An engine comprises an annular chamber, a plurality of runners disposed in the annular chamber in a manner to be moved in the same direction by gas pressure through the annular chamber, the runners being divided into two equal groups each having at least two units, two rotor members respectively coupled with each group of runners, inertia imparting blocks attached to the respective rotor members so as to apply the momentum of the runners of one group to those of the other group by collision between the block associated with one rotor member and that coupled with the other rotor member, a power take off shaft journaled in bearings in a manner to be aligned with the rotating axis of the rotor members, two power transmitting members fixed to the power take off shaft so as to cooperate with each rotor member in the advancing direction of the runner, and means for preventing the rotor members from being moved backwards.

7 Claims, 12 Drawing Figures
The present invention relates to an engine with an annular chamber wherein a plurality of runners are advanced by gas pressure in one direction, and more particularly to an engine usable as an ignition combustion engine, compression combustion engine, steam engine and the like.

The feature of this invention consists in obtaining rotation power directly from the circular movement of runners disposed in the annular chamber, so that the engine of this invention is driven with higher efficiency than the prior reciprocating engine of the piston-cylinder type.

According to the present invention, the engine comprises an annular chamber, a plurality of runners so disposed in the annular chamber as to divide it into the same number of gas-actuated areas as the runners and moved along the circular line of the chamber in one direction by the actuation of gasses introduced into said areas, the runners being divided into two equal groups each having at least two units in such a manner that the runners of one group are alternately arranged with those of the other group, two rotor members respectively coupled with each group of runners, inertia imparting blocks attached to the respective rotor members so as to apply the momentum of the runners of one group to those of the other group by collision between the block associated with one rotor member and that coupled with the other rotor member, a power take off shaft journaled in bearings in a manner to be aligned with the rotating axis of the rotor members, two power transmitting members fixed to the power take off shaft so as to cooperate with each rotor member in the advancing direction of the runner, and means for preventing the rotor members from being moved backwards.

The other features and advantages of the present invention will be understood from the following description with reference to the accompanying drawings, in which:

FIG. 1 is a vertical cross sectional view of a two cycle ignition combustion engine embodying the present invention;

FIG. 2 is another cross sectional view of the engine of FIG. 1;

FIG. 3 is an end view of the engine taken along a line III—III of FIG. 1;

FIG. 4 is a perspective view, partly broken away, of the engine of FIG. 1;

FIGS. 5A and 5B are perspective views of the engine of FIG. 1,

where the parts of the engine are demounted;

FIG. 6 is a vertical cross sectional view of a steam engine further embodying the present invention;

FIG. 7 is an end view of the engine taken along a line VII—VII of FIG. 6;

FIG. 8 is a cross sectional view of the engine taken along a line VIII—VIII of FIG. 6;

FIG. 9 is a cross sectional view of the engine taken along a line IX—IX of FIG. 6;

FIG. 10 is a cross sectional view of the engine taken along a line X—X of FIG. 6; and

FIG. 11 is a cross sectional view of the engine taken along a line XI—XI of FIG. 6.

FIG. 12 is an ignition combustion gasoline engine embodying this invention. The engine comprises an engine body or housing I having a central circular hollow portion 2a, and an endless tubular portion 2b disposed on the periphery thereof so as to form therein an annular chamber 2 having a circular cross section. A plurality of runners are disposed in the annular chamber 2 movably through the tube, and divided into two equal groups, each of which has at least two units or, as indicated, four units totaling eight represented by reference characters 3a, 3b, 3c and 3d, 3e, 3f, 3g and 3h) in such a manner that the runners 3a, 3b, 3c and 3d of one group are alternately arranged with those 3e, 3f, 3g and 3h of the other group, and that the chamber 2 is divided into the same number of gas-actuated areas 4a to 4h as all the runners. The runners of each group are arranged on a circular line at a prescribed space.

The engine further comprises two disc-shaped rotor member 5 and 5' respectively coupled with the runners of each group, which are attached to the peripheral portion of the rotor member. The rotor members 5 and 5' are disposed in the central circular hollow portion 2a which communicates with the annular chamber 2 through an annular slot 6 formed in the inside peripheral portion of the tubular portion 2b. The peripheral portion of the rotor members 5 and 5' slideably contact each other and the opposite inner surfaces of the annular slot 6 with an air-tight seal there between.

