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(54) **Limit switch**

Endschalter

Interrupteur de fin de course

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US-A- 3 749 860 **US-A- 3 829 637**
US-A- 3 959 614

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Description

The present invention relates to a limit switch for various kinds of production equipment, industrial robots and so forth, and particularly relates to a limit switch which detects an object by means of a manipulation lever rotatably supported by the head of the switch.

DESCRIPTION OF THE RELATED ART

Limit switches in general comprise a case housing, a basic switching mechanism having a manipulation rod of the pushed-in type, a head housing a cam for converting a rotating motion into a straight motion, and a manipulation lever pivotally coupled to the head. When the manipulation lever is rotated to an operative position against the force of a return spring by a detected object such as a workpiece, the cam acts to convert the rotation of a rotary shaft associated with the manipulation lever, into straight motion of a plunger supported by the case or the head, so that the manipulation rod of the basic switching mechanism is pushed in by the plunger. Since the manipulation lever receives the force of the return spring when the lever is rotated back to the free position thereof, the lever is likely to be rotated back beyond the free position. Since the force of the return spring for the manipulation lever is stronger than that of a spring for returning the manipulation rod of the basic switching mechanism, the rod is pushed in to generate an inversion signal if the lever is rotated back beyond the free position. This generation of an erroneous inversion signal is a problem.

FIGS. 1 and 2 shown a limit switch which is relevant to the present invention. The limit switch includes a case 1, a basic switching mechanism 2 housed in the case, and a head 3 secured to the upper end of the case. A rotary shaft 4 is rotatably supported by bearings 5 and 6 is the head 3, and projects out of the cylindrical portion 3a of the head at one end of the shaft. The butt 7a of a manipulation lever 7 for detecting an object is secured to the rotary shaft 4 at the above-mentioned end thereof. A roller 8 is rotatably supported by a shaft 9 at the tip 7b of the manipulation lever 7. The opening of the cylindrical portion 3a of the head 3 is closed with a seal plate 10. An oil seal 11 is interposed between the rotary shaft 4 and the cylindrical portion 3a of the head 3. An annular groove 12 is provided in the outside circumferential surface of the rotary shaft 4. An O-ring 13 is fitted in the annular groove 12. The rotary shaft 4 has a flat portion 14, on the top of which a return plunger 15 shaped as a bottomed cylinder is provided. A return coil spring 16 is engaged between the return plunger 15 and the inside surface of the upper portion of the head 3 so that a returning force is applied to the flat portion 14 of the rotary shaft 4 through the return plunger by the spring. A fixed plate 17 is fitted in the lower portion of the head 3. A manipulation plunger 20, which is driven by a disk cam 19 secured to the rotary shaft 4, is fitted in the center

hole 18 of the fixed plate 17 so that the plunger is movable in the axial direction thereof. A lever 21 is supported by a shaft 22 in the case 1 so that the lever is rotatable and the tip of the lever is in contact with the manipulation rod 23 of the basic switching mechanism 2. The central portion of the lever 21 has a projection 21b, which is pushed in by the manipulation plunger 20. An O-ring 24 is provided between the mutually fitted portions of the case 1 and the head 3. A name plate 25 is attached to the outside of the case 1. A terminal box 26 housing terminals 27 is attached to the case 1. A screw 28 for attaching the basic switching mechanism 2 is tightened thereon. An E-shaped washer 29 for securing the disk cam 19 is provided.

The operation of the limit switch is now described in detail. When the object has come into contact with the roller 8, the rotary shaft 4 is rotated against the force of the return coil spring 16. As a result, the disk cam 19 is turned so that the manipulation plunger 20 is moved down following the surface of the cam. The projection 21b of the lever 21 is pushed in due to the above-mentioned downward movement of the plunger 20 so that the lever is rotated counterclockwise about the shaft 22 with regard to FIG. 2. Accordingly, the manipulation rod 23 of the basic switching mechanism 2 is pushed in by the tip 21a of the lever 21 so that the mechanism is turned on. When the object thus breaks contact with the roller 8, the rotary shaft 4 is rotated back to the original position thereof by the force of the return coil spring 16. As a result, the manipulation rod 23 of the basic switching mechanism 2 is moved back to the original position thereof so that the mechanism is turned off.

Since the rotary shaft 4 is rotated back to the original position thereof by the force of the return coil spring 16, the manipulation lever 7 is likely to be rotated back beyond the free position thereof due to the inertial force thereof so as to cause the basic switching mechanism 2 to chatter. This is a problem. In addition, since the flat portion 14 of the rotary shaft 4 and the return plunger 15 collide with each other when the manipulation lever 7 is rotated back to the free position thereof, the edge of the flat portion or the like is likely to be worn. This is another problem.

A limit switch according to the preamble of claim 1 is known from US-A-3 829 637.

DE-A-1 920 237 discloses a limit switch having a drive lever between the cam means and the manipulation rod. The force counteracting a rotation of the manipulation lever back beyond its neutral position tends to zero as the manipulation lever approaches this position.

SUMMARY OF THE INVENTION

The present invention was made in order to solve the above-mentioned problems.

Accordingly, it is an object of the present invention to provide a limit switch in which a manipulation lever is

prevented from being moved back to the free position.

The limit switch according to the invention is as defined in claim 1.

