their respective pistons compressing a fuel-air mixture between them as they approach each other. After ignition, the rotors are simultaneously driven away from each other during expansion, the burnt gasses then being expelled through the respective burnt gas outlets in the internal annular walls.

An important feature of the invention includes the provision of a fresh air inlet means for the portions of the cavities under the pistons, there being provided a check valve in this inlet means so that air can only pass from the exterior into this portion of the cavity. As a consequence, fresh air is drawn into the cavity portion beneath the piston when the piston moves radially outwardly and compressed when the piston moves radially inwardly. A portion of the cavity has an outlet so that when the piston is moved all the way radially inwardly, the compressed air can pass about the piston. With such an arrangement, the fuel-air mixture is effectively supercharged by the fresh air during a portion of the compression of the mixture and during the exhausting portion of the cycle, the fresh air aids in purging the burnt gasses. An auxiliary advantage is the cooling effected by this unique fresh air arrangement.

Because the combustion forces of the expanding fuel-air mixture acts on peripheral portions of the rotor, torque is developed. Further, because of the purging of the burnt gasses with the fresh air and also the supercharging, complete combustion with a minimum of pollution is realizable.

BRIEF DESCRIPTION OF THE DRAWINGS

A better understanding of the invention will be had by now referring to the following drawings in which:

FIG. 1 is a diagramatic cutaway perspective view of a simplified embodiment of the rotary internal combustion engine of this invention;

FIG. 2 is a cross-section taken in the direction of the arrows 2—2 of FIG. 1;

FIG. 3 is another fragmentary cross-section taken in the direction of the arrows 3—3 of FIG. 1; and,

FIGS. 4, 5, 6, and 7 are fragmentary cross-sections illustrating successive rotor positions during a complete cycle of operation of the engine.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to both FIGS. 1 and 2, the rotary internal combustion engine includes an outer casing 10 having shafts 11 and 12 rotatably mounting rotors 13 and 14. The shafts 11 and 12 are parallel and separated by a distance slightly greater than the diameter of the rotors so that peripheral portions of the rotors are close to each other at the central portion of the casing 10 as shown in FIG. 2. The rotors 13 and 14 are identical in construction and therefore a detailed description of one will suffice for both.

Referring specifically, accordingly, to the rotor 13 shown in the broken-away view of FIG. 1, the rotor includes a cavity 15 formed in its peripheral surface within which there is mounted a piston 16 for movement radially in inward and outward directions. In the particular embodiment illustrated, this movement is effected by a rocking motion of the piston 16 about a shaft forming one end of a bell crank 17 passing through opposite walls of the rotor 13 in sealing relationship. The one end 17 of the shaft is rigidly secured to the rotor and the other end terminates in a cam follower 18 riding on a convex cam surface 19 integrally formed on the inner front wall of the casing 10. A similar bell crank 20 on the opposite side of the rotor 13 in turn extends from the piston and terminates in a second cam follower 21 riding on a concave cam surface 22 integrally formed on the interior of the rear wall for the casing 10. The bell cranks, cam followers, and cam surfaces constitute a cooperating cam means on the piston and casing for guiding the movement of the piston to
various consistent positions throughout one complete rotation of the rotor.

As mentioned, the rotor 14 includes a similar peripheral cavity, piston, and cooperating cam means, the two rotors being coupled together by gears 23 and 24 on the shafts 11 and 12 meshing with a central gear 25 secured to an output shaft 26 so that the rotors are tied together for simultaneously rotation. In FIG. 1 there is shown a spark plug 27 mounted on the upper central portion of the casing 10.