The rotor members 5 and 5' are rotated about their common axis, which is aligned with that of a power take off shaft 7 journaled in bearings 8 and 8' mounted on the side portions of the housing 1. There are provided inertia imparting blocks divided into two groups represented by reference characters 9a, 9b, 9c, 9d, and 9e, 9f, 9g, 9h. The grouped blocks are arranged on the respective inside surfaces of the rotor members 5 and 5' in such a manner that the blocks of one group bear an alternate relationship with those of the other group along a circular line coxial with the axis of the rotor member.

The aforementioned alternate arrangement assures that rotation of either of the rotor members 5 and 5' causes the blocks of the corresponding group to strike those of the other group and the momentum of the runners associated with the blocks of the former group is transmitted to those of the latter, before the forward ends of the runners of the former group reach the rear ends of those of the latter.

On the power take off shaft 7 are fixed two power transmitting members 10 and 10' which have bearing portions 10a and 10'a, and stop portions 10b and 10'b respectively. The bearing portions 10a and 10'a rotatably bear the bosses of the rotor members 5 and 5'. The bosses of the rotor members have inner stepped portions 5e and 5f facing the stop portions 10b and 10'b respectively and each having circularly arranged ratchet teeth 10c engaging in a clockwise direction, in which the runner advances as shown in FIG. 5b, with paws 11 which are pivotally disposed in grooves 12 formed on the periphery of the stop portions 10b (10'b).

In the inner peripheral portions of the housing 1 facing the outer periphery of the bosses of the rotor members 5 and 5' are positioned circularly arranged ratchet teeth represented by reference characters 13a and 13b. The ratchet teeth 13a are engageable in an anticlockwise direction, namely, opposite to that in which the runner advances, with paws 14 pivotally disposed in grooves 15a formed on the peripheral portion of each of the bosses of the rotor members 5 and 5'. The ratchet teeth 13a are engageable in a clockwise direction, in which the runner advances, with paws 14a pivotally set in grooves 15a formed on the peripheral portion of each of the bosses of the rotor members 5 and 5'.

To the power transmitting members 10 and 10' are attached disengaging members 10d and 10'd, which are used in such a manner that the paws 14 of the stopped rotor member which are associated with the ratchet teeth 13a are depressed into the grooves 15a thereof by the corresponding disengaging member so as to cause the paws 14a to be disengaged from the ratchet teeth 13a immediately before the stop of the preceding runners.

On the mutually facing surfaces of the bosses of the rotor members 5 and 5' are formed bevel-gear teeth 16 and 16' coaxial with the axis of the shaft 7 and alternately engageable with bevel-gear teeth 17a and 17a' formed on a gear wheel 17 which is, for example, splined on the shaft 7, namely, in a manner to remain fixed in the rotating direction of an engine, but be movable in the axial direction thereof.

On one of the opposite walls of the endless tubular portion 1b along the circular line thereof are arranged at an equal spacing six ignition plugs 18a to 18f. On the other wall of the endless tubular portion 1b along the circular line thereof are formed six pairs of intake ports 19a to 19f, and exhaust ports 20a to 20f spaced from the intake ports by a pitch therebetween. Each pair of intake and exhaust ports has valve seats 21 and 22 on which there rest poppet valve discs 23 and 24 respectively in a manner to be removable therewith. The valve discs 23 and 24 include operating rods 25 and 26 pro-
jecting out of the housing 1 and having at the outer ends guide heads 25a and 26a respectively. Furthermore, each of the valve discs 23 and 24 is outwardly urged by means of a compression spring member 27 surrounding the guide rod 25 or 26, in such manner that the valve disc contacts the corresponding seat so as to cause the corresponding port to be shut.

To the side portion of the housing 1 is attached a cup-like gear casing 28 which contains three bevel gears 29, 30 and 31 serially engaged with each other. The bevel gear 29 is attached to the end of the shaft 7, the bevel gear 31 is attached to a shaft 32 journalized with the end of the gear casing 28 coaxially with the shaft 7 and projecting therefrom, and the bevel gear 30 is attached to a shaft 33 journalized with a part of the gear casing 28 perpendicularly to the axis of the shaft 7. To the outer end portion of the shaft 32 is attached a turn table 34 for controlling the respective poppet valves.

