(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 2 015 160 A1**

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
14.01.2009 Bulletin 2009/03

(51) Int Cl.:
G05G 9/047 *(2006.01)*

(21) Application number: **08425425.9**

(22) Date of filing: **16.06.2008**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MT NL NO PL PT RO SE SI SK TR
Designated Extension States:
AL BA MK RS

(30) Priority: **11.07.2007 IT VR20070098**

(71) Applicant: **Autec S.R.L.**
36030 Caldogno (VI) (IT)

(72) Inventors:
- **Battistella, Giuseppe Mario**
  36030 Caldogno (VI) (IT)
- **Bonan, Alessandro**
  36030 Caldogno (VI) (IT)
- **Silvestri, Antonio**
  36030 Caldogno (VI) (IT)

(74) Representative: **Iannone, Carlo Luigi et al**
Barzanò & Zanardo Roma S.p.A.
Via Piemonte 26
00187 Roma (IT)

(54) Joystick device

(57) Joystick having a containment and support base or body (2), an articulation group (3) for at least one driven shaft (15,16), a control lever (5) having an end cinematically connected to the articulation group (3) and the other end which can be engaged by operator's hand, a plurality of electrical sliding contacts (9,10), printed circuit boards (8) in sliding relation with the plurality of electrical sliding contacts (9,10).

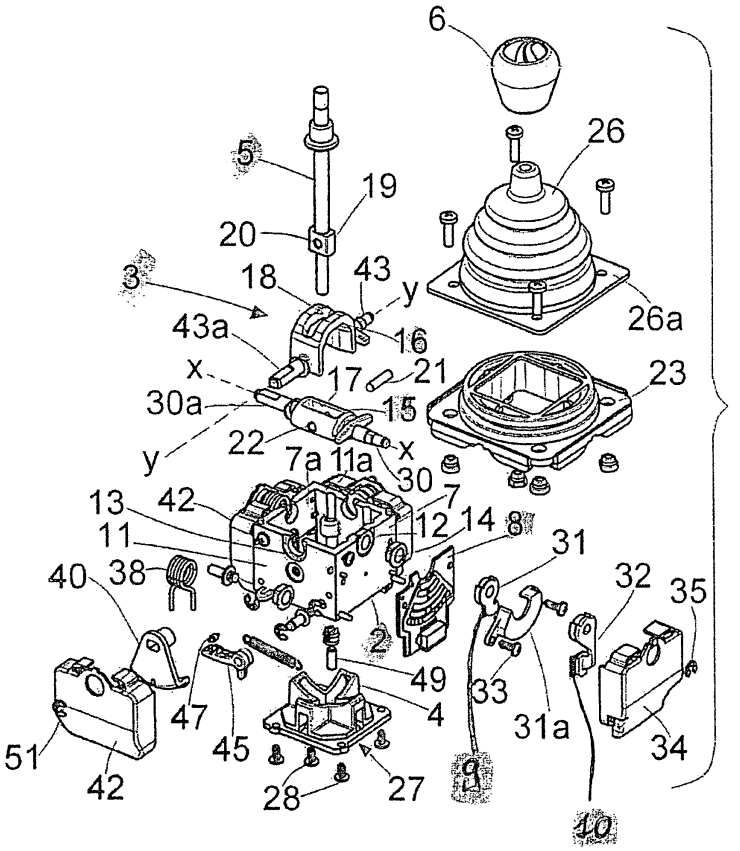


Fig. 4

EP 2 015 160 A1

Description

[0001] This invention relates to a manually driven electromechanical actuator of the so-called "joystick" type, particularly but not exclusively for the use in control boxes, including the remote control, for example through radiofrequency or cable, of machines in general, such as cranes, bridge cranes, concrete pumps and similar.

[0002] Joystick actuators devices of various kinds have already been proposed in the state of the art, which, also due to safety regulations requirements, can present two switches generally made by printed circuit board or cards electrically and physically separated from each other, in order to avoid, obviously, that they are simultaneously shortcircuited owing to wear or rupture. Such actuators consist of expensive redundant systems as the make necessary to provide dedicated housing seats for the two cards in spaces which must necessarily very be very small in dimensions.

[0003] The main aim of the present invention is to provide a single-axis or dual-axis actuator of the joystick type specified above, in which the necessary functionality is ensured with drastically reduced dimensions compared to the traditional actuators.

[0004] Another aim of the present invention is to provide a new conceiving joystick actuator which, besides ensuring a high degree of efficiency, can be produced at competitive costs.

[0005] These and other aims which will better result afterwards are achieved by a manually driven electromechanical actuator, of the joystick type, particularly for control boxes, according to the attached claim 1, to which they refer for the sake of brevity.

[0006] Further aspects and advantages of the present invention will also result by the following detailed description of a currently preferred embodiment thereof, given by way of illustrative but not limiting example, with reference to the attached drawings, where:

- figure 1 is an overall schematic perspective view of a joystick actuator according to the present invention;
- figure 2 is a side elevation view in enlarged scale of the device of figure 1;
- figure 3 is a top view of the device of figure 2;
- figure 4 is an exploded view of the device of figure 1;
- figure 5 is an exploded view of a plurality of electrical sliding contacts and printed circuit boards, in sliding relationship with the plurality of electrical contacts, as well as of respective protection elements, representing part of the device according to the present invention;
- figure 5a is an enlarged scale particular of figure 5;
- figure 6 is an exploded view of a return device in starting position for the control lever of the device according to the present invention;
- figure 7 is a perspective view of a cardan group for driving the control lever of the device according to the invention rotated by 180° around a vertical axis, compared to the set up illustrated in figure 4;
- figure 8 is an exploded view of an enlarged scale particular of figure 4;
- figure 9 is a front view of an electrical board of figure 4 in enlarged scale;
- figure 10 is a table with an example on how the closure of contacts varies when the operation angle varies, and
- figure 11 is an exploded view showing a variation of a particular of figure 4.