When the manipulation lever is on the verge of being rotated back beyond the free position by the force of the return spring, the drive lever provided between the cam and the manipulation rod of the basic switching mechanism counteracts the driving force of the cam to the manipulation rod because of the leverage of the drive lever (which is the ratio of the length from the fulcrum for the drive lever to the point of application of over the length from the fulcrum to the point of action of the lever) so that the manipulation rod is prevented from being pushed in. For that reason, the inversion signal is prevented from being generated.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cutaway front view of a limit switch provided in accordance with a related art.

FIG. 2 is a cutaway side view of the limit switch.

FIG. 3 is a cutaway side view of a limit switch which is an embodiment of the present invention.

FIG. 4 is a cutaway front view of the head of the limit switching shown in FIG. 3.

FIG. 5 is a sectional view of the basic switching mechanism of the limit switch shown in FIG. 3.

FIG. 6 is a view showing the direction of the motion of the manipulation lever of the limit switch shown in FIG. 3.

FIG. 7a is a view showing the state of the basic switching mechanism, which corresponds to the neutral free position of a manipulation lever.

FIG. 7b is a view showing the state of the basic switching mechanism, which corresponds to the clockwise rotated position of the manipulation lever.

FIG. 7c is a view showing the state of the basic switching mechanism, which corresponds to the counterclockwise rotated position of the manipulation lever.

DETAILED DESCRIPTION OF AN EMBODIMENT

FIG. 3 shows a limit switch which is yet another embodiment. The limit switch includes a case 301 housing a basic switching mechanism 302, a head 303 secured to the upper end of the case, and a rotary shaft 304 supported by bearings 305 and 306 in the head. The butt 307a of the manipulation lever 307 of the limit switch is secured to the rotary shaft 304 at the outer end 304a thereof. The outside circumferential surface of the rotary shaft 304 has an annular groove 308. A roller 309, with which a detected object such as a workpiece comes into contact, is rotatably supported with a shaft 310 at the tip 307b of the manipulation lever 307. An O-ring 311 is fitted in the annular groove 308. An oil seal 312 is provided between the head 303 and the rotary shaft 304. A first cam 313A and a second cam 313B are secured side by side to the rotary shaft 304. The surface 313a of the first

cam 313A is set for clockwise rotation shown by arrows a in FIGS. 18 and 20. The surface 313b of the second cam 313B is set for counterclockwise rotation shown by arrows b in FIGS. 18 and 20. The surface 313b of the second cam 313B is set for counterclockwise rotation shown by arrows b in FIGS. 18 and 20. A spring 314 is engaged around the first and the second cams 313A and 313B so as to apply a returning force to the manipulation lever 307 through the cams. As shown in FIG. 4, a first plunger 316A and a second plunger 316B, which correspond to the first and the second cams 313A and 313B, are movably supported in the axial directions of the plungers by a plunger holder 315 provided at the bottom of the head 303. A first lever 317A and a second lever 317B are supported with shafts 318A and 318B by the holder 315. The first plunger 316A is driven by the first lever 317A and the first cam 313A. The second plunger 316B is driven by the second lever 317B and the second cam 313B. A first drive lever 320A and a second drive lever 320B are supported by a shaft 319 in the case 301 between the basic switching mechanism 302 and the first and the second plungers 316A and 316B. The leverages of the drive levers 320A and 320B, each of which is the ratio of the length from the fulcrum for the drive lever to the point of application of force to the drive lever to the length from the fulcrum to the point of application of force to the drive lever, are set so that the basic switching mechanism 302 is turned on or off through the motions of the plungers 316A and 316B in the axial directions thereof. The drive levers counteract the driving actions of the plungers when the manipulation lever 307 is on the verge of being rotated back beyond the free position thereof, which is shown by a reference symbol FP in FIG. 6.

FIG. 5 shows the basic switching mechanism 302 of the limit switch shown in FIG. 3. The mechanism 302 includes an upper switching unit SW₁ and a lower switching unit SW₂ provided in the casing 331 of the mechanism, and a first manipulation rod 332A and a second manipulation rod 332B supported concentrically to each other with return springs 333A and 333B in the casing so that the rods are movable up and down. When the manipulation lever 307 is rotated clockwise with regard to FIG. 6, the first manipulation rod 332A is pushed in by the first drive lever 320A. When the manipulation lever 307 is rotated counterclockwise with regard to FIG. 6, the first manipulation rod 332A is pushed in by the first drive lever 320A. When the manipulation lever 307 is rotated counterclockwise with regard to FIG. 6, the second manipulation rod 332B is pushed in by the second drive lever 320B. A first movable spring 334A and a second movable spring 334B, each of which is generally W-shaped, are engaged with the first and the second manipulation rods 332A and 332B, respectively. A first movable member 335A and a second movable member 335B are driven by the first and the second manipulation rods 332A and 332B through the actions of both the ends of the first and the second movable

springs 334A and 334B, respectively. Movable contacts 336A and 337A are secured to the first movable member 335A at both the ends thereof. Movable contacts 336B and 337B are secured to the second movable member 335B at both the ends thereof. A part of fixed terminals 338A and 339A and another pair of fixed terminals 340A and 341A are secured to the upper portion of the casing 331. Normally-open fixed contacts 342A and 343A are secured to the fixed terminals 338A and 339A and face the movable contacts 336A and 337A, respectively. Normally-closed fixed contacts 344A and 345A are secured to the other fixed terminals 340A and 341A and face the movable contacts 336A and 337A, respectively. A pair of fixed terminals 338B and 339B and another pair of fixed terminals 340B and 341B are secured to the lower portion of the casing 331. Normally-open fixed contacts 342B and 343B are secured to the fixed terminals 338B and 339B and face the movable contacts 336B and 337B, respectively. Normally-closed fixed contacts 344B and 345B are secured to the other fixed terminals 340B and 341B and face the movable contacts 336B and 337B, respectively.

