United States Patent

Saito

[15] **3,670,705**

[45] **June 20, 1972**

[54] **ENGINE WITH AN ANNULAR CHAMBER**

[72] Inventor: **Masahiro Saito,** 407 Takashi, Mobara-shi, Chiba-ken, Japan

[22] Filed: **July 28, 1970**

[21] Appl. No.: **58,800**

[52] **U.S. Cl.** **123/8.47,** 418/36

[51] **Int. Cl.** **F02b 55/00**

[58] **Field of Search** 418/36, 38; 123/8.47

[56] **References Cited**

UNITED STATES PATENTS

1,212,649	1/1917	Krikorian	123/8.47 X
1,131,148	3/1915	Manuel	418/34 X
3,244,156	4/1966	Curtiss	418/36
3,302,625	2/1967	Cunningham	418/36 X

Primary Examiner—William E. Wayner
Attorney—Flynn & Frishauf

[57] **ABSTRACT**

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

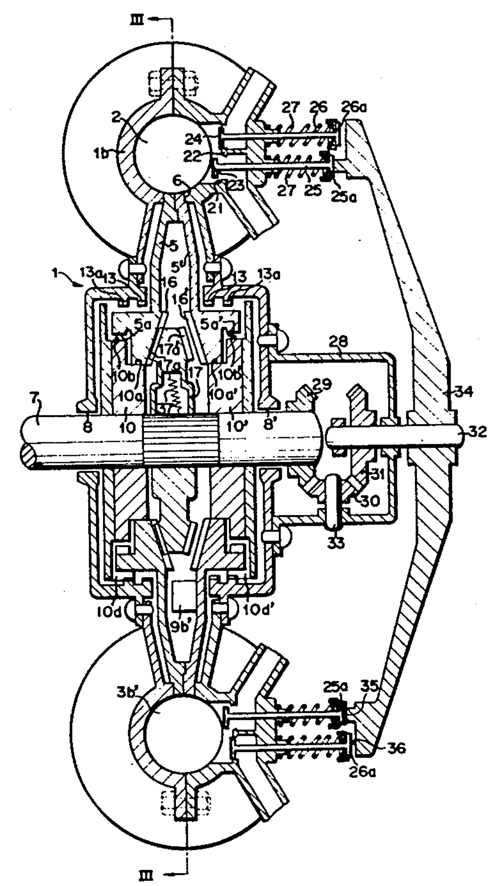


FIG. 1

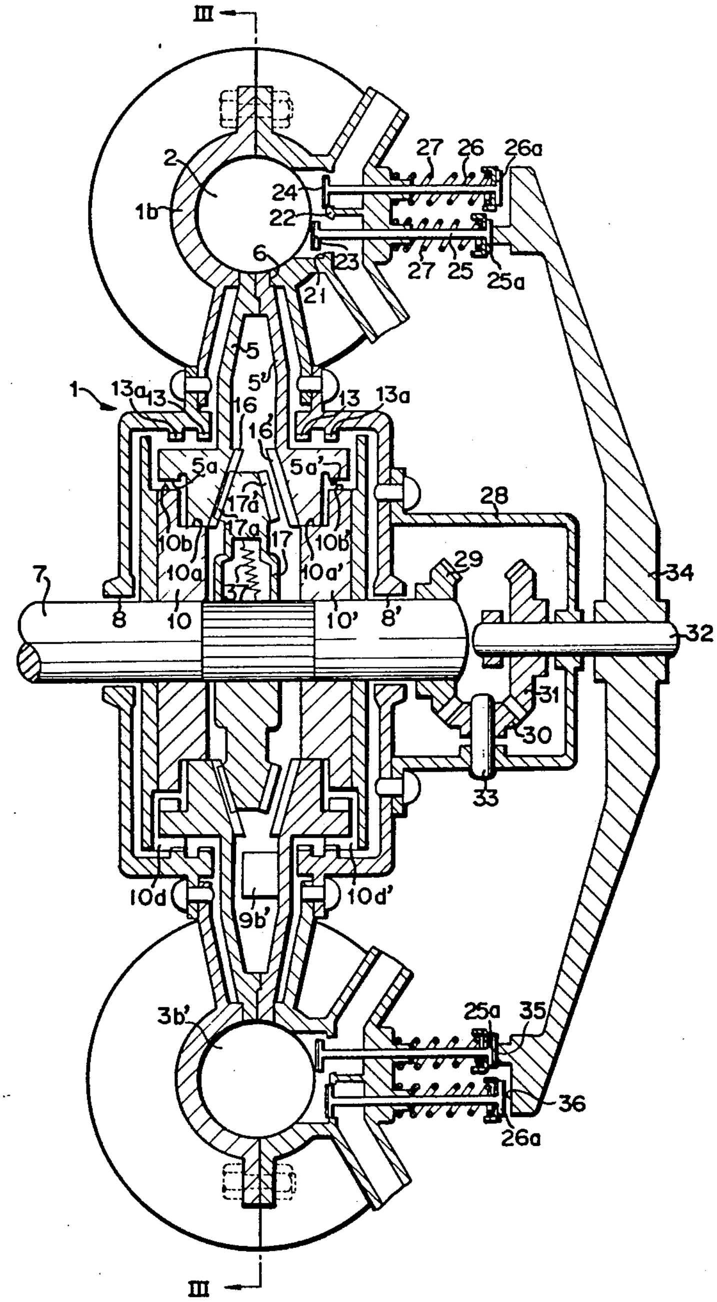
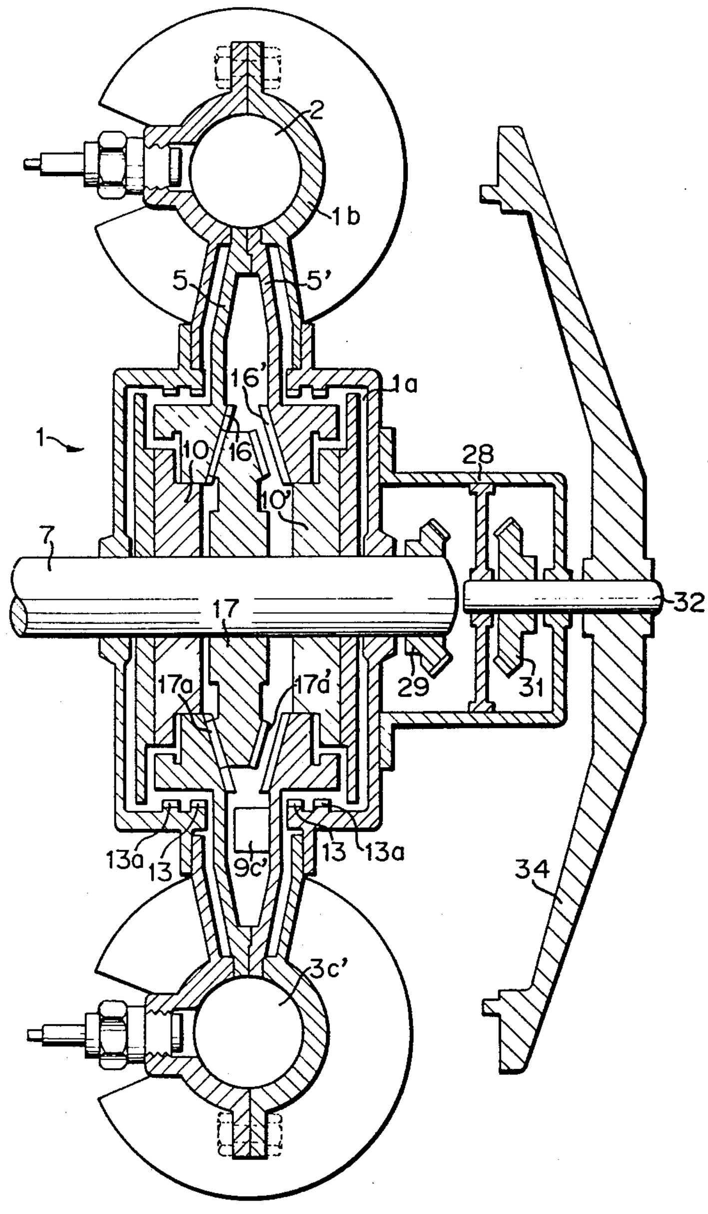

III
2
1b
24
22
6
23
21
27 26 26a
27 25 25a
5
5'
1
13a 13
16
16'
13 13a
5a
5a'
17a'
17a
17
10b
10b'
10a
10a'
28
29
34
7
8
10
37
10'
8'
32
31
30
33
10d
9b'
10d'
3b'
25a 35
36
26a
III

