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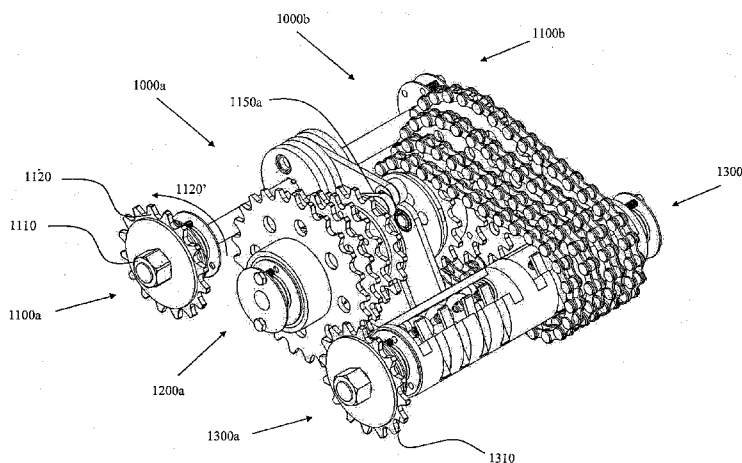


Fig.2

(57) Abstract: The present invention relates to an automatic gearbox comprising at least a drive transmission assembly. The drive transmission assembly comprises an active shaft (1100a) rotatable in a predetermined direction, an intermediate shaft (1200a), and a passive shaft (1300a). A connecting rod (1150a) is connected in a rotatable manner at its one end to the active shaft (1100a) and at its other end to the intermediate shaft (1200a). The connecting rod (1150a) is adapted to transmit rotary motion of the active shaft (1100a) to the intermediate shaft (1200a) so that the intermediate shaft (1200a) is rotatable in two different directions in a predetermined angle. The drive transmission pairs connect the intermediate shaft (1200a) and the passive shaft (1300a) so as to transmit rotary motion of the intermediate shaft (1200a) to the passive shaft (1300a). The drive transmission pairs are adapted in a way that they are only in the drive transmission state when the intermediate shaft (1200a) rotates in a predetermined direction.



AUTOMATIC GEARBOX

Field of the invention

The present invention relates to automatic drive transmission, and particularly to an automatic gearbox used for transmitting rotary motion of an active shaft to a passive shaft, and a drive transmission method used in the gearbox.

Background of the invention

In practice, automatic gearboxes have been widely used, especially in the transport industry. In a drive transmission system of a transport vehicle, such as a motor vehicle, an automatic gearbox is used in a manner that, when the vehicle runs at a slower speed, the system will change to a smaller drive transmission ratio so that the vehicle moves slowly but has a high traction, and when the vehicle runs at a faster speed, the system will change to a larger drive transmission ratio.

In other application such as energy industry, industrial production machines, an automatic gearbox can be used to obtain energy from an instability energy source and then convert into a stability energy source in compliance with a demand. In such applications, the passive shaft is usually required a constant speed, while the active shaft is affected by energy sources that are continuously changing intensity. Therefore, the system must change the drive transmission ratio so that for any speed of the active shaft, the system can transfer energy from the active shaft to the passive shaft.

Therefore, there is a need to have a gearbox used to transmit rotary motion from the active shaft to the passive shaft at any rotary speeds of the active shaft.

Summary of the invention

The present invention provides an automatic gearbox so as to carry out the above object and also has other advantages and effects.

According to the first aspect, the present invention provides a gearbox comprising a first drive transmission assembly. The first drive transmission assembly comprises a first active shaft which is rotatable in a predetermined direction, a first intermediate shaft, and a first passive shaft; a means for connecting the first active shaft to the first intermediate shaft, the means is adapted to transmit rotary motion of the first active shaft to the first intermediate shaft so that the first intermediate shaft is rotatable in the two opposing directions in a predetermined rotational angle. Drive transmission pairs connect the first intermediate shaft with the first passive shaft so as to transmit rotary motion of the first intermediate to the first passive shaft, wherein these drive transmission pairs are adapted so that they are only in a drive transmission state when the first intermediate shaft rotates in a predetermined direction.

In one embodiment, said drive transmission pairs are adapted so that at each speed of the first active shaft and the first passive shaft, at most there is one drive transmission pair of these drive transmission pairs in the drive transmission state.

In one embodiment, a means for connecting the first active shaft with the first intermediate shaft is a connecting rod, wherein the connecting rod is connected in a rotatable manner at its one end to the first active shaft and at its other end to the first intermediate shaft.

In one embodiment, said connecting rod is connected in a rotatable manner at its one end to a flywheel of the first active shaft.

In one embodiment, the flywheel comprises a center hole disposed at the center of the flywheel and side holes, wherein the centers of the side holes are equal-spaced from the center of the flywheel.

In one embodiment, the flywheel comprises two side holes that are disposed in a manner that a center angle of the flywheel created by two rays starting from the center of the flywheel and going through two centers of the two side holes, respectively, is 180° , and said connecting rod is connected in a rotatable manner at its one end to an axis mounted on a side hole of the flywheel.

In one embodiment, said drive transmission pairs have different drive transmission ratios.

In one embodiment, each drive transmission pair of said drive transmission pairs comprises a first gear mounted on the first intermediate shaft and a second gear mounted on the first passive shaft, the first gear and the second gear of each drive transmission pair comprise external teeth and connected to each other by a chain, and the second gear of each drive transmission pair further comprises internal teeth.

In one embodiment, numbers of external tooth of the first gears are different.

The first intermediate shaft further comprises actuating pins, that responsive to the rotation of the first intermediate shaft in said predetermined direction for rotating the first gears of the drive transmission pairs, respectively, in the same direction and at the same speed with respect to the first intermediate shaft in a predetermined order of the first gears, wherein the predetermined order is the order of the first gears of the drive transmission pairs that have drive transmission ratios gradually increased.

In one embodiment, a chain of each drive transmission pair responsive to the rotation of the first gear of that drive transmission pair for rotating its second gear in the same direction with respect to its first gear.

In one embodiment, each drive transmission pair of said drive transmission pairs comprises a first pulley mounted on the first intermediate shaft and a second pulley mounted on the first passive shaft, wherein the first pulley and the second pulley of each drive transmission pair are connected to each other by a belt lace, wherein the second pulley of each drive transmission pair further comprises internal teeth.

In one embodiment, the first passive shaft comprises fastening pins rotatable about an axis, each fastening pin disposed in a slot of the first passive shaft, and wherein the second gear of each drive transmission pair overlaps a respective fastening pin.

In one embodiment, when a speed of a second gear is greater than that of the first passive shaft, a respective fastening pin overlapped by a second gear responsive to the rotation of the second gear for hooking its first end on an internal tooth of the second gear, thereby defining a drive transmission pair for transmitting rotary motion from the first intermediate shaft to the first passive shaft by means of the defined drive transmission pair.

In one embodiment, the first passive shaft further comprises a ball box, wherein the ball box comprises balls and pushing pins, each pushing pin is placed beneath the second end of a fastening pin.

In one embodiment, the fastening pin beneath the second gear of the defined drive transmission pair responsive to the hook of a first end of a fastening pin on an internal tooth of a second gear for pressing a pushing pin beneath it into the inner of the ball box, thereby the other pushing pins apply

forces on respective second ends of fastening pins respective to the other pushing pins so as to cause the first ends of the respective fastening pins not to hook on internal teeth of the respective second gears, thereby invalidating the respective drive transmission pairs.

In one embodiment, the first drive transmission assembly further comprises an output gear mounted on the first passive shaft, this output gear is used to transmit rotary motion of the first passive shaft to an energy-obtaining object.

In one embodiment, the first drive transmission assembly further comprises an input gear mounted on the first active shaft, the input gear is used to obtain energy from an energy delivery source so as to rotate the first active shaft.

In a second aspect of the present invention, the gearbox of the first aspect further comprises a second drive transmission assembly. The second drive transmission assembly comprises the second active shaft rotatable in a predetermined direction, the second intermediate shaft, and the second passive shaft; a means for connecting the second active shaft and the second intermediate shaft, this means is adapted to transmit rotary motion of the second active shaft to the second intermediate shaft so that the second intermediate shaft is rotatable in two different directions in a predetermined rotary angle; drive transmission pairs for connecting the second intermediate shaft and the second passive shaft, used to transmit rotary motion of the second intermediate shaft to the second passive shaft, wherein the drive transmission pairs of the second drive transmission assembly are adapted so that they are only in the drive transmission state when the second intermediate shaft rotates in a predetermined direction, wherein the first active shaft of the first drive transmission assembly is connected to the second active shaft of the second drive transmission assembly

so as to transmit rotary motion of the first active shaft to the second active shaft, wherein the second passive shaft of the second drive transmission assembly is connected to the first passive shaft of the first drive transmission assembly so as to transmit rotary motion of the second passive shaft to the first passive shaft.

In one embodiment of the second aspect, the drive transmission pairs of the second drive transmission assembly are adapted so that at each speed of the second active shaft and the second passive shaft, at most there is one drive transmission pair of the second drive transmission assembly in the drive transmission state.

In one embodiment of the second aspect, the first drive transmission assembly and the second drive transmission assembly are adapted so that at each speed of the first active shaft and the first passive shaft of the first drive transmission assembly, at most there is one drive transmission pair of the first and second drive transmission assemblies in the drive transmission state.

In one embodiment of the second aspect, the first passive shaft of the first drive transmission assembly are integrally formed with the second passive shaft of the second drive transmission assembly.

In one embodiment of the second aspect, the first active shaft of the first drive transmission assembly are connected to the second active shaft of the second drive transmission assembly by means of a connecting flywheel.

In one embodiment of the second aspect, the first drive transmission assembly and the second drive transmission assembly are dephased 180°.

In a third aspect of the present invention, a gearbox further comprises a plurality of drive transmission assemblies including N-1 drive transmission assemblies, wherein N is a positive integer, each drive transmission assembly of the plurality of drive transmission assemblies is identical to the first drive

transmission assembly, wherein the first active shaft and the active shafts of the drive transmission assemblies of the plurality of drive transmission assemblies are connected to each other so as to transmit rotary motion of the first active shaft to the active shafts of the drive transmission assemblies of the plurality of drive transmission assemblies, wherein the first passive shaft and the passive shafts of the drive transmission assemblies of the plurality of the drive transmission assemblies are connected to each other so as to transmit rotary motion of the passive shafts of the drive transmission assemblies of the plurality of drive transmission assemblies to the first passive shaft.

In one embodiment of the third aspect, the first drive transmission assembly and the drive transmission assemblies of the plurality of drive transmission assemblies are adapted so that at each speed of the first active shaft and the first passive shaft of the first drive transmission assembly, at most there is one drive transmission pair of the first drive transmission assembly and the plurality of drive transmission pairs in the drive transmission state.

In one embodiment of the third aspect, the first passive shaft and the passive shafts of the drive transmission assemblies of the plurality of drive transmission pairs are integrally formed with each other.

In one embodiment of the third aspect, the active shafts of two adjacent drive transmission assemblies of the first drive transmission assembly and the plurality of drive transmission assemblies are connected to each other by means of a connecting flywheel.

In one embodiment of the third aspect, each drive transmission assembly of the first drive transmission assembly and the plurality of drive transmission assemblies are dephased with other two drive transmission assemblies by two angles of $360/N$ degree.

Brief description of the drawings

The above objects of the present inventions will be clearly understood by the following detailed description with reference to the accompanying drawings, in which:

Fig.1A is a perspective view of an automatic gearbox in accordance with an embodiment of the present invention;

Fig.1B a perspective view of the automatic gearbox of Fig.1A, in which a top cover and a bottom cover are detached;

Fig.2 is a perspective view of two drive transmission assemblies of Fig.1B in accordance with an embodiment of the present invention, in which certain elements of one drive transmission assembly are removed;

Fig.3A is a perspective view showing active shafts and connecting rods of the drive transmission assemblies, in accordance with an embodiment of the present invention;

Fig.3B is an exploded perspective view of the active shafts and the connecting rods of Fig.3A;

Fig.4A is a perspective view showing a shaft body and an element of an active shaft, in accordance with an embodiment of the present invention. Fig.4B is an exploded perspective view of the shaft body and the element of Fig.4A;

Fig.5A is a perspective view of a flywheel, in accordance with an embodiment of the present invention;

Fig.5B is an exploded perspective view of the flywheel of Fig.5A;

Fig.6A is a perspective view of a pivot of Fig.3B, in accordance with an embodiment of the present invention;

Fig.6B is an exploded perspective view of the pivot of Fig.6A;

Fig.7 is an exploded perspective view of a connecting rod of Fig.3B, in accordance with an embodiment of the present invention;

Fig.8A is a perspective view showing the shaft body of an active shaft of another drive transmission assembly, in accordance of an embodiment of the present invention;

Fig.8B is an exploded perspective view of the shaft body of Fig.8A;

Fig.9A is a perspective view showing a first intermediate shaft and first gears of the drive transmission pairs of a drive transmission assembly, in accordance with an embodiment of the present invention;

Fig.9B is an exploded perspective view of the first intermediate shaft and the first gears of Fig.9A;

Fig.10A is a perspective view showing passive shafts and second gears of the drive transmission pairs of the drive transmission assemblies, in accordance with an embodiment of the present invention;

Fig.10B is an exploded perspective view of the passive shafts and the second gears of Fig.10A;

Fig.11A is a perspective view of the shaft bodies of the passive shafts, in accordance with an embodiment of the present invention;

Fig.11B is an exploded perspective view of the shaft bodies of Fig.11A;

Fig.12A is a perspective view of a ball bearing assembly of Fig.10B, in accordance with an embodiment of the present invention;

Fig.12B is exploded perspective view of the ball bearing assembly of Fig.12A;

Fig.13A is a perspective view showing an input gear and a nut of Fig.2, in accordance with an embodiment of the present invention;

Fig.13B is an exploded perspective view of the input gear and the nut of Fig.13A;

Fig.14A is a cross-section view of the shaft body of a passive shaft and a gear disposed on this shaft body along a cross-section plane including a line A-A of Fig.10A;

Fig.14B is a cross-section view of the shaft body and the gear of Fig.14A in another position; and

Figs.15A-15D show different positions of pushing pins, in accordance with an embodiment of the present invention.

