(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
11 January 2018 (11.01.2018)

WIPO | PCT

(10) International Publication Number
WO 2018/007947 A1

(51) International Patent Classification:
F16H 59/10 (2006.01) *F16H 59/02* (2006.01)
F16H 59/04 (2006.01)

(21) International Application Number:
PCT/IB2017/054033

(22) International Filing Date:
04 July 2017 (04.07.2017)

(25) Filing Language: Italian

(26) Publication Language: English

(30) Priority Data:
102016000069085 04 July 2016 (04.07.2016) IT

(71) Applicant: **SILATECH S.R.L.** [IT/IT]; Zona Industriale, 66052 Gissi (Chieti) (IT).

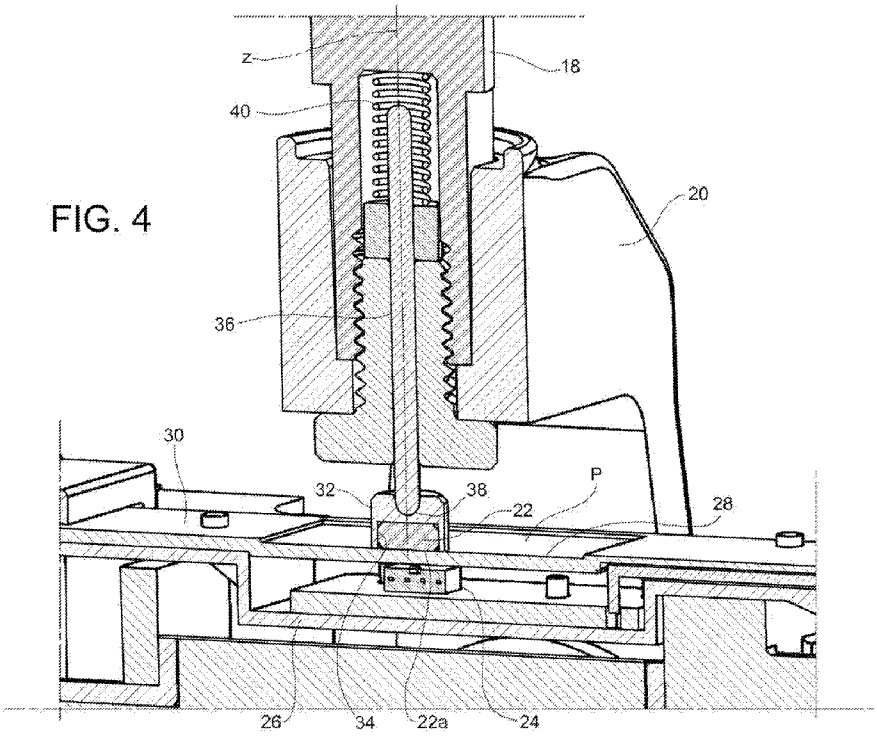
(72) Inventors: **MONGARLI, Edoardo Placido**; c/o SILATECH S.R.L., Zona Industriale, 66052 Gissi (Chieti) (IT). **PAIRONA, Aldo**; c/o SILATECH S.R.L., Zona Industriale, 66052 Gissi (Chieti) (IT).

(74) Agent: **RONDANO, Davide** et al.; c/o Jacobacci & Parterns S.p.A., Corso Emilia 8, 10152 Torino (IT).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,

(54) Title: GEAR SHIFT CONTROL DEVICE WITH A CONTROL LEVER SUPPORTED BY MEANS OF A UNIVERSAL JOINT AND WITH A POSITION DETECTION SYSTEM FOR DETECTING THE POSITION OF THE CONTROL LEVER

FIG. 4



(57) Abstract: The gear shift control device (10) comprises a control lever (12), a support body (14) arranged to be rigidly connected to the vehicle passenger compartment, a universal joint (16) by means of which the control lever (12) is supported by the support body (14) so as to be rotatable about a first axis of rotation (x) and a second axis of rotation (y) perpendicular to the first one, and a position detection system (22, 24) arranged to detect the position of the control lever (12). The position detection system (22, 24, 36, 38, 40) comprises one single permanent magnet (22), which is connected to the control lever (12) so as to move as a result of tilting of the control lever (12) about the first and the second axis of rotation (x, y), and a Hall effect magnetic field sensor (24), which is mounted on a sensor-carrying plate (26) attached to the support body (14) so as to be operatively exposed to the magnetic flux generated by the

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SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*

permanent magnet (22) and is arranged to output signals indicative of the components of such a magnetic flux. The permanent magnet (22) is forced to move on a plane (P) extending parallel to and at a distance from the sensor-carrying plate (26). The position detection system (22, 24, 36, 38, 40) further comprises connection means (36, 38, 40) which connect the permanent magnet (22) to the control lever (12) and are configured to convert the tilting movement of the control lever (12) about the first and the second axis of rotation (x, y) into a movement of the permanent magnet (22) on said plane (P).

