Sept. 10, 1963 H. N. PRICE ETAL 3,103,208

INTAKE PORT CONSTRUCTION FOR ROTARY MECHANISMS

Filed June 7, 1960 3 Sheets-Sheet 1

FIG. 1.

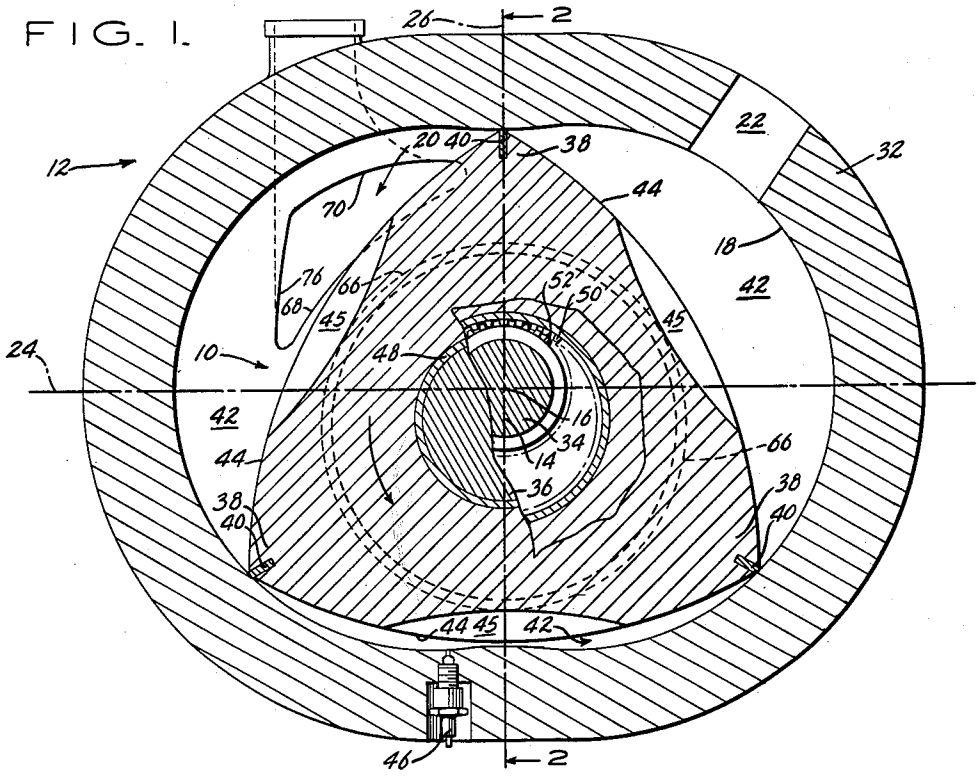

FIG. 2.

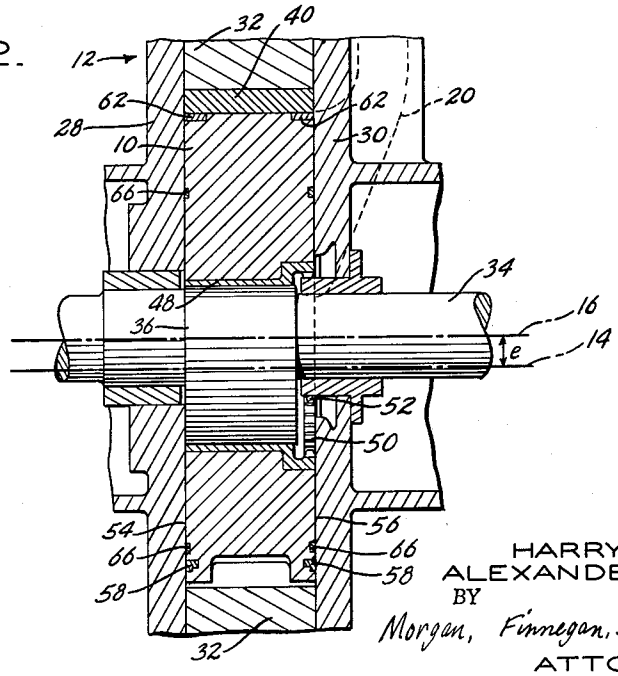

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FIG. 3.

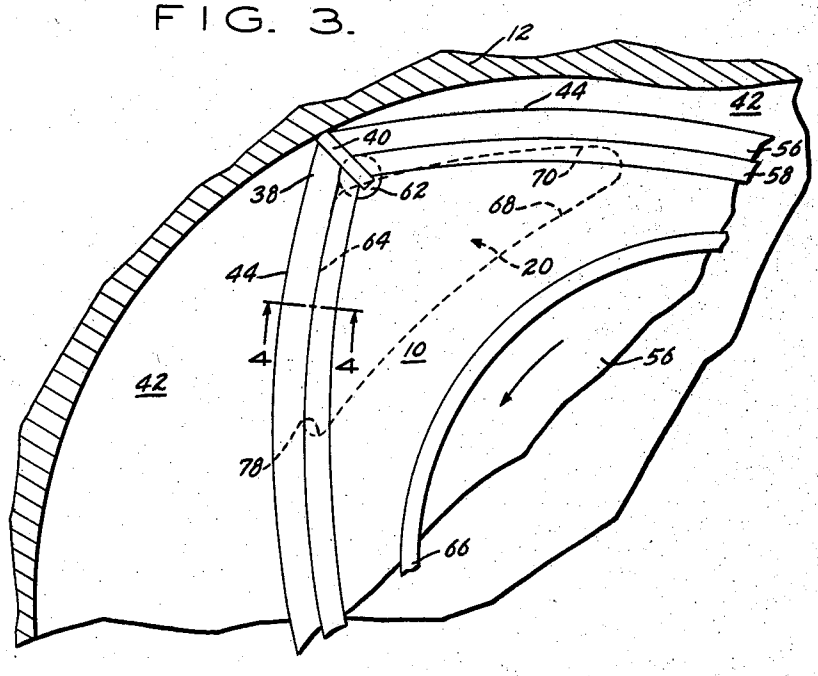

FIG. 4.

