US 20110138939A1

(19) **United States**

(12) **Patent Application Publication**

(10) **Pub. No.: US 2011/0138939 A1**

(43) **Pub. Date: Jun. 16, 2011**

Carr

(54) **FIXED MOMENT ARM COMBUSTION APPARATUS**

(76) Inventor: **William James Carr**, San Jose, CA (US)

(21) Appl. No.: **12/727,264**

(22) Filed: **Mar. 19, 2010**

Related U.S. Application Data

(60) Provisional application No. 61/285,544, filed on Dec. 11, 2009.

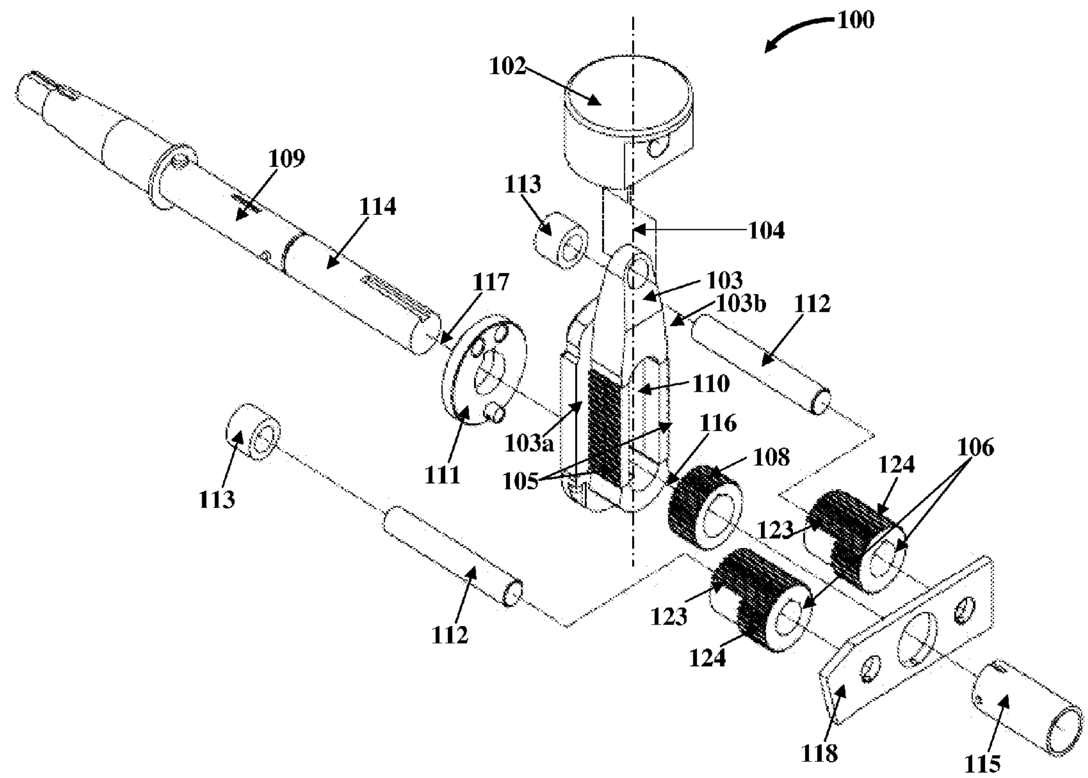
Publication Classification

(51) **Int. Cl.**
F16H 19/04 (2006.01)

(52) **U.S. Cl.** **74/32**

(57) **ABSTRACT**

An apparatus for converting linear reciprocal motion to rotary motion is provided. The apparatus comprises a reciprocating assembly comprising a reciprocating component and a reciprocating rod. The reciprocating component is rigidly attached to the reciprocating rod and is supported by a housing. The reciprocating rod is slidably connected to an idler gear via a guide pin. Multiple gear racks are disposed on the reciprocating rod for transmitting motion to one or more gearing elements. The gearing elements are disposed on opposing sides of the reciprocating rod and are in alternate mesh with the gear racks to transmit the motion to the idler gear. Each of the gearing elements and each of the gear racks together define a fixed moment arm. The gearing elements mesh with the idler gear rigidly mounted on a power shaft to convert linear reciprocal motion of the reciprocating assembly to rotary motion of the power shaft.



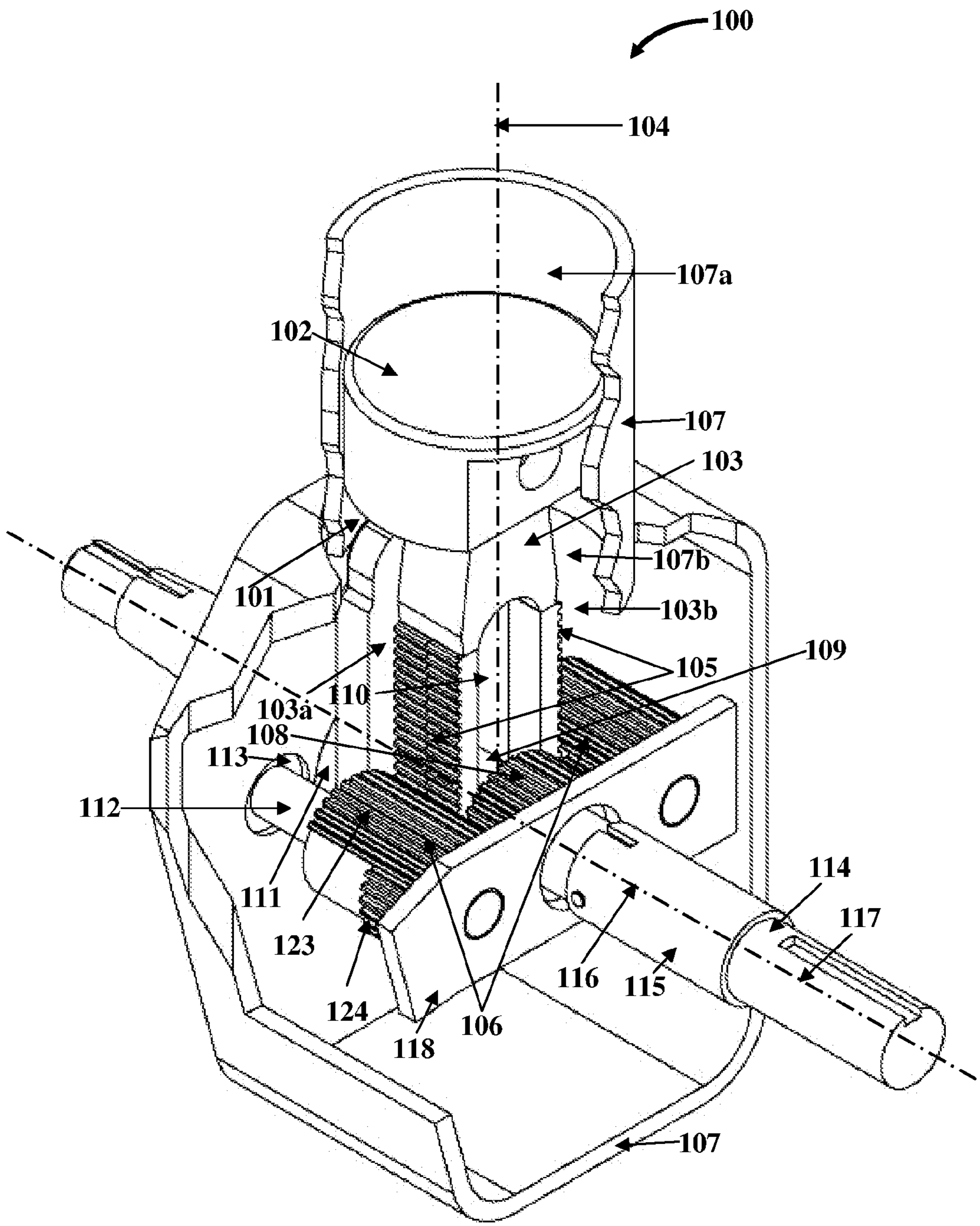

100
104
107a
102
107
103
101
107b
103b
105
109
103a
110
108
113
112
111
123
124
118
106
116
115
114
117
107

FIG. 1

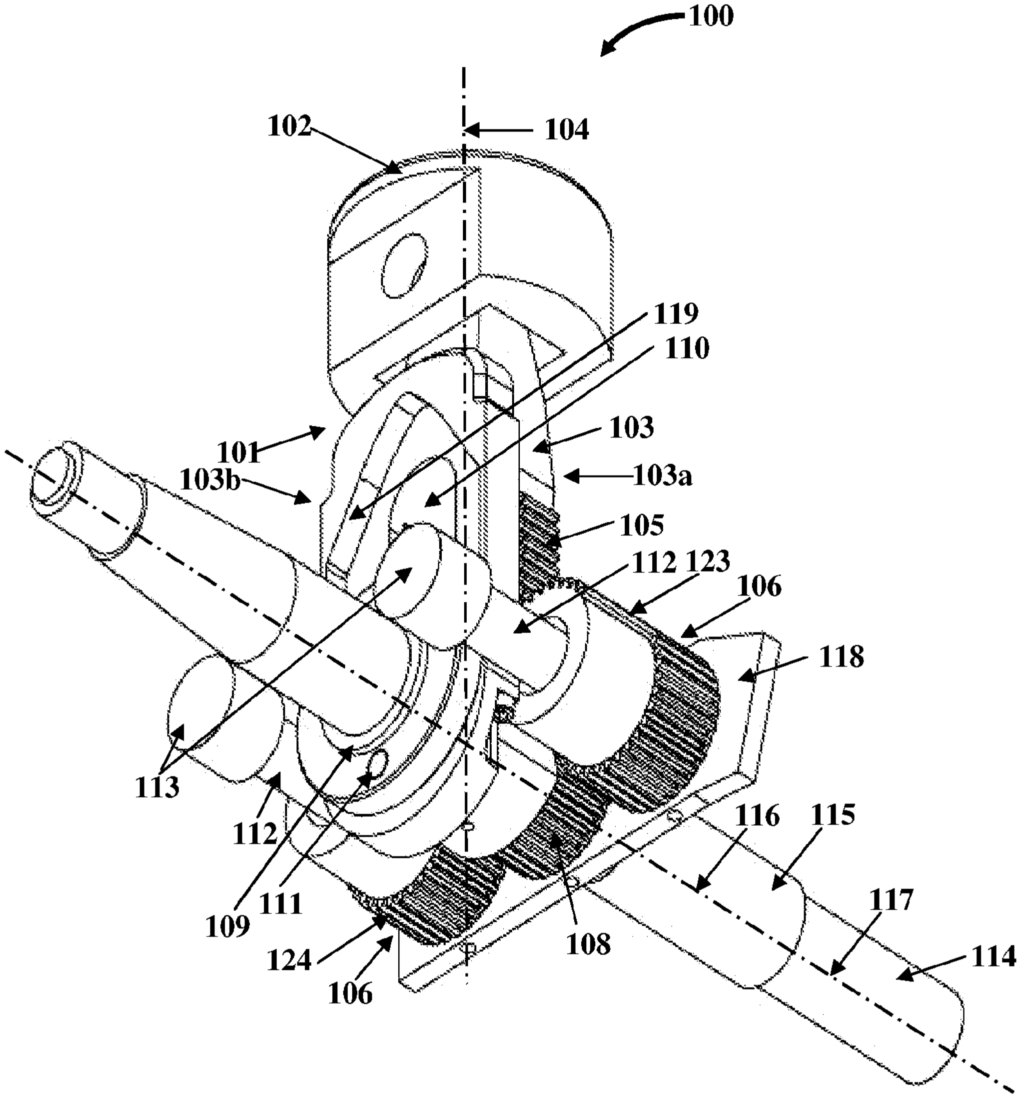

100
102
104
119
110
101
103
103b
103a
105
112 123
106
118
113
112
116
115
117
114
109
111
124
106
108

FIG. 2

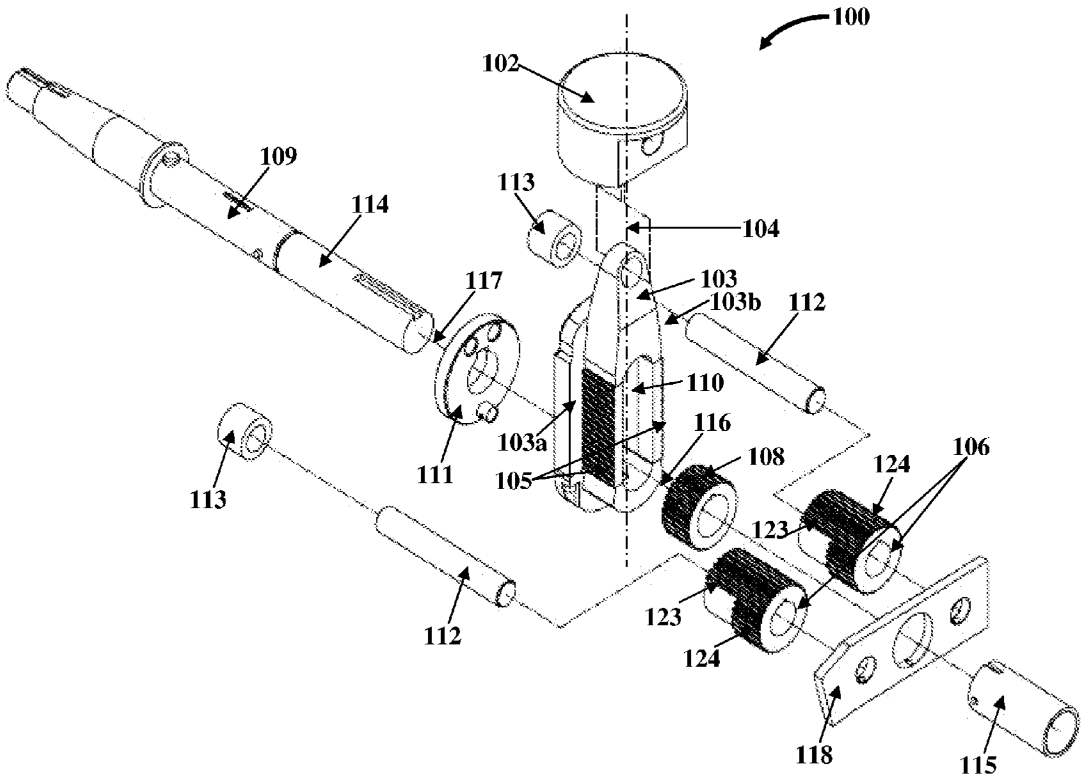

100
102
109
114
113
104
103
103b
112
117
110
111
103a
105
116
108
124
106
113
123
112
123
124
118
115

FIG. 3

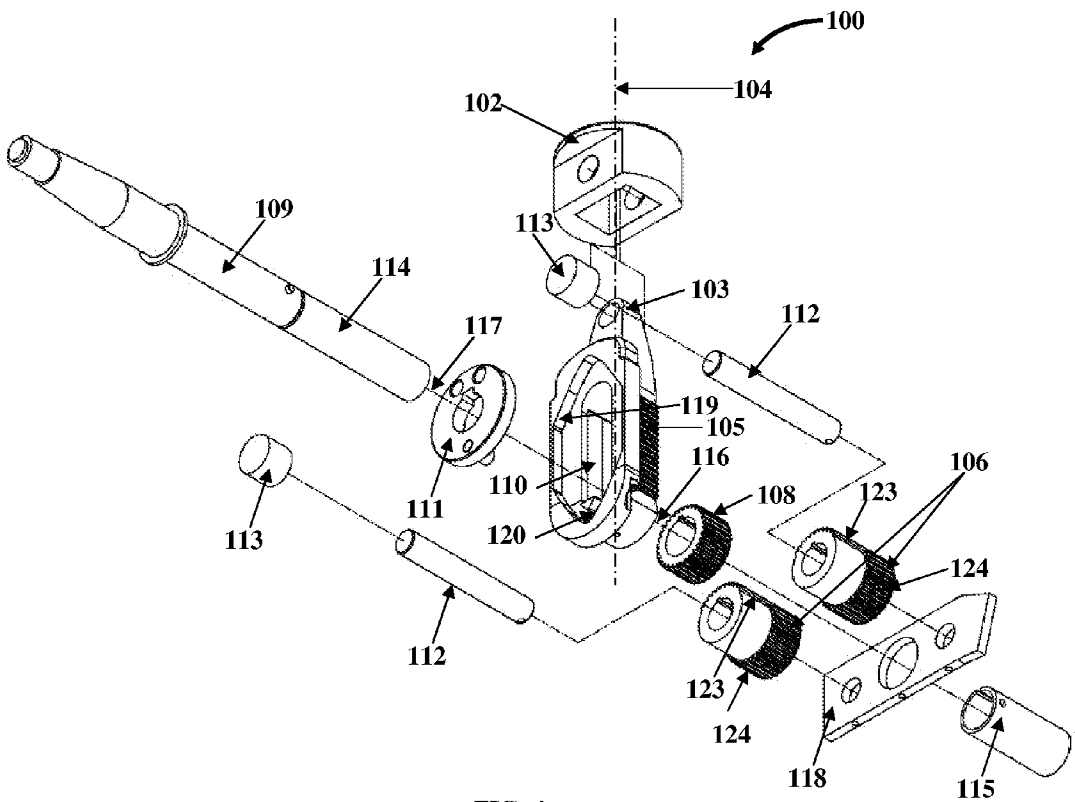

100
104
102
109
113
114
103
112
117
119
105
116
106
110
108
123
111
113
120
124
112
123
124
118
115