Gear shift control device with a control lever supported by means of a universal joint and with a position detection system for detecting the position of the control lever

The present invention relates to a gear shift control device for a vehicle gearbox comprising a support body arranged to be rigidly connected to a part of the vehicle passenger compartment, for example to the floor or dashboard, a control lever supported by the support body by means of a universal joint so as to be able both to tilt to the left or to the right about a first axis of rotation directed longitudinally and to tilt forward and backward about a second axis of rotation directed transversely to perform the gear selection and engagement movements, respectively, and a position detection system for continuously detecting the position of the control lever, wherein the position detection system comprises a single permanent magnet, which is connected to the control lever so as to move as a result of the tilting of the control lever about the first and the second axis of rotation, and a single Hall effect magnetic field sensor, which is mounted on a sensor-carrying plate attached to the support body and is arranged to output signals indicative of the components of the magnetic flux generated by the permanent magnet and applied to the sensor itself, as specified in the preamble of independent claim 1.

A gear shift control device of the type identified above is known for example from DE 10 2011 119 862. According to this known solution, the permanent magnet of the position detection system is mounted onto the control lever so as to be drivingly connected therewith, both in the tilting movement about the first axis of rotation and in the tilting movement about the second axis of rotation. More specifically, the permanent magnet is arranged with its magnetic axis parallel to, and at a distance from, the first axis of rotation. Consequently, as a result of the tilting of the control lever about the first and the second axis of rotation, the permanent magnet moves in space, that is, travels along a path extending in the three dimensions. This makes the measurement, carried out by the sensor, of the components of the magnetic flux generated by the permanent magnet more difficult and less accurate, resulting in reduced accuracy in the detection of the position of the control lever.

It is therefore an object of the present invention to provide a gear shift control device of the type identified above, wherein the position detection system is able to detect the position of

the control lever with greater accuracy compared to the prior art discussed above.

These and other objects are fully achieved according to the present invention by virtue of a gear shift control device having the features defined in the appended independent claim 1.

Preferred embodiments of the invention are defined in the dependent claims, whose content is to be understood as forming an integral and integrating part of the present description.

In summary, the invention is based on the idea of providing a gear shift control device of the type identified above, wherein the permanent magnet is constrained to move on a plane extending parallel to and at a distance from the sensor-carrying plate and is connected to the control lever via connection means configured to convert the tilting movement of the control lever about the first and the second axis of rotation into a movement of the permanent magnet on said plane. With such a configuration of the position detection system, the tilting of the control lever about the first and the second axis of rotation results in the movement of the permanent magnet on a plane extending parallel to and at a distance from the sensor-carrying plate. Accordingly, the sensor is able to detect with high accuracy the position of the permanent magnet on the plane and therefore the position detection system is able detect the position of the control lever more accurately than the prior art.

According to an embodiment of the invention, the connection means are configured to convert the tilting movement of the control lever about the first axis of rotation into movement of the permanent magnet on said plane along a first direction and to convert the tilting movement of the control lever about the second axis of rotation into movement of the permanent magnet on said plane along a second direction perpendicular to the first direction.

According to an embodiment of the invention, the permanent magnet is mounted in a in a magnet-carrying body and is slidably arranged on a flat sliding surface formed by a further plate attached to the support body parallel to and at a distance from the sensor-carrying plate. Preferably, the connection means comprise at least one spring acting directly or indi-

rectly on the magnet-carrying body so as to keep the permanent magnet permanently in contact with the flat sliding surface, irrespective of the position of the control lever.

Further features and advantages of the present invention will appear from the following detailed description, given purely by way of a non-limiting example with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of a gear shift control device according to an embodiment of the present invention;

Figures 2 and 3 are two further perspective views showing in more detail, from two different points of view, the gear shift control device of Figure 1;

Figure 4 is a perspective view showing the position detection system of the gear shift control device of Figure 1, sectioned through a first sectional plane passing through the first axis of rotation of the control lever; and

Figure 5 is a perspective view showing the position detection system of the gear shift control device of Figure 1, sectioned through a second sectional plane passing through the second axis of rotation of the control lever.

In the following description and claims, terms such as "longitudinal" and "transverse" as well as "horizontal" and "vertical" refer to the condition of installation of the control device on board of the vehicle. Moreover, the term "longitudinal" is used herein to indicate a direction parallel to the front-back direction (or driving direction) of the vehicle, while the term "transversal" is used herein to indicate a direction perpendicular to the longitudinal direction.

With reference initially to Figures 1 to 3, a gear shift control device for a vehicle gearbox according to an embodiment of the present invention is generally indicated 10. The control device 10 basically comprises a control lever 12 through which the driver is able to impart commands to the vehicle gearbox, a support body 14 arranged to be rigidly connected to the vehicle compartment, for example to the floor or the dashboard, and a universal joint 16 by meas of which the control lever 12 is supported by the support body 14 so as to be able to rotate about two perpendicular axes of rotation, i.e. a first axis of rotation x directed longitudinally and a second axis of rotation y directed transversely, wherein for example

the first axis of rotation x is a stationary axis, that is, fixed with respect to the support body 14, while the second axis of rotation y rotates about the first axis of rotation x along with the control lever 12 when the latter is tilted in one direction or the other about the first axis of rotation x. The control lever 12 comprises, in a per-se-known manner, a rod 18 and a knob (not shown, but of per-se-known type) mounted at the upper end of rod 18. By rotation about the first axis of rotation x, the control lever 12 tilts in a transverse plane (selection plane) to the left or to the right to transmit selection commands to the gearbox, while by rotation about the second axis of rotation y, the control lever 12 tilts in a longitudinal plane (engagement plane) back and forth to transmit engagement commands to the gearbox.