Two parallel circular guide portions 35 and 36 are formed on the side wall of the turn table 34 in a manner to face the guide heads 25a and 26a of each pair of the poppet valves used in the intake and exhaust ports.

The top surface of the guide portions 35 and 36 is corrugated particularly in such a manner that the guide head of each of the poppet valves moves relative to the direction in which there is formed the corrugation so as to operate the poppet valves in the following time sequence.

While the runners of one group represented by reference characters 3a, 3b, 3c and 3d, together with the corresponding rotor member 5a, make a first one-twelfth revolution due to the explosion of compressed gases in the areas 4a and 4c caused by the energized ignition plugs 18a and 18d, the gas filled in the areas 4a and 4c is compressed by the advancing movement of the runners 3a and 3c. Simultaneously, the poppet valves 23 provided in the intake ports 19a and 19d, though the valves of the other intake ports are closed, are opened so as to allow waste gas to be expelled therethrough due to the shrinkage of the areas 4d and 4h caused by the advancing movement of the runners 3b and 3d.

Next, when a second group of runners 3a', 3b', 3c' and 3d', together with the corresponding rotor member 5b, similarly make a one-twelfth revolution, the same cycle of operation is conducted as in the preceding case by another set of runners immediately succeeding the preceding ones in the direction in which the runners peripherally advance. Namely, when the runners 3a', 3b', 3c' and 3d' make a one-twelfth revolution due to the explosion of compressed gases in the areas 4b and 4f caused by the energized ignition plugs 18b and 18c, the gas filled in the areas 4e and 4g respectively is compressed by the advancing movement of the runners 3a' and 3c'. Simultaneously, the poppet valves 23 provided in the intake ports 19b and 19e are opened so as to allow fresh gas to be sucked in due to the expansion of the areas 4d and 4h caused by the advancing movement of the runners 3b' and 3d'.

When the first mentioned runners 3a, 3b, 3c and 3d similarly make again a one-twelfth revolution, the same cycle of operation is conducted as in the preceding case by another set of runners immediately succeeding the preceding ones. Consequently, the aforementioned two cycles of operation of the groups of runners are conducted alternately.

The direction of the preceding runners of one group is transmitted to the stopped runners of the other group by collision between the inertia imparting blocks associated with the former group and those coupled with the latter.

When the runners 3a, 3b, 3c and 3d together with the rotor member 5, are advanced along the circular locus defined by the circular chamber in a clockwise direction as shown in FIG. 3, their one-twelfth revolution is imparted to the transmitting member 10 by ratchet teeth 10c of the stop portion 10b engaged with the paws 11, and the rotor member 5' corresponding to the stopped runners 3a', 3b', 3c' and 3d' is not urged in the advancing direction, regardless of the rotation of the shaft 7 by the power transmitting member 10 which is forcibly urged by the former rotor member 5, because the ratchet teeth 10c of the stop portion 10b' are disengaged from the paws 11.

Similarly, when the runners 3a', 3b', 3c' and 3d' together with the rotor member 5', are advanced along the circular locus, their one-twelfth revolution is imparted to the transmitting member 10' by the ratchet teeth 10c of the stop portion 10b' engaged with the paws 11. In this case, the rotor member 5 corresponding to the runners 3a, 3b, 3c and 3d is not urged by the ratchet teeth 10c of the stop portion 10b disengaged from the paws 11.

When the gas pressure of the areas is increased by explosion, one group of runners and the corresponding rotor member, which are stopped, are prevented from making a backward motion in an opposite direction to that shown in FIG. 3, by the ratchet teeth 13a engaged with the paws 14a until the preceding rotor member completes its movement.

Since the teeth 17a of the gear wheel 17 always engage with those of the moving rotor member, the shaft 7 is rotated at the same speed as the moving rotor member, so that the shaft 7 makes no idle movement.

When the inertia of one group of runners and rotor member is imparted to the other group of runners and rotor member by the inertia imparting blocks with the resultant stop of the former group, then the engaged gear teeth of the gear wheel 17 are disengaged from the bevel-gear teeth corresponding to the former group, and the other gear teeth of the gear wheel 17 are engaged with the other bevel-gear teeth corresponding to the latter group so that the latter group is prevented from making an idle movement against the power transmitting member.