FIG. 4

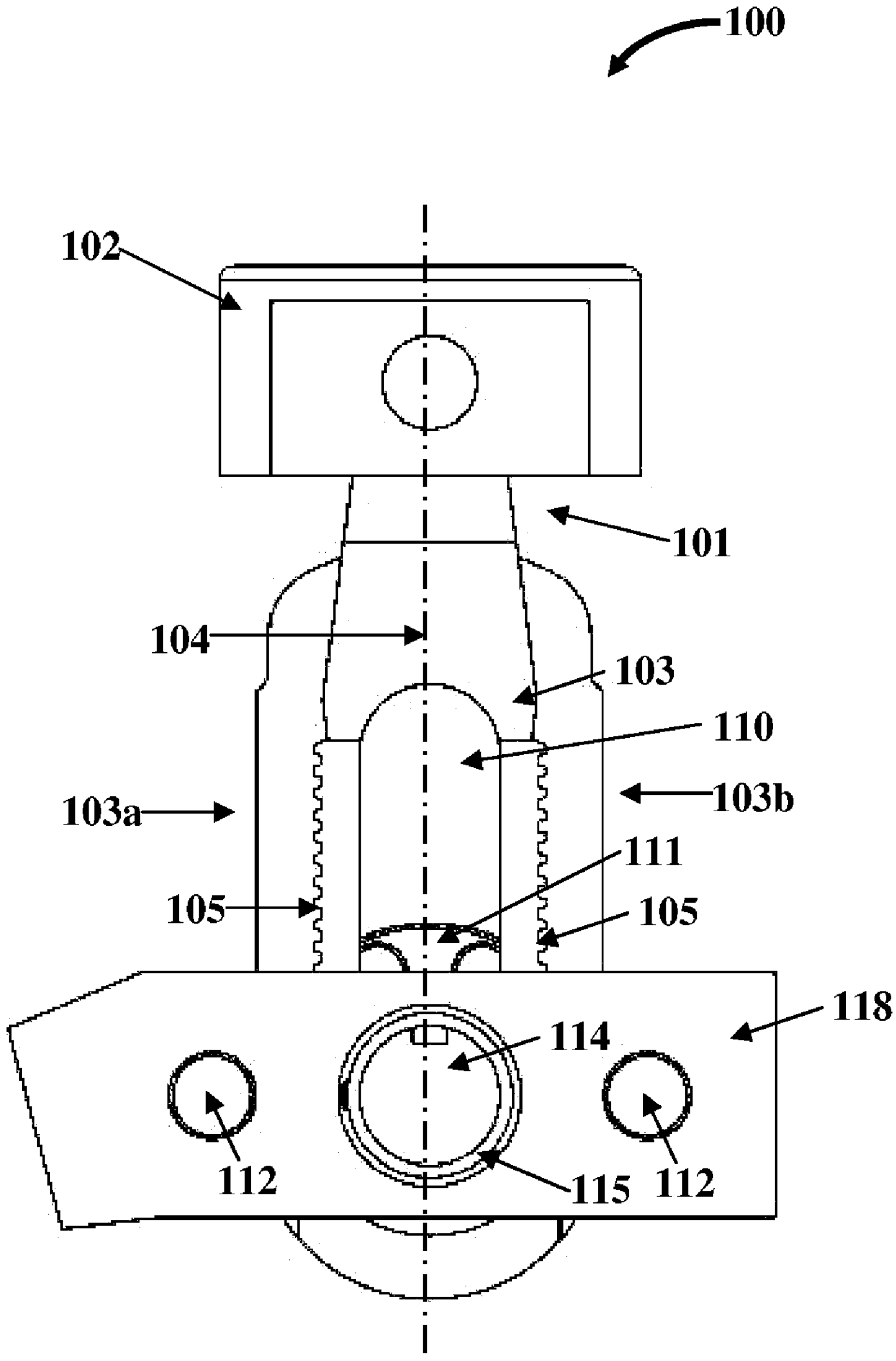

100
102
101
104
103
110
103a
103b
111
105
105
118
114
112
115
112

FIG. 5

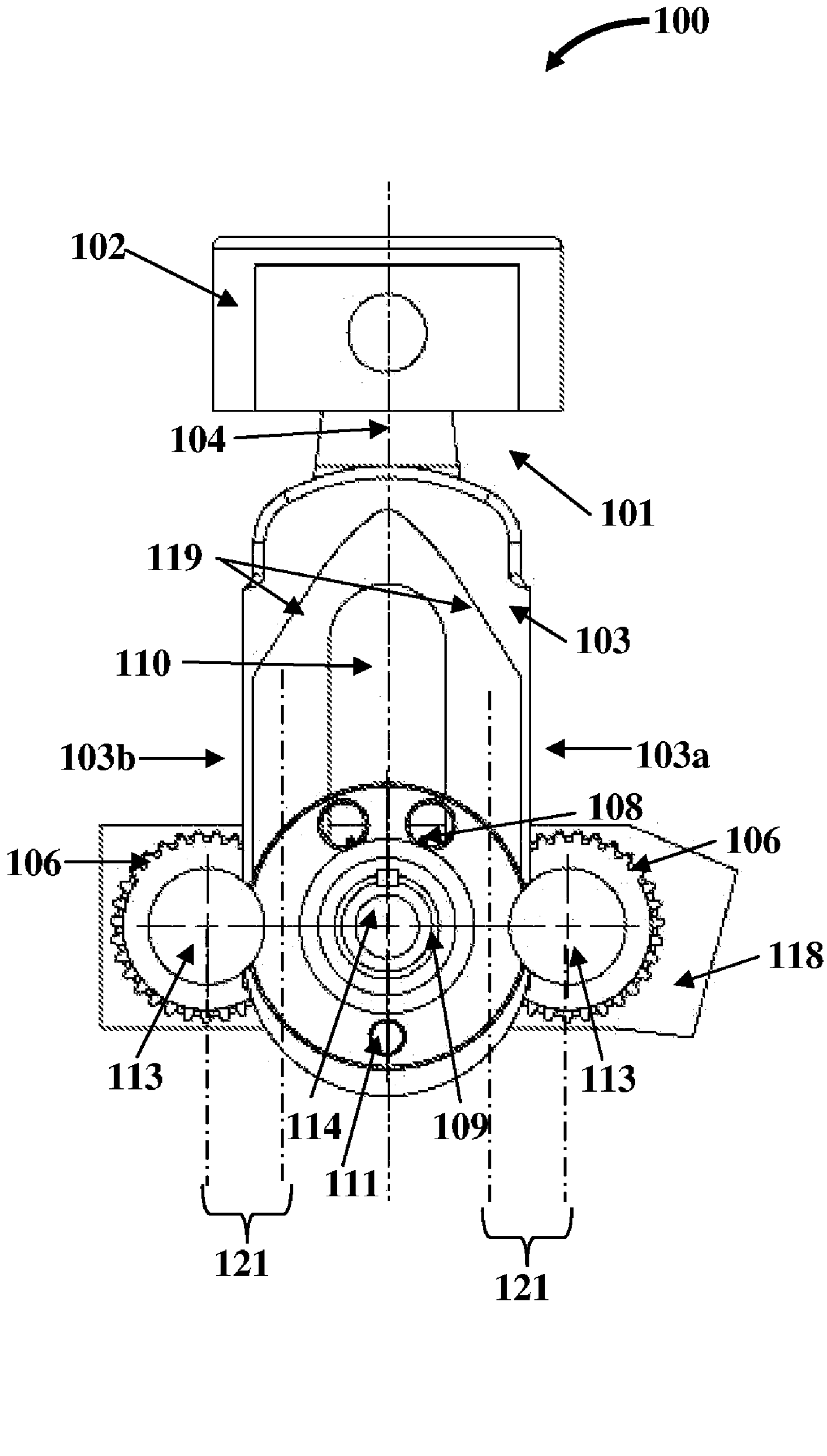

100
102
104
101
119
103
110
103b
103a
108
106
106
118
113
113
114
109
111
121
121

FIG. 6

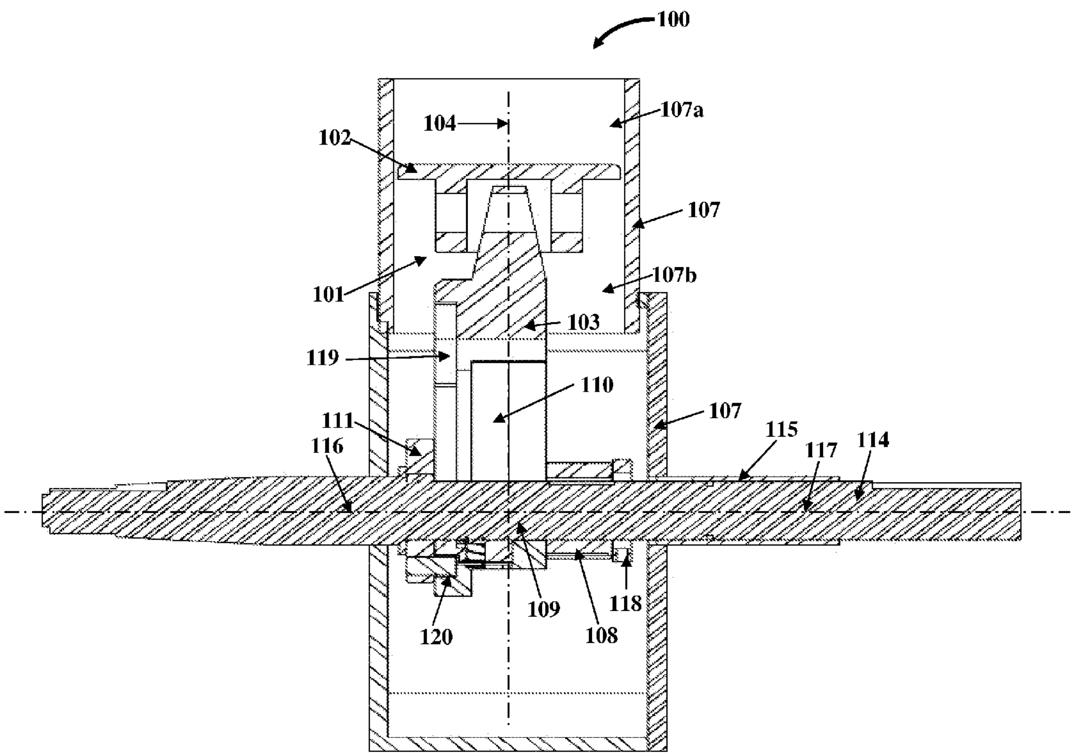

100
104
107a
102
107
101
107b
103
119
110
111
107
115
116
117
114
120
109
118
108

