

Feb. 9, 1937.

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2,070,138

ROTARY INTERNAL COMBUSTION ENGINE

Filed June 3, 1936

3 Sheets-Sheet 1

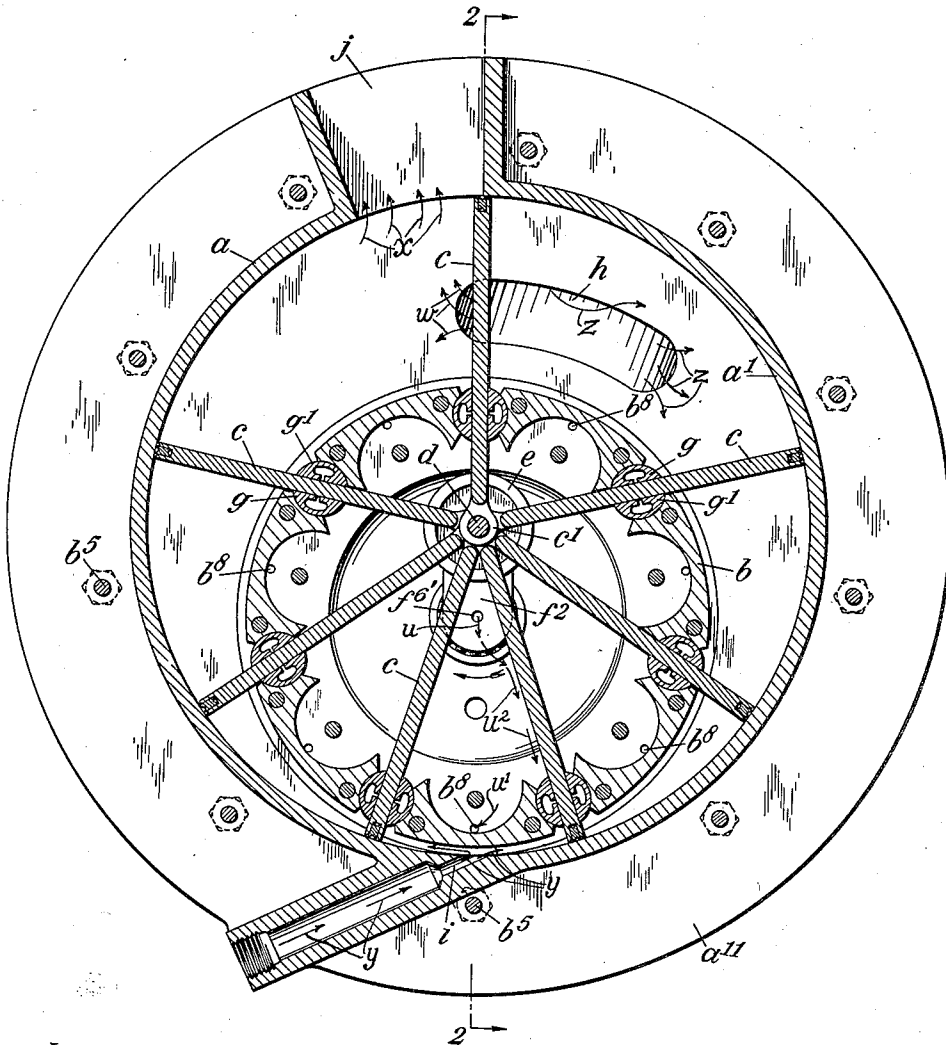


Fig. 1

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3 Sheets-Sheet 2

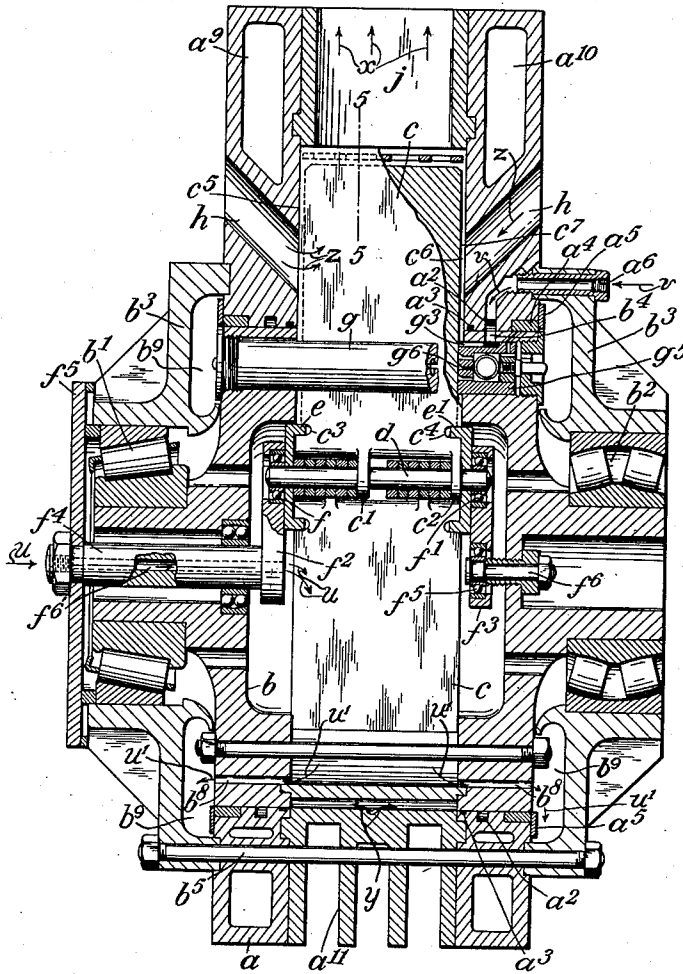


Fig.2

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UNITED STATES PATENT OFFICE

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ROTARY INTERNAL COMBUSTION ENGINE

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In Great Britain June 28, 1935

15 Claims. (Cl. 123—16)

This invention relates to rotary internal combustion engines. Some features of the invention are also applicable to devices of a like kind such as pumps or compressors, which will be collectively referred to herein as rotary engines.

The invention relates to rotary engines of the type in which a rotor is eccentrically mounted within a stator and said rotor carries trunnions for sliding vanes which are articulated to an axle concentric with the stator and which divide the space between the rotor and the stator into a number of chambers. In the case of an internal combustion engine, these chambers form the combustion chambers of the engine, while in pumps or compressors they form the compression chambers.

It will be appreciated that with engines intended to operate at high speed, it is extremely important to avoid friction between the relatively rotating portions of the vanes and stator and yet at the same time secure the proper packing between the chambers enclosed by the successive pairs of vanes.

According to this invention, in rotary engines of the type specified above, bearings are provided in the interior of the rotor for supporting the vanes against loads due to centrifugal force. These bearings prevent the vanes from being thrown outwards and pressing against the stator and thus avoid friction between the outer edges of the vanes and the interior surfaces of the stator.

The engine according to this invention may comprise a rotor, eccentrically mounted within a stator, trunnions around said rotor carrying sliding vanes articulated to an axle concentric with the stator, bearings in said rotor for supporting the vanes against loads due to centrifugal force and for holding said vanes out of contact with the stator, each of said vanes being formed with a groove or depression in the parts which rotate relatively to the stator and means for supplying fluid to said groove or depression. In the case of an internal combustion engine, water may be continuously supplied to the groove while the engine is running when the water will become vaporized by the hot parts of the engine, and the vapour will attain sufficient pressure, owing to the high temperature obtaining in the engine and the restrictive groove or depression provided in the vanes, to form an effective seal between adjacent chambers. In this construction, there will be a small but definite clearance (say .0025 inch), between the outer edges of the vanes and the interior of the stator. Grooves will also be formed

along the opposite side edges of the vanes and also along the portions of the rotor and/or stator where the rotor and stator nearly contact with each other in the neighbourhood of the trunnions. Such grooves are connected to a water inlet in the stator. Instead of a single groove the said parts may be formed with a main groove and with another groove or grooves on one or both sides of the main groove forming a gland of the labyrinth type. Such a method of sealing the chambers between the vanes may be applied to any engine, pump or compressor of the type specified above.