In this case, the gear wheel 17 is so constructed that, for example, the surface of each of its gear teeth 17a inclined in the direction in which the runners revolve is depressed toward the corresponding surface of each of the bevel-gear teeth 16 engaged with gear teeth 17a so as to cause the gear wheel 17 to be moved away from the rotor member 5 along the spline of the shaft 7 when the rotor member 5 is stopped, and the gear wheel 17, together with the shaft 7, rotates forward relative to the rotor member 5.

Preferably, the gear wheel 17 is urged backward to its original position at the center of the spline of the shaft 7 by means of a toggle spring member 37.

FIGS. 7 to 9 illustrate a steam engine further embodying this invention. The engine comprises an engine body having an annular chamber 102 like that of the first mentioned embodiment. A plurality of, for example, six runners are disposed in the annular chamber 102 movably along a circular locus defined by the annular chamber 102 of the previously mentioned embodiment, and divided into two equal groups, each of which has at least two units, or, as indicated, three units totaling six represented by reference characters 103a, 103b and 103c of (103a, 103b and 103c). The chamber 102 is divided into gas-actuated areas 104a to 104f by the runners.

The engine further comprises two disc-shaped rotor members 105 and 105' respectively coupled with the runners of each group, which are attached to the peripheral portion of said rotor member. The rotor members 105 and 105' are disposed in the central hollow portion of the engine body.
3,670,705

A turn table 134 for controlling the respective poppet valves is attached to the end portion of a shaft 132 coaxially with the axis of the shaft 107 and journalled in a gear casing 156 mounted on the end portion of the engine body.

The shaft 132 has an internal gear 157 meshing with a spur gear 158 pivoted to the end portion of the housing. The spur gear 158 registers with another spur gear 159 mounted on the end portion of the shaft 107. On one side of the turn table 134 there are formed two parallel circular guide portions 135 and 136 in a manner to face the guide heads 154a and 155a of each pair of the poppet valves 154 and 155 used in the intake and exhaust ports.

The top surfaces of the guide portions 135 and 136 are corrugated particularly in such a manner that the guide head of the poppet valve moves relative to the direction in which there is formed the corrugation so as to operate the poppet valve in the following time sequence.

When the runners of one group represented by reference characters 103a, 103b and 103c, together with the corresponding rotor member 105, make a first-sixth revolution into the areas 104b, 104c and 104f through the valves 154 provided in the intake ports 119c, 119g and 119h, then the areas 104a, 104c and 104a are shrunk by the advancing movement of the above-mentioned runners 103a, 103b and 103c.

During the shrinkage of said areas 104a, 104c and 104e, the valves 155 provided in the exhaust ports 120b, 120c and 120f are opened so as to exhaust waste steam to the atmosphere or into a reservoir (not shown).

Next, when the runners of one group represented by reference characters 103a, 103b and 103c together with the corresponding rotor member 105, make a starting e motion as a result of collision between the inertia imparting blocks 109a, 109b and 109c and the blocks 109a, 109b and 109c, and a one-sixth revolution due to the force of compressed gas or steam into the areas 104a, 104c and 104f through the valves 154 provided in the intake ports 119b, 119g and 119f, then the areas 104a, 104c and 104f are shrunk by the advancing movement of the above-mentioned runners 103a, 103b and 103c.

During the shrinkage of said areas 104b, 104d and 104f, the valves 155 provided in the exhaust ports of the first group 120a, 120b and 120c, are opened so as to expel waste steam to the atmosphere or into a reservoir (not shown).

When the first-mentioned runners 103a, 103b and 103c again make a one-sixth revolution, the same cycle of operation is conducted as in the preceding case by another set of runners immediately following the corresponding ones in the direction in which the runners peripherally advance.

