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

(11) **EP 4 553 607 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
14.05.2025 Bulletin 2025/20

(21) Application number: **23208550.6**

(22) Date of filing: **08.11.2023**

(51) International Patent Classification (IPC):
G05G 1/04 *(2006.01)* ***G05G 5/03*** *(2008.04)*
G05G 5/05 *(2006.01)* *G05G 9/047* *(2006.01)*
E02F 9/20 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
G05G 5/03; G05G 5/05; G05G 1/04; G05G 9/047; G05G 2009/04766

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

(71) Applicant: **elobau GmbH & Co. KG**
88299 Leutkirch im Allgäu (DE)

(72) Inventors:
- **Christlbauer, Richard**
  87452 Altusried (DE)
- **Rottach, Andreas**
  87452 Altusried (DE)

(74) Representative: **Knöner, Gregor et al**
Kahler Käck Mollekopf
Partnerschaft von Patentanwälten mbB
Vorderer Anger 239
86899 Landsberg am Lech (DE)

(54) **OPERATING ELEMENT FOR A MACHINE**

(57) An operating element for a controlling a function of a machine is provided. The operating element comprises a lever (11) that is pivotable about a rotational axis (12), a restoring assembly (20) configured to apply a restoring torque to the lever (11) to return the lever to an initial position, and a torque modifying assembly (40) configured apply a modifying torque to the lever (11) to modify a torque required to pivot the lever (11) about the rotational axis (12). The restoring assembly (20) comprises a first guiding element (21) having a first guiding surface (22) for applying a force to generate the restoring torque. The torque modifying assembly (40) comprises a second guiding element (41) having a second guiding surface (42) for applying a force to generate the modifying torque. The first guiding surface (22) is spatially separate and distinct from the second guiding surface (42).

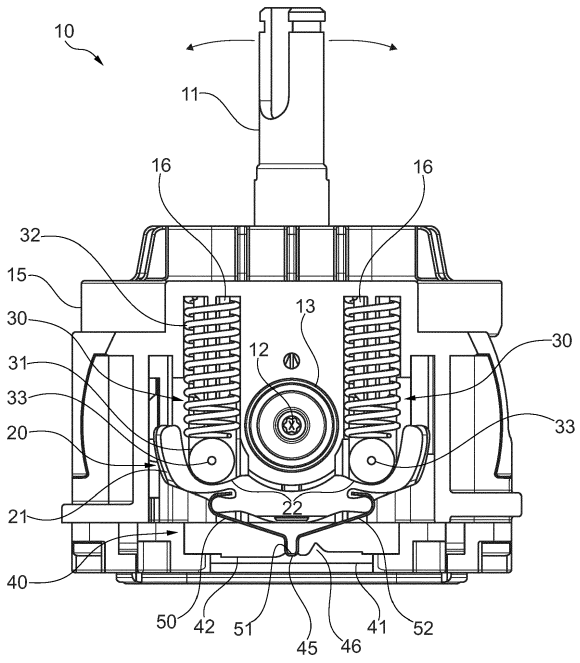

Fig. 1

EP 4 553 607 A1

Description

FIELD OF THE INVENTION

[0001] The present invention relates to an operating element for controlling a function of a machine, in particular of a mobile machine, such as a vehicle, and to a method of operating such operating element.

BACKGROUND

[0002] Mobile machines, such as agricultural or construction vehicles, often comprise a plurality of different functionalities that need to be controlled. This may comprise controlling the movement of the vehicle itself and controlling different functions of such vehicle, such as an excavator arm or an agricultural tool. A respective mobile machine may accordingly comprise a plurality of different operating elements, such as levers (e.g. in the form of joysticks), switches, buttons, and the like. The space requirement of such large number of operating elements is excessive.

[0003] The installation space available for respective operating elements thus becomes smaller, resulting in the need for more compact operating elements. To be able to provide a more complex operating element, such as a joystick, within such small installation space, the operating elements are often provided with a simple configuration and reduced functionality. This may however make the operating elements less user-friendly and may result in a reduced strength or reduced lifetime. The lever of a conventional joystick may for example simply be coupled to a spring to provide a restoring force that restores the lever to a central position. Such simplified configuration may for example suffer from excessive play, e.g. when the joystick is in the central position, and may further have a quite limited functionality.

[0004] More complex configurations that provide improved functionality and an improved handling of such operating element are known; however, these often result in larger installation space requirements. The document DE 10 2012 104 098 A1 for example describes an operating element in form of a joystick that has a restoring mechanism with two springs mounted to the joystick lever wherein the lever can be locked in a pivoted position. Although such joystick provides an improved functionality, it has relatively large space requirements.

[0005] It is thus desirable to provide a compact operating element that facilitates the operation by a user. It is further desirable to allow a flexible use of such operating element and to provide such operating element in a robust way to improve lifetime.

SUMMARY

[0006] Accordingly, there is a need to mitigate at least some of the drawbacks mentioned above and to provide an improved operating element. In particular, there is a need for a compact and easily configurable control element.

[0007] This need is met by the features of the independent claims. The dependent claims describe embodiments of the invention.

[0008] According to an embodiment of the invention, an operating element for controlling a function of a machine, in particular of a mobile machine such as a vehicle, is provided. The operating element comprises a lever that is pivotable about a rotational axis, a restoring assembly configured to apply a restoring torque to the lever to return the lever to an initial position, and a torque-modifying assembly configured to apply a modifying torque to the lever to modify a torque required to pivot the lever about the rotational axis. The restoring assembly comprises a first guiding element and at least one restoring force application element having a first contact part. The first contact part is arranged to move on a first guiding surface of the first guiding element when the lever is pivoted. The first guiding surface is shaped to cause the restoring force application element to apply a force to the first guiding surface to generate the restoring torque when the lever is pivoted. The torque-modifying assembly comprises a second guiding element and a modifying force application element having a second contact part. The second contact part is arranged to move on a second guiding surface of the second guiding element when the lever is pivoted. The second guiding surface is shaped to cause the modifying force application element to apply a force to the second guiding surface to generate the modifying torque when the lever is pivoted. The first guiding surface is spatially separate and distinct from the second guiding surface.

[0009] Such configuration may provide a compact operating element having a high degree of functionality. By providing a torque-modifying assembly, several types of haptic feedback may be implemented which facilitates an intuitive operation of the operating element by the user and makes the operating element suitable for controlling a variety of functions of the machine. By separating the second guiding surface via which the modifying torque is applied from the first guiding surface that generates the restoring torque, a compact and flexible configuration can be achieved. The first guiding element may for example have a simpler structure and may be placed closer to the rotating axis, thus decreasing the installation depth of the operating element. Further, the separate second guiding surface may be shaped so as to provide a dedicated torque characteristic when operating the lever. Further, as it is provided separately, the operating element may be equipped with different types, in particular different shapes, of the second guiding surface, thus allowing an adaptation of the torque characteristic. The versatility of the operating element may thereby be improved. For example, different shapes of the second guiding surface may be mounted at the end of the assembly of the operating element, thus being capable of providing operating elements with different torque char-

acteristics in a standardized assembly process and with a standardized form factor.

[0010] In some embodiments, the operating element may only comprise the restoring assembly, and the torque-modifying assembly is only optional. In such embodiments, the restoring assembly may have any of the configurations disclosed herein. In other embodiments, only the torque-modifying assembly may be provided, and the restoring assembly is optional. In such embodiments, the torque-modifying assembly may have any of the configurations described herein. Several advantageous embodiments of the operating element may thereby be achieved.