Detailed description of the invention

Fig.1A is a perspective view of an automatic gearbox in accordance with an embodiment of the present invention. Fig.1B is a perspective view of the automatic gearbox of Fig.1A, in which a top cover 2100 and a bottom cover 2200 are detached. In the described embodiment in Fig.1B, the automatic gearbox comprises two drive transmission assemblies 1000a and 1000b mounted inside of the top cover 2100 and the bottom cover 2200.

Fig.2 is a perspective view of the two drive transmission assemblies 1000a and 1000b of Fig.1B in accordance with the described embodiment of the present invention, in which certain elements of the drive transmission assembly 1000a are removed. The structure of the drive transmission assembly 1000a is

similar to that of the drive transmission assembly 1000b, and will be described in details below.

In one embodiment of the present invention, the drive transmission assembly 1000a comprises an active shaft 1100a, an intermediate shaft 1200a, and a passive shaft 1300a, a means for connecting the active shaft 1100a with the intermediate shaft 1200a so as to transmit rotary motion of the active shaft 1100a to the intermediate shaft 1200a, and a means for connecting the intermediate shaft 1200a with the passive shaft 1300a so as to transmit rotary motion of the intermediate shaft 1200a to the passive shaft 1300a. In the described embodiment, the means for connecting the active shaft 1100a with the intermediate shaft 1200a is a connecting rod 1150a, the means for connecting the intermediate shaft 1200a with the passive shaft 1300a is drive transmission pairs using gears and chains. Each of the drive transmission pairs comprises a first gear mounted on the intermediate shaft 1200a, a second gear mounted on the passive shaft 1300a, and a chain connecting these two gears. The second gears and the chains of the drive transmission pairs of the drive transmission assembly 1000a are not shown in Fig.2, but these second gears and these chains are similar to the second gears and the chains of the drive transmission pairs of the drive transmission assembly 1000b as shown in Fig.2. In the described embodiment, there are four drive transmission pairs used to connect the intermediate shaft 1200a with the passive shaft 1300a. Nevertheless, it should be noted that number of drive transmission pairs can be of any value.

In one embodiment of the present invention, an input gear 1120 is mounted on the active shaft 1100a, the input gear is used to obtain energy from an energy-generating source so as to rotate the active shaft 1100a. In addition, an output gear 1310 is mounted on the passive shaft 1300a, the output gear is used to transmit rotary motion of the passive shaft 1300a to an energy-receiving

object. In the described embodiment, the input gear 1120 and the output gear 1310 have the same structure.

In one embodiment of the present invention, the active shaft 1100a, the intermediate shaft 1200a, the passive shaft 1300a, the connecting rod 1150a, and the drive transmission pairs are adapted so that rotary motion of the active shaft 1100a (obtained from an energy generating source through the input gear 1120) is transmittable to the passive shaft 1300a by the intermediate shaft 1200a, thereby the rotary motion of the active shaft 1100a is transmitted to the output gear 1310 so as to subsequently transmit an energy receiving object. This configuration can be achieved by a structure and a mounting manner of the elements of the drive transmission assembly 1000a, and will be described in details below.

In the described embodiment, the connecting rod 1150a is connected in a rotatable manner at its one end to the active shaft 1100a, and is connected in a rotatable manner at its other end to the intermediate shaft 1200a. The connecting rod is adapted to transmit rotary motion of the active shaft 1100a to the intermediate shaft 1200a so that the intermediate shaft 1200a is able to rotate in the two opposing directions in a predetermined rotary angle. This configuration can be achieved by a structure and a mounting manner of the connecting rod 1150a, the active shaft 1100a, and the intermediate shaft 1200a, and will be described in details in the following description.

In the described embodiment, the drive transmission pairs have different drive transmission ratios, the drive transmission pairs connect the intermediate shaft 1200a to the passive shaft 1300a so as to transmit rotary motion of the intermediate shaft 1200a to the passive shaft 1300a. The drive transmission pairs are adapted so that they transmit motion (hereinafter called drive transmission state) only if the intermediate shaft 1200a rotates in a predetermined direction.

Additionally, the drive transmission pairs are also adapted so that at each speed of the active shaft 1100a and the passive shaft 1300a, at most there is one drive transmission pair in the drive transmission state (i.e., there is only one drive transmission pair in the drive transmission state or no drive transmission pair in the drive transmission state), the other drive transmission pairs do not transmit motion (hereinafter called non-drive transmission state or not in drive transmission state). This configuration can be achieved by the structure and the mounting manner of the drive transmission pairs, the intermediate shaft 1200a, and the passive shaft 1300a, and will be described in details in the following description.

The structure of the drive transmission assembly 1000b is similar to that of the drive transmission assembly 1000a. Nevertheless, in the described embodiment, the drive transmission assembly 1000b is not mounted an input gear and an output gear (such as the input gear 1120 and the output gear 1310 mounted on the drive transmission assembly 1000a).

The structure and the mounting manner of the elements of the drive transmission assemblies 1000a and 1000b will be described in details below.

Fig.3A is a perspective view showing the active shafts and the connecting rods of the drive transmission assemblies 1000a and 1000b, in accordance with the described embodiment of the present invention. Fig.3B is an exploded perspective view of the active shafts and the connecting rods of Fig.3A. As shown in Fig.3A and Fig.3B, the active shaft 1100a of the drive transmission assembly 1000a comprises a shaft body 1130a and a flywheel 1140a. The flywheel 1140a is fixed to a first end of the shaft body 1130a. A ball bearing assembly 1160a is mounted on a second end of the shaft body 1130a. The connecting rod 1150a is connected in a rotatable manner to the flywheel 1140a of the active shaft 1100a at one end of this connecting rod. In the described

embodiment, the connecting rod 1150a is connected to the flywheel 1140a by a pivot 1170a.

In one embodiment of the present invention, the active shaft 1100a further comprises an element 1180 used to mount to the input gear 1120 (Fig.2). In the described embodiment, the element 1180 is a cylinder element, connected to the shaft body 1130a at the second end of the shaft body so as to transmit rotary motion of the input gear 1120 (obtained from an energy receiving source) to the shaft body 1130a, thereby rotate the active shaft 1100a. The element 1180 can be connected to the shaft body 1130a in any manner. In the described embodiment, the element 1180 is integrally formed with the shaft body 1130a.

The structure of the active shaft 1100b of the drive transmission assembly 1000b is similar to that of the active shaft 1100a. More specifically, the active shaft 1100b comprises a shaft body 1130b and a flywheel 1140b. The flywheel 1140b is fixed to a first end of the shaft body 1130b. A ball bearing assembly 1160b is mounted on a second end of the shaft body 1130b. The connecting rod 1150b is connected in a rotatable manner to the flywheel 1140b of the active shaft 1100b at one end of this connecting rod. In the described embodiment, the connecting rod 1150b is connected to the flywheel 1140b by a pivot 1170b. Nevertheless, in the described embodiment, the active shaft 1100b is not mounted to an input gear, thereby does not have an element similar to the element 1180 of the active shaft 1100a.

In one embodiment of the present invention, the active shaft 1100a and the active shaft 1100b can be connected together so that by this connection, rotary motion of the active shaft 1100a does rotate the active shaft 1100b. In the described embodiment, the active shaft 1100a and the active shaft 1100b are connected together at the flywheels 1140a and 1140b through a connecting flywheel 1140c. More specifically, the flywheel 1140a is connected to the

connecting flywheel 1140c by the pivot 1170a, and the flywheel 1140b is connected to the connecting flywheel 1140c by the pivot 1170b. That is to say, the pivot 1170a connects all of the flywheel 1140a, the connecting rod 1150a, and the flywheel 1140c, and the pivot 1170b connects all of the flywheel 1140b, the connecting rod 1150b, and the flywheel 1140c. Thus, when the active shaft 1100a rotates, then the flywheel 1140a rotates, thereby rotates the connecting flywheel 1140c. The connecting flywheel 1140c rotates the flywheel 1140b and thereby rotates the active shaft 1100b. In the described embodiment, the flywheels 1140a, 1140b, and 1140c have the same structure. The pivots 1170a and 1170b have the same structure. The connecting rods 1150a and 1150b have the same structure.

Fig.4A is a perspective view showing the shaft body 1130a and the element 1180 of the active shaft 1100a, in accordance with the described embodiment of the present invention. Fig.4B is an exploded perspective view of the shaft body 1130a and the element 1180 of Fig.4A. It should be noted that the element 1180 is integrally formed with the shaft body 1130a.

Fig.5A is a perspective view of the flywheel 1140a, in accordance with the described embodiment of the present invention. Fig.5B is an exploded perspective view of the flywheel 1140a of Fig.5A. As shown in Fig.5A and Fig.5B, the flywheel 1140a has a center hole at the center of this flywheel, used to fit with the shaft body 1130a, and two side holes (a first side hole and a second side hole) situated at opposite positions through the center of the flywheel. In other words, the angle at the center point of the flywheel created by two rays which start from the center point of the flywheel and go through the center points of the first side hole and the second side holes, respectively, is 180°. In the described embodiment, the center points of the first side hole and the second side hole are equally apart from the center point of the flywheel 1140a. The first side hole is used for mounting the connecting rod 1150a by

means of the pivot 1170a. Spacer rings 1142a and 1144a are mounted in these two side holes, respectively. In another embodiment, there is only the center hole in the flywheel 1140a used to mount to the shaft body 1130a and the first side hole used to mount the connecting rod 1150a.

In the described embodiment, the structures of the flywheels 1140b and 1140c are similar to the structure of the flywheel 1140a of Fig.5A and Fig.5B. As shown in Fig.3A, the flywheel 1140a is connected to the connecting rod 1150a at its first side hole, and the flywheel 1140b is connected to the connecting rod 1150b at its second side hole. Accordingly, motions of the two connecting rods 1150a and 1150b deviates 180° from each other.

Fig.6A is a perspective view of the pivot 1170a of Fig.3B, in accordance with an embodiment of the present invention. Fig.6B is an exploded perspective view of the pivot 1170a of Fig.6A. It should be noted that, in the described embodiment, the structure of the pivot 1170b is the same as that of the pivot 1170a of Fig.6A and Fig.6B.

Fig.7 is an exploded perspective view of the connecting rod 1150a of Fig.3B, in accordance with the described embodiment of the present invention. A hole disposed at one end of this connecting rod is used for connection with the first side hole of the flywheel 1140a by means of the pivot 1170a, as described above and as shown in Fig.3A. A hole disposed at the other end of this connecting rod is used for connection with the intermediate shaft 1200a, as shown in Fig.2 and will be described in the following description. The spacer rings 1152a and 1154a are mounted in these two holes, respectively. It should be noted that, in the described embodiment, the structure of the connecting rod 1150b is similar to that of the connecting rod 1150a of Fig.7.

Fig.8A is a perspective view showing the shaft body 1130b of the active shaft 1100b of the drive transmission assembly 1000b, in the described

embodiment of the present invention. Fig.8B is an exploded perspective view of the shaft body 1130b of Fig.8A. In the described embodiment, the structure of the shaft body 1130b is similar to that of the shaft body 1130a of Fig.4A and Fig.4B, however, the shaft body 1130b does not comprise an element connecting to the output gear 1120 (the element 1180 of the shaft body 1130a).

Fig.9A is a perspective view showing the intermediate shaft 1200a and the first gears of the drive transmission pairs of the drive transmission assembly 1000a, in accordance with an embodiment of the present invention. Fig.9B is an exploded perspective view of the intermediate shaft 1200a and the first gears of Fig.9A. In the embodiment as shown in Fig.9B, the intermediate shaft 1200a comprises only the shaft body 1210a. There is a cylinder element 1212a protruding at one end of the shaft body 1210a, this cylinder element is used for connecting to one end of the connecting rod 1150a (Fig.3A) in a rotatable manner. This cylinder element is disposed at outer portion of the shaft body 1210a (deviating from the center point of the shaft body 1210a). The shaft body 1210a is mounted on a shaft holder 1250a and a ball bearing assembly 1240a by means of cylinder elements protruding from the center of the two ends of the shaft body 1210a. In the described embodiment, the base of the shaft holder 1250a comprises holes used to mount the shaft holder 1250a to the bottom cover 2200 by means of, e.g., bolts.

As shown in Fig.9A and Fig.9B, the first gears 1220a, 1222a, 1224a, and 1226a of the first, second, third, and fourth drive transmission pairs, respectively, of the drive transmission assembly 1000a comprise external teeth, in which tooth number of each first gear is different from each other. In one embodiment, the external tooth numbers of the first gears 1220a, 1222a, 1224a, and 1226a are 14, 18, 22, and 26, respectively. The first gears are mounted to the shaft body 1210a in an order so that the drive transmission pairs have drive transmission ratios that are gradually increased or decreased. For instance, the

first gears are mounted to the shaft body 1210a in an order of the gears that have the tooth numbers gradually increased or decreased. In the described embodiment, the gears are mounted to the shaft body 1210a in an order of the gears that have the tooth numbers gradually increased.

In particularly, the gear 1220a is fixed to the shaft body 1210a by means of tight joints between four slots in the gear 1220a and four protrusions 1214a on the shaft body 1210a (a protrusion 1214a is best shown in Fig.9B). The gears 1222a, 1224a, and 1226a are mounted in a rotatable manner to the shaft body 1210a by means of actuating pins 1290a, through the sliding slots 1223a, 1225a, and 1227a in the gears 1222a, 1224a, and 1226a, respectively. It should be noted that the actuating pins 1290a are fixed to the shaft body 1210a, while the gears can rotate on the shaft body 1210a due to the gap between the actuating pins 1290a and the respective sliding slots on the gears. The spacer rings 1260a, 1262a, and 1264a are disposed between the gear pairs 1120a and 1222a, 1222a and 1224a, 1224a and 1226a. The spacer rings prevent the gears from contacting with each other while these gears rotate on the shaft body 1210a.

In the described embodiment, a sliding slot in one gear is disposed on a hollow cylinder body, which extends along the axial line of the shaft body 1210a. The diameters of the hollow shaft bodies are equal.

The length of the sliding slot in each gear depends on the number of the external tooth of that gear. In the described embodiment, a gear has more teeth, then the length of the sliding slot in that gear is larger. In one embodiment, the lengths of the sliding slots in the gears 1222a, 1224a, and 1226a are 10 mm, 15 mm, and 20 mm, respectively.