The operation of the limit switch shown in FIG. 3 is now described in detail. When the manipulation lever 307 is in the neutral free position FP shown in FIG. 6, the first and the second manipulation rods 332A and 332B of the basic switching mechanism 302 are not pushed in, so that the first and the second switching units SW_1 and SW_2 are in states shown in FIG. 7a. When the detected object has come into contact with the roller 309 so that the manipulation lever 307 is rotated clockwise with regard to FIG. 6, the first and the second cams 313A and 313B are turned by the rotary shaft 304 against the force of the return spring 314. At that time, the first lever 317A is rotated by the surface 313a of the first cam 313A so that the first plunger 316A is moved down in the axial direction thereof. Because of the downward movement of the plunger 316A, the first manipulation rod 332A of the basic switching mechanism 2 is pushed in through the action of the drive lever 320A. When the manipulation lever 307 is rotated further clockwise to an operative position OP_1 shown in FIG. 6, the first movable spring 334A is inverted due to the displacement of the first manipulation rod 332A so that the first movable member 335A is moved up. As a result, the movable contacts 336A and 337A come into contact with the normally-open fixed contacts 342A and 343A, respectively, as shown in FIG. 7b. When the detected object breaks contact with the roller 309, the manipulation lever 307 is rotated back to the neutral free position FP by the force of the return spring 314. At that time, the first manipulation rod 332A of the basic switching mechanism 302 is returned to the original position thereof by the force of the return spring 333A, the movable member 335A is moved back to the original position thereof through the action of the movable spring 334A, and the movable contacts 336A and 337A come into contact with the normally-closed fixed contacts 344A

and 345A, respectively. When the manipulation lever 307 is rotated counterclockwise 6 from the neutral free position FP with regard to FIG. 6, the second lever 317B is rotated by the surface 313B of the second cam 313B so that the second plunger 316B is moved down. Because of the downward movement of the second plunger 316B, the second manipulation rod 332B of the basic switching mechanism 302 is pushed in through the action of the drive lever 320B. When the manipulation lever 307 is rotated counterclockwise further to an operative position OP_2 shown in FIG. 6, the second movable spring 334B is inverted due to the displacement of the second manipulation rod 332B so that the second movable member 335B is moved up. As a result, the movable contacts 336B and 337B come into contact with the normally-open fixed contacts 342B and 343B, respectively, as shown in FIG. 7c. When the detected object then breaks contact with the roller 309, the manipulation lever 307 is rotated back to the neutral free position FP. At that time, the second manipulation rod 332B is returned to the original position thereof by the force of the return spring 333B, the movable member 335B is moved back to the original position thereof through the action of the movable spring 334B, and the movable contacts 336B and 337B come into contact with the normally-closed fixed contacts 344B and 345B, respectively.

When the manipulation lever 307 is rotated back to the neutral free position FP from the operative position OP_1 , for example, the lever could be rotated back beyond the neutral free position due to the force of the return spring 314. However, the leverage of the first drive lever 320A, which is the ratio of the length from shaft 319 to the point of application of force (where the first plunger 316A comes into contact with the first drive lever) over the length from shaft 319 to the point of action (where the tip of the first drive lever comes into contact with the first manipulation rod 332A) is selectively preset so that the first drive lever counteracts the driving force of the first cam 313A when the manipulation lever 307 is on the verge of being rotated back beyond the neutral free position FP thereof. For that reason, the manipulation lever 307 is prevented from being rotated back beyond the neutral free position FP thereof. The first manipulation rod 332A is thus prevented from being pushed in to unnecessarily turn on the first switching unit SW_1 of the basic switching mechanism 302.

Claims

1. A limit switch comprising:

- a case (301) housing a switching means (302);
- a head (303) secured to one end of said case;
- a rotary shaft (304) rotatably supported by said head;
- a manipulation lever (307) secured at a butt end

thereof to said rotary shaft;
 cam means (313A, 313B) provided on said rotary shaft (304) for converting rotational motion into straight motion;
 a return spring (314) for applying a returning force to said lever through said cam means and said rotary shaft to return the manipulation lever to a free position;
 plunger means (316A, 316B) for switching said switching means disposed within the limit switch and driven axially in response to said cam means; characterized in that
 said switching means comprises two basic switching mechanisms each of which has a pushed-in type manipulation rod (332A, 332B); and
 drive lever means are provided comprising two drive levers (320A, 320B), one of said drive levers (320A) pushing the one manipulation rod (332A) when said manipulation lever (307) with said cam rotates in the clockwise direction from its free position, and the other one of said drive levers (320B) pushing the other manipulation rod (332B) when said manipulation lever (307) with said cam rotates in the counterclockwise direction from its free position,
 each said drive lever (320A, 320B) having a leverage, defined as the ratio of the distance from the fulcrum of the drive lever to the point of action on the corresponding manipulation rod (332A, 332B) to the distance from said fulcrum to the point where the drive lever (320A, 320B) is acted on through said cam means (313A, 313B), set such that said drive lever (320A, 320B) counteracts the driving force exerted on the cam means by said returning spring (314) when said manipulation lever (307) is on the verge of being rotated back beyond its neutral free position so as to prevent rotation of said manipulation lever (307) back beyond said free position.