FIG. 7

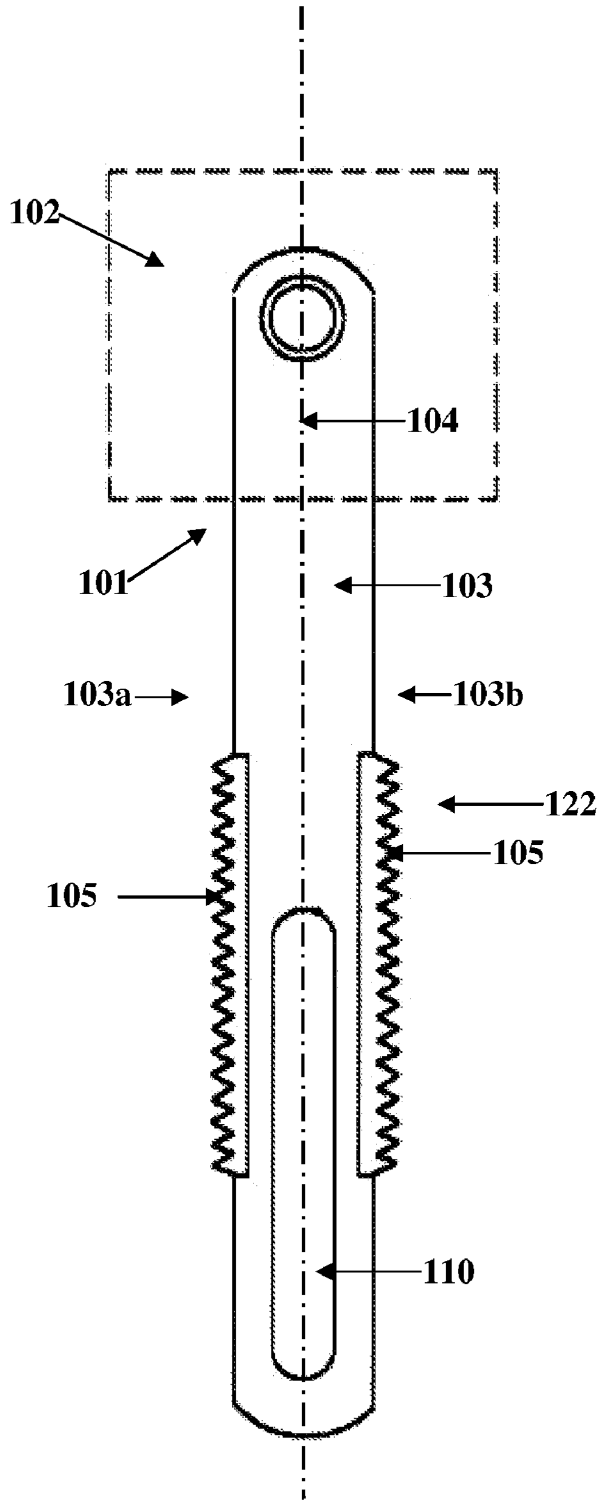


FIG. 8

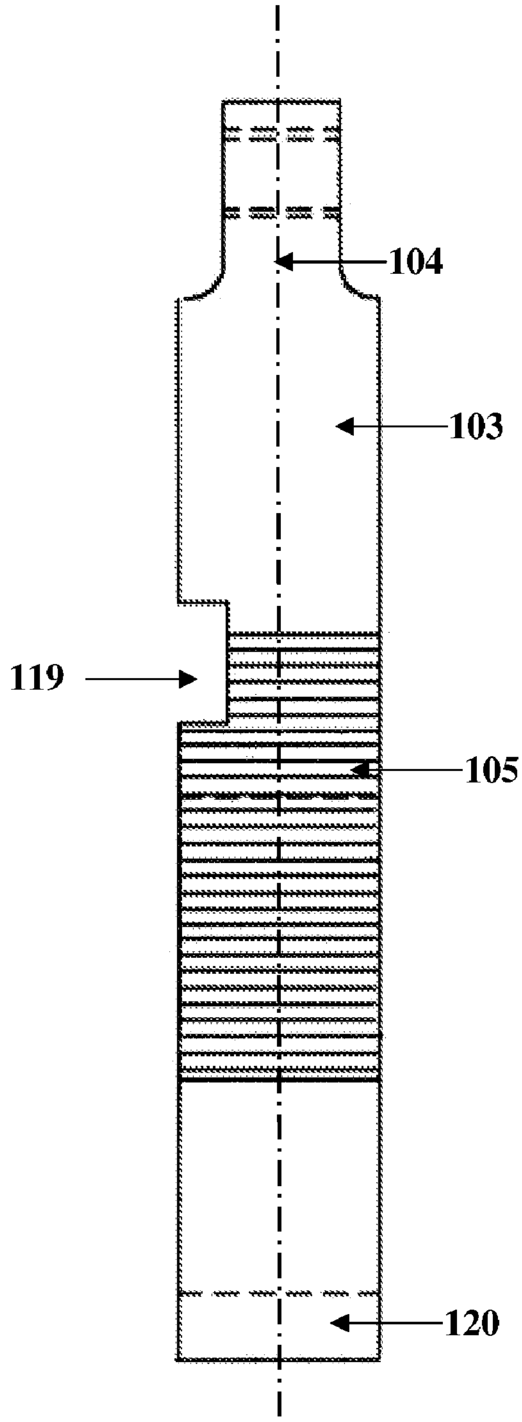


FIG. 9

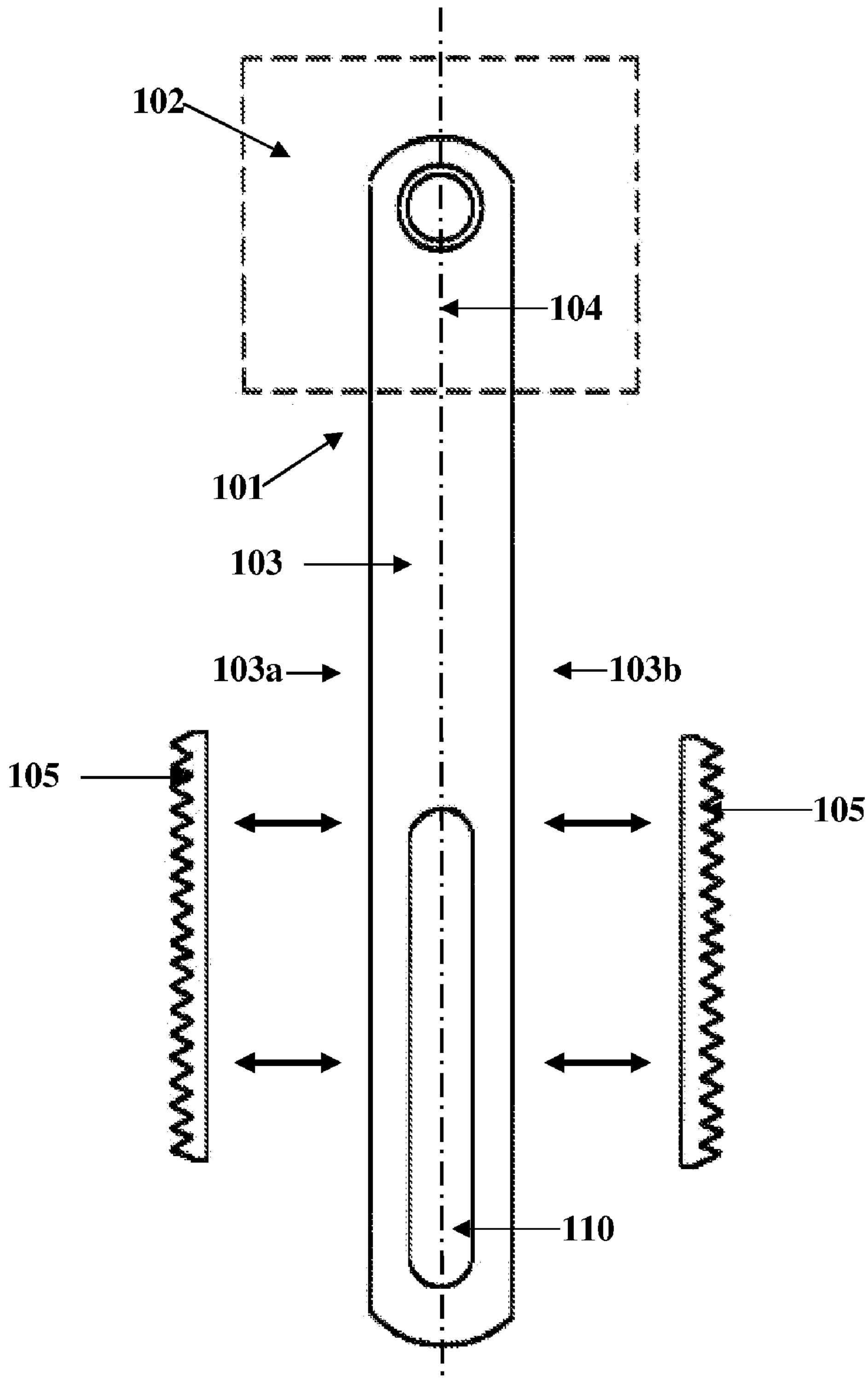


FIG. 10

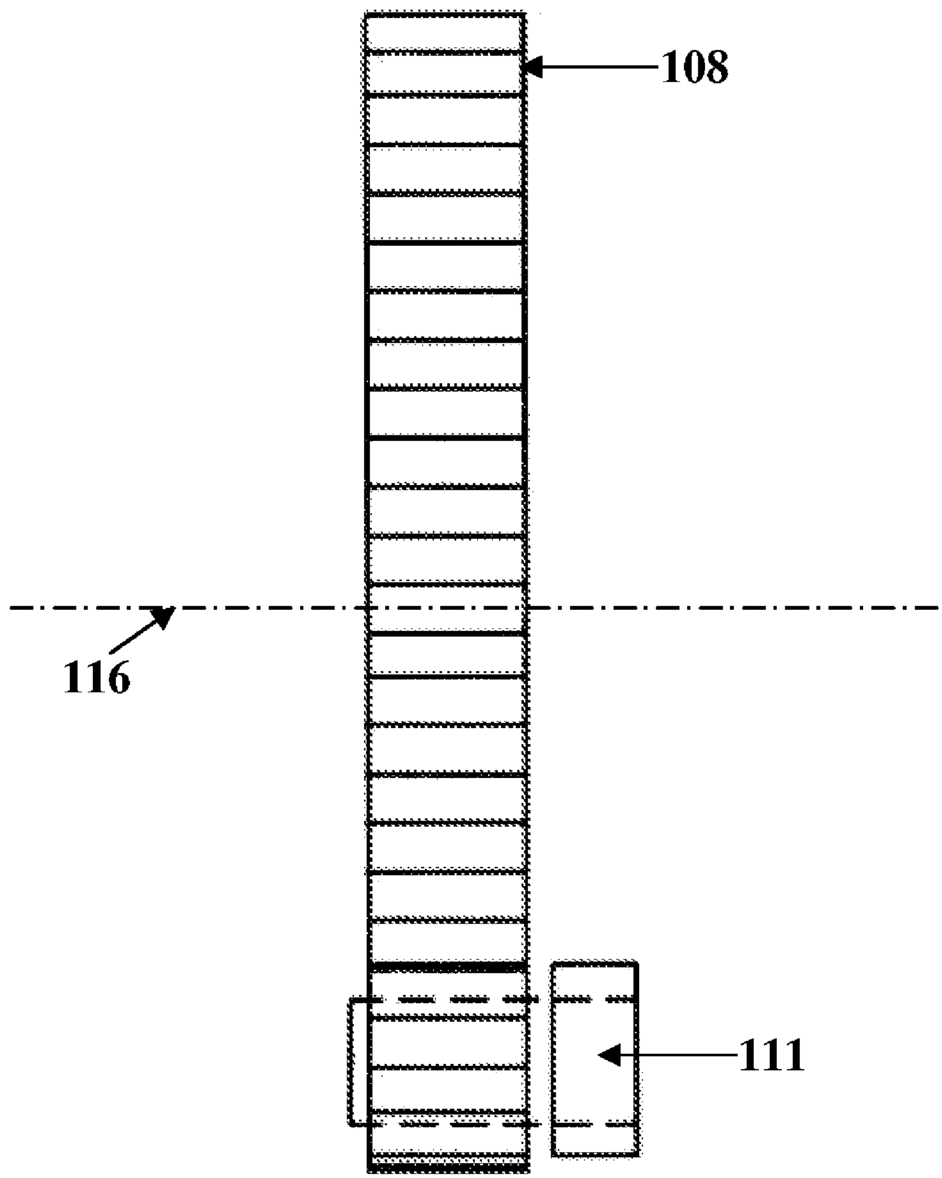


FIG. 11

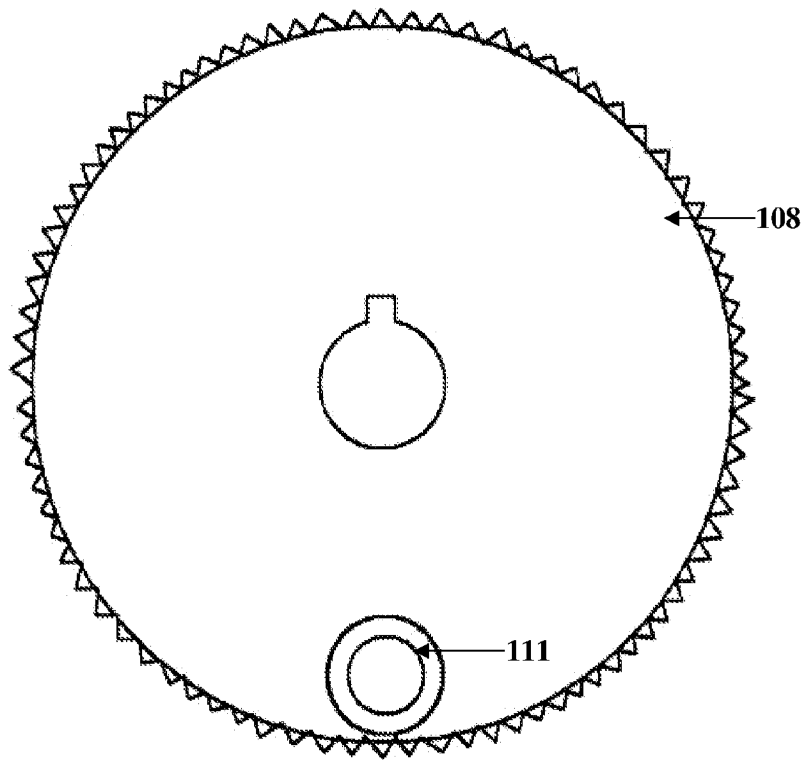


FIG. 12

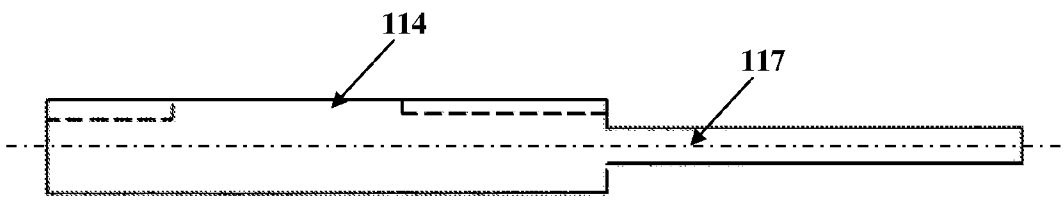


FIG. 13

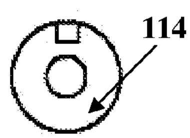


FIG. 14

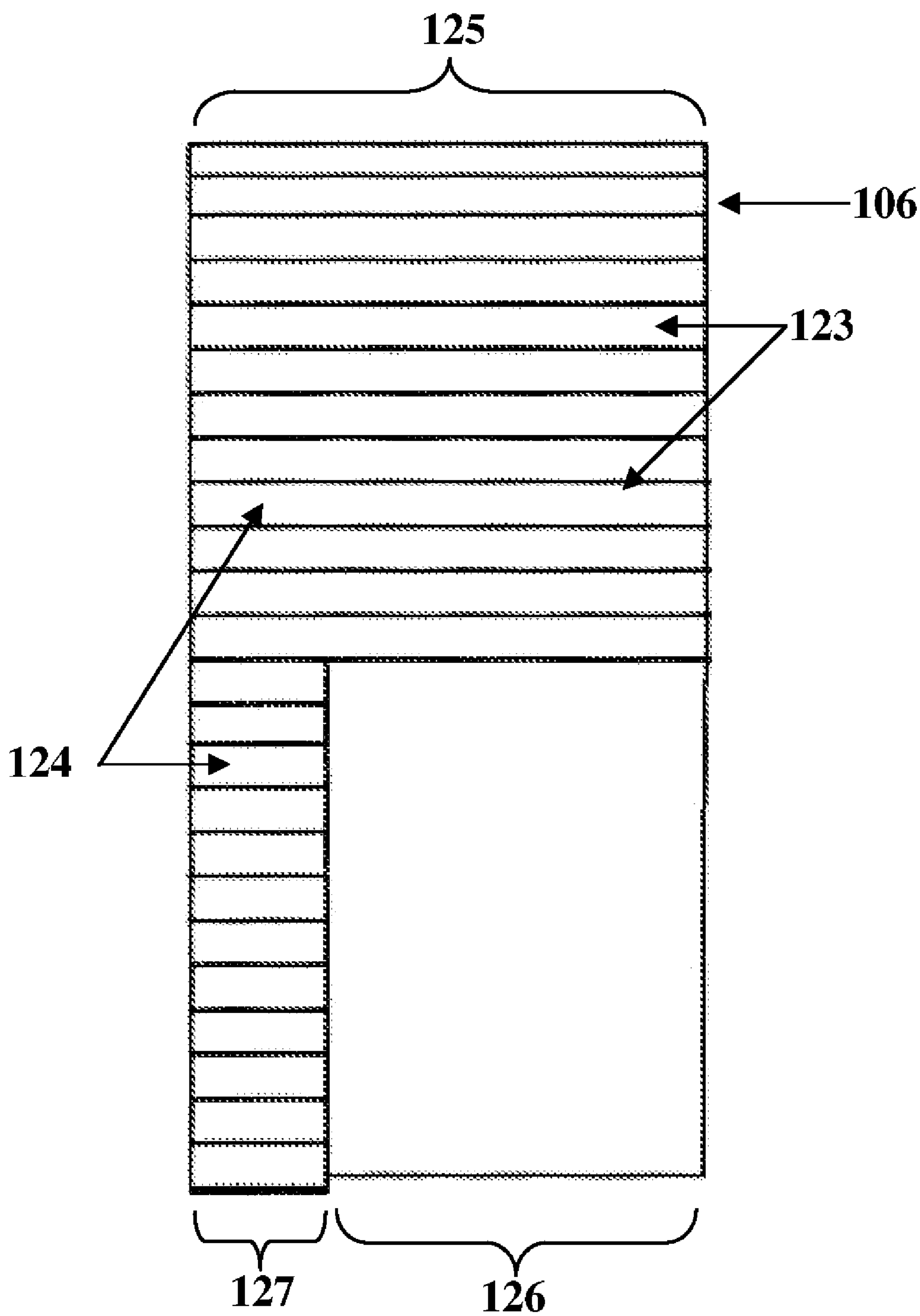


FIG. 15

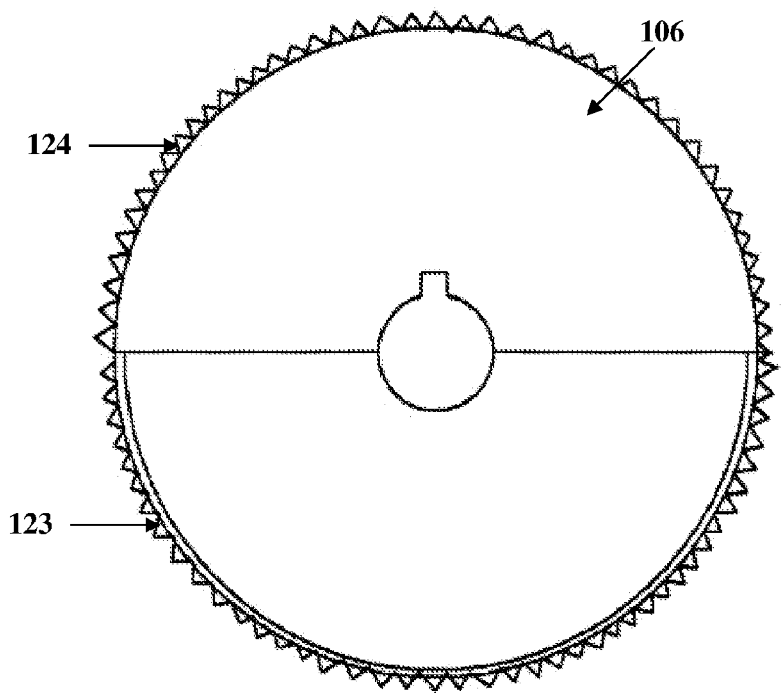


FIG. 16

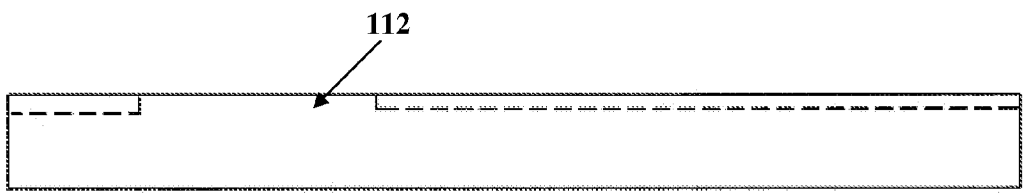


FIG. 17

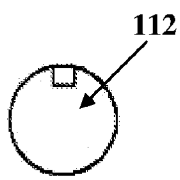


FIG. 18

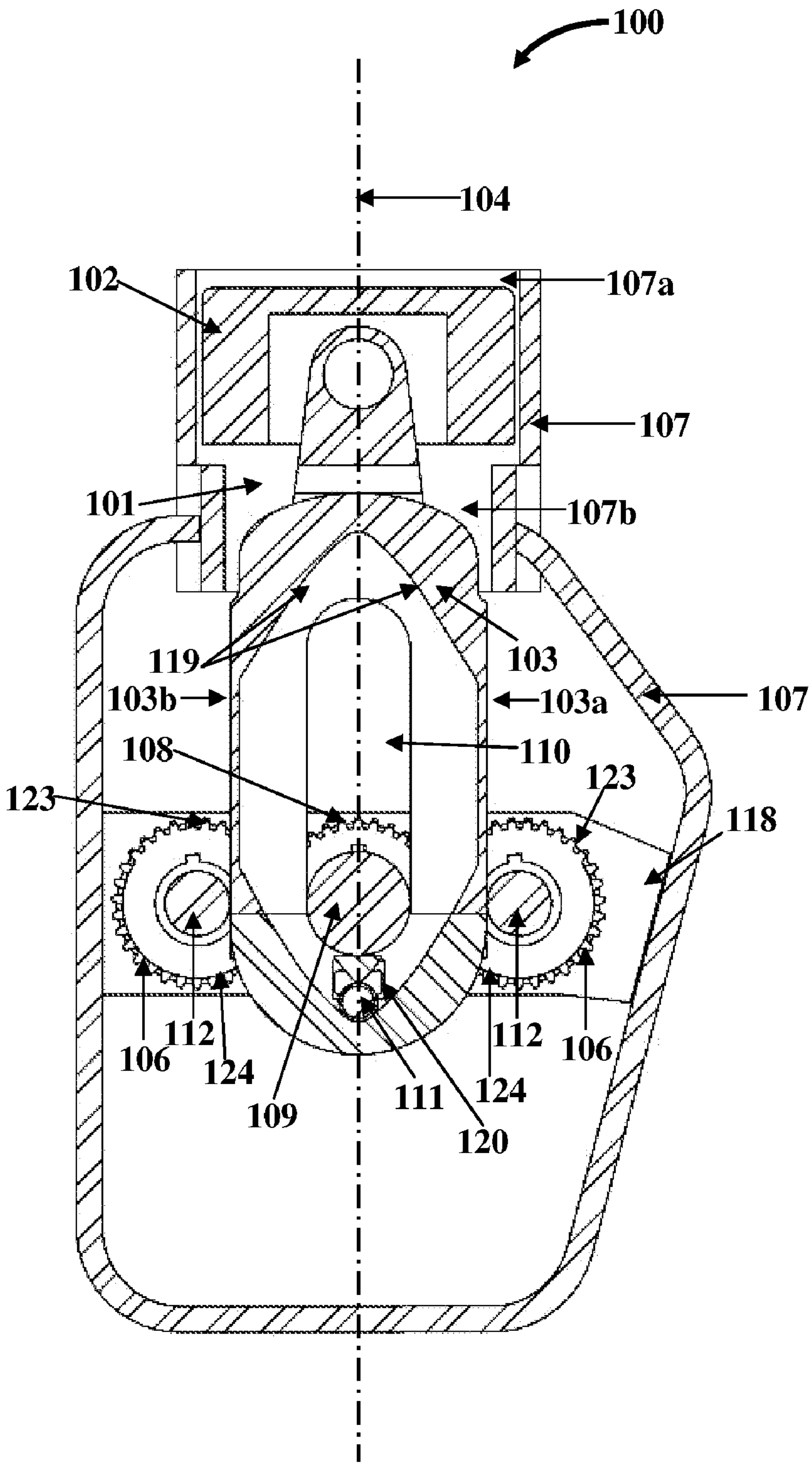

