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(54) **AIR COMPRESSOR**

(71) Applicant: **UNIK WORLD INDUSTRIAL CO., LTD.**, Tainan City (TW)

(72) Inventors: **Wen San Chou**, Tainan City (TW); **Cheng Hsien Chou**, Tainan City (TW)

(73) Assignee: **UNIK WORLD INDUSTRIAL CO., LTD.**, Tainan City (TW)

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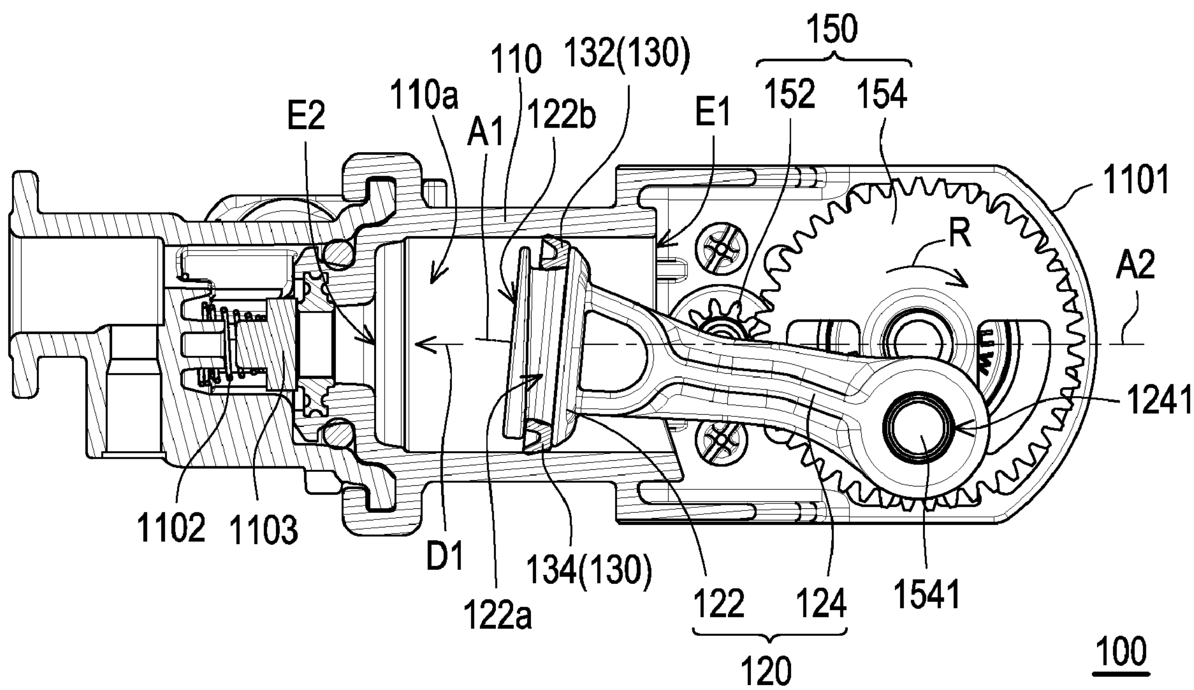
(57) **ABSTRACT**

An air compressor includes a cylinder having a piston passage having rear and front ends, a piston including piston and shaft portions, a piston ring, and a driving unit. The piston portion is in the piston passage and has an annular groove. The shaft and piston portions are connected via the rear end. The piston ring is at the annular groove. First and second portions of the piston ring are at first and second side portions of the piston portion respectively. The driving unit is coupled to the shaft portion and drives the piston portion to move back and forth between the front and rear ends via the shaft portion. A width of the annular groove at the first side portion is greater than that at the second side portion. The first portion moves along a width direction of the annular groove as the piston portion moves back and forth.