2. A limit switch according to claim 1, characterized in that lever means (317A, 317B) acting between the cam means (313A, 313B) and the plunger means (316A, 316B) are provided.
3. A limit switch according to claim 1 or 2, characterized in that the cam means comprises two cams (313A, 313B) each associated with one of the two manipulation rods (332A, 332B).

Patentansprüche

1. Endschalter mit

einem Schaltmittel (302) aufnehmenden Ge-

häuse (301),
 einem an einem Ende des Gehäuses angebrachten Kopf (303),
 einer von dem Kopf drehbar gehaltenen Drehwelle (304),
 einem an seinem Fußende an der Drehwelle befestigten Betätigungshebel (307),
 auf der Drehwelle (304) vorgesehenen Nockenmitteln (313A, 313B) zur Umwandlung einer Drehbewegung in eine geradlinige Bewegung,
 einer Rückholfeder (314) zum Aufbringen einer Rückführkraft auf den Hebel über die Nockenmittel und die Drehwelle zur Rückführung des Betätigungshebels in eine freie Stellung,
 Kolbenmitteln (316A, 316B) zum Schalten der in dem Endschalter angeordneten Schaltmittel und ansprechend auf die Nockenmittel axial angetrieben, dadurch gekennzeichnet, daß die Schaltmittel zwei Schaltgrundmechanismen aufweisen, von denen jeder einen Ein-drück-Betätigungsstab (332A, 332B) aufweist, und
 Antriebshebelmittel vorgesehen sind, welche zwei Antriebshebel (320A, 320B) aufweisen, von denen einer (320A) auf den einen Betätigungsstab (332A) drückt, wenn der Betätigungshebel (307) mit dem Nocken aus seiner freien Stellung im Uhrzeigersinn dreht, und der andere der Antriebshebel (320B) auf den anderen Betätigungsstab (332B) drückt, wenn der Betätigungshebel (307) mit dem Nocken aus seiner freien Stellung im Gegenuhrzeigersinn dreht,
 wobei jeder der Antriebshebel (320A, 320B) ein Hebelverhältnis, definiert als das Verhältnis des Abstandes zwischen dem Drehpunkt des Antriebshebels und dem Einwirkungspunkt auf den entsprechenden Betätigungsstab (332A, 332B) zum Abstand zwischen dem Drehpunkt und dem Punkt, wo auf den Antriebshebel (320A, 320B) über die Nockenmittel (313A, 313B) eingewirkt wird, derart hat, daß der Antriebshebel (320A, 320B) der Bewegungskraft entgegenwirkt, die auf die Nockenmittel durch die Rückholfeder (314) ausgeübt wird, wenn der Betätigungshebel (307) im Begriff ist, über seine freie Neutralstellung hinaus zurückbewegt zu werden, um so eine Drehung des Betätigungshebels (307) zurück über seine freie Stellung hinaus zu verhindern.

2. Endschalter nach Anspruch 1, dadurch gekennzeichnet, daß Hebelmittel (317A, 317B), die zwischen den Nockenmitteln (313A, 313B) und den Kolbenmitteln (316A, 316B) wirken, vorgesehen sind.

3. Endschalter nach Anspruch 1 oder 2, dadurch gekennzeichnet, daß die Nockenmittel zwei Nocken (313A, 313B) aufweisen, von denen jeder einem der beiden Betätigungsstäbe (332A, 332B) zugeordnet ist.

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Revendications

1. Commutateur de fin de course comprenant :

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un boîtier (301) logeant un moyen de commutation (302) :

une tête (303) fixée à une extrémité dudit boîtier ;

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un arbre rotatif (304) supporté rotatif par ladite tête :

un levier de manipulation (307) fixé à une de ses extrémités audit arbre rotatif :

des moyens de came (313A, 313B) montés sur ledit arbre rotatif (314) pour convertir un mouvement de rotation en un mouvement rectiligne :

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un ressort de rappel (314) destiné à exercer une force de rappel sur ledit levier par l'intermédiaire desdits moyens de came et dudit arbre rotatif pour ramener le levier de manipulation à une position libre ;

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des moyens de pistons plongeurs (316A, 316B) destinés à commuter ledit moyen de commutation disposé dans le commutateur de fin de course et entraînés axialement en réponse auxdits moyens de came ; caractérisé en ce que

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ledit moyen de commutation comprend deux mécanismes de commutation de base dont chacun comprend une tige de manipulation du type poussée vers l'intérieur (332A, 332B) ; et des moyens de levier de commande sont prévus et comprennent deux leviers de commande (320A, 320B), l'un desdits leviers de commande (320A) poussant l'une des tiges de manipulation (332A) lorsque ledit levier de manipulation (307) tourne avec ladite came dans le sens horaire à partir de sa position libre, et l'autre desdits leviers de commande (320B) poussant l'autre tige de manipulation (332B) lorsque ledit levier de manipulation (307) tourne avec ladite came dans le sens anti-horaire à partir de sa position libre,

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chacun desdits leviers de commande (320A, 320B) ayant une force de bras de levier définie comme étant le rapport de la distance comprise entre le point d'appui du levier de commande et le point d'action sur la tige correspondante de manipulation (332A, 332B) à la distance comprise entre ledit point d'appui et le point auquel le levier de commande (320A, 320B) su-

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bit l'action desdits moyens de came (313A, 313B), ladite force de bras de levier étant réglée de façon que ledit levier de commande (320A, 320B) agisse à l'encontre de la force de commande exercée sur les moyens de came par ledit ressort de rappel (314) lorsque ledit levier de manipulation (307) est sur le point d'être entraîné en rotation vers l'arrière au-delà de sa position neutre libre, afin d'empêcher la rotation dudit levier de manipulation (307) vers l'arrière au-delà de ladite position libre.

