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(54) **OPERATING UNIT**

(57) The present invention relates to an operating unit (1) comprising a housing (2) for at least partially accommodating a control adapter (3) comprising a lever adapter (4) and a substantially cylindrical bearing seat (5), wherein the control adapter (3) is pivotally mounted relative to the housing (2) around a longitudinal axis (6) of the bearing seat (5), and restoring means (7), wherein the restoring means (7) are at least two torsion springs (8) each comprising a first end (9) and a second end (10), wherein the first ends (9) rest against the control adapter (3) and the second ends (10) rest at least indirectly against the housing (2).

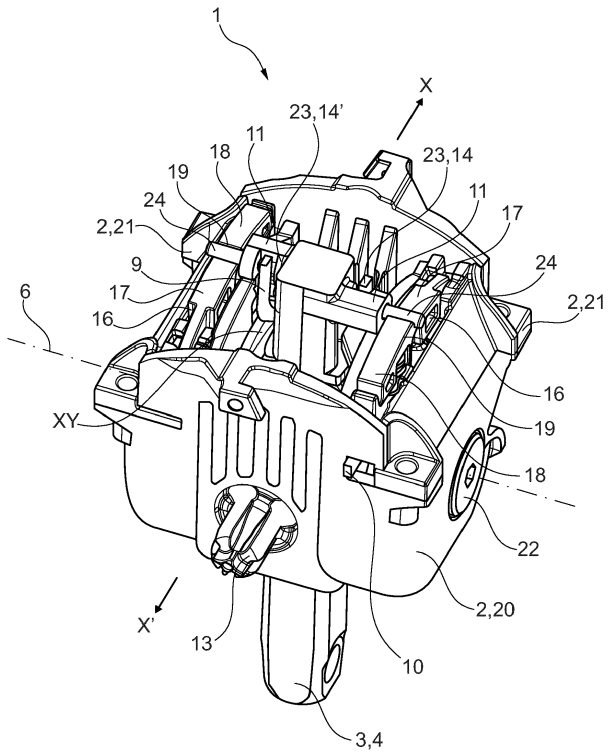

Fig. 1

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Description

[0001] The present invention relates to an operating unit comprising a housing for at least partially accommodating a control adapter and restoring means, wherein the restoring means are at least two torsion spring.

[0002] Nowadays electronic systems are used to control machines such as agricultural vehicles, in particular excavators. To facilitate user feedback in such systems that are nearly free of sensible mechanical resistance, which has typically given rise to user feedback, special components need to be integrated. These create an artificial mechanical resistance that is noticeable by a machine user. Especially in agricultural vehicles, these feedback forces need to be stronger than the vibrations and jerking that are omnipresent in the typical use environment of these vehicles to be sensible by the user.

[0003] Operating levers are widely used in agricultural vehicles. They are commonly controlled by an operating unit. The form of the operating unit amongst others gives rise to an opposing force enabling user feedback in an electric steering system.

[0004] In use, the operating lever is pivoted by a user. The operating lever is connected to the operating unit via a control adapter, which transfers the motion of the operating lever to the operating unit. For restoring or re-positioning the operating lever and the control adapter in their neutral or starting position, restoring means are provided, commonly in form of a single torsion spring. The mentioned operating levers are commonly moved in at least two opposite directions and have to undergo multiple motion cycles. Therefore, the torsion spring has to be designed to withstand these numerous load-cycles through a long lifetime and maintain a blacklash-free re-positioning. This requirement leads to a rather large torsion spring that disadvantageously requires a large space within a housing of the operating unit.

[0005] Thus, the problem to be solved is to provide an operating unit requiring a minimum space as well as providing for an effective and blacklash-free restoring of the operating unit's operating lever.

[0006] According to the invention, this objective is achieved by an operating unit comprising a housing for at least partially accommodating a control adapter comprising a lever adapter and a substantially cylindrical bearing seat, wherein the control adapter is pivotally mounted relative to the housing around a longitudinal axis of the bearing seat, further comprising restoring means, wherein the restoring means are at least two torsion springs each comprising a first end and a second end, wherein the first ends rest against the control adapter and the second ends rest at least indirectly against the housing.