In the attached drawings identical or similar parts or components have been marked with the same reference numbers.

[0007] Referring firstly to figures from 1 to 9, it can be noted as an actuator of the joystick type, generally indicated with 1, with one or two movement axes, according to the present invention, is provided with a containment and support body 2, preferably consisting of a square section tubular stretch made of synthetic material, an articulation group supported by the containment and support body 2 and including an universal cardan joint system 3 and two pairs of guide positioned in cross or coulisse cross 4, as well as a control lever 5, having its own end which is intended to be cinematically connected to the universal joint system 3 and which can be engaged by sliding with two pairs of cross guides 4 and its other end intended to lie, in use, outside the containment and support body 2 and provided with a handle knob 6 for the grip by the hand of an operator. The containment and support body 2 supports, preferably on the external face of its own wall, for example of the wall 7, a printed circuit board or card 8 (figures 4, 5 and 9) provided with sliding contact tracks, as will be further explained later on. A first series or group of electrical sliding contacts 9 and a second series or group of electrical sliding contacts 10, each of which is angularly movable along their respective tracks of the printed circuit board 8, in the way that will be described below, are arranged to roll on the tracks of the printed circuit board 8.

[0008] Noting in particular figures 4, 7 and 8, it can be seen that in the containment and support body 2 at the middle of the upper edge of each of its four walls 7, 7a (opposed to the wall 7), 11 and 11a (opposed to the wall 11) two pairs of grooves 12, 12a (the latter not visible in the drawings) and 13, 13a (the latter not visible in the drawings) are obtained, preferably all equal among themselves, each of which is intended to serve as housing seat for their respective bush or ferrule 14 intended to support its relative hub of the articulation group 3. More specifically, the bushes 14 arranged in the grooves 12 and 12a aligned along a movement axis x-x are intended to rotatingly support the hubs of a shaft 15 (also called in jargon "main bow") of the articulation group 3, while the bushes 14 arranged in the grooves 13 and 13a aligned along a movement axis y-y, orthogonal and substantially coplanar to the axis x-x are suitable to rotatingly

support the hubs of a curved shaft 16 (also called in jargon "secondary bow") of the same articulation group.

[0009] The middle portion of the shaft or main bow 15 is bulged and an aperture or axial central slot 17 is made thereon. Similarly, the middle portion of the shaft or secondary bow 16, on which a longitudinal through slit 18 is obtained, is bulged and arched.

[0010] At an appropriate distance from its outer end cinematically connected to the articulation group 3, the lever 5 presents a cross through hole, in correspondence of which there is a cursor 19 also provided with a cross hole 20, through which a pin 21 can be installed, intended to be also installed in two aligned cross through holes 22 made in the main shaft 15 in correspondence of the slot 17, so that the lever 5 can be pivoted to the shaft 15 and extend through the slit 18 of the secondary shaft 16.

[0011] With this structure, each angular displacement of the lever 5 parallely to the axis x-x turns into a corresponding angular displacement of the shaft 16, where its displacement parallely to the axis y-y turns into a corresponding angular displacement of the shaft 15.

[0012] On the top, the containment and support body 2 is closed by a hollow flanged lid 23 which can be fixed in position by any fixing means, for example four screws 23a (figures 1-4 and 8). The bottom edge 25a of bellows 26, from which, in use, the end of manoeuvre of the control lever 5 ending with its own knob 6 comes out, is bound to the flanged lid 23. On the bottom, the body 2 is closed by a base 27 which can be fixed in position by any suitable fastening means, such as screws 28, and supports the coulisse cross 4 intended to slidingly engage the lower end of the lever 5 to guide it along two parallel directions, respectively, the x-x and y-y axes.

[0013] The shaft 15 has a front hub or tang 30 with several diameters and a rear hub or tang 30a. In use, the front hub 30 protrudes from the wall 7 of the containment and support body 2 and beyond the card 8 applied to the wall 7. In the middle stretch of the front hub 30 a first sliding contacts carrier 31 is keyed (figures 4 and 5), preferably of the oscillating arm or "wiper" type, while at its terminal stretch with the smallest diameter a second sliding contacts carrier 32 is keyed, preferably of the wiper type too and configured as the first contacts carrier 31, but dimensioned differently with respect to it, typically with longer arm.

[0014] The card 8 can be preferably detachably fixed to the wall 7, for example by screws. A protection carter 31a bounding a housing and protection seat both for part of the safety contacts of the card 8 and the contacts carrier wiper 31 can also be partially fixed around the hub 30, for example by screws 33, to the wall 7. A carter 34 for the total covering both of the card 8 and the wipers 31 and 32 can be coupled by snap with the flanged lid 23. A device suitable to pack the wipers 31 and 32, such as a seeger ring 35, is finally provided on the final part of the hub 30.

[0015] With this structure, the card 8 presents two sectors 36 and 37 of sliding tracks, which are typically arranged relatively far and separate and in any case shielded from each other, at all benefit for the very low dimensions of the actuator 1 as a whole.

[0016] The sliding contacts group 9 borne by the oscillating arm or wiper 31 can slide on the sector 36, the wiper 31 being suitable to electrically connect the superior track P1, connected to a reference voltage through a connector Cl, with the underlying adjacent track P2, which is divided into three sections or areas, respectively "a", "b" and "c", so as to bring the reference voltage to as many output terminals of the connector Cl whenever the wiper 31 moves angularly out from its rest position, corresponding to the middle section b.

[0017] The sliding contacts group 10 borne by the oscillating arm or wiper 32 is intended to slide on the sector 37, the wiper 32 being responsible to electrically connect the superior track P3, electrically connected to a reference voltage through the connector Cl, with the adjacent tracks P4 and P5, each of which is divided in an appropriate number of sectors or sections which varies depending on the specific applications to which the actuator according to the present invention is intended, so as to bring the reference voltage to the same amount of output terminals of the connector Cl, corresponding to prearranged angular positions reached by the wiper 32.