With the structure and the mounting manner in the described embodiment in Fig.9A and Fig.9B, the intermediate shaft 1200a is rotatable in a predetermined angle, e.g., an angle of 270° . When the intermediate shaft 1200a

rotates in the direction 1200; the actuating pins 1290a will slide in the sliding slots 1223a, 1225a, and 1227a, respectively, and when they slides to the end of these sliding slots, they will affect to the gears 1222a, 1224a, and 1226a so as to rotate the gears in the same direction and at the same speed with respect to the intermediate shaft 1200a. As the lengths of the sliding slots are different, a gear has a shorter sliding slot, such a gear will be early affected by an applied force of an actuating pin 1290a, and will rotate at the same speed with respect to the intermediate shaft 1200a. Thus, the gears 1222a, 1224a, and 1226a will be affected by applied forces of the respective actuating pins 1290a and rotate at the same speed with respect to the intermediate shaft 1200a. It should be noted that the gear 1220a always rotates at the same speed with respect to the intermediate shaft 1200a, as this gear is fixed to the intermediate shaft 1200a. Similarly, when the intermediate shaft 1200a rotates in the direction 1200', the gears 1222a, 1224a, and 1226a will be affected by applied forces of the respective actuating pins and rotates at the same speed with respect to the intermediate shaft 1200a.

Fig.10A is a perspective view showing the passive shafts 1300a and 1300b, and the second gears of the drive transmission pairs of the drive transmission assemblies 1000a and 1000b, in the described embodiment of the present invention. Fig.10B is an exploded perspective view of the passive shafts 1300a and 1300b, and the second gears in Fig.10A. As shown in Fig.10B, the passive shaft 1300a comprises the shaft body 1320a. A ball bearing assembly 1370a is mounted to a cylinder element 1320a' protruding from one end of the shaft body 1320a.

As shown in Fig.10A and Fig.10B, according to the described embodiment, the second gears 1340a, 1342a, 1344a, and 1346a of the first, second, third, and fourth drive transmission pairs, respectively, of the drive transmission assembly 1000a have the external teeth, and the number of external

tooth of each of the second gears are the equal. In an example, the number of external tooth of each of the second gears 1340a, 1342a, 1344a, or 1346a is 16. Thus, the drive transmission ratios of the drive transmission assemblies depend on number of external tooth of the first gears 1220a, 1222a, 1224a, and 1226a: the number of external tooth is larger, then the drive transmission ratio is larger.

In the described embodiments, the maximum drive transmission ratio of the drive transmission pairs is TR_{max} . In the described embodiment, the drive transmission pair having the maximum drive transmission ratio, TR_{max} , is the fourth drive transmission pair, which comprises the first gear 1226a and the second gear 1346a.

In addition, the second gear also has internal teeth. In the described embodiment, each second gear has the same number of internal tooth. The second gears are mounted to the shaft body 1320a at positions so that each second gear overlaps an actuating pin 1322a of the shaft body 1320a. The spacer rings 1350a, 1352a, and 1354a are disposed between the second gears 1340a and 1342a, 1342a and 1344a, 1344a and 1346a, respectively. The spacer ring prevents the second gears to physically contact with each other when they rotate about the shaft body 1320a.

In the described embodiment, the passive shaft 1300a also comprises an element 1390 used for mounting to the output gear 1310 (Fig.2). The element 1390 is connected to the shaft body 1320a so as to transmit rotary motion of the shaft body 1320a to the output gear 1310 by means of the element 1390. The element 1390 can be connected to the shaft body 1320a by any manner. In the described embodiment, the element 1390 is integrally formed with the shaft body 1320a, and particularly, this element is integrally formed with the cylinder element 1320a'.

In the described embodiment, the structure of the passive shaft 1300b of the drive transmission assembly 1000b is similar to that of the passive shaft 1300a as described above, nevertheless, the passive shaft 1300b does not comprise a connecting element to the output gear (such as the element 1390 of the passive shaft 1300a).

In one embodiment of the present invention, the shaft body 1320a of the passive shaft 1300a and the shaft body 1320b of the passive shaft 1300b can be connected to each other so that by means of this connection, rotary motion of the shaft body 1320b rotates the shaft body 1320a. The shaft body 1320a and the shaft body 1320b can be connected to each other in any manner. In the described embodiment, the shaft body 1320a and the shaft body 1320b is integrally formed with each other. Therefore, the rotary motion of the shaft body 1320b rotates the shaft body 1320a, and by means of the element 1390 so as to rotate the output gear 1310.

In the drive transmission assembly 1000a, the actuating pins 1322a are adapted so that at any time, there is no any actuating pin 1322a that engages with an internal tooth of a second gear (when the gears 1342a rotate about the shaft body 1320a in a predetermined direction) or there is only one actuating pin 1322a that engages with an internal tooth of a second gear (when the second gear 1342a rotates about the shaft body 1320a in a direction opposing to the above direction). Similarly, in the drive transmission assembly 1000b, the actuating pins 1322b are adapted so that at any time, there is no any actuating pin 1322b that engages with an internal tooth of a second gear or there is only one actuating pin 1322b that engages with an internal tooth of a second gear. This structure can be constructed by arranging a ball box in the passive shaft, as described below.

Fig.11A is a perspective view of the shaft bodies 1320a and 1320b, in one embodiment of the present invention. Fig.11B is an exploded perspective view of the shaft bodies 1320a and 1320b in Fig.11A. As shown in Fig.11A and Fig.11B, each actuating pin 1322a is placed in a respective actuating pin 1321a' of the shaft core 1321a and is rotatable about an axis 1327a disposed in a slot running along the shaft core 1321a. A ball box is disposed in a slot 1321a'' axially extending along the shaft core 1321a. The ball box comprises balls 1325a, actuating pins 1328a, springs 1324a disposed in two ends of the ball box so as to push the balls toward the middle of the ball box, and a ball cover 1326a has circle holes in order to guide the actuating pins 1328a to move upwardly or downwardly. Each ball blocking cover 1323a is disposed between a spring and a ball closing to such a spring.

Each of the springs 1329a is placed in a fastening pin slot 1321a' so as to push the first end of a respective fastening pin, thereby the second end of this fastening pin is pushed toward the ball cover 1326a. It should be noted that the second end of the fastening pin overlaps an actuating pin 1328a of the ball box (as better shown in Fig.14A and Fig.14B).

Similarly, in the described embodiment, a ball box is disposed in the passive shaft 1320b of the drive transmission assembly 1000b.

Fig.12A is a perspective view of a ball bearing assembly 1370a in Fig.10B, in the described embodiment of the present invention. Fig.12B is an exploded view of the ball bearing assembly 1370a in Fig.12A. In the described embodiment of the present embodiment, the ball bearing assemblies 1160a and 1160b (Fig.3B), 1240a (Fig.9B), and 1370b (Fig.10B) have the structure that is similar to that of the ball bearing assembly 1370a as shown in Fig.12A and Fig.12B. The ball bearing assemblies are placed in the holes formed by the

sidewall of the top cover 2100 and the bottom cover 2200 when these two covers are fitted with each other (Fig.1A and Fig.1B).

Fig.13A is a perspective view showing the input gear 1120 and a nut 1110 in Fig.2, in one embodiment of the present invention. Fig.13B is an exploded perspective view of the input gear 1120 and a nut 1110 in Fig.13A.

Fig.14A is a cross-section view of the shaft body 1320a and the gear 1342a along a plane defined by a line A-A in Fig.10A and perpendicular to the centerline of the shaft body 1320a. Accordingly, the fastening pin 1322a will not hook on an internal tooth of the gear 1342a when this gear rotates in the counterclockwise direction. Fig.14B is a cross-section view of the shaft body 1320a and the gear 1342a of Fig.14A at a position at which the fastening pin 1322a is hooked on an internal tooth of the gear 1342a when this gear rotates in the counterclockwise direction. In the described embodiment, the structure and operation of the gears 1340a, 1344a, and 1346a are similar to those of gears 1342a in Fig.14A and Fig.14B. The structure and operation of the gears 1340b, 1342b, 1344b, and 1346b on the passive shaft 1300b are similar to those of the gear 1342a in Fig.14A and Fig.14B.

Figs. 15A to 15D are cross-section views of the passive shaft 1320a along the ball box, showing different positions of the actuating pins 1328a, in accordance with the described embodiments of the present invention. Accordingly, when a pushing pin 1328a is pressed downwardly, then the other pushing pin 1328a will be pushed upwardly. Accordingly, at a time, there is only one fastening pin 1322a that is hooked on an internal tooth of a respective gear or there is no fastening pin 1328a is hooked on an internal tooth of respective gears (when all of the gears rotate in the counterclockwise direction as shown in Fig.14A). Similarly, for the passive shaft 1320b, at a time, there is only one fastening pin 1322b that is hooked on an internal tooth of a respective gear or

there is no fastening pin 1328b that is hooked on an internal pin of the respective gears.

Operation principle of automatic gearbox

Because operation of the drive transmission assembly 1000a is similar to that of the drive transmission assembly 1000b, therefore the following description depicts the operation of the drive transmission assembly 1000a.

According to the described embodiment, when the active shaft 1100a rotates in the direction 1120' (Fig.2), the connecting rod 1150a transmits rotary motion of the active shaft 1100a to the intermediate shaft 1200a, thereby rotates the intermediate shaft 1200a in the two different directions within a predetermined angle. The predetermined angle is less than 360° . This angle depends on the space between the active shaft and the intermediate shaft, the length of the connecting rod 1150a, etc.. A half of a revolution of the active shaft 1100a will cause the intermediate shaft 1200a to rotate in a reverse direction with respect to the active shaft 1100a, the other half of the active shaft 1100a will cause the intermediate shaft 1200a to rotate in the same direction with respect to the active shaft 1100a.

When the intermediate shaft 1200a rotates in the reverse direction with respect to the active shaft 1100a, then the actuating pins 1290a (Fig.9A and Fig.9B) applies a force on the first gears 1222a, 1224a, and 1226a so as to push the first gears to one side. When the intermediate shaft 1200a stops rotating in the reverse direction with respect to the rotary direction of the active shaft 1100a, each first gear 1220a, 1222a, 1224a, or 1226a will be at a position, hereafter called its starting position. When the intermediate shaft 1200a rotates in the same direction with respect to the active shaft 1100a, then the first gear 1220a immediately rotates in the same direction and at the same speed with respect to the intermediate shaft 1200a.

At the same time, the actuating pins 1290a moves along the sliding slots on the respective gears, after moving to the end of the sliding slots, they apply forces on the respective gears causing the gears rotate in the same direction and at the same speed with respect to the intermediate shaft 1200a. Using connection by chain between the first gears and the second gears on the passive shaft 1300a, therefore the second gears on the passive shaft 1300a will rotate in the same direction with respect to the intermediate shaft 1200a, i.e., in the same direction with respect to the active shaft 1100a. Speed of each second gear depends on, and more particularly, in direct proportion to, drive transmission ratio of each transmission gear.

It should be noted that, as the lengths of the sliding slots on the first gear are different, the length of the sliding slot of a first gear is shorter (i.e., the tooth number of such a gear is fewer, in accordance with the described embodiment), such a first gear is affected by an actuating pin 1290a in advance, and will rotate in the same direction and at the same speed with respect to the intermediate shaft 1200a. Thus, the drive transmission ratio of a drive transmission pair is smaller, then the second gear of such a drive transmission pair on the passive shaft 1300a will be transmission in advance.

Thus, the second gears 1340a, 1342a, 1344a, and 1346a will be transmitted in turn and rotate in the same direction with respect to the active shaft 1100a. It should be noted that speeds of the second gears gradually increase in order of the gears 1340a, 1342a, 1344a, and 1346a (as the drive transmission ratios of the drive transmission pairs gradually increase (Fig.9B)).

When the speed of a second gear is greater than that of the passive shaft 1300a, then an internal tooth of this second gear is hooked and applies a force on the first end of a respective fastening pin 1322a disposed beneath this second gear, so that the other end (second end) of the fastening pin 1322a presses the

cover of the ball box 1326a (thereby rotates the passive shaft 1300a in the same direction and at the same speed with respect to the second gear), simultaneously presses a respective pushing pin 1328a of the ball box to move into the inner of the ball box. (That is to say, the respective fastening pin 1322a overlapped by the second gear hooks its first end on an internal tooth of the second gear, thereby defining a drive transmission pair so as to perform the transmission and transmit rotary motion from the intermediate shaft 1200a to the passive shaft 1300a by the defined drive transmission pair.) Accordingly, the other pushing pins 1328a is protruded upper of the ball box (see Fig.15A to Fig.15D) and apply on the second end of the respective fastening pins, thereby the first ends of the respective fastening pins hide in the shaft body 1321a and cannot hook on the internal teeth of the respective second gears. (In other words, the fastening pins 1322a beneath the second gear of the defined drive transmission pair (or in the drive transmission state) responsive to the hook of its first end on an internal tooth of the second gear for using its second end to press the respective pushing pin 1328a beneath the fastening pins into the inner of the ball box, thereby the other pushing pins apply on the second ends of the respective fastening pins so as to prevent the first ends of the fastening pins hook on the internal teeth of the respective second gear, thereby invaliding the respective drive transmission pairs.) Thus, the drive transmission pairs respective to the pushing pins 1328a that protrudes the upper of the ball box are invalidated.

When the speed of a second gear of a drive transmission pair is lower than that of the passive shaft 1300a, then the drive transmission pair does not transmit motion to the passive shaft 1300a (i.e., in the non-drive transmission state or not in the drive transmission state). When the speed of a second gear of the drive transmission pair is greater than that of the passive shaft 1300a, then the drive transmission pair is defined to do the transmission (in the drive transmission

state). At a speed of the active shaft 1100a and the passive shaft 1300a, then at most there is a drive transmission pair in the drive transmission state.

Thus, the method for determining a drive transmission pair used to transmit motion from the intermediate shaft 1200a to the shaft 1300a comprises the step of trying the drive transmission pairs in turn in an order of the drive transmission pairs that have the drive transmission ratios gradually increased, until an appropriate drive transmission pair is defined. After an appropriate drive transmission pair has been defined, the other drive transmission pairs will be invalidated.

The operation of the drive transmission assembly 1000b is similar to that of the drive transmission assembly 1000a, wherein rotary motion of the active shaft 1100b is obtained through the connection with the active shaft 1100a.

As described above, a half of revolution of the active shaft 1100a causes the intermediate shaft 1200a to rotate in the reverse direction with respect to the active shaft 1100a and do not transmit to the passive shaft, the other half of revolution of the active shaft 1100a causes the intermediate shaft 1200a to rotate in the same direction with respect to the active shaft 1100a and transmit to the passive shaft 1300a. In the described embodiment, the drive transmission assemblies 1000a and 1000b are dephased 180° so as to do the transmission continuously. Therefore, when the intermediate shaft 1200a returns to the starting position, then the intermediate shaft 1200b starts detecting a drive transmission ratio and then transmitting motion, and vice versa. Thus, at the same time, at each speed of the active shaft 1100a and the passive shaft 1300a, at most there will be one drive transmission pair in the drive transmission pairs of the drive transmission assemblies 1000a and 100b in the drive transmission state.