FIG. 2



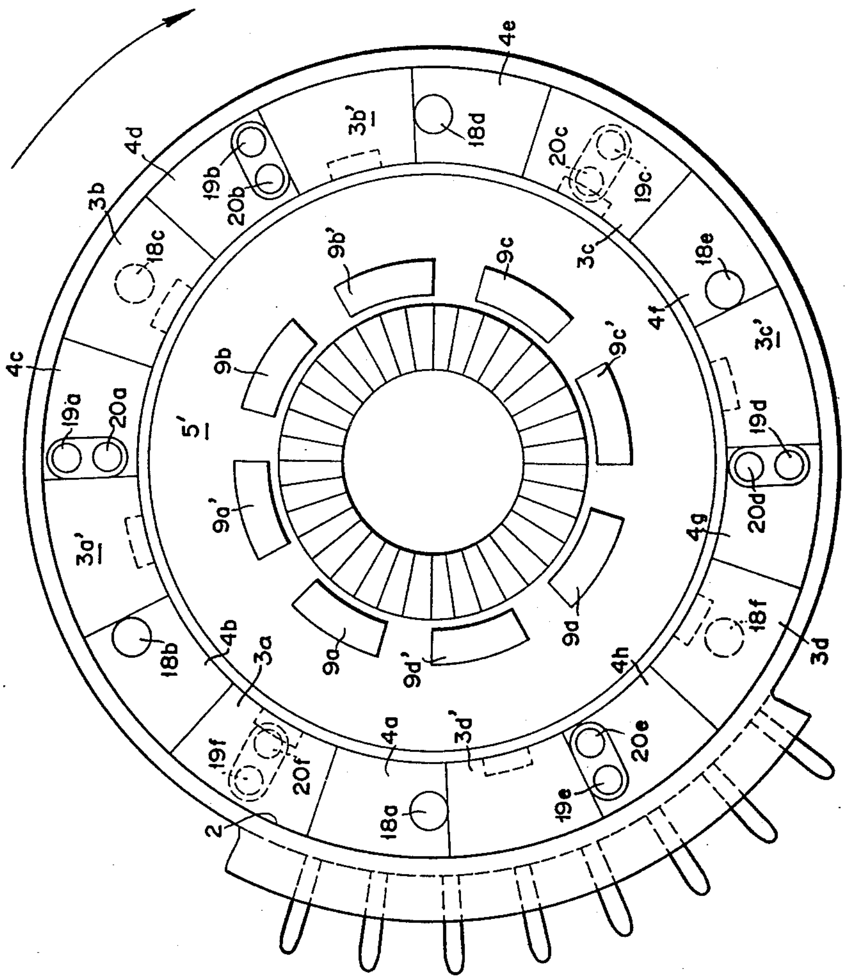

4e
4d
3b
3b'
18d
20c
19c
19b
20b
18c
3c
18e
9b'
9c
4c
4f
3c'
9b
9c'
19a
20a
5'
19d
20d
9a'
3a'
4g
18b