[0007] The housing and the control adapter are preferably connected through a control shaft, which is statically mounted within the housing. More preferably, at least two bearings connect the control shaft and the control adapter, wherein the bearings are mounted on an inner surface of the bearing seat, which is hollow cylindrical. By "substantially cylindrical" the invention understands the bearing seat has an outer partly cylindrical surface, which is interrupted by the lever adapter in its middle along a longitudinal axis of a sliding sleeve. Further, the inner shape of the bearing seat may provide at least one stop for mounting a bearing. Further, the invention understands by "substantially cylindrical" a cylindrical shape, which might have some deviations from the mathematical definition of cylindrical. Such deviations appear especially during the manufacturing process.

[0008] In a preferable manner, the operating unit according to the invention is mounted in a further outer housing, while the operating unit is relatively pivotally mounted in the outer housing along a pivoting axis, wherein the pivoting axis is perpendicularly orientated to the longitudinal axis. Thus, a user is able to pivot the operating lever, which transfers its motion through the control adapter to the operating unit in any pivoting direction, since the control adapter can be pivoted by itself and/or relatively by the pivoting motion of the housing. Between the housing and the outer housing additional restoring means are accommodated to restore the housing in its initial position, when the operating lever is released by the user. These additional restoring means correspond to the restoring means partly accommodated in the housing, wherein the additional restoring means are at least two further torsion springs each comprising a first end and a second end, wherein the first ends rest against the housing and the second ends rest against the outer housing.

[0009] In another embodiment of the invention, the first ends are pivotally mounted relative to the housing and the second ends are statically mounted relative to the housing. The second ends of the at least two torsion springs are firmed up to the housing, so that the first end is relatively moved to the second end during the pivoting motion of the operating lever and hence the control adapter. Each torsion spring of the embodiment therefore substantially remains in its position during every movement / displacement of the control adapter. Only the first end of each torsion spring is partly taken along with the motion of the lever adapter in one pivoting direction. The required space needed for accommodating the torsion springs can thus be reduced with great advantage.

[0010] In another embodiment of the invention, the control adapter comprises at least one adapter stop to rest each first end of the restoring means there against and the housing comprises at least one housing stop to rest each second end of the restoring means there against. With respect to the adapter stop and the housing stop, the control adapter and the housing are connected indirectly through the restoring means. Preferably, the adapter stop und the housing stop are designed in such a way, that no further components are needed for resting the first and second end there against. For that, the second end is positively connected to the housing stop

and/or the first end is positively connected to the adapter stop. The housing provides preferably two housing stops, which are positioned opposite to each other and the control adapter and the restoring means in between. The second ends of the at least two torsion springs are firmed up to the housing stop, so that the first end is moved relatively to the second end during the pivoting motion of the operating lever and hence the control adapter. By using two housing stops, the torsion springs can be identical, differing only in the mounting orientation (one torsion spring is rotated 180° along a longitudinal axis of the lever adapter and mounted this way). The adapter stop is designed to take at least one torsion spring along the lever adapter while it is deflected in a first pivoting direction and to take at least one other torsion spring along the lever adapter while it is deflected in a second pivoting direction. Each one torsion spring, which is not taken along the lever adapter during a pivoting motion along a first or second pivoting direction remains substantially motionless on its initial position. This is due to the first end resting additionally on a security stop, which is attached to the housing. The security stop secures the restoring means in its initial position and saves an initial torque within the at least two torsion springs. This is even the case during a motion of the control adapter in which the respective torsion spring does not rest against the control adapter.

[0011] According to an embodiment of the invention, the at least one adapter stop is positioned on an outer end of the lever adapter opposite the bearing seat and/or the at least one adapter stop is extended parallel to the longitudinal axis. The control adapter transfers the external force during use from the operating lever to the restoring means. The larger the distance between the adapter stop and the bearing seat, the bigger is the torque applied onto the bearing seat. Since the bearing seat is connected to a control shaft through at least two bearings, the torque will not be transferred. Instead, the restoring means, which are mounted substantially coaxial to the bearing seat, will absorb the incoming torque for later re-positioning the control adapter to its initial position at the moment, the user releases it.