When the runners 103a, 103b and 103c, together with the rotor member 105, are advanced along the circular locus defined by the annular chamber in a clockwise direction shown in FIG. 8, their one-sixth revolution is imparted to the transmitting member 110 by the ratchet teeth 110c of the stop portion 110b engaged with the paws 111. In this case, the rotor member 105 corresponding to the stopped runners 103a, 103b and 103c is not urged forward, regardless of the rotation of the shaft 107 by the power transmitting member 110 which is forcibly urged by the rotor member 105, because the ratchet teeth 110c of the stop portion 110b are disengaged from the paws 111 of the advancing member 110 coupled with the shaft 107.

Similarly, when the runners 103a, 103b and 103c, together with the rotor member 105, are advanced along the circular locus, their one-sixth revolution is imparted to the transmitting member 110 by the ratchet teeth 110c of the stop portion 110b engaged with the paws 111. In this case, the rotor member 105 corresponding to the runners 103a, 103b and 103c is not urged forward by the ratchet teeth 110c of the stop portion 110b disengaged from the paws 111.

When compartments each other on a circular annular chamber, each pair of the intake and exhaust ports includes poppet valves 154 and 155 provided in the same manner as in the first mentioned embodiment.

5

The annular chamber 102 communicates with the central hollow portion of the engine body defining the chamber 102. The peripheral portions of the rotor members 105 and 105' slidably contact each other and the opposite walls of the slot 106 in air-tight seal.

The rotor members 105 and 105' are rotated about their common axis, which is aligned with that of a power take off shaft 107 journalled in bearings 108 and 108' mounted on the side portions of the engine body. There are provided in the periphery of the annular chamber 102, rod members represented by reference characters 109a - 109b - 109c and 109d - 109b - 109c. The grouped blocks are attached to the inside surfaces of the respective rotor members in such a manner that the blocks of one group are alternately arranged with those of the other group along a circular locus co-axial with the axis of the rotor member.

The blocks of both groups are actuated in the same manner, as hereinbefore mentioned embodiment.

On the power take off shaft 107 are fixed two power transmitting members 110 and 110' which have stop portions 110b and 110'b respectively. Each of the stop portions 110b and 110'b has ratchet teeth 110c and 110d' formed on the peripheral portion thereof.

On the inner periphery of the central hollow portion of the engine body, there are arranged circularly arranged ratchet teeth 113 and 113a so as to face the ratchet teeth 110c and 110d' respectively. During the rotation of one of the rotor members 105 and 105', the paws 111 are engageable with the ratchet teeth 110c as shown in FIG. 8 so as to transmit the advancing movement of the rotor member to the corresponding power transmitting member. The paws 111 are engageable with the ratchet teeth 113 as shown in FIG. 11 so as to prevent the rotor member from making a backward movement. And the paws 114a are engageable with the ratchet teeth 113a as shown in FIG. 10 so as to prevent the stopped rotor member from being idly moved.

Each of the rotor members 105 and 105' includes three sectorial windows 115a, 115b and 115c (115a, 115b and 115c'). The paws 111, 111a, 114 and 114a are attached to pivots 152, 152a, 153 and 153a which are rotatable secured to the rotor members 105 and 105' in such a manner that the pivots 152a and 153a associated with one rotor member particularly project through the windows of the other rotor member. The paws 111 and 111a swing themselves in such a manner that their ends are depressed on the surfaces of the ratchet teeth 110c and 110d' respectively. The paws 114 and 114a are urged by means of torsional springs (not shown) so as to be depressed on the surfaces of the ratchet teeth 113 and 113a.

The rotor members 105 and 105' comprise disengaging members 160 which are so actuated that immediately before either of the rotor members 105 and 105' stops rotation, the corresponding disengaging members release the paws 111a associated with the rotor member which is stationary from the ratchet teeth 113a.

On one of the opposite inner walls of the annular chamber 102 are formed twelve pairs of intake ports 119a to 119f, and exhaust ports 120a to 120f equally spaced around the annular chamber. Each pair of the intake and exhaust ports includes poppet valves 154 and 155 provided in the same manner as in the first mentioned embodiment.
In order to better adjust the timing of the mutual action of each pair of the intake and exhaust valves, the engine device of this invention may involve guide portions 135 and 136 constituted by separate members capable of being adjustably positioned on one side of a turn table 134.