2. Commutateur de fin de course selon la revendication 1, caractérisé en ce que des moyens de levier (317A, 317B) agissant entre les moyens de came (313A, 313B) et les moyens de pistons plongeurs (316A, 316B) sont prévus.

3. Commutateur de fin de course selon la revendication 1 ou 2, caractérisé en ce que les moyens de came comprennent deux cames (313A, 313B) dont chacune est associée à l'une des deux tiges de manipulation (332A, 332B).

FIG. 1

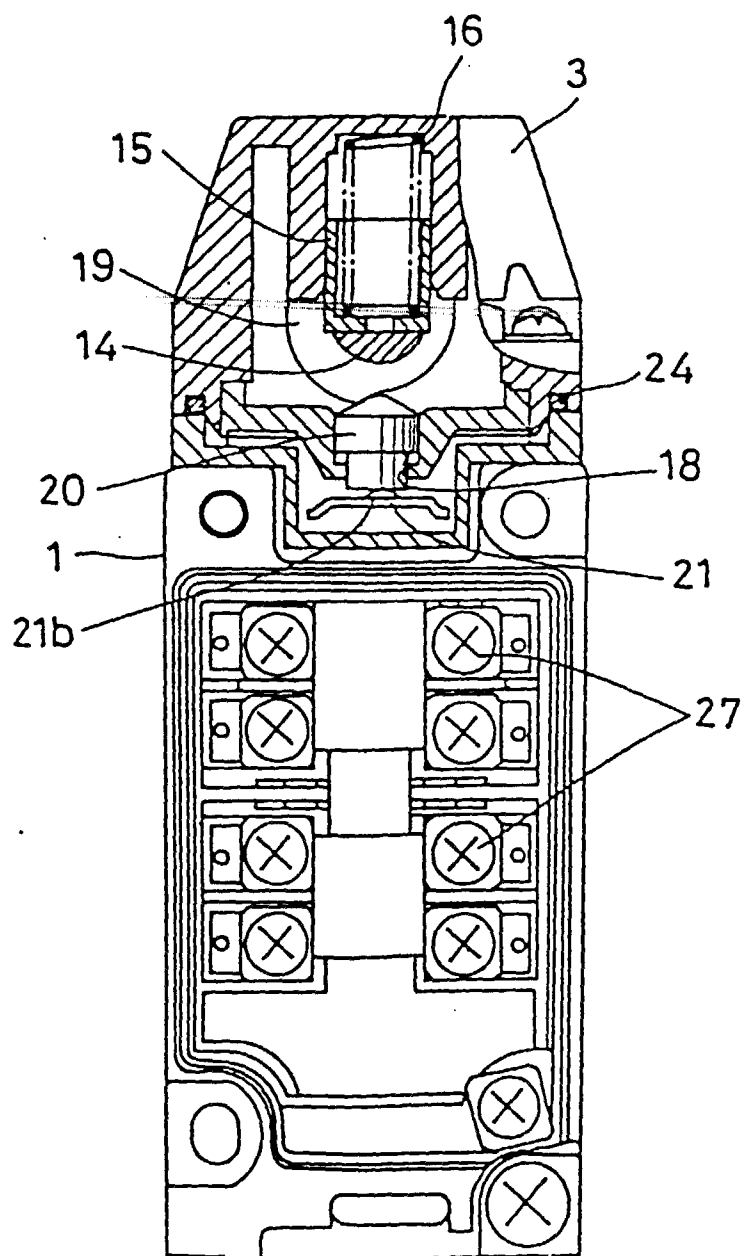
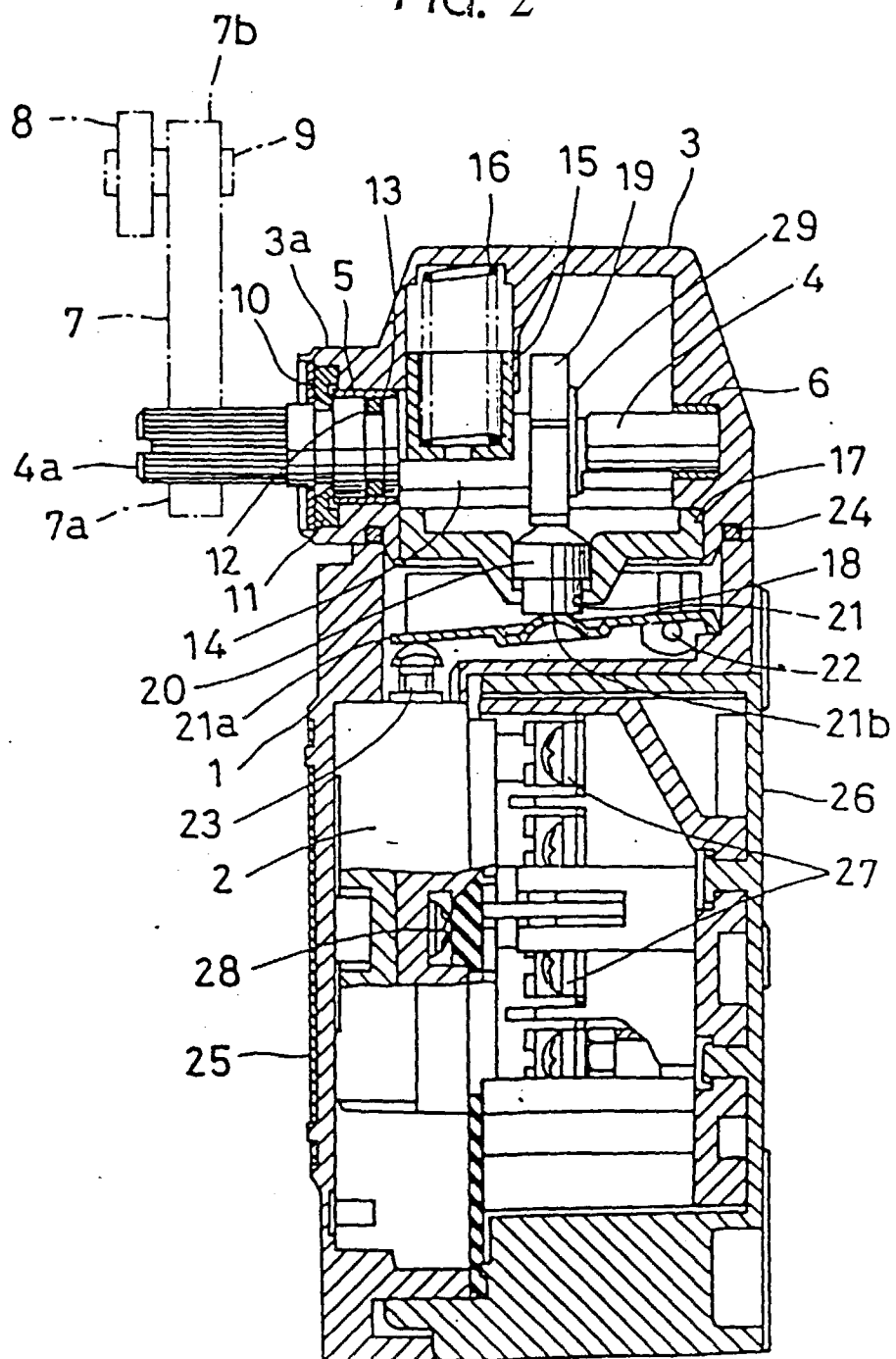