4b
3a
9a
18f
3d
9a
9d'
4h
19f
20f
4a
3d'
20e
2
18a
19e

FIG. 3

FIG. 4

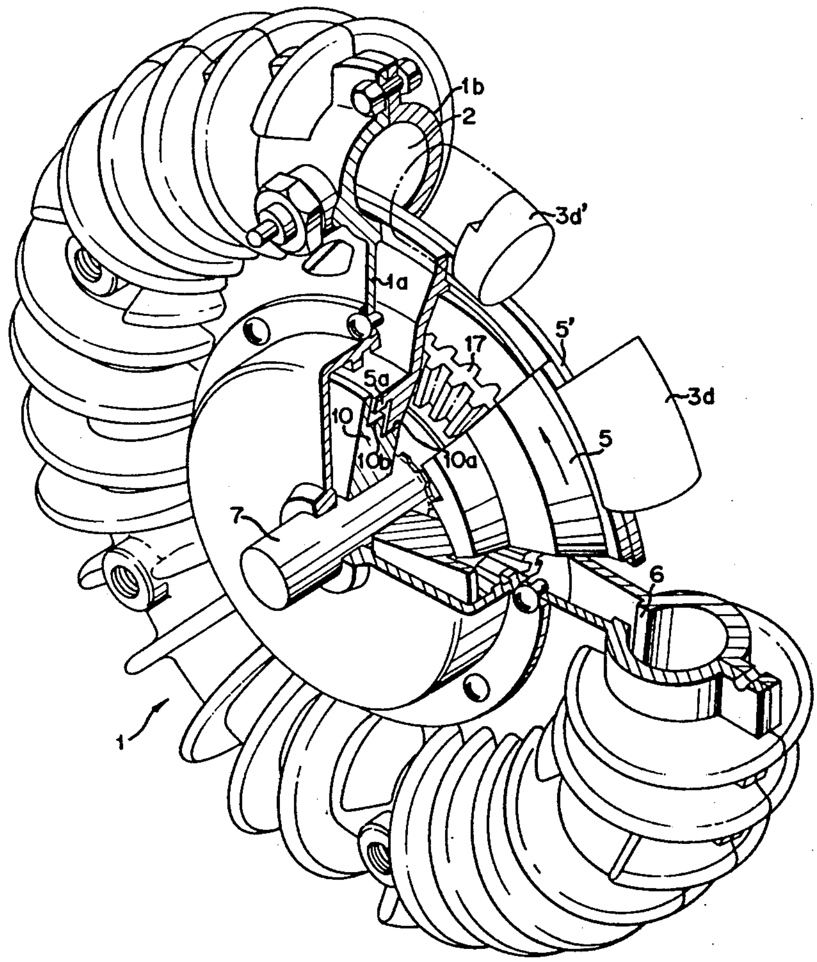
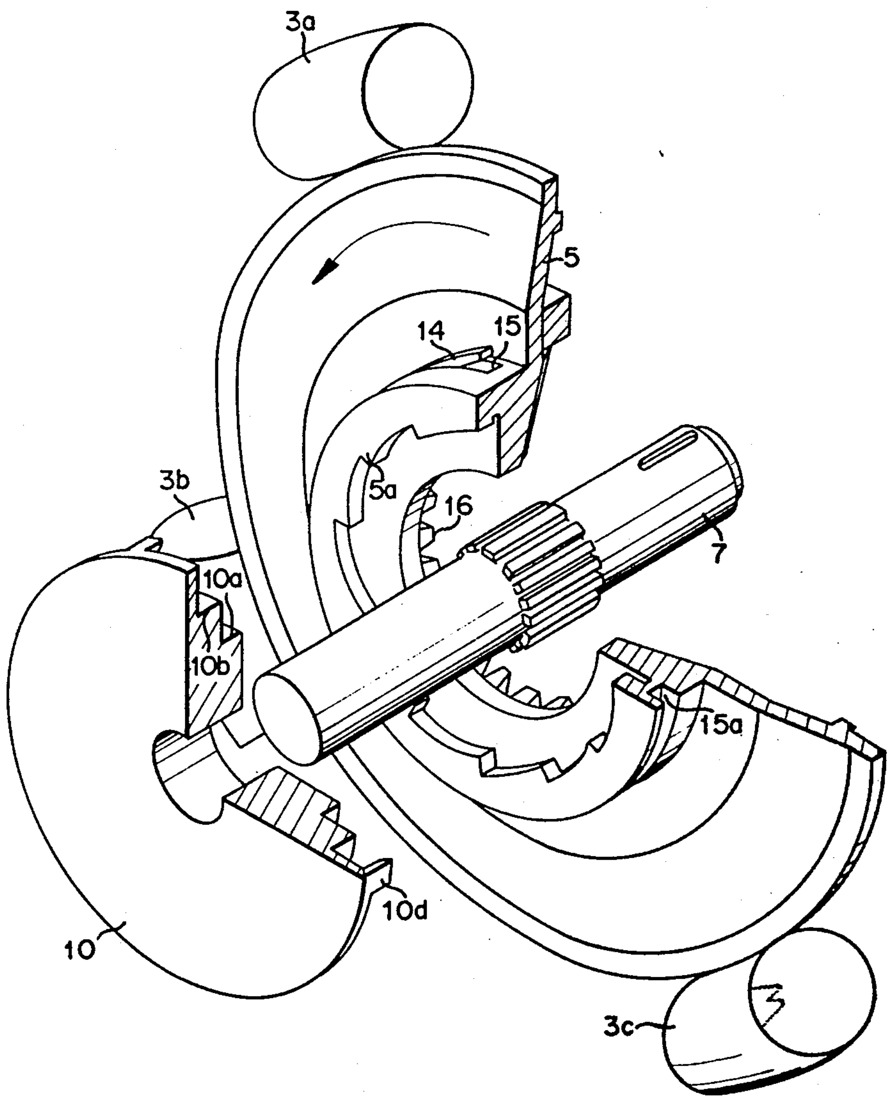