[0018] The sectors 36 and 37 and the arms 31 and 32 are kept physically separated from each other by the carter 31a in order to make possible failure modes of the respective series of contacts 9, 10 independent. More in particular, the presence of a physical barrier, consisting in the carter 31a, between the sectors 36 and 37 helps to ensure an optimal electrical insulation between the two sectors and a mechanical protection especially useful for example in case of rupture of the wiper 31, but also against dust.

[0019] An example of a switching pattern is shown in figure 10 which contains a table regarding a control function at five speeds.

[0020] In correspondence both of the opposite hub 30a of the main shaft 15 which, in use, protrudes from the wall 7a parallel to the wall 7, and of the hub 43a of the secondary shaft 16, as will be further described later on (figures 6 and 7), it is provided a respective elastic return loading means, typically consisting of a helical spring 38 which is keyed on the relative hub 30a, 43a and has its own ends striking from opposite plate against a respective stop element 39 which can be fixed, respectively, to the wall 7a and 11a, and in an exemplifying way of an angular sector element 40 keyed on the respective hub and below and externally toothed in 41 for engaging with a correspondent tooth or braking roll, as will be further explained with particular reference to the shaft 16. Everything remains closed by a carter or lid 42 similar to the carter 34.

[0021] The shaft or secondary bow 16 presents two axially aligned hubs 43 and 43a intended to protrude, in use, from the respective walls 11, 11a of the containment and support body 2. A mobile equipment 31 and 32, all

similar to that one described with reference to the hub 30 of the main shaft 15, can be keyed on the hub 43 protruding from the wall 11a, the mobile equipment moving close to a card (not visible in the drawings) completely similar to the card 8 detachably fixed to the outside wall of the wall 11a, while a respective spring 38 and a respective angular sector element 40 with lower external teeth 41 can be keyed on the hub 43a, as it has been specified above.

[0022] As it can be better seen in figures 4, 6 and 11, an elastically yielding support, constituted for example by an elbow lever 45 which can be pivoted on a respective support pin 46 that can be screwed in the respective wall 11, 7a, is positioned below each angular sector element 40, 40a both of the hub 43a and the hub 30a. An arm of the elbow lever 45 or a fork 45a which can be arranged between the ends of the spring 38 supports a rotating roll 47 intended to engage in the depressions between a tooth and another of the teeth 41, which can be obtained on the respective angular sector element 40 and drag by it or which can be obtained on an area 41a that can be fixed to the respective wall of the body 2 (figure 11) always to serve as a control element of the rotation of the shaft 16 through the angular sector element 40. The other arm of the lever 45 (figures 4 and 6) is engaged to one end of a return spring 48, whose other end is anchored to a stop 49 which can be fixed to the respective wall 11, 7a. Everything is covered with a lid or carter 42 which can be engaged by snap with the flanged lid 23. The components inserted into both the hub 43a of the shaft 16 and the hub 30a of the shaft 15 are packed with a relative seeger 51.

[0023] The functioning of a joystick device like the one described above is simple and with high reliability.

[0024] Acting on the lever 5 the operator can cause angular displacements along the axis x-x or y-y or both. The angular displacements of the main 15 and secondary 16 shafts cause angular displacements of the mobile sliding contacts of safety 9 and of work 10, reciprocally isolated, which may, as it is known in the state of the art, give outputs of the analog or digital at one or more speed type, according to several arrangements of the contacts in the printed circuit board 8.

[0025] By means of the electromechanical actuator 1, any possible failure of the sliding work contacts 10, no matter causes it, does not jeopardize the functional integrity of the sliding safety contacts 9 which, in such situations of risk, continue to effectively and efficiently operate, with the clear benefits that this entails for the safety of the operator.

[0026] This mainly happens by virtue of the fact that, in the invention, the sectors 36, 37 of sliding tracks provided in the printed circuit board 8 are distinct, independent, separate and spaced apart from each other.

[0027] The electromechanical actuator 1 referred to the invention ensures, therefore, the redundancy of the electrical signal coming out from the printed circuit board 8, required by the regulations in force relevant for safety certification, which allows to safely manage the manoeuvres of a machine tool.

[0028] In the invention, this result is achieved using only one printed circuit board for each of the movement axes of the machine itself, unlike the known art in which the redundancy of the signal is achieved using more than one board.

[0029] This leads with respect to the known technique to a reduction of the dimensions of the electromechanical actuator, declared goal of the invention.

[0030] A joystick device according to the present invention is, therefore, particularly suitable in those practical applications where the functional safety or protection against failures, which can also be potentially dangerous, is important. Specific applications of a joystick device in accordance with the present invention are on console fixed inside a machine or on remote control box, with both radiofrequency and cable signals transmission.

[0031] The invention described above is susceptible to numerous changes and variations within its protective scope defined by the tenor of the claims.

[0032] Thus, for example, if a guide which extends parallel to x-x or y-y axis is provided instead of the coulisse 4, a joystick device of the single-axis type will result. If, however, the coulisse 4 is not provided, the joystick device described above enables the lever 5 to carry out angular movements in all directions like an articulated joint.

[0033] The materials used and the dimensions may be different depending on needs.

Claims

1. Actuator of the joystick type moving along one or more movement axes (x-x, y-y), which has a containment and support base or body (2), an articulation group (3) for at least one driven shaft (15, 16) supported by the containment and support body (2), a control lever (5) having an end cinematically connected to said articulation group (3) and the other end which can be engaged by operator's hand, a plurality of electrical sliding contacts (9, 10) which can be operated by said control lever (5), a plurality of printed circuit boards (8) in connection with said plurality of electrical sliding contacts (9, 10) **characterized in that** said plurality of electrical sliding contacts comprises a first (9) and a second (10) series of electrical contacts angularly and simultaneously movable along respective sliding contact tracks (36, 37) provided in at least one of said printed circuit boards (8), each of said printed circuit boards (8) being supported by said containment and support body (2) and being suitable to move a machine tool along a relative movement axis (x-x, y-y).