The universal joint 16 may be of any known type and will therefore not described herein in detail. In general terms, the universal joint 16 comprises a fork 20 and a cross (not shown in the figures). The cross comprises a first shaft which extends in the longitudinal direction (i.e. in the direction of the first axis of rotation x) and a second shaft which extends in the transverse direction (i.e. in the direction of the second axis of rotation y). The first shaft is rotatably supported by the support body 14 for rotation about the first axis of rotation x (stationary axis of rotation), while the second shaft is drivingly connected with the first shaft for rotation about the first axis of rotation x and is therefore a movable axis of rotation. The fork 20 is connected to the second shaft of the cross so as to rotate therewith about the first axis of rotation x and further rotate with respect to the first shaft about the second axis of rotation y. The rod 18 of the control lever 12 is rigidly connected at the lower end thereof to the fork 20. The control lever 12 can thus rotate both about the first axis of rotation x and about the second axis of rotation y for transmitting to the gearbox the selection and engagement commands, respectively, imparted by the driver.

The selection and engagement commands imparted by the driver via the control lever 12 can be transmitted to the gearbox either mechanically, i.e. through mechanical connection members, such as for example a pair of push-pull cables, connecting the control lever 12 to special actuation members provided in the gearbox, or by the so-called shift-by-wire mode, i.e. by an electronic control unit which generates appropriate control signals for selection and engagement actuators provided in the gearbox as a function of input signals indicative

of the position of the control lever 12.

With particular reference to Figures 4 and 5, the gear shift control device 10 further comprises a position detection system adapted for continuously detecting the position of the control lever 12, namely both the angular position about the first axis of rotation x and the angular position about the second axis of rotation y. The position detection system comprises one single permanent magnet 22, which is connected to the control lever 12, in particular to the fork 20, so as to move as a result of tilting of the control lever 12 about the first axis of rotation x and the second axis of rotation y, and a Hall effect magnetic field sensor 24 (in particular made as an integrated chip), which is mounted on a sensor-carrying plate 26 attached to the support body 14 so as to be operatively exposed to the magnetic flux generated by the permanent magnet 22 and is arranged to output signals indicative of the components of such a magnetic flux.

According to an aspect of the invention, the permanent magnet 22 is forced to move on a plane P extending parallel to and at a distance from the sensor-carrying plate 26. In the embodiment illustrated herein, the plane P extends above the sensor-carrying plate 26, but according to alternative embodiments it might also be arranged underneath such a plate. The plane P is defined for example by a flat sliding surface 28 formed by a plate 30 that is attached to the support body 14 and extends parallel to and at a distance from the sensor-carrying plate 26. Preferably, the permanent magnet 22 has a flat lower side 22a adapted to slide on the flat sliding surface 28.

The permanent magnet 22 is mounted in a magnet-carrying body 32, and is for example force-fitted in a suitably shaped cavity 34 of the magnet-carrying body 32.

According to another aspect of the invention, the permanent magnet 22 is connected to the control lever 12 by means of connection means configured to convert the tilting movement of the control lever 12 about the first axis of rotation x and the second axis of rotation y into a movement of the magnet on the plane P, in particular into a movement of the magnet along two perpendicular directions. In the proposed embodiment, the connection means are configured in such a way that the tilting of the control lever 12 about the first axis of rota-

tion x results in a movement of the permanent magnet 22 on the plane P along a first direction parallel to the first axis of rotation x, while the tilting of the control lever 12 about the second axis of rotation y results in a movement of the permanent magnet 22 on the plane P long a second direction parallel to the second axis of rotation y.

The connection means comprise a connection element 36 (which in the example shown in Figures 4 and 5 is made as a rod) which on the one side is connected by means a ball-and-socket joint 38 to the permanent magnet 22, or rather to the magnet-carrying body 32, and on the other side is slidably mounted into the control lever 12 (in particular, according to the illustrated example, into rod 18) along a sliding direction z. Preferably, the sliding direction z is directed perpendicular to the plane formed by the first axis of rotation x and by the second axis of rotation y, in the condition where the control lever 12 is in the neutral position.

Preferably, the connection means further comprise at least one spring 40 acting on the connection means 36 so as to push the assembly formed by the connection element 36 and the magnet-carrying body 32 towards the plate 30, and thus keep the permanent magnet 22 permanently in contact with the flat sliding surface 28, irrespective of the position of the control lever 12.

With such a configuration of the connection means, the permanent magnet 22 moves on the plane P as a result of the tilting of the control lever 12 about the first axis of rotation x and the second axis of rotation y. In particular, there is a biunique correspondence between the position of the permanent magnet 22 on the plane P and the position of the control lever 12 (defined by the angular position about the first axis of rotation x and by the angular position about the second axis of rotation y), whereby each position of the control lever 12 corresponds to one and only one position of the permanent magnet 22 on the plane P and vice versa. Therefore, detecting the position of the permanent magnet 22 on the plane P through the sensor 24, the position control system is able to continuously detect the position of the control lever 12. The accuracy obtainable with such a position detection system is higher than that of the prior art, since the permanent magnet 22 is constrained to move on a plane, namely a plane parallel to the plane of sensor 24.