[0012] Additionally, the user gets some feedback on how much he has deflected the operating lever. The control adapter is pivotally mounted along the longitudinal axis. Therefore, a pivoting motion in two opposite directions is possible. If the adapter stop extends parallel to the longitudinal axis, the first end of the restoring means can easily rest against the adapter stop without the need of any additional components for maintaining the connection.

[0013] Further, a preferable development of the invention provides that at least two first ends of the restoring means rest on different adapter surfaces of the adapter stop, wherein the different adapter surfaces oppose each other. Every motion of the control adapter is preferably restored by a different torsion spring. Also more than one torsion spring can restore the control adapter to its initial position, while such a group of torsion springs rest on the identical adapter surface. By opposing the adapter surfaces to each other, the control adapter is reliably restored after a deflection in two opposing pivot directions. Thus, only a few of the restoring means are used while deflecting the control adapter. The load-cycles of each torsion spring are thus halved, leading to the advantage, that the torsion spring can be designed smaller, thereby reducing the required space for mounting. During use, deformations on the adapter surfaces and/or the first ends lead to the adapter surfaces getting a substantially concave shape. Due to resting of the torsion springs on the opposite adapter surfaces, a tolerance of the initial position will be improved since the initial torques of the torsion springs affect against each other additionally to a stop. Thus, a blacklash-free re-positioning / restoring is provided during the whole lifetime of the operating unit. Both of the torsion springs, which each rest against opposite adapter surfaces, force the lever adapter in opposite pivoting directions by the initial torques of the torsion springs, even when a deformation on the adapter surface and/or the first ends appear. While this effect appears, the lever adapter is held in its initial position. Due to the deformation a smaller tolerance or space between the first ends and the respective adapter surfaces appears and the hold of the lever adapter in its initial position even becomes better. This circumstance is defined as self-healing effect. Preferably, the adapter stop has two grooves that are opposed to each other, that the first ends of at least two torsion springs each are insertable in the grooves of the adapter stop to provide a reliable rest of the first ends on the adapter surfaces. The adapter surfaces are preferably formed by the bottom surfaces of the grooves.

[0014] An embodiment of the invention provides that the at least two torsion springs have a different spring ratio and/or a rectangular cross section. Advantageously, with respect to the individual use of the operating unit, the spring ratio is chosen to provide sufficient resistance to get the user a clear feedback and to reliably restore the control adapter towards a starting position. While different torsion springs interact as restoring means during different motions, the choice of the spring ratio also depends, whether a user needs to push or pull the operating lever and thus the control adapter. The at least one torsion spring absorbs a relative motion between the control adapter and the housing, while moving the control adapter in one first pivot direction and the other at least one torsion spring absorbs another relative motion between the control adapter and the housing, while moving the control adapter in one second pivot direction, which opposes the first pivot direction. Thus, different torsion springs provide different restoring torques regarding to the pivot direction a user moves the control adapter. The rectangular cross section provides surfaces by which especially the first and second end of the torsion spring can be rested to other components. Further, the manufacturing of torsion springs with such a shape is easy and

cheap. The use of torsion springs with a circular cross section is also possible. A spring angle, which is defined between the first end and the second end of each torsion spring, is preferably 90° in an initial position of the control adapter and not deflected. The spring angle is preferably between 110° and 120°, in particular 115° in a maximum deflected position of the control adapter. An initial torque of the torsion spring in the initial position of the control adapter is preferably between 0.5 Nm and 2 Nm, in particular between 0.75 Nm and 1.5 Nm. The maximum torque of the torsion spring in the maximum deflected position of the control adapter is preferably between 0.75 Nm and 3 Nm, in particular between 0.9 Nm and 2.5 Nm. For increasing the torque of the torsion spring, the cross-sectional shape of the torsion spring can be increased and or the amount of windings of the torsion spring can be increased.