While it is preferred to use water as a seal forming fluid, it may, if desired, be replaced by some other fluid which will be vaporized when it comes into contact with the hot parts. In cases where the temperature would be insufficient to vaporize the fluid, a fluid (e. g. mercury) may be supplied which is either of itself sufficient to form a seal or is supplied under sufficient pressure to form a seal in the unvaporized condition.

To facilitate the understanding of this invention, a practical embodiment as applied to a rotary internal combustion engine embodying a water seal for the combustion chambers will now be described, by way of example, with reference to the accompanying drawings, in which:—

Fig. 1 is a sectional elevation of the rotary engine.

Fig. 2 is a cross-section on the line 2—2 of Fig. 1.

Fig. 3 illustrates a fragment of Fig. 2 drawn to an enlarged scale.

Fig. 4 is a section on the line 4—4 in Fig. 3.

Fig. 5 is a section on the line 5—5 in Fig. 2 illustrating part of the stator and part of one of the vanes.

Figs. 6 and 7 are views illustrating diagrammatically the arrangement of grooves in the rotor and stator, Fig. 6 showing the arrangement on the low pressure side of the engine and Fig. 7 the arrangement on the high pressure side of the engine.

Fig. 8 is a section on the line 8—8 in Fig. 7, but showing both the rotor and the stator.

In the embodiment illustrated, the engine comprises a stator *a* having a cylindrical cavity *a*¹ within which is located an eccentrically mounted rotor *b*. The rotor is journaled in roller bearings *b*¹, *b*² carried in end plates *b*³, *b*³ attached to the stator by bolts *b*⁵.

As shown seven vanes are provided, each vane being of the same construction and consisting of a plate *c* formed at its inner end with a pair of

projecting eyes c^1 , c^2 which are threaded on to the spindle d in the manner of a door hinge. The eyes of the seven vanes are arranged in different positions so that the eyes of all the vanes are accommodated on the same spindle. The vanes are thus articulated to the spindle and are, therefore, free to rotate relatively to the spindle. In the interior of the rotor, and near to the spindle, the vanes are formed with side recesses c^3 , c^4 for bearings which support the vanes against loads due to centrifugal force. These bearings are in the form of cup members e , e^1 , the flanges of which engage in the recesses in the vanes while the web portion is mounted on opposite ends of the spindle d . The spindle d is rotatably mounted in ball bearings f , f^1 in end plates f^2 , f^3 located in a fixed position within the rotor. The end plate f^2 is carried by a shaft f^4 fixed by means of a cross plate f^5 to one of the end plates b^3 . The other end plate f^3 is mounted by means of a ball bearing f^5 on a stub spindle f^6 which is rotatable with the rotor. Where the vanes emerge from the rotor they are carried in trunnions each formed of two D-shaped trunnion parts g , g^1 , these trunnion parts being journaled at their ends in the rotor so that they can turn relative to the rotor and also permit the vanes to slide through them.

The vanes are all of equal length and are so arranged that there is a small clearance, say of about .0025 inch, between their outer ends and the cylindrical cavity in the stator. As will be seen from Fig. 1, as the rotor rotates the angle between the successive vanes will change continually. In the neighbourhood of the air inlet h the air enters the combustion chamber as indicated by the arrows z (Figs. 1 and 2) and the angle is a maximum but as the rotor swings round, the vanes are caused to approach each other and the rotor also approaches the stator, thus compressing the air contained in the combustion spaces formed between the vanes and the rotor and stator until, at a point almost diametrically opposite the air inlet, the angle between the vanes is at a minimum and the space between the rotor and the stator is also at a minimum so that the charge is compressed to the maximum extent. At this point an inlet i for a fuel injector is provided so that a charge of fuel can be introduced into the combustion chamber in the direction of the arrows y (Figs. 1 and 2) and the resulting explosion serves to drive the rotor round in the direction of the arrow in Fig. 1. As the rotation continues the combustion chambers continue to expand until, at or near the point of maximum expansion, the chamber is opened to the exhaust port j through which the products of combustion flow out in the direction of the arrows x (Figs. 1 and 2) from the combustion chambers. The air inlet port h is so arranged that it is opened to the combustion chamber to admit air as indicated by the arrows w (Fig. 1) while the latter is still open to the exhaust port so as to allow for the entry of air to scavenge the combustion chamber. Continued rotation causes the combustion chamber to be cut off from the exhaust port while still being in communication with the air inlet so that fresh air is trapped in the combustion chamber which gradually reduces in size and repeats the cycle of operations already described.