In general embodiment, a gearbox can comprise N drive transmission assemblies that are similar to the drive transmission assembly 1000a or 1000b, wherein N is a positive integer, are dephased to each other and each drive transmission assembly is dephased $360^\circ/N$ with respect to two other drive transmission assemblies. (In other words, each drive transmission assembly is dephased to each two other drive transmission assemblies in two identical angles.) The adjacent drive transmission assemblies are connected to each other in a manner that is similar to the connection manner of the drive transmission assemblies 1000a and 1000b (such as the connection manner of the two active shafts, the connection manner of the two passive shafts). In this embodiment, with a revolution of the active shaft, it in turn has a drive transmission pair of each drive transmission assembly in the drive transmission state so as to transmit motion to the passive shaft. This can be made by means of the structure of the flywheels and the connection manner of the connecting rods to the flywheels in a manner that is similar to the connection manner of the two drive transmission assemblies 1000a and 1000b.

In the described embodiments, the drive transmission pairs use gears and chains, wherein each drive transmission pair comprises a first gear is mounted in the intermediate shaft, a second gear is mounted on the passive shaft, and a chain used to connect these two gears. In another embodiment, the drive transmission pairs use pulleys and belt laces. Each drive transmission pair comprises a first pulley mounted on the intermediate shaft, a second pulley mounted on the passive shaft, and a belt lace used to connect these two pulleys. Accordingly, the pulleys have appropriate diameters for satisfying the required drive transmission ratio. Also, the second pulleys have internal gears that are similar to those of the second gears.

In another embodiment, it can use both drive transmission pairs (gear-chain and pulley-belt lace) on the same drive transmission assembly.

Accordingly, a drive transmission assembly comprises some drive transmission pair using gear and chain, and other drive transmission pairs using pulley and belt lace.

While the invention has been described in terms of exemplary embodiments and aspects thereof, and with reference to the accompanying drawings, it will be understood by those skilled in the art that the invention is not limited to the exemplary and illustrative embodiments. Rather, various modifications and the like could be made thereto without departing from the scope of the invention as defined in the appended claims.

CLAIMS

1. An automatic gearbox comprising a first drive transmission assembly (1000a), wherein the first transmission assembly comprises:

a first active shaft (1100a) being rotatable in a predetermined direction, a first intermediate shaft (1200a), and a first passive shaft (1300a);

a means for connecting the first active shaft (1100a) and the first intermediate shaft (1200a), this means is adapted to transmit rotary motion of the first active shaft (1100a) to the first intermediate shaft (1200a) so that the first intermediate shaft (1200a) is rotatable in two different directions in a predetermined rotary angle; and

drive transmission pairs connecting the first intermediate shaft (1200a) and the first passive shaft (1300a) for transmitting rotary motion of the first intermediate shaft (1200a) to the first passive shaft (1300a),

wherein the drive transmission pairs are adapted so that they are only in a drive transmission state when the first intermediate shaft (1200a) rotates in a predetermined direction.

2. The automatic gearbox according to claim 1, wherein said drive transmission pairs are adapted so that at each speed of the first active shaft (1100a) and the first passive shaft (1300a), at most there is a drive transmission pair in said drive transmission pairs in the drive transmission state.

3. The automatic gearbox according to claim 1 or claim 2, wherein the means for connecting the first active shaft (1100a) and the first intermediate shaft (1200a) is a connecting rod (1150a), and wherein the connecting rod is connected in a rotatable manner at its one end to the first active shaft (1100a) and at its other end to the first intermediate shaft (1200a).

4. The automatic gearbox according to claim 3, wherein said connecting rod (1150a) is connected in a rotatable manner at its one end to a flywheel (1140a) of the first active shaft (1100a).

5. The automatic gearbox according to claim 4, wherein the flywheel (1140a) comprises a center hole disposed at the center of the flywheel and side holes, wherein the centers of the side holes are equal-spaced from the center of the flywheel.

6. The automatic gearbox according to claim 5,

wherein the flywheel (1140a) comprises two side holes that are disposed so that a center angle of the flywheel created by two rays starting from the center of the flywheel and going through two centers of the two side holes, respectively, is 180° , and

wherein said connecting rod (1150a) is connected in a rotatable manner at its one end to an axis (1170a) mounted on a side hole of the flywheel (1140a).

7. The automatic gearbox according to any claim of claims 1-6, wherein said drive transmission pairs have different drive transmission ratios.

8. The automatic gearbox according to any one of claims 1-7, wherein each drive transmission pair of said drive transmission pairs comprises a first gear (1220a, 1222a, 1224a, or 1226a) mounted on the first intermediate shaft (1200a) and a second gear (1340a, 1342a, 1344a, and 1346a) mounted on the first passive shaft (1300a),

wherein the first gear and the second gear of each drive transmission pair comprise external teeth and connected to each other by a chain, and

wherein the second gear of each drive transmission pair further comprises internal teeth.

9. The automatic gearbox according to claim 8, wherein numbers of external tooth of the first gears are different.

10. The automatic gearbox according to claim 8 or claim 9, wherein the first intermediate shaft (1200a) further comprises actuating pins (1290a), that responsive to the rotation of the first intermediate shaft (1200a) in said predetermined direction for rotating the first gears (1220a, 1222a, 1224a, 1226a) of the drive transmission pairs, respectively, in the same direction and at the same speed with respect to the first intermediate shaft (1200a) in a predetermined order of the first gears, and

wherein the predetermined order is the order of the first gears of the drive transmission pairs that have drive transmission ratios gradually increased.

11. The automatic gearbox according to claim 10, a chain of each drive transmission pair responsive to the rotation of the first gear of that drive transmission pair for rotating its second gear in the same direction with respect to its first gear.

12. The automatic gearbox according to any claim of claims 1-7, wherein each drive transmission pair of said drive transmission pairs comprises a first pulley mounted on the first intermediate shaft (1200a) and a second pulley mounted on the first passive shaft (1300a),

wherein the first pulley and the second pulley of each drive transmission pair are connected to each other by a belt lace, and

wherein the second pulley of each drive transmission pair further comprises internal teeth.

13. The automatic gearbox according to any claim of claims 8-11, wherein the first passive shaft (1300a) comprises fastening pins (1322a) rotatable about an axis (1327a), each fastening pin is disposed in a slot (1321a') in the first passive shaft (1300a), and wherein the second gear of each drive transmission pair overlaps a respective fastening pin.

14. The automatic gearbox according to claim 13, wherein when a speed of a second gear is greater than that of the first passive shaft (1300a), a respective fastening pin (1322a) overlapped by a second gear responsive to the rotation of the second gear for hooking its first end on an internal tooth of the second gear, thereby defining a transmission gear for transmitting rotary motion from the first intermediate shaft (1200a) to the first passive shaft (1300a) by means of the defined drive transmission pair.

15. The automatic gearbox according to claim 13 or claim 14, wherein the first passive shaft (1300a) further comprises a ball box, wherein the ball box comprises balls (1325a) and pushing pins (1328a), each pushing pin is placed beneath the second end of a fastening pin.

16. The automatic gearbox according to claim 15, wherein the fastening pin (1328a) beneath the second gear of the defined drive transmission pair responsive to hook of a first end of a fastening pin on an internal tooth of a second gear for pressing a pushing pin beneath it into the inner of the ball box, thereby the other pushing pins apply forces on respective second ends of fastening pins respective to the other pushing pins so as to cause the first ends of the respective fastening pins not to hook on internal teeth of the respective second gears, thereby invalidating the respective drive transmission pairs.

17. The automatic gearbox according to any one of claims 1-16, wherein the first drive transmission assembly further comprises an output gear (1310)

mounted on the first passive shaft (1300a) for transmitting rotary motion of the first passive shaft (1300a) to an energy-obtaining object.

18. The automatic gearbox according to any one of claims 1-17, wherein the first drive transmission assembly further comprises an output gear (1120) mounted on the first active shaft (1100a) for obtaining energy from an energy delivery source so as to rotate the first active shaft (1100a).

19. The automatic gearbox according to any one of the preceding claims, wherein the gearbox further comprises a second drive transmission assembly, the second drive transmission assembly comprises:

a second active shaft (1100b) being rotatable in a predetermined direction, a second intermediate shaft (1200b), a second passive shaft (1300b);

a means for connecting the second active shaft (1100b) and the second intermediate shaft (1200b), this means is adapted to transmit rotary motion of the second active shaft (1100b) to the second intermediate shaft (1200b) so that the second intermediate shaft (1200b) is rotatable in two different directions in a predetermined rotary angle; and

drive transmission pairs for connecting the second intermediate shaft (1200b) and the second passive shaft (1300b) for transmitting rotary motion of the second intermediate shaft (1200b) to the second passive shaft (1300b),

wherein the drive transmission pairs of the second drive transmission assembly are adapted so that they are only in the drive transmission state when the second intermediate shaft (1200b) rotates in a predetermined direction,

wherein the first active shaft (1100a) of the first drive transmission assembly (1000a) is connected to the second active shaft (1100b) of the second

drive transmission assembly so as to transmit rotary motion of the first active shaft (1100a) to the second active shaft (1100b), and

wherein the second passive shaft (1300b) of the second drive transmission assembly (1000b) is connected to the first passive shaft (1300a) of the first drive transmission assembly (1000a) so as to transmit rotary motion of the second passive shaft (1300b) to the first passive shaft (1300a).

20. The automatic gearbox according to claim 19, wherein the drive transmission pairs of the second drive transmission assembly (1300b) are adapted so that at each speed of the second active shaft (1100b) and the second passive shaft (1300b), at most there is one drive transmission pair of the second drive transmission assembly in the drive transmission state.

21. The automatic gearbox according to claim 19 or claim 20, wherein the first drive transmission assembly (1000a) and the second drive transmission assembly (1000b) are adapted so that at each speed of the first active shaft (1100a) and the first passive shaft (1300a) of the first drive transmission assembly, at most there is one drive transmission pair of the first and second drive transmission assemblies in the drive transmission state.

22. The automatic gearbox according to any one of claims 19-21, wherein the first passive shaft (1300a) of the first drive transmission assembly is integrally formed with the second passive shaft (1100b) of the second drive transmission assembly.

23. The automatic gearbox according to any one of claims 19-22, wherein the first active shaft (1100a) of the first drive transmission assembly (1000a) are connected to the second active shaft (1100b) of the second drive transmission assembly by means of a connecting flywheel (1140c).

24. The automatic gearbox according to any one of claims 19-23, wherein the first drive transmission assembly and the second drive transmission assembly are dephased 180°.

25. The automatic gearbox according to claim 1, wherein the gearbox further comprises a plurality of drive transmission assemblies including N-1 drive transmission assemblies, wherein N is a positive integer, each drive transmission assembly of the plurality of drive transmission assemblies is identical to the first drive transmission assembly of claim 1,

wherein the first active shaft and the active shafts of the plurality of drive transmission assemblies are connected to each other so as to transmit rotary motion of the first active shaft to the active shafts of the plurality of drive transmission assemblies, and

wherein the first passive shaft and the passive shafts of the plurality of the drive transmission assemblies are connected to each other so as to transmit rotary motion of the passive shafts of the plurality of drive transmission assemblies to the first passive shaft.

26. The automatic gearbox according to claim 25, wherein the first drive transmission assembly and the plurality of drive transmission assemblies are adapted so that at each speed of the first active shaft and the first passive shaft of the first drive transmission assembly, at most there is one drive transmission pair of the first drive transmission assembly and the plurality of drive transmission pairs in the drive transmission state.

27. The automatic gearbox according to claim 25 or claim 26, wherein the first passive shaft and the passive shafts of the plurality of drive transmission pairs are integrally formed with each other.

28. The automatic gearbox according to any one of claims 25-27, wherein the active shafts of two adjacent drive transmission assemblies of the first drive transmission assembly and the plurality of drive transmission assemblies are connected to each other by means of a connecting flywheel.

29. The automatic gearbox according to any one of claims 25-28, wherein each drive transmission assembly of the first drive transmission assembly and the plurality of drive transmission assemblies are dephased with other two adjacent drive transmission assemblies by two angles of $360/N$ degree, respectively.