[0015] According to a preferable embodiment of the invention, the restoring means are orientated axisymmetric, perpendicular to the lever adapter. Torsion springs are able to receive a generated force during a rotational motion. Preferably, the restoring means of the at least two torsion springs are substantially coaxially mounted to the bearing seat, wherein the at least two torsion springs have a hollow cylindrical shape and the first end and second end extending from the cylindrical shape. The lever adapter is perpendicularly orientated to the longitudinal axis of the bearing seat. The bearing seat is preferably positioned at a lever end of the lever adapter or in between the lever adapter. The axis symmetry of the restoring means to the lever adapter provides for a steady external force to the control adapter and therefore to a bearing, which indirectly connects the control adapter with a control shaft, which is statically mounted in the housing. The axes of the lever adapter and the restoring means are orientated perpendicular to each other.

[0016] A further preferable embodiment of the invention provides that the operating unit comprises a sliding sleeve, wherein the sliding sleeve is mounted between the bearing seat und the restoring means. The sliding sleeve is preferably mounted coaxially to the bearing seat and is statically mounted on the housing. The sliding sleeve does not contact the control adapter directly, while it separates the control adapter from the restoring means to reduce friction during a motion of the control adapter in use. Further, the sliding sleeve comprises two equal sleeve portions, which are substantially cylindrical. Each sleeve portion has a first axial end a second axial end and an outwardly directed receiving region between the first and the second axial end for receiving at least one torsion spring on each of the sleeve portions.

[0017] Another embodiment of the invention further provides that the operating unit comprises at least two spring-loaded links, wherein the links are mounted on the housing, wherein the links each are divided by a step in a first guiding part and a second guiding part. The spring-loaded link generates an additional resistance against the movement of a pin, which extends the adapter stop parallel to the longitudinal axis in a pivoting direction. When the pin is moved against the step, said resistance is increased rapidly. Thus, a user needs to actively push the operating lever - hence the control adapter - there against. After having passed the step, the pin switches from movement along a first guiding part to a movement along the thereto relatively elevated second guiding part of the link. Said elevated guiding part is pushed down by the guiding pin against a force of a spring that is mounted underneath the link, especially underneath the second guiding part.

[0018] The invention is described in more detail below with reference to one embodiment with reference to the figures of the drawings.

Fig. 1 shows a perspective view of an operating unit;

Fig. 2 shows a sectional side view of the operating unit;

Fig. 3 shows a perspective view of the operating unit mounted in a further outer housing.

[0019] **Fig. 1** shows a perspective view of an operating unit 1 comprising a housing 2, wherein the housing 2 is separated into one first housing section 20 and two second housing sections 21. The first and second housing sections 20, 21 are attached to each other by screws. According to some preferable embodiments of the invention, the first and second housing sections 20, 21 can be attached to each other by clipping, pressing or wedging, too. A control adapter 3 is partly accommodated within the housing 2, wherein the control adapter 3 comprises a lever adapter 4 and a bearing seat 5 (shown in **Fig. 2).** The control adapter 3 is pivotally mounted along a longitudinal axis 6 of the bearing seat 5 in the housing 2. The bearing seat 5 is connected to the housing 2 with a control shaft 22 through bearings (not shown). The control shaft 22 is positioned concentrically to the bearing seat 5. Restoring means 7 in form of two torsion springs 8 are positioned axisymmetric to the lever adapter 4, wherein a first end 9 of each torsion spring 8 rests on an adapter stop 11. The adapter stop 11 is positioned on an outer end 13 of the lever adapter 4. The adapter stop 11 extends parallel to the longitudinal axis 6 and has two grooves 23, which oppose each other along the longitudinal axis 6.

[0020] The grooves 23 provide adapter surfaces 14, 14', wherein each first end 9 of one torsion spring 8 rest on one of the adapter surfaces 14, 14'. Further, the adapter stop 11 provides a pin 24 on each of its longitudinal ends, wherein each pin 24 rests on a spring-loaded link 16, wherein the link 16 is mounted on the housing 2, wherein the link 16 is divided in a first guiding part 17 and a second guiding part 18 by a step 19. In an initial position of the control adapter 3, shown in **fig. 1,** each pin 24 rests on the step 19 for a backlash-free position of the control adapter 3. If the control adapter 3 is deflected in a first pivoting direction X, the link 16 is pushed downwards and the pin

24 changes its position from the first guiding part 17 to the second guiding part 18. One of the torsion springs 8 are taken along with the lever adapter 4 and the other torsion spring 8 remains unchanged in its position. The second ends 10 of the torsion springs 8 rest on a housing stop 12, wherein each housing stop 12 is positively connected with the second end 10. For this, the housing stop 12 is formed as four housing grooves in the first housing section 20, wherein each second end 10 is inserted in one of these housing grooves. Each second housing section 21 closes two of the housing grooves.