In order to use water as a seal forming fluid, each vane is formed along its side edges c^5 , c^6 which are adjacent to the stator with grooves c^7 to which water is supplied under a small head from an annular channel a^2 in the wall of the

stator located just outside the trunnions and communicating with a water inlet a^8 through which water enters in the direction indicated by the arrows v (Figs. 2 and 3). This annular channel communicates with the adjacent groove c^7 through a port b^4 in the rotor which, in turn, communicates with a longitudinal groove g^3 extending from the outer border of the port b^4 to the bottom of the groove in the vane. The hole b^4 is controlled by a sealing device g^4 which permits water to flow into the groove g^3 but prevents the water or vapour from returning to said hole. The groove g^3 is contained in a block g^5 which fits in between the trunnion parts g , g^1 where these parts project laterally at either side of the engine beyond the vanes c . A cylindrical spring g^7 is provided between the internal face of the block g^5 and the nut g^8 . The nut g^8 is adjustable by the shouldered screw g^9 on rotation of which the nut g^8 is forced against the spring which in turn acts against the block g^5 to force it into close contact with the side of the vane. It will be understood that the nut g^8 will be held against rotation with the screw but will be permitted to slide longitudinally thereof. The block g^5 is formed with grooves g^6 arranged labyrinth fashion in the parts which contact with the base of the groove c^7 to prevent escape of water or vapour inwardly into the rotor. The water supplied from the annular channel a^2 to the grooves c^7 as indicated by the arrows v^1 (Fig. 3) flows by centrifugal force outwardly towards the tips of the vanes which are formed with a further groove c^8 . The groove c^8 is of rectangular form in cross-section but near its outer ends its walls slant away at an angle of about 45° to join the outer walls of the vane. Into this groove is fitted a substantially rectangular block c^9 having holes c^{10} formed through it from the inner to the outer edge at intervals and having its inner and outer edges arranged to form V-shaped channels c^{11} , c^{12} on the interior and exterior of the block with which the holes c^{10} communicate. The outer groove c^{12} is spaced very slightly from the inner surface of the stator housing and the water from the rectangular groove passing down the channel c^{11} will enter this channel c^{12} through the holes c^{10} . Thus water is supplied to channels running round the three sides of the vane which contact with the stator and owing to the high temperatures obtained on the high pressure region of the engine the water is vaporized and the vapour which attains a considerable pressure forms a seal between the successive chambers of the engine.

A similar water vapour seal is provided between the portions of the rotor which extend laterally beyond the vanes and the contacting portion of the stator. Here again water from the annular channel a^2 is caused to flow into a groove a^3 in the stator on the inside of the channel a^2 . The water in the groove a^3 is vaporized by the heat of the engine and forms an effective seal.

In order to prevent leakage of water from the annular channel a^2 closely fitting blocks a^4 of any known composition which requires no lubrication may be fitted in a recess in the stator as shown, or in the rotor, so as to bear against the other part, said block being retained in position by the retaining ring a^5 .

Wastage of steam in the grooves between the contacting portions of the stator and rotor may be excessive for some purposes (e. g. for mobile engines), and for economy the groove a^3 may vary in depth, being shallow in the high pressure

region and deep in the low pressure region, and these grooves may also be vented near the exhaust port region so as to provide a pressure gradient around the grooves approximating to the mean pressure, within the combustion chamber bounded by the grooves, at any point. Steam issuing from the vent can be condensed and the condensate returned with the water to the annular groove through the inlet a^6 .