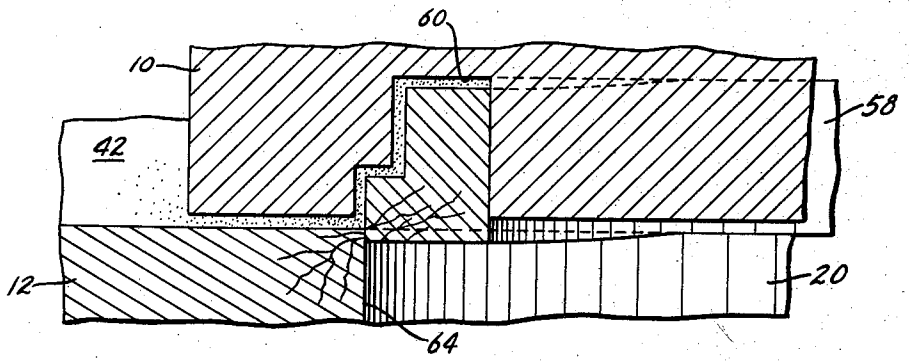

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FIG. 5.

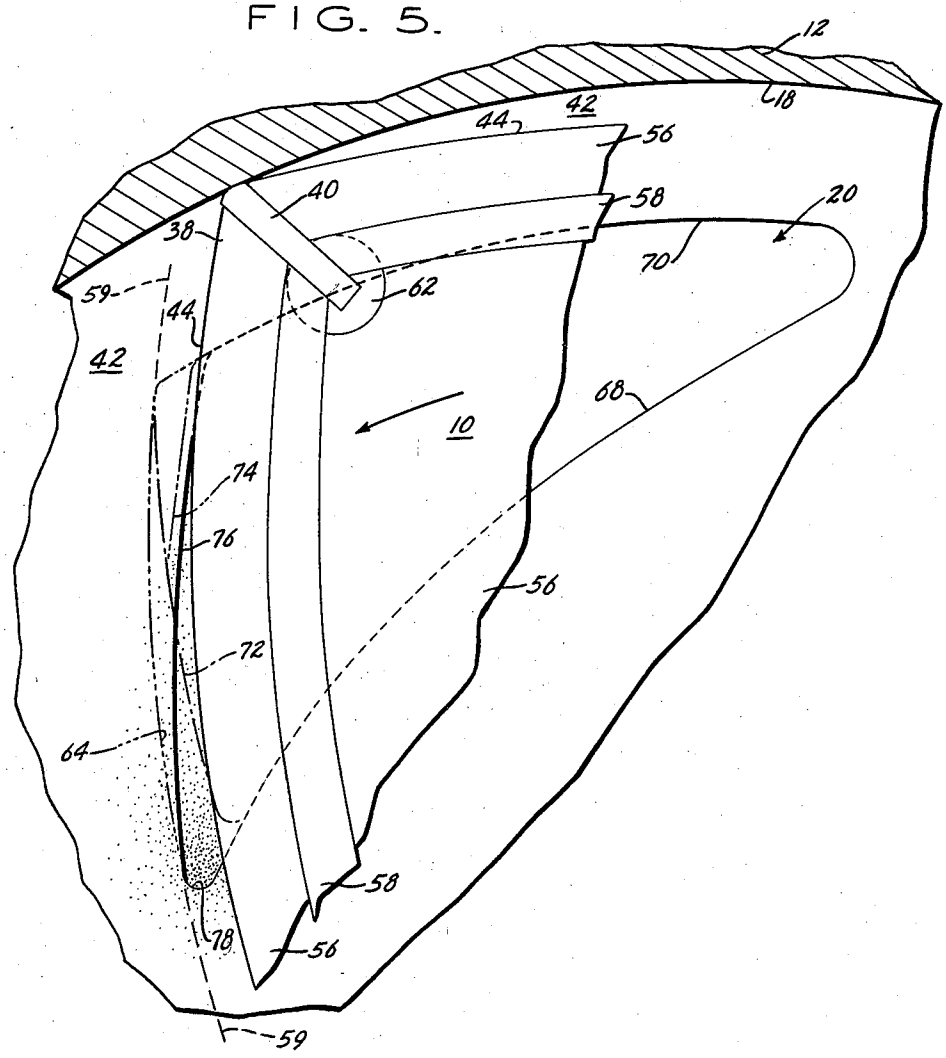
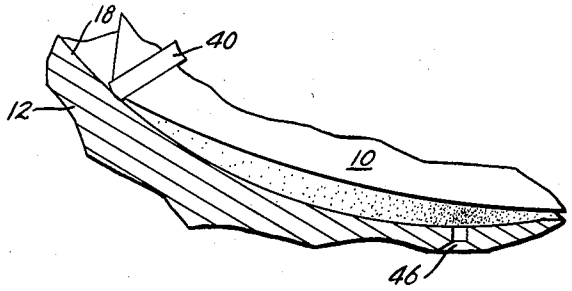


FIG. 6.