Naturally, the principle of the invention remaining unchnaged, the embodiments and manufacturing details may widely vary compared to those described and illustrated purely by way of a non-limiting example, without thereby departing from the scope of the invention as defined in the accompanying claims.

CLAIMS

1. Gear shift control device (10) for a vehicle gearbox, comprising a control lever (12), a support body (14) arranged to be rigidly connected to the vehicle passenger compartment, a universal joint (16) by means of which the control lever (12) is supported by the support body (14) so as to be rotatable about a first axis of rotation (x) and a second axis of rotation (y) perpendicular to the first axis of rotation (x), and a position detection system (22, 24) arranged to detect the position of the control lever (12),
wherein the position detection system (22, 24, 36, 38, 40) comprises one single permanent magnet (22), which is connected to the control lever (12) so as to move as a result of the tilting of the control lever (12) about the first and the second axis of rotation (x, y), and a Hall effect magnetic field sensor (24), which is mounted on a sensor-carrying plate (26) attached to the support body (14) so as to be operatively exposed to the magnetic flux generated by the permanent magnet (22) and is arranged to output signals indicative of the components of said magnetic flux,
characterized
in that the permanent magnet (22) is forced to move on a plane (P) extending parallel to and at a distance from the sensor-carrying plate (26), and
in that the position detection system (22, 24, 36, 38, 40) further comprises connection means (36, 38, 40) which connect the permanent magnet (22) to the control lever (12) and are configured to convert the tilting movement of the control lever (12) about the first and the second axis of rotation (x, y) into a movement of the permanent magnet (22) on said plane (P).

2. Gear shift control device according to claim 1, wherein said connection means (36, 38, 40) are configured to convert the tilting movement of the control lever (12) about the first axis of rotation (x) into a movement of the permanent magnet (22) on said plane (P) along a first direction and to convert the tilting movement of the control lever (12) about the second axis of rotation (y) into a movement of the permanent magnet (22) on said plane (P) along a second direction perpendicular to the first direction.

3. Gear shift control device according to claim 2, wherein said first and second direc-

tions are parallel to the first axis of rotation (x) and to the second axis of rotation (y), respectively.

4. Gear shift control device according to any of the preceding claims, wherein said connection means (36, 38, 40) comprise a connection element (36) which on one side is connected to the permanent magnet (22) by means of a ball-and-socket joint (38) and on the other side is slidably mounted in the control lever (12) along a sliding direction (z).

5. Gear shift control device according to claim 4, wherein said sliding direction (z) is directed perpendicular to the plane formed by the first axis of rotation (x) and by the second axis of rotation (y), in the condition where the control lever (12) is in the neutral position.

6. Gear shift control device according to any of the preceding claims, wherein the permanent magnet (22) is mounted in a magnet-carrying body (32).

7. Gear shift control device according to any of the preceding claims, wherein the position detection system (22, 24, 36, 38, 40) has a flat sliding surface (28) which defines said plane (P) and on which the permanent magnet (22) is forced to slide.

8. Gear shift control device according to claim 7, wherein said connection means (36, 38, 40) further comprise at least one spring (40) acting directly or indirectly onto the permanent magnet (22) so as to keep the permanent magnet (22) permanently in contact with said flat sliding surface (28).