2. Actuator according to claim 1, **characterized in that** at least one between said first (9) and said second

(10) series of contacts is delimited by a respective seat bounded by a protection element (31a) suitable to form a protection-separation barrier between said first (9) and said second (10) series of contacts.

3. Actuator according to claim 2, **characterized in that** each seat is formed by a respective carter (31a).

4. Actuator according to any of the claims from 1 to 3, **characterized in that** said sliding contact tracks in each board include at least one group of safety tracks (36) and at least one group of work tracks (37) spaced apart and separate from the group of safety tracks (36).

5. Actuator according to any of the claims from 1 to 4, **characterized in that** each driven shaft (15, 16) of said articulation group (3) presents at least one hub (30, 43) intended to support and to angularly move a first (9) and a second (10) series of sliding contacts.

6. Actuator according to claim 5, **characterized in that** each driven shaft (15, 16) of said articulation group (3) presents two aligned hubs or tangs (30, 30a; 43, 43a), the first (30, 43) of which is intended to support and angularly move a respective first (9) and a respective second (10) series of sliding contacts, while the second hub (30a, 43a) is elastically loaded.

7. Actuator according to claim 6, **characterized in that** said first hub (30, 43) is intended to support at least a housing and protection element (31a) for said group of safety tracks (36) of a corresponding board and for at least one respective first (9) series of sliding contacts.

8. Actuator according to claim 7, **characterized in that** it includes a coverage element (34) both of the relative board and said first and second series of sliding contacts (9, 10).

9. Actuator according to any of the claims from 5 to 8, **characterized in that** each of said second hubs (30a, 43a) supports over it at least one elastic return means (38) having its own ends which strike from opposite plate against a stop element (39) which can be fixed to or integral with said containment and support body (2), and at least one angular sector element (40) cooperating with a teeth (41) intended to engage with a respective tooth or braking roll (47) borne by an elastically yielding support (45).

10. Actuator according to claim 9, **characterized in that** said teeth (41) is obtained on said angular sector element (40).

11. Actuator according to claim 10, **characterized in that** said elastically yielding support includes an elbow lever (45) which can be pivoted on a respective support pin (46) borne by said containment and support body (2).

Fig. 2

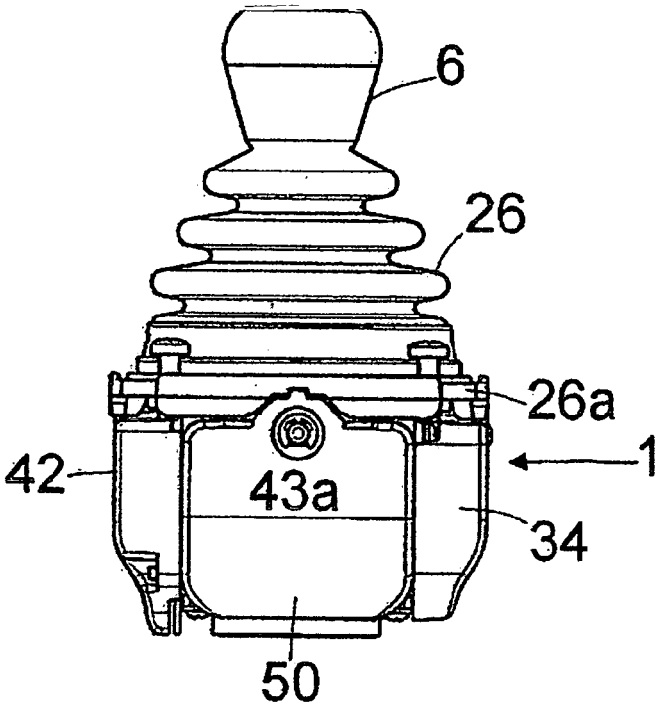


Fig. 1

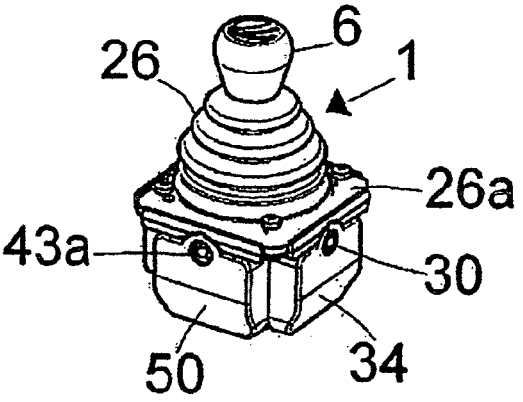
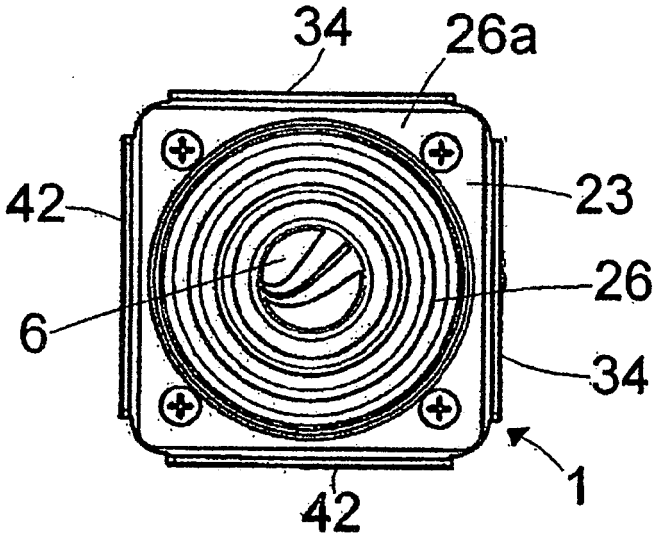