100
104
102
107a
107
101
107b
119
103
103b
103a
107
108
110
123
123
118
106
112
124
109
111
120
124
112
106

FIG. 19A

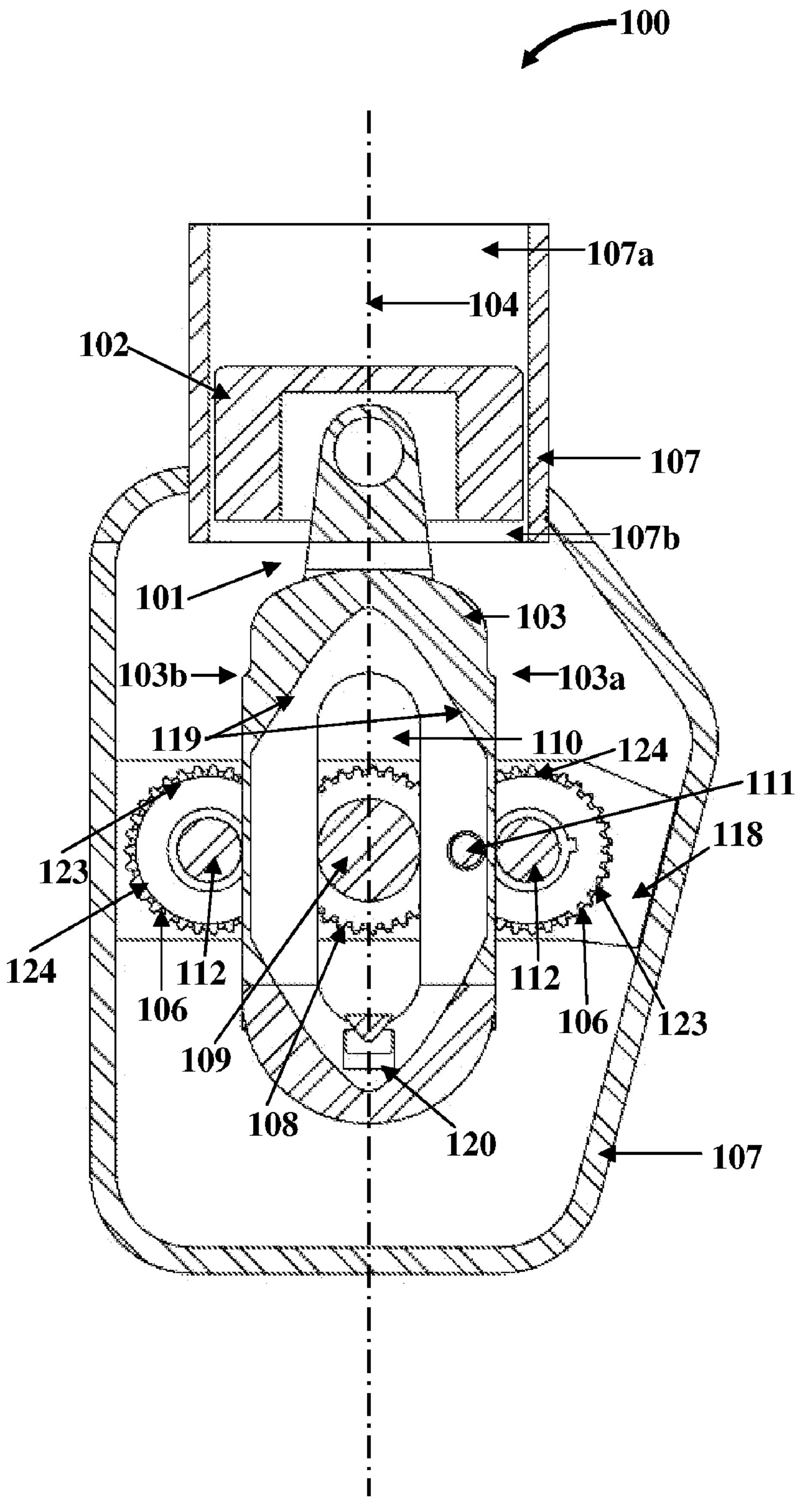

100
107a
104
102
107
107b
101
103
103b
103a
119
110
124
111
118
123
124
112
106
109
108
120
112
106
123
107

FIG. 19B

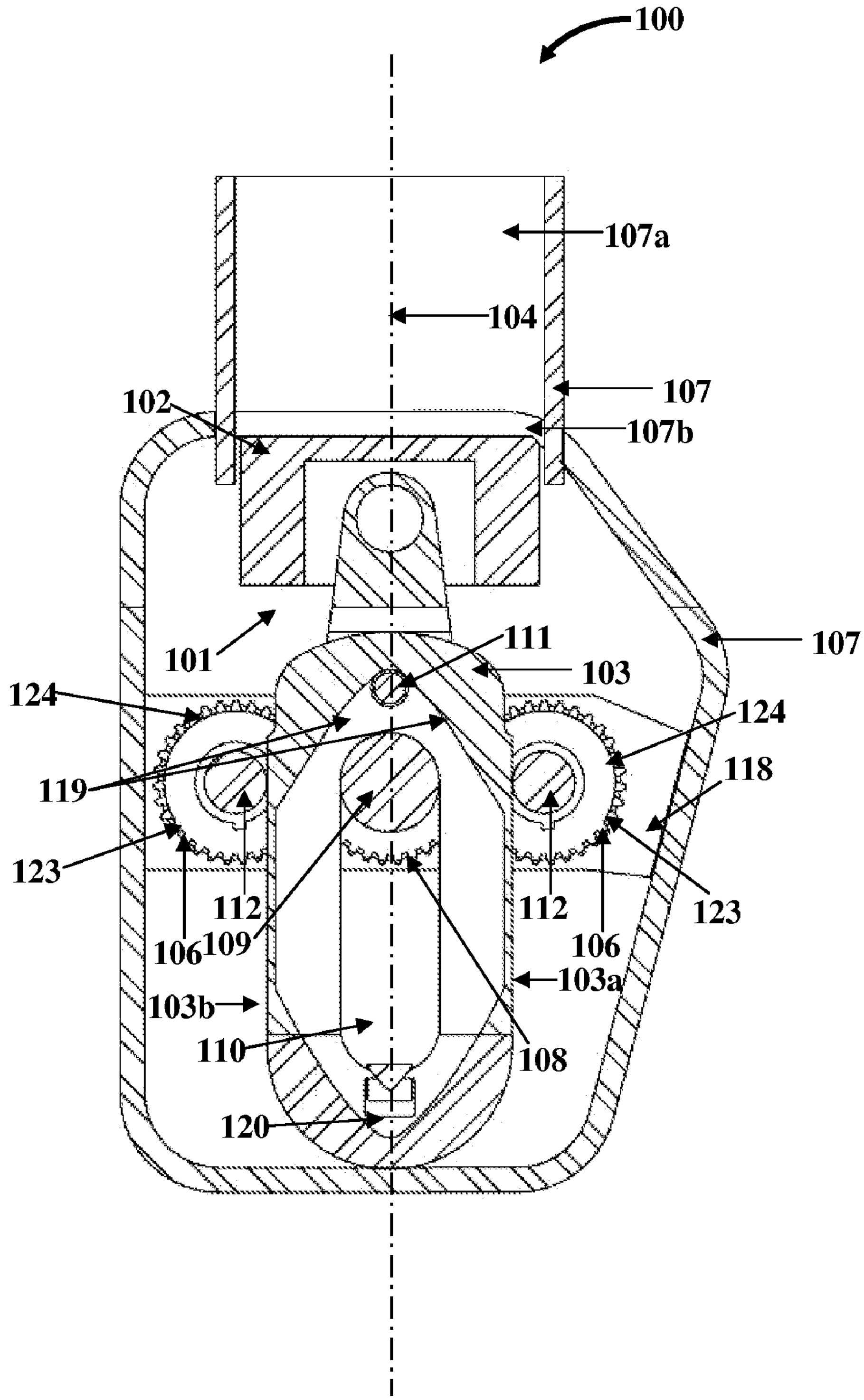

100
107a
104
107
102
107b
107
111
101
103
124
124
118
119
123
112
112
123
106
109
106
103a
103b
110
108
120

FIG. 19C

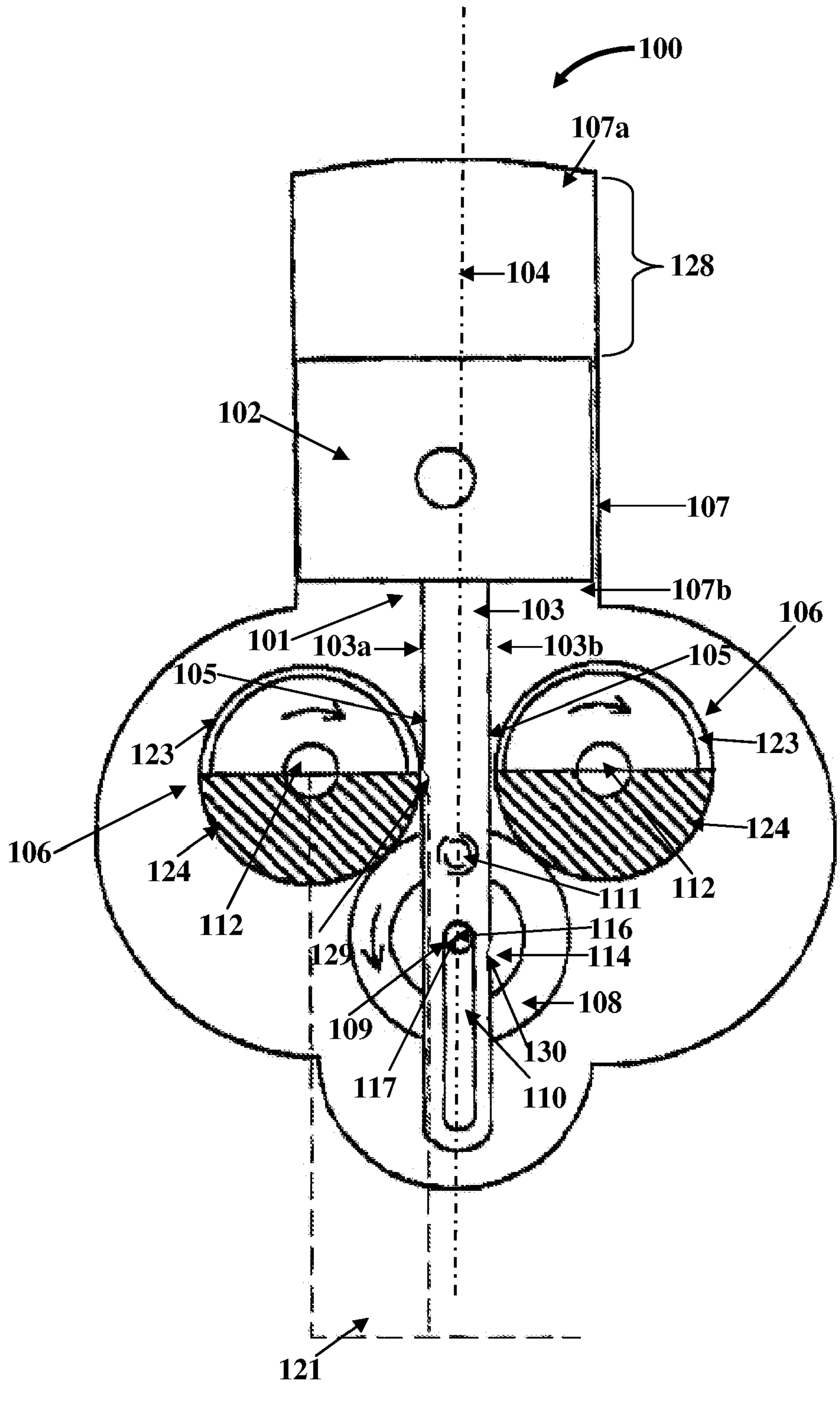

100
107a
104
128
102
107
107b
103
106
101
103a
103b
105
105
123
123
106
124
124
112
112
111
116
114
129
108
109
130
117
110
121