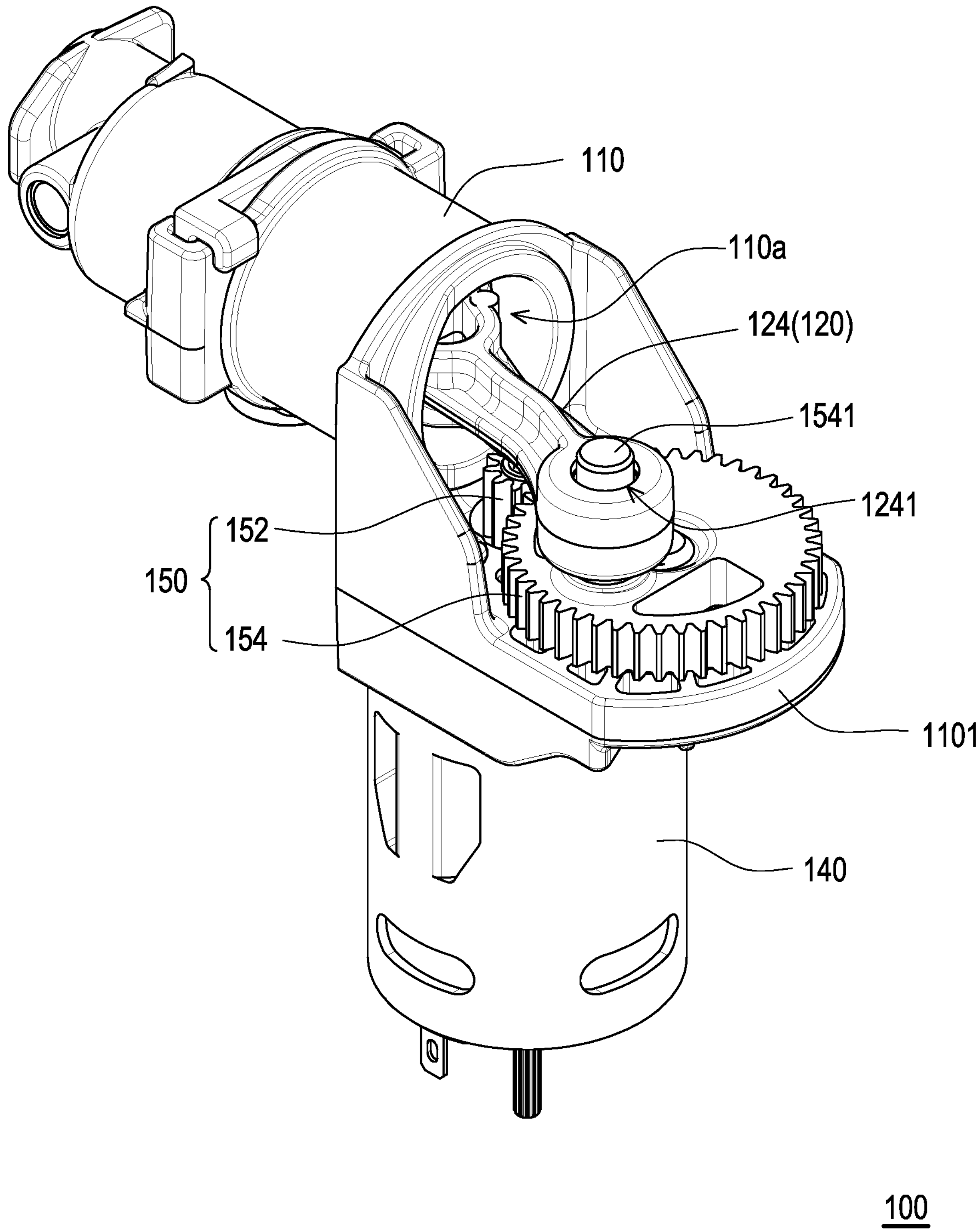



FIG. 1A

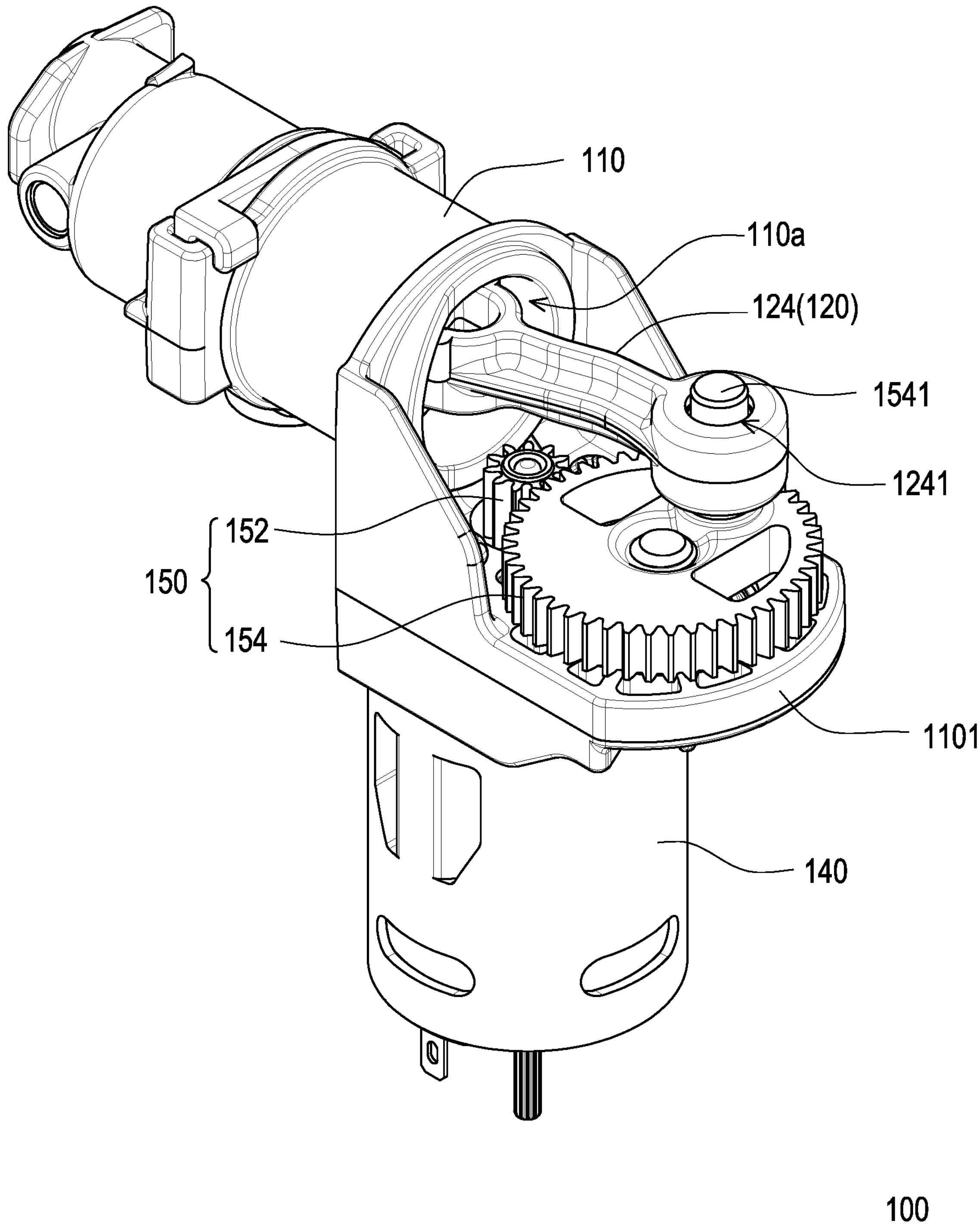



FIG. 1B

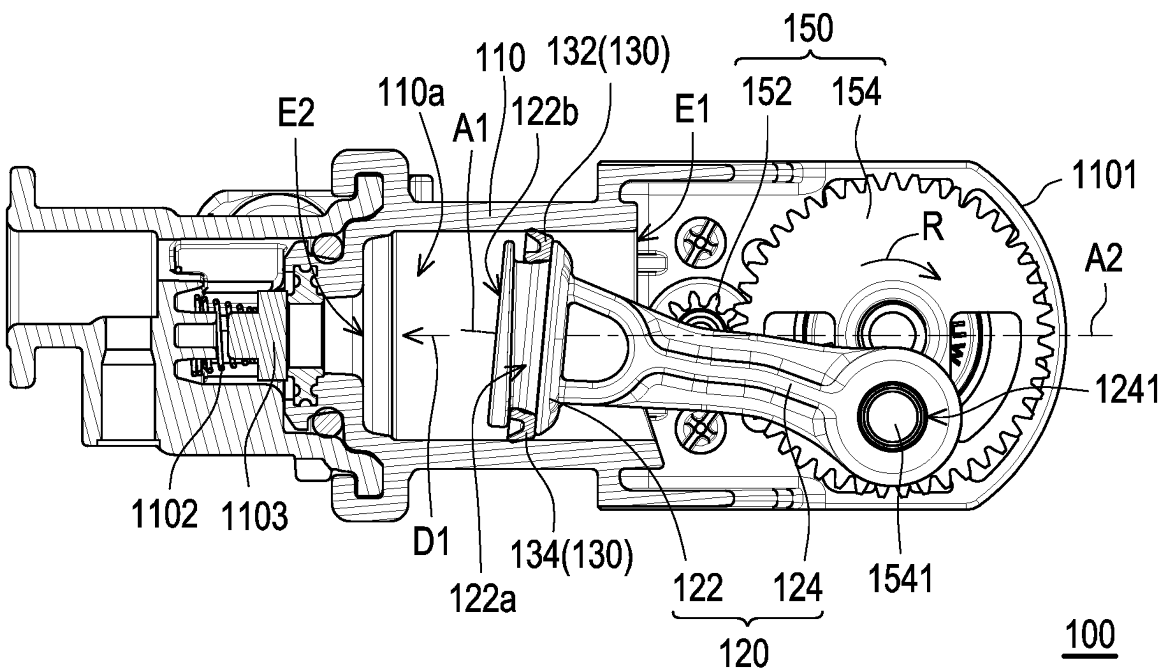

150
110
132(130)
152
154
110a
122b
E2
A1
E1
1101
R
A2
1241
1102
1103
D1
134(130)
122
124
1541
122a
120
100