Fig. 3



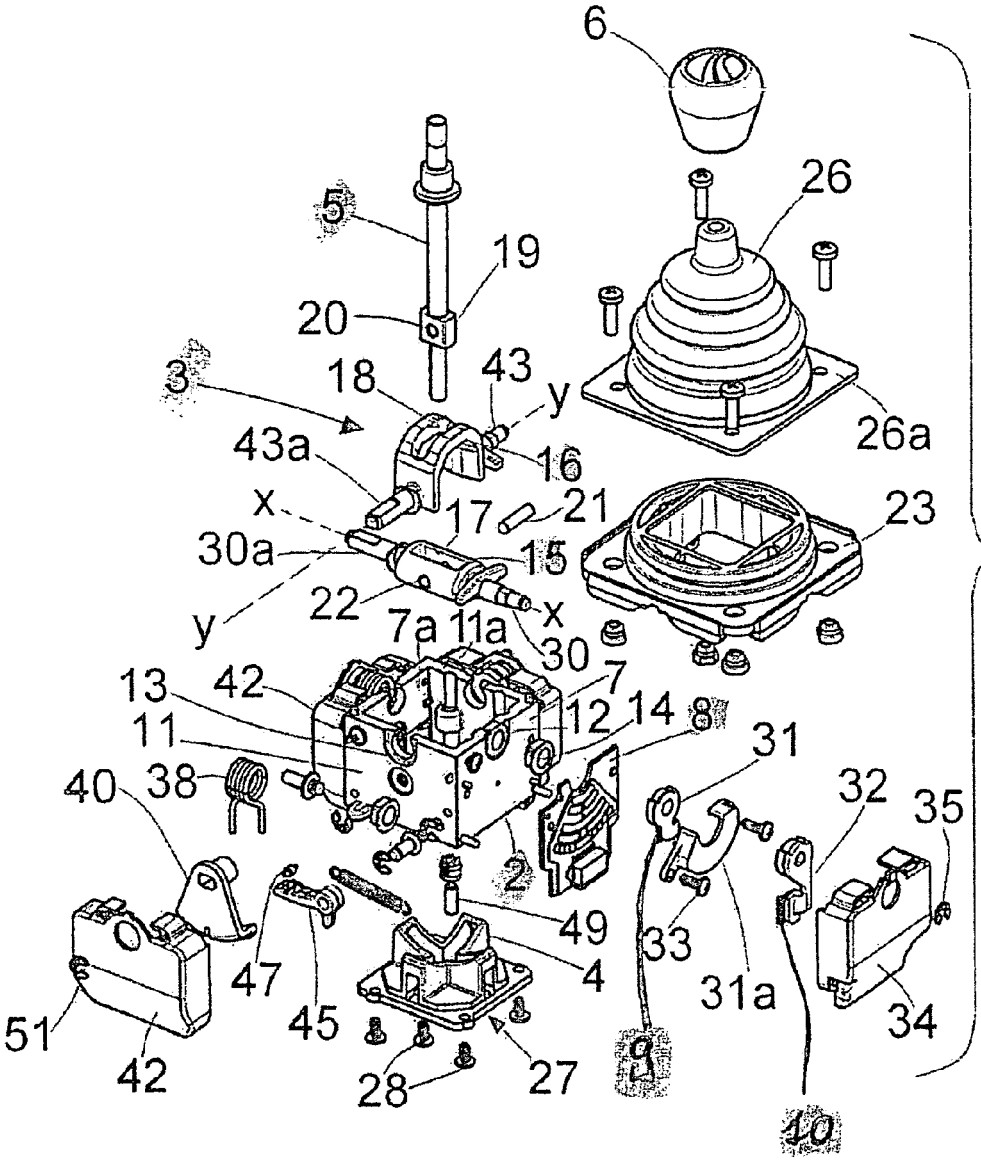

6
26
5
19
20
3
18
43
y
26a
43a
16
x
17
21
23
30a
15
22
x
y
7a
11a
30
7
13
42
12
14
8
11
31
40
38
32
35
2
49
33
4
47
31a
45
34
51
42
28
27
9
10