Referring specifically now to FIG. 2, the cam surfaces 19 and 22 are depicted in dotted lines and it will be clear upon rotation of the rotor 13 the manner in which the piston 16 is guided in radial inward and outward movement. The casing portion circumferentially surrounding the rotor defines a fuel-air mixture inlet port 28, a combustion chamber 29, and a burnt gas exhaust outlet or port 30 all circumferentially spaced as shown such that the cavity 15 successively communicates therewith as the rotor 13 rotates in a counterclockwise direction. With respect to the other rotor 14 the corresponding fuel-air mixture inlet port is indicated at 28' and the burnt gas outlet port at 30'. The combustion chamber 29 is defined between the closest peripheral portions of the rotors 13 and 14 are the common wall portions of the casing 10.

It will be noted in FIG. 2 that the cavity 15 has an outlet 15a for a by-pass air passage 15b this being exposed when the piston 16 is in its radially inwardly most position. The portion of the cavity 15 underneath the piston 16 communicates with a fresh air inlet passage 31 which may pass axially through the shaft 11 by way of a branch passage 32. This fresh air inlet passage includes a check valve indicated in dotted lines at 33 in FIG. 3 which will permit fresh air to enter the portion of the cavity 15 beneath the piston 16 from the exterior of the casing 10 but will block air in this portion of the cavity from passing out of the passages. should be understood that the peripheral surface of the rotor 13 is in sealing engagement with the interior annular wall 34 of the casing 10 surrounding the rotor. The same situation obtains for the rotor 14 as indicated at 34'.

Referring now to the fragmentary cross-section of FIG. 3, the foregoing described arrangement of the rotor, cavity 15, piston 16, cooperating cam means, and the fresh air inlet passages will be clear. Thus the fresh air passage 31 is shown in dotted lines coaxial with the shaft 11 extending to the branch passage 32 communicating with the bottom of the cavity 15. The check valve 33 is schematically indicated also in dotted lines as formed at the central entrance of the air passage to the rotor 13. The cam follower 18 riding on the convex cam surface 19 will urge the piston 16 in radial outward directions whereas the cam follower 21 riding on the concave cam surface 22 shown in dotted lines in FIG. 3 urges the piston 16 in the radial inward direction. The piston is thus positively guided and assumes various consistent positions throughout a complete rotation of the rotor.

OPERATION

The operation of the rotary internal combustion engine described in conjunction with FIGS. 1 to 3 may most easily be understood by now referring to FIGS. 4 to 7 which successively illustrate various positions of component parts during one cycle of operation.

Thus, referring first to FIG. 4 and assuming that the rotor 13 is rotating counterclockwise, the piston 16 is shown in its radial inwardly most position after having moved there from its outermost position. This movement of the piston 16 draws a fuel-air mixture into the upper portion of the cavity 15 between the top of the piston and the interior annular wall 34 through the inlet port 28. Simultaneously with this action, the air under the piston 16 is compressed by the inward movement of the piston 16, the check valve 33 preventing escape of the air against the passage 32. However, when the piston 16 passes the outlet 15a of the passage 15b this compressed air can escape through the passage to the top of the piston 16 and serves, in effect, to supercharge the fuel-air mixture.

As the rotor 13 continues to rotate in a counterclockwise direction, the piston 16 is urged radially outwardly by the cooperating cam means of the fuel-air mixture, maximum compression occurring as the cavity 15 and piston approach a position juxtaposed to the combustion chamber 29 as depicted in FIG. 5. At this point, the fuel-air mixture urged into the combustion chamber 29 is ignited by the spark plug 27 and the expanding gasses thus act on the cavity portion above the piston 16 and the piston 16 itself to drive the rotor further in a counterclockwise direction, the piston then moving inwardly as illustrated in FIG. 6.

With reference to FIG. 6, as the piston 16 moves radially inwardly, it will again compress fresh air in the portion of the cavity beneath the piston and when the piston reaches its radially inwardly most position, it will pass the outlet 15a of the air passage 15b so that the compressed air can then escape around the top of the piston. This escaping fresh air serves to purge out the burnt gasses through the exhaust or outlet portion 30, all of the burnt gasses essentially being purged by movement of the piston 16 radially outwardly as the piston passes this port as indicated in FIG. 7.