[0021] **Fig. 2** shows a sectional side view of the operating unit 1, wherein the torsion spring 8 and the control shaft 22 are positioned coaxially to the bearing seat 5 of the control adapter 3. The first end 9 of the torsion spring 8 rests on a security stop 25 of the housing 2. The security stop 25 keeps the first end 9 in its initial position, while the control adapter 3 hence to adapter stop 11 is deflected in a first pivoting direction X. The second end 10 of the torsion spring 8 rests on the housing stop 12. The angle between the first end 9 and the second end 10 in this initial position of the control adapter 3 is 90°.

[0022] **Fig. 3** shows a perspective view of the operating unit 1 mounted in a further outer housing 26, wherein the operating unit 1 is relatively pivotally mounted in the outer housing 26 along a pivoting axis 27, wherein the pivoting axis 27 is perpendicularly orientated to the longitudinal axis 6. Thus, a user is able to pivot the not shown operating lever and hence the control adapter 3 in the outer housing 26 along any of the pivoting directions X, X', X", X‴ and sum of the overlapping of these pivoting directions X, X', X", X"'. The control adapter 3 can be pivoted along the longitudinal axis 6 by itself and/or indirectly along the pivoting axis 27, while the whole operating unit 1 is pivoted along the pivoting axis 27. Between the housing 2 and the outer housing 26 additional restoring means 7 are accommodated to restore the housing 2 and hence the operating unit 1 with the control adapter 3 in its initial position, when the operating lever (not shown) is released by the user. These additional restoring means 7 are two further torsion springs 8 each comprising a first end 9 and a second end 10, wherein the first ends 9 rest against the housing 2 and the second ends 10 rest against the outer housing 26. Each of the four torsion springs 8 are chosen due to the motion they restore, so each of the four torsion springs 8 can have different spring ration to optimize motion and restoring appearance of an user. It is also possible, that all four torsions springs 8 are equal or at least two torsion springs 8 are equal.

LIST OF REFERENCES

[0023]

1	operating unit
2	housing
3	control adapter
4	lever adapter
5	bearing seat
6	longitudinal axis
7	restoring means
8	torsion spring
9	first end
10	second end
11	adapter stop
12	housing stop
13	outer end
14, 14'	adapter surface
16	link
17	first guiding part
18	second guiding part
19	step
20	first housing section
21	second housing section
22	control shaft
23	groove
24	pin
25	security stop
26	outer housing
27	pivoting axis
X, X', X", X‴	pivoting direction

Claims

1. Operating unit (1) comprising a housing (2) for at least partially accommodating

   a control adapter (3) comprising a lever adapter (4) and a substantially cylindrical bearing seat (5), wherein the control adapter (3) is pivotally mounted relative to the housing (2) around a longitudinal axis (6) of the bearing seat (5),
   and restoring means (7), wherein the restoring means (7) are at least two torsion springs (8) each comprising a first end (9) and a second end (10),
   wherein the first ends (9) rest against the control adapter (3) and the second ends (10) rest at least indirectly against the housing (2).

2. Operating unit (1) according to claim 1, **characterized in that** the first ends (9) are pivotally mounted relative to the housing (2) and the second ends (10) are statically mounted relative to the housing (2).

3. Operating unit (1) according to claim 1 or 2, **characterized in that** the control adapter (3) comprises at least one adapter stop (11) to rest each first end (9) of the restoring means (7) there against and the housing (1) comprises at least one housing stop (12) to rest each second end (10) of the restoring means (7) there against.

4. Operating unit (1) according to claim 3, **characterized in that** the at least one adapter stop (11) is

positioned on an outer end (13) of the lever adapter (4) opposite the bearing seat (5) and/or the at least one adapter stop (11) is extended parallel to the longitudinal axis (6).

5. Operating unit (1) according to claim 3 or 4, **characterized in that** at least two first ends (9) of the restoring means (7) rest on different adapter surfaces (14,14') of the adapter stop (11), wherein the different adapter surfaces (14, 14') oppose each other.