In addition to the groove a^3 and the water channel a^2 in the stator, the rotor may be formed as shown in chain dotted lines in Figs. 6, 7 and 8 with a series of grooves b^6 arranged obliquely and forming scrolls which extend in such a direction that when the rotor revolves a certain amount of water will be carried around the scrolls and will be flung against the stator filling the gap between the rotor and the stator, and this water will tend to move towards the interior of the stator as indicated by the arrows in Figs. 6 and 7.

In order to increase the desired effect counter scrolls may be provided on the stator, for instance inclined recesses a^7 arranged obliquely parallel to the recesses b^6 may be provided on the low pressure side of the engine so that the water is given an outward velocity on this low pressure side as indicated by the arrow in Fig. 6. Similar recesses a^8 may be provided on the high pressure side but in this case the recesses are inclined in an opposite direction to the recesses b^6 so that the water is given an inward velocity in the high pressure region.

In order to ensure dissipation of heat the stator may be cooled by circulating water through the spaces a^9 , a^{10} . Similarly the rotor interior and vanes are to be cooled by passing oil through the interior. Such oil may be supplied through the hole f^6 in the shaft f^4 through which it flows as indicated by arrows u (Figs. 1 and 2) and the heated oil may be withdrawn from the rotor in any suitable manner, oil drain holes b^8 being indicated in Figs. 1 and 2 of the drawings through which the oil leaves as indicated by arrows u^1 . The oil in the rotor will flow down the sides of the vanes as indicated by the arrows u^2 in Fig. 2 and will act as a lubricant for the hollow trunnions which are so arranged as to prevent oil from passing into the combustion space. On leaving the holes b^8 the oil will flow into the oil collecting grooves b^9 in the end plates b^3 .

Alternatively, air could be drawn through the interior and the hollow trunnions could be used for lubricating purposes.

The fuel need not be injected against the direction of rotation, but can be injected in any desired direction. The injection may, for instance, be across the air stream. If several nozzles are provided, some may be arranged in advance of the others for still better distribution, as the time required for injection would probably be considerably less than the time taken by the passage of the chamber past the nozzle.

The effectiveness of the vapour seals as hereinbefore described will depend upon keeping the stator and vanes substantially coaxial with each other so that the vane clearance will be approximately constant. This can be achieved by taking certain precautions which will now be referred to. The stator cylinder shall be provided as shown with flanges a^{11} of circumferential form which are both stiff and cool with respect to the stator cylinder so that they will prevent deformation of said cylinder. These flanges facilitate the transference of heat from the more highly heated

parts to the lesser heated parts both by conduction to other parts and also by transferring heat to the cooling medium surrounding them. This attempt to distribute the heat so as to maintain the temperature of different parts as uniform as possible can also be achieved by admitting the cooling water to the hottest part and allowing it to pass when heated over the cooler parts. The temperature gradient existing across the radial extensions of the stator should be such that the most highly heated parts of the stator cylinder will tend to distort into a shape which is opposed to the shape that it would tend to assume owing to variation of pressure within. The stiffness of the radial sections can be arranged so that one deformation will tend to cancel the other, i. e. the dimensions of the cylinder walls and flanges need not be constant throughout.

The mounting for the spindle d may be made of a material or combination of materials such that when heated it will be kept at approximately the axis of the heated stator.

Since the only portion of the vane which can expand is that part located outside the surface contacting with the bearings e , the vane clearance can be controlled by the material of which the vanes are made; by the material of which the bearing plates e are made, or by controlling the amount of oil passed through the rotor for cooling purposes.

What I claim as my invention and desire to secure by Letters Patent is:—

1. A rotary engine comprising a stator, a rotor eccentrically mounted in said stator, trunnions carried by said rotor, an axle concentric with the stator, vanes slidably carried in said trunnions, means for attaching said vanes to said axle so that they can articulate, said vanes dividing the space between the rotor and stator into a number of separate chambers and rotatable bearings in the interior of said rotor, said bearings engaging the said vanes for supporting them independently of said means against loads due to centrifugal force.