Fig. 4

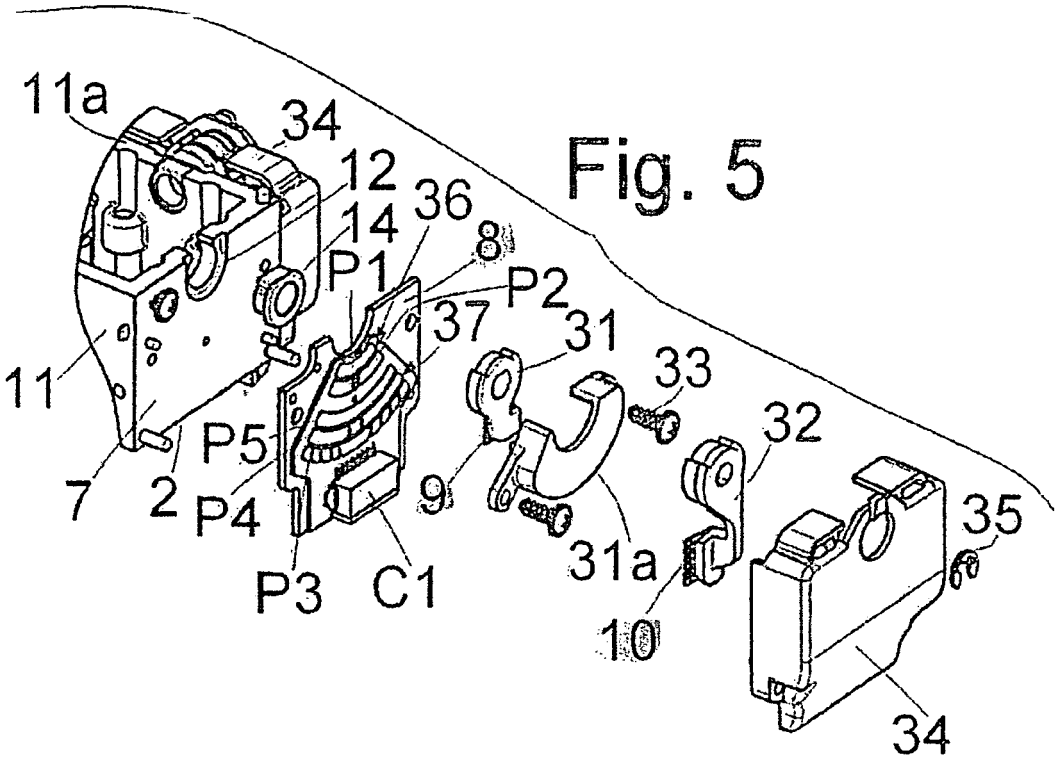

11a
34
12
14
36
8
P1
P2
37
31
33
32
11
P5
7
2
P4
9
35
31a
P3
C1
10
34

Fig. 5

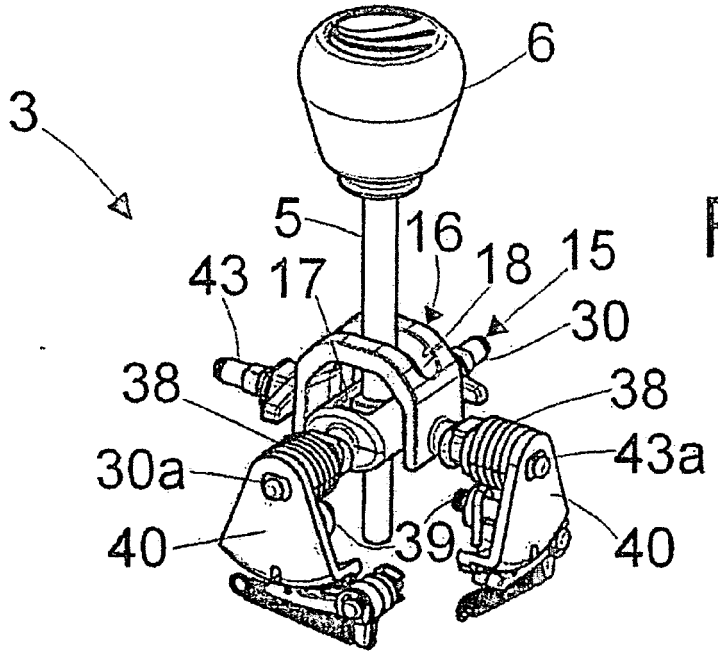

3
6
5
16
18
15
43
17
30
38
38
30a
43a
40
39
40

Fig. 7

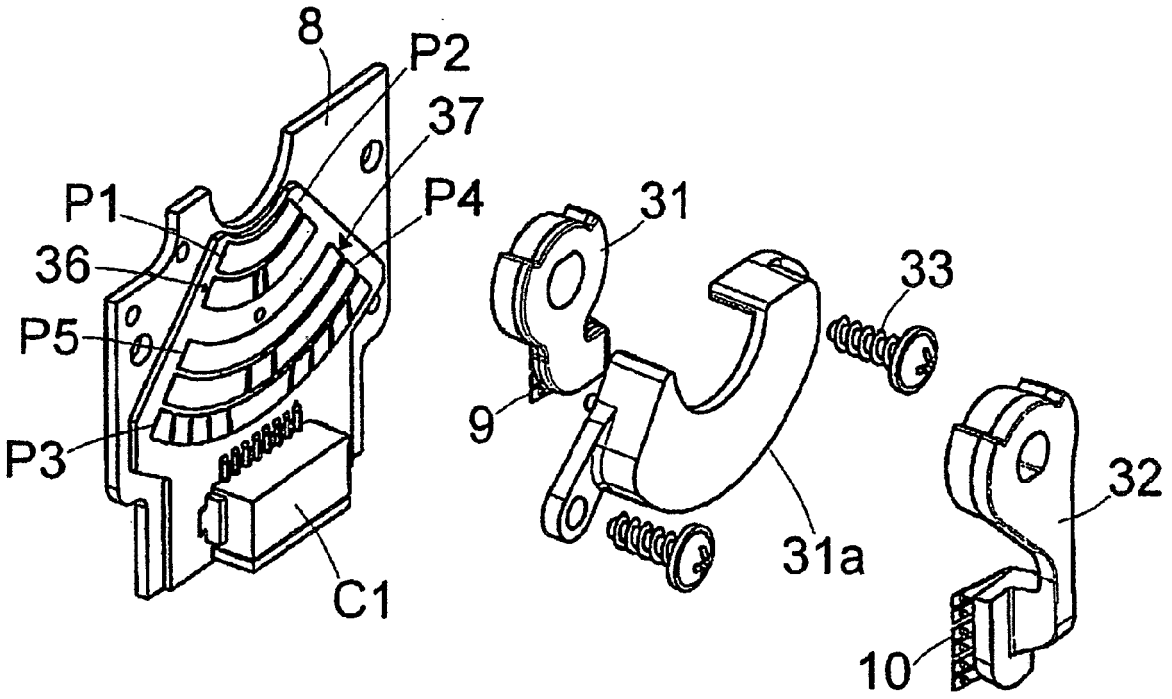


Fig. 5a

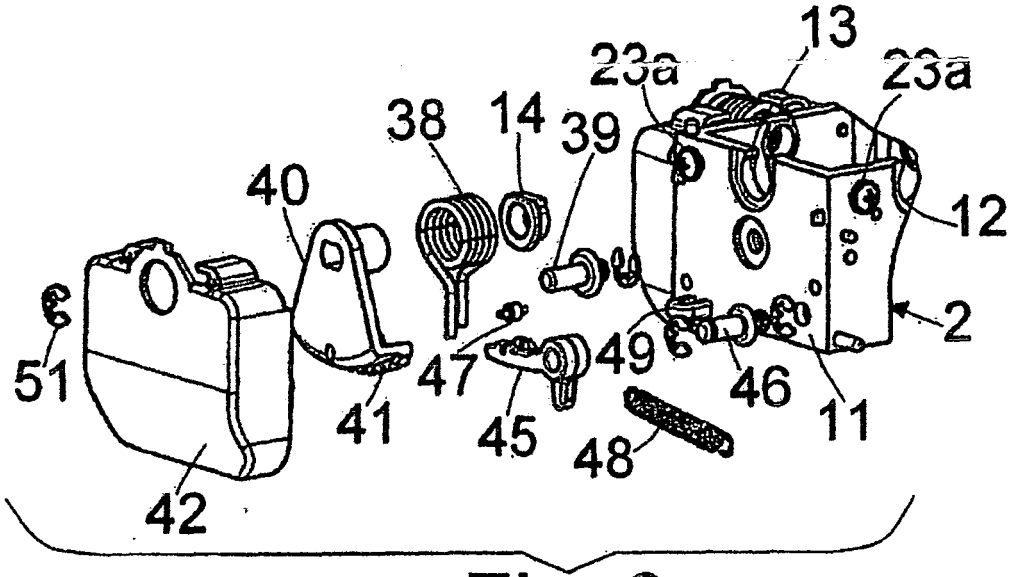