Fig.1A

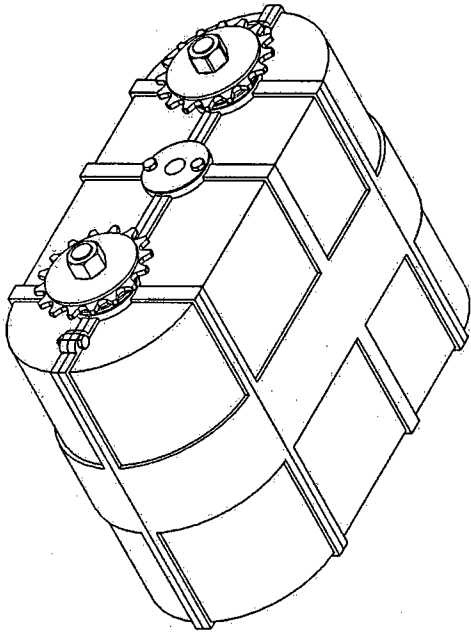
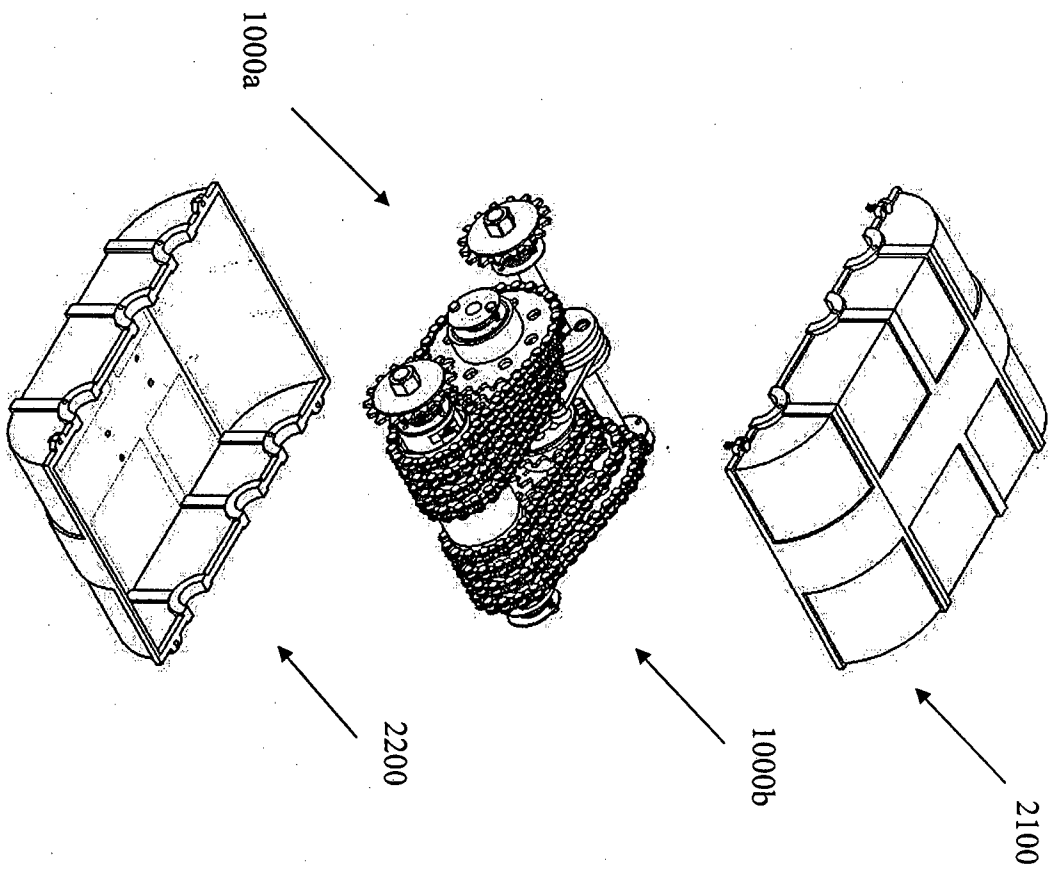
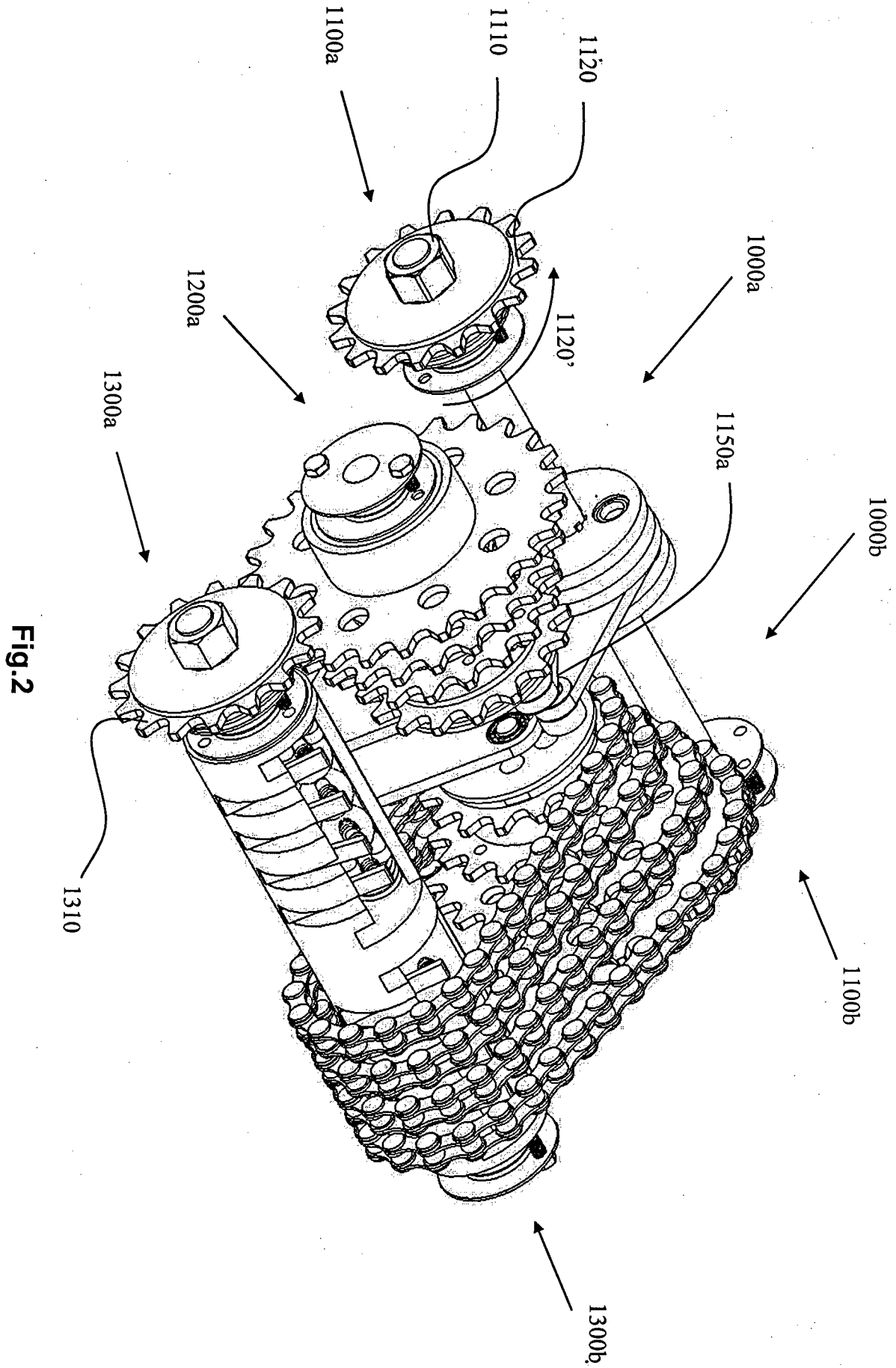
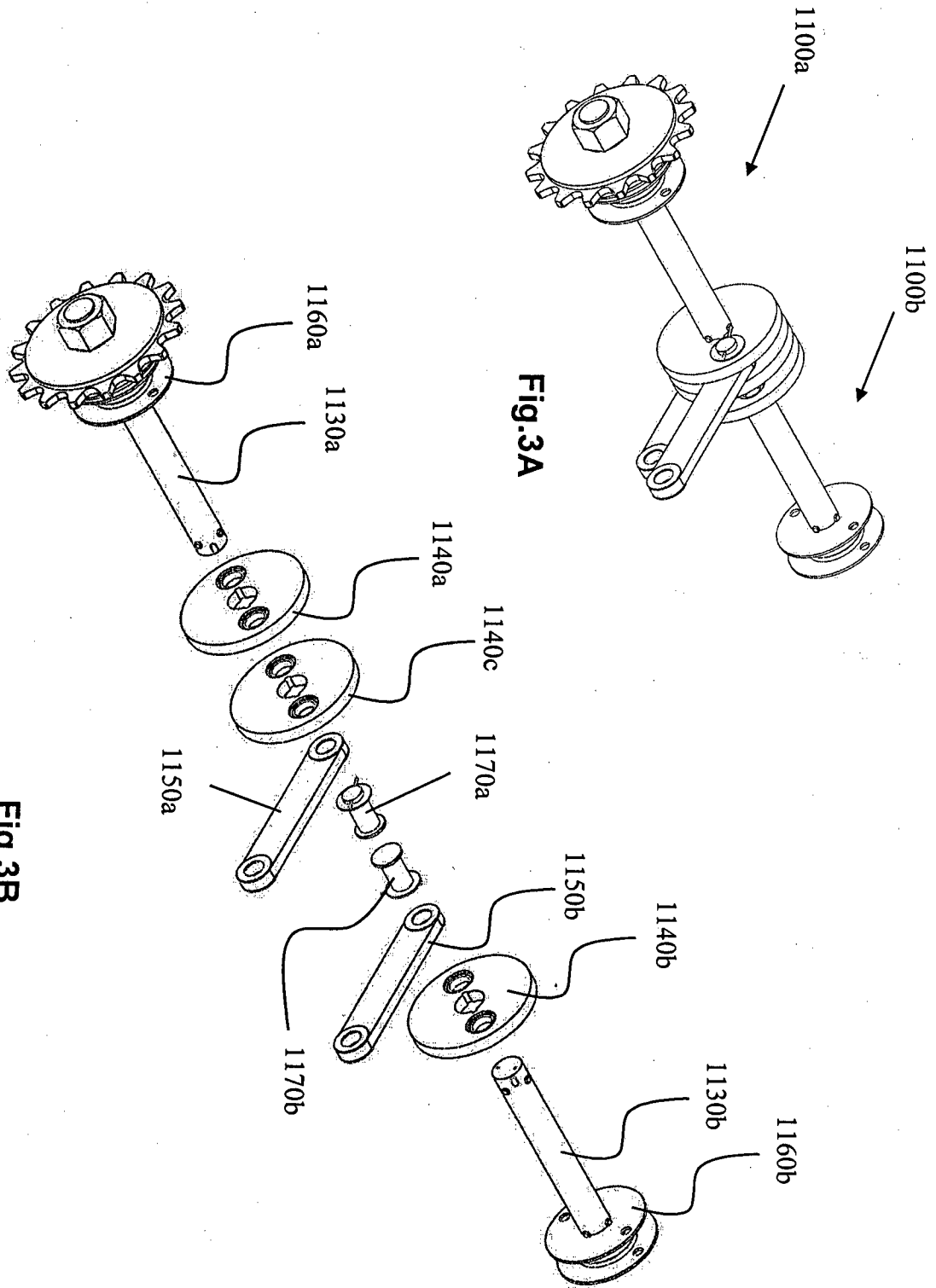