After the burnt gasses have been exhausted, continued rotation of the rotor 30 will then start the piston moving radially inwardly and thus start to draw in fresh fuel-air mixture through the inlet port 28, the various operations successively described in FIGS. 4, 5, 6 and 7 then repeating.

It should be understood in the preferred embodiment of the invention that the rotor 14 described in FIG. 2 simultaneously functions in the same manner as the rotor 13 so that effectively the pistons in each of the rotors as they approach each other will compress the fuel-air mixture in the combustion chamber portion 29, the ultimate ignition and expansion of the fresh mixture driving the pistons away from each other. The operation in this respect is analogous to two pistons in a reciprocating device being driven apart by the single explosion of the fuel-air mixture but in the present invention, the driving apart operates along a tangent line to the rotors, the overall operation being rotary in nature rather than reciprocating.

In the actual embodiment, the casing 10 would be partially filled with oil to assure proper lubrication of the rotors and cam cooperating means as well as effective sealing of the peripheral surface of the rotors with the interior opposed annular wall portions of the casing.

In utilizing the two rotors together, it should be understood that both may rotate in a counterclockwise direction as illustrated or alternatively both may rotate...
in a clockwise direction by suitably changing the inlet and outlet ports and the piston configuration, or, one may rotate clockwise and one may rotate counterclockwise. In this latter event, the coupling gears on the shafts 11 and 12 described in FIG. 1 could be directly coupled, the gear 25 being eliminated and either shaft 11 or 12 used as an output so that the rotations of the respective rotors are in opposite directions. It should further be understood that while only a single peripheral cavity and piston for each rotor have been illustrated, each of the rotors could include more than one peripheral cavity and piston with a resulting increase in power without appreciably increasing the overall physical dimensions of the engine.

As stated heretofore, an important feature of this invention resides in the fresh air inlet arrangement for passing fresh air to the portion of the cavity 15 beneath the piston 16. This particular unique arrangement provides for the supercharging of the fuel-air mixture as described above as well as for complete purging by fresh air of the burnt gasses all done by the same piston. As a consequence, there is not only simplicity in design but an assurance of substantially complete combustion, and any smog producing ingredients are substantially reduced. This fresh air inlet arrangement also provides for cooling of the cavity and piston components.

Because the force of the expanding fuel-air mixture upon ignition acts on the peripheral portions of the rotors, maximum torque or turning force is realized for a given sized rotor. The torque arm for the shafts corresponds substantially to the radius of the rotors and therefore maximum power can be delivered in a very compact configuration. In prior art reciprocating type internal combustion engines utilizing crank shafts, such torque arm is substantially less for an engine of comparable size to the present engine.

Finally, the pistons and cooperating cam means effectively control the various portions of the cycle so that no valves (inlet or outlet) are necessary, again making for a very simple and reliable engine.

From the above description, it will be evident that the present invention has provided a greatly improved rotary internal combustion engine over those available heretofore.

What is claimed is:

1. A rotary internal combustion engine including: a pair of rotors mounted on parallel shafts passing through a casing defining interior annular walls in sealing engagement with the peripheral surfaces of the rotors respectively, each rotor having at least one piston in a peripheral cavity mounted for rocking movement inwardly away from and outwardly towards its associated annular wall; cooperating cam means for guiding said rocking movement of the pistons to throughout one complete rotation of the rotors, the peripheral portions of the rotors closest to each other defining with common portions of the interior annular walls a combustion chamber; fuel-air inlet means and burnt gas outlet means at circumferentially spaced portions of the interior annular walls for communicating with the portions of the cavities between the pistons and interior annular walls as the peripheral cavities pass the inlet and outlet means when the rotors rotate; means gearing the rotors together for simultaneous rotation, said cooperating cam means including for each rotor bell cranks having first ends passing through sealed bearings in the sides of the rotor rigidly secured to the associated piston to define a rocking pivot for said rocking movement of the piston towards and away from its associated annular wall, the other ends of the bell cranks terminating in cam followers; and first and second cam surfaces formed in opposite walls of the casing on either side of the rotors cooperating with the cam followers to guide the movement of the pistons.