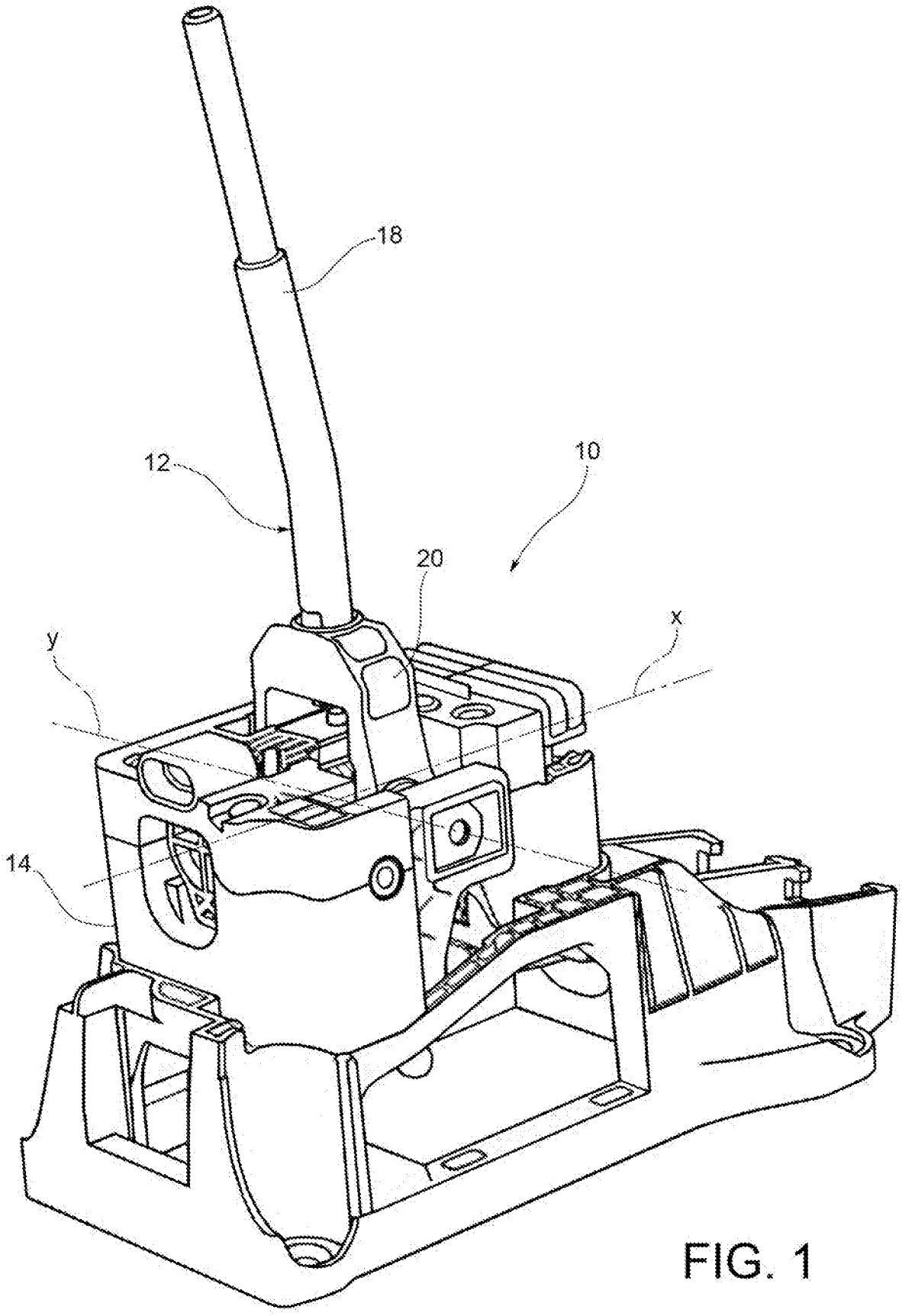

FIG. 1

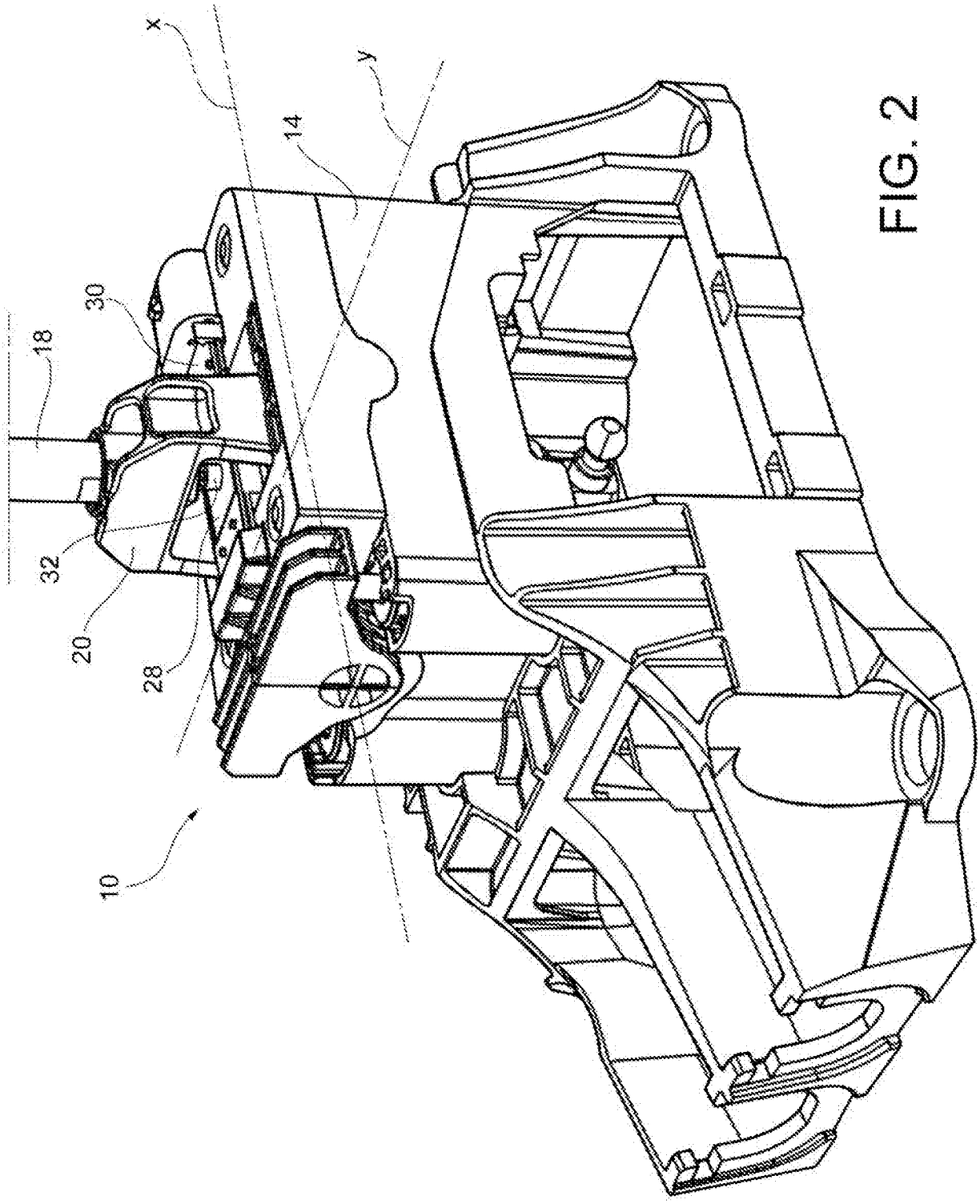

FIG. 2

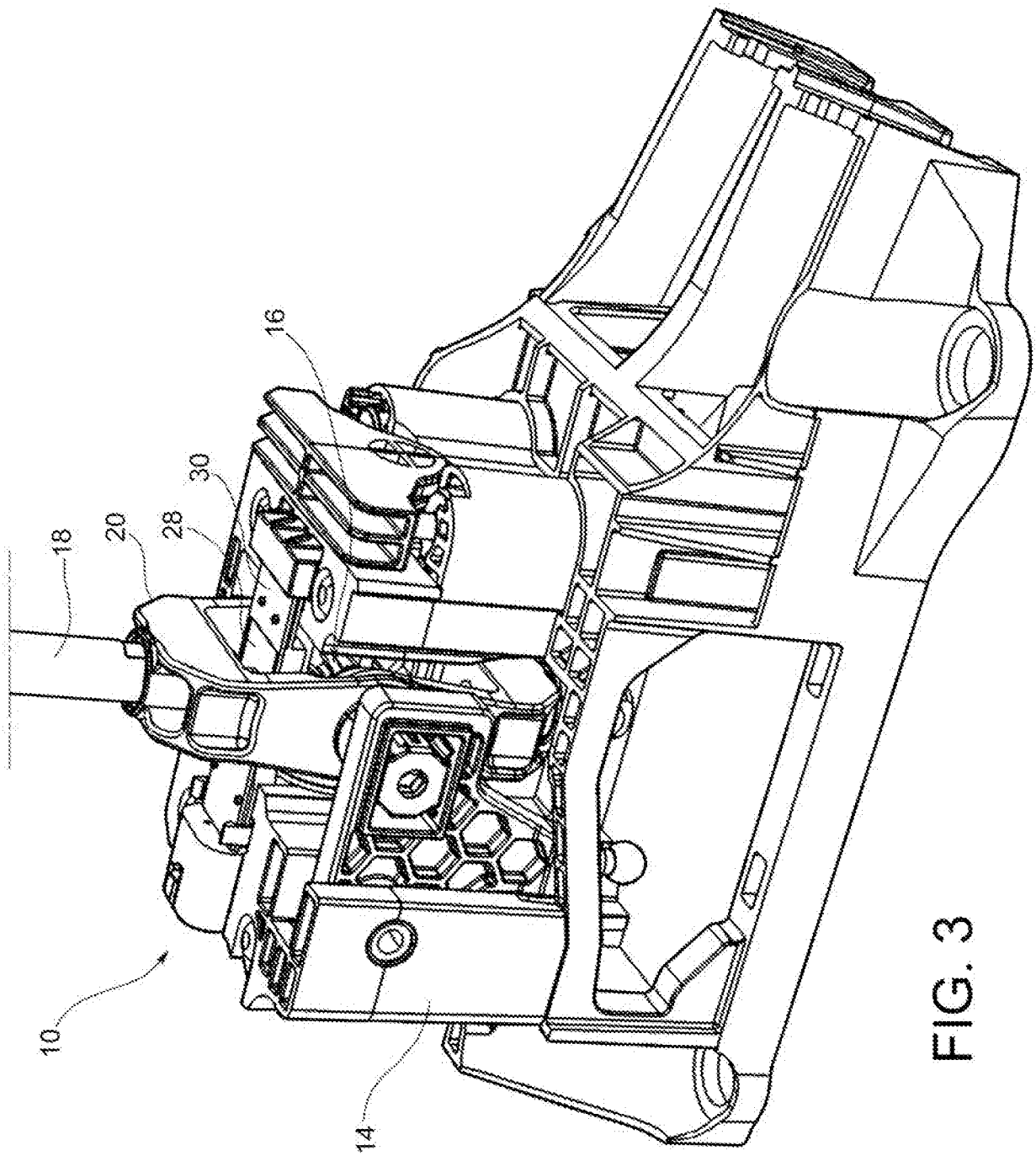

FIG. 3

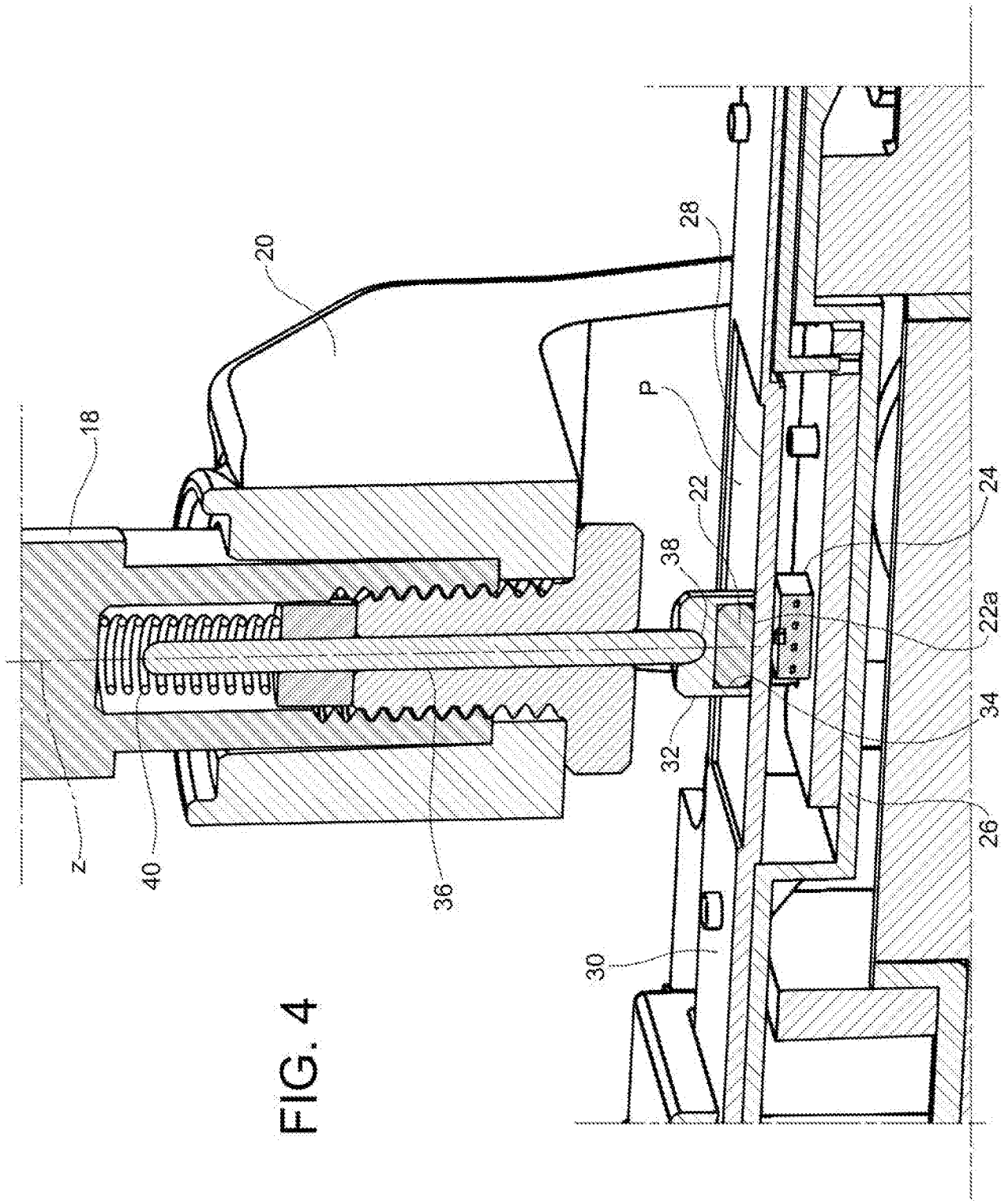

FIG. 4

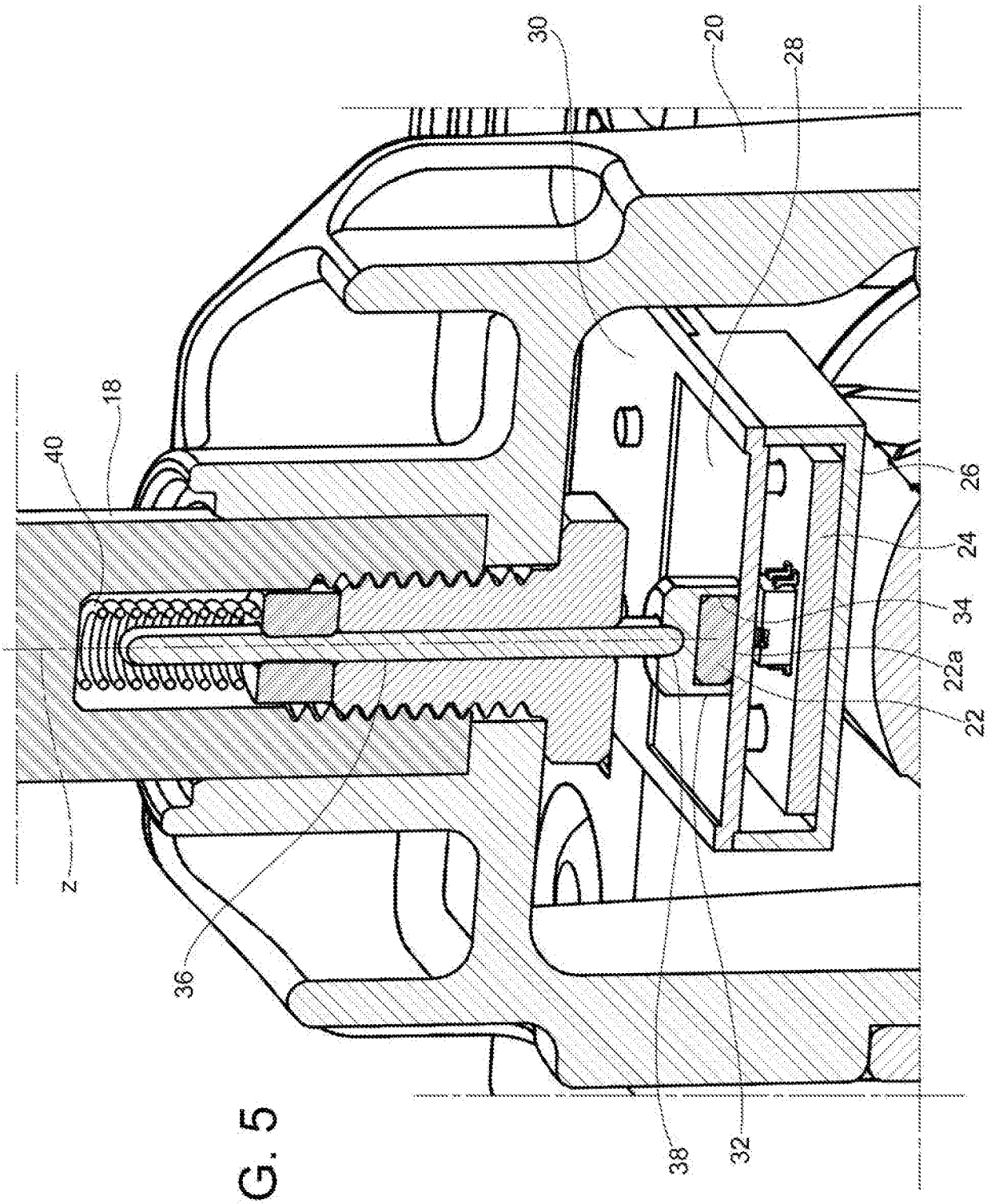

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2017/054033

A. CLASSIFICATION OF SUBJECT MATTER
INV. F16H59/10 F16H59/04 F16H59/02
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F16H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 620 385 A1 (JAEGER [FR]) 19 October 1994 (1994-10-19) figures 1, 3 column 6, lines 4-20 column 7, lines 26-43	1-8