Fig.1B







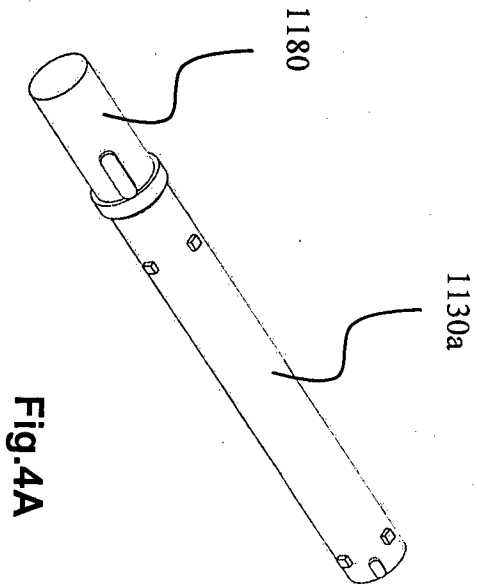


Fig. 4A

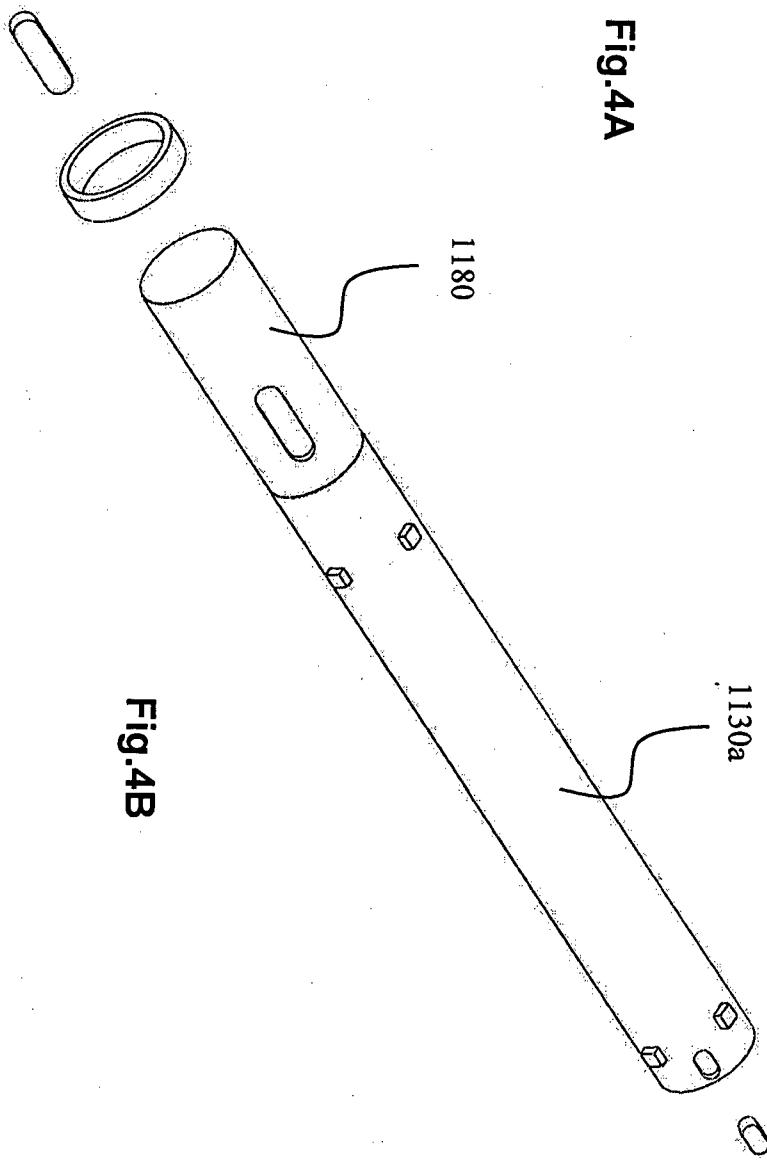


Fig. 4B

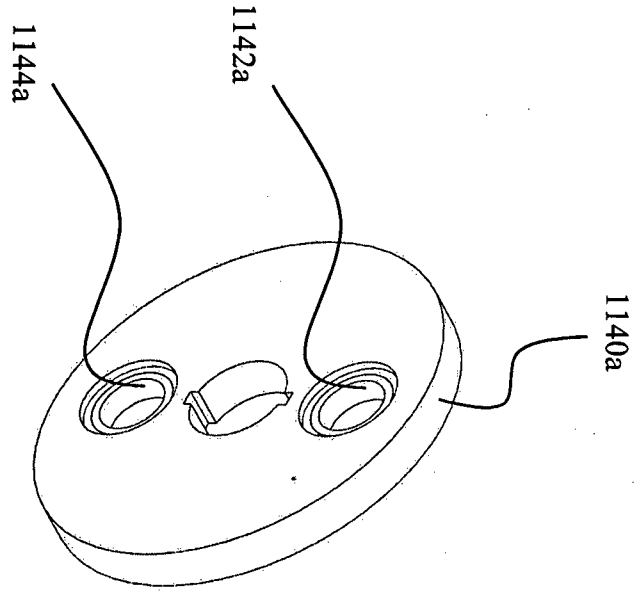


Fig. 5A

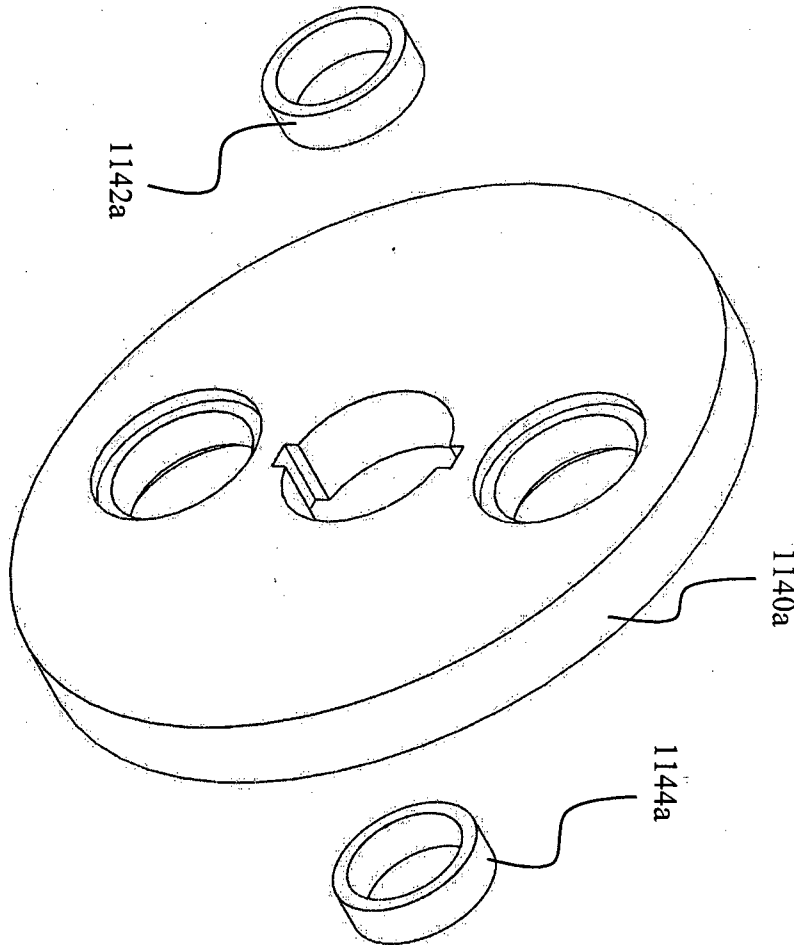


Fig. 5B

Fig.6A

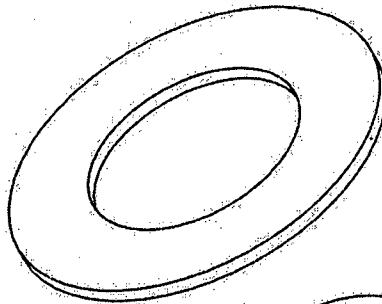
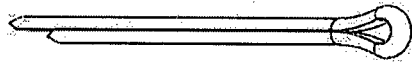
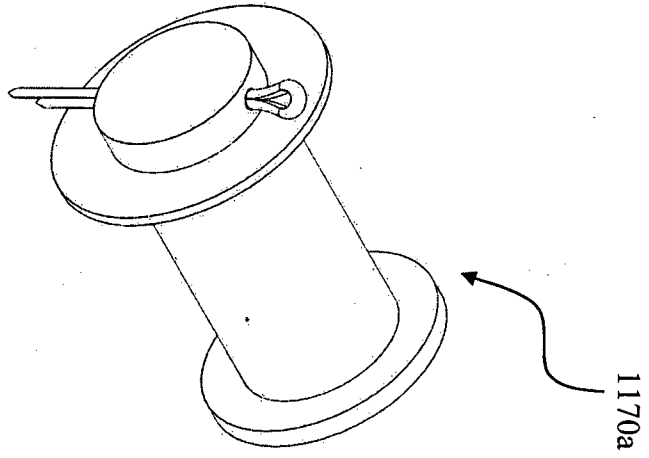
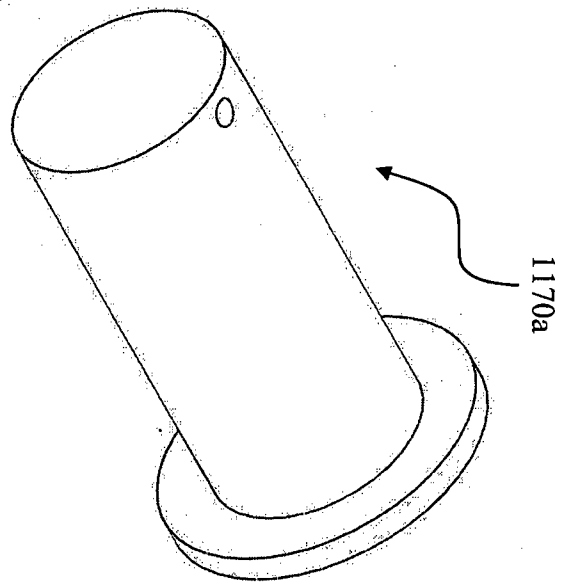