FIG. 5a



F I G. 5b

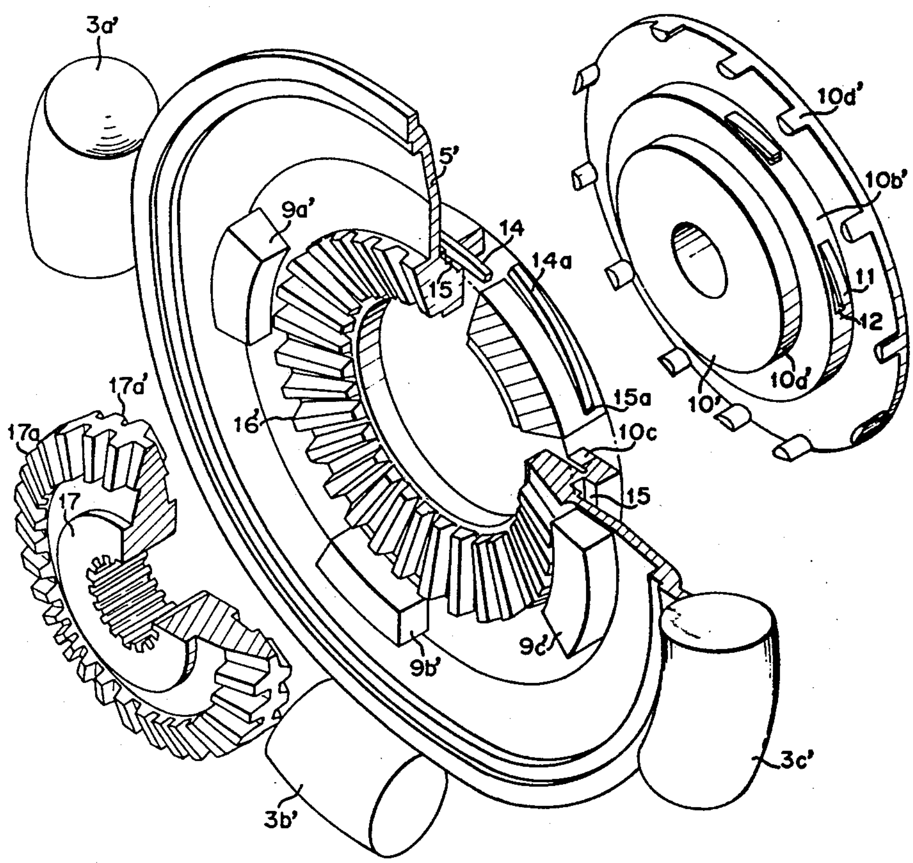

3a'
5'
9a'
14
14a
15
10d'
10b'
11
12
10d'
10'
15a
10c
15
16'
17a'
17a
17
9b'
9c'
3b'
3c'