[0011] The operating element may comprise a housing, and the lever may be pivotable relative to such housing. The respective torque may in particular be applied to the lever with respect to the housing, e.g. it may act between the housing and the lever. The operating element may be a single axis or multi-axes operating element. The operating element may be a respective joystick.

[0012] The first and second guiding surfaces may be arranged on the same side of the rotational axis, in particular on the same side of a plane that includes the rotational axis when the lever is in the initial position. In particular, when the lever is in the initial position, both guiding surfaces may be arranged on one side of a plane that includes the rotational axis, and a handle of the lever may be arranged on the other side of the plane. Similarly, in the initial position of the lever, the first guiding element and the second guiding element may be arranged on the same side of a plane that includes the rotational axis.

[0013] Further, the first guiding surface and the second guiding surface may be arranged on different sides of a plane that is parallel to the rotation axis when the lever is in the initial position. For example, this plane may further be perpendicular to a direction of extension of the lever or to a direction of force application by the restoring force application element when the lever is in the initial position. The guiding surfaces may thus not interfere with each other.

[0014] One of the first guiding surface and the second guiding surface may be stationary with respect to a housing of the operating element, and the other of the first guiding surface and the second guiding surface may be coupled to the lever to move with the lever.

[0015] In an embodiment, the second guiding surface is shaped so as to generate a modifying torque that provides one or a combination of the following: A pressure point that has to be overcome when pivoting the lever; a locked position different from the initial position in which the lever is locked after being released; and/or a default position for which the modifying torque has to be overcome for moving the lever out of the default position. Such default position may be the initial position of the lever, for example an equilibrium position. The locked position may for example be a position at which the lever is latched or snapped in; the user may for example pivot the lever into the locked position and release the lever, upon which the lever remains in the locked position. By means of such torque-modifying assembly, plural different torque characteristics of the operating element may thus be achieved. The torque characteristic may thus be adapted to the functionality for which the operating element is provided, in particular by respectively shaping the second guiding surface.

[0016] For example, if the operating element is used to control a hydraulic function of a machine, such as an agricultural machine or construction machine (e.g., tractor, excavator, or the like), the second guiding surface may be shaped so as to provide a pressure point. By applying sufficient torque to the lever to move over the pressure point, a float position of the hydraulic system may for example be reached. The user of the operating element can thus reliably determine when the float position is reached.

[0017] The lever may be pivotable in two opposing directions (e.g. back and forth), and the modifying torque generated by the torque-modifying assembly may be the same or may be different for the different directions of operation of the lever. Different modifying torques may be achieved by different shapes of the second guiding surface for the different directions of movement of the second contact part on the second guiding surface, e.g. starting from the initial position. As an example, a pressure point may be symmetrically provided on each side, or two or more pressure points may be provided on at least one side, or one side of the second guiding surface may not generate any modifying torque. Other examples and combinations are of course conceivable.

[0018] The first guiding element or the at least one restoring force application element may be coupled, in particular mounted, to the lever and may be pivoted with the lever. Preferably, the first guiding element is coupled to the lever to pivot with the lever, for example mounted to a shaft that rotates when pivoting the lever.

[0019] The modifying force application element or the second guiding element may be coupled, in particular mounted, to the lever and may be pivoted with the lever. Preferably, the modifying force application element is coupled to the lever and pivots with the lever.

[0020] For example, the first guiding element is coupled to the lever to pivot with the lever and the modifying force application element is mounted to the first guiding element. A compact configuration may thereby be achieved.

[0021] The coupling to the lever may be an indirect coupling. For example, the lever may be supported by a gimbal mount, and the respective first guiding element or second guiding element may be mounted to a shaft of the gimbal mount (e.g., to a stub shaft) that rotates with the lever when the lever is pivoted.

[0022] The arrangement may be such that the first guiding surface faces the rotational axis. A distance of the first guiding surface from the rotational axis (taken perpendicular to the rotational axis) may be smaller than

a distance of the rotational axis to an end of a housing of the operating element, the distance being taken in the direction of the lever. In other words, the first guiding element may be mounted close to the rotational axis, thereby achieving a compact configuration.

[0023] The restoring assembly may comprise two restoring force application elements arranged on opposite sides of the rotation axis. Each restoring force application element may apply a force to the first guiding surface to generate a restoring torque on the lever. The restoring torque generated by a first of the two restoring force application elements may be opposite to a restoring torque generated by a second of the two restoring force application elements. By such counteracting force application elements, a stable positioning, also in the initial position, may be achieved, and a favorable restoring torque characteristic may be obtained.

[0024] The first guiding surface may for example be shaped such that the restoring torque acting to the restore the lever to the initial position is larger than the opposite restoring torque when the lever is moved out of the initial position. The restoring torque may thus safely return the lever to the initial position.

[0025] The first and the second restoring force application elements may be pre-tensioned to apply a restoring torque of a similar (or of the same) magnitude when the lever is in the initial position. The initial position may accordingly be an equilibrium position in which both restoring torques offset each other. Such pre-tensioning may have the advantage of a very well defined initial position, and may further cause that the torque that needs to be applied to move the lever out of the initial position raises rather steeply. This reduces the play of the lever in the initial position and may essentially eliminate such central play. The lever will thus be centered reliably at the initial position, which improves the haptic feedback for the operator and in particular allows the operator to determine whether the lever has actually been actuated or not.

[0026] The first guiding surface may have a shape that at least partly surrounds the first contact part of each of the two restoring force application elements.

[0027] Each restoring force application element may comprise a spring acting on the respective first contact part, in particular pushing the first contact part, to cause the first contact part to apply the force to the first guiding surface. A simple and compact configuration may thereby be provided. The spring may be a coil spring. The spring may have one end supported by a housing of the operating element; the end may rest against a housing part. For example, such housing part may have a protrusion that is inserted into the coil spring and that provides guidance for the coil spring when the coil spring is being compressed or expanded.

[0028] The first contact part may be supported by a shaft (e.g. an axle) that is movably supported in a housing of the operating element. The first contact part may for example be a roller that rolls on the first guiding surface.

[0029] In an embodiment, the housing comprises a mount, and a shaft of the first contact part is supported in the mount. The mount may be configured to allow movement of the shaft in one dimension, in particular perpendicular to an axial direction of the shaft. For example, it may allow movement in a direction parallel to a direction of extension of a spring of the restoring force application element. The first contact part may thus stay in contact with the spring and can move in axial direction of the spring when the spring is being compressed or expanded. The direction of extension of the spring may in particular be a central axial direction of a coil spring (i.e., the central axis of the cylindrical shape). The mount may for example be a slot or recess in the housing, wherein the slot or recess extends in the respective direction of the spring. It may also be formed by parallel ridges or ribs that are provided on a part or on a wall of the housing. Such contact part may provide an efficient torque application while at the same time may reduce the frictional resistance of the pivoting movement of the lever.

[0030] In an embodiment, the modifying force-generating element comprises a spring, wherein the spring is arranged to push the second contact part onto the second guiding surface to apply the force to the second guiding surface. The second guiding surface may be shaped to change a spring loading of the spring when the lever is pivoted about the rotational axis to generate the modifying torque. A compact arrangement may thus be achieved that provides an efficient torque application while being mechanically simple.

[0031] The modifying force-generating element may for example comprise a flat spring, in particular a sheet metal spring. By using such type of spring, the installation depth of the operating element may be kept small.

[0032] The second contact part may be formed by a protrusion of the spring. It may in particular be integral with the spring. For example, a flat spring or a sheet metal spring may have a shape that forms such protrusion that bulges outwardly, for example at a central position where two spring arms meet. As the modifying force-generating element may thus consist of a single part, the complexity of the operating element may further be reduced.