FIG. 20

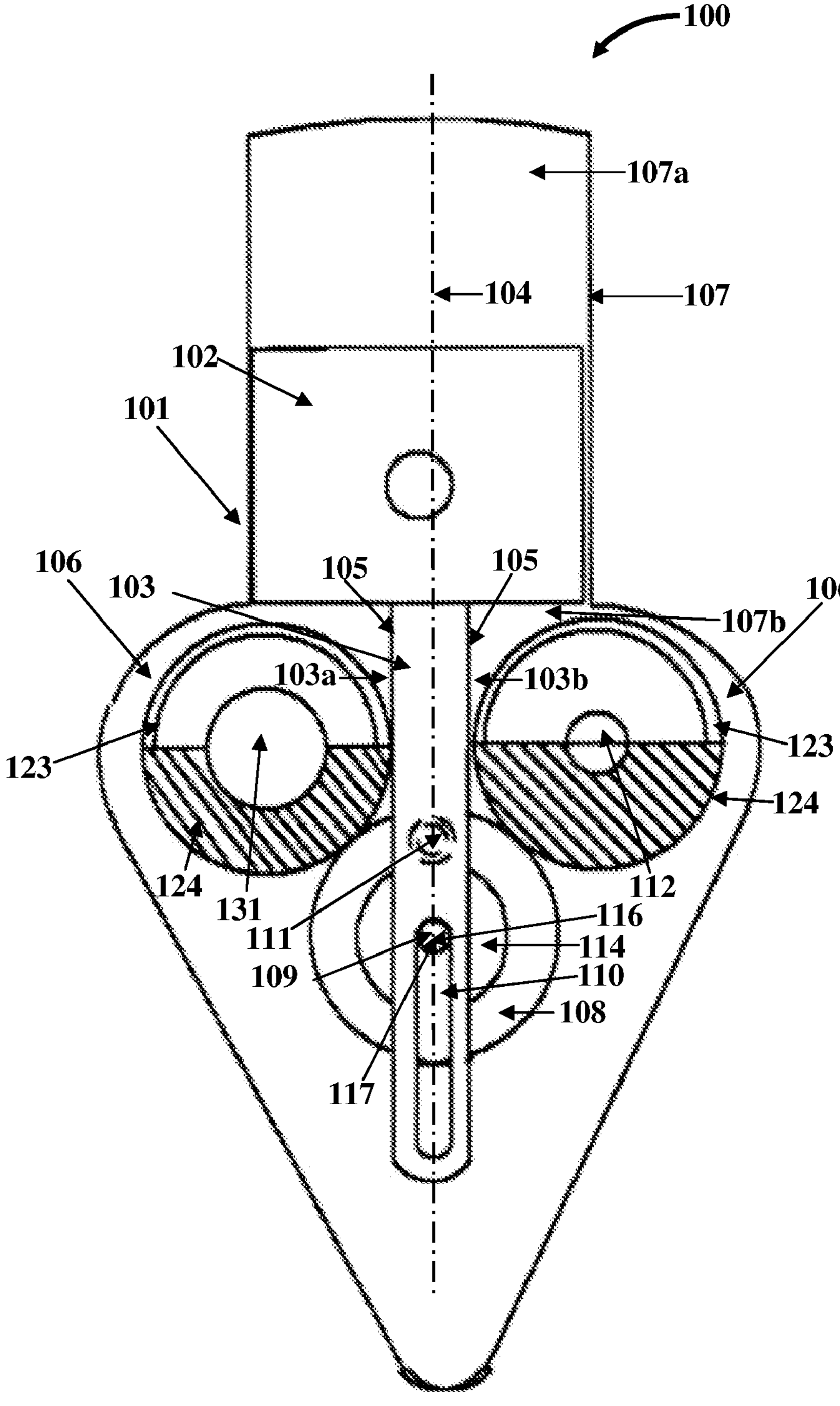

100
107a
104
107
102
101
106
103
105
105
106
107b
103a
103b
123
123
124
124
131
112
111
116
114
109
110
108
117

FIG. 21A

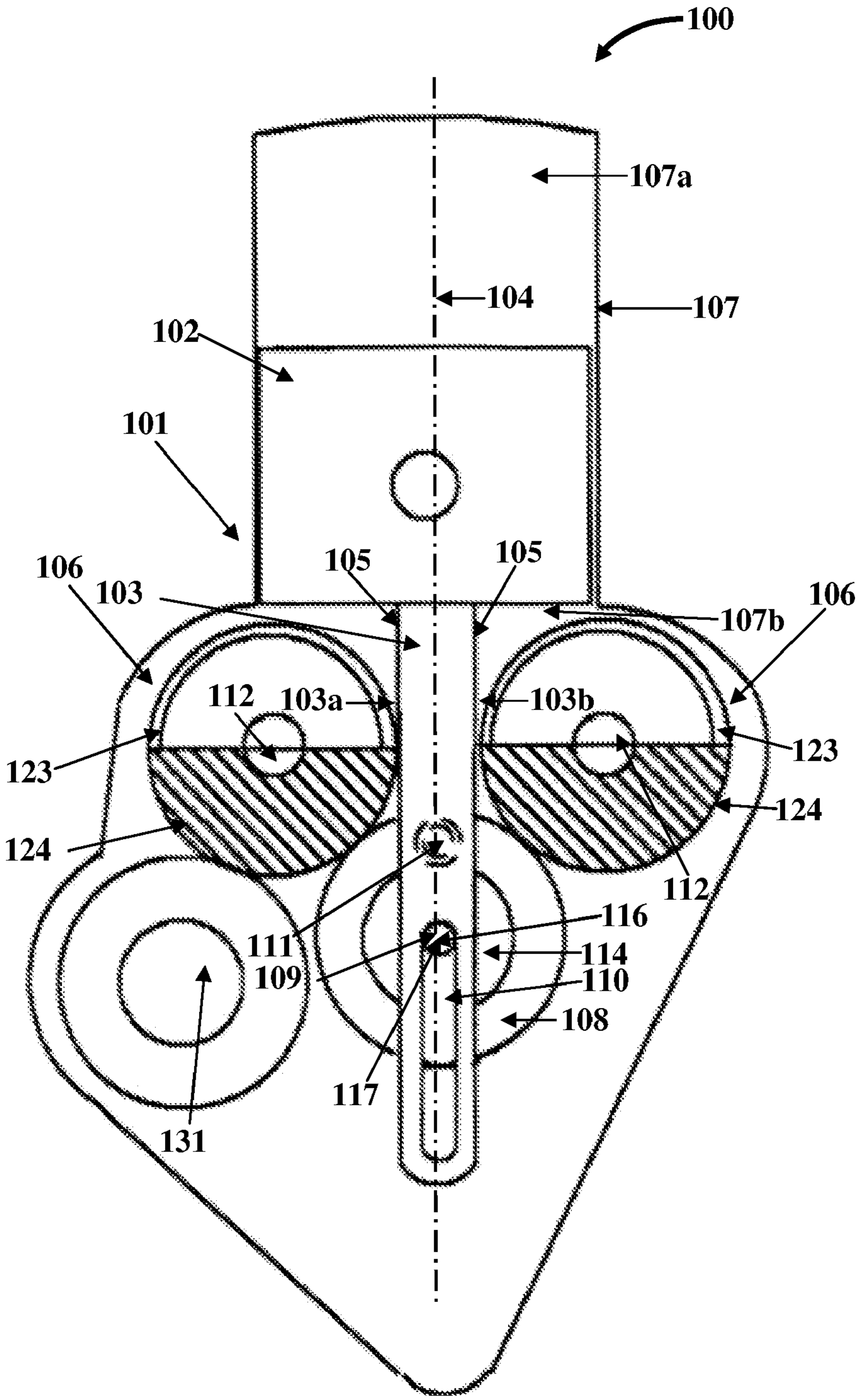

100
107a
104
107
102
101
106
103
105
105
106
107b
112
103a
103b
123
123
124
124
112
111
116
109
114
110
108
117
131

FIG. 21B

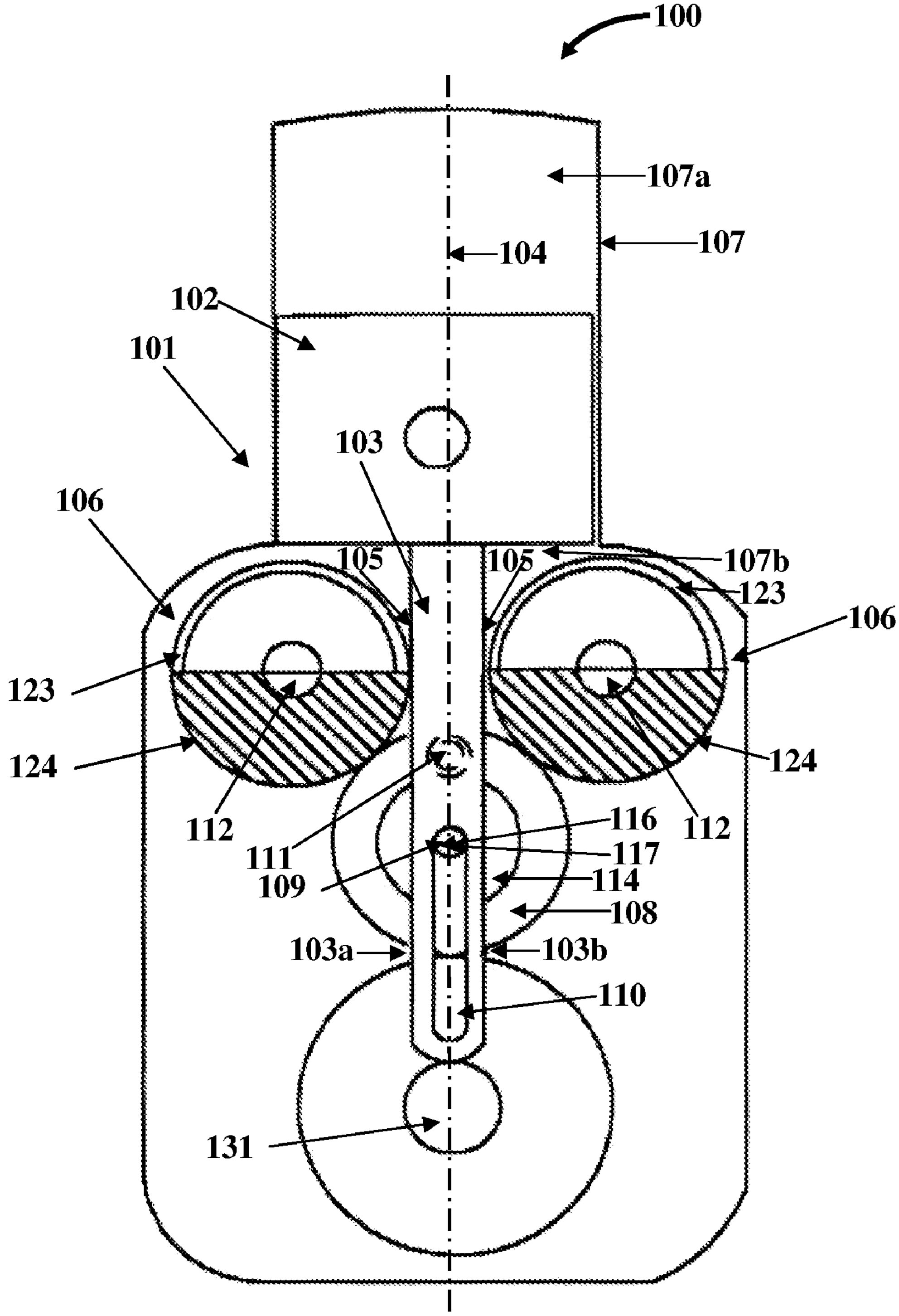
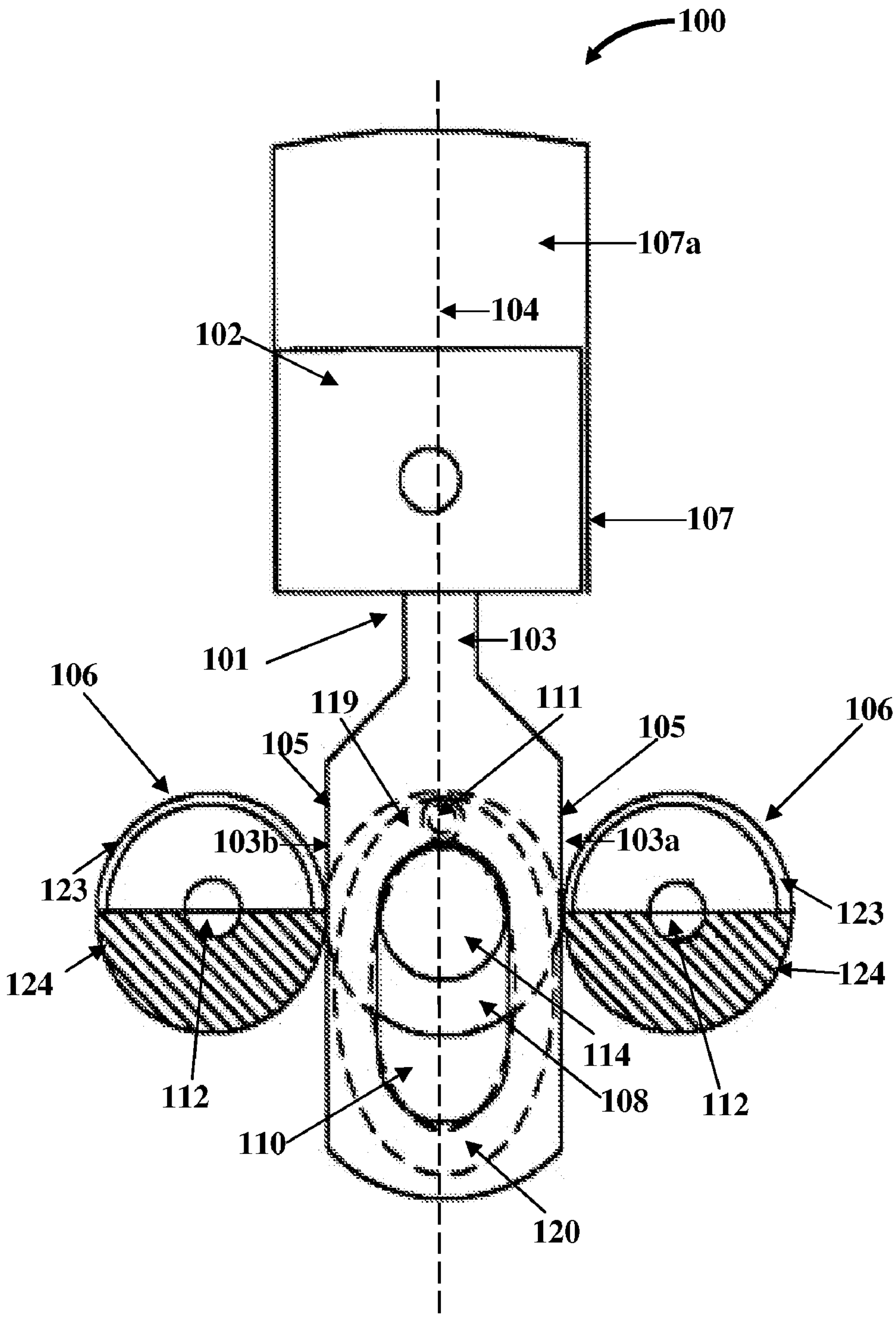

100
107a
107
104
102
101
103
106
105
105
107b
123
106
123
124
112
124
112
116
111
117
109
114
108
103a
103b
110
131

FIG. 21C



100
107a
104
102
107
101
103
106
119
111
105
105
106
103b
103a
123
123
124
124
112
114
108
112
110
120

FIG. 22

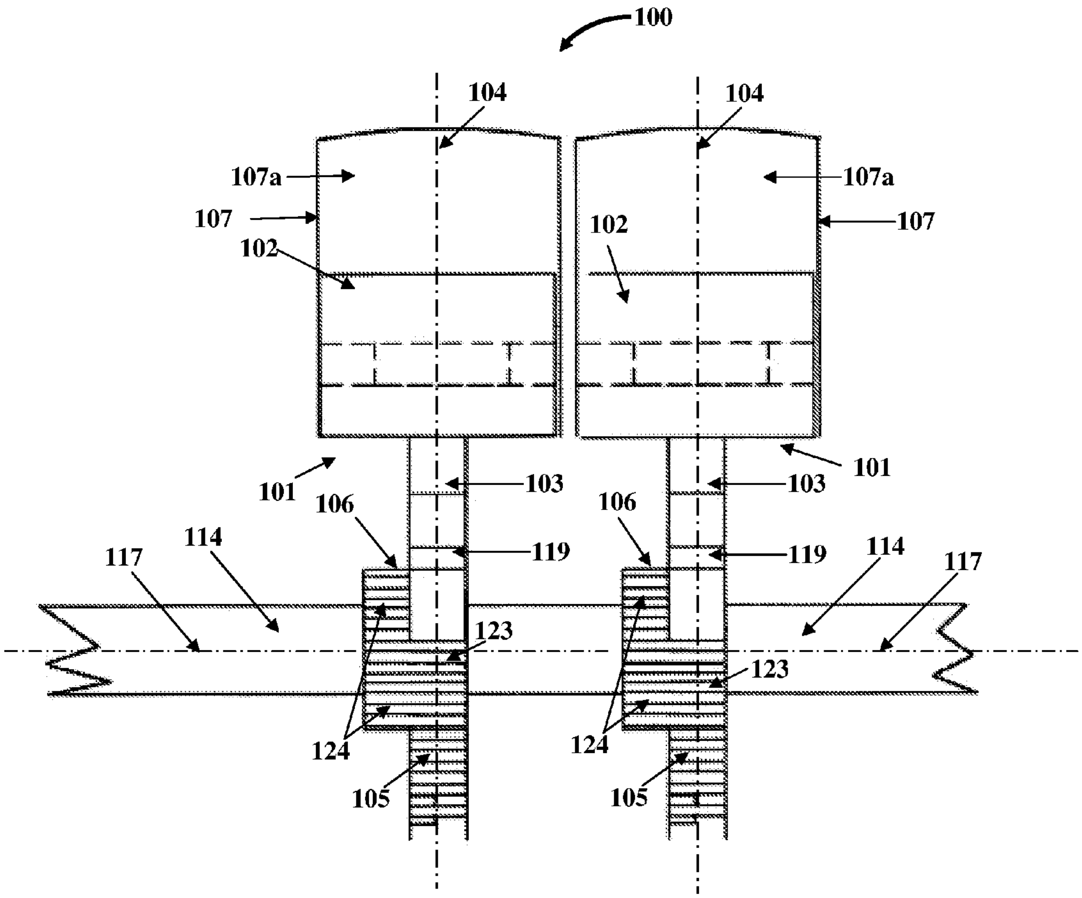

100
104
104
107a
107a
107
107
102
102
101
103
103
101
106
106
119
119
117
114
114
117
123
123
124
124
105
105