6. Operating unit (1) according to any of the preceding claims, **characterized in that** the at least two torsion springs (8) have a different spring ratio and/or a rectangular cross section.

7. Operating unit (1) according to any of the preceding claims, **characterized in that** the restoring means (7) are orientated axisymmetric, perpendicular to the lever adapter (4).

8. Operating unit (1) according to any of the preceding claims, **characterized in that** the operating unit (1) comprises a sliding sleeve, wherein the sliding sleeve is mounted between the bearing seat (5) und the restoring means (7).

9. Operating unit (1) according to any of claims 3 to 8, **characterized in that** the operating unit (1) comprises at least two spring-loaded links (16), wherein the links (16) are mounted on the housing (2), wherein the links (16) each are divided in a first guiding part (17) and a second guiding part (18) by a step (19).

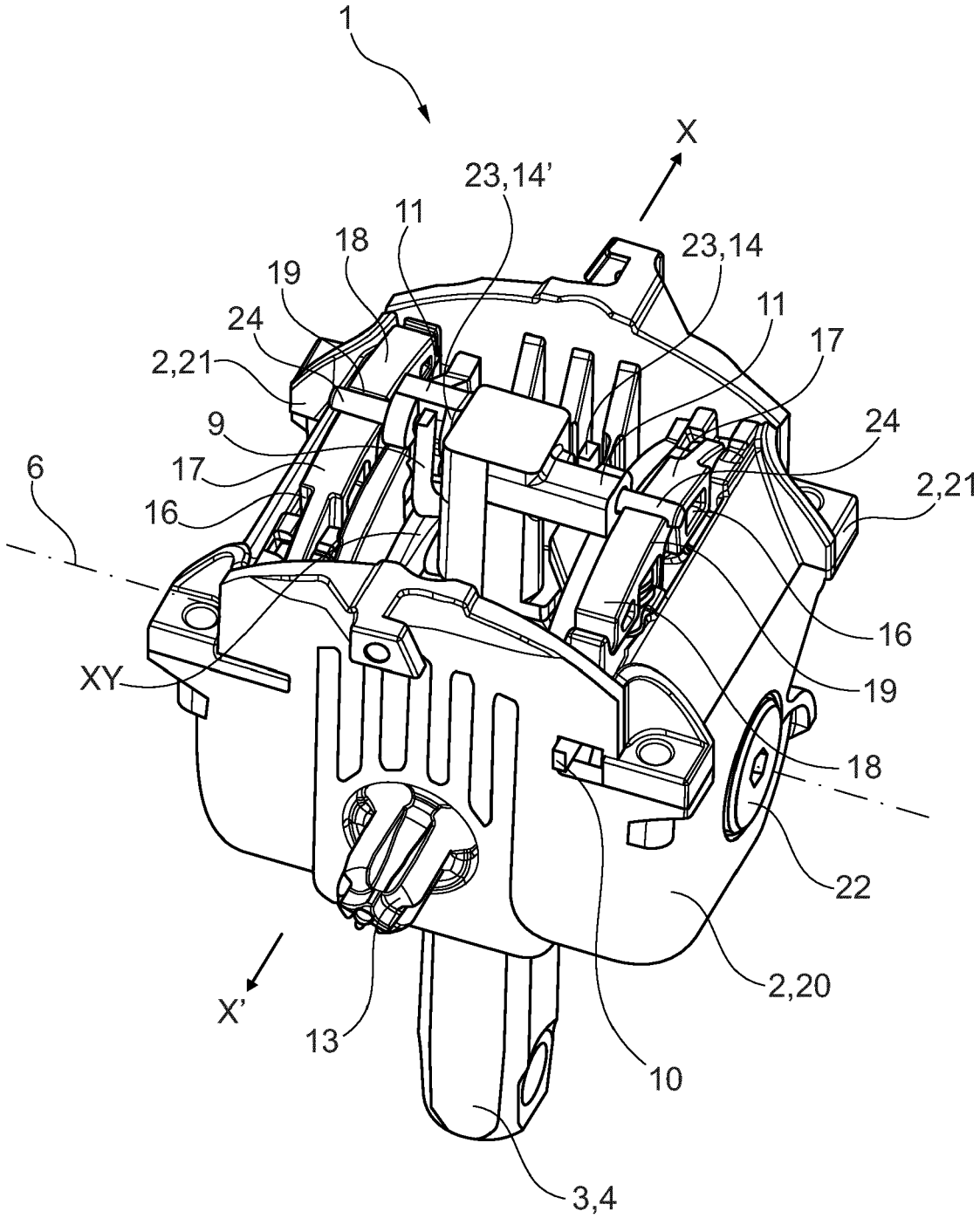
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Fig. 1