FIG. 6

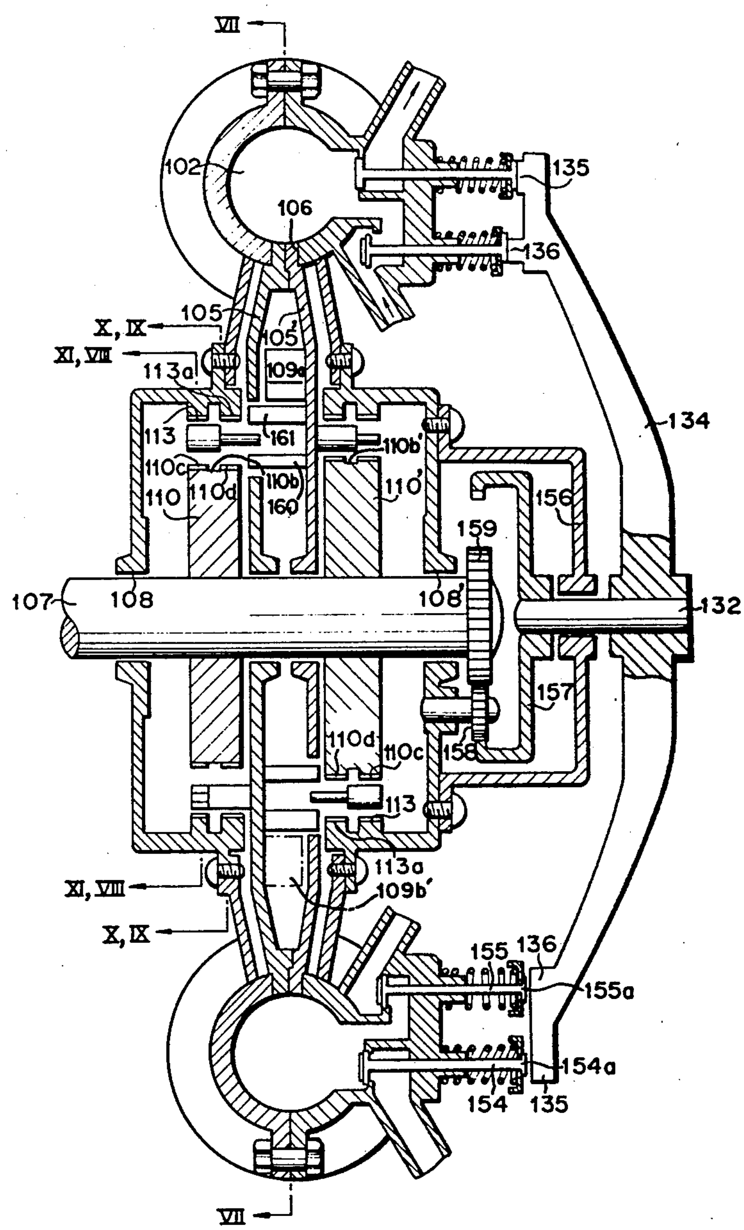

VII
102
106
135
136
105
X, IX
105'
XI, VIII
109a
113a
113
161
110b'
110c
110b
110
110d
160
110'
134
156
159
107
108
108'
132
157
110d
110c
158
113
113a
XI, VIII
109b'
X, IX
155
136
155a
154a
154
135
VII

FIG. 7

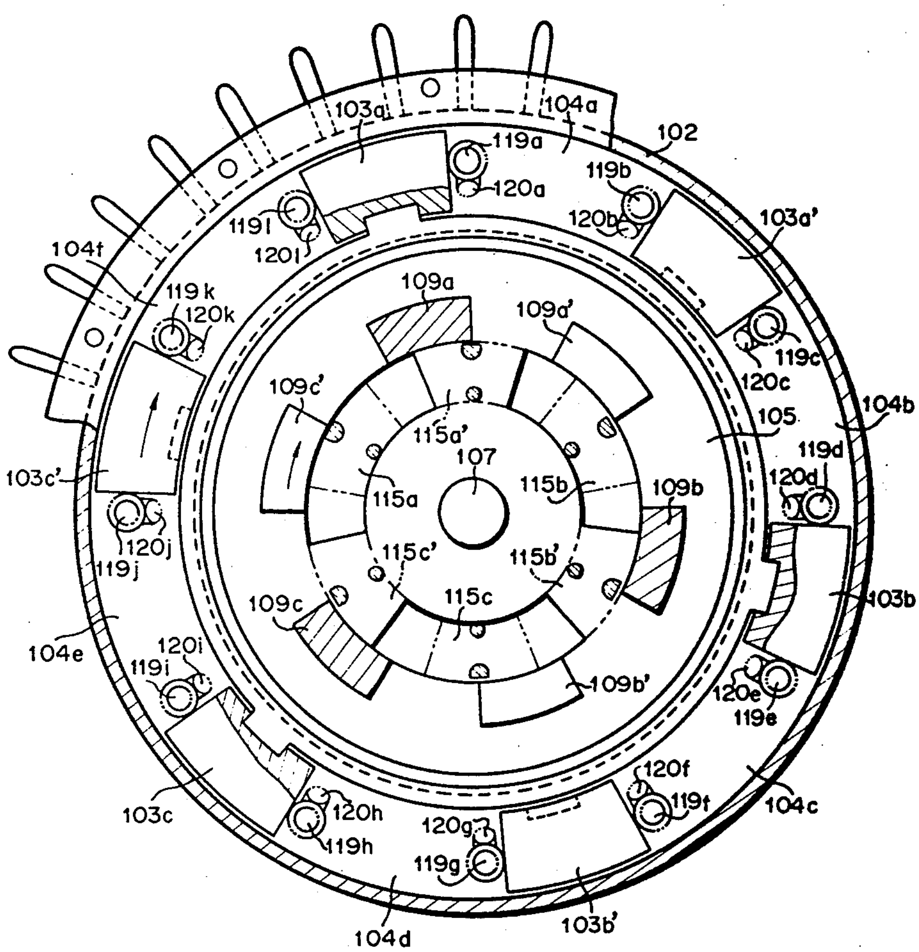

103a
104a
102
119a
120a
119b
119l
120b
103a'
120l
104f
109a
119k
120k
109a'
119c
120c
109c'
104b
115a'
105
107
119d
103c'
115b
120d
115a
109b
120j
119j
115c'
115b'
115c
103b
109c
104e
120i
119i
109b'
120e
119e
120f
104c
103c
120h
119f
120g
119h
119g
104d
103b'