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3,103,208

INTAKE PORT CONSTRUCTION FOR ROTARY MECHANISMS

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3 Claims. (Cl. 123—8)

The present invention relates to intake port constructions for rotary mechanisms, and more particularly to an intake port construction which improves the fluid sealing characteristics of the mechanism and helps to insure relatively trouble-free and smooth functioning of the seals.

Although this invention is applicable to and useful in almost any type of rotary mechanism, such as combustion engines, fluid motors, fluid pumps, compressors, and the like, it is particularly useful in rotating combustion engines. To simplify and clarify the explanation of the invention, the description which follows will, for the most part, be restricted to the use of the invention in a rotating combustion engine. It will be apparent from the description, however, that with slight variations which would be obvious to a person skilled in the art, the invention is equally applicable to other types of rotary mechanisms.

The present invention is particularly useful in rotary mechanisms of the type which comprise an outer body having an axis, axially-spaced end walls, and a peripheral wall interconnecting the end walls. In such rotary mechanisms the inner surfaces of the peripheral wall and end walls form a cavity, and the mechanism also includes an inner body or rotor which is mounted within the cavity between its end walls.

The axis of the inner body or rotor is eccentric from and parallel to the axis of the cavity of the outer body, and the rotor has axially-spaced end faces disposed adjacent to the end walls of the outer body, and a plurality of circumferentially-spaced apex portions. The rotor is rotatable relative to the outer body, and its apex portions substantially continuously engage the inner surface of the outer body to form a plurality of working chambers which vary in volume during engine operation, as a result of relative rotation between the rotor and outer body.

The inner surface of the peripheral wall of the outer body has a multi-lobed profile which is preferably an epitrochoid and the number of lobes of this epitrochoid is one less than the number of apex portions of the inner body or rotor.

By suitable arrangement of ports, such rotary mechanisms may be used as fluid motors, compressors, fluid pumps, or internal combustion engines. The invention is of particular importance when employed with a rotary mechanism which is designed for use as a rotating combustion engine, and, accordingly, will be described in combination with such an engine. As the description proceeds, however, it will be apparent that the invention is not limited to this specific application.

When the rotary mechanism is designed for use as a rotating combustion engine, such engines also include an intake passage means for administering a fuel-air mixture to the variable volume working chambers, an exhaust passage means communicating with the working chambers, and suitable ignition means so that during engine operation the working chambers of the engine undergo a cycle of operation which includes the four phases of intake, compression, expansion, and exhaust. This cycle of operation is achieved as a result of the relative rotation of the inner body or rotor and outer body and for this purpose both the inner body or rotor or outer body may rotate at different speeds, but preferably the inner body or rotor rotates while the outer body is stationary.

For efficient operation of the engine, its working chambers should be sealed, and therefore an effective seal is provided between each rotor apex portion and the inner surface of the peripheral wall of the outer body, as well as between the end faces of the rotor and the inner surfaces of the end walls of the outer body.

Between the apex portions of its outer surface the rotor has a contour which permits its rotation relative to the outer body free of mechanical interference with the multi-lobed inner surface of the outer body. The maximum profile which the outer surface of the rotor can have between its apex portions and still be free to rotate without interference is known as the "inner envelope" of the multi-lobed inner surface, and the profile of the rotor which is illustrated in the accompanying drawings approximates this "inner envelope."

For purposes of illustration, the following description will be related to the present preferred embodiment of the engine in which the inner surface of the outer body defines a two-lobed epitrochoid, and in which the rotor or inner body has three apex portions and is generally triangular in cross-section but has curved or arcuate sides.

It is not intended that the invention be limited, however, to the form in which the inner surface of the outer body approximates a two-lobed epitrochoid and the inner body or rotor has only three apex portions. In other embodiments of the invention the inner surface of the outer body may have a different plural number of lobes with a rotor having one more apex portion than the inner surface of the outer body has lobes.

The sealing means which provides sealing between the end faces of the rotor and the end walls of the outer body, in the present embodiment, extend along the end faces of the rotor between its apex portions, and are substantially parallel to the outer peripheral edges of the rotor. These seals are carried in the rotor and normally engage the end walls of the outer body in sliding, gas-sealing contact as the rotor revolves relative to the outer body.

When the intake port which communicates with the variable volume working chambers of the engine is provided in the end wall of the outer body, rather than in its peripheral wall, it is termed a "side intake port." The present invention is applicable to rotary mechanisms which employ a side intake port in at least one of the outer body end walls as opposed to an intake port in the peripheral wall of the outer body.

When the end face seals, during rotation of the rotor relative to the outer body, move across the intake port, or span it, during a portion of the rotor travel relative to the outer body, the seals tend to bow outward towards the end walls so that they extend into the intake cavity or port. The seals are caused or tend to bow out in this manner because of mechanical means used to exert an outward pressure on the seals to keep them in sealing contact with the end walls of the outer body.

Obviously then, during the final portion of the intake phase of the engine cycle, the portion of the seal which extends into the intake cavity or port will tend to come into engagement with the closing edge of the intake port formed between the intake port and the end wall of the outer body. This relationship presents a problem in engine functioning, since repeated contact between the edge of the seal and the closing edge of the intake port, at the least, leads to excessive and uneven wear of the seal and the edge of the port, and at the worst, can lead to seal breakage through shearing engagement between the seal and the edge of the port, and seal breakage may, in turn, even lead to engine failure.

The instant invention is primarily directed to improving the relationship between the contour of the edge of the intake port and the contour of the seal to avoid the

undesirable effects which are otherwise created when the seal bows, even slightly, into the intake port.