FIG. 2



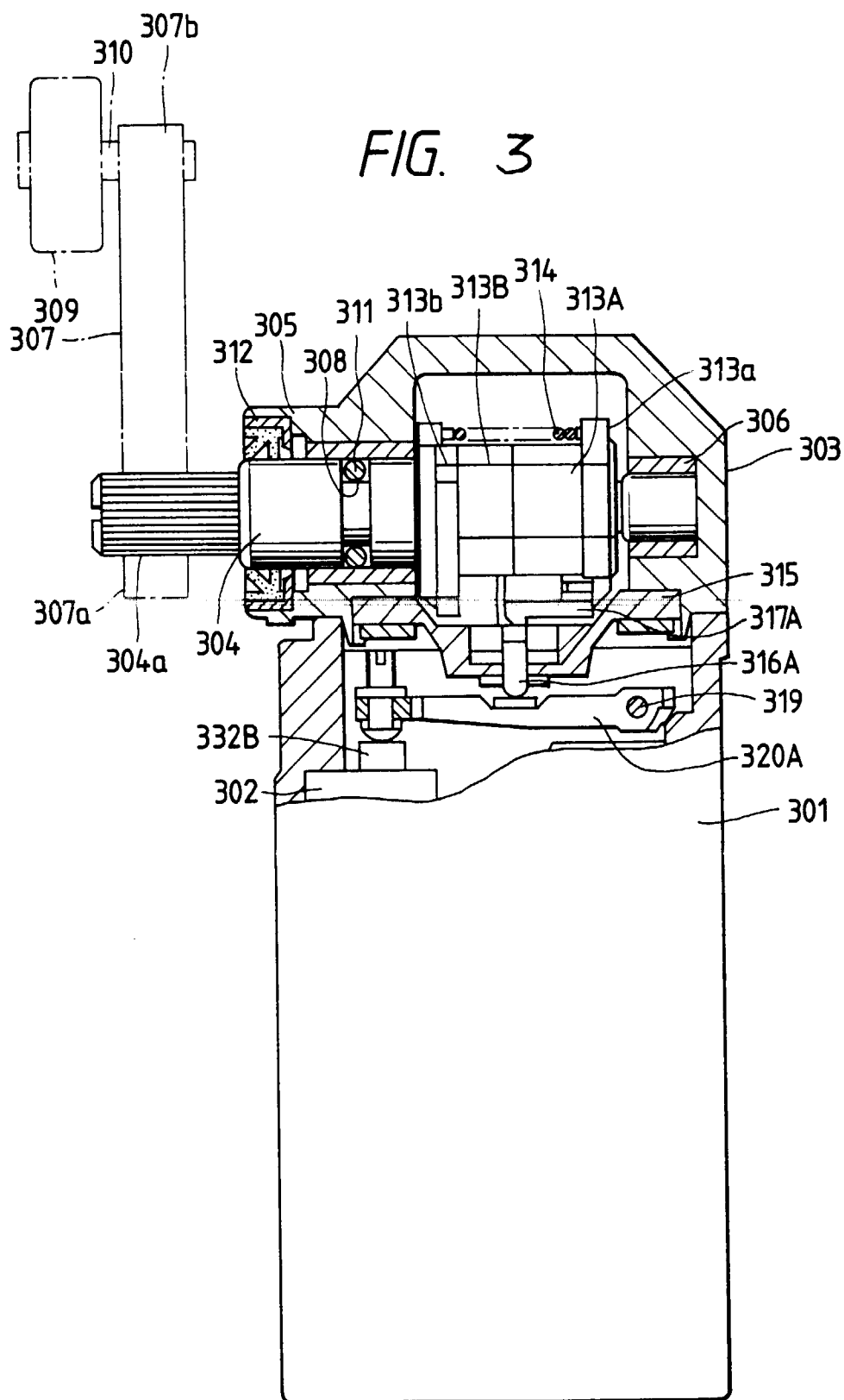


FIG. 4

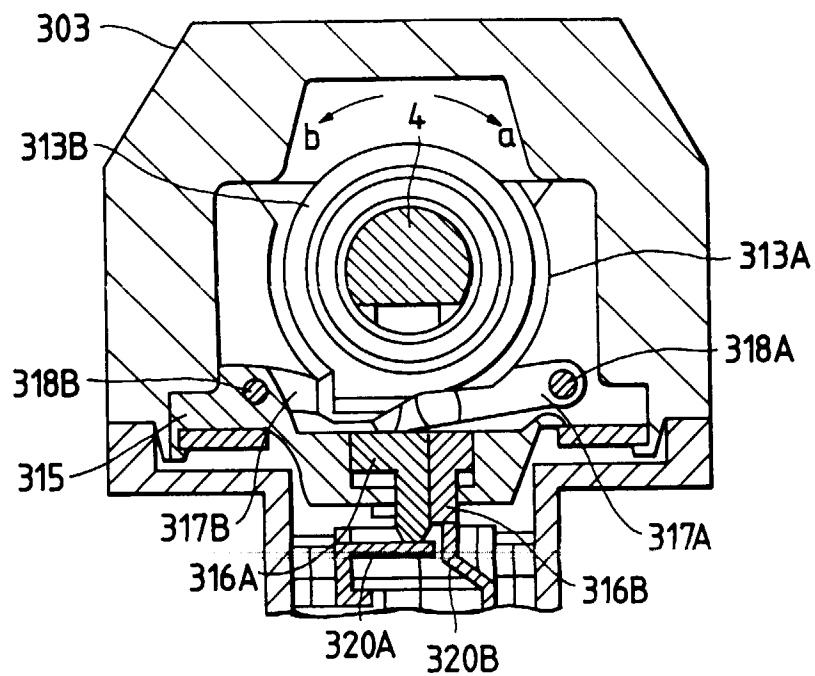