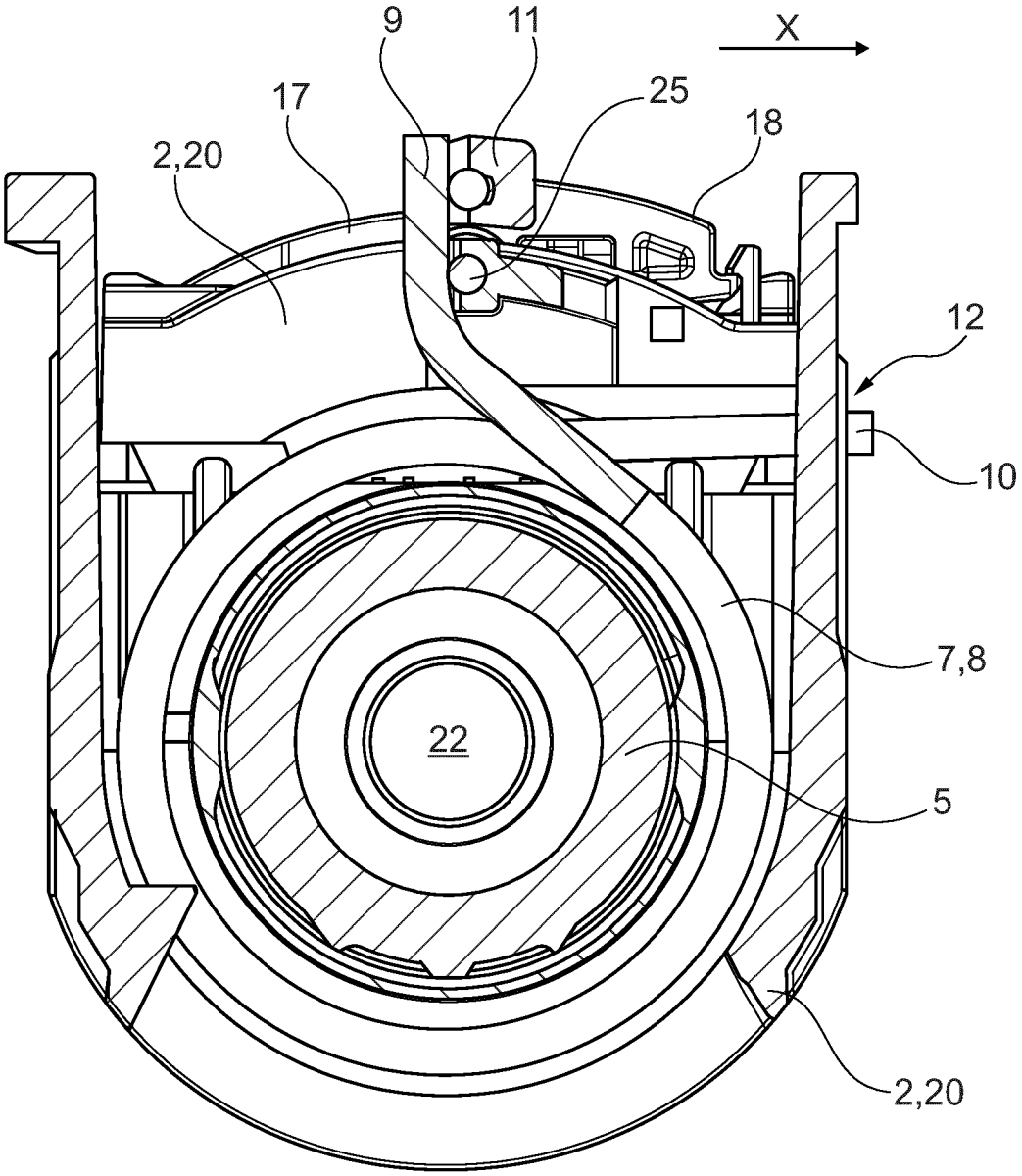

Fig. 2

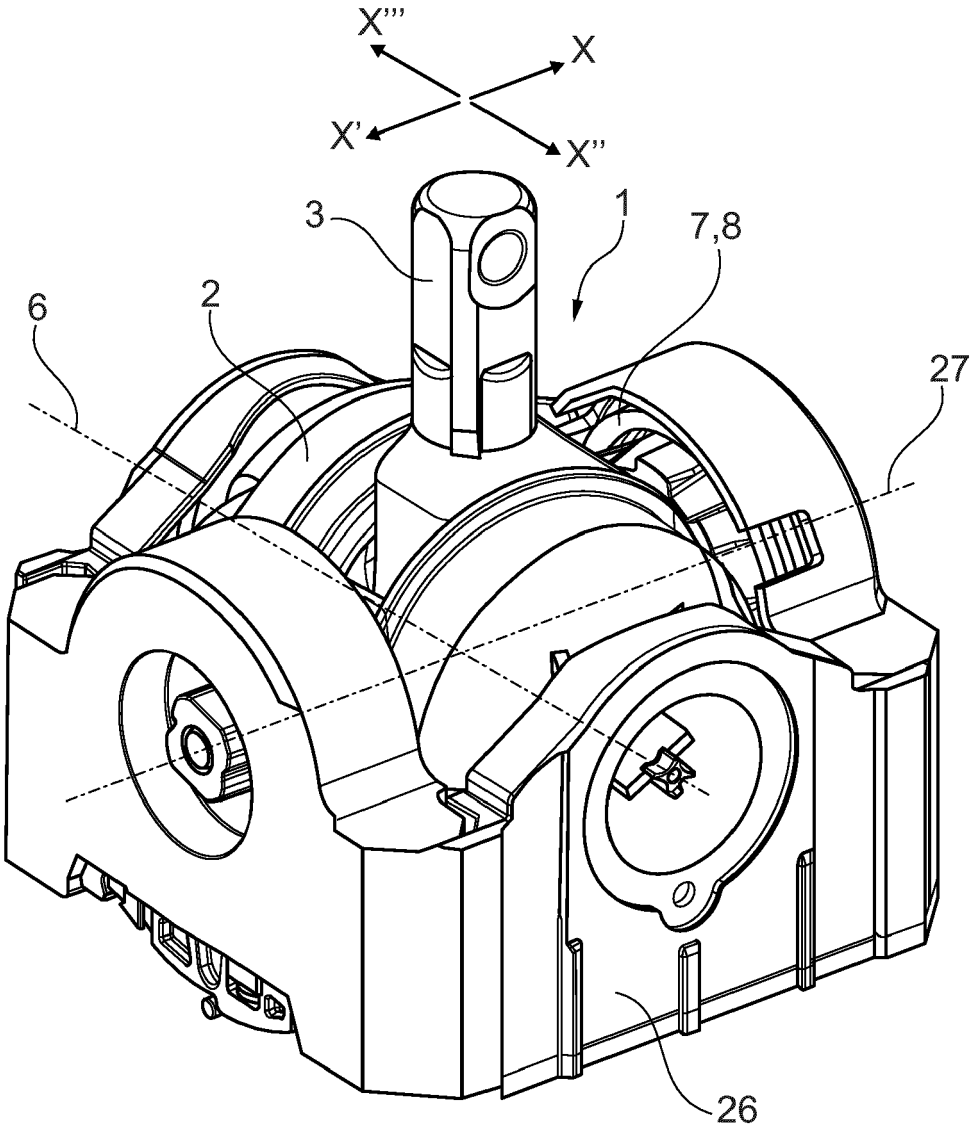

Fig. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 23 22 0481

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G05G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	26 June 2024	Huyge, Kevin

CATEGORY OF CITED DOCUMENTS

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