It is known to those skilled in the internal combustion engine art that the fuel-air mixture which is drawn into the working chamber during the last stage of the intake phase is normally a particularly fuel-rich mixture. It is also a well-known desideratum of internal combustion engines that the closing of the intake port should be accomplished by moving from a large area of opening to a closed port or zero area condition as quickly as possible, and this desideratum may be termed "a quick closing" characteristic.

This "quick closing" characteristic can be achieved most efficaciously by providing a contour for the closing edge of the intake port which is substantially coincident with the peripheral edge of the rotor when the rotor edge is moving over the port. Since the end face seal is approximately parallel to the rotor edge and only a short distance radially inward on the rotor from the edge, the seal will also be substantially coincident with such a closing edge contour as it moves over the port edge immediately behind the rotor edge. Although such a closing edge contour provides the ideal attainable quick-closing characteristic, it is undesirable from the standpoint of seal durability.

As explained previously, if the closing edge of the intake port and the end face seal have virtually identical and aligned contours, the seal as it moves over the edge and re-engages the end wall of the outer body in sealing contact will be subjected to a shock and shearing action each time the port is closed.

In operation of a rotating combustion engine, the last portion of the fuel-air mixture to enter the working chamber during intake is a fuel-rich mixture. Since fuel is heavier than air, it lags behind the air as it flows into the chamber through the intake port. Because of this phenomenon, the last portion of the mixture to enter the chamber will be fuel-rich compared to the first portion of the mixture. Also, since the compression phase has commenced by the time the port has closed, the last fuel-rich portion of the mixture to enter the chamber is not appreciably dispersed or diffused through the chamber but tends to remain in the same general location with respect to the working face of the rotor.

Accordingly, it is possible to relate the position of the fuel-rich mixture at the end of the intake phase to the position of the ignition means when the working face moves from its position at the end of the intake phase to its firing position opposite the ignition means, and thereby to insure that this fuel-rich mixture will be opposite to or adjacent to the ignition means at the time of firing.

It is, accordingly, a primary object of the present invention to provide means to insure quick closing of the intake port and at the same time avoid any excessive wear or shock to the rotor end face seal when it comes into contact with the closing edge of the intake port.

It is another object of the instant invention to provide means for gradually picking up or removing the rotor end face seal from its bridging position across the intake port or cavity.

It is another object of the present invention to provide means to gradually pick up or remove the rotor end face seal from the intake port or cavity from the outside moving inwardly toward the axis of the outer body.

It is another object of the present invention to provide means for gradually picking up or removing the rotor end face seal from the intake port or cavity from the inside moving outwardly away from the axis of the outer body.

Another object of the instant invention is to provide means for gradually picking up or removing the rotor end face seal from the intake port or cavity moving from both the inner and outer ends of the intake port closing edge toward an intermediate portion of the closing edge.

It is a further object of the instant invention to provide means to insure that an enriched fuel-air mixture is located opposite the spark plug location when ignition takes place.

It is a still further object of the instant invention to provide means to yield better ignition characteristics in a rotating combustion engine and faster and more constant flame propagation velocities to give smoother operation and improve combustion.

In the description which follows it is to be recognized that, in practice, either the outer body or the inner rotor may rotate while the other member remains fixed or stationary, or both members may rotate as long as there is relative rotation between them to provide variable volume working chambers.

In the description of the present preferred embodiment, for purposes of clarity, the invention will be described with reference to a rotary mechanism in which the outer body or housing is fixed or stationary and the inner body is rotatable, or a rotor.

For purposes of definition in the specification and claims, the term "outside" refers to an area or point near, adjacent to, or in the direction of the peripheral wall of the outer body; while the term "inside" refers to an area or a point located near, adjacent to, or in the direction of the axis or center of the outer body.

Broadly described, the present invention provides means for gradually picking up or removing the rotor end face seal from a bridged position across the intake port or cavity and placing it in continuous contact position against the inner surface of the end wall of the outer body without appreciably sacrificing the quick-closing characteristic of the intake phase; and the invention also provides means to insure that a fuel-rich fuel-air mixture is located opposite the ignition means at the time of firing.

Additional objects and advantages of the invention will be set forth in part in the description which follows, and in part will be obvious from the description, or may be learned by practice of the invention, the objects and advantages being realized and attained by means of the instrumentalities and combinations particularly pointed out in the appended claims.

The invention consists in the novel parts, constructions, arrangements, combinations, and improvements shown and described.

The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate one embodiment of the invention and, together with the description, serve to explain the principles of the invention.

Of the drawings:

FIG. 1 is a side elevation of the mechanism with one end wall of the outer body removed to show the rotor positioned within the outer body. Portions of the rotor and outer body are shown partially in section;

FIG. 2 is a central vertical section of the mechanism taken along the line 2—2 of FIG. 1 in which the rotor and outer body are shown in section while the shaft and eccentric are shown without sectioning;

FIG. 3 is a fragmentary view showing the intake port section of the inner surface of the outer body and a portion of the rotor in the position it occupies with respect to the intake port shortly after closing of the intake port. This view shows the conditions which would exist in a rotary mechanism without the benefits of the present invention;

FIG. 4 is an enlarged fragmentary sectional view taken along the line 4—4 of FIG. 3 to illustrate the deleterious effects which may occur to the rotor end face sealing means in a rotary mechanism to which the present invention has not been applied. For clarity of explanation, and to permit visual apprehension of operative effects, certain portions of this figure have been grossly exaggerated;

FIG. 5 is a fragmentary view showing the intake port

section of the outer body and a portion of the rotor in the position it occupies with respect to the intake port at a time just prior to closing of the intake port. This view illustrates by means of various types of broken and phantom lines, three different ways in which the beneficial results of the present invention may be achieved in practice. For ease and clarity of explanation, certain portions of this view have also been exaggerated;

FIG. 6 is a fragmentary and partially schematic view illustrating how a fuel-rich fuel-air mixture may be placed in a location substantially opposite the ignition means in a rotating combustion engine at the time when ignition takes place.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory but are not restrictive of the invention.