FIG. 6

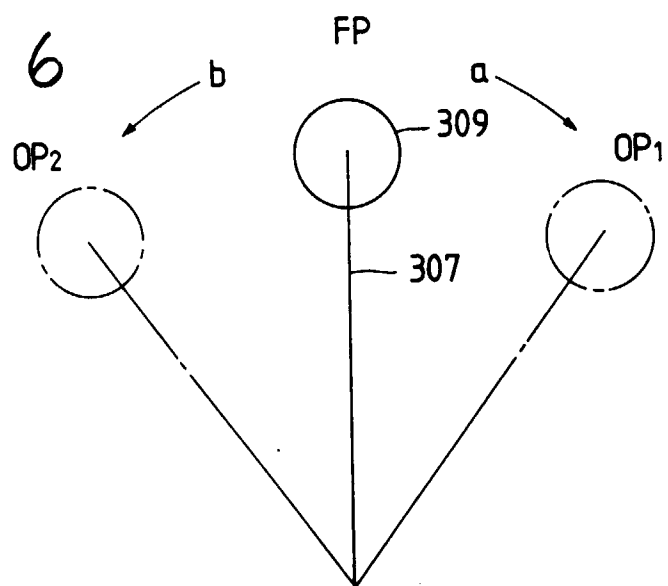


FIG. 5

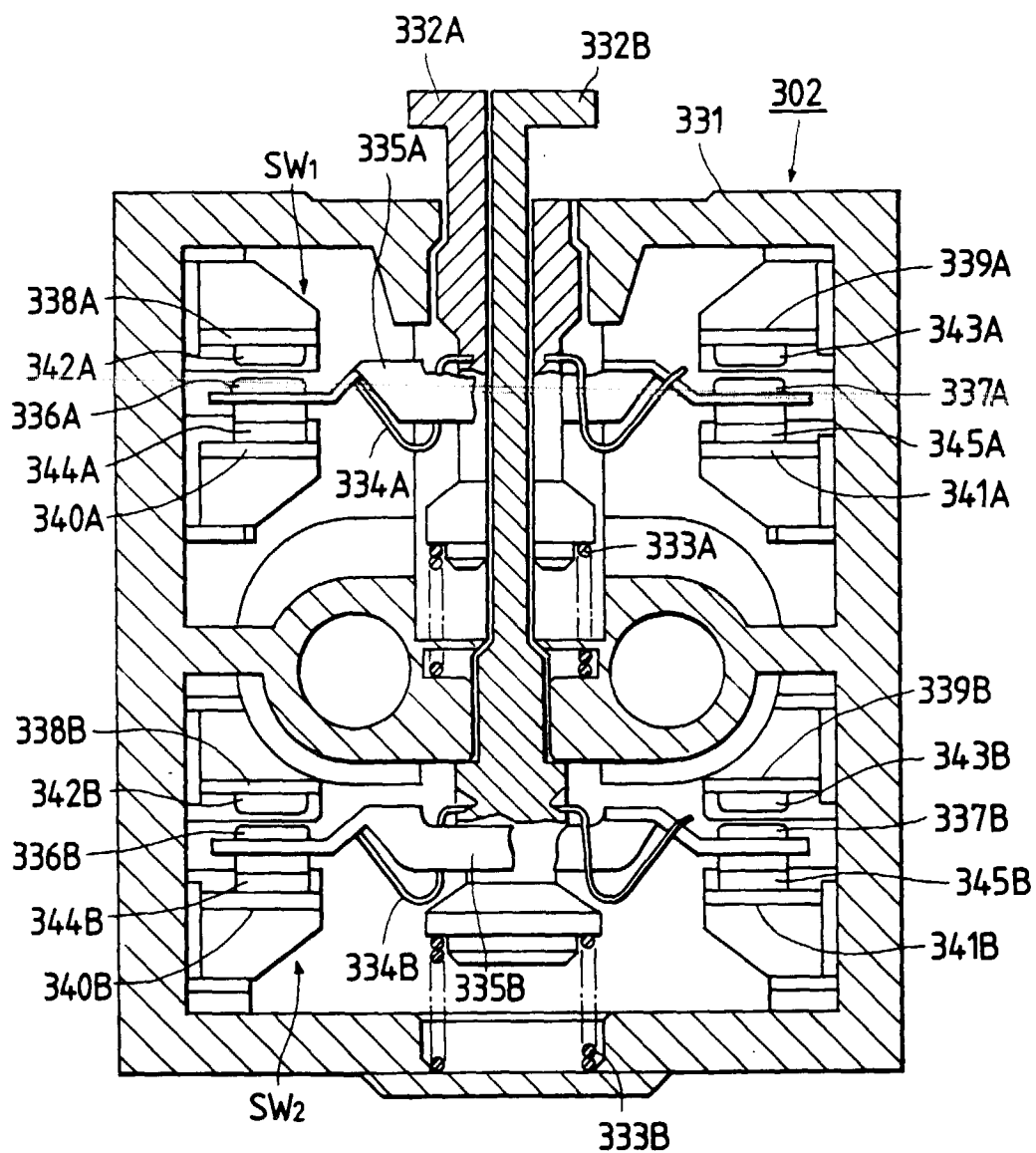


FIG. 7a