[0033] The protrusion may for example slide on the second guiding surface when the lever is pivoted. Accordingly, the shape of the second guiding surface results in different compression of the respective flat or sheet metal spring, and thus in different modifying torques applied to the lever.

[0034] In an example, the second guiding surface is shaped to provide one or a combination of the following:

(1) A recess arranged such that the second contact part engages the recess when the lever is in the initial position; the protrusion of the spring may for example engage the recess. This may increase the torque required to move the lever out of the initial position in both directions of movement. Central play of the lever may thereby further be reduced, and a better

definition of the initial position may be achieved.

(2) At least one recess or protrusion over which the second contact part has to be moved when the lever is pivoted from a first position to a second position, wherein the recess or protrusion is shaped such that the modifying torque generated by moving the second contact part over the recess or protrusion, respectively, is smaller than the restoring torque at the position of the recess or protrusion, respectively. A pressure point may thereby be generated over which the lever has to be moved, and haptic feedback is thus provided for the lever reaching a particular position. As the modifying torque is smaller than the restoring torque, the lever will return to the initial position when released. One or more pressure points (i.e., respective recesses or protrusions) may be provided on one or on each side of the second guiding surface.

(3) At least one recess or protrusion over which the second contact part has to be moved when the lever is pivoted from a first position to a second position, wherein the recess or protrusion is shaped such that the modifying torque generated by moving the second contact part over the recess or protrusion, respectively, is larger than the restoring torque at the position of the recess or protrusion, respectively. A locked position may thereby be generated that provides a resistance against pivoting of the lever. The torque at the locked position has to be overcome when moving the lever, thus receiving haptic feedback. Further, when the lever is released at the locked position, it will not return to the initial position since the restoring torque is smaller than the modifying torque at the locked position. Such locked position may also be designated as a latched position or engaged position.

[0035] The guiding surface may be shaped so as to provide a combination of respective functionalities; it may for example provide a respective recess for defining a default position and may provide a pressure point and/or locked position on one or on both sides thereof.

[0036] The second guiding element may be a distinct part that is mounted in a replaceable or exchangeable manner to a side of a housing of the operating element. It may for example be mounted to a lower side opposite to an upper side from which the lever protrudes. This may facilitate defining the torque characteristic of the operating element in a final assembly step in which the respective second guiding element is mounted. Further it may facilitate changing the torque characteristic by exchanging the second guiding element. It may in particular allow an on-site adaptation of the functionality of the operating element. The flexibility may thereby be increased significantly and the effort required to change the characteristics of the operating element may be reduced.

[0037] The second guiding element may for example be shaped as a plate or frame. The second guiding element may be configured to be mountable in two orientations to the housing of the operating element. The second guiding element may have two different second guiding surfaces, and in each orientation, a different second guiding surface may interact with the modifying force application element. The torque characteristic of the operating element may thus simply be changed by rotating the second guiding element. It may for example be mounted by one, two or more screws to the housing of the operating element so that it can easily be exchanged or rotated.

[0038] In an embodiment, the lever is pivotable about a second rotational axis, in particular perpendicular to the first rotational axis. It may thus implement a multi-axes operating element. The second guiding element may have a further second guiding surface for generating a modifying torque that is applied to the lever when the lever is pivoted about the second rotational axis. A single second guiding element may thus define in a simple and independent manner the torque characteristic for both pivoting directions of the lever, thereby providing a compact and simple mechanical configuration.

[0039] For a two-axis operating element, the operating element may for example comprise a second restoring assembly configured to apply a restoring torque to the lever about the second rotational axis to return the lever to a second initial position and a second torque-modifying assembly configured to apply a modifying torque to the lever about the second rotational axis to modify a torque required to pivot the lever about the second rotational axis. For both directions in which the lever may be pivoted, a respective assembly for generating the restoring torque and the modifying torque may thus be provided. As mentioned above, either one of the restoring assembly and the torque-modifying assembly is optional, so that the operating element may only comprise a second restoring assembly or a second torque-modifying assembly.

[0040] The second restoring assembly may have any configuration disclosed herein with respect to the first mentioned restoring assembly. The second torque-modifying assembly may have any configuration disclosed herein with respect to the first mentioned torque-modifying assembly. Accordingly, similar advantages may also be achieved for the second pivoting direction of the lever.

[0041] The lever may for example be mounted by a gimbal mount having two shafts that are rotated about the respective rotational axes when the lever is pivoted in the respective direction. A component of the respective restoring assembly and a component of the respective torque-modifying assembly may be mechanically coupled or mounted to the respective shaft to pivot with the shaft when the shaft is rotated by pivoting the lever. Such gimbal mount may also be termed "cardan suspension". The operating element may thus have a rather

symmetric configuration for the two different pivoting directions, thus further simplifying the mechanical configuration.

[0042] According to a further embodiment of the present invention, a machine, in particular a mobile machine, such as a construction vehicle, an agricultural vehicle, or an industrial vehicle, is provided. The machine comprises an operating element having any of the configurations described herein, wherein the operating element is arranged to control at least one function of the machine.

[0043] According to a further embodiment of the invention, a method of operating an operating element having any of the configurations described herein is provided. The method comprises pivoting the lever from the initial position about the rotational axis, thereby generating a restoring torque on the lever by means of the restoring assembly and generating a modifying torque on the lever by means of the torque-modifying assembly. By such method, advantages similar to the ones outlined further above may be achieved.

[0044] As mentioned above, only one of the restoring assembly and the torque-modifying assembly may be provided, and the method may be adapted accordingly.

[0045] It is to be understood that the features mentioned above and those yet to be explained below can be used not only in the respective combinations indicated, but also in other combinations or in isolation, without leaving the scope of the present invention. In particular, the features of the different aspects and embodiments of the invention can be combined with each other unless noted to the contrary.

BRIEF DESCRIPTION OF THE DRAWINGS

[0046] The forgoing and other features and advantages of the invention will become further apparent from the following detailed description read in conjunction with the accompanying drawings. In the drawings, like reference numerals refer to like elements.

Fig. 1 is a schematic drawing showing a sectional side view of an operating element according to an embodiment.

Fig. 2 is a schematic drawing showing a simplified sectional side view of the operating element of figure 1, wherein the lever is in a pivoted position.

Fig. 3 is a schematic drawing showing a perspective view of the operating element of figure 1.

Fig. 4 is a schematic drawing showing a perspective view of the partly disassembled operating element of figure 1.

Fig. 5 is a schematic drawing showing a perspective view of a housing and of a second guiding element of the operating element of figure 1.

Fig. 6 is a flow diagram illustrating a method of operating an operating element according to an embodiment.

DETAILED DESCRIPTION

[0047] In the following, embodiments of the invention will be described in detail with reference to the accompanying drawings. It is to be understood that the following description of the embodiments is given only for the purpose of illustration and is not to be taken in a limiting sense. It should be noted that the drawings are to be regarded as being schematic representations only, and elements in the drawings are not necessarily to scale with each other. Rather, the representation of the various elements is chosen such that their function and general purpose become apparent to a person skilled in the art. As used herein, the singular forms "a," "an," and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. The terms "comprising," "having," "including," and "containing" are to be construed as openended terms (i.e., meaning "including, but not limited to,") unless otherwise noted.