13
23a
23a
38
14
39
40
12
2
51
47
49
46
11
41
45
48
42

Fig. 6

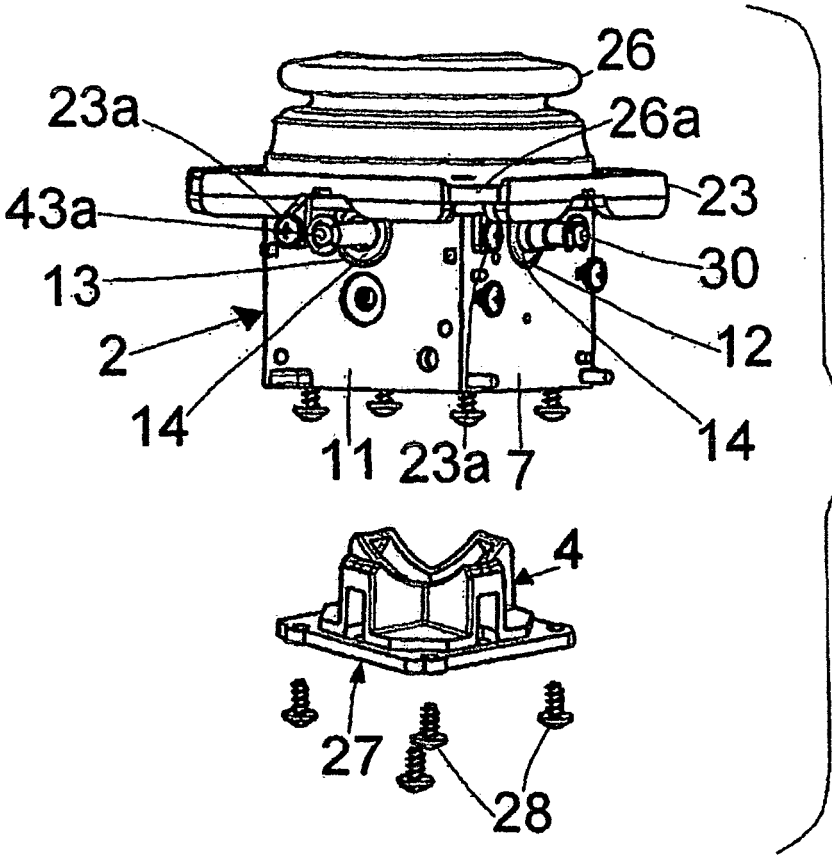

26
23a
26a
43a
23
13
30
2
12
14
14
11
23a
7
4
27
28

Fig. 8

Fig. 9

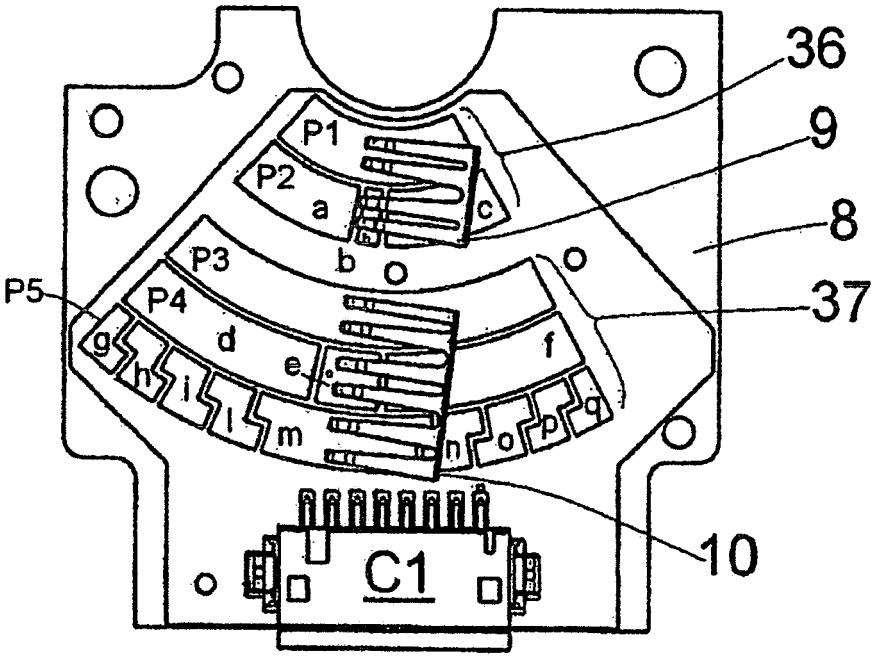


Fig. 10

Tabella: Esempio di commutazione in funzione dell'angolo di spostamento dei contatti 9 e 10