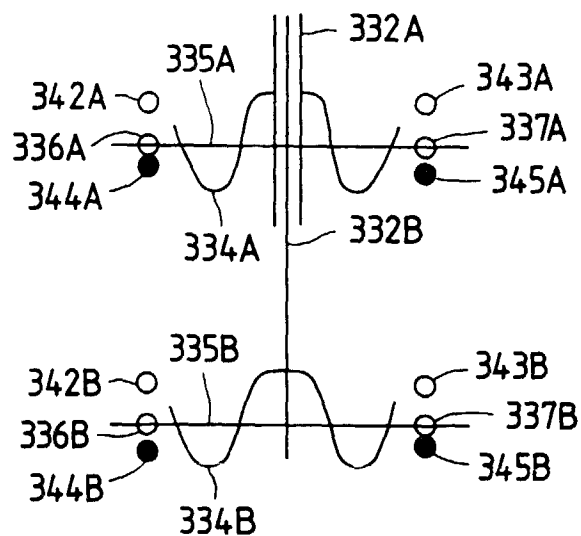


FIG. 7b

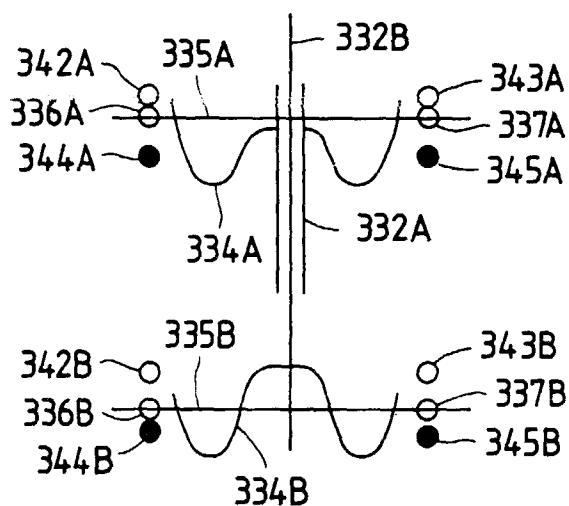


FIG. 7c