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

As shown in FIG. 1, a generally triangular rotor **10** having arcuate sides is eccentrically supported for rotation within an outer body **12**. Although in the illustrative embodiment shown in the drawings the outer body **12** is fixed or stationary, a practical and useful form of the invention may be constructed in which both the outer body and rotor are rotary, but the eccentric is stationary; in this latter form of the invention the power shaft is driven directly by the rotation of the outer body and the inner rotor rotates relative to the outer body.

A still third form of the invention is possible in which the rotor remains fixed or stationary and the outer body and eccentric are rotatable.

As shown in FIGS. 1 and 2, the outer body **12** has a cavity, and the cavity has an axis **16**. The rotor **10** is mounted for rotation within the cavity on an axis **14** which is parallel to and laterally spaced from the axis **16**. The profile of the curved inner surface **18** of the outer body **12** has basically the form of an epitrochoid. The center of this epitrochoid is on the axis **16**, and the epitrochoid includes two arched lobe-defining portions, or lobes.

An intake port **20** is arranged to communicate with one lobe of the epitrochoidal inner surface **18**, and an exhaust port **22** is arranged to communicate with the other lobe.

The center of the epitrochoid which is described by the projection of the inner surface **18** on a plane transverse to the axis **16** of the outer body **12** coincides with the axis **16**. There are two points of least radius on the epitrochoid from its center **16**. A line which connects these two points of least radius and passes through the center of the epitrochoid is designated its minor axis **26**. Similarly, the epitrochoid has two points of greatest radius, and a line connecting these two points and passing through the center of the epitrochoid is designated its major axis **24**.

As embodied, it is apparent that the minor axis **24** divides the epitrochoid into two halves. For convenience, the half or lobe which communicates with the exhaust port **22** may be called the exhaust lobe and the half or lobe which communicates with the intake port **20** may be called the intake lobe.

As embodied, the generally triangular shape of the rotor **10** corresponds in its configuration to the "inner envelope" or the maximum profile of the rotor which will permit interference-free rotation of the rotor **10** within the outer body **12**.

As shown in FIGS. 1 and 2, the outer body **12**, which is stationary in this embodiment, comprises two end walls **28** and **30** and a peripheral wall **32** interconnecting these end walls. A shaft **34** is rotatably supported by the end walls **28** and **30** of the outer body **12** by means of conventional bearings, and the axis of the shaft **34** is coincident with the axis **16** of the outer body **12**.

An eccentric **36** is rigidly mounted on and forms an integral part of the shaft **34**; the axis of the eccentric **36** is eccentric from and parallel to the shaft axis **16**. The rotor **10** is rotatably supported upon the eccentric **36**, and the central axis of the eccentric **36** is coincident with the axis **14** of the rotor **10**.

As shown in FIG. 1, the rotor **10** includes three apex portions **38** which carry radially movable sealing members **40**. The sealing members **40** are in substantially continuous sliding, gas-sealing contact with the inner surface **18** of the outer body **12**, as the rotor **10** rotates within and relative to the outer body **12**.

By means of the relative rotation of the rotor **10** to the outer body **12**, three variable volume working chambers **42** are formed between the outer peripheral working faces **44** of the rotor **10** and the inner surface **18** of the outer body **12**. As embodied in FIG. 1, the rotation of the rotor relative to the outer body is counterclockwise and is indicated by an arrow.

A spark plug **46** is mounted in the peripheral wall **32** of the outer body **12**, and at the appropriate time in the engine cycle, spark plug **46** provides ignition for a compressed combustible mixture which upon expansion drives the rotor in the direction of the arrow.

The eccentricity *e* (FIG. 2) of the rotor axis **14** from the outer body axis **16** acts as a crank arm or moment arm to convert the energy of the expanding gases into torque on the shaft **34**.

As the rotor **10** rotates, fresh combustible gases are drawn into the working chambers **42** through the intake port **20**. These combustible gases, or the fuel-air mixture, are then successively compressed, ignited, expanded, and finally exhausted through the exhaust port **22**.

All four successive phases of the engine cycle: intake, compression, expansion, and exhaust, take place within each one of the variable volume working chambers each time the rotor completes one revolution within the outer body; or for each revolution of the rotor, the engine goes through one complete cycle.

Cut-away portions or channels **45** are provided in the working faces **44** of the rotor to permit the free passage of combustion gases between the intake lobe and the exhaust lobe of the inner surface **18** of the outer body when the rotor is in or near the position of top dead center compression.

A bearing **48** is provided between the bearing bore of the rotor **10** and the eccentric **36**. As shown most clearly in FIG. 2, an internally-toothed or ring gear **50** is integrally attached to the bearing **48**, and both the bearing **48** and ring gear **50** are fixed to the rotor **10**.

This ring gear **50** is in meshing engagement with an externally-toothed gear or pinion **52** which is rigidly attached to the outer body **12**. The gear ratio between the rotor ring gear **50** and the outer body gear or pinion **52** is 3:2 so that for every revolution of the rotor **10** about its own axis **14**, the shaft **34** rotates three times in the same direction.