	P1	P2			P3	P4			P5								
Angolo		a	b	c		d	e	f	g	h	i	l	m	n	o	p	q
0°	x		x		x		x						x				
14°	x	x			x	x						x					

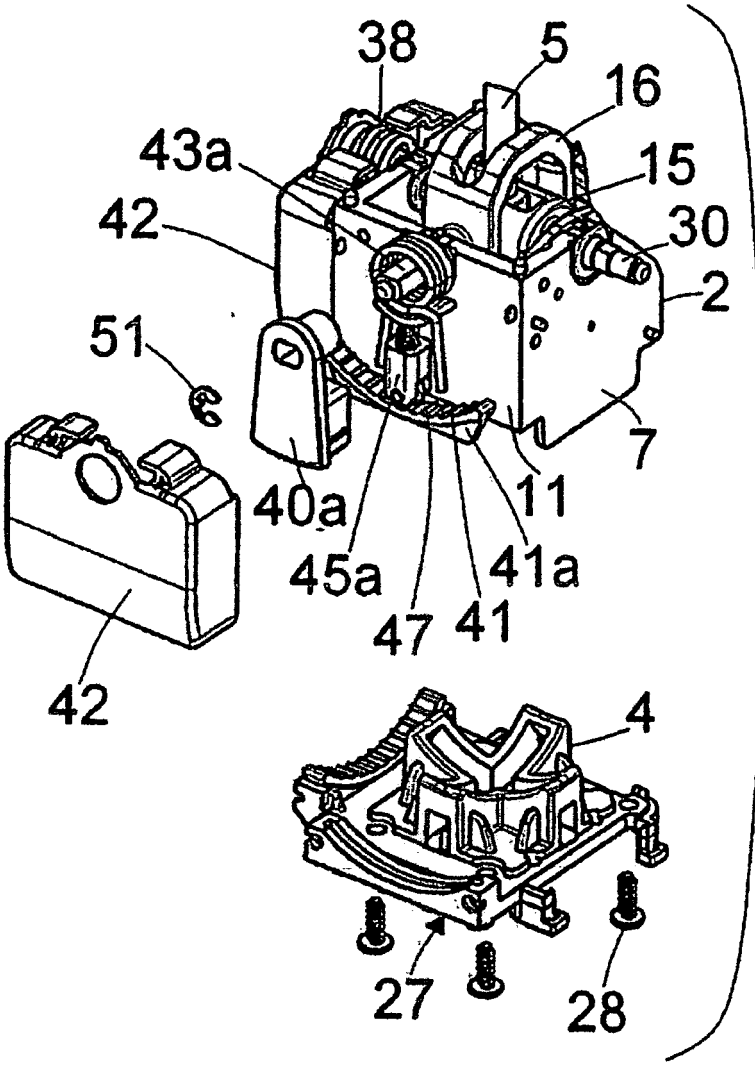


Fig. 11

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 08 42 5425

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 3 372 359 A (WILSON GORDON K) 5 March 1968 (1968-03-05) * column 2 - column 5; figures *	1-8	INV. G05G9/047
X	US 5 640 177 A (HSU FAN-YI [TW]) 17 June 1997 (1997-06-17) * column 2 - column 3; figures 2-7 *	1-5	
X	US 5 068 499 A (KURATANI JUNICHI [JP]) 26 November 1991 (1991-11-26) * column 2 - column 6; figures *	1-5	
X	US 6 538 639 B1 (TAKAHASHI KISABURO [JP]) 25 March 2003 (2003-03-25) * column 7 - column 13; figures 1-7 *	1-3	
X	US 2003/058220 A1 (WANG KART [TW]) 27 March 2003 (2003-03-27) * abstract; figures *	1-3	
A	US 5 087 904 A (DEVOLPI DEAN [US]) 11 February 1992 (1992-02-11) * the whole document *	1-4	TECHNICAL FIELDS SEARCHED (IPC) G05G
A	US 2 842 645 A (WHITE DALGLEISH JAMES ET AL) 8 July 1958 (1958-07-08) * the whole document *	6	
A	US 5 436 640 A (REEVES DAVID W [US]) 25 July 1995 (1995-07-25) * column 4 - column 7; figures *	9	
A	US 2006/073762 A1 (ARAI MASAHIRO [JP] ET AL) 6 April 2006 (2006-04-06) * the whole document *	9-11	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	24 October 2008	Popescu, Alexandru

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

1

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 08 42 5425

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

24-10-2008

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 3372359 A	05-03-1968	NONE	
US 5640177 A	17-06-1997	NONE	
US 5068499 A	26-11-1991	NONE	
US 6538639 B1	25-03-2003	CN 1284689 A	21-02-2001
		CN 1571093 A	26-01-2005
		HK 1032654 A1	12-05-2006
		KR 20010029884 A	16-04-2001
		TW 463078 B	11-11-2001
US 2003058220 A1	27-03-2003	CN 1409206 A	09-04-2003
		TW 528940 B	21-04-2003
US 5087904 A	11-02-1992	NONE	
US 2842645 A	08-07-1958	NONE	
US 5436640 A	25-07-1995	NONE	
US 2006073762 A1	06-04-2006	CN 1765451 A	03-05-2006
		JP 2006102010 A	20-04-2006
		KR 20060051842 A	19-05-2006

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82