X	US 2014/145712 A1 (NAKAMURA TOKUO [JP] ET AL) 29 May 2014 (2014-05-29) figure 15 paragraphs [0098] - [0100]	1-3
X	FR 2 638 230 A1 (FICHTEL & SACHS AG [DE]) 27 April 1990 (1990-04-27) figure 4	1-3
X	DE 10 2007 032545 A1 (CHERRY GMBH [DE]) 20 November 2008 (2008-11-20) figures 1-4	1-3

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search	Date of mailing of the international search report
28 September 2017	11/10/2017

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Pérez de Unzueta, C

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INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2017/054033

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2008 239057 A (TOKAI RIKA CO LTD) 9 October 2008 (2008-10-09) figures 2-4 -----	1-3
X	WO 2010/026947 A1 (ALPS ELECTRIC CO LTD [JP]; TAKIGAWA MAKITO [JP]; YAMADA YUKIMITSU [JP]) 11 March 2010 (2010-03-11) figure 2 abstract -----	1

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2017/054033

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0620385 A1	19-10-1994	BR 9401470 A	29-11-1994
		DE 69408356 D1	12-03-1998
		DE 69408356 T2	18-06-1998
		EP 0620385 A1	19-10-1994
		ES 2113060 T3	16-04-1998
		FR 2703958 A1	21-10-1994
US 2014145712 A1	29-05-2014	JP 5936126 B2	15-06-2016
		JP 2014107189 A	09-06-2014
		US 2014145712 A1	29-05-2014
FR 2638230 A1	27-04-1990	DE 3836145 A1	26-04-1990
		FR 2638230 A1	27-04-1990
		GB 2224791 A	16-05-1990
DE 102007032545 A1	20-11-2008	AT 520905 T	15-09-2011
		AT 522753 T	15-09-2011
		CN 101730807 A	09-06-2010
		DE 102007032545 A1	20-11-2008
		EP 2176569 A2	21-04-2010
		JP 5561865 B2	30-07-2014
		JP 2010533093 A	21-10-2010
		US 2010175494 A1	15-07-2010
		WO 2009007449 A2	15-01-2009
JP 2008239057 A	09-10-2008	JP 4806647 B2	02-11-2011
		JP 2008239057 A	09-10-2008
WO 2010026947 A1	11-03-2010	NONE	