The purpose of the gearing between the rotor **10** and the outer body **12** is to register or index the rotor in its position relative to the outer body, and to relieve the positioning load from the apex portions **38** and sealing members **40** of the rotor which would otherwise bear the load of determining the registration of the rotor with respect to the outer body. The gearing, thus, does not function to impart torque to the shaft **34**, this function being accomplished through the moment arm of the eccentricity *e* of the eccentric **36** or rotor axis **14**.

In accordance with the invention, means are provided for admitting the fuel-air mixture into the intake chamber of the engine. As embodied, this means preferably takes the form of a passage or cavity in an end wall which terminates in an intake port in the intake lobe of the epitrochoidal inner surface of the outer body.

This intake passage and its port may be located in either or both end walls of the outer body. In the

form of the invention illustrated in the accompanying drawings (FIG. 1), this means is shown as the intake port 20 in the end wall 30.

It is apparent, however, that a second intake port could be located opposite the intake port 20 in the other end wall 30. Also as embodied, and shown in FIGS. 1, 3, and 5, the intake port has roughly the shape of a triangle.

In the present embodiment, the base or longest leg of the triangle is generally inside or toward the center of the outer body 12 (see FIG. 1). The apex opposite the base of the triangle lies generally outside, near, or in the direction of the peripheral wall of the outer body. The edges or sides of the triangular-shaped intake port or cavity 20 are curved or bowed toward the peripheral wall.

This particular shape for the intake port 20 has been arrived at in existing engines to a large extent because of certain dimensional characteristics of the rotor 10. How these characteristics tend to determine the shape of the intake port will be more fully explained below.

As can be seen most clearly in FIG. 5, means are provided for sealing the rotor at its apex portions by the sealing members 40, which act as seals between the adjacent working chambers of the engine and which are radially movable within the apex portions 38 to form substantially continuous sliding and gas-sealing contact with the curved peripheral inner surface 18 of the outer body 12.

Means are also provided in the rotor end faces 54 and 56 (FIG. 2) to provide substantially continuous sliding and gas-sealing contact against the inner surface of the end walls 28 and 30 of the outer body 12 as the rotor rotates. These latter sealing means can be seen most clearly in FIG. 5, and, as here embodied, they have the form of as trip 58 which runs continuously along the rotor end face between apex sealing members 40.

These end face gas seals 58, as here preferably embodied, have an L-shaped cross section (as shown in FIG. 4), but could have numerous other shapes, e.g., a straight strip or T-shape. In the present embodiment, the L-shaped cross section provides the beneficial result of utilizing the gas pressure against the seal to aid in holding the contact face of the seal against the end wall of the outer body and also uses gas forces to hold the seal in intimate contact with the inside wall of the sealing slot 60 in the rotor end face.

To complete the means for sealing gases within the working chambers, a connecting seal means 62 is provided at the juncture of the end face seals 58 and the apex sealing members 40. This connecting sealing means, as here embodied, is in the form of a pin which serves to effectively seal the area of contact between the end face seals 58 and the apex sealing members 40. This connecting seal means 62 can be seen most clearly in FIG. 5.

The basic problem which the present invention solves is illustrated in FIGS. 3 and 4. From a study of FIG. 3 it can be seen that, as normally constructed, the closing edge or side 64 of the three-sided intake port 20 is virtually coincident with the contour of both the peripheral edge of the rotor working face 54 and also with the outer peripheral edge of the end seal 58 as the seal moves across the closing edge of the intake port.

FIG. 3 illustrates this condition by showing the relative position of the end face seal 58 in line with or almost coincident with the closing edge 64 immediately after the rotor itself has closed or masked the intake port 20.

Normally, the contour of the closing edge 64 conforms to and is coincident with the peripheral edge of the working face of the rotor 44 to insure that the desideratum of quick closing of the intake port is obtained to the maximum extent possible, after other factors governing the general configuration of the intake port 20 have been taken into consideration.

The other factors affecting the configuration of the intake port 20 are the position of the oil seal 66 of the rotor relative to the end face seals 58, and the position of the connecting seal means 62 with respect to the end wall 28.

As shown in FIGS. 1, 2 and 3, oil sealing means must be provided to prevent the combined lubrication and cooling fluid, which lubricates the bearing means 43 and cools the rotor 10, from running across the rotor end faces 54 and 56 into the working chambers 42. As here embodied, this oil sealing means comprises an oil seal 66 which circumscribes and encloses the bearing bore rotor 10.

As shown in FIG. 1, it is apparent that the oil seal 66 will be close to the end face seals 58 in the area between apex portions on the end faces of the rotor, but that it will be further separated from the end face seals 58 near the apex portions 38 of the rotor end faces. Obviously, to avoid leakage of lubricating and cooling fluid, the intake port 20 must remain outside of the path described on the inner surface of the end wall by the oil seal as the rotor rotates within the outer body, and this factor effectively determines the extent to which the inside edge or base 68 of the triangular-shaped intake port 20 may be moved inside toward the axis of the outer body. The path described by the oil seal against the end face 28, thus, describes the interior limit of the inside edge 68 (see FIG. 3).

Similarly, the requirement that the connecting seal means 62 must be at least partially supported at all times by the end face 28 to prevent its projecting into the intake port 20 is the determining factor in arriving at the contour for the outside leg or edge 70 of the triangular intake port. The position of the outside edge 70 may thus be roughly determined by the path described by the connecting seal 62 against the end face 28 as the rotor moves within the outer body 12.

From the foregoing, it is easily realized that the area of the intake port is definitely restricted in its maximum size by the positions of the oil seal 66 and connecting seal 62.