Fig.6B



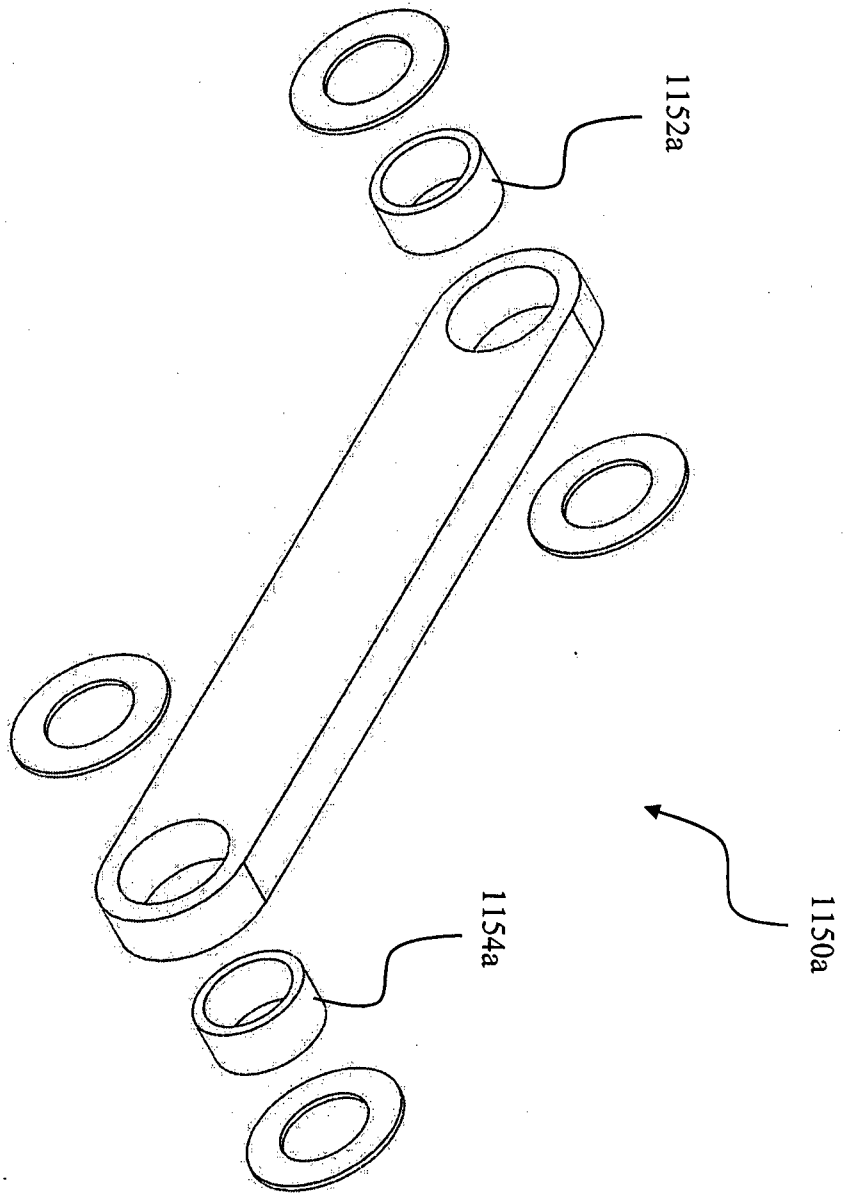


Fig.7

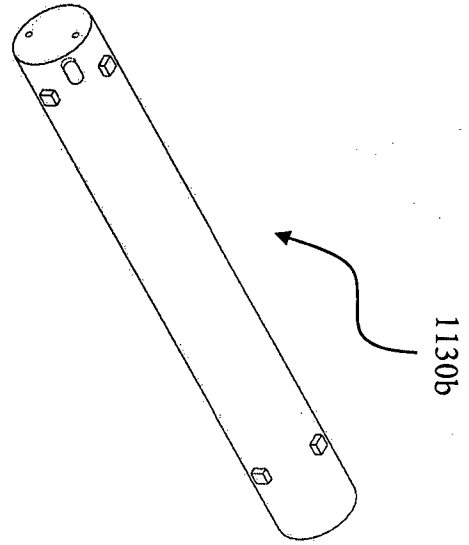


Fig. 8A

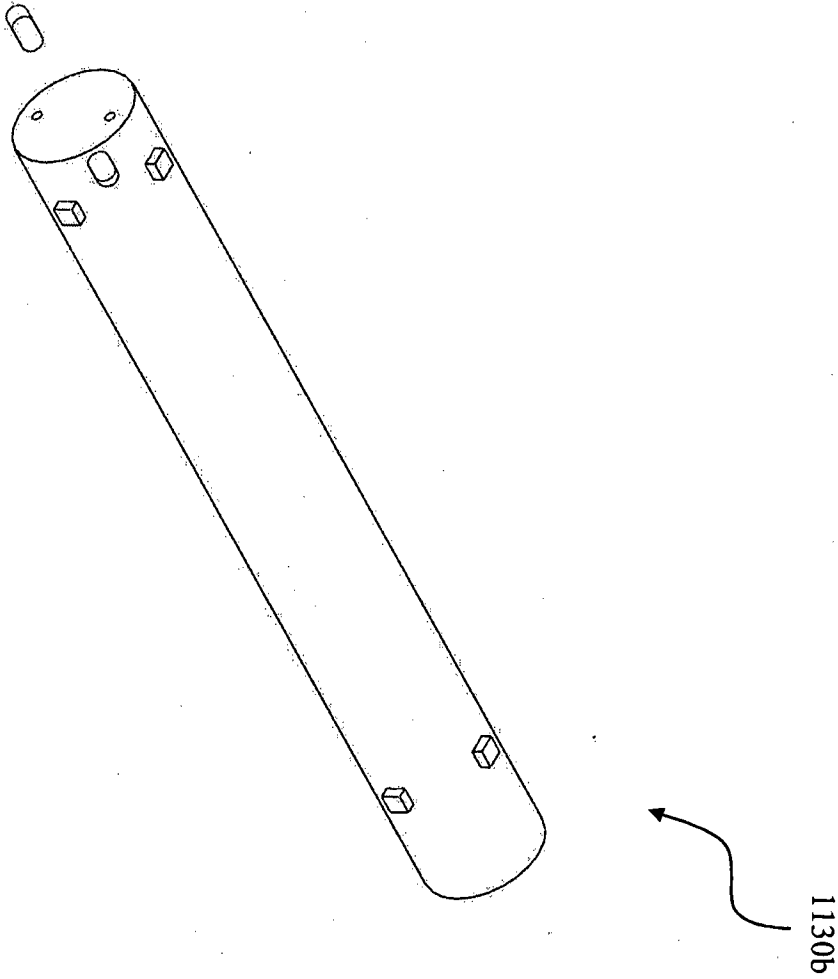


Fig. 8B

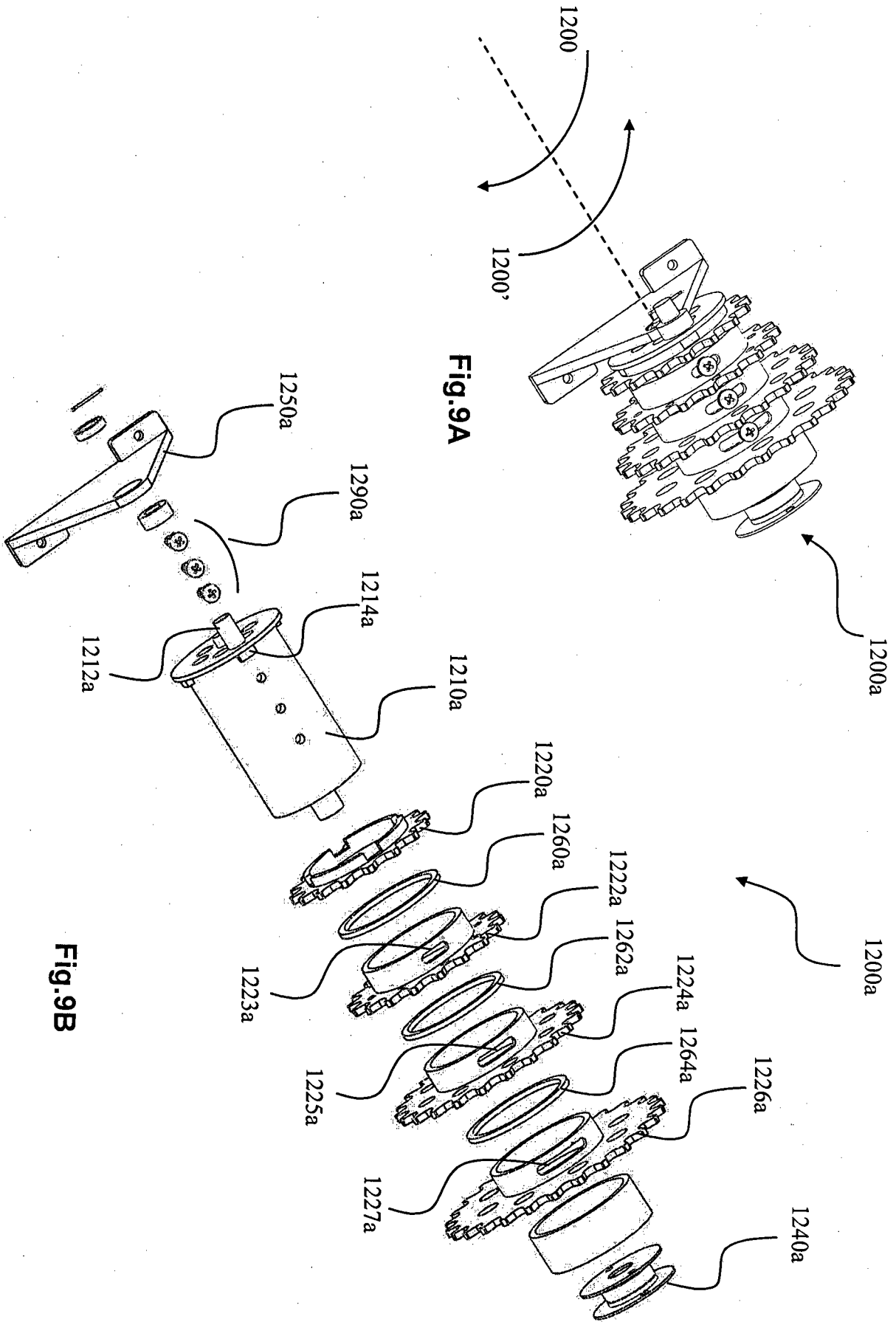


Fig. 9A

Fig. 9B

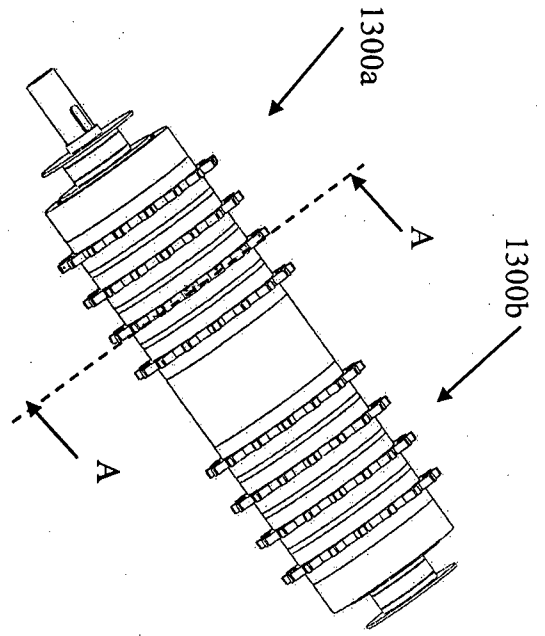


Fig. 10A

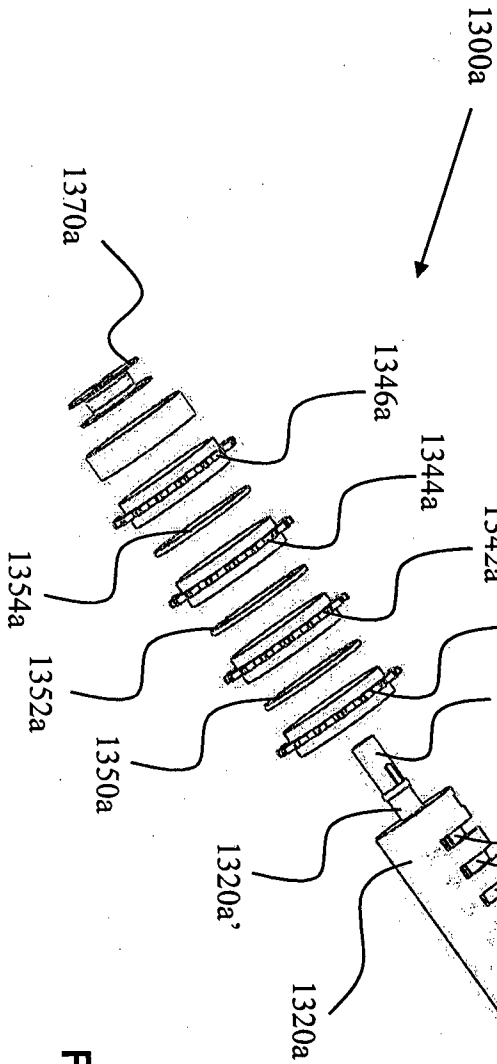
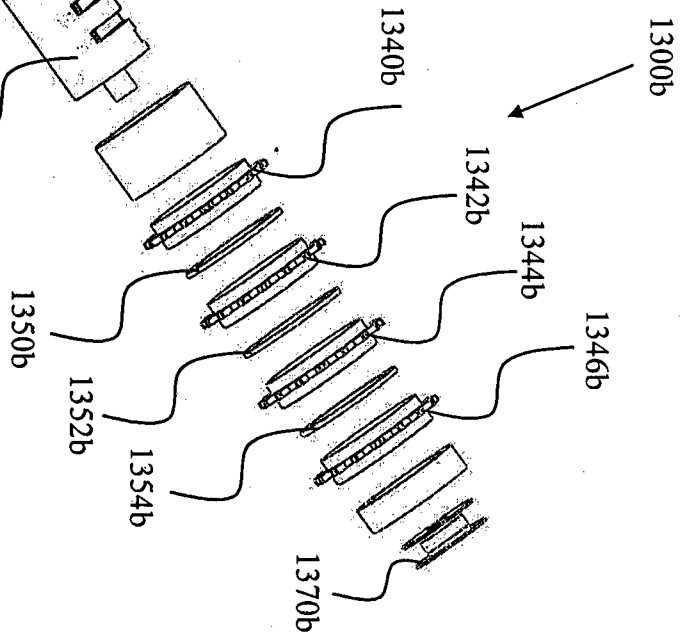


Fig. 10B



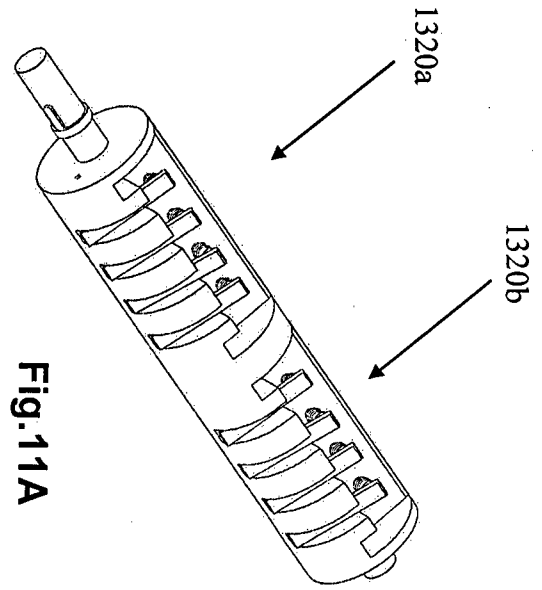


Fig. 11A

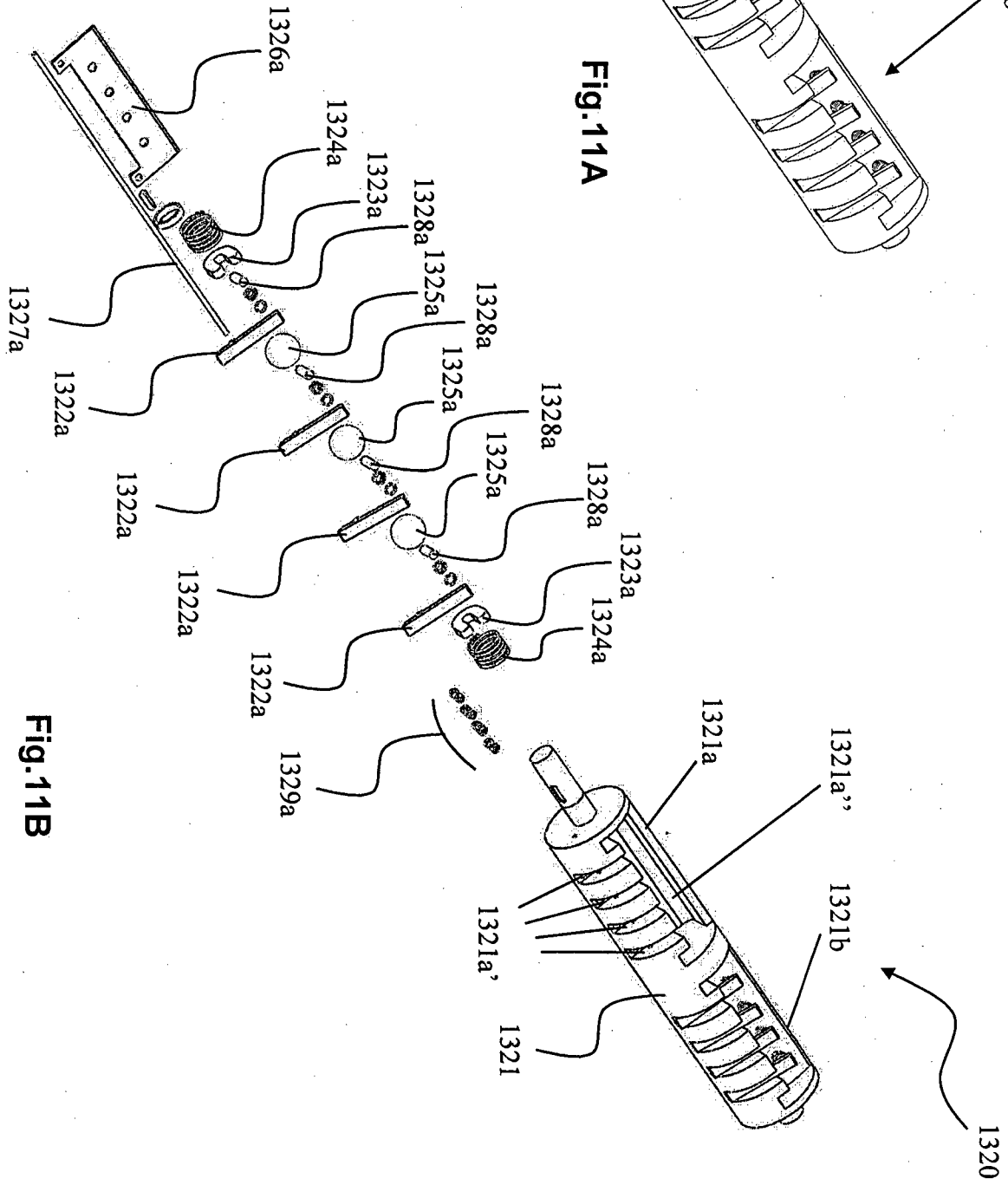


Fig. 11B

Fig. 12A

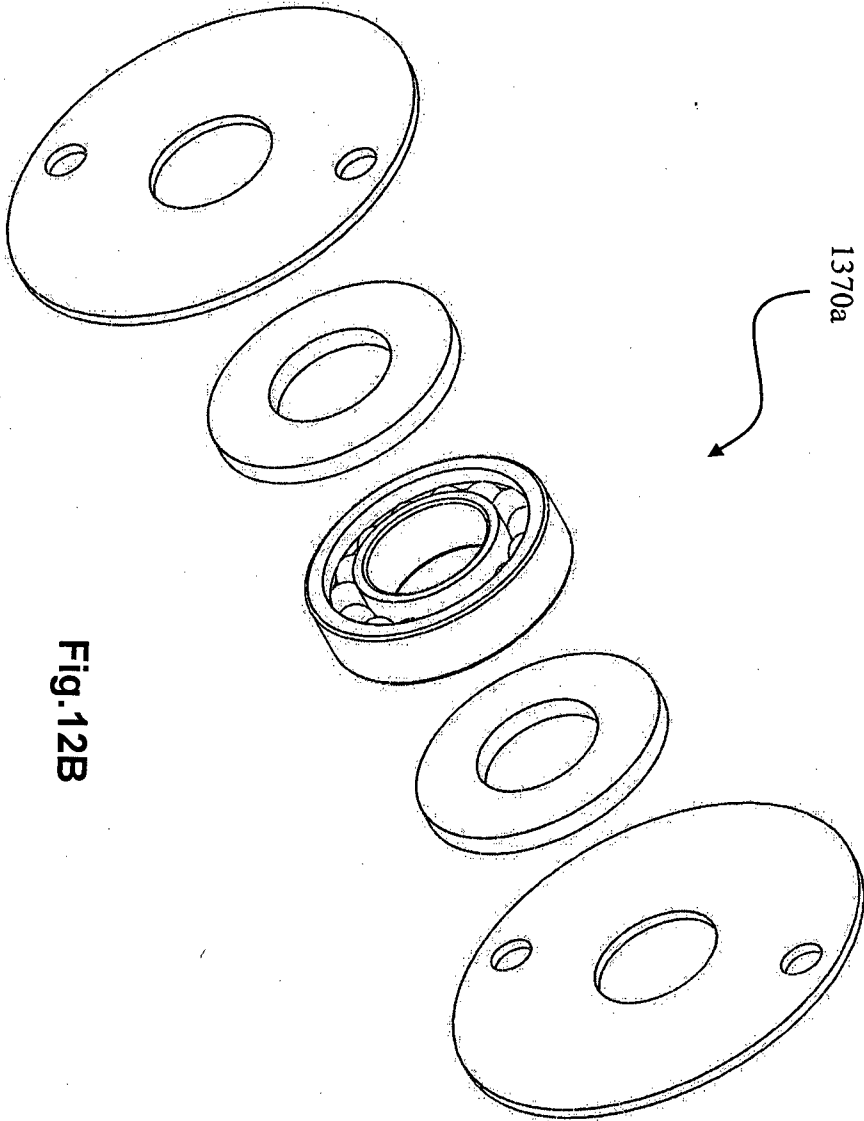
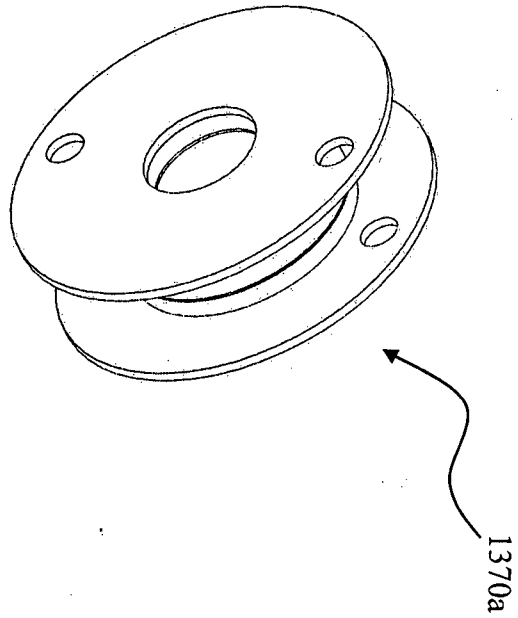