FIG. 23

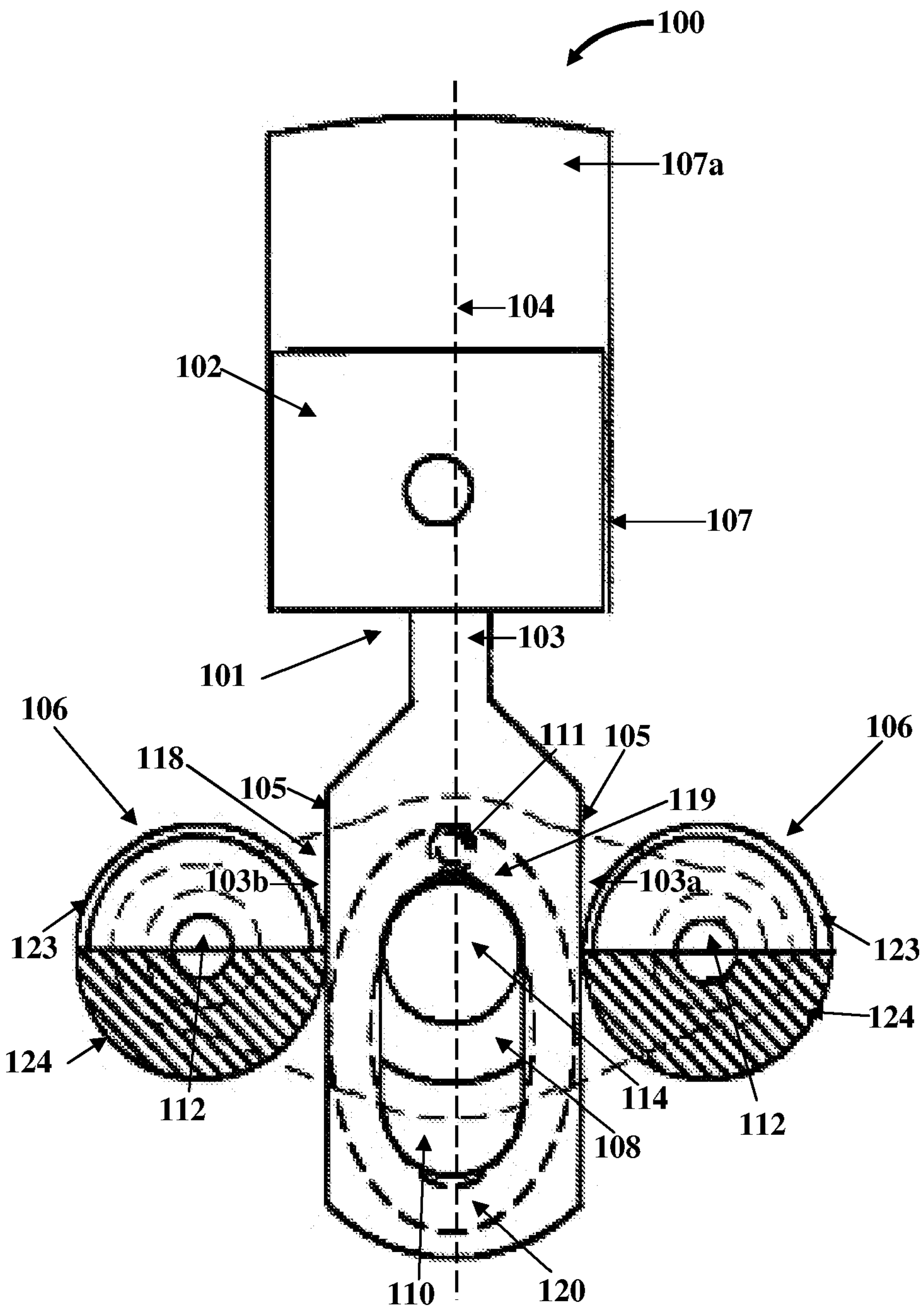

100
107a
104
102
107
101
103
106
118
105
111
105
119
106
103b
103a
123
123
112
114
124
124
112
108
110
120

FIG. 24

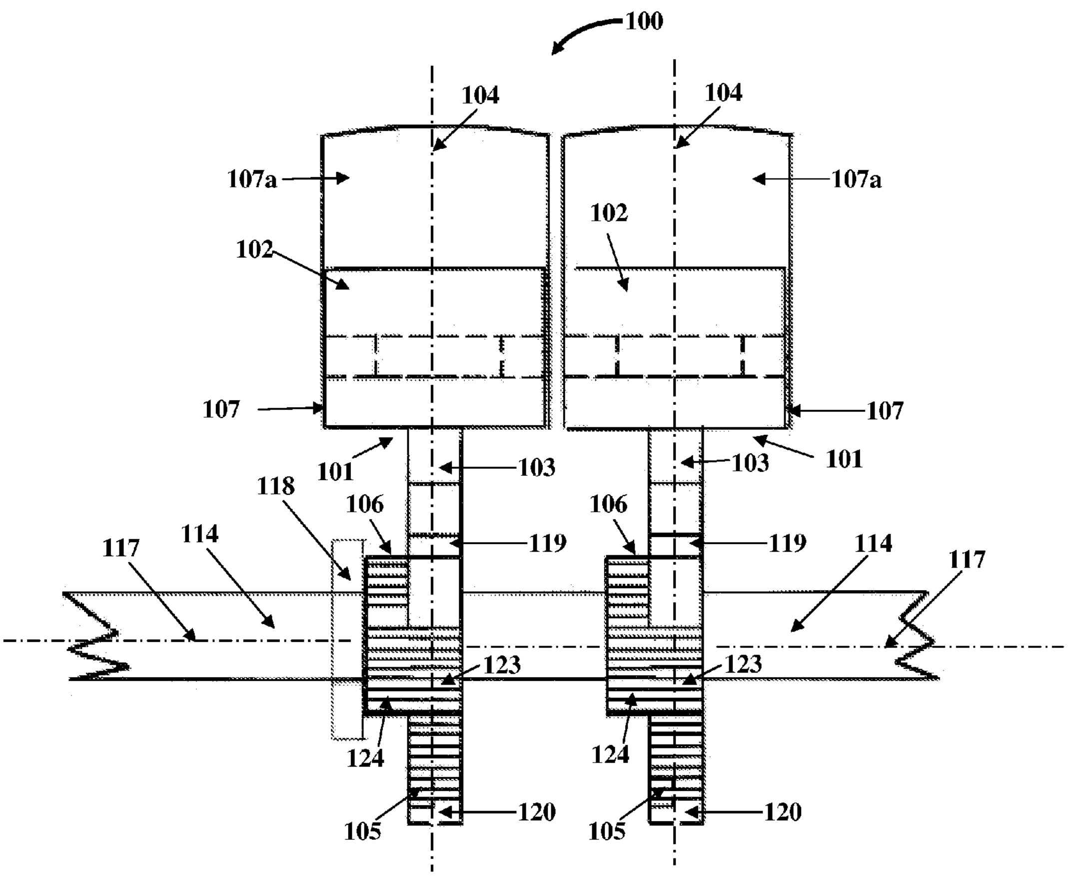

100
104
104
107a
107a
102
102
107
107
101
101
103
103
118
106
106
119
119
117
114
114
117
123
123
124
124
105
120
105
120

FIG. 25

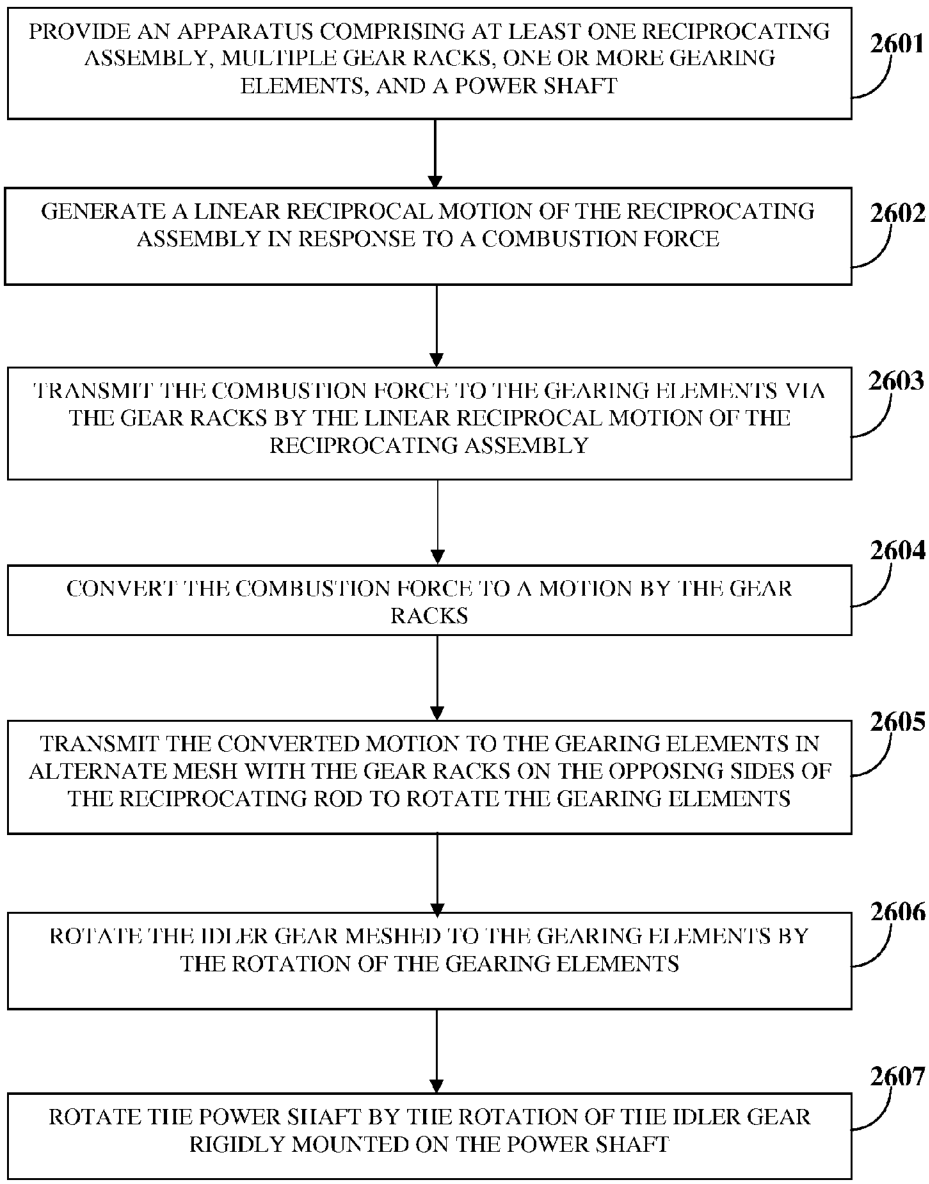

PROVIDE AN APPARATUS COMPRISING AT LEAST ONE RECIPROCATING ASSEMBLY, MULTIPLE GEAR RACKS, ONE OR MORE GEARING ELEMENTS, AND A POWER SHAFT
2601
GENERATE A LINEAR RECIPROCAL MOTION OF THE RECIPROCATING ASSEMBLY IN RESPONSE TO A COMBUSTION FORCE
2602
TRANSMIT THE COMBUSTION FORCE TO THE GEARING ELEMENTS VIA THE GEAR RACKS BY THE LINEAR RECIPROCAL MOTION OF THE RECIPROCATING ASSEMBLY
2603
CONVERT THE COMBUSTION FORCE TO A MOTION BY THE GEAR RACKS
2604
TRANSMIT THE CONVERTED MOTION TO THE GEARING ELEMENTS IN ALTERNATE MESH WITH THE GEAR RACKS ON THE OPPOSING SIDES OF THE RECIPROCATING ROD TO ROTATE THE GEARING ELEMENTS
2605
ROTATE THE IDLER GEAR MESHED TO THE GEARING ELEMENTS BY THE ROTATION OF THE GEARING ELEMENTS
2606
ROTATE THE POWER SHAFT BY THE ROTATION OF THE IDLER GEAR RIGIDLY MOUNTED ON THE POWER SHAFT
2607

FIG. 26

FIXED MOMENT ARM COMBUSTION APPARATUS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of provisional patent application No. 61/285,544 titled "Fixed Moment Arm Combustion Engine", filed on Dec. 11, 2009 in the United States Patent and Trademark Office.

[0002] The specification of the above referenced application is incorporated herein by reference in its entirety.

BACKGROUND

[0003] Conventional reciprocating engines consist of a cylinder body and a piston with a connecting rod and a crank assembly. During operation of a conventional reciprocating engine, the connecting rod and crank assembly convert linear reciprocal motion to rotary motion. A mixture of fuel and air is ignited in the cylinder body and a combustion force is produced as a result of the ignition of the mixture of fuel and air. The piston executes linear reciprocal motion. The connecting rod is displaced, horizontally and vertically, along a vertical plane when the piston executes the linear reciprocal motion. This displacement of the connecting rod angularly displaces the combustion force while transmitting the combustion force to the crank assembly. Furthermore, the angular displacement of the combustion force is varying with respect to the position of the piston in the cylinder body. Thus, a variable moment arm exists and subsequently a constantly varying component of the combustion force is transmitted to the crank assembly over a cycle of operation of the conventional reciprocating engine. The displacement of the connecting rod allows only a component of the combustion force to be transmitted to the crank assembly and hence results in wastage of energy and high fuel consumption for a rated power output.

[0004] Consider a conventional reciprocating engine with a fixed stroke length, for example, a two inch stroke length. The length of the variable moment arm, approximately averaging 0.333 inch moment arm for a two inch stroke length, would be a varying one, for example, 0 inch to 1 inch, at different instants of operation. A 2" stroke average moment arm for the crank/piston relationship is 0.333". This is achieved by taking the moment arm at the start, which is 0, the moment arm at the middle, which is 1, and the moment arm at the finish, which is 0. On adding these moment arms together and dividing by three, the average moment arm is 0.333". The moment arm here is a variable moment arm due to its varying length, that is, 0 inch to 1 inch. Hence, the varying length of the variable moment arm in a conventional reciprocating engine allows only a component of the combustion force to be transmitted to the power shaft via the crank assembly due to the pivotal arrangement of the connecting rod and the crank assembly.

[0005] Hence, there is an unmet but unresolved need for an apparatus that converts linear reciprocal motion to rotary motion and recovers the portion of wasted energy and uses the recovered energy completely to drive a power shaft.

SUMMARY OF THE INVENTION

[0006] This summary is provided to introduce a selection of concepts in a simplified form that are further described in the detailed description of the invention. This summary is not intended to identify key or essential inventive concepts of the claimed subject matter, nor is it intended for determining the scope of the claimed subject matter.

[0007] The apparatus disclosed herein addresses the above stated needs for converting linear reciprocal motion to rotary motion by eliminating and replacing the crank assembly with a fixed moment arm. This is achieved by means of a fixed moment arm orientation between a reciprocating rod and gearing elements in which the combustion force is always perpendicular to the surface on which the combustion force is transmitted. Therefore, the apparatus disclosed herein, with the fixed moment arm orientation between the reciprocating rod and the gearing elements, possesses an inherent and perennial advantage over conventional reciprocating engines. The reciprocating rod of the apparatus disclosed herein transfers all or most part of the combustion force into driving the gearing elements. Furthermore, the apparatus disclosed herein has a larger effective moment arm compared to a conventional reciprocating engine. In operation, the apparatus disclosed herein inherently eliminates the presence of angularity while transmitting combustion force from the reciprocating rod to the gearing elements, and also transmits the combustion force perpendicularly at all times.

[0008] The apparatus disclosed herein comprises at least one reciprocating assembly, multiple gear racks, and one or more gearing elements. The reciprocating assembly comprises a reciprocating component and a reciprocating rod capable of linear reciprocal motion in unison. The reciprocating component is a piston. The reciprocating component is rigidly attached to the reciprocating rod along a vertical axis of the reciprocating rod. The reciprocating component is supported by a housing. The reciprocating rod is slidably connected to an idler gear via a guide pin. The reciprocating rod comprises an elongated aperture along the vertical axis of the reciprocating rod. The guide pin is disposed within the elongated aperture to slidably connect the reciprocating rod to the idler gear.