FIG. 4 illustrates in an exaggerated manner, for clarity, the deleterious effects on both the end face seals 58 and the closing edge 64 of the intake port when the means of the present invention are not provided, and closing of the intake port is accomplished in the usual manner as illustrated in FIG. 3. It can be seen in FIG. 4, that the leading edge of the end face seal 58 tends to engage the closing edge 64 of the intake port when the closing edge 64 and the end face seal 58 are at or near a condition of coincidence as they pass each other and as shown in FIG. 3. Although FIG. 4 presents this condition in an exaggerated manner, it will be readily apparent from FIG. 4 that even a slight interference contact between the end face seal 58 and the closing edge 64 will have very obvious deleterious effects on both of these parts.

The problem of avoiding excessive wear or damage to the end face seal 58 and the closing edge 64 of the intake port because of the bowing out or sinking of the end face seal 58 into the port 20 may be resolved by a slight but important modification in the contour of the closing edge 64. The possible ways of accomplishing the beneficial results to be achieved from the present invention are illustrated in FIG. 5 where the possible means for achieving the invention are depicted in an exaggerated manner for clarity of illustration and explanation. By a very slight change in the contour of the closing edge 64, an interaction and cooperation of parts is attained that produces new, useful, and beneficial results in the operation of the engine, and particularly in improving its reliability, durability, and over-all endurance and performance characteristics.

Further, by accomplishing the primary desired object of the instant invention in minimizing wear and the chances for failure of the end face seals 58 and closing edge 64 of the intake port by providing for a scissor-like action between the edge and the seal in one particular way out of the different possible ways, an important additional benefit and result in improved operation of the

engine can be obtained. This improvement provides better ignition characteristics, faster and more constant flame propagation, and generally smoother operation and improved combustion.

In accordance with the invention, means are provided to gradually pick up and remove the end face seals 58 from its slightly bowed condition in the intake port 20 immediately after the commencement of closing of the port, or as the seal engages the edge of the port. As embodied, three possible means of achieving the desired results of the instant invention are shown in FIG. 5. The conventional closing edge 64 of the intake port is depicted by a triple dot-dash phantom line.

Also shown in FIG. 5 is a rotor apex portion including the peripheral edge of one working face of the rotor as it approaches the closing edge 64 just prior to covering and closing the intake port. The leading edge 57 of the end face seal 58 is shown in broken line coincident with the conventional closing edge 64; this is the position which the leading edge 57 of the end face seal 58 occupies as the seal passes over the closing edge of the port, and as described previously and as shown in FIG. 4, presents a condition which can lead to destructive effects on the seal unless the closing edge 64 is modified.

One means of achieving the result of the present invention, without changing the timing of the intake phase, is depicted by a single dot-dash phantom line in which the end seal 58 is picked up from the inside portion of the outwardly modified closing edge 72 and gradually lifted into its proper place by a scissor-like action as the point of juncture between the seal and the edge travels outwardly away from the radially inner portion of the seal along the outwardly modified closing edge 72. The scissor-like action occurs when the seal and the closing edge wipe across each other like the two halves of a pair of scissors. This modification of the closing edge slightly, but not materially, reduces the area of the intake port.

A second possible means of accomplishing the benefits of the present invention, also without changing the timing of the intake phase, is illustrated by the double dot-dash phantom line in FIG. 5 which represents a further modification of the outward closing edge 72 and is designated as 74. This combined outwardly and inwardly modified closing edge 74 of the intake port 20 provides a means by which the end seal 58 will be gradually picked up from the port from both ends of the modified closing edge 74 and will be gradually lifted into its proper place by being moved both from the outside toward the inside and from the inside toward the outside so that the last portion of the port to be closed will be adjacent to an intermediate portion 75 of the modified closing edge 74.

It will be apparent from a study of FIG. 5 that by changing the ratio between the lengths of the outside-to-inside portion and the inside-to-outside portion of the modified closing edge 74, the portion of the port which will be last to close in relation to the working face 44 of the rotor can be exactly predetermined.

A third possible means for achieving the results of the instant invention, again without changing the timing of the intake phase, is shown in FIG. 5 by the solid line inwardly modified closing edge contour 76. This is the generally preferred means for achieving the instant invention. Although all three primary forms of the modified closing edge, i.e., edges 72, 74, and 76, slightly reduce the area of the intake port, the reduction does not have any significant effect on engine operation.

When this inwardly modified closing edge 76 is used, the end seal 58 is picked up from the outside portion of the closing edge and is gradually lifted into its proper position in the end face seal slot 60 by a scissor-like action as it travels inwardly away from its outer portion along the inwardly modified closing edge 76 toward the axis 16 of the outer body 12. Why this latter means of achieving the invention by the inwardly modified closing edge 76 is generally the preferred means for accomplishing beneficial results of the invention requires further explanation.

Most forms of the rotating combustion engine have a construction such that the portion of the working face 44 of the rotor 10 which is opposite to or most nearly adjacent to the ignition means 46 at the time of firing is also the portion of the working face which passes closest to the inside apex 78 of the intake port 20 at or near the time when the rotor is closing the port.

It is a well-known characteristic of internal combustion engines that fuel flow tends to lag air flow during the intake process and accordingly the last quantity of fuel-air mixture to enter the intake chamber is a fuel-rich mixture. If this fuel-rich mixture, which has highly desirable combustion characteristics, can be placed opposite the ignition means at the time of firing, the following highly beneficial results will ensue: better ignition characteristics, faster and more constant flame propagation velocity, smoother operation of the engine, and generally improved combustion characteristics.