Fig. 12B

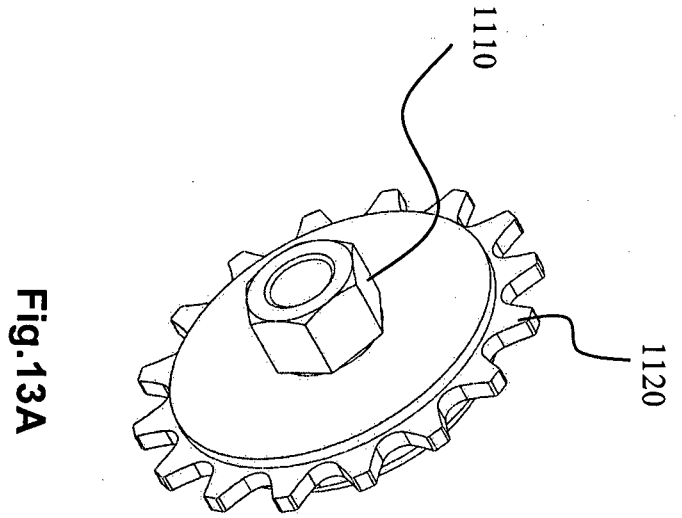


Fig. 13A

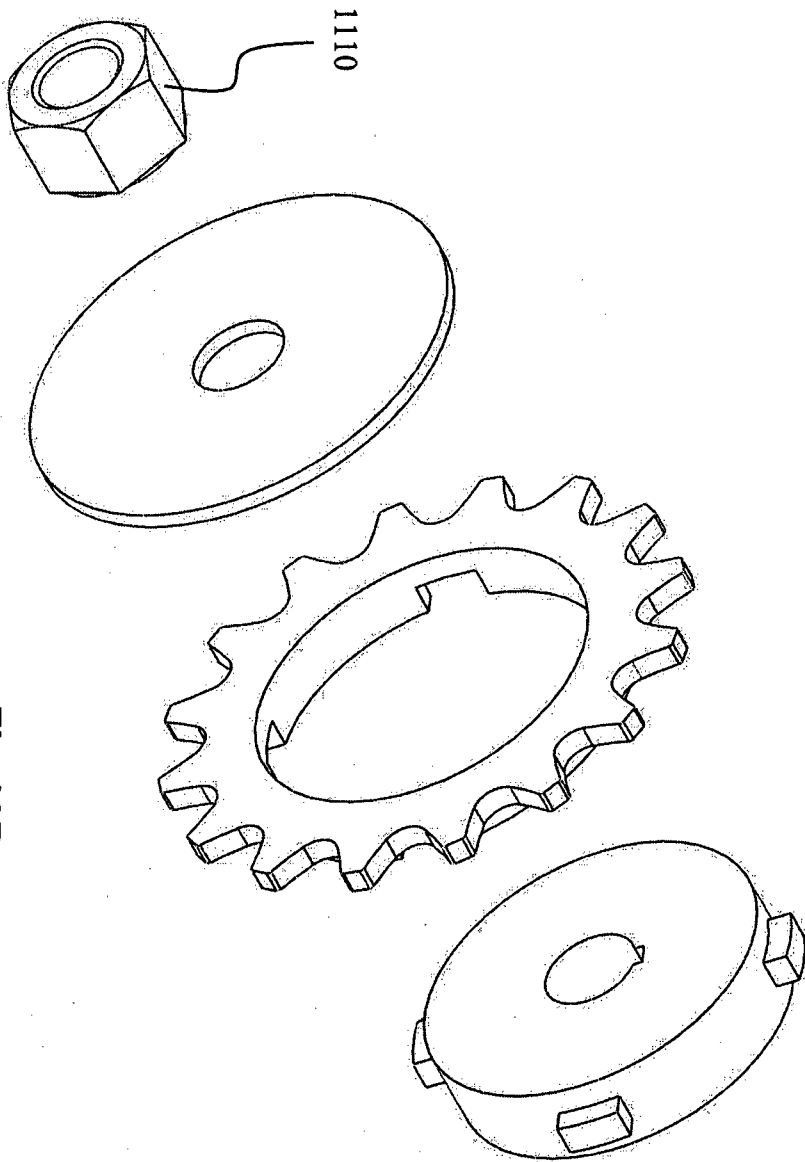


Fig. 13B

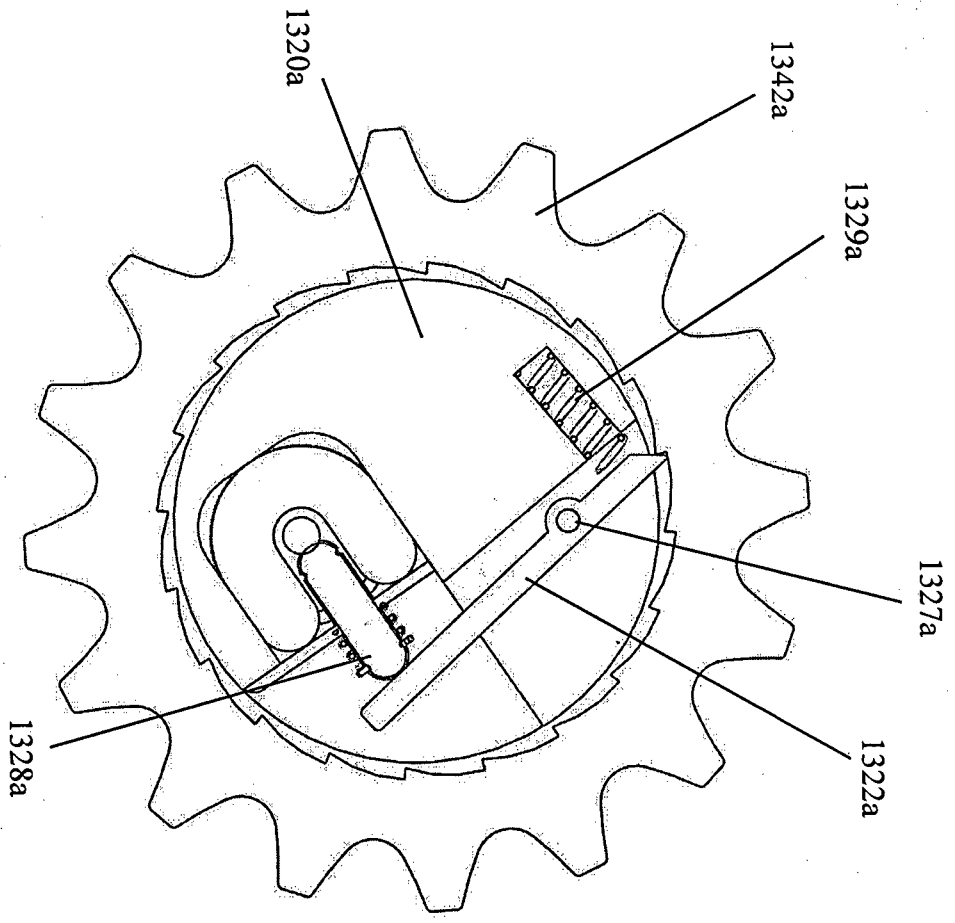


Fig. 14A

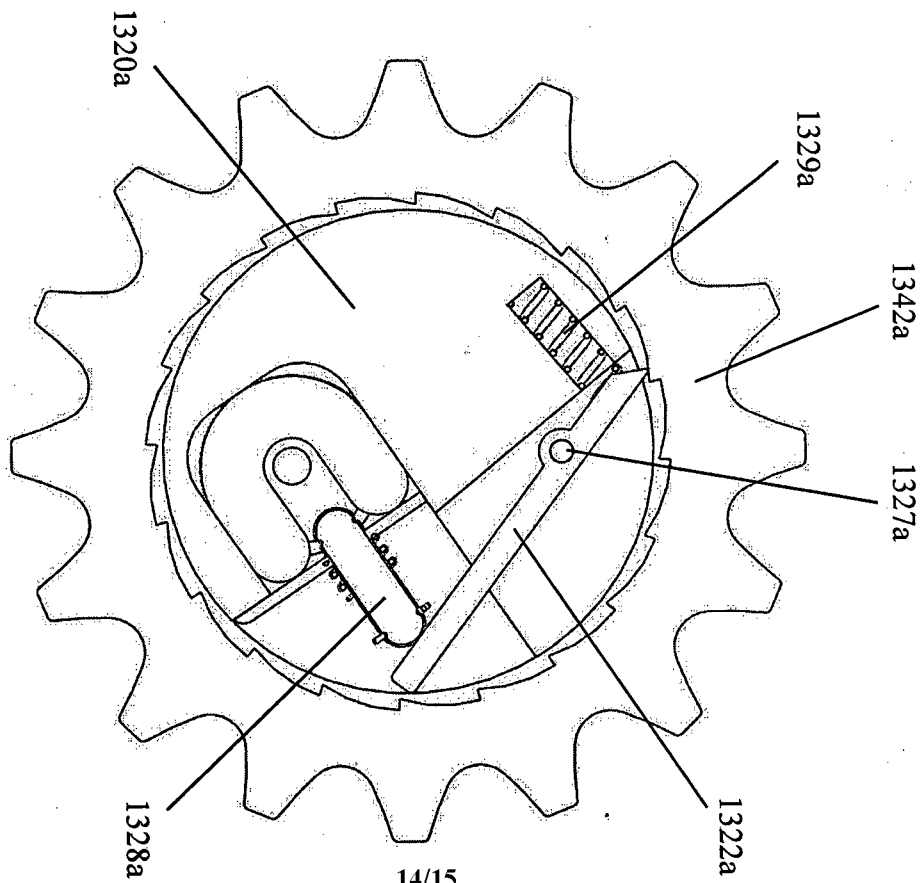


Fig. 14B

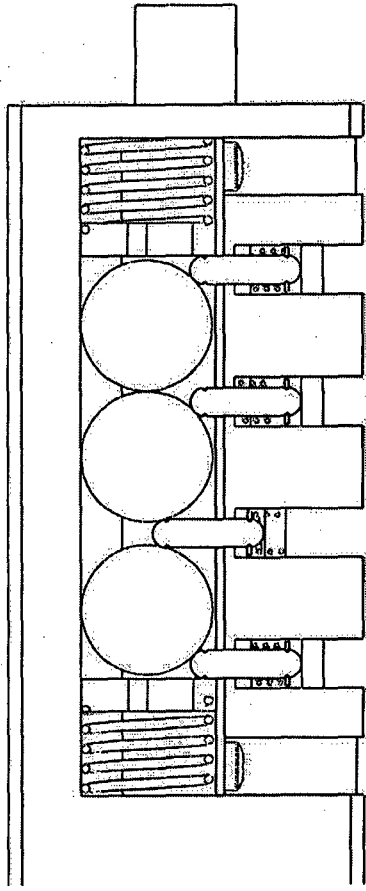


Fig.15C

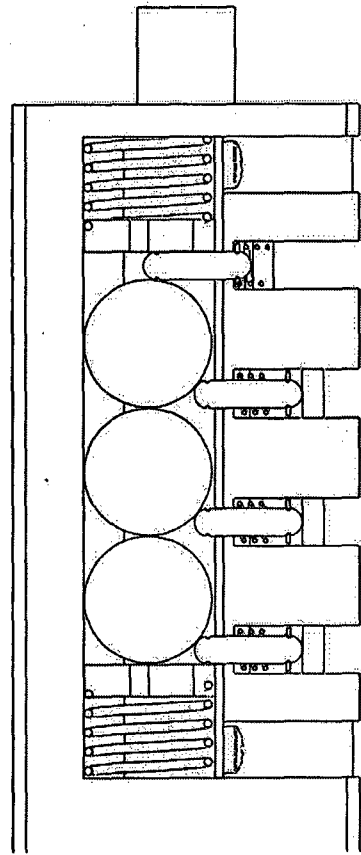


Fig.15A

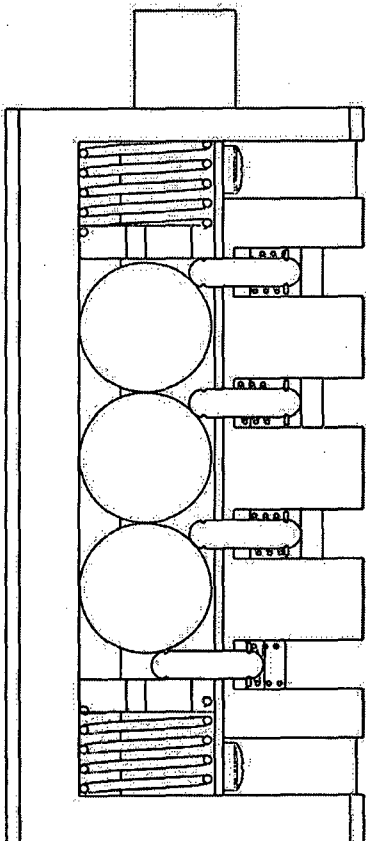


Fig.15D

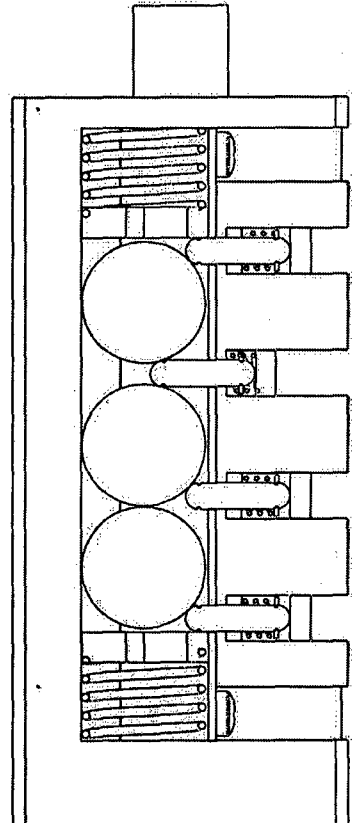


Fig.15B