2. A rotary engine comprising a stator, a rotor eccentrically mounted in said stator, trunnions carried by said rotor, an axle concentric with the stator, vanes slidably carried in said trunnions, means for attaching said vanes to said axle so that they can articulate, said vanes dividing the space between the rotor and stator into a number of separate chambers and said vanes having grooves in the parts which rotate relative to the stator, rotatable bearings in the interior of said rotor, said bearings engaging the said vanes for supporting them independently of said means against loads due to centrifugal force and holding said vanes out of contact with the stator and means for supplying fluid to said grooves in the vanes for sealing the said chambers.

3. A rotary engine comprising a stator, a rotor eccentrically mounted in said stator, trunnions carried by said rotor, an axle concentric with the stator, vanes slidably carried in said trunnions, means for attaching said vanes to said axle so that they can articulate, said vanes dividing the space between the rotor and stator into a number of separate chambers and said vanes having grooves in the parts which rotate relative to the stator, rotatable bearings in the interior of said rotor, said bearings engaging the said vanes for supporting them independently of said means against loads due to centrifugal force and holding said vanes out of contact with the stator and means for continuously supplying water to

the grooves in the vanes while the engine is running to seal said chambers.

4. A rotary engine comprising a stator, a rotor eccentrically mounted in said stator, trunnions carried by said rotor, an axle concentric with the stator, vanes slidably carried in said trunnions, means for attaching said vanes to said axle so that they can articulate, said vanes dividing the space between the rotor and stator into a number of separate chambers and said vanes having recesses in their side edges and flanged cup members in the interior of said rotor, said cup members having their flanges engaging with said recesses in the vanes for supporting said vanes against loads due to centrifugal force.

5. A rotary engine comprising a stator, a rotor eccentrically mounted in said stator, trunnions each formed of two D-shaped parts journaled at their ends in the rotor, an axle concentric with the stator, vanes slidably carried between the two D-shaped parts of the said trunnions, means for attaching said vanes to said axles so that they can articulate, said vanes dividing the space between the rotor and stator into a number of separate chambers and rotatable bearings in the interior of said rotor, said bearings engaging the said vanes for supporting them independently of said means against loads due to centrifugal force.

6. A rotary internal combustion engine comprising a stator, a rotor eccentrically mounted in said stator, trunnions carried by said rotor, an axle concentric with the stator, vanes slidably carried in said trunnions, means for attaching said vanes to said axle so that they can articulate, said vanes dividing the space between the rotor and stator into a number of separate chambers and said vanes having grooves in their parts adjacent to the stator, said stator having an annular channel and said rotor having a port communicating with said annular channel and with a groove in each trunnion extending from the said port to the bottom of the adjacent groove in the vane, rotatable bearings in the interior of said rotor, said bearings engaging the said vanes for supporting them independently of said means against loads due to centrifugal force and means for supplying a sealing fluid to said annular channel whereby it is carried to the grooves in the vanes.

7. A rotary engine comprising a stator, a rotor eccentrically mounted in said stator, trunnions each formed of two D-shaped parts journaled at their ends in the rotor, an axle concentric with the stator, vanes slidably carried between the two D-shaped parts of the said trunnions, means for attaching said vanes to said axle so that they can articulate, said vanes dividing the space between the rotor and stator into a number of separate chambers and said vanes having grooves in their parts which lie close to the stator, a block mounted between the two parts of the trunnion where these project beyond each side of the vane, said block having a longitudinal groove therein communicating with one of the grooves in the vane, said rotor having a port communicating with said groove and said stator having an annular channel communicating with said port, rotatable bearings in the interior of said rotor, said bearings engaging the said vanes for supporting them independently of said means against loads due to centrifugal force and holding said vanes out of contact with the stator and means for supplying water to said annular channel in the stator while the engine is running.