[0048] Fig. 1 shows a sectional view of an embodiment of an operating element 10. The lever 11 of operating element 10 is pivotable with respect to a housing 15 of operating element 10. Lever 11 may be suspended by a shaft 13 rotatable about the rotational axis 12. Housing 15 may be adapted to the size of the available installation space and may have any of the known configurations; details are omitted here for the sake of a compact presentation.

[0049] Operating element 10 includes a restoring assembly 20 for restoring lever 11 into an initial or default position, which may be the position shown in Fig. 1. Restoring assembly 20 has a first guiding element 21 that is coupled to lever 11 and therefore pivots with the lever 11. First guiding element 21 may be mounted to an end of lever 11 (for a single axis operating element) or may be mounted directly or indirectly to the shaft 13 that rotates when lever 11 is pivoted. First guiding element 21 includes a guiding surface 22 that faces the rotation axis 12. The first guiding element 21 and its guiding surface 22 extend symmetrically in a lateral direction perpendicular to the direction in which lever 11 extends. Consequently, when lever 11 is pivoted, the distance of the guiding surface 22 to the walls of housing 15 changes.

[0050] The restoring assembly 20 further includes two restoring force application elements 30 that are mounted to the housing 15 on opposite sides of the rotation axis 12. Each restoring force application element 30 includes a first contact part 31 that is pushed into contact with the first guiding surface 22. It further comprises a spring 32, in particular a coil spring, that applies the pushing force to the contact part 31 to apply a respective force via contact part 31 to the first guiding surface 22. Housing 15 may comprise a protrusion or support 16 that is inserted into spring 32 and that supports and guides spring 32 when it

is being compressed or expanded. Spring 32 and protrusion 16 extend in a direction perpendicular to rotational axis 12 and substantially parallel to the extension of lever 11 in the initial or default position. In particular, they extend from an upper side of housing 15, from which the lever 11 extends, downwardly towards the first guiding surface 22.

[0051] When lever 11 is pivoted towards the left, as shown in Fig. 2, a left part of guiding element 21 pivots downwardly whereas a right part of guiding element 21 pivots upwardly. Accordingly, the right-hand spring 32 is compressed via the first contact part 31. The restoring force application element 30 on the right-hand side thus applies an increased force to the guiding surface 22, so that a restoring torque that acts to pivot lever 11 in the right direction is applied via the guiding element 21 to the lever 11. Due to the shape of the first guiding surface 22, the compression of spring 32 on the left-hand side is changed only slightly. A certain amount of spring tension may thus be maintained.

[0052] By selecting the shape of the first guiding surface 22, a torque characteristic of the restoring torque can be adapted. In particular, it may be determined how steeply the torque rises when the lever is pivoted out of its initial position, and how the restoring torque changes along the pivoting range.

[0053] The first contact part 31 may be a roller that is supported by a shaft 33 and that rotates about the shaft. Friction may thereby be reduced, making operation of lever 11 smoother. In order to allow the position of the first contact part 31 to change, and to thus allow compression of spring 32, the housing 15 may be provided with a mount that allows a respective movement of shaft 33. The mount may in particular allow a one-dimensional movement of shaft 33 in a direction perpendicular to the rotational axis of shaft 33 and essentially parallel to the direction in which spring 32 is compressed and expanded. Fig. 3 illustrates an exemplary implementation of mount 17. Mount 17 is provided as an elongated recess or slit in a wall of housing 15 in which an end of shaft 33 is guided. The slot in the housing 1 extends parallel to the extension of spring 32. Fig. 3 illustrates on the left-hand side a situation in which the left-hand spring is expanded (shaft 33 on bottom of slot) and the right-hand spring is compressed (shaft 33 in the upper part of slot 17), similar to the situation in Fig. 2. Note that this only schematically illustrates the different positions that shaft 33 can take, which do not correspond to the position of lever 11 in Fig. 3.

[0054] Turning back to Fig. 1, the springs 32 on opposite sides of rotation axis 12 are pre-tensioned so that in the initial position of Fig. 1, a force is applied to the guiding surface 22 on either side of the rotational axis 12. The configuration may be symmetric about a plane through the rotational axis 12 (in the default position, the configuration is mirror symmetric about a plane including rotation axis 12 and a central axis of lever 11). The applied forces may thus be similar, and similar restoring torques acting in opposite directions may thus be applied to lever 11. Accordingly, lever 11 is maintained in the equilibrium position, corresponding to the initial position. Due to the pre-tensioning, the play of lever 11 in such initial position is reduced significantly, and a well-defined initial position providing improved haptic feedback can be provided.

[0055] Operating element 10 further comprises a torque-modifying assembly 40 that generates a torque acting on lever 11 when the lever 11 is pivoted. Assembly 40 includes a second guiding element 41 on which a second contact part 51 of a modifying force application element 50 is guided and is moved when the lever 11 is pivoted. As shown, the second guiding surface 42 of second guiding element 41 is separate from the first guiding surface 22. Accordingly, the modifying torque, which may for example provide haptic feedback, can be adjusted and generated independently from the restoring torque.

[0056] Modifying force application element 50 is provided in form of a flat spring 52 that is bent to form a protrusion which provides the second contact part 51. Spring 52 is mounted to the first guiding element 21 and therefore pivots together with lever 11 about the rotational axis 12. When pivoting, the second contact part 51 is moved, in particular slides, across the second guiding surface 42. The second guiding surface 42 includes recesses and/or protrusions, which have to be overcome when the second contact part 51 is moved along guiding surface 42. As a force is required to move the contact part 51 out of a recess or over a protrusion, a respective torque or force needs to be applied to lever 11. Interaction of spring 52 and guiding surface 42 therefore results in a modification of the torque characteristics of lever 11 and to the application of a corresponding modifying torque to the lever 11 that has to be overcome for moving the lever.

[0057] In the example of Fig. 1, the guiding surface 42 includes a recess 45 positioned such that the second contact part 51 engages recess 45 when the lever is in the initial position, as shown in Fig. 1. As additional torque has to be applied to move second contact part 51 out of the recess, the play of lever 11 in the initial position is reduced and the operating element holds lever 11 more stably in the initial position.

[0058] Guiding surface 42 further includes a protrusion 46 that requires additional torque to be applied to lever 11 to cause the contact part 51 to overcome the protrusion 46. Once the protrusion 46 is overcome, the torque required to move the lever is again lower. A user pivoting the lever will accordingly feel the required torque that needs to by applied (i.e. a pressure point) and will thus obtain haptic feedback when moving the lever.

[0059] Fig. 2 shows the lever in a position in which the second contact part 51 has overcome the protrusion 46. If the user now releases the lever, and the modifying torque generated by protrusion 46 is lower than the restoring torque generated by restoring assembly 20, the lever will return to its initial position. By increasing the size of protrusion 46, the torque required to overcome protrusion 46 may be larger than the restoring torque, so that the

lever 11 will retain its pivoted position if released. This accordingly corresponds to a locked position at which lever 11 is locked or latched. By adapting the shape of the second guiding surface 42, it thus becomes possible to implement different functionalities for the operating element 10. In the example of Figs. 1 and 2, a single pressure point 46 is provided on one side of the initial position (at recess 45). For movement of the lever in the opposite direction, second guiding surface 42 does not comprise any recesses or protrusions, so that the torque is not modified. In other implementations, the second guiding surface 42 may have the same shape on either side of the initial position 45. One, two or more pressure points and/or one, two or more locked positions may be provided on one or on either side of the initial position. Recess 45 at the initial position is optional. Instead of using a protrusion, a pressure point may also be provided with a recess. Likewise, a locked position may be provided with a (deeper) recess.