2. A rotary internal combustion engine according to claim 1, in which one of the cam surfaces is convex to guide one cam follower in a manner urging the piston outwardly and the opposite cam surface is concave to guide the other cam follower in a manner urging the piston inwardly.

3. A rotary internal combustion engine comprising, in combination:
   a. a casing defining a cylindrical interior annular wall;
   b. a rotor in the casing;
   c. a shaft mounting the rotor for rotation in the casing with the periphery of the rotor in sealing relationship with the interior annular wall;
   d. at least one piston in a cavity in the periphery of the rotor, the piston being mounted for inward and outward movement to vary the volume of the cavity between the outer surface of the piston and the interior annular wall of the casing;
   e. cooperating cam means on the piston and casing for guiding the movement of the piston to various consistent positions throughout one complete rotation of the rotor;
   f. means in the casing defining on the interior annular wall a fuel-air mixture inlet port at a first portion; a combustion chamber at a second circumferentially spaced portion; and an exhaust port at a third circumferentially spaced portion, the circumferential spacing being such that the volume of the cavity between the piston and interior wall increases as the cavity passes the first portion so that a fuel-air mixture is drawn into the cavity, the volume decreasing as the cavity approaches the second portion to effect a compression, the compressed fuel-air mixture being ignited as the cavity passes the second portion, the volume increasing between the second and third portions to define an expansion, and the volume decreasing as the cavity passes the third portion to exhaust burnt gasses, the cycle then being repeated; and
   g. fresh air inlet means communicating with the portion of the cavity under the piston, said fresh air inlet means including a check valve so that air can pass only from the exterior of the casing into the portion of the cavity under the piston, said rotor including an air passage having an inlet communicating with the fresh air inlet means, the cavity including an outlet from said air passage, said outlet being exposed when the piston is in its inward position whereby fresh air is drawn into the cavity portion beneath the piston when said piston moves outwardly, the air being compressed as the piston moves inwardly until the piston passes the outlet, the compressed air then passing through the passage to be received in the volume above the piston, said air supercharging the fuel-air mixture drawn into the volume prior to combustion and purging the burnt gasses out of the exhaust after expansion and simultaneously cooling the cavity and piston.

4. A rotary combustion engine according to claim 3, including an additional cylindrical interior annular wall.
in said casing within which there is rotatably mounted an additional rotor with its shaft parallel to the first mentioned rotor shaft and spaced slightly greater than the diameter of the rotors so that the peripheries of the two rotors at their closest points define a narrow passage therebetween which, with the common wall portions of the casing constitute the combustion chamber, said additional rotor and additional interior annular wall functioning identically to the first mentioned rotor and interior annular wall so that there results two rotors working together with their respective pistons compressing a fuel-air mixture between them as they approach each other and both being simultaneously driven away from each other during expansion as they recede from each other; and intercoupling means connecting the shafts of the rotors to a common output shaft.

5. A rotary combustion engine according to claim 3, in which said fresh air inlet is provided by an axial passage in the shaft of the rotor and a branch passage extending radially from the axial passage to a bottom opening in the cavity under the piston.

6. A rotary combustion engine according to claim 3, in which said cooperating cam means includes bell cranks having first ends passing through sealed bearings in the sides of the rotor rigidly secured to the piston to define a rocking point for rocking movement of the piston towards and away from the annular wall, the other ends of the bell cranks terminating in cam followers; and first and second cam surfaces formed in opposite walls of the casing on either side of the rotor cooperating with the cam followers to guide the movement of the piston, one of the cam surfaces being convex to guide one cam follower in a manner urging the piston outwardly and the opposite cam surface being concave to guide the other cam follower in a manner urging the piston inwardly.

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