8. A rotary engine comprising a stator, a rotor

eccentrically mounted in said stator, trunnions each formed of two D-shaped parts journaled at their ends in the rotor, an axle concentric with the stator, vanes slidably carried between the two D-shaped parts of the said trunnions, means for attaching said vanes to said axle so that they can articulate, said vanes dividing the space between the rotor and stator into a number of separate chambers and said vanes having grooves in their parts which lie close to the stator, a block mounted between the two parts of the trunnion where these project beyond each side of the vane, said block having a longitudinal groove therein communicating with one of the grooves in the vane and said block having grooves arranged in labyrinth fashion in its face contacting with the vane to prevent escape of water or vapour inwardly of the rotor, said rotor having a port communicating with said groove and said stator having an annular channel communicating with said port, rotatable bearings in the interior of said rotor, said bearings engaging the said vanes for supporting them independently of said means against loads due to centrifugal force and holding said vanes out of contact with the stator means for supplying water to said annular channel in the stator while the engine is running.

9. A rotary engine comprising a stator, a rotor eccentrically mounted in said stator, trunnions carried by said rotor, an axle concentric with the stator, vanes slidably carried in said trunnions and extending radially outward to divide the space between the rotor and stator into a number of separate chambers, means for attaching said vanes to said axle so that they can articulate, each of said vanes having grooves in its outer and side edges, a block of substantially rectangular cross-section in the groove in the outer edge of each of said vanes, said block having a channel on its outer edge and a channel on its inner edge and holes passing through the block and communicating with said inner and outer channels and rotatable bearings in the interior of the rotor, said bearings engaging the said vanes for supporting them independently of said means against loads due to centrifugal force and for holding said vanes out of contact with the stator.

10. A rotary engine comprising a stator, a rotor eccentrically mounted in said stator, trunnions carried by said rotor, an axle concentric with the stator, vanes slidably carried in said trunnions, means for attaching said vanes to said axle so that they can articulate, said vanes dividing the space between the rotor and stator into a number of separate chambers and said vanes having grooves in their parts adjacent to the stator, said stator having an annular channel and said rotor having a port communicating with said annular channel and with a groove in each trunnion extending from the said port to the bottom of the adjacent groove in the vane, and said stator having a groove adjacent to and on the inside of the annular channel for the reception of sealing fluid adapted to be vaporized and to seal effectively the relative rotating parts of the rotor and stator, rotatable bearings in the interior of said rotor, said bearings engaging said vanes for supporting them independently of said means against loads due to centrifugal force and means for supplying a sealing fluid to said annular channel whereby it is carried to the grooves between the vanes and the stator.

11. A rotary engine comprising a stator, a rotor

eccentrically mounted in said stator, trunnions carried by said rotor, an axle concentric with the stator, vanes slidably carried in said trunnions, means for attaching said vanes to said axle so that they can articulate, said vanes dividing the space between the rotor and stator into a number of separate chambers and said vanes having grooves in their parts adjacent to the stator, said stator having an annular channel and said rotor having a port communicating with said annular channel and with a groove in said trunnion extending from the said port to the bottom of the adjacent groove in the vane, rotatable bearings in the interior of said rotor, said bearings engaging said vanes for supporting them independently of said means against loads due to centrifugal force, means for supplying a sealing fluid to said annular channel whereby it is carried to the grooves between the vanes and the stator and means between said rotor and stator on the outside of the annular channel for preventing leakage of fluid from said channel.

12. A rotary internal combustion engine comprising a stator having inlet and exhaust ports therein, a rotor eccentrically mounted in said stator, trunnions carried by said rotor, an axle concentric with the stator, vanes slidably carried in said trunnions, means for attaching said vanes to said axle so that they can articulate, and extending radially outward to divide the space between the rotor and stator into a number of separate chambers adapted to receive air from the inlet, to compress it and exhaust it, means for injecting fuel into a portion of said air when compressed, said vanes having grooves in their parts adjacent to the stator, said stator having an annular channel and said rotor having a port communicating with said annular channel and with a groove in each trunnion extending from the said port to the bottom of the adjacent groove in the vane and said rotor and stator having grooves of varying depth in their adjacent parts, the stator grooves being shallow in the high pressure region and deep in the low pressure region, rotatable bearings in the interior of said rotor, said bearings engaging the said vanes for supporting them independently of said means against loads due to centrifugal force and means for supplying a sealing fluid to said annular channel whereby it is carried to the grooves in the vanes.