[0060] The second guiding element 41 may be a component that is mounted to the housing 15, e.g. to a side thereof, in particular to a lower side thereof opposite to the side from which lever 11 extends. It may thus easily be exchanged, so that the torque profile of lever 11 can be adapted to the required functionality. The guiding element 42 may be screwed by one, more or two screws 19 to the housing 15 or may otherwise be fastened thereto (Fig. 5).

[0061] Figs. 1 and 2 illustrate the pivoting of lever 11 about one rotational axis 12; operating element 10 may be implemented as a single axis operating element, e.g. joystick. It may further be implemented as a multi-axes operating element having for example a first rotational axis 12-1 and a second rotational axis 12-2 about which the lever 11 can be rotated, as illustrated in Fig. 3. Lever 11 may be mounted by a gimbal mount suspended by two respective rotational shafts 13-1 and 13-2, so that lever 11 may rather freely be pivoted about the two rotational axes. Such gimbal mounts are commonly known, and will thus not be explained in greater detail here. Shafts 13-1 and 13-2 are suspended in the housing 15, and a respective restoring assembly 20 and/or a respective torque-modifying assembly 40 may be provided on either shaft. If higher torques are needed, two respective assemblies may likewise be provided on either side of the same rotational axis. The configuration of such further restoring assemblies and/or torque-modifying assemblies may be similar to the configurations described herein above.

[0062] The torque-modifying assemblies 30 for both axes 12-1 and 12-2 may share the same second guiding element 41, which may provide two distinct second guiding surfaces 42-1 and 42-2, as shown in Fig. 3.

[0063] Fig. 4 shows a perspective view of the configuration of Fig. 3, wherein the housing and further components have been removed to simplify the representation. The second guiding element 41 with its two guiding surfaces 42-1 and 42-2 is visible, and respective flat springs 52 in engagement with recess 45 are shown. Housing 15 and second guiding element 41 are configured such that the second guiding element 41 can be mounted in different orientations, it may in particular be rotated by 90°. It may have plural different guiding surfaces 41-1 to 41-4 and by rotating the guiding element 41, a particular guiding surface may be brought into engagement with a respective flat spring 52. Thus, it becomes possible to quickly adapt the torque characteristic of the lever 11 by rotating the second guiding element 42 and mounting it in a different orientation to housing 15. Further, it can be easily exchanged to change the torque characteristic.

[0064] This is further apparent from Fig. 5, which shows a perspective view of an underside of the operating element 10, wherein only the housing 15 and the second guiding element 41 are shown. Second guiding element 41 may be provided in form of a rectangular or square plate or frame that may optionally have an opening in the middle and that provides the respective guiding surfaces. A simple mounting and unmounting of the second guiding element 42 by means of bolts 19 is possible. Besides reducing play in the initial position and providing a great flexibility with respect to the torque characteristic, the disclosed configuration also has a reduced installation depth, since the separation of the two guiding surfaces 22, 42 allows a simplification of both configurations. Further, by using a flat spring 52, a particularly low profile configuration of the torque-modifying assembly 40 can be achieved.

[0065] Fig. 6 shows a flow diagram of an exemplary method of operating a respective operating element 10. In step S1, the lever 11 is pivoted out of the initial position by an operator or user, i.e. the position at which the second contact part 51 engages the recess 45 and in which both springs 32 apply equal restoring torques to lever 11. By pivoting the lever, the restoring assembly 20 provides in step S2 a restoring torque to the lever 11. Further, by such pivoting, a modifying torque is applied to the lever to the torque-modifying assembly 40 in step S3, thereby changing the torque which the operator has to apply to the lever. The method may be performed with the operating element 10 in any of the above described configurations.

[0066] Although in the above embodiments, the first guiding element 21 and the modifying force application element 50 are coupled to the lever 11, it should be clear that the configuration may also be changed. For example, it is also possible to couple the restoring force application elements 30 to the lever 11 and to keep the first guiding element 21 stationary with respect to housing 15, and/or to couple the second guiding element 41 to the lever 11 and keep the modifying force application element 50 stationary with respect to the housing.

[0067] While specific embodiments are disclosed herein, various changes and modifications can be made without departing from the scope of the invention. The present embodiments are to be considered in all respects

as illustrative and non-restrictive, and all changes coming within the meaning and equivalency range of the appended claims are intended to be embraced therein.

List of reference signs

[0068]

10	operating element
11	lever
12	rotation axis
13	shaft of gimbal mount
15	housing
16	protrusion - support for spring
17	mount for roller shaft
19	screw
20	restoring assembly
21	first guiding element
22	first guiding surface
30	first force application element
31	first contact part
32	coil spring
33	roller shaft
40	torque modifying assembly
41	second guiding element
42	second guiding surface
45	recess - default position
46	protrusion - pressure point
50	second force application element
51	second contact part
52	flat spring
S 1-S3	method steps

Claims

1. An operating element for a controlling a function of a machine, comprising:

- a lever (11) that is pivotable about a rotational axis (12);
- a restoring assembly (20) configured to apply a restoring torque to the lever (11) to return the lever to an initial position; and
- a torque modifying assembly (40) configured apply a modifying torque to the lever (11) to modify a torque required to pivot the lever (11) about the rotational axis (12),

wherein the restoring assembly (20) comprises a first guiding element (21) and at least one restoring force application element (30) having a first contact part (31), wherein the first contact part (31) is arranged to move on a first guiding surface (22) of the first guiding element (21) when the lever (11) is pivoted, wherein the first guiding surface (22) is shaped to cause the restoring force application element (30) to apply a force to the first guiding surface (22) to generate the restoring torque when the lever is pivoted, and

wherein the torque modifying assembly (40) comprises a second guiding element (41) and a modifying force application element (50) having a second contact part (51), wherein the second contact part (51) is arranged to move on a second guiding surface (42) of the second guiding element (41) when the lever (11) is pivoted, wherein the second guiding surface (42) is shaped to cause the modifying force application element (50) to apply a force to the second guiding surface (42) to generate the modifying torque when the lever (11) is pivoted, wherein the first guiding surface (22) is spatially separate and distinct from the second guiding surface (42).

2. The operating element according to claim 1, wherein the second guiding surface (42) shaped so as to generate a modifying torque that provides a pressure point (46) that has to be overcome when pivoting the lever (11), and/or a locked position different from the initial position in which the lever (11) is locked after being released, and/or a default position (45) for which the modifying torque has to be overcome to move the lever (11) out of the default position.

3. The operating element according to claim 1 or 2, wherein the first guiding element (21) or the at least one restoring force application element (30) is coupled to the lever (11) and is pivoted with the lever, and/or wherein the modifying force application element (50) or the second guiding element (42) is coupled to the lever (11) and is pivoted with the lever.

4. The operating element according to any of the preceding claims, wherein the first guiding element (21) is coupled to the lever (11) and is pivoted with the lever, and wherein the modifying force application element (50) is mounted to the first guiding element (21).

5. The operating element according to any of the preceding claims, wherein the restoring assembly (20) comprises two restoring force application elements (30) arranged on opposite sides of the rotation axis (12), each restoring force application element (30) applying a force to the first guiding surface (22) to generate a restoring torque on the lever (11), wherein the restoring torque generated by a first of the two restoring force application elements is opposite to a restoring torque generated by a second of the two restoring force application elements.

6. The operating element according to claim 5, wherein the first and the second restoring force application elements (30) are pretensioned to apply a restoring torque of similar magnitude when the lever (11) is in

the initial position.

7. The operating element according to any of the preceding claims, wherein each restoring force application element (30) comprises a spring (32) acting on the respective first contact part (31) to cause the first contact part (31) to apply said force to the first guiding surface (22).