[0009] The gear racks are disposed, for example, on opposing sides of the reciprocating rod, for transmitting motion to the gearing elements. Each of the gear racks may be integrated on the reciprocating rod or externally attached to the reciprocating rod. One or more gearing elements are disposed on the opposing sides of the reciprocating rod. The gearing elements are in alternate mesh with the gear racks on the opposing sides of the reciprocating rod to transmit the motion to the idler gear. Each of the gearing elements and each of the gear racks together define a fixed moment arm. The gear racks and the gearing elements are constructed in, for example, a spur gear configuration, a helical gear configuration, or a herringbone gear configuration. The gearing elements mesh with the idler gear rigidly mounted on a power shaft to convert linear reciprocal motion of the reciprocating assembly to rotary motion of the power shaft. A centric axis of the idler gear is collinear to a longitudinal axis of the power shaft. The power shaft is rotatably supported by the housing. In an embodiment, multiple idler gears are rigidly mounted on the power shaft.

[0010] Each of the gearing elements comprises a partial gear area on a first section of its width and a full gear area on a second section of its width. The partial gear area on each of the gearing elements is in mesh with one of the gear racks. The full gear area on each of the gearing elements is in mesh with the idler gear. Each of the gearing elements is rigidly mounted on a shaft rotatably supported by the housing.

[0011] The apparatus disclosed herein further comprises at least one transfer roller rotatably connected to the reciprocating rod or the idler gear for assisting in alternation of the mesh of the gear racks with each of the gearing elements. The apparatus disclosed herein further comprises a top recess and a bottom recess on the reciprocating rod on a locus of rotation of the transfer roller, to allow passage of the transfer roller through the reciprocating rod. The apparatus disclosed herein further comprises a stabilizing fixture rotatably connected to the power shaft and rigidly attached to the housing to operatively reduce vibrations within the apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The foregoing summary, as well as the following detailed description of the invention, is better understood when read in conjunction with the appended drawings. For the purpose of illustrating the invention, exemplary constructions of the invention are shown in the drawings. However, the invention is not limited to the specific components and methods disclosed herein.

[0013] FIG. **1** exemplarily illustrates a front perspective view of an apparatus for converting linear reciprocal motion to rotary motion.

[0014] FIG. **2** exemplarily illustrates a bottom perspective view of the apparatus showing gearing elements and an idler gear.

[0015] FIG. **3** exemplarily illustrates an exploded view of the apparatus for converting linear reciprocal motion to rotary motion.

[0016] FIG. **4** exemplarily illustrates an exploded view of the apparatus showing a top recess and a bottom recess of a reciprocating rod of the apparatus.

[0017] FIG. **5** exemplarily illustrates a front orthogonal view of the apparatus showing a stabilizing fixture.

[0018] FIG. **6** exemplarily illustrates a rear orthogonal view of the apparatus showing gearing elements.

[0019] FIG. **7** exemplarily illustrates a side sectional view of the apparatus showing a power shaft rotatably supported by a housing.

[0020] FIG. **8** exemplarily illustrates a front orthogonal view of a reciprocating assembly with gear racks.

[0021] FIG. **9** exemplarily illustrates a side orthogonal view of a reciprocating rod of the reciprocating assembly with gear racks.

[0022] FIG. **10** exemplarily illustrates a front orthogonal view of a reciprocating rod of the reciprocating assembly with external gear racks attachable to the reciprocating rod.

[0023] FIG. **11** exemplarily illustrates a side orthogonal view of an idler gear of the apparatus.

[0024] FIG. **12** exemplarily illustrates a front orthogonal view of the idler gear of the apparatus.

[0025] FIG. **13** exemplarily illustrates a side orthogonal view of a power shaft of the apparatus.

[0026] FIG. **14** exemplarily illustrates a front orthogonal view of the power shaft of the apparatus.

[0027] FIG. **15** exemplarily illustrates a side orthogonal view of a gearing element of the apparatus.

[0028] FIG. **16** exemplarily illustrates a front orthogonal view of the gearing element of the apparatus.

[0029] FIG. **17** exemplarily illustrates a side orthogonal view of a shaft of the gearing element.

[0030] FIG. **18** exemplarily illustrates a front orthogonal view of the shaft of the gearing element.

[0031] FIGS. **19**A-**19**C exemplarily illustrate rear sectional views of the apparatus in operation.

[0032] FIG. **20** exemplarily illustrates an orthogonal view of the apparatus showing the fixed moment arm achieved.

[0033] FIGS. **21**A-**21**C exemplarily illustrate orthogonal views of the apparatus showing variations in position of an additional power shaft.

[0034] FIG. **22** exemplarily illustrates an orthogonal view of the apparatus in a multi-cylinder environment.

[0035] FIG. **23** exemplarily illustrates a side orthogonal view of the apparatus in a multi-cylinder environment.

[0036] FIG. **24** exemplarily illustrates an orthogonal view of the apparatus showing the stabilizing fixture in a multi-cylinder environment.

[0037] FIG. **25** exemplarily illustrates a side orthogonal view of the apparatus showing the stabilizing fixture in a multi-cylinder environment.

[0038] FIG. **26** exemplarily illustrates a method of converting linear reciprocal motion to rotary motion.

DETAILED DESCRIPTION OF THE INVENTION

[0039] FIG. **1** exemplarily illustrates a front perspective view of an apparatus **100** for converting linear reciprocal motion to rotary motion. The apparatus **100** disclosed herein comprises at least one reciprocating assembly **101**, gear racks **105**, and gearing elements **106**. The reciprocating assembly **101** comprises a reciprocating component **102** and a reciprocating rod **103** capable of linear reciprocal motion in unison. The reciprocating component **102** is rigidly attached to the reciprocating rod **103** along a vertical axis **104** of the reciprocating rod **103**. The reciprocating component **102** is supported by a housing **107**. The reciprocating component **102** is a piston and is herein referred to as a "piston" **102**. The reciprocating rod **103** is slidably connected to an idler gear **108** via a guide pin **109** as exemplarily illustrated in FIG. **3**. The gear racks **105** disposed on opposing sides **103***a* and **103***b* of the reciprocating rod **103** transmit motion to the gearing elements **106**. The reciprocating rod **103** comprises an elongated aperture **110** along the vertical axis **104** of the reciprocating rod **103**. The guide pin **109** is disposed within the elongated aperture **110** to slidably connect the reciprocating rod **103** to the idler gear **108**.

[0040] The gearing elements **106** are disposed on opposing sides **103***a* and **103***b* of the reciprocating rod **103**. Each of the gearing elements **106** is rigidly mounted on a shaft **112** rotatably supported by the housing **107** via a collar bush **113** rigidly attached to the housing **107**. Each of the gearing elements **106** comprises a partial gear area **123** and a full gear area **124** as disclosed in the detailed description of FIG. **15**. The gearing elements **106** are in alternate mesh with the gear racks **105** on opposing sides **103***a* and **103***b* of the reciprocating rod **103** to transmit the motion to the idler gear **108**. That is, during operation of the apparatus **100** disclosed herein, the partial gear area **123** of one gearing element **106** on one opposing side **103***a* of the reciprocating rod **103** is in mesh with the gear rack **105** on that opposing side **103***a* of the reciprocating rod **103**, while the partial gear area **123** on the opposing gearing element **106** on the other opposing side **103***b* is not in mesh with the gear rack **105** on the other opposing side **103***b* of the reciprocating rod **103**. As used herein, "alternate mesh" refers to an alternation in meshing of the partial gear areas **123** of the opposing gearing elements **106** with the gear racks **105** on the opposing sides **103***a* and

103*b* of the reciprocating rod **103**, while the full gear areas **124** of the opposing gearing elements **106** are constantly in mesh with the idler gear **108**.

[0041] The gear racks **105** and the gearing elements **106** are constructed in, for example, a spur gear configuration, a helical gear configuration, or a herringbone gear configuration. The gearing elements **106** mesh with the idler gear **108** rigidly mounted on a power shaft **114** to convert the linear reciprocal motion of the reciprocating assembly **101** to rotary motion of the power shaft **114**. A centric axis **116** of the idler gear **108** is collinear to a longitudinal axis **117** of the power shaft **114**. The power shaft **114** is rotatably supported by the housing **107** via a collar bush **115** rigidly attached to the housing **107**.

[0042] The apparatus **100** disclosed herein further comprises a transfer roller **111** rotatably connected to the reciprocating rod **103**. The transfer roller **111** assists in alternation of the mesh of the gear racks **105** with each of the gearing elements **106**. In an embodiment, the reciprocating rod **103** comprises a top recess **119** and a bottom recess **120**, as exemplarily illustrated in FIG. **4**, on a locus of rotation of the transfer roller **111**, to allow passage of the transfer roller **111** through the reciprocating rod **103**.

[0043] The apparatus **100** further comprises a stabilizing fixture **118** rigidly attached to the housing **107** to operatively reduce vibrations within the apparatus **100**. The power shaft **114** and the shafts **112** of the apparatus **100** are rotatably connected to the stabilizing fixture **118**.

[0044] FIG. **2** exemplarily illustrates a bottom perspective view of the apparatus **100** showing the gearing elements **106** and the idler gear **108**. The centric axis **116** of the idler gear **108** is collinear to the longitudinal axis **117** of the power shaft **114**. The idler gear **108** is rigidly attached to the power shaft **114**. The reciprocating rod **103** is slidably connected to the idler gear **108** via the guide pin **109** as disclosed in the detailed description of FIG. **1**.

[0045] FIG. **3** exemplarily illustrates an exploded view of the apparatus **100** for converting linear reciprocal motion to rotary motion. The piston **102** is rigidly attached to the reciprocating rod **103** along the vertical axis **104** of the reciprocating rod **103**. The reciprocating rod **103** comprises the elongated aperture **110** along the vertical axis **104** through which the guide pin **109** is inserted to slidably connect the reciprocating rod **103** to the idler gear **108**. Furthermore, the centric axis **116** of the idler gear **108** is collinear to the longitudinal axis **117** of the power shaft **114**.

[0046] FIG. **4** exemplarily illustrates an exploded view of the apparatus **100** showing a top recess **119** and a bottom recess **120** of the reciprocating rod **103** of the apparatus **100**. The top recess **119** and the bottom recess **120** is provided on the reciprocating rod **103** on a locus of rotation of the transfer roller **111**, to allow passage of the transfer roller **111** through the reciprocating rod **103** as disclosed in the detailed description of FIG. **1**.

[0047] FIG. **5** exemplarily illustrates a front orthogonal view of the apparatus **100** showing a stabilizing fixture **118**. The stabilizing fixture **118** is rigidly attached to the housing **107** of the apparatus **100** as disclosed in the detailed description of FIG. **1**. The stabilizing fixture **118** is rigidly attached to the housing **107** by, for example, riveting, bolting, welding, etc. In an embodiment, the stabilizing fixture **118** is pre-cast or integrated as a part of the housing **107**. The stabilizing fixture **118** is rotatably connected to the power shaft **114**. Since the power shaft **114** and the reciprocating assembly **101** exhibit vibrations, the stabilizing fixture **118** transmits the vibrations to the housing **107** thereby reducing the vibrations of the power shaft **114** and the reciprocating assembly **101** within the apparatus **100**.

[0048] FIG. **6** exemplarily illustrates a rear orthogonal view of the apparatus **100** showing the gearing elements **106**. The gearing elements **106** are disposed on opposing sides **103***a* and **103***b* of the reciprocating rod **103**. The gearing elements **106** are in alternate mesh with the gear racks **105** on opposing sides **103***a* and **103***b* of the reciprocating rod **103** to transmit the motion to the idler gear **108** as disclosed in the detailed description of FIG. **1**. Each of the gearing elements **106** and each of the gear racks **105** together define a fixed moment arm **121** as disclosed in the detailed description of FIG. **20**.

[0049] FIG. **7** exemplarily illustrates a side sectional view of the apparatus **100** showing a power shaft **114** rotatably supported by a housing **107** via a collar bush **115**. The reciprocating rod **103** comprises the top recess **119** and the bottom recess **120** on the locus of rotation of the transfer roller **111**, to allow passage of the transfer roller **111** through the reciprocating rod **103** during operation of the apparatus **100**. The top recess **119** is in operation when the piston **102** is at a bottom dead center (BDC) **107***b* of the housing **107** as exemplarily illustrated in FIG. **19**C. The top recess **119** is disposed on the reciprocating rod **103** to allow passage of the transfer roller **111** through the reciprocating rod **103** when the piston **102** is at the BDC **107***b* of the housing **107**. The top recess **119** on the reciprocating rod **103** facilitates soft engagement of the transfer roller **111** with the reciprocating rod **103**. The bottom recess **120** on the reciprocating rod **103** facilitates soft engagement of the transfer roller **111** with the reciprocating rod **103**. The bottom recess **120** is in operation when the piston **102** is at a top dead center (TDC) **107***a* of the housing **107** as exemplarily illustrated in FIG. **19**A. The bottom recess **120** is disposed on the reciprocating rod **103** to allow passage of the transfer roller **111** through the reciprocating rod **103** when the piston **102** is at the TDC **107***a* of the housing **107**. The top recess **119** and the bottom recess **120** provide a curvature to ensure smooth transition of the reciprocating rod **103** within the apparatus **100** during operation. In an embodiment as exemplarily illustrated in FIG. **20**, an up exit relief **130** and a down exit relief **129** are disposed along the gear racks **105** to provide for an extra space between the gear racks **105** and the gearing elements **106** as the gearing elements **106** come in alternate mesh with the gear racks **105** on the opposing sides **103***a* and **103***b* of the reciprocating rod **103**.

[0050] FIGS. **8-10** exemplarily illustrate orthogonal views of the reciprocating assembly **101** with the gear racks **105** of the apparatus **100**. In an embodiment as exemplarily illustrated in FIG. **8**, each of the gear racks **105** is integrated on the reciprocating rod **103**. For example, a racked reciprocating rod **122** is provided as a combination of the reciprocating rod **103** and the gear racks **105**. FIG. **9** also illustrates the top recess **119** and the bottom recess **120** of the reciprocating rod **103**. The top recess **119** and the bottom recess **120** allow the transfer roller **111** to pass through the reciprocating rod **103**. In another embodiment as exemplarily illustrated in FIG. **10**, each of the gear racks **105** is externally attached to the reciprocating rod **103**. In this embodiment, the gear racks **105** and the reciprocating rod **103** are separate entities, wherein the gear racks **105** are externally attached to the reciprocating rod **103**.

[0051] FIGS. **11-12** exemplarily illustrate a side orthogonal view and a front orthogonal view of the idler gear **108** of the apparatus **100** respectively. The idler gear **108** is rigidly mounted on the power shaft **114** as disclosed in the detailed description of FIG. **1**. The gearing elements **106** synchronously mesh with the idler gear **108** to convert linear reciprocal motion of the reciprocating assembly **101** to rotary motion of the power shaft **114**. In an embodiment, the idler gear **108** is rotatably attached with at least one transfer roller **111** to alternate the mesh of the gear racks **105** on the reciprocating rod **103** with each of the gearing elements **106** that mesh with the idler gear **108**. The centric axis **116** of the idler gear **108** is collinear to the longitudinal axis **117** of the power shaft **114** as exemplarily illustrated in FIGS. **3-4**.

[0052] FIGS. **13-14** exemplarily illustrate a side orthogonal view and a front orthogonal view of the power shaft **114** of the apparatus **100** respectively. The power shaft **114** is rotatably supported by the housing **107** as exemplarily illustrated FIG. **1**. The idler gear **108** is rigidly mounted on the power shaft **114**. The centric axis **116** of the idler gear **108** is collinear to the longitudinal axis **117** of the power shaft **114**. The idler gear **108** may be secured to the power shaft **114** by, for example, a key, a thermal weld, etc.

[0053] FIGS. **15-16** exemplarily illustrate a side orthogonal view and a front orthogonal view of the gearing element **106** of the apparatus **100**. Each of the gearing elements **106** is rigidly mounted on the shaft **112** as exemplarily illustrated in FIGS. **1-2**. Each of the gearing elements **106** comprises a partial gear area **123** on a first section **126** of its width **125** and a full gear area **124** on a second section **127** of its width **125**. The partial gear area **123** on each of the gearing elements **106** is in mesh with one of the gear racks **105** on the reciprocating rod **103** and the full gear area **124** on each of the gearing elements **106** is in mesh with the idler gear **108** as exemplarily illustrated in FIGS. **1-2**.

[0054] For purposes of illustration, the detailed description refers to a partial gear area **123** and a full gear area **124** defined on the first section **126** and the second section **127** of the width **125** of the gearing element **106** respectively; however, the scope of the gearing element **106** disclosed herein is not limited to a partial gear area **123** on the first section **126** and a full gear area **124** on the second section **127** of the width **125** of the gearing element **106** but may be extended to include variable gear areas on different sections of the gearing element **106**. For example, alternate approximate quadrant sections of partial gear area **123** may be defined on the first section **126** of the width **125** of the gearing element **106** and a full gear area **124** may be defined on the second section **127** of the width **125** of the gearing element **106**.

[0055] FIGS. **17-18** exemplarily illustrate a side orthogonal view and a front orthogonal view of a shaft **112** of each of the gearing elements **106** respectively. Each of the gearing elements **106** is rigidly mounted on the shaft **112** as disclosed in the detailed description of FIG. **1**. Each of the gearing elements **106** is rigidly mounted on the shaft **112** by, for example, a key, a thermal weld, etc.