13. A rotary internal combustion engine comprising a stator having inlet and exhaust ports therein, a rotor eccentrically mounted in said stator, trunnions carried by said rotor, an axle concentric with the stator, vanes slidably carried in said trunnions, means for attaching said vanes to said axle so that they can articulate and extending radially outward to divide the space between the rotor and stator into a number of separate chambers adapted to receive air from said inlet, to compress it and to exhaust a portion of it through said exhaust port, said vanes having grooves in their parts adjacent to the stator, means for injecting fuel into a portion of said air when compressed, said stator having an annular channel and said rotor having a port communicating with said annular channel and communicating with a groove in each trunnion extending from the said port to the bottom of the adjacent groove in the vane, means for supplying fluid to said annular channel, whereby said fluid is conveyed to the grooves in the vanes, said stator having grooves of varying depth adapted to re-

ceive sealing fluid, and the rotor having grooves adapted to receive sealing fluid, said rotor grooves being obliquely arranged to form scrolls which extend in such a direction that the sealing fluid will tend during rotation of the rotor to move toward the interior of the stator and rotatable bearings in the interior of said rotor, said bearings engaging said vanes for supporting them independently of said means against loads due to centrifugal force and holding said vanes out of direct bearing contact with the stator.

14. A rotary internal combustion engine comprising a stator having inlet and exhaust ports therein, a rotor eccentrically mounted in said stator, trunnions each formed of two D-shaped parts carried by said rotor, an axle concentric with the stator, vanes slidably carried between the two D-shaped parts of the said trunnions, means for attaching said vanes to said axle so that they can articulate and extending radially outward to divide the space between the rotor and stator into a number of separate chambers adapted to receive air from said inlet, to compress it and to exhaust a portion of it through said exhaust port, said vanes having grooves in their parts adjacent to the stator, means for injecting fuel into a portion of said air when compressed, said stator having an annular channel and said rotor having a port communicating with said annular channel and communicating with a groove in each trunnion extending from the said port to the bottom of the adjacent groove in the vane, means for supplying a sealing fluid to said annular channel whereby it is carried to the grooves in the vanes, and said stator having grooves of varying depth in their adjacent parts adapted to receive sealing fluid, the grooves being shallow in the high pressure region and deep in the low pressure region and rotatable bearings in the interior of said rotor, said bearings engaging the said vanes for supporting them independently of said means against loads due to centrifugal force and holding said vanes out of direct bearing contact with the stator.

15. A rotary internal combustion engine comprising a stator having inlet and exhaust ports therein, a rotor eccentrically mounted in said stator, trunnions carried by said rotor, an axle concentric with the stator, vanes slidably carried in said trunnions, means for attaching said vanes to said axle so that they can articulate and extending radially outward to divide the space between the rotor and stator into a number of separate chambers adapted to receive air from said inlet, to compress it and to exhaust a portion of it through said exhaust port, said vanes having grooves in their parts adjacent to the stator, means for injecting fuel into a portion of said air when compressed, said stator having an annular channel and said rotor having a port communicating with said annular channel and communicating with a passage in each trunnion extending from the said port to the bottom of the adjacent groove in the vane, means for supplying a sealing fluid to said annular channel whereby it is carried to the grooves in the vanes, said rotor having recesses in parts which nearly contact with the stator adapted to receive sealing fluid, said rotor recesses being obliquely arranged to form scrolls which extend in such a direction that the sealing fluid will tend during rotation of the rotor to move toward the interior of the stator, and said stator having annular grooves of varying depth adapted to receive sealing fluid, the grooves being shallow in the high pressure

region and deep in the low pressure region and having a vent near the exhaust port, said stator having inclined recesses which are arranged parallel to the recesses in the rotor on the low pressure side so that sealing fluid on this side is given an outward velocity while the recesses on the high pressure side are inclined in an opposite direction to those on the low pressure side so that the

sealing fluid is given an inward velocity in the high pressure region and rotatable bearings in the interior of said rotor, said bearings engaging said vanes for supporting them independently of said means against loads due to centrifugal force. 5

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