8. The operating element according to any of the preceding claims, wherein a housing (15) of the operating element (10) comprises a mount (17), wherein a shaft (33) of the first contact part (31) is supported in the mount (17), the mount (17) being configured to allow movement of the shaft (33) in one dimension perpendicular to an axial direction of the shaft (33).

9. The operating element according to any of the preceding claims, wherein the modifying force generating element (50) comprises a spring (52), wherein the spring (52) is arranged to push the second contact part (51) onto the second guiding surface (42) to apply said force to the second guiding surface (42), wherein the second guiding surface (42) is shaped to change a spring loading of the spring (52) when the lever is pivoted about the rotational axis to generate the modifying torque.

10. The operating element according to claim 9, wherein the second contact part (51) is formed by a protrusion of the spring (52).

11. The operating element according to any of the preceding claims, wherein the second guiding surface (42) is shaped to provide at least one of:

- a recess (45) arranged such that the second contact part (51) engages the recess (45) when the lever (11) is in the initial position;
- at least one recess or protrusion (46) over which the second contact part (51) has to be moved when the lever (11) is pivoted from a first position to a second position, wherein the recess or protrusion (46) is shaped such that the modifying torque generated by moving the second contact part (51) over the recess or protrusion is smaller than the restoring torque at the position of the recess or protrusion, respectively; and
- at least one recess or protrusion over which the second contact part (51) has to be moved when the lever is pivoted from a first position to a second position, wherein the recess or protrusion is shaped such that the modifying torque generated by moving the second contact part (51) over the recess or protrusion is larger than the restoring torque at the position of the recess or protrusion, respectively.

12. The operating element according to any of the preceding claims, wherein the second guiding element (41) is a distinct part that is removably mounted to a side of a housing (15) of the operating element (10).

13. The operating element according to any of the preceding claims, wherein the lever (11) is pivotable about a second rotational axis (12-2), wherein the second guiding element (42) has a further second guiding surface (42-2) for generating a modifying torque that is applied to the lever (11) when the lever (11) is pivoted about the second rotational axis (12-2).

14. The operating element according to any of the preceding claims, wherein the lever (11) is pivotable about a second rotational axis (12-2), wherein the operating element (11) comprises a second restoring assembly (20) configured to apply a restoring torque to the lever (11) about the second rotational axis (12-2) to return the lever to a second initial position, and/or a second torque modifying assembly (40) configured apply a modifying torque to the lever (11) about the second rotational axis (12-2) to modify a torque required to pivot the lever (11) about the second rotational axis (12-2).

15. A method of operating an operating element (10) according to any one of the preceding claims, wherein the method comprises:

- pivoting the lever (11) from the initial position about the rotational axis (12), thereby generating a restoring torque on the lever (11) by means of the restoring assembly (20) and generating a modifying torque on the lever (11) by means of the torque modifying assembly (40).

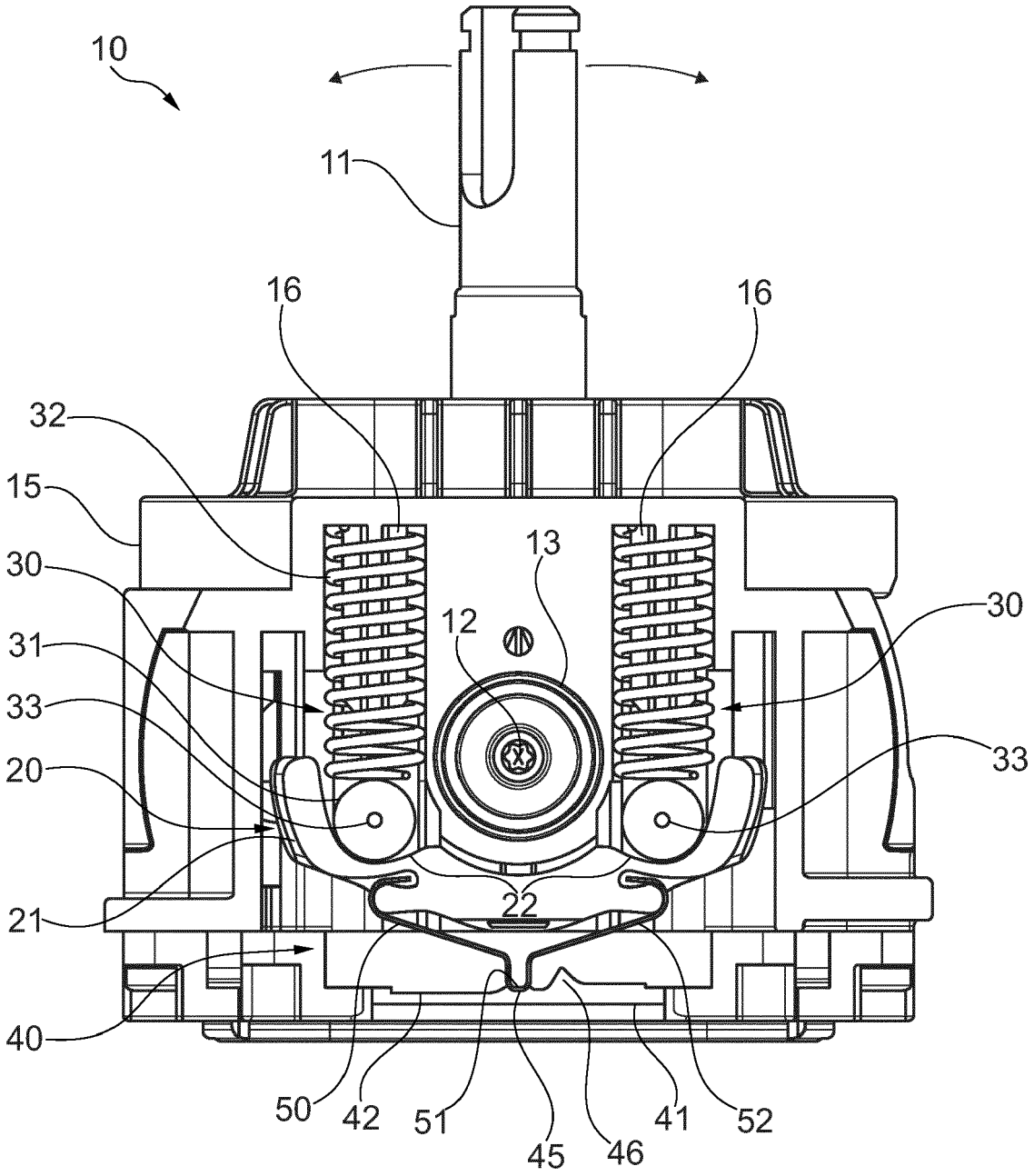

Fig. 1

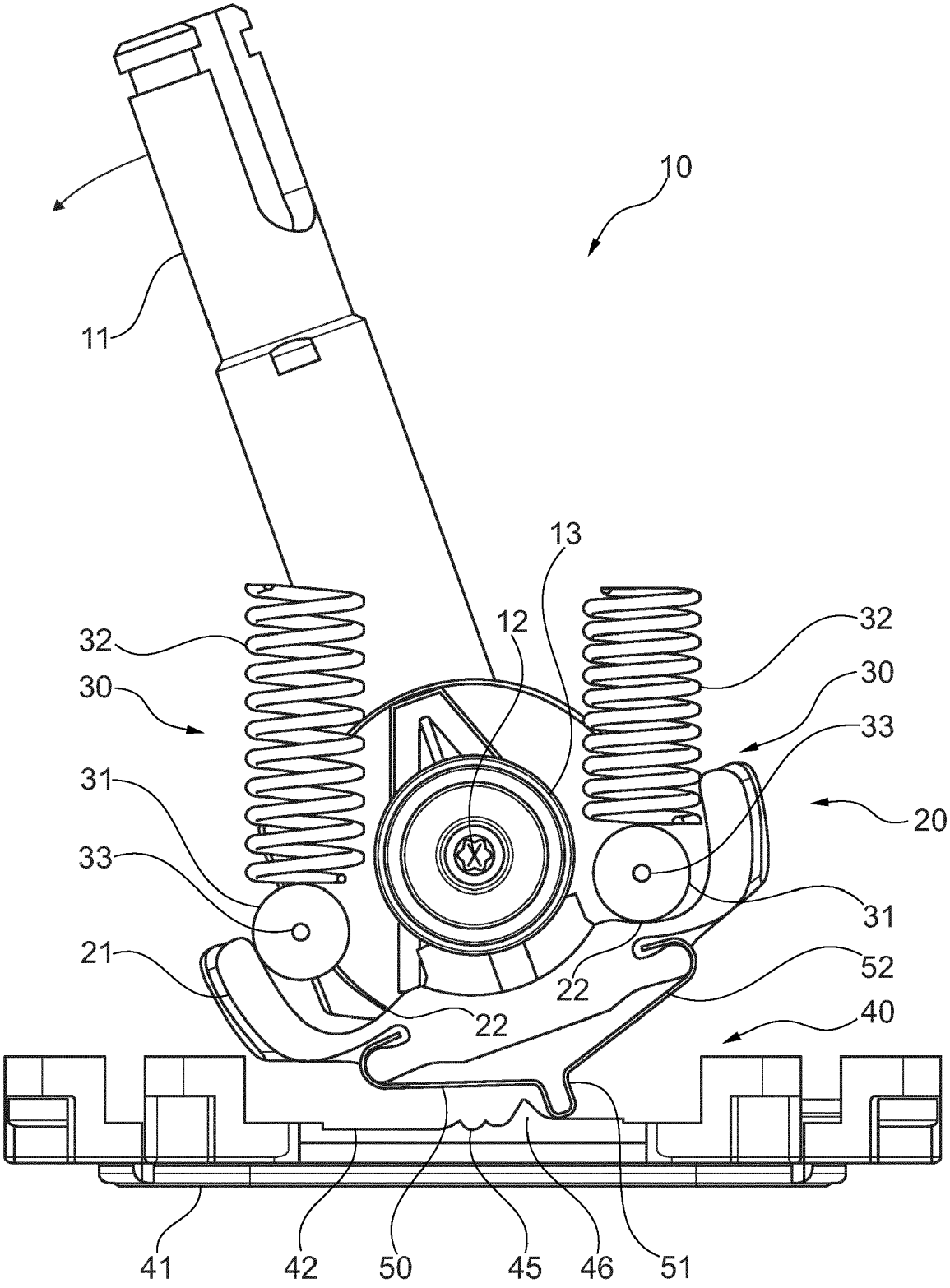

Fig. 2

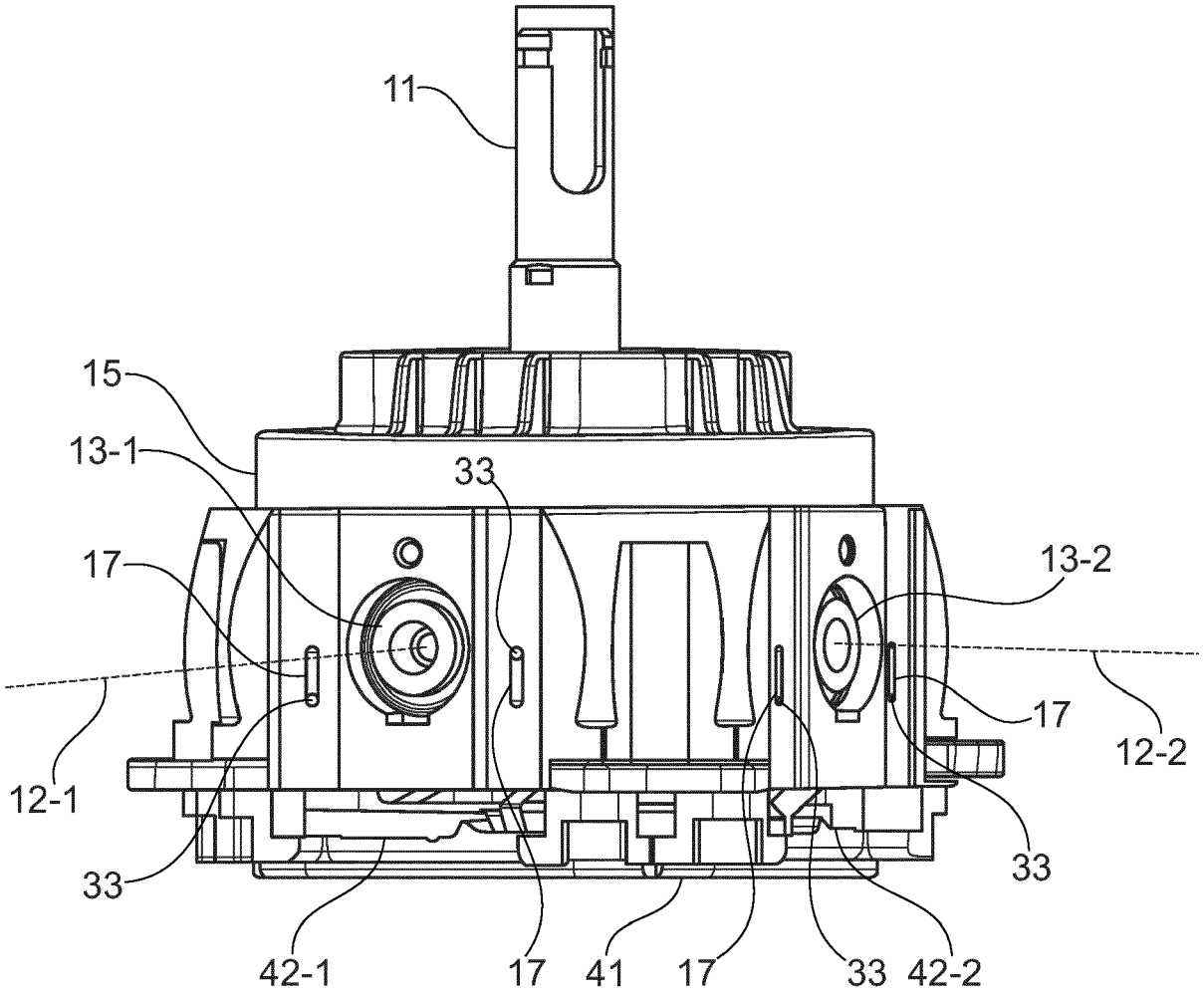

Fig. 3

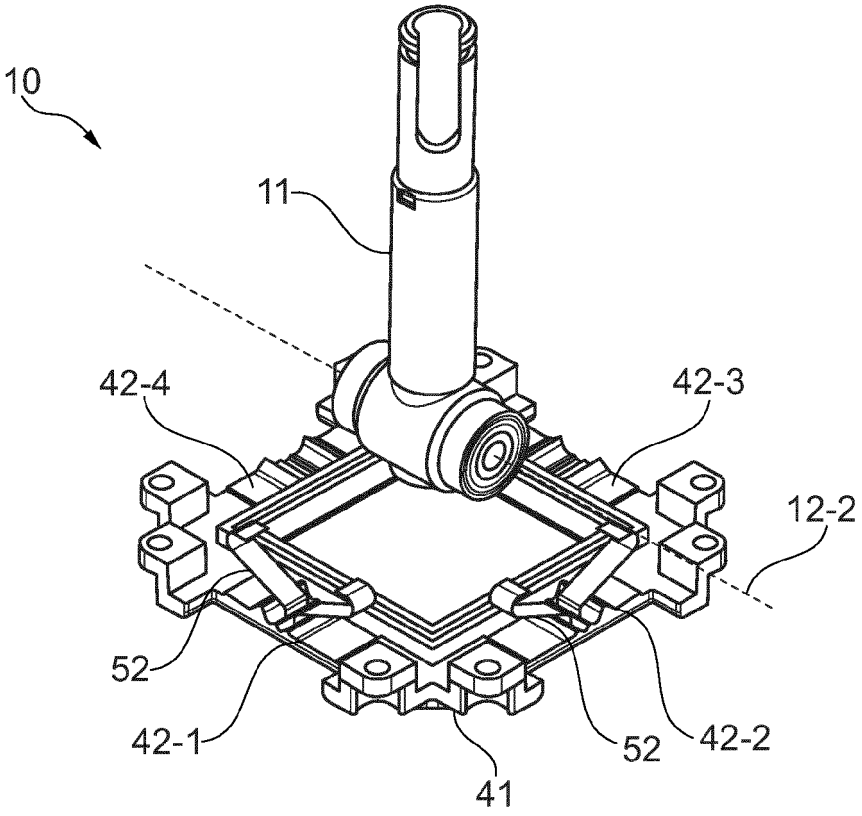

Fig. 4

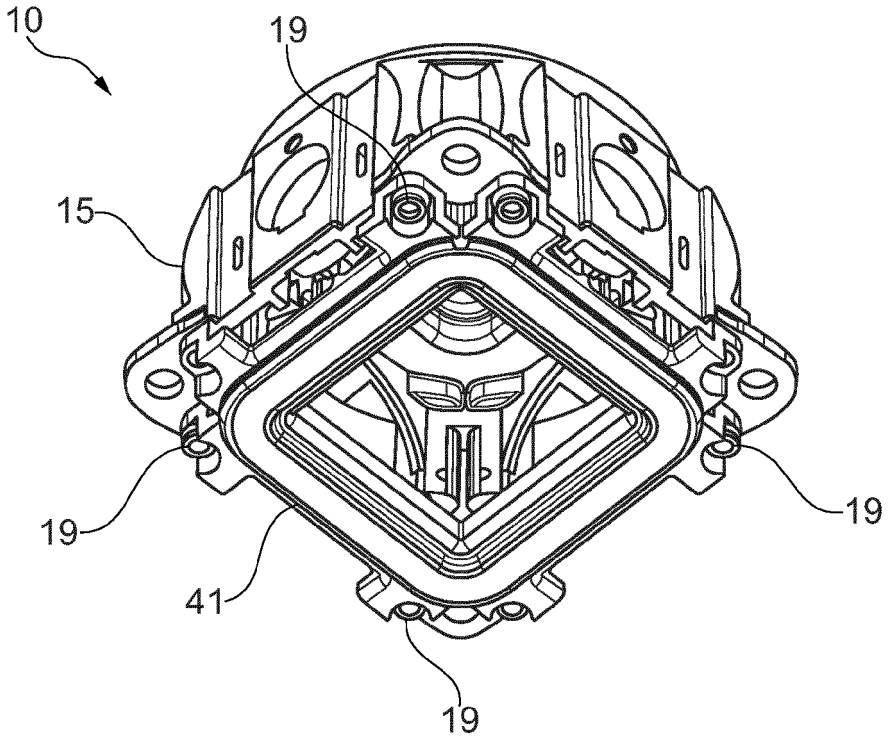

Fig. 5

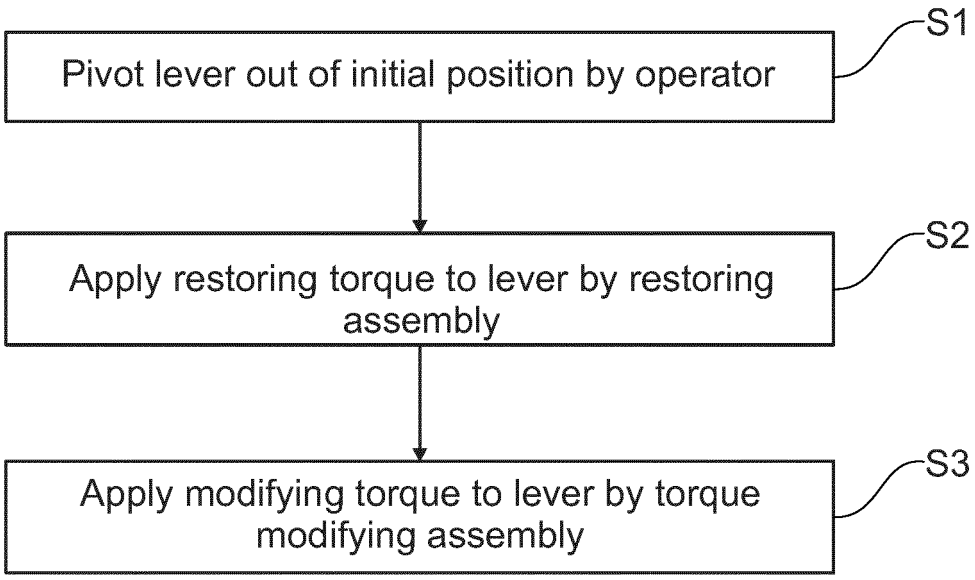
Pivot lever out of initial position by operator
S1
Apply restoring torque to lever by restoring assembly
S2
Apply modifying torque to lever by torque modifying assembly
S3

Fig. 6

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 23 20 8550

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 A	US 5 176 041 A (MEIER DIETMAR [DE] ET AL) 5 January 1993 (1993-01-05) * figures 1-4 *	1-4,7,9, 11,13,15 5,6,8, 10,12,14	INV. G05G1/04 G05G5/03 G05G5/05
X A	DE 10 2012 104098 B4 (ELOBAU GMBH & CO KG [DE]) 27 August 2015 (2015-08-27) * claim 1; figures 1-3 *	1-7,9, 11-15 8,10	ADD. G05G9/047 E02F9/20
A	US 6 403 898 B2 (ITT MFG ENTERPRISES INC [US]) 11 June 2002 (2002-06-11) * figure 1 *	1,15	

TECHNICAL FIELDS SEARCHED (IPC)

G05G
E02F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	24 April 2024	Huyge, Kevin

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

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 23 20 8550

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.

24-04-2024

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5176041 A	05-01-1993	DE 4017696 A1	05-12-1991
		EP 0459183 A1	04-12-1991
		ES 2048527 T3	16-03-1994
		US 5176041 A	05-01-1993
DE 102012104098 B4	27-08-2015	NONE	
US 6403898 B2	11-06-2002	AT E272249 T1	15-08-2004
		DE 10027446 A1	13-12-2001
		DE 60104488 T2	02-12-2004
		EP 1164607 A2	19-12-2001
		JP 2002050264 A	15-02-2002
		US 2002003082 A1	10-01-2002

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- DE 102012104098 A1 **[0004]**