By using certain preferred means for achieving the present invention, it is possible to essentially localize the terminal enriched intake mixture and position it adjacent to or opposite the ignition means at the time of firing. Depending upon the particular construction of the engine, this desideratum can be accomplished by using either the inwardly modified edge 76 or the inwardly and outwardly modified edge 74 (FIG. 5).

Generally, however, for most engines, the inwardly modified edge 76 yields the best results, since it localizes the enriched mixture on the working face 44 in the proper position to place it opposite the ignition means when ignition occurs, and at the same time it provides a simple and direct means of gradually lifting the end seal 58 into place in the rotor 10 upon closing of the intake port 20.

Although in general there is considerable diffusion of the fuel-air mixture within the intake chamber while the intake process is occurring, it will be observed that even before complete closing of the intake port 20 by the rotor 10, the compression phase for the chamber begins, i.e., the rotor 10 has moved past its position of bottom dead center and has begun to compress the charge by the time the intake port closes. Also, the engine moves through the compression phase so rapidly that once compression starts, the combustible mixture does not become substantially further diffused or dispersed because the inertia of the mixture itself is high compared to the time period of the compression phase. Probably because of the facts just mentioned, the fuel-rich mixture which enters the intake chamber last, if it enters from the inside apex of the intake port, tends to remain localized in its position with respect to the working face 44 of the rotor at least until the rotor has moved into firing position and placed this fuel-rich mixture opposite the ignition means. This is another reason why the inwardly modified closing edge 76 is considered the preferred means of achieving the instant invention.

Although the outwardly modified closing edge 72 is just as desirable as the inwardly modified edge 76 from the standpoint of smoothly guiding the end seal 58 back into sealing contact with the end wall 28, it does not provide the unusual interaction and cooperation of parts which are derived by using the inwardly modified closing edge 76 (or for some constructions of the engine the outwardly and inwardly modified closing edge 74). The inwardly modified closing edge 76, thus, provides the combination of smoothly guiding the end seal 58 back into contact with the end wall 28 while at the same time it localizes the enriched terminal intake mixture in the desired position on the working face 44 of the rotor 10. It can be seen in FIG. 5 that in one sense the inwardly modified closing edge 76 may be created by employing a contour for the edge which will insure that the edge will be inclined to each end face seal 58 throughout a major length of the edge as the seal moves over the edge.

This difference in inclination should not be great, however, since it is desirable from a combustion standpoint to have the closing edge of the intake port 20 and the end seal 58 fairly close in contour to preserve the desired timing for the intake phase without substantially altering the area of the intake port. It is also very desirable to preserve as nearly as possible the quick-closing characteristic for the intake port.

The inclination of the closing edge must, however, be sufficient to give adequate lifting action against the end face seal 58. In one embodiment of the engine, the angle of inclination between the closing edge and the end face seal 58, when using the inwardly modified closing edge 76, has a value of 25° as the seal 58 first comes into contact with the edge 76, and this angle between the edge and the seal is gradually reduced to 0° by the time this seal passes over the port. Of course, the angle between the seal and the edge could vary considerably and one of the primary objects of the invention, scissor action between the seal and edge, could still be achieved.

The present invention relates to the discovery that by a slight but unobvious mechanical change in the construction of the rotating combustion engine, or other rotary mechanisms, it is possible to achieve a very important combination of unexpected beneficial results. This achievement is accomplished by providing an inwardly closing modified edge for the intake port to greatly improve end seal performance and at the same time to provide better ignition, flame propagation, combustion, and smooth operating characteristics for the engine.

This invention in its broader aspects is not limited to the specific mechanisms shown and described, but also includes within the scope of the accompanying claims any departures made from such mechanisms which do not depart from the principles of the invention and which do not sacrifice its chief advantages.

What is claimed is:

1. A rotary mechanism comprising a hollow outer body having an axis, axially-spaced end walls, and a peripheral wall interconnecting the end walls, at least one of the end walls having an intake port means therein; a rotor mounted within the outer body on an axis eccentric to the axis of the outer body and rotatable relative to the outer body, the rotor having end faces disposed adjacent to the end walls and a plurality of circumferentially-spaced apex portions for sliding in sealing engagement with the inner surface of the peripheral wall to form a plurality of working chambers between the rotor and peripheral wall that vary in volume upon relative rotation of the rotor within the outer body, sealing means extending along the end faces of the rotor between the apex portions in sealing contact with the end walls, ignition means in operative association with the working chambers, a carburetor that supplies a fuel-air mixture to the working chambers of the engine through the intake port, the fuel-air mixture becoming increasingly rich from the beginning to the end of intake in any one working chamber, the rotor also having working faces interconnecting apex portions and extending from one apex portion to an adjacent apex portion, the closing edge contour of the intake port means being inclined to the edge of the working face of the rotor as the working face of the rotor moves over the closing edge, whereby the portion of the fuel-air mixture richest in fuel has an extent less than the extent of the closing edge contour and remains contiguous in the working chamber to the area of the working face that is adjacent the ignition means at the time of firing.

2. The invention as defined in claim 1, in which the edge of the sealing means is substantially parallel to the edge of the adjacent working face of the rotor, and in which the closing edge is so inclined to the edge of the adjacent working face of the rotor that the port closes in a direction outwardly from the axis of the outer body.

3. The invention as defined in claim 1, in which the edge of the sealing means is substantially parallel to the edge of the adjacent working face of the rotor, and in which the closing edge is so inclined to the edge of the adjacent working face of the rotor that the port closes in a direction inwardly toward the axis of the outer body.

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