FIG. 2A

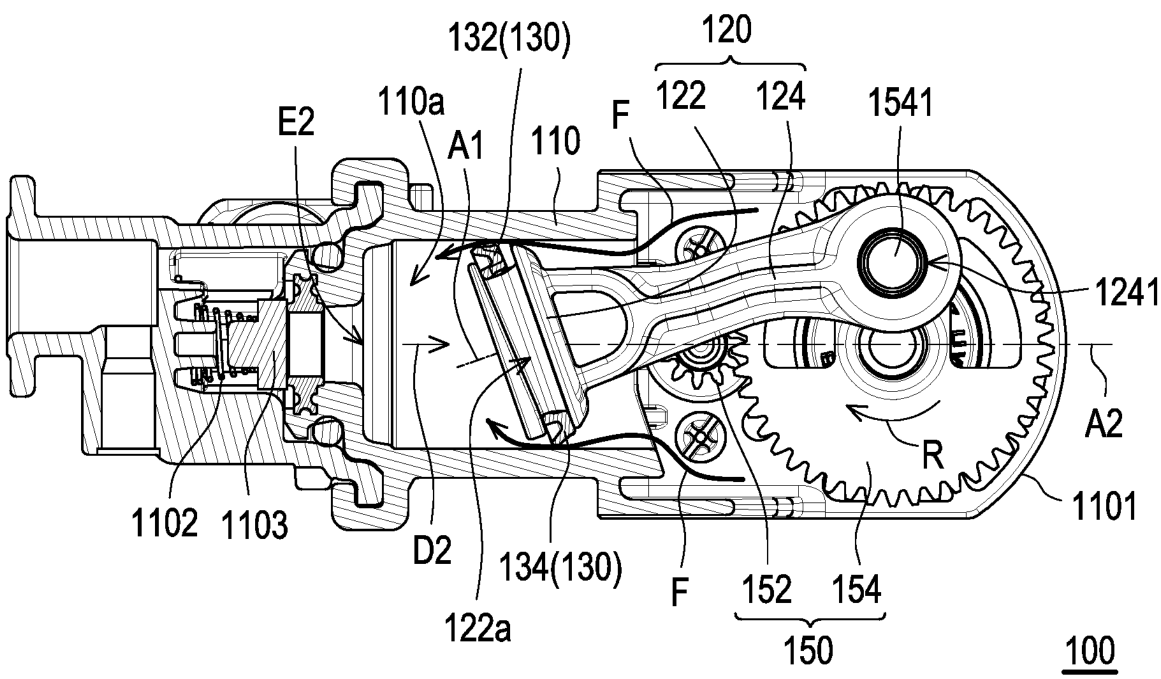

132(130)
120
110a
122
124
1541
E2
F
A1
110
1241
A2
R
1101
1102
1103
D2
134(130)
F
152
154
122a
150
100

FIG. 2B

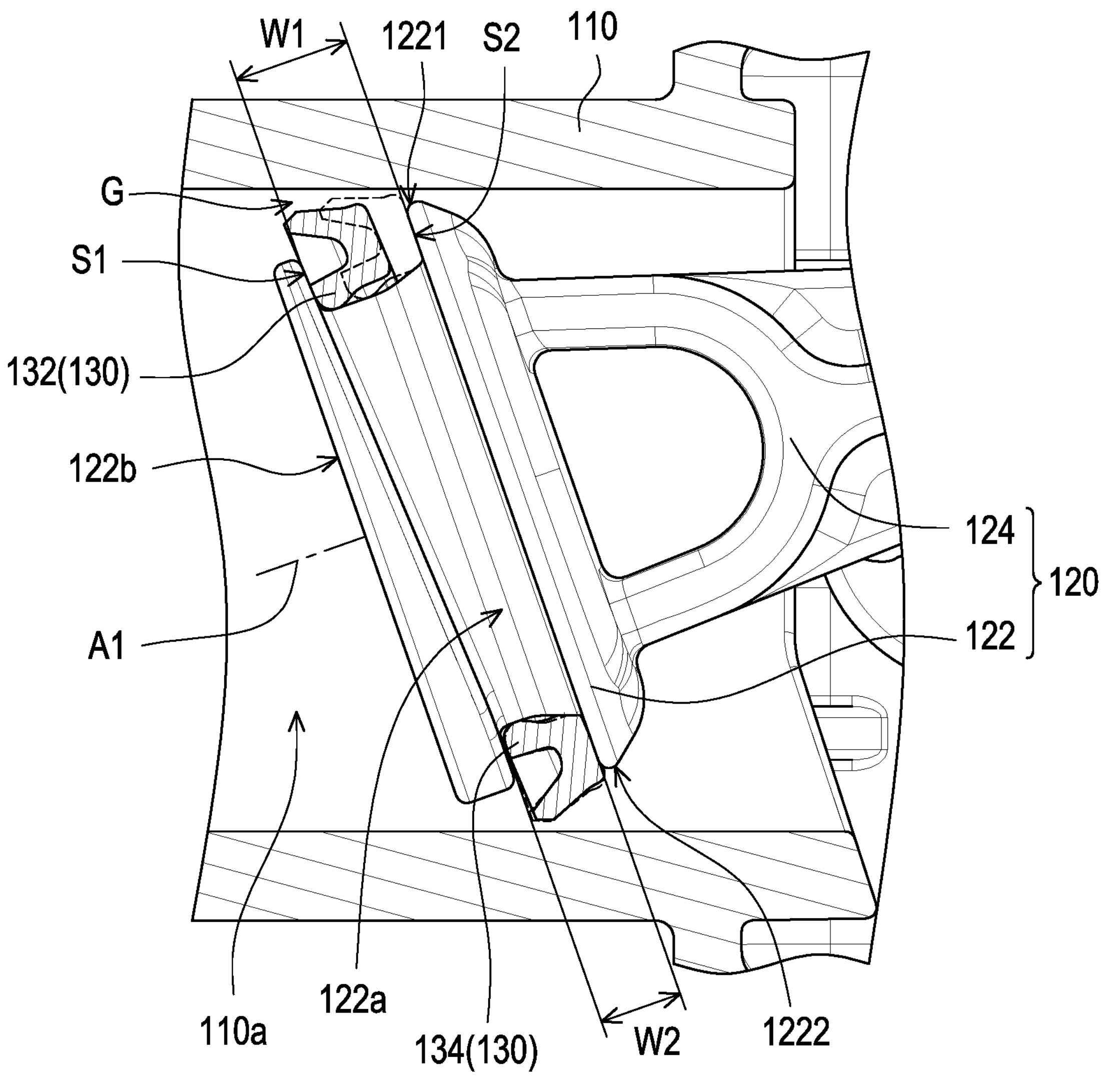
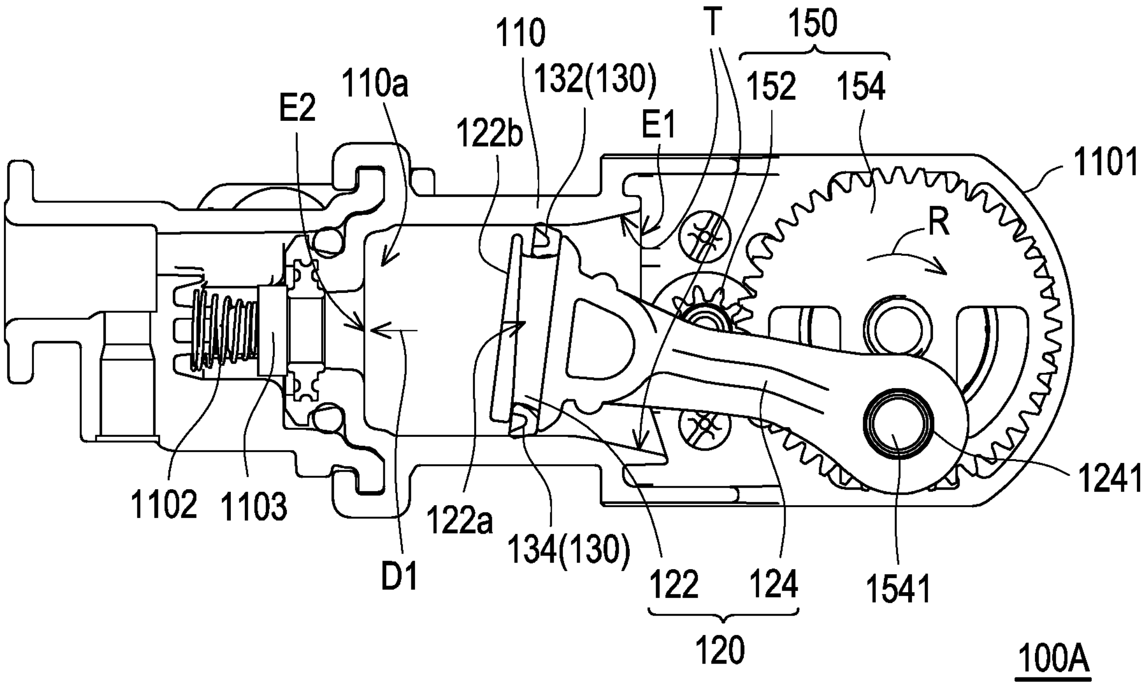

W1
1221
S2
110
G
S1
132(130)
122b
124
120
A1
122
110a
122a
134(130)
W2
1222

FIG. 3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T
150
110a
132(130)
152
154
E2
122b
E1
1101
R
1102
1103
122a
1241
134(130)
D1
122
124
1541
120
100A

FIG. 4A

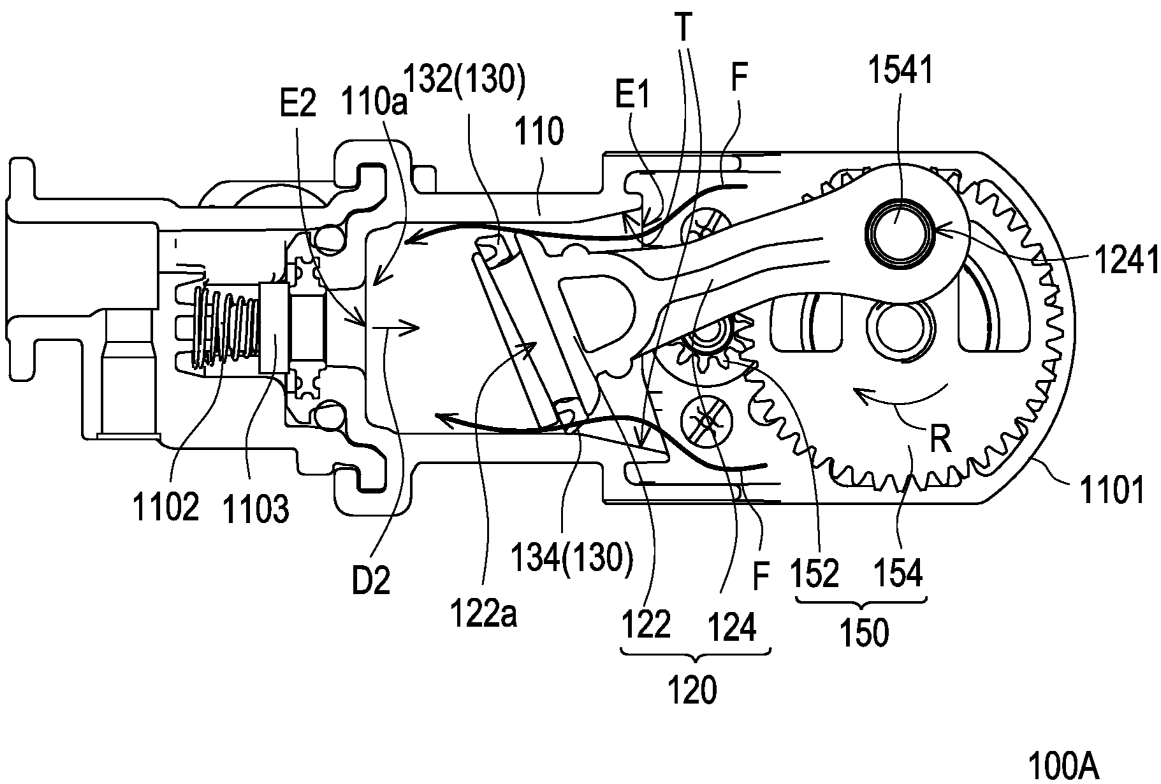

T
1541
E2
110a
132(130)
E1
F
110
1241
R
1101
1102
1103
134(130)
D2
F
122a
152
154
122
124
150
120
100A

FIG. 4B

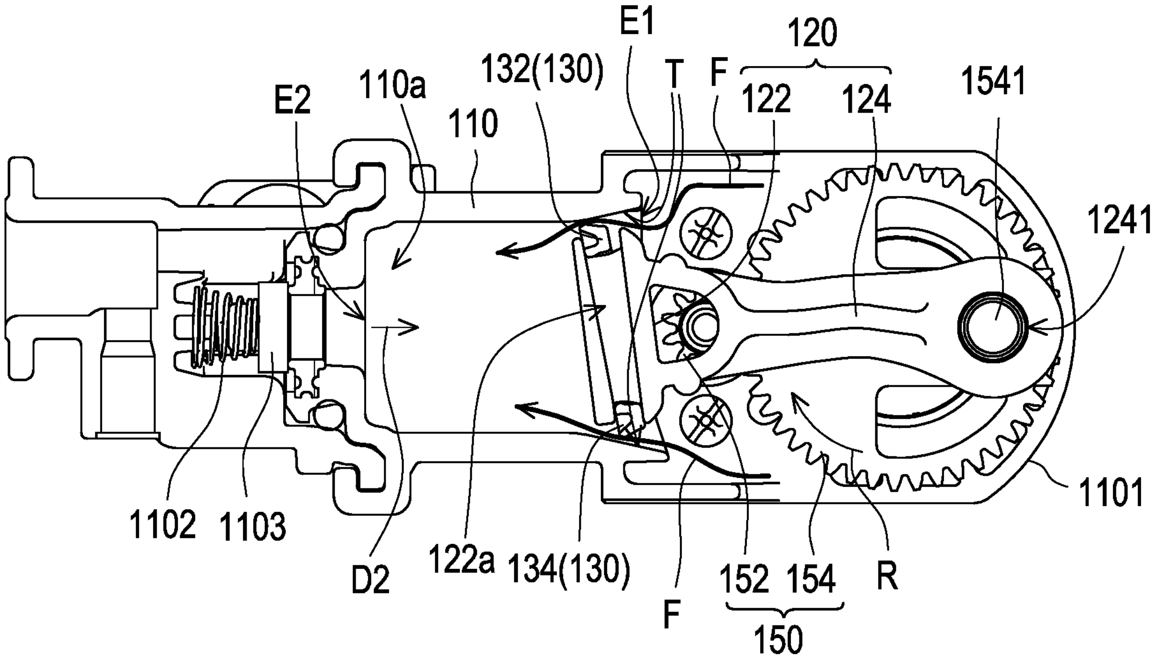
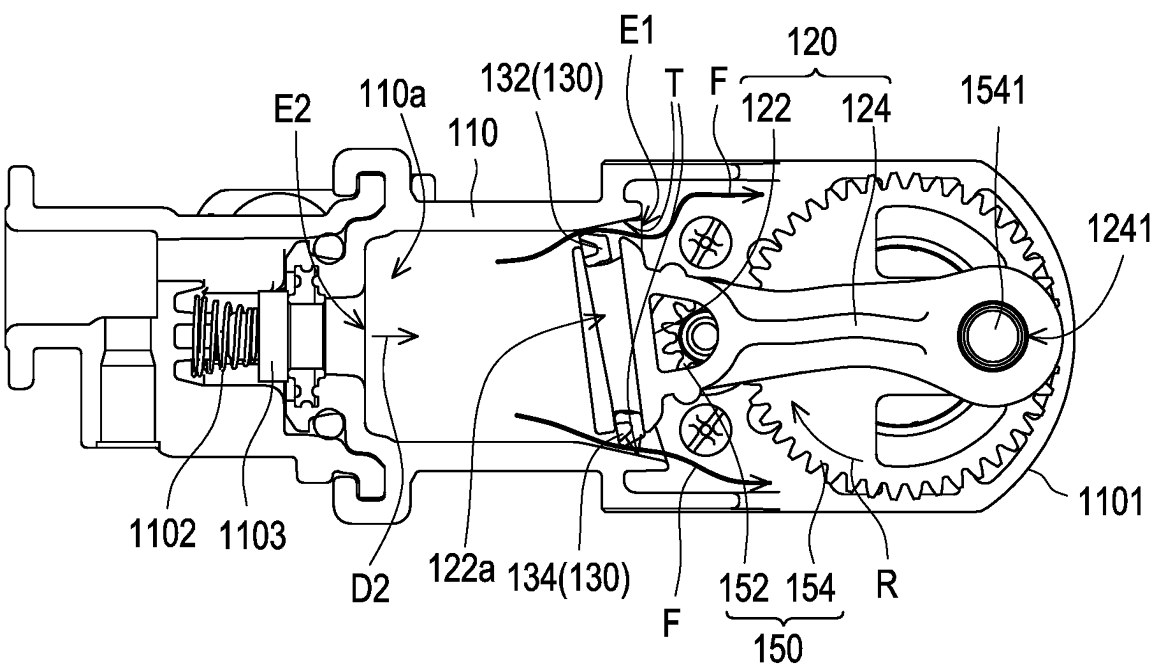

E1
120
132(130)
T
F
122
124
1541
E2
110a
110
1241
1101
1102
1103
D2
122a
134(130)
F
152
154
R
150

FIG. 4C


E1
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132(130)
T
F
122
124
1541
E2
110a
110
1241
1101
1102
1103
D2
122a
134(130)
F
152
154
R
150

FIG. 4D

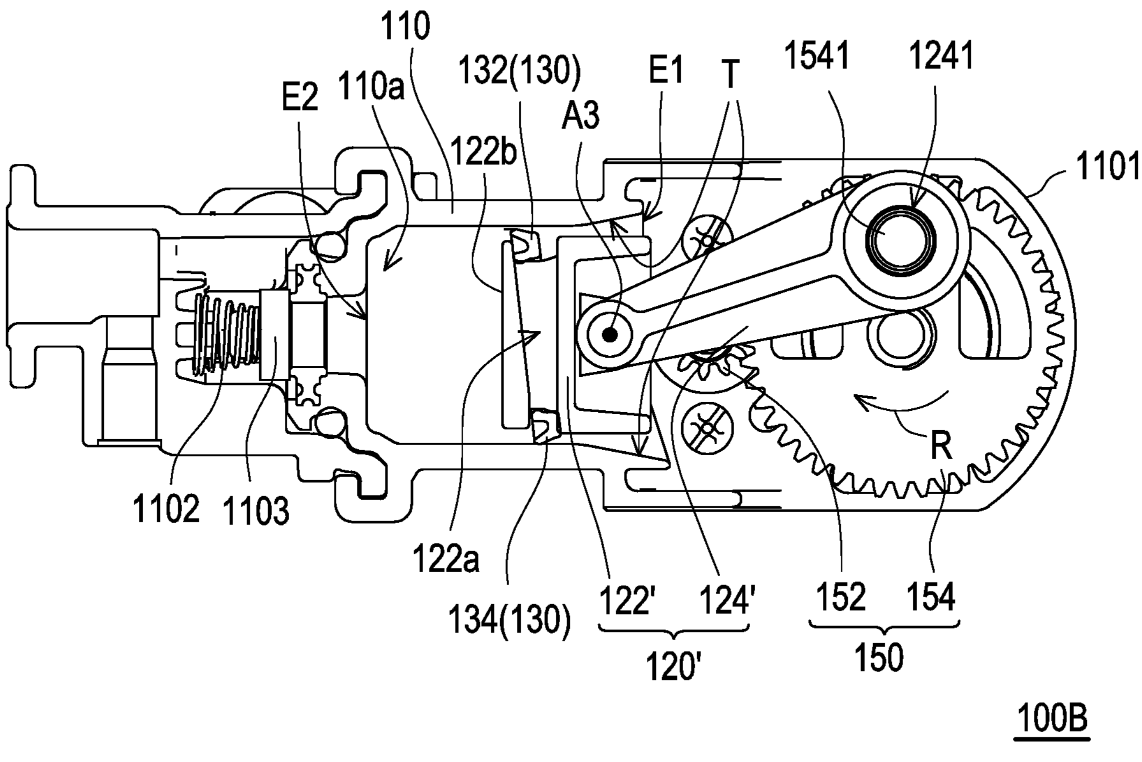
110
E2
110a
132(130)
122b
A3
E1
T
1541
1241
1101
R
1102
1103
122a
134(130)
122'
124'
120'
152
154
150
100B

FIG. 5

# AIR COMPRESSOR

## CROSS-REFERENCE TO RELATED APPLICATION

**[0001]** This application claims the priority benefit of Taiwan application serial no. 113106064, filed on Feb. 21, 2024. The entirety of the above-mentioned patent application is hereby incorporated by reference herein and made a part of specification.

## BACKGROUND OF THE INVENTION

### Field of the Invention

**[0002]** The invention relates to an air compressor, and in particular to a piston air compressor.

### Description of Related Art

**[0003]** A vehicle-mounted air compressor may be used with a tire sealant bottle to repair and inflate a tire of a vehicle, and may also be used to inflate the tire of the vehicle without a tire sealant bottle. The air compressor may be a piston air compressor. When the piston portion of the piston thereof advances in the cylinder, the piston ring around the piston portion is in contact with the inner wall of the cylinder and the space in the cylinder is gradually less as the piston portion advances. As a result, the air in the cylinder is compressed, and the check valve at the front end of the cylinder is pushed open by high-pressure air, so that the high-pressure air is output via the check valve. When the piston portion retreats in the cylinder, the space in the cylinder is gradually greater, causing the internal air pressure thereof to drop, and the piston portion is tilted due to the swing of the shaft portion of the piston, creating a gap between the piston ring and the inner wall of the cylinder. As a result, the air outside the cylinder is sucked into the cylinder from the rear end of the cylinder and compressed the next time the piston advances, thus creating a continuous cycle.

**[0004]** However, when the piston portion retreats in the cylinder as described above, the degree to which the piston portion is tilted due to the swing of the shaft portion is limited. Therefore, it is difficult to further increase the gap between the piston ring and the inner wall of the cylinder, and the air intake efficiency of the cylinder may not be improved.

## SUMMARY OF THE INVENTION

**[0005]** The invention provides an air compressor having good air intake efficiency.

**[0006]** An air compressor of the invention includes a cylinder, a piston, a piston ring, and a driving unit. The cylinder has a piston passage. The piston passage has a rear end and a front end opposite to each other. The piston includes a piston portion and a shaft portion. The piston portion is located in the piston passage and has an annular groove, and the shaft portion is connected to the piston portion via the rear end. The piston ring is disposed at the annular groove. A first portion of the piston ring is located at a first side portion of the piston portion, and a second portion of the piston ring is located at a second side portion of the piston portion. The driving unit is coupled to the shaft portion and adapted to drive the piston portion to move back and forth between the front end and the rear end via the shaft portion. A width of the annular groove at the first side portion is greater than a width of the annular groove at the second side portion, such that the first portion of the piston ring is movable along the width direction of the annular groove as the piston portion moves back and forth.

**[0007]** In an embodiment of the invention, when the piston portion moves along a direction from the front end toward the rear end, a gap between the first portion of the piston ring and an inner wall of the piston passage is increased as the first portion moves along the width direction of the annular groove.

**[0008]** In an embodiment of the invention, the shaft portion has an eccentric shaft portion and is coupled to the driving unit via the eccentric shaft portion, and when viewed along an axial direction of the eccentric shaft portion, the first side portion and the second side portion are radially opposite two side portions of the piston portion.

**[0009]** In an embodiment of the invention, when the piston portion moves along a direction from the front end toward the rear end, the eccentric shaft portion and the first side portion are located at a same side of a central axis of the piston passage.

**[0010]** In an embodiment of the invention, the annular groove has a first inner wall and a second inner wall, the first inner wall and the second inner wall are opposite to each other in the width direction of the annular groove, the first inner wall is located between the second inner wall and the front end, and a gap between the first portion of the piston ring and an inner wall of the piston passage is increased as the first portion moves from the second inner wall toward the first inner wall.

**[0011]** In an embodiment of the invention, a width of the annular groove is gradually increased from the second side portion toward the first side portion.

**[0012]** In an embodiment of the invention, the piston portion has a top surface, the top surface faces the front end, the annular groove has a first inner wall and a second inner wall, the first inner wall and the second inner wall are opposite to each other in the width direction of the annular groove, the first inner wall is located between the second inner wall and the front end, and the first inner wall is inclined to the top surface.

**[0013]** In an embodiment of the invention, the second portion of the piston ring is fixed to the annular groove.

**[0014]** In an embodiment of the invention, the first portion of the piston ring is adapted to move along the width direction of the annular groove via a friction force between an inner wall of the piston passage and the first portion.

**[0015]** In an embodiment of the invention, the first portion of the piston ring is adapted to move along the width direction of the annular groove via a pressure difference between the rear end and the front end.

**[0016]** In an embodiment of the invention, the piston passage has a slope at the rear end, so that an inner diameter of the piston passage at the rear end is gradually increased toward an outside of the piston passage.

**[0017]** In an embodiment of the invention, the piston portion and the shaft portion are pivotally connected to each other.

**[0018]** Based on the above, in the air compressor of the invention, the annular groove of the piston portion is designed to have unequal widths at two sides. Accordingly, the piston ring has a moving space where the annular groove has a greater width. When the piston portion retreats, the gap between the piston ring and the inner wall of the piston passage may be increased via the movement of the piston ring, thereby improving the air intake efficiency of the cylinder.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0019]** FIG. **1**A and FIG. **1**B respectively illustrate different operating states of an air compressor of an embodiment of the invention.

**[0020]** FIG. **2**A and FIG. **2**B are cross-sectional views of the air compressor of FIG. **1**A and FIG. **1**B respectively.

**[0021]** FIG. **3** is a partial enlarged view of the air compressor of FIG. **2**B.

**[0022]** FIG. **4**A to FIG. **4**D are respectively cross-sectional views of an air compressor in different operating states of another embodiment of the invention.

**[0023]** FIG. **5** is a cross-sectional view of an air compressor of another embodiment of the invention.

## DESCRIPTION OF THE EMBODIMENTS

**[0024]** FIG. **1**A and FIG. **1**B respectively illustrate different operating states of an air compressor of an embodiment of the invention. FIG. **2**A and FIG. **2**B are cross-sectional views of the air compressor of FIG. **1**A and FIG. **1**B respectively. Please refer to FIG. **1**A to FIG. **2**B. An air compressor **100** of the present embodiment is, for example, a vehicle-mounted air compressor used to provide high-pressure air needed for inflating and/or repairing a tire of a vehicle. However, the invention is not limited thereto. The air compressor **100** includes a cylinder **110**, a piston **120**, a piston ring **130**, and a driving unit **140**. The cylinder **110** has a piston passage **110***a*, and the piston passage **110***a* has a rear end E**1** and a front end E**2** opposite to each other. The piston **120** includes a piston portion **122** and a shaft portion **124**. The piston portion **122** is located in the piston passage **110***a* and has an annular groove **122***a*. The annular groove **122***a* surrounds a central axis A**1** of the piston portion **122**. The shaft portion **124** is connected to the piston portion **122** via the rear end E**2** of the piston passage **110***a*. The piston ring **130** is made of, for example, rubber or other elastic sealing materials and disposed at the annular groove **122***a* of the piston portion **122** and surrounds the central axis A**1** of the piston portion **122**.

**[0025]** The driving unit **140** is, for example, a motor, and is coupled to the shaft portion **124** of the piston **120**. Specifically, the air compressor **100** further includes a gear set **150**. The gear set **150** is disposed on an extended housing **1101** of the cylinder **110** and includes a first gear **152** and a second gear **154**. The first gear **152** is disposed coaxially with the driving unit **140** and meshes with the second gear **154**, and an eccentric shaft portion **1241** (for example, an axis hole) of the shaft portion **124** is eccentric to the center of the second gear **154** and pivotally connected to a column **1541** on the second gear **154** to achieve coupling between the driving unit **140** and the shaft portion **124**. Accordingly, the driving unit **140** may drive the eccentric shaft portion **1241** of the shaft portion **124** to move around the center of the second gear **154** via the gear set **150** to drive the piston portion **122** to move back and forth between the front end E**2** and the rear end E**1** of the piston passage **110***a* via the shaft portion **124**.

**[0026]** In the present embodiment, the second gear **154** is driven via the driving unit **140** to rotate along a rotation direction R shown in FIG. **2**A and FIG. **2**B. As a result, in the operating state shown in FIG. **2**A, the piston portion **122** of the piston **120** advances in the piston passage **110***a* of the cylinder **110** along a direction D**1** toward the front end E**2** of the piston passage **110***a*, and the piston ring **130** around the piston portion **122** is in contact with the inner wall of the piston passage **110***a* and the space in the piston passage **110***a* is gradually less as the piston portion **130** advances, so that the air in the piston passage **110***a* is compressed. When the air pressure in the piston passage **110***a* is increased sufficiently as the piston portion **122** advances, high-pressure air resists the elastic force of a check spring **1102** to push the check valve **1103** at the front end of the cylinder **110** open along the direction D**1**, so that the high-pressure air is output via the check valve **1103**.

**[0027]** On the other hand, in the actuation state shown in FIG. **2**B, the piston portion **122** of the piston **120** retreats in the piston passage **110***a* of the cylinder **110** along a direction D**2** toward the rear end E**1** of the piston passage **110***a*, the space in the piston passage **110***a* is gradually greater so that the internal air pressure thereof is dropped below one atmosphere (i.e., lower than the air pressure of the external environment), and the piston portion **122** is tilted via the swing of the shaft portion **124** of the piston **120** to create a gap between the piston ring **130** and the inner wall of the piston passage **110***a*. Therefore, an air F outside the cylinder **110** is sucked into the piston passage **110***a* from the rear end E**1** of the piston passage **110***a* and compressed the next time the piston portion **122** advances, thereby continuously circulating.

**[0028]** FIG. **3** is a partial enlarged view of the air compressor of FIG. **2**B. Please refer to FIG. **3**, the piston portion **122** has a first side portion **1221** and a second side portion **1222**. When viewed along the axial direction of the eccentric shaft portion **1241** (shown in FIG. **2**B), the first side portion **1221** and the second side portion **1222** are radially opposite two side portions of the piston portion **122** shown in FIG. **3**. A first portion **132** of the piston ring **130** is located at the first side portion **1221** of the piston portion **122**, and a second portion **134** of the piston ring **130** is located at the second side portion **1222** of the piston portion **122**. A width W**1** of the annular groove **122***a* at the first side portion **1221** is greater than a width W**2** of the annular groove **122***a* at the second side portion **1221**, such that the first portion **132** of the piston ring **130** is movable along the width direction of the annular groove **122***a* as the piston portion **122** moves back and forth. The second portion **134** of the piston ring **130** is fixed to the annular groove **122***a*, for example.

**[0029]** As described above, in the air compressor **100** of the present embodiment, the annular groove **122***a* of the piston portion **122** is designed to have unequal widths at two sides. Accordingly, the piston ring **130** has a moving space where the annular groove **122***a* has a greater width. When the piston portion **122** retreats, a gap G between the piston ring **130** and the inner wall of the piston passage **110***a* may be increased via the movement of the piston ring **130**, thereby improving the air intake efficiency of the cylinder **110**.

**[0030]** The structure and operation of the air compressor **100** of the present embodiment are described more clearly below.

**[0031]** Please refer to FIG. **3**. Specifically, the annular groove **122***a* of the present embodiment has a first inner wall S**1** and a second inner wall S**2**, the first inner wall S**1** and the second inner wall S**2** are opposite to each other in the width direction of the annular groove **122***a*, and the first inner wall S**1** is located between the second inner wall S**2** and the front end E**2** (shown in FIG. **2**B) of the piston passage **110***a*, and the first portion **132** of the piston ring **130** may move between the first inner wall S**1** and the second inner wall S**2**. In addition, the piston portion **122** has a top surface **122***b*, the top surface **122***b* faces the front end E**2** of the piston passage **110***a*, and the central axis A**1** of the piston portion **122** is perpendicular to the top surface **122***b*. The second inner wall S**2** of the annular groove **122***a* is parallel to the top surface **122***b*, and the first inner wall S**1** of the annular groove **122***a* is inclined to the top surface **122***b*, so that the width of the annular groove **122***a* is gradually increased from the second side portion **1222** toward the first side portion **1221**, so that the annular groove **122***a* has a greater width W**1** at the first side portion **1221** as mentioned above.

**[0032]** When the piston portion moves along the direction D**2** from the front end E**2** toward the rear end E**1** of the piston passage **110***a*, the eccentric shaft portion **1241** of the shaft portion **124** and the first side portion **1221** of the piston portion **122** are located at the same side of a central axis A**2** of the piston passage **110***a*, so that the piston portion **122** becomes an inclined state shown in FIG. **2**B and FIG. **3**. As a result, when the piston portion **122** moves along the direction D**2**, the gap G between the first portion **132** of the piston ring **130** and the inner wall of the piston passage **110***a* is increased as the first portion **132** moves along the width direction of the annular groove **122***a* from the second inner wall S**2** toward the first inner wall S**1**.

**[0033]** In the present embodiment, the first portion **132** of the piston ring **130** may be driven via the air flow and/or via the friction force between the inner wall of the piston passage **110***a* and the first portion **132** to move from the second inner wall S**2** toward the first inner wall S**1** as mentioned above. Specifically, when the piston portion **122** moves along the direction D**2**, the pressure difference between the rear end E**2** and the front end E**1** of the piston passage **110***a* causes the air F to flow along the direction from the rear end E**2** to the front end E**1**. Therefore, the first portion **132** of the piston ring **130** may be driven by the air flow and move toward the first inner wall S**1** of the annular groove **122***a* along the width direction of the annular groove **122***a*. Moreover, during the process of the piston **120** operating from the state of FIG. **2**A to the state of FIG. **2**B, when the first portion **132** of the piston ring **130** is still in contact with the inner wall of the piston passage **110***a* and the piston portion **122** starts to move along the direction D**2**, the friction force between the inner wall of the piston passage **110***a* and the first portion **132** may drive the first portion **132** to move toward the first inner wall S**1** of the annular groove **122***a* along the width direction of the annular groove **122***a*.

**[0034]** FIG. **4**A to FIG. **4**D are respectively cross-sectional views of an air compressor in different operating states of another embodiment of the invention. An air compressor **100**A of FIG. **4**A to FIG. **4**D is different from the air compressor **100** of the previous embodiment in that: the piston passage **110***a* of the air compressor **100**A has a slope T at the rear end E**1**, so that the inner diameter of the piston passage **110***a* at the rear end E**1** is gradually increased toward the outside of the piston passage **110***a*. Accordingly, when the piston **120** moves along the direction D**2** to the state shown in FIG. **4**C, there is a gap between the slope T of the rear end E**1** and the piston ring **130** of the piston passage **110***a* to further improve the air intake efficiency of the cylinder **110**. In addition, the check valve **1103** at the front end of the cylinder **110** may be poorly sealed, causing the high-pressure air at the pneumatic equipment end to enter the cylinder **110** via the check valve **1103** to form a high pressure. The gap between the inclined surface T of the rear end E**1** of the piston passage **110***a* and the piston ring **130** may further discharge the high-pressure air out of the cylinder **110** as shown in FIG. **4**D. As a result, the piston **120**, the driving unit **140**, the gear set **150**, etc. may be prevented from being damaged due to the impact of high-pressure air in the cylinder **110** when the piston **120** advances along the direction D**1** next time. The remaining configurations and functions of the air compressor **100**A of FIG. **4**A to FIG. **4**D are the same as or similar to the air compressor **100** in the previous embodiment, and are not described again here.

**[0035]** FIG. **5** is a cross-sectional view of an air compressor of another embodiment of the invention. The difference between an air compressor **100**B of FIG. **5** and the air compressor **100**A of the previous embodiment is that: a piston portion **122'** and a shaft portion **124'** of a piston **120'** of the air compressor **100**B are pivotally connected to each other along a rotation axis A**3** and may be relatively rotated during the actuation process. The remaining configurations and functions of the air compressor **100**B of FIG. **5** are the same as or similar to the air compressor **100**A in the previous embodiment, and are not described again here.

**[0036]** Based on the above, in the air compressor of the invention, the annular groove of the piston portion is designed to have unequal widths at two sides. Accordingly, the piston ring has a moving space where the annular groove has a greater width. When the piston portion retreats, the gap between the piston ring and the inner wall of the piston passage may be increased via the movement of the piston ring, thereby improving the air intake efficiency of the cylinder. In addition, the piston passage may have a slope at the rear end, so that the inner diameter of the piston passage at the rear end is gradually increased toward the outside of the piston passage. Accordingly, when the piston portion actuates to the rear end of the piston passage, there is a gap between the slope at the rear end and the piston ring of the piston passage to further improve the air intake efficiency of the cylinder.

What is claimed is:

**1**. An air compressor, comprising:

a cylinder having a piston passage, wherein the piston passage has a rear end and a front end opposite to each other;

a piston comprising a piston portion and a shaft portion, wherein the piston portion is located in the piston passage and has an annular groove, and the shaft portion is connected to the piston portion via the rear end;

a piston ring disposed at the annular groove, wherein a first portion of the piston ring is located at a first side portion of the piston portion, and a second portion of the piston ring is located at a second side portion of the piston portion; and

a driving unit coupled to the shaft portion and adapted to drive the piston portion to move back and forth between the front end and the rear end via the shaft portion, wherein a width of the annular groove at the first side portion is greater than a width of the annular groove at the second side portion, such that the first portion of the piston ring is movable along the width direction of the annular groove as the piston portion moves back and forth.

**2**. The air compressor of claim **1**, wherein when the piston portion moves along a direction from the front end toward the rear end, a gap between the first portion of the piston ring and an inner wall of the piston passage is increased as the first portion moves along the width direction of the annular groove.

**3**. The air compressor of claim **1**, wherein the shaft portion has an eccentric shaft portion and is coupled to the driving unit via the eccentric shaft portion, and when viewed along an axial direction of the eccentric shaft portion, the first side portion and the second side portion are radially opposite two side portions of the piston portion.

**4**. The air compressor of claim **3**, wherein when the piston portion moves along a direction from the front end toward the rear end, the eccentric shaft portion and the first side portion are located at a same side of a central axis of the piston passage.

**5**. The air compressor of claim **1**, wherein the annular groove has a first inner wall and a second inner wall, the first inner wall and the second inner wall are opposite to each other in the width direction of the annular groove, the first inner wall is located between the second inner wall and the front end, and a gap between the first portion of the piston ring and an inner wall of the piston passage is increased as the first portion moves from the second inner wall toward the first inner wall.

**6**. The air compressor of claim **1**, wherein a width of the annular groove is gradually increased from the second side portion toward the first side portion.

**7**. The air compressor of claim **1**, wherein the piston portion has a top surface, the top surface faces the front end, the annular groove has a first inner wall and a second inner wall, the first inner wall and the second inner wall are opposite to each other in the width direction of the annular groove, the first inner wall is located between the second inner wall and the front end, and the first inner wall is inclined to the top surface.

**8**. The air compressor of claim **1**, wherein the second portion of the piston ring is fixed to the annular groove.

**9**. The air compressor of claim **1**, wherein the first portion of the piston ring is adapted to move along the width direction of the annular groove via a friction force between an inner wall of the piston passage and the first portion.

**10**. The air compressor of claim **1**, wherein the first portion of the piston ring is adapted to move along the width direction of the annular groove via a pressure difference between the rear end and the front end.

**11**. The air compressor of claim **1**, wherein the piston passage has a slope at the rear end, so that an inner diameter of the piston passage at the rear end is gradually increased toward an outside of the piston passage.

**12**. The air compressor of claim **1**, wherein the piston portion and the shaft portion are pivotally connected to each other.

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