[0056] FIGS. 19A-19C exemplarily illustrate rear sectional views of the apparatus **100** in operation. The full gear area **124** on each of the gearing elements **106** is constantly in mesh with the idler gear **108** during each instant of operation of the apparatus **100**.

[0057] As exemplarily illustrated in FIG. **19**A, the piston **102** is at the TDC **107***a* of the housing **107** while the transfer roller **111** provided on the idler gear **108** is within the bottom recess **120** of the reciprocating rod **103**. During this instant of operation, the partial gear area **123** of one of the gearing elements **106** on one of the opposing sides **103***b* approaches a mesh with the gear rack **105** on the reciprocating rod **103** while the partial gear area **123** of the other one of the gearing elements **106** on the other opposing side **103***a* exits a mesh with the gear rack **105** on the reciprocating rod **103**.

[0058] As exemplarily illustrated in FIG. **19**B, the piston **102** is approximately mid-way between the TDC **107***a* and the BDC **107***b* of the housing **107** while the transfer roller **111** provided on the idler gear **108** is between the top recess **119** and the bottom recess **120** of the reciprocating rod **103**. During this instant of operation, the partial gear area **123** of one of the gearing elements **106** is in mesh with the gear rack **105** on one of the opposing sides **103***b* of the reciprocating rod **103** while the partial gear area **123** of another of the gearing elements **106** is not in mesh with the gear rack **105** on the opposing side **103***a* of the reciprocating rod **103**.

[0059] As exemplarily illustrated in FIG. **19**C, the piston **102** is at the BDC **107***b* of the housing **107** while the transfer roller **111** provided on the idler gear **108** is within the top recess **119** of the reciprocating rod **103**. During this instant of operation, the partial gear area **123** of one of the gearing elements **106** on the opposing side **103***a* approaches a mesh with the gear rack **105** while the partial gear area **123** of another one of the gearing elements **106** exits a mesh with the gear rack **105** on the opposing side **103***b* of the reciprocating rod **103**.

[0060] Consider the operation of the apparatus **100** disclosed herein. A mixture of fuel and air is ignited at the TDC **107***a* of the housing **107**. The piston **102** exhibits a linear reciprocal motion. The reciprocating rod **103** which is rigidly attached to the piston **102** consequently exhibits the linear reciprocal motion along with the piston **102**. The gear racks **105** rigidly attached on the opposing sides **103***a* and **103***b* of the reciprocating rod **103** transfer the linear reciprocal motion to the gearing elements **106**. The gearing elements **106** convert the linear reciprocal motion into a rotary motion and transfer this rotary motion to the idler gear **108**. The transfer roller **111** on the idler gear **108** alternates the transmission of the linear reciprocal motion from the gear racks **105** to the gearing elements **106**, that is, when the piston **102** moves from the TDC **107***a* of the housing **107** to the BDC **107***b* of the housing **107**, the linear reciprocal motion of the reciprocating rod **103** is transferred from the gear racks **105** on one of the opposing sides **103***a* of the reciprocating rod **103** to the gearing elements **106** disposed on the associated one of the opposing sides **103***a* of the reciprocating rod **103**, and when the piston **102** moves from the BDC **107***b* to the TDC **107***a* of the housing **107**, the linear reciprocal motion of the reciprocating rod **103** is transferred from the gear racks **105** on the other opposing side **103***b* of the reciprocating rod **103** to the gearing elements **106** disposed on the other opposing side **103***b* of the reciprocating rod **103**. In this manner, the linear reciprocal motion of the reciprocating rod **103** is transmitted to the gearing elements **106** on opposing sides **103***a* and **103***b* of the reciprocating rod **103** alternately and the subsequent rotary motion of each of the gearing elements **106** is transmitted to the idler gear **108** alternately.

[0061] FIG. **20** exemplarily illustrates an orthogonal view of the apparatus **100** showing the fixed moment arm **121** achieved. The apparatus **100** disclosed herein comprises a fixed stroke length **128** of the piston **102**, for example, a two inch stroke length, for which a fixed moment arm **121** exists, for example, a 0.633 inch moment arm. In the apparatus **100** disclosed herein, a mixture of fuel and air is ignited in the housing **107** and a combustion force is produced as a result of the ignition of the mixture of fuel and air. This combustion force is transmitted, with its maximum magnitude, to the power shaft **114**, thereby increasing efficiency by approximately 93 percent for a two inch stroke length as disclosed below.

[0062] The apparatus **100** disclosed herein using a two inch stroke length develops a fixed moment arm **121**. For a 2" stroke length, the circumferences of the gearing elements **106** and the idler gear **108** must be a working **4"**, thereby creating a working diameter of 1.27" for each of the gearing elements **106**. By dividing the working diameter by two, a 0.633" fixed moment arm **121** is obtained. This fixed moment arm **121** yields approximately 93% increase in power output and torque of the apparatus **100** by evaluating the percentage change in moment arm length, 0.3", over the original moment arm length 0.33" of a conventional reciprocating engine.

[0063] Hence, the apparatus **100** having a two inch stroke length is approximately 93% more efficient compared to the conventional reciprocating engine having the same stroke length. Alternatively, the apparatus **100** can be reduced in size by approximately 93% when compared to the 2" stroke length conventional reciprocating engine for the same power output. The apparatus **100** disclosed herein is used in, for example, aircrafts, trains, buses, trucks, cars, motorcycles, lawnmowers, pumps, motors, generators, other engine driven devices, etc.

[0064] FIGS. **21**A-**21**C exemplarily illustrate orthogonal views of the apparatus **100** showing variations in position of an additional power shaft **131**. In an embodiment, in addition to the power shaft **114**, another power shaft **131** is provided to adjustably vary the origin of output power in the apparatus **100**. In another embodiment, the shaft **112** of each of the gearing elements **106** may also be used to draw output power generated by the apparatus **100**. The power shaft **131** is disposed proximal to the idler gear **108**. The power shaft **131** is positioned, for example, above, below, or alongside the idler gear **108**. The variation in position of the power shaft **131** enables adjustable variation of the origin of output power. For example, in FIG. **21**A, the power shaft **131** is positioned above the idler gear **108** and is rigidly connected to the gearing element **106** which is in mesh with the idler gear **108**. In another example as illustrated in FIG. **21**B, the power shaft **131** is positioned alongside the idler gear **108**. In another example as illustrated in FIG. **21**C, the power shaft **131** is positioned below the idler gear **108**. The origin of the power output is thereby adjustably varied to suit a specific requirement of the apparatus **100**.

[0065] FIG. **22** exemplarily illustrates an orthogonal view of the apparatus **100** in a multi-cylinder environment. The apparatus **100** disclosed herein is adapted for a multi-cylinder environment, where more than one piston **102** and reciprocating rod **103** arrangement exists. In the multi-cylinder environment, multiple reciprocating assemblies **101** are rotatably secured to the power shaft **114** via multiple reciprocating rods **103**. The power shaft **114** in a multi-cylinder application is substantially elongated to enable rotatable connection to more than one reciprocating assembly **101**.

[0066] FIG. **23** exemplarily illustrates a side orthogonal view of the apparatus **100** in a multi-cylinder environment. Multiple idler gears **108** are rigidly mounted on the power shaft **114** of the apparatus **100** to adapt to the multi-cylinder environment. The power shaft **114** in a multi-cylinder application enables easy drawing of power from a single point of the apparatus **100**. In another embodiment, multiple power shafts **114** are provided, for example, above, below, or alongside the idler gear **108** if the power needs to be drawn from multiple points of the apparatus **100** as disclosed in the detailed description of FIGS. **21**A-**21**C.

[0067] FIG. **24** exemplarily illustrates an orthogonal view of the apparatus **100** showing a stabilizing fixture **118** in the multi-cylinder environment, wherein more than one piston **102** and reciprocating rod **103** arrangement exists. The stabilizing fixture **118** is disposed on the power shaft **114** to provide tolerance to the piston **102** and the shafts **112**. For example, in a multi-cylinder environment, the stabilizing fixture **118** is provided to reduce vibrations of the piston **102**.

[0068] FIG. **25** exemplarily illustrates a side orthogonal view of the apparatus **100** showing the stabilizing fixture **118** in the multi-cylinder environment. The stabilizing fixture **118** is rotatably connected to the power shaft **114** to provide tolerance to the power shaft **114**.

[0069] FIG. **26** exemplarily illustrates a method of converting linear reciprocal motion to rotary motion. An apparatus **100** comprising at least one reciprocating assembly **101**, multiple gear racks **105**, one or more gearing elements **106**, and a power shaft **114** as illustrated and disclosed in the detailed description of FIGS. **1**-**25**, is provided **2601**. The gearing elements **106** are disposed in a predetermined configuration to enable alternate meshing of the gearing elements **106** with the gear racks **105** on the opposing sides **103***a* and **103***b* of the reciprocating rod **103** and to enable constant meshing of the gearing elements **106** with the idler gear **108** during operation of the apparatus **100**. For example, the gearing elements **106** are arranged in a configuration such that the partial gear area **123** of one gearing element **106** is in mesh with the gear rack **105** on one of the opposing sides **103***a* of the reciprocating rod **103** while the partial gear area **123** of an opposing gearing element **106** is not in mesh with the gear rack **105** disposed on the other opposing side **103***b* of the reciprocating rod **103**. Therefore, the partial gear area **123** of each of the gearing elements **106** on opposing sides **103***a* and **103***b* is in alternate mesh with the gear racks **105** on the reciprocating rod **103**.

[0070] A linear reciprocal motion of the reciprocating assembly **101** is generated **2602** in response to a combustion force. The combustion force is transmitted **2603** to the gearing elements **106** via the gear racks **105** by the linear reciprocal motion of the reciprocating assembly **101**. The gear racks **105** convert **2604** the combustion force to a motion. The converted motion is transmitted **2605** to the gearing elements **106** in alternate mesh with the gear racks **105** on opposing sides **103***a* and **103***b* of the reciprocating rod **103** to rotate the gearing elements **106**. The meshing of the gear racks **105** with each of the gearing elements **106** is alternated using a transfer roller **111** rotatably connected to the reciprocating rod **103** or the idler gear **108**. The idler gear **108** meshed to the gearing elements **106** is rotated **2606** by the rotation of the gearing elements **106**. The power shaft **114** is rotated **2607** by the rotation of the idler gear **108** rigidly mounted on the power shaft **114**. The rotary motion is thereby generated at the power shaft **114** of the apparatus **100**. The vibrations within the apparatus **100** are operatively reduced using the stabilizing fixture **118** rotatably connected to the power shaft **114** and rigidly attached to the housing **107**.

[0071] The foregoing examples have been provided merely for the purpose of explanation and are in no way to be construed as limiting of the present invention disclosed herein. While the invention has been described with reference to various embodiments, it is understood that the words, which have been used herein, are words of description and illustration, rather than words of limitation. Further, although the invention has been described herein with reference to particular means, materials and embodiments, the invention is not intended to be limited to the particulars disclosed herein; rather, the invention extends to all functionally equivalent structures, methods and uses, such as are within the scope of the appended claims. Those skilled in the art, having the benefit of the teachings of this specification, may effect numerous modifications thereto and changes may be made without departing from the scope and spirit of the invention in its aspects.

I claim:

1. An apparatus for converting linear reciprocal motion to rotary motion, comprising:

at least one reciprocating assembly comprising a reciprocating component and a reciprocating rod capable of said linear reciprocal motion in unison, wherein said reciprocating component is rigidly attached to said reciprocating rod along a vertical axis of said reciprocating rod, wherein said reciprocating component is supported by a housing, and wherein said reciprocating rod is slidably connected to an idler gear via a guide pin;

a plurality of gear racks disposed on said reciprocating rod for transmitting motion to one or more of a plurality of gearing elements; and

said one or more gearing elements disposed on opposing sides of said reciprocating rod, wherein said gearing elements are in alternate mesh with said gear racks on said opposing sides of said reciprocating rod to transmit said motion to said idler gear, wherein each of said gearing elements and each of said gear racks together define a fixed moment arm, and wherein said gearing elements mesh with said idler gear rigidly mounted on a power shaft to convert said linear reciprocal motion of said reciprocating assembly to rotary motion of said power shaft, said power shaft being rotatably supported by said housing.

2. The apparatus of claim **1**, wherein a centric axis of said idler gear is collinear to a longitudinal axis of said power shaft.

3. The apparatus of claim **1**, wherein said each of said gearing elements comprises a partial gear area on a first section of its width and a full gear area on a second section of its width, wherein said partial gear area on said each of said gearing elements is in mesh with one of said gear racks on said reciprocating rod, and wherein said full gear area on said each of said gearing elements is in mesh with said idler gear.

4. The apparatus of claim **1**, wherein said each of said gearing elements is rigidly mounted on a shaft rotatably supported by said housing.

5. The apparatus of claim **1**, wherein said gear racks and said gearing elements are constructed in one of a spur gear configuration, a helical gear configuration, and a herringbone gear configuration.

6. The apparatus of claim **1**, wherein said reciprocating component is a piston.

7. The apparatus of claim **1**, wherein said reciprocating rod comprises an elongated aperture along said vertical axis of said reciprocating rod, wherein said guide pin is disposed within said elongated aperture to slidably connect said reciprocating rod to said idler gear.

8. The apparatus of claim **1**, wherein each of said gear racks is one of integrated on said reciprocating rod and externally attached to said reciprocating rod.

9. The apparatus of claim **1**, further comprising at least one transfer roller rotatably connected to said reciprocating rod, wherein said transfer roller assists in alternation of said mesh of said gear racks with said each of said gearing elements.

10. The apparatus of claim **9**, further comprising a top recess and a bottom recess on said reciprocating rod on a locus of rotation of said transfer roller, to allow passage of said transfer roller through said reciprocating rod.

11. The apparatus of claim **1**, further comprising at least one transfer roller rotatably attached to said idler gear to alternate said mesh of said gear racks with said each of said gearing elements.

12. The apparatus of claim **1**, further comprising one or more idler gears rigidly mounted on said power shaft.

13. The apparatus of claim **1**, further comprising a stabilizing fixture rotatably connected to said power shaft and rigidly attached to said housing to operatively reduce vibrations within said apparatus.

14. A method of converting linear reciprocal motion to rotary motion, comprising:

providing an apparatus comprising:

at least one reciprocating assembly comprising a reciprocating component and a reciprocating rod capable of said linear reciprocal motion in unison, wherein said reciprocating component is rigidly attached to said reciprocating rod along a vertical axis of said reciprocating rod, wherein said reciprocating component is supported by a housing, and wherein said reciprocating rod is slidably connected to an idler gear via a guide pin; wherein said rigid attachment of said reciprocating component to said reciprocating rod enables said linear reciprocal motion of said reciprocating assembly;

a plurality of gear racks disposed on said reciprocating rod; and

one or more gearing elements disposed on opposing sides of said reciprocating rod, wherein said gearing elements are in alternate mesh with said gear racks on said opposing sides of said reciprocating rod, wherein each of said gearing elements and each of said gear racks together define a fixed moment arm, and wherein said gearing elements mesh with said idler gear rigidly mounted on a power shaft, said power shaft being rotatably supported by said housing;

generating said linear reciprocal motion of said reciprocating assembly in response to a combustion force, wherein said linear reciprocal motion of said reciprocating assembly enables transmission of said combustion force to said gearing elements via said gear racks, wherein said gear racks convert said combustion force to a motion;

transmitting said converted motion to said gearing elements in said alternate mesh with said gear racks on said opposing sides of said reciprocating rod to rotate said gearing elements, wherein said rotation of said gearing elements causes rotation of said idler gear meshed to said gearing elements; and

rotating said power shaft by said rotation of said idler gear rigidly mounted on said power shaft;

whereby said rotary motion is generated at said power shaft of said apparatus.

15. The method of claim **14**, wherein said each of said gearing elements comprises a partial gear area on a first section of its width and a full gear area on a second section of its width, wherein said each of said gearing elements is disposed alongside and in said alternate mesh with said gear racks on said reciprocating rod through said partial gear area while said full gear area on said each of said gearing elements is constantly in mesh with said idler gear during operation of said apparatus.

16. The method of claim **14**, wherein a centric axis of said each of said gearing elements is parallel to a centric axis of said idler gear during operation of said apparatus.

17. The method of claim **14**, wherein said gearing elements are disposed in a predetermined configuration to enable said alternate meshing of said gearing elements with said gear racks on said opposing sides of said reciprocating rod and to enable constant meshing of said gearing elements with said idler gear during operation of said apparatus.

18. The method of claim **14**, further comprising operatively reducing vibrations within said apparatus using a stabilizing fixture rotatably connected to said power shaft and rigidly attached to said housing.

19. The method of claim **14**, further comprising alternating said mesh of said gear racks with said each of said gearing elements using a transfer roller rotatably connected to one of said reciprocating rod and said idler gear.

* * * * *