FIG. 8

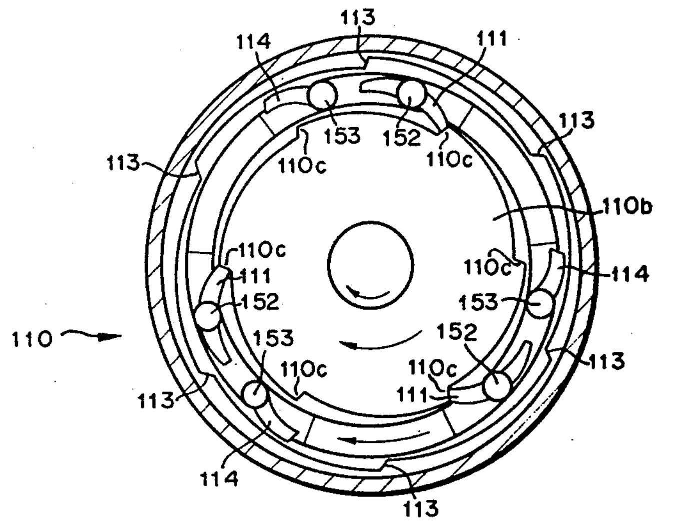

113
114
111
153
152
113
113
110c
110c
110b
110c
111
152
110c
114
153
110
153
152
113
110c
110c
111
113
114
113

FIG. 9

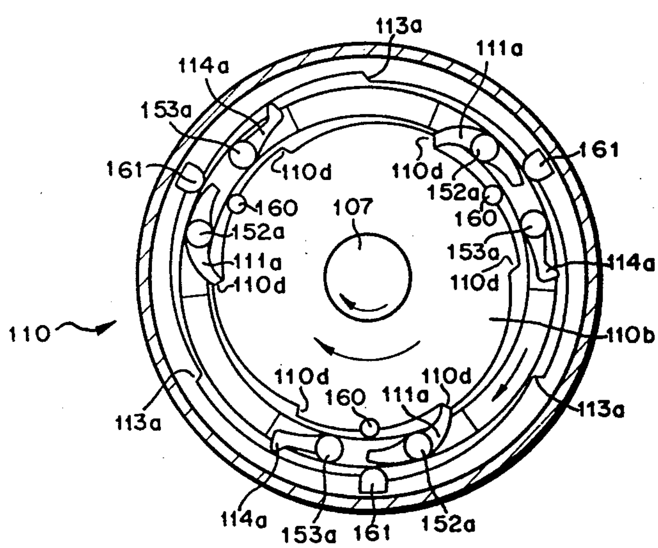

113a
114a
111a
153a
161
161
110d
110d
152a
160
107
160
152a
153a
111a
110d
110d
114a
110
110b
110d
110d
160
111a
113a
113a
114a
153a
161
152a

FIG. 10

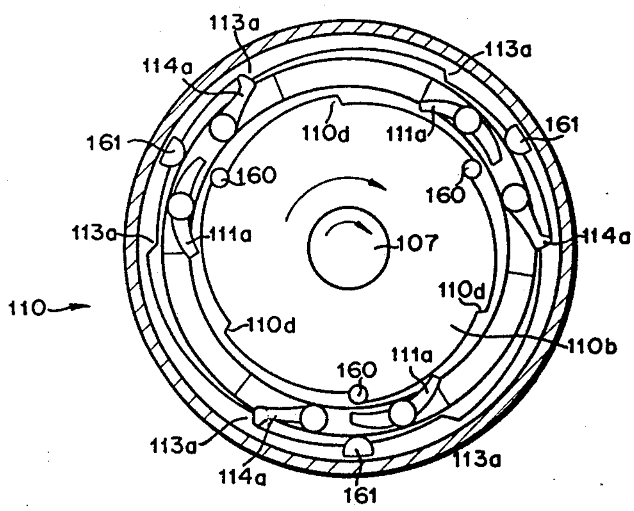
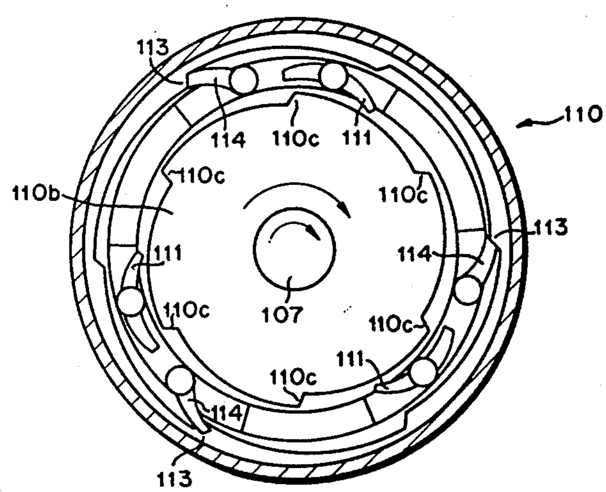

113a
113a
114a
161
111a
110d
161
160
160
113a
111a
107
114a
110d
110
110d
110b
160
111a
113a
114a
113a
161

FIG. 11


113
110
114
110c
111
110c
110b
110c
111
114
113
110c
107
110c
111
110c
114
113

ENGINE WITH AN ANNULAR CHAMBER

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 gases 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.

FIGS. 1 to 5 indicate an ignition combustion gasoline engine embodying this invention. The engine comprises an engine body or housing 1 having a central circular hollow portion *1a*, and an endless tubular portion *1b* 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* *3a'*, *3b'*, *3c'* and *3d'*) in such a manner that the runners *3a*, *3b*, *3c* and *3d* of one group are alternately arranged with those *3a'*, *3b'*, *3c'* and *3d'* 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 *1a* which communicates with the annular chamber 2 through an annular slot 6 formed in the inside peripheral portion of the tubular portion *1b*. The peripheral portion of the rotor members 5 and 5' slidably 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 *9a'*-*9b'*-*9c'*-*9d'*. 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 coaxial 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 *10a'*, and stop portions *10b* and *10b'* respectively. The bearing portions *10a* and *10a'* rotatably bear the bosses of the rotor members 5 and 5'. The bosses of the rotor members have inner stepped portions *5a* and *5a'* facing the stop portions *10b* and *10b'* respectively and each having circularly arranged ratchet teeth *10c* engageable in a clockwise direction, in which the runner advances as shown in FIG. *5b*, with pawls 11 which are pivotably disposed in grooves 12 formed on the periphery of the stop portions *10b* (*10b'*).

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 13 and *13a*. The ratchet teeth 13 are engageable in an anticlockwise direction, namely, opposite to that in which the runner advances, with pawls 14 pivotably disposed in grooves 15 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 pawls *14a* pivotably 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 *10d'*, which are used in such a manner that the pawls *14a* 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 pawls *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 ignition plug by half 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 projecting out of the housing 1 and having at the outer ends guide heads **25***a* and **26***a* 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** journaled 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** journaled with the side portion 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 **25***a* and **26***a* 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 **3***a*, **3***b*, **3***c* and **3***d*, together with the corresponding rotor member **5**, make a first one-twelfth revolution due to the explosion of compressed gases in the areas **4***a* and **4***e* caused by the energized ignition plugs **18***a* and **18***d*, the gas filled in the areas **4***b* and **4***f* is compressed by the advancing movement of the runners **3***a* and **3***c*. Simultaneously, the poppet valves **23** provided in the intake ports **19***a* and **19***d*, though the valves of the other intake ports are closed, are opened so as to allow fresh gas to be sucked in due to the expansion of the areas **4***c* and **4***g* caused by the advancing movement of the runners **3***b* and **3***d*. On the other hand the poppet valves **24** positioned in the exhaust ports **20***b* and **20***e*, though the valves of the other exhaust ports are closed, are opened so as to allow waste gas to be expelled therethrough due to the shrinkage of the areas **4***d* and **4***h* caused by the advancing movement of the runners **3***b* and **3***d*.

Next, when a second group of runners **3***a'*, **3***b'*, **3***c'* and **3***d'*, together with the corresponding rotor member **5'**, 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 to the preceding ones in the direction in which the runners peripherally advance. Namely, when the runners **3***a'*, **3***b'*, **3***c'* and **3***d'* make a one-twelfth revolution due to the explosion of compressed gases in the areas **4***b* and **4***f* caused by the energized ignition plugs **18***b* and **18***e*, the gas filled in the areas **4***c* and **4***g* respectively is compressed by the advancing movement of the runners **3***a'* and **3***c'*. Simultaneously, the poppet valves **23** provided in the intake ports **19***b* and **19***e* are opened so as to allow fresh gas to be sucked in due to the expansion of the areas **4***d* and **4***h* caused by the advancing movement of the runners **3***b'* and **3***d'*, and the poppet valves **24** positioned in the exhaust ports **20***c* and **20***f* are opened so as to allow waste gas to be expelled therethrough due to the shrinkage of the areas **4***e* and **4***a* caused by the advancing movement of the runners **3***b'* and **3***d'*.

When the first mentioned runners **3***a*, **3***b*, **3***c* and **3***d* 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 to the preceding ones. Consequently, the aforementioned two cycles of operation of the groups of runners are conducted alternately.

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

Similarly, when the runners **3***a'*, **3***b'*, **3***c'* and **3***d'* 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 **10***c* of the stop portion **10***b'* engaged with the pawls **11**. In this case, the rotor member **5** corresponding to the runners **3***a*, **3***b*, **3***c* and **3***d* is not urged by the ratchet teeth **10***c* of the stop portion **10***b* disengaged from the pawls **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 **13** of stopping portion corresponding to the group engaged with the pawls **14**.

And the stopped rotor member, together with the associated group of runners is simultaneously prevented from making an unnecessary run in a clockwise direction in FIG. 3, by the ratchet teeth **13***a* engaged with the pawls **14***a* until the preceding rotor member completes its movement.

Since the teeth **17***a* 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 **17***a* 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 **17***a* 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** as in the first 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 **103***a*, **103***b* and **103***c* (**103***a'*, **103***b'* and **103***c'*). The chamber **102** is divided into gas-actuated areas **104***a* to **104***f* 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 which communicates with the annular chamber **102** through a circular slot **106** formed inside of the periphery of the tubular 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 wall surfaces 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** journaled in bearings **108** and **108'** mounted on the side portions of the engine body. There are provided inertia imparting blocks divided into two groups represented by reference characters **109***a* – **109***b* – **109***c* and **109***a'* – **109***b'* – **109***c'*. 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 in the first mentioned embodiment.

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

On the inner periphery of the central hollow portion of the engine housing are circularly arranged ratchet teeth **113** and **113***a* so as to face the ratchet teeth **110***c* and **110***d* respectively. During the rotation of one of the rotor members **105** and **105'**, the pawls **111** are engageable with the ratchet teeth **110***c* as shown in FIG. **8** so as to transmit the advancing movement of the rotor member to the corresponding power transmitting member. The pawls **111***a* are engageable with the ratchet teeth **110***d* as shown in FIG. **9** so as to prevent the power transmitting member from making a clockwise run when braking is applied to the engine. According to the arrangement of the other rotor member which is stationary, pawls **114** 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 pawls **114***a* are engageable with the ratchet teeth **113***a* 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 **115***a*, **115***b* and **115***c* (**115***a'*, **115***b'* and **115***c'*). The pawls **111**, **111***a*, **114** and **114***a* are attached to pivots **152**, **152***a*, **153** and **153***a* which are rotatably secured to the rotor members **105** and **105'** in such a manner that the pivots **152***a* and **153***a* associated with one rotor member particularly project through the windows of the other rotor member. The pawls **111** and **111***a* swing themselves in such a manner that their ends are depressed on the surfaces of the ratchet teeth **110***c* and **110***d* respectively. The pawls **114** and **114***a* are urged by means of torsional springs (not shown) so as to be depressed on the surfaces of the ratchet teeth **113** and **113***a*.

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 pawls **111***a* associated with the rotor member which is about to stand at rest from the ratchet teeth **110***d*.

The rotor members **105** and **105'** comprise other disengaging members **161** which are so operated that, immediately before either of the rotor members **105** and **105'** stops rotation, the corresponding disengaging members release the pawls **114***a* associated with the rotor member which is stationary from the ratchet teeth **113***a*.

On one of the opposite inner walls of the annular chamber **102** are formed twelve pairs of intake ports **119***a* to **119***l*, and exhaust ports **120***a* to **120***l* equally spaced from each other on a circular locus defined by 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.

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 journaled in a gear casing **156** mounted on the end portion of the engine body.

The shaft **132** has an internal gear **157** intermeshing 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 **154***a* and **155***a* 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 **103***a*, **103***b* and **103***c*, together with the corresponding rotor member **105**, make a first one-sixth revolution due to the force of compressed gas or steam introduced into the areas **104***b*, **104***d* and **104***f* through the valves **154** provided in the intake ports **119***c*, **119***g* and **119***k*, then the areas **104***a*, **104***c* and **104***e* are shrunk by the advancing movement of the above-mentioned runners **103***a*, **103***b* and **103***c*. During the shrinkage of said areas **104***a*, **104***c* and **104***e*, the valves **155** provided in the exhaust ports **120***b*, **120***f* and **120***j* 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 **103***a'*, **103***b'* and **103***c'* together with the corresponding rotor member **105'**, make a starting e motion as a result of collision between the inertia imparting blocks **109***a*, **109***b*, and **109***c* and the blocks **109***a'*, **109***b'* and **109***c'*, and a one-sixth revolution due to the force of compressed gas or steam introduced into the areas **104***a*, **104***c* and **104***e* through the valves **154** provided in the intake ports **119***b*, **119***f* and **119***j*, then the areas **104***b*, **104***d* and **104***f* are shrunk by the advancing movement of the above-mentioned runners **103***a'*, **103***b'* and **103***c'*. During the shrinkage of said areas **104***b*, **104***d* and **104***f*, the valves **155** provided in the exhaust ports **120***a*, **120***e* and **120***i* are opened so as to expel waste steam to the atmosphere or into a reservoir (not shown).

When the first mentioned runners **103***a*, **103***b* and **103***c* 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 **103***a*, **103***b* and **103***c*, 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 **110***c* of the stop portion **110***b* engaged with the pawls **111**. In this case, the rotor member **105'** corresponding to the stopped runners **103***a'*, **103***b'* and **103***c'* is not urged forward, regardless of the rotation of the shaft **107** by the power transmitting member **110** which is forcedly urged by the rotor member **105**, because the ratchet teeth **110***c* of the stop portion **110***b'* are disengaged from the pawls **111** of the advancing member **110'** coupled with the shaft **107**.

Similarly, when the runners **103***a'*, **103***b'* and **103***c'*, 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 **110***c* of the stop portion **110***b'* engaged with the pawls **111**. In this case, the rotor member **105** corresponding to the runners **103***a*, **103***b* and **103***c* is not urged by the ratchet teeth **110***c* of the stop portion **110***b* disengaged from the pawls **111**.

When compressed steam is supplied to an operating area, the group of runners and rotor member which is stopped is prevented after start from making an anticlockwise movement shown in FIG. **11**, by engagement with pawls **114** of the ratchet teeth **113** of stop portion corresponding to said group.

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 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 **1** 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.

* * * * *

PO-1050
(5/69)

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