What is claimed is:

1. A rotary engine comprising:
   a. an engine housing having an annular chamber;
   b. a power take-off shaft journaled at the axis of said annular chamber;
   c. a first rotor member and a second rotor member disposed oppositely to each other and loosely mounted for rotation on said shaft;
   d. a plurality of runners provided on each of said rotor members in circumferentially spaced fashion and slidably inserted in said annular chamber, the runners on the first rotor member alternating with those on the second rotor member such that two adjacent runners and the inner wall of said annular chamber define a gas actuated area;
   e. first and second power transmitting means fixedly connected to said shaft;
   f. first means causing the first and second rotor members to engage respectively with the first and second power transmitting means so as to prevent said transmitting means from idly moving backward with respect to said rotor members;
   g. second means causing the first and second rotor members to engage with the engine housing so as to prevent the backward idle movement of the rotor members;
   h. a pair of third means causing the rotor members to engage with the engine housing so as to prevent the forward idle movement of the rotor members while the rotor members are kept stationary;
   i. means for operating the third means to disengage the rotor members from the engine housing so as to allow the rotor members to move forward;
   j. means for connecting the running rotor member with the shaft to prevent the shaft from idly moving forward with respect to the running rotor member;
   k. at least one intake port on the annular chamber for introducing expansible gas into said gas actuated areas; and
   l. at least one exhaust port on the annular chamber for exhausting used gas from the actuated areas;

2. The rotary engine according to claim 1 wherein said connecting means comprises a gear wheel fixed to the shaft and telescopically movable between the rotor members and having on the both sides bevel gear teeth engageable with bevel gear teeth provided on the inner sides of the rotor members, said bevel gear teeth of the gear wheel being formed so as to engage with those of the rotor members while the rotor members are running and to disengage from those of the rotor members while the rotor members are kept stationary, whereby the gear wheel selectively engages with the running rotor members to connect said running rotor members with the shaft so as to prevent the idle forward movement of the shaft.

3. The rotary engine according to claim 2 wherein each of said third means comprises ratchet teeth arranged coaxially with the shaft on the inside of the engine housing and depressible pawls provided circumferentially on each of the rotor members so as to engage the corresponding ratchet teeth while the rotor members are kept stationary; and said operating means comprises a plurality of disengaging members projecting laterally from each of the power transmitting means and arranged thereon in circumferentially spaced relationship to depress the pawls of the rotor members so as to disengage the rotor members from the corresponding power transmitting means while the rotor members are rotated.

4. The rotary engine according to claim 3 wherein said connecting means comprises first ratchet teeth arranged coaxially with the shaft on each of the power transmitting means, a plurality of first pawls provided and circumferentially spaced on the corresponding rotor member to engage with the first ratchet teeth so as to prevent the forward idle movement of the shaft while said corresponding rotor member is turning, and first disengaging members provided and circumferentially spaced on the other rotor member to disengage the first pawls from the first ratchet teeth while said corresponding rotor member is kept stationary.

5. The rotary engine according to claim 4 wherein each of said third means comprises second ratchet teeth arranged coaxially with the shaft on the inside of the engine housing, a plurality of second pawls circumferentially spaced on the corresponding rotor member to engage with the second ratchet teeth so as to prevent the forward idle movement of the corresponding rotor member while it is kept stationary, and said operating means comprises second disengaging members circumferentially spaced on the other rotor member to disengage the second pawls from the second ratchet teeth while said corresponding rotor member is running.

6. The rotary engine according to claim 1 including a plurality of circumferentially spaced inertia imparting blocks on each of the inner sides of the first and second rotor members, the blocks on the first rotor member alternating with those of the second rotor member, the blocks on the running first or second member striking against the stationary second or first member, respectively.

7. The rotary engine according to claim 1 wherein said first runners, second runners, intake ports and exhaust ports are respectively four, four, six and six in number, said engine having six ignition plugs, six pairs of said intake and exhaust ports, said ignition plugs and pairs of ports being alternately arranged on, and communicating with, the annular chamber, said engine including means for operating said ignition plugs and pairs of intake and exhaust ports in timed relationship with the rotation of said shaft.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,670,705               Dated June 20, 1972

Inventor(s) Masahiro SAITO

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

Page 1, In the heading add the following Priority data:

--[30] Foreign Application Priority Data

April 10, 1970 Japan..................30316/70.--

Signed and sealed this 5th day of December 1972.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents