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

(11) EP 4 571 452 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
18.06.2025 Bulletin 2025/25

(21) Application number: **23217133.0**

(22) Date of filing: **15.12.2023**

(51) International Patent Classification (IPC):
G05G 9/047 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
G05G 9/047; G05G 2009/04748

(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:
- **Beckers, Ralf**
88410 Bad Wurzach (DE)
- **Schwarz, Dominik**
87448 Waltenhofen (DE)
- **Zodel, Steffen**
88299 Leutkirch (DE)
- **Morent, Ulrich**
88299 Leutkirch (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, in particular a joystick, for controlling the operation of a machine is provided. The operating element comprises a control lever (20), a support assembly (30) that mechanically supports the control lever (20) such that the control lever (20) is pivotable about a first rotational axis (11) and is pivotable about a second rotational axis (12) that is perpendicular to the first rotational axis (11) and a yoke element (40) that is supported in a housing (15) of the operating element (10) and that is pivotable about a third rotational axis (13). The yoke element (14) is configured to provide a mechanical signal transmission of a pivoting of the control lever (20) about the first rotational axis (11). The operating element further includes a guide element (50) mechanically coupled to the control lever (20) to pivot with the control lever (20), wherein the guide element (50) is configured to interact with the yoke element (40) to pivot the yoke element (40) about the third rotational axis (13) when the control lever (20) is pivoted about the first rotational axis (11) and to move relative to the yoke element (40) when the control lever (20) is pivoted about the second rotational axis (12). The yoke element (40) comprises a guide bracket (41) and the guide element (50) has an engagement portion (51) configured to engage the guide bracket at least from two sides so as to restrict movement of the guide bracket at least in two opposing directions relative to the guide element.

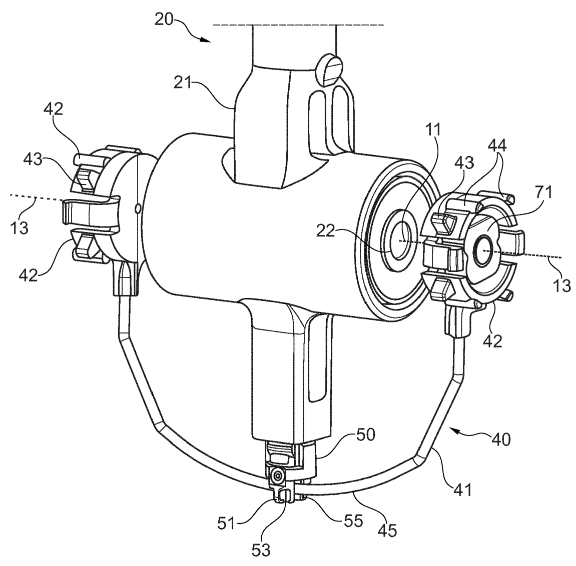

Fig. 2

EP 4 571 452 A1

Description

FIELD OF THE INVENTION

[0001] The present invention relates to an operating element, such as a joystick, for controlling the operation of a machine. It further relates to a method of manufacturing a respective operating element.

BACKGROUND

[0002] A mobile machine, such as a agricultural or construction vehicle, can be controlled by means of an operating element in form of a joystick. Such operating element may control movement of the machine, wherein pushing the joystick forward or pulling the joystick backwards may correspond to a forward motion and a backward motion of the machine, respectively. Pivoting the joystick to the left or right may result in a corresponding movement of the machine in a left direction and in a right direction, respectively. To allow the pivoting of the joystick about two orthogonal axes, a gimbal mount or cardan mount may be used to support the joystick lever. In such configuration, it may be difficult to provide a robust configuration in which the movement can be detected electrically in a reliable manner.

[0003] The document US 4,763,100 A discloses a joystick with an additional degree of control. The joystick includes a pivotably mounted X yoke connected to an X potentiometer and a pivotably mounted Y yoke connected to a Y potentiometer. The X yoke element has a central arcuate portion with a slot through which a vertical segment of a leg portion integrally connected to a platform member slidably extends. The lever of the joystick is mounted to the platform member. When the joystick is pivoted along the X axis, the vertical segment causes the X yoke element to pivot. Such configuration is however difficult to manufacture, since it requires several tolerances to be tuned with respect to one another and thus makes the configuration of manufacturing tools difficult. It is further difficult to mount the components in such assembly. Also, the configuration results in a relatively high friction and may require additional force for actuation of the joystick lever. The operability of the joystick by a user may thus suffer.

[0004] It is thus desirable to facilitate the manufacturing of a respective operating element and to make the manufacturing more cost-efficient. Further, it is desirable to improve the operability of such operating element, and in particular to provide smooth operation at reduced force. It is further desirable to provide a precise detection of the movement of the lever of such operating element.

SUMMARY

[0005] Accordingly, there is a need to mitigate at least some of the drawbacks mentioned above and to provide an improved operating element. It is particularly desirable to improve the operability of such operating element while simplifying the manufacturing and making it more cost-efficient.

[0006] This need is met by the features of the independent claims. The dependent claims describe embodiments of the invention.

[0007] According to an embodiment of the invention, an operating element, such as a joystick, for controlling the operation of a machine is provided. The operating element comprises a control lever and a support assembly that mechanically supports the control lever. The support is configured such that the control lever is pivotable about a first rotational axis and is pivotable about a second rotational axis that is perpendicular to the first rotational axis. The operating element further comprises a yoke element that is supported in a housing of the operating element and that is pivotable about a third rotational axis. The yoke element is configured to provide a mechanical signal transmission of a pivoting of the control lever about the first rotational axis. The operating element further comprises a guide element mechanically coupled to the lever to pivot with the lever. The guide element is configured to interact with the yoke element to pivot the yoke element about the third rotational axis when the control lever is pivoted about the first rotational axis, and to move relative to the yoke element when the lever is pivoted about the second rotational axis. The yoke element comprises a guide bracket and the guide element has an engagement portion configured to engage the guide bracket at least from two sides so as to restrict movement of the guide bracket at least in two opposing directions relative to the guide element.

[0008] Several benefits may be achieved by such configuration. By providing the yoke element separate from the support assembly of the control lever, forces acting on the control lever, such as originated by a user, may be absorbed by the support assembly, so that the yoke element that provides the signal transmission may be operated in an essentially force-free manner. The yoke element may thus have a relatively simple, light weight and easy to manufacture configuration. No large forces thus need to be transmitted for detecting the pivoting about the first rotational axis. The yoke element and the guide element may, as a consequence, be made relatively small, so that small tolerances may result. This may result in a more precise signal transmission. Further, by providing the yoke element as a guide bracket and by engaging the guide bracket by the guide element from two (e.g. opposing) sides, for example by grasping or gripping the guide bracket by the guide element, a configuration may be achieved in which the yoke element becomes more compact and easier to produce. Further, by such engagement, relatively low friction between the yoke element and the guide element may result, thus improving the operability of the operating element. Such guide element may be manufactured in a relatively simple manner with a high degree of accuracy, so that both, the mechanical complexity may be reduced, and the accuracy of the control may be improved. Also, assembly may be facilitated, since such guide bracket may be easy to mount and the engagement with the engagement portion may be established in a simple and straightforward manner.

[0009] Besides being more compact, such configuration may result in reduced weight and in a reduced number of parts. Such guide bracket may further be manufactured in a simple manner and with predefined dimensions, in particular a predefined width, thus further improving accuracy of the control.

[0010] Preferably, relative movement in the at least two opposite directions is prevented. For example, there may be hardly any play or no play between the engagement portion and the guide bracket in the at least two opposite directions.

[0011] The at least two opposite directions, in which relative movement is restricted, may correspond to the directions of motion of the guide bracket when pivoting about the third rotational axis. The two opposite directions may for example be (substantially) perpendicular to the third rotational axis. For example, they may be tangential to a circle described by the guide bracket at the respective position when pivoting about the third rotational axis. By such engagement, a pivoting of the lever may reliably be transferred into a pivoting of the yoke element, which may result in a reliable mechanical signal transmission.

[0012] The guide bracket may preferably be arranged between portions of the engagement portion that engage the guide bracket.

[0013] The engagement portion may for example engage the guide bracket at least from two opposing sides. In other examples, it may engage the guide bracket from three or more sides, which may be distributed about a cross section of the guide bracket (e.g. from three directions offset by 90 degrees, or from three directions offset by 120 degrees). Also by such engagement, a restriction of the relative movement in at least the two opposing directions may be achieved. The portions of the engagement portion by which the guide bracket is engaged may be provided by two, three, or more engagement members, or by a single engagement member that may for example extend about a section of the circumference (e.g. a half circle, or two quarter circles or the like) of the guide bracket and that has several portions in engagement with the guide bracket, which portions may also continuously span such section of the circumference.

[0014] The engagement portion may be configured to grip or grasp the guide bracket from the two opposing sides (i.e., from the two opposing directions). The engagement portion may encompass the guide bracket on two opposing sides. The guide bracket may also be termed "driver".

[0015] In an embodiment, the engagement portion of the guide element is configured to slide and/or roll along the guide bracket when the lever is pivoted about the second rotational axis. A sliding engagement or rolling engagement may thus be provided between the engagement portion and the guide bracket. Such configuration may allow a pivoting of the lever about the second rotational axis with reduced friction.

[0016] At least a section of the guide bracket on which the guide element moves when the lever is pivoted about the second rotational axis may have a shape of a circular section of a circle having a center that lies on the second rotational axis.

[0017] The third rotational axis may be perpendicular to the second rotational axis. An axial direction of the first rotational axis may be pivoted about the second rotational axis when the lever is pivoted about the second rotational axis. The first rotational axis may for example be parallel to the third rotational axis when the lever is at a default position.

[0018] When the lever is positioned such that the first rotational axis is parallel to the third rotational axis, the first rotational axis is preferably superimposed on the third rotational axis. In such configuration, relative movement between the guide element and the guide bracket may be reduced or minimized during pivoting of the lever about the first rotational axis.

[0019] The support assembly may be a cardan suspension or a gimbal mount, and the first and second rotational axes, and optionally the third rotational axis, may intersect in an intersection point. Such configuration may provide a precise control and beneficial haptic experience.

[0020] In an embodiment, the yoke element comprises a single guide bracket. In may in particular not comprise any other guide elements. Such configuration may further simplify manufacturing of the operating element and may reduce the part number. Friction may further be reduced by having only a single guide bracket. Further, the configuration and adjustment of a manufacturing tool may be simplified by such configuration.

[0021] The guide bracket may comprise or may be a curved rod. In particular, it may comprise or may be a bent wire. Such rod or wire may be manufactured in a cost-efficient way with high precision. Such wire may have a circular cross-section with a precise diameter having a low tolerance, thus reducing the play in the engagement between the engagement portion and the guide bracket. Accuracy of the control may thereby be improved. Further, the guide bracket may simply be manufactured by bending a respective piece of wire. The guide bracket may for example be made of a metal, such as steel, aluminum, or the like.

[0022] The engagement portion may for example be U-shaped. It may have a slit, and the guide bracket may be received in the slit. In other words, the guide bracket may be in engagement with the slit. Such configuration may facilitate assembly while providing a low friction but precise interaction between guide element and guide bracket.

[0023] The engagement portion may comprise two protrusions that protrude from opposite sides towards the guide bracket, in particular to provide an engagement from two opposing sides. Such protrusions may form the above-mentioned slit. By means of respective protrusions, the area of interaction between the guide element and the guide bracket may be well defined, which may improve control accuracy, and may further be made small, which may reduce friction. In other examples, three or more protrusions may engage the guide bracket, or a protrusion spanning part of a circumference of the guide bracket may engage the guide bracket.

[0024] For example, the engagement portion of the guide element may comprise two engagement members that extend in an axial direction of the lever away from the lever. They may for example extend in a (fourth) direction that is perpendicular to the first and second rotational axes. Each engagement member may have an engagement face arranged opposite to the engagement face of the other engagement member. Each engagement face may comprise a respective protrusion that extends towards the protrusion of the engagement face of the other engagement member. The guide bracket may be received between the protrusions of both engagement members. This may simplify the configuration of the guide element and may facilitate manufacturing.

[0025] The protrusions may have rounded edges or have a rounded shape. In particular, they may have such rounded edges or rounded shape in a cross-section taken perpendicular to the direction of extension of the engagement members, e.g. to the fourth direction. A rounded edge may mean that the edge in cross section forms a continuously bending curve. For example, each protrusion may have a bulged shape in the cross-section. A respective shape of the protrusions may allow the orientation of the guide element relative to the guide bracket to change without jamming between the guide bracket and the engagement portion of the guide element.

[0026] In some embodiments, each protrusion may have a convex shape, for example in a cross section perpendicular to the fourth direction (which is perpendicular to the first and second rotational axes). In other examples, the protrusions may have a concave shape. Such shape may improve the ability of the engagement portion to rotate with respect to the guide bracket without causing a jamming of the guide element on the guide bracket.

[0027] Each protrusion may for example form in cross section a continuously bending curve that, e.g., extends away from the respective engagement member (i.e. towards the other engagement member), curves around and bends towards the engagement member, thus forming a convex shape of the protrusion. As another example, each protrusion may have in cross section a first straight or (concavely) curved section extending away from the respective engagement member (in particular from the respective engagement face, if provided), a second convexly curved section, an optional third straight section extending parallel to the engagement member (in particular to the first rotational axis), a fourth convexly curved section, and a fifth straight or (concavely) curved section extending towards the engagement member (e.g. towards the respective engagement face, if provided). The profile may for example correspond to two mirrored S-shaped sections that are connected optionally via a straight section. Also this way, a protrusion having an overall convex shape may be formed. Preferably, the extension of both convexly curved sections in a direction parallel to the first rotational axis may be larger than the extension of the (optional) third straight section parallel to the first rotational axis. A sufficiently rounded shape that avoids jamming may thus be achieved. Optionally, the convexly curved sections may have the shape of a circular segment. A curved section may be a section that continuously bends.

[0028] In the direction along the extension of the engagement members (e.g., the fourth direction), the cross-sectional shape of the engagement members may remain (relatively) constant, at least over the range over which the engagement portion engages the guide bracket during operation. Variations in the positioning of the guide bracket relative to the guide element in the fourth direction may thus not have any significant effect on the interaction between the guide element and the guide bracket. Accurate control may thereby be achieved even if the distance in the fourth direction between these two elements changes.

[0029] The guide element may be mounted to the lever by a rotatable mount configured to allow an orientation of the engagement portion relative to the control lever to change. As the lever is pivoted in both directions (i.e. about the first and second rotational axes), a certain rotation of the lever about its longitudinal axis may result. Such rotatable mount may compensate for such rotation. In particular, it may avoid excessive rotation of the engagement portion against the guide bracket, and may thus avoid a jamming of the engagement portion on the guide bracket. For example, if the lever is pivoted about both the first and second axes, the engagement portion may adapt its orientation to the orientation of the guide bracket. The rotatable mount may in particular provide a rotation about a fourth rotational axis, which may be perpendicular to the first and second rotational axis. The fourth rotational axis may in particular extend in the fourth direction.

[0030] A longitudinal extension of the lever may be in the direction of the fourth rotational axis. However, it should be clear that the lever may have a handle that is configured in any ergonomically desirable shape and extends in any desirable direction. The lever may be composed of plural components. It may for example include a pivotable component to which the guide element is mounted by the rotatable mount, a handle mounted to the pivotable component, and possibly other components, e.g. intervening components.

[0031] The rotatable mount may be configured to allow movement of the guide element relative to the lever for a predetermined distance in an axial direction of a rotational axis of the rotatable mount (in particular the axial direction of the fourth rotation axis). This may allow a compensation of any change of distance between the guide element and the guide bracket. In other words, the rotatable mount may have a certain predefined play in axial direction.

[0032] The rotatable mount may comprise a latch for latching the guide element to the control lever. The rotatable mount may for example comprise a latch tongue or protrusion provided on the lever, such as on a pivotable component thereof, and a recess or hole on the guide element into which the latch element is engaged. Mounting of the guide element to the lever may thus be facilitated.

[0033] The yoke element may comprise a bracket mount at one or at each end of the guide bracket. The bracket mount may be configured to rotatably mount the guide bracket to a component of the operating element, such as to a housing part of the operating element. The yoke element may thus have a simple configuration that is easy to produce.

[0034] For example, the bracket mount may be made of plastic material, and it may be molded to the guide bracket. It may for example be molded to a bent wire that provides the guide bracket. The yoke element may thus be manufactured by bending a respective wire and molding a bracket mount to each end of the bent wire. The yoke element may in particular consist of the bent wire and a bracket mount molded to each end of the bent wire. This may allow manufacturing of the yoke element in a simple and cost-efficient way.

[0035] The bracket mount may be configured to provide the pivoting of the yoke element about the third rotational axis. It may for example engage a hole in the housing part and may be rotatable within such (circular) hole.

[0036] The bracket mount may for example comprise one or more latches and may be configured to be latched into an opening, e.g. circular hole, provided in a housing part of a housing of the operating element. Assembly may be facilitated by such configuration. The bracket mount may comprise two, three or more radically extending bulges configured to slide on an inner surface of the hole in a housing part. This may reduce friction.

[0037] Preferably, the yoke element, in particular at least one bracket mount of the yoke element, comprises a sensor component of a (rotational) sensor configured to detect a rotation of the guide bracket about the third rotational axis. The sensor element may be coupled, in particular mounted, to the yoke element to rotate or pivot with the yoke element about the third rotational axis. Such sensor may in particular convert the mechanical signal transmitted by the yoke element into an electrical signal for detecting actuation of the lever about the first rotational axis.

[0038] The sensor component may for example comprise a magnet or magnet arrangement, an optical indicator, or the like. Preferably, the sensor component contactlessly interacts with a second sensor component mounted fixedly to a housing part of the operating element. The sensor component may in particular rotate with the guide bracket about the third rotational axis.

[0039] The sensor may for example comprise a Hall-sensor mounted to a circuit board in the housing of the operating element, the Hall-sensor detecting a rotation of the magnet or magnet arrangement on the bracket mount of the yoke element. In another exemplary implementation, the sensor may comprise an optical detector detecting a rotation of the optical indicator on the bracket mount, such as of an optical rotational encoder. The sensor component may thus be a simple structure the rotation of which can be detected optically. A magnetic sensor is however preferred, as it provides for robustness against dirt or debris entering the operating element housing.

[0040] In an embodiment, the operating element is configured such that forces acting on the lever are not taken up by the yoke element. The yoke element may only track the position of the lever, but may not take up forces. Requirements on a robustness of the yoke element may thus be kept low, resulting in a simple and cost-effective manufacturing.

[0041] The coupling between the guide element and the yoke element may be an (essentially) force-free coupling. Besides the (low) force (frictional force) required to rotate the yoke element about the third rotational axis, no forces may be applied by the yoke element to the guide element.

[0042] The support assembly may comprise a frame, a first rotating suspension that supports the lever in the frame so as to be rotatable about the first rotational direction, and a second rotating suspension that supports the frame in a housing of the operating element so as to be rotatable about the second rotational direction. The support assembly may implement a cardan suspension, a gimbal mount, or the like. The frame may in particular be a cardan frame. The first rotating suspension and the second rotating suspension may be configured to bear forces acting on the lever, such as forces applied by a user. The yoke element may thus be kept substantially force-free.

[0043] A sensor component of a (rotational) sensor may be mechanically coupled to the cardan frame, for example, it may be mounted to a shaft stub of the cardan frame that provides rotation about the second rotational axis. Again, such sensor component may be a magnet or magnet assembly, an optical indicator or the like. It may in particular have a configuration corresponding to the configuration of the sensor component mounted to the yoke element, in particular to the bracket mount thereof. Such second rotational sensor may have a similar configuration as the above-mentioned (first) rotational sensor. The operating element may comprise the respective (first and/or second) rotational sensor(s).

[0044] Accordingly, pivoting of the lever about the first rotational axis may be detected (indirectly) by detecting pivoting of the yoke element about the third rotational axis using the first rotational sensor, and pivoting of the lever about the second rotational axis may be detected (directly) by detecting rotation of the cardan frame about the second rotational axis.

[0045] According to a further embodiment of the invention, a machine, in particular a mobile machine, such as an agricultural vehicle, a construction vehicle, or an industrial vehicle, is provided. The machine comprises an operating element having any of the configurations described herein and being adapted to control a function of the machine.

[0046] According to a further embodiment of the invention, a method of manufacturing an operating element, in particular a joystick, is provided. The method includes providing a control lever; providing a support assembly and mechanically supporting the control lever by the support assembly such that the control lever is pivotable about a first rotational axis and is pivotable about a second rotational axis that is perpendicular to the first rotational axis; providing a yoke element and supporting the yoke element in a housing of the operating element such that it is pivotable about a third rotational axis, wherein the yoke element is configured to provide a mechanical signal transmission of a pivoting of the control lever about the first rotational axis and wherein the yoke element comprises a guide bracket; mechanically coupling a guide element to the lever to pivot with the lever, wherein the guide element is configured to interact with the yoke element to pivot the yoke element about the third rotational axis when the control lever is pivoted about the first rotational axis and to move relative to the yoke element when the lever is pivoted about the second rotational axis; and engaging the guide bracket with an engagement portion of the guide element at least from two sides. The engagement may be such that movement of the guide bracket relative to the guide element is restricted at least in two opposing directions. By such method, an operating element may be obtained that has any of the advantages outlined above.

[0047] In an embodiment, the method may comprise bending a wire to manufacture the guide bracket.

[0048] In a further embodiment, the method may include moulding a bracket mount to at least one, preferably to each end of the guide bracket.

[0049] The method may further include mounting the guide element to a pivotable component of the lever by latching the guide element to the pivotable component. The mounting may occur by means of a rotatable mount.

[0050] The method may further comprise latching at least one, preferably each, bracket mount of the guide bracket to a housing part of a housing of the operating element. A rotatable connection is preferably established by such latching.

[0051] The method may further include mounting a sensor component, which may have any of the above-described configurations, to the yoke element, in particular to a bracket mount thereof.

[0052] The method may be performed so as to manufacture an operating element having any of the configurations described herein. Further, the operating element may have any of the configurations resulting from the performing of the manufacturing method.

[0053] 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

[0054] 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 perspective view of a lever component with a guide element and a yoke element of an operating element according to a further embodiment.

Fig. 3 is a schematic drawing showing an enlarged view of the guide element interacting with the guide bracket of the yoke element of figure 2.

Fig. 4 is a schematic drawing showing an enlarged view of the guide element mounted to the lever component of figure 2.

Fig. 5 is a schematic drawing showing a sectional view of the guide element mounted to the lever component of figure 2.

Fig. 6 is a schematic drawing showing an enlarged view of the guide element interacting with the guide bracket of the yoke element of figure 2.

Fig. 7 is a schematic drawing showing a perspective view of an embodiment of an operating element that includes the lever component, the guide element, and the yoke element of figure 2.

Fig. 8 is a flow diagram illustrating a method of manufacturing an operating element according to an embodiment.

DETAILED DESCRIPTION

[0055] 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.

[0056] Fig. 1 schematically illustrates an operating element 10 having a lever 20 that is supported by a support assembly 30. Support assembly 30 is configured to allow rotation of lever 20 about a first rotational axis 11 (i.e., in and out of the drawing plane) and about a second rotational axis 12 (as indicated by the arrow), which is perpendicular to the drawing plane. Support assembly 30 may be provided as a gimbal mount, in particular as a cardan suspension. It may include a cardan frame 31 supporting a shaft 32 about which lever 20 is rotatable about axis 11. Cardan frame 31 may be rotatable about the second rotational axis 12. It may for example be supported by means of shaft stubs 33 (which are indicated but actually lie outside the drawing plane in the sectional view of Fig. 1) in a part of the housing 15 of operating element 10. Lever 20 may thus be rotatable about the two orthogonal rotational axes 11, 12. Operating element 10 may be implemented as a 2D-joystick.

[0057] It will be readily apparent that in such configuration, forces acting on the lever are borne by shafts 32, 33 which transfer these forces to housing 15 of the operating element 10. Further, as the cardan frame 31 rotates together with the lever 20 about the second rotational axis 12, it is difficult to measure rotation about first rotational axis 11, as a respective rotation sensor would need to rotate as well. To provide a transmission of the mechanical rotation signal about the first rotational axis 11, a yoke element 40 that includes a guide bracket 41 is provided. Yoke element 40 further includes a bracket mount 42 at each end of guide bracket 41, by means of which the yoke element 40 is supported, in particular mounted, to a housing part 16 of housing 15. Yoke element 40 is mounted by a rotatable mount that allows pivoting of the yoke element 40 about a third rotational axis 13. Rotational axis 13 is stationary with respect to housing 15 so that detection of pivoting of yoke element 40 is facilitated. Second rotational axis 12 is likewise stationary with respect to housing 15, whereas the first rotational axis 11 is rotated about the second rotational axis 12 when lever 20 is pivoted about second rotational axis 12.

[0058] If implemented as a gimbal mount, first and second rotational axes 11, 12 intersect. It may be beneficial if the third rotational axis 13 intersects the second rotational axis 12, in particular at the same intersection point. In the default position illustrated in Fig. 1, the first rotational axis 11 may thus be coincidental with the third rotational axis 13. Any pivoting of lever 20 about the first rotational axis 11 may thus be translated in a corresponding pivoting of the yoke element 40 about third rotational axis 13. A mechanical signal transmission can thus be implemented that allows a precise detection of the pivotal position of lever 20 about first rotational axis 11.

[0059] To cause yoke element 40 to pivot together with lever 20, a guide element 50 is provided that engages the guide bracket 41 of yoke element 40. Guide element 50 has an engagement portion 51 that engages the guide bracket 41 from two opposing sides, in particular grips or grasps the guide bracket 41. The engagement is such that when lever 20 is pivoted about rotational axis 11, the guide element 50 causes the yoke element 40 to pivot by the same angle about the third rotational axis 13. Yoke element 40 may thus implement a driver that is driven by pivoting of lever 20 about axis 11.

[0060] The engagement is further such that when lever 20 is pivoted about the second rotational axis 20, the guide element 50 moves relative to yoke element 40. In particular, the engagement portion 51 slides or rolls on the guide bracket 41. Pivoting of lever 20 about rotational axis 12 may thus not affect the pivotal position of yoke element 40.

[0061] To facilitate such movement along guide bracket 41, the guide bracket 41 may comprise a circular section 45 that is curved in correspondence to a section of a circle. Such circle may have a center that coincides with the second rotational axis 12, i.e. that may be concentric with second rotational axis 12. When lever 20 pivots about second rotational axis 12, the spacing between guide element 50 and guide bracket 41 may thus remain essentially constant. A required tolerance for axial movement between guide element 50 and guide bracket 41 can thus be kept low and friction may be reduced.

[0062] It should be clear that such circular section 45 may only extend over a range corresponding to a pivoting range of lever 20 about second rotational axis 12.

[0063] By such configuration, forces acting on lever 20 can be absorbed by the supporting assembly 30, so that the yoke element 40 can be kept essentially force-free. Further, by engaging the guide bracket 41 by engagement portion 51 of guide element 50, an accurate and low friction interaction between these components may be achieved. An accurate and precise detection of the pivoting position of lever 20 may thereby be enabled, while improving haptic experience of the user in view of the reduced frictional forces.

[0064] Fig. 2 illustrates a particular implementation of certain components of the operating element 10 of Fig. 1, so that the above explanations apply correspondingly. Fig. 2 illustrates a pivotable component 21 of lever 20 that may include a through-hole 22 by which it is supported rotatably about axis 11 on the shaft 32 (see Fig. 1). Pivotable component 21 may for example comprise bearings to facilitate rotation on shaft 32. The lever 20 may further include a handle (not shown) mounted to pivotable component 21. Pivotable component 21 extends in an axial direction perpendicular to the first rotational axis 11. On a side opposite to the side on which the handle is mounted, the guide element 50 is mounted to pivotable component 21. The engagement portion 51 includes a first engagement member 53 and a second engagement member 55 which engage the guide bracket 41 from opposing sides, as described in further detail below.

[0065] The yoke element 40 comprises only one single guide bracket 41. Guide bracket 41 may be a curved rod or a bent wire. Yoke element 40 may thus be manufactured in a simple way by bending a respective wire of the desired diameter into the desired shape, as shown in Fig. 2, and by molding a bracket mount 42 to each end of the wire. A simple and cost-effective solution may thereby be achieved.

[0066] Further, as such wire is obtainable with a predefined diameter having a low tolerance, it is possible to provide a matching in size between the engagement portion 51 and the guide bracket 41 in a simple and cost-efficient way. Accuracy can thereby be increased while friction may be kept low.

[0067] As exemplarily shown in Fig. 2, the bracket mounts 42 are provided with latches in order to latch the yoke element 40 to housing parts 16 of housing 15. They further include stops for fixing bracket mounts 42 in a predefined axial position (axial stops 43). Bracket mount 42 further includes rounded protrusions 44, for example three, four, or more rounded protrusions 44, which may interact with an inner circumferential surface of a hole in housing part 16 into which the bracket mount 42 is inserted. Such rounded protrusions 44 may reduce friction between housing part 16 and bracket mount 42 when the yoke element 40 is pivoted about the third rotational axis 13. The rounded protrusions 44 may be distributed circumferentially on the bracket mount 42 about the rotational axis 13; they may be equidistant to rotational axis 13.

[0068] Fig. 3 illustrates in detail the engagement between the engagement portion 51 and the guide bracket 41 of the embodiment of Fig. 2. Fig. 3 shows a bottom view in which the engagement members 53, 55 extend in an axial direction of the pivotable component 21, which is perpendicular to the drawing plane in Fig. 3. First engagement member 53 includes a first engagement surface 54 that faces the second engagement surface 56 of the second engagement member 55. On each engagement surface 54, 56, a respective protrusion 52 is provided that protrudes towards the protrusion on the respective other engagement surface.

[0069] Protrusions 52 are configured and sized so as to interact with the guide bracket 41, in particular to abut the guide bracket 41 from two opposing sides. Accordingly, a spacing between the opposing protrusions 52 may be sized so as to correspond to an outer dimension, in particular diameter, of the guide bracket 41. As guide bracket 41 may have a low tolerance in its diameter, a precise alignment of the spacing of protrusions 52 to the diameter of guide bracket 41 becomes possible. The interaction may thus occur with little play and reduced friction, resulting in improvements to the accuracy and haptic perception of the control.

[0070] The protrusion 52 has a rounded shape. In particular, it has rounded edges in a section taking through the engagement zone parallel to the drawing plane of Fig. 3. Each protrusion 52 may in particular form a bulge that bulges outwardly from the respective engagement surface 54, 56. Engagement by that such rounded or bulged protrusion 52 may further reduce friction. Further, it allows a certain play in the angular orientation between the guide element 50 and the guide bracket 41 about an axis 14 parallel to the extension of engagement members 53, 55, i.e. in about an axis 14 perpendicular to the drawing plane. Such configuration may reduce the probability of the occurrence of a jamming between the guide element 50 and the guide bracket 41 as they move relative to each other, e.g. slide relative to each other when a lever 20 is pivoted about the second rotational axis 12.

[0071] Fig. 4 is an enlarged view showing an exemplary implementation of a mounting of the guide element 50 to the pivotable component 21 of lever 20 of Fig. 2. A rotatable mount 60 is provided by means of which the guide element 50 is rotatable about a fourth rotational axis 14 relative to the lever component 21. Rotational axis 14 may correspond to an axial extension of the lever component 21. Fourth rotational axis 14 may in particular be perpendicular to the first and second rotational axes 11, 12. Rotational axes 11, 12 and 14 may intersect at the same intersection point. It should however be clear that the guide element 50 may also be offset, e.g. along an arcuate direction prescribed by the circular component 45, in which case rotational axis 14 does not need to be perpendicular to the first or second rotational axes 11, 12.

[0072] Rotatable mount 60 may include a latched connection 61. Such latched connection may include a locking tab 62 at one component and a snap-in hole 63 at the other component. Snap-in hole 63 may be wide enough to allow a rotation of the guide element 50 with respect to the lever component 21. Other implementations of rotatable mount 60 are of course conceivable. The latching configuration illustrated in Fig. 4 may for example be reversed.

[0073] Fig. 5 illustrates a sectional view through the pivotable component 21 of the lever and the guide element 50. Pivotable component 21 includes a stub on which locking tab 62 is provided, and the guide element 50 has a mounting portion shaped as a cap that includes the snap-in hole 63 that is placed over the stub so as to generate a latching engagement with the locking tap 62. As shown in Fig. 5, the rotatable mount 60 may further provide a play in axial direction of the fourth rotational axis 14 so that the guide element 50 is allowed to move a certain distance in the axial direction relative to the component 21 of the lever. Any relative change in the spacing between the guide bracket 41 and the lever component 21 in the axial direction of axis 14 may thus be compensated, which may for example occur due to a misalignment between the rotational axes 11, 13 due to manufacturing tolerances.

[0074] As further visible in the sectional view of Fig. 5, the engagement portion 51, in particular the engagement members 53, 55 form a slit 57 in which the guide bracket 41 is received. In the axial direction of the component 21, e.g. in direction of axis 14, the engagement portion 51, in particular the protrusions 52, provide a spacing that remains substantially constant over the interaction range. This may further relax the tolerance requirements in axial direction for the engagement of the guide bracket 41 by guide element 50.

[0075] Such rotational mount is optional, and the guide element 50 may also fixedly be mounted to the lever 20, or may even be molded to lever 20 or produced integrally with lever 20.

[0076] Fig. 6 shows an enlarged section of the operating element 10 of Fig. 2, wherein lever 20 has been pivoted about both first and second rotational axes 11, 12. As a result, the orientation of the lever 20 about the rotational axis 14 has changed, so that the lever is misaligned with the guide bracket 41 of the yoke element 40. As visible in Fig. 6, the rounded shape of the protrusions 52 allows (at least partial) compensation of such misalignment. As a result, the guide element 50 can still slide with relative low friction along the guide bracket 41 while still providing accurate mechanical signal transmission, substantially without play. As will be readily apparent, by allowing relative rotation of guide element 50 relative to lever component 21, the risk of a respective jamming may further be reduced, and the orientation between the guide element 50 and guide bracket 41 may be maintained even if orientation of lever component 21 about axis 14 changes.

[0077] Turning back to Fig. 2, operating element 10 may comprise a sensor component 71 provided on the yoke element 40, for example on one or on both bracket mounts 42. Sensor component 71 preferably interacts with a second sensor component (not shown) of a rotational sensor in a contactless manner. In the present example, sensor component 71 is a magnet assembly comprising one or plural permanent magnets. The second sensor component, such as a Hall-sensor, may then detect rotation of the magnetic field when yoke element 40 is pivoted. In other implementations, an optical signaling component may be employed the rotation of which may be detected optically. Other configurations are conceivable.

[0078] Fig. 7 shows an embodiment of the operating element 10 that employs the components of Fig. 2. As can be seen, the bracket mount 42 is received in an opening 17 of housing 15 such that it is rotatable about the third rotational axis 13. Rounded protrusions 44 center the bracket mount 42 in the opening 17 and ensure reduced friction. Other means of engagement, such as rollers, a bearing or the like are certainly conceivable.

[0079] The pivotable component 21 of the lever is supported in a cardan frame (not visible in Fig. 7) wherein a stub shaft 33 is supported in the housing 15 to allow rotation of the cardan frame about the second rotational axis 12. A sensor component 72 that may be configured in correspondence to sensor component 71 is provided on the shaft 33. Pivoting of lever 20 about the second rotational axis 12 may thus be detected by a corresponding rotational sensor, which may form part of operating element 10.

[0080] As further visible in Fig. 7, the guide element 50 protrudes from the lever component 21 and engages the guide bracket 41 of the yoke element 40, so that when lever 20 is pivoted about the first rotational axis 11 (not visible in Fig. 7), the yoke element 40 is correspondingly pivoted about third rotational axis 13. Such pivoting is detected by a respective rotational sensor, of which sensor component 71 forms part, and which may be comprised in operating element 10. A mechanical simple and reliable solution providing a high detection accuracy may thus be achieved.

[0081] Fig. 8 shows a flow diagram of a method of manufacturing an operating element 10 having any of the configurations described herein. In step S1, the control lever, e.g. lever component 21, is provided. In step S2, the guide element 50 is mounted to the control lever 20, e.g. by using the latching connection and snapping guide element 50 onto the locking tab 62. In step S3, the control lever is mounted to the support assembly, for example by mounting the lever component 21 to the cardan frame 31 using shaft 32. In step S4, the yoke element is mounted to the housing part 16 of operating element 10, for example by clipping the bracket mounts 41 into openings 17 provided in the housing 15. In step S5, the guide bracket 41 is engaged by the engagement portion 51 of guide element 50. This may occur concurrently with step S4. Operating element 10 may thus be assembled in a fast and efficient way. It should be clear that the order of the steps may be reversed, that some steps are optional and that some steps may be performed simultaneously.

[0082] 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

[0083]

10	operating element
11	first rotational axis
12	second rotational axis
13	third rotational axis
14	fourth rotational axis
15	housing
16	housing part
17	opening in housing part
20	lever
21	pivotable component of lever
22	shaft hole
30	support assembly
31	cardan frame
32	shaft
33	shaft stub
40	yoke element
41	guide bracket
42	bracket mount
43	axial stop
44	rounded protrusion
45	circular section
50	guide element
51	engagement portion
52	protrusion
53	first engagement member
54	first engagement face
55	second engagement member
56	second engagement face
57	slot
60	rotatable mount
61	latched connection
62	locking tab
63	snap-in hole
70	rotational sensor
71	sensor component
72	sensor component
S1-S5	method steps

Claims

1. An operating element, in particular a joystick, for controlling the operation of a machine, comprising:

- a control lever (20);
- a support assembly (30) that mechanically supports the control lever (20) such that the control lever (20) is pivotable about a first rotational axis (11) and is pivotable about a second rotational axis (12) that is perpendicular to the first rotational axis (11);
- a yoke element (40) that is supported in a housing (15) of the operating element (10) and that is pivotable about a third rotational axis (13), the yoke element (14) being configured to provide a mechanical signal transmission of a pivoting of the control lever (20) about the first rotational axis (11); and
- a guide element (50) mechanically coupled to the control lever (20) to pivot with the control lever (20), wherein the guide element (50) is configured to interact with the yoke element (40) to pivot the yoke element (40) about the third rotational axis (13) when the control lever (20) is pivoted about the first rotational axis (11) and to move relative to the yoke element (40) when the control lever (20) is pivoted about the second rotational axis (12),

wherein the yoke element (40) comprises a guide bracket (41) and the guide element (50) has an engagement portion (51) configured to engage the guide bracket (41) at least from two sides so as to restrict movement of the guide bracket (41) relative to the guide element (50) at least in two opposing directions.

2. The operating element according to claim 1, wherein the engagement portion (51) of the guide element (50) is configured to slide and/or roll along the guide bracket (41) when the control lever (20) is pivoted about the second rotational axis (12).

3. The operating element according to claim 1 or 2, wherein the yoke element (40) comprises a single guide bracket (41) and/or wherein the guide bracket is arranged between portions of the engagement portion that engage the guide bracket.

4. The operating element according to any of the preceding claims, wherein the guide bracket (41) comprises or is a curved rod or a bent wire.

5. The operating element according to any of the preceding claims, wherein the engagement portion (51) has a slit (57), wherein the guide bracket (41) is received in the slit (57).

6. The operating element according to any of the preceding claims, wherein the engagement portion (51) comprises two or more protrusions (52) that protrude from opposite sides towards the guide bracket (41).

7. The operating element according to any of the preceding claims, wherein the engagement portion (51) of the guide element (50) comprises two engagement members (53, 55) extending in an axial direction away from the lever, wherein each engagement member (53) has an engagement face (54) arranged opposite to the engagement face (56) of the other engagement member (55), wherein each engagement face (54, 56) comprises a protrusion (52) that extends towards the engagement face of the other engagement member, the guide bracket (41) being received between the protrusions (52) of both engagement members (53, 55).

8. The operating element according to claim 6 or 7, wherein the protrusions (52) have rounded edges or have a rounded shape and/or have a bulged shape in cross section.

9. The operating element according to any of the preceding claims, wherein the guide element (50) is mounted to the lever (20) by a rotatable mount (60) configured to allow an orientation of the engagement portion (51) relative to the control lever (20) to change.

10. The operating element according to any of the preceding claims, wherein the yoke element (40) comprises a bracket mount (42) at one or at each end of the guide bracket (41), wherein the bracket mount (40) is configured to rotatably mount the guide bracket (41) to a component of the operating element (10), in particular to a housing part (16) of the operating element (10).

11. The operating element according to any of the preceding claims, wherein the yoke element (40), in particular the at least one bracket mount (42), comprises a sensor component (71) of a sensor configured to detect a pivoting of the guide bracket (41) about the third rotational axis (13), the sensor component (71) being coupled to the yoke element (40) to rotate or pivot with the yoke element (40) about the third rotational axis (13).

12. The operating element according to claim 10 or 11, wherein the bracket mount (42) is made of plastic material and is molded to the guide bracket (41), in particular to a bent wire that provides the guide bracket (41).

13. The operating element according to any of the preceding claims, wherein the operating element (10) is configured such that forces acting on the lever (20) are not taken up by the yoke element (40).

14. The operating element according to any of the preceding claims, wherein the support assembly (30) comprises a frame (31), a first rotating suspension (32) that supports the lever in the frame (31) so as to be rotatable about the first rotational direction (11), and a second rotating suspension (33) that supports the frame (31) in a housing (15) of the operating element (10) so as to be rotatable about the second rotational direction (12).

15. A method of manufacturing an operating element, in particular a joystick, comprising:

- providing a control lever (20);
- providing a support assembly (30) and mechanically supporting the control lever (20) by the support assembly (30) such that the control lever (20) is pivotable about a first rotational axis (11) and is pivotable about a second rotational axis (12) that is perpendicular to the first rotational axis (13);
- providing a yoke element (40) and supporting the yoke element (40) in a housing (15) of the operating element (10) such that it is pivotable about a third rotational axis (13), wherein the yoke element (40) is configured to provide a mechanical signal transmission of a pivoting of the control lever (20) about the first rotational axis (11) and wherein the yoke element (40) comprises a guide bracket (41);
- mechanically coupling a guide element (50) to the control lever (20) to pivot with the control lever (20), wherein the guide element (50) is configured to interact with the yoke element (40) to pivot the yoke element (40) about the third rotational axis (13) when the control lever (20) is pivoted about the first rotational axis (11) and to move relative to the yoke element (40) when the control lever (20) is pivoted about the second rotational axis (12); and
- engaging the guide bracket (41) with an engagement portion (51) of the guide element (50) at least from two sides so as to restrict movement of the guide bracket (41) relative to the guide element (50) at least in two opposing directions.

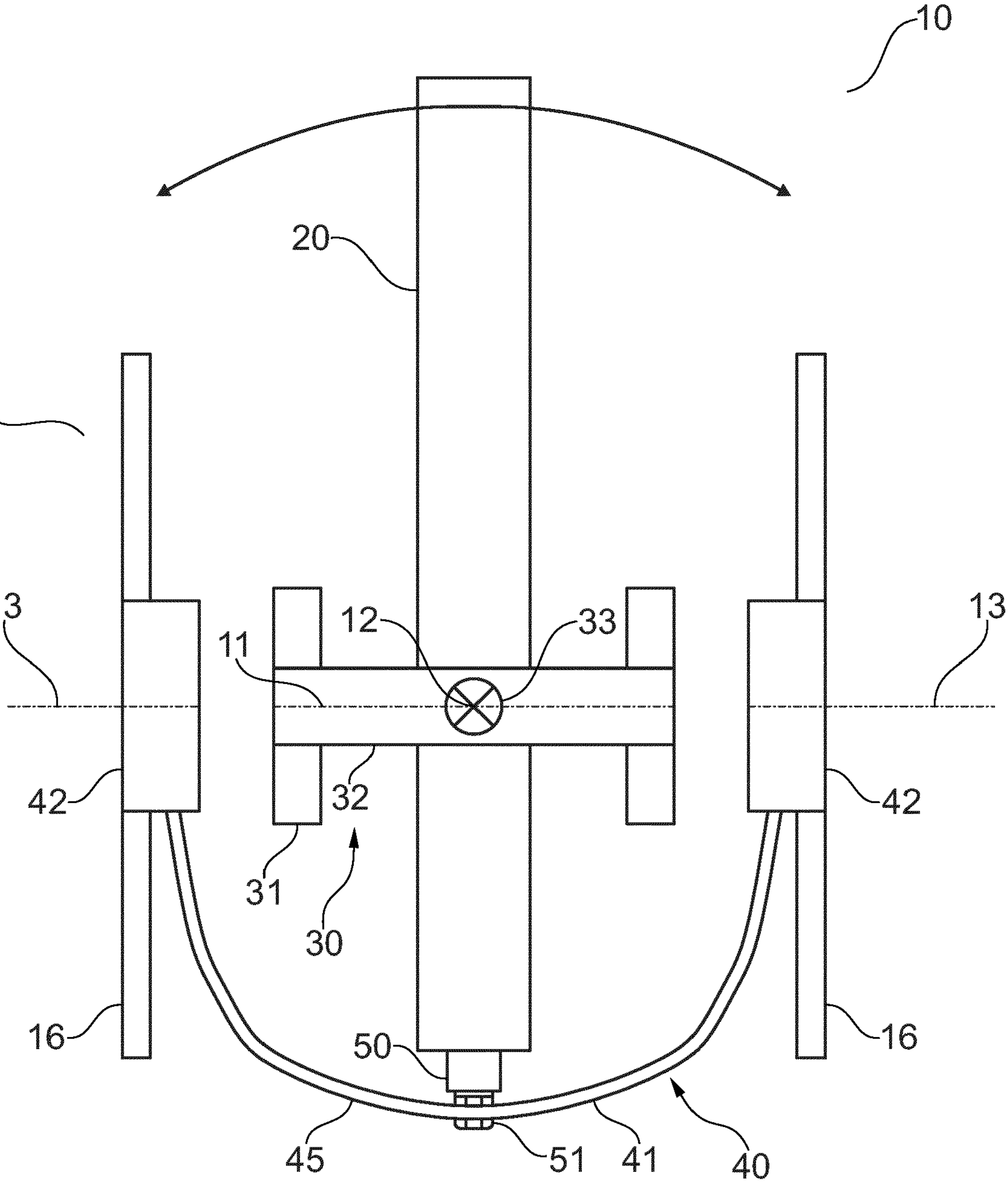

Fig. 1

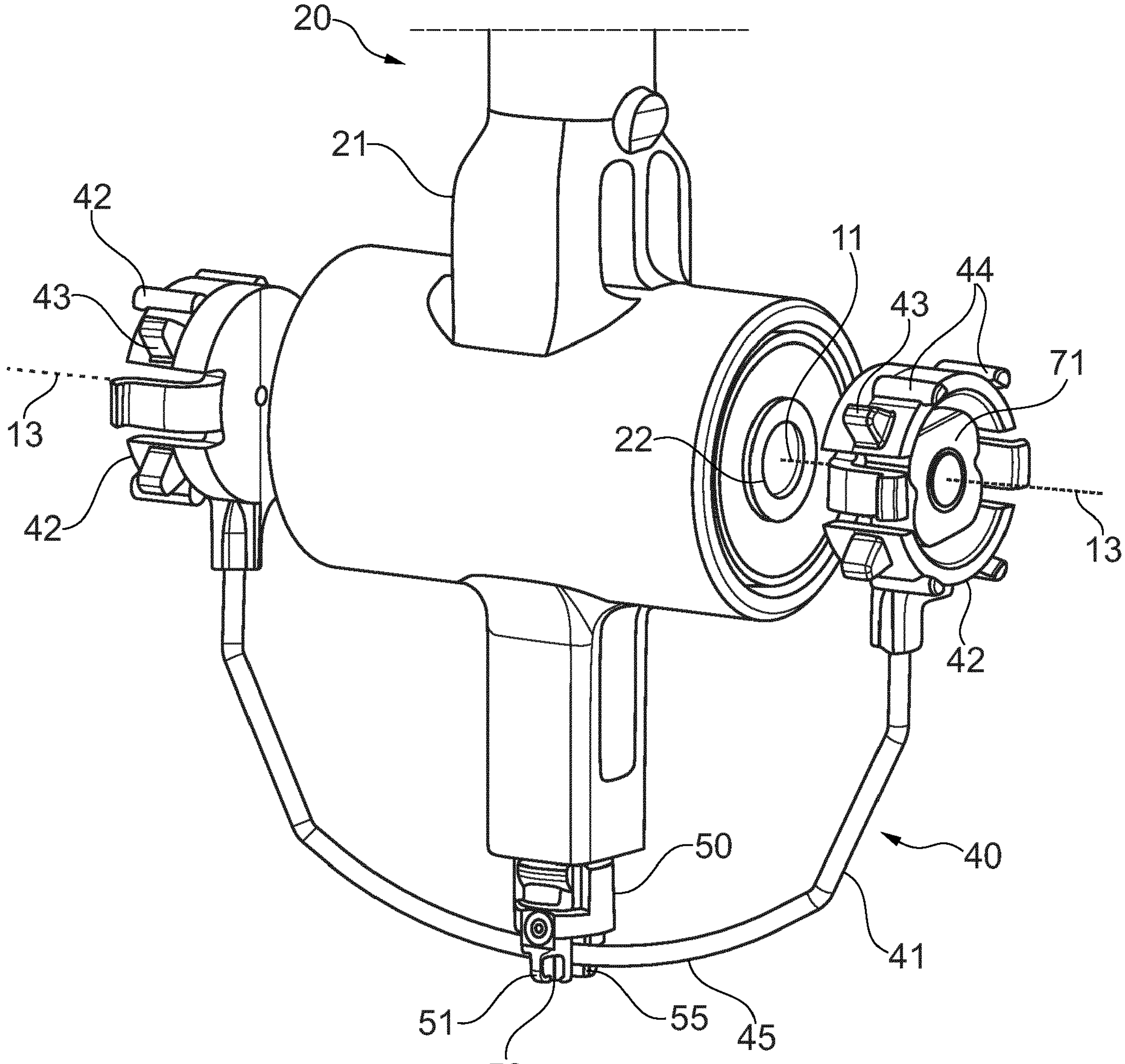

Fig. 2

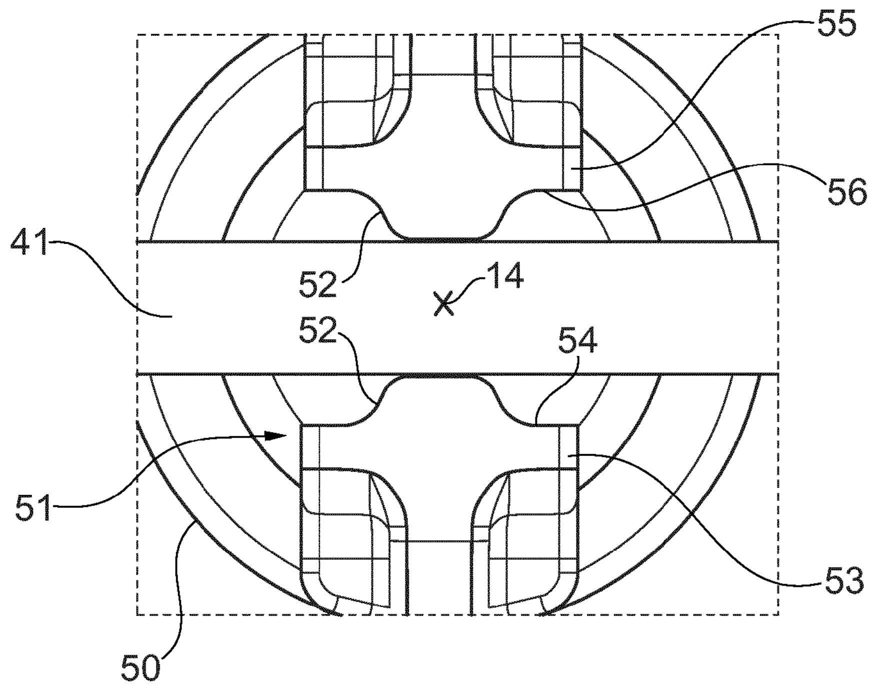

Fig. 3

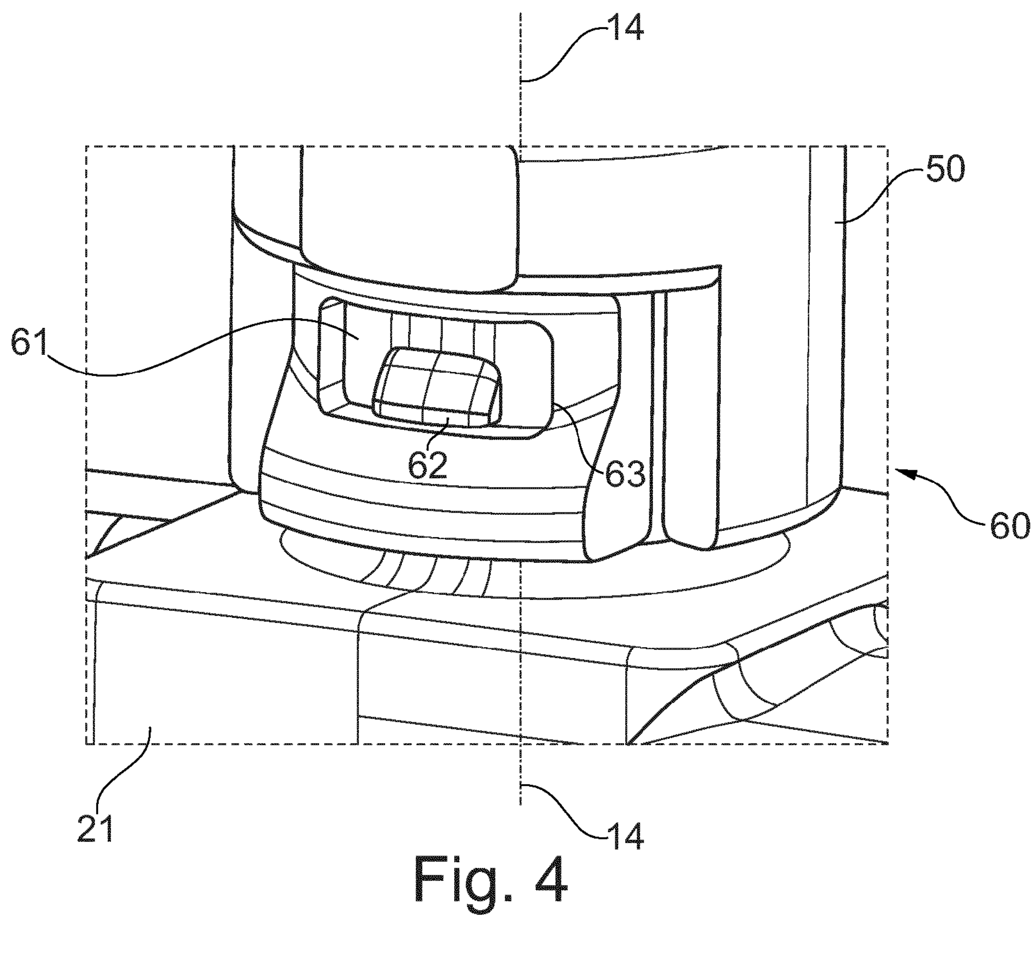

Fig. 4

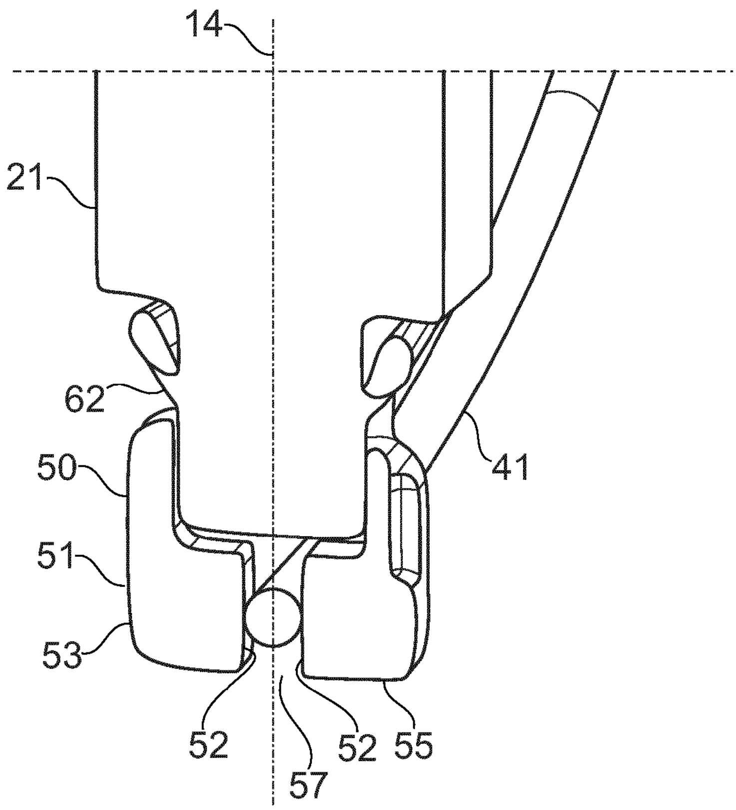

Fig. 5

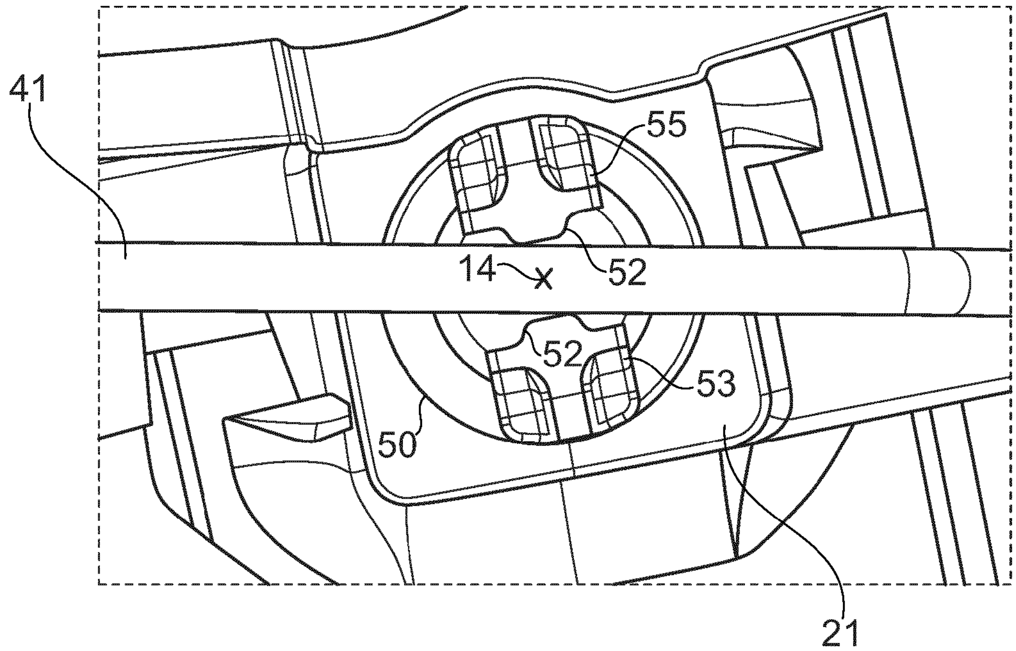

Fig. 6

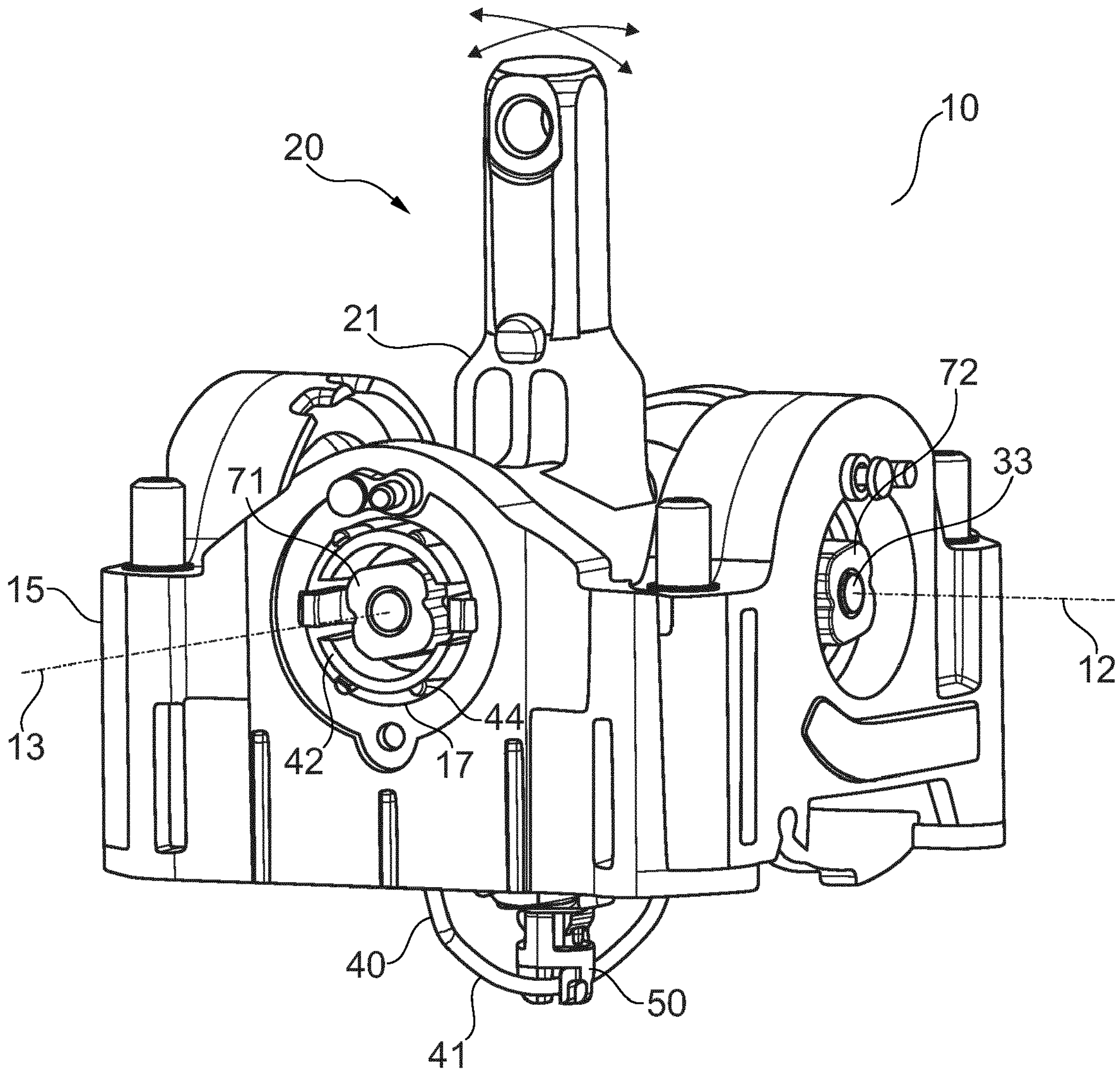

Fig. 7

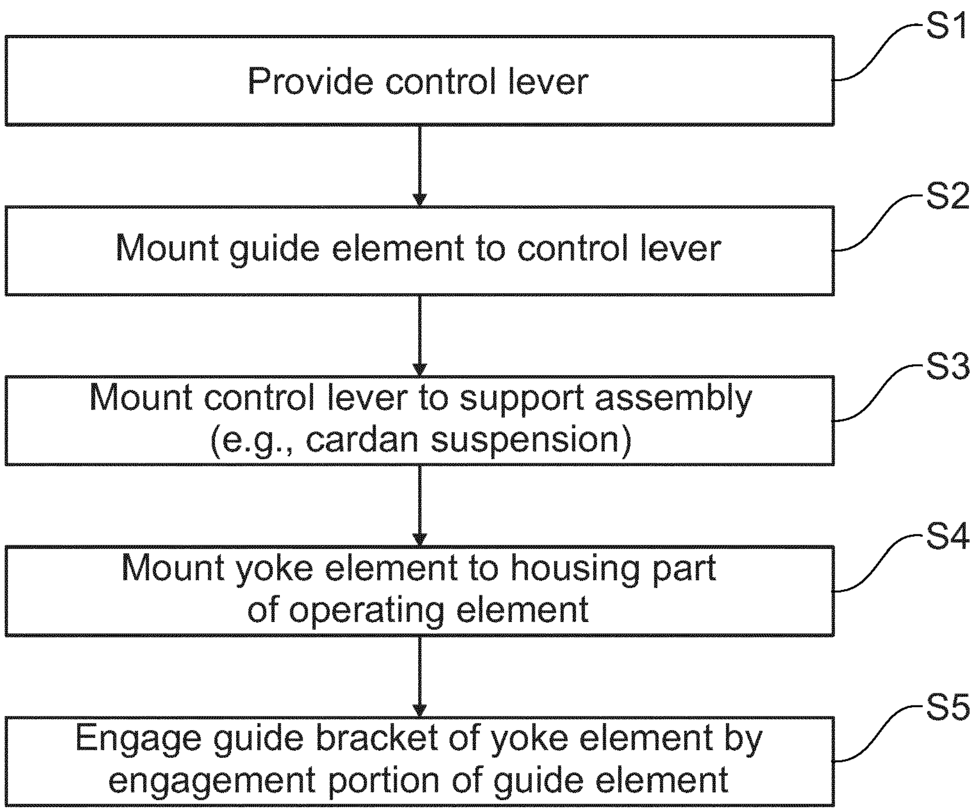
Provide control lever
S1
Mount guide element to control lever
S2
Mount control lever to support assembly (e.g., cardan suspension)
S3
Mount yoke element to housing part of operating element
S4
Engage guide bracket of yoke element by engagement portion of guide element
S5

Fig. 8

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 23 21 7133

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A,D	US 4 763 100 A (WOOD LAWSON A [US]) 9 August 1988 (1988-08-09) * claim 1; figures *	1-15	INV. G05G9/047
A	DE 25 15 096 A1 (GEIGER SIEGFRIED ING GRAD) 21 October 1976 (1976-10-21) * figures 1-4 *	1,15	
A	US 6 222 179 B1 (MIKAN PETER J [US]) 24 April 2001 (2001-04-24) * claim 1; figure 4 *	1,15	
A	US 5 929 846 A (ROSENBERG LOUIS B [US] ET AL) 27 July 1999 (1999-07-27) * figures 8, 18 *	1,15	

TECHNICAL FIELDS SEARCHED (IPC)

G05G

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	22 May 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 21 7133

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.

22-05-2024

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
US 4763100	A	09-08-1988	NONE			
DE 2515096	A1	21-10-1976	NONE			
US 6222179	B1	24-04-2001	NONE			
US 5929846	A	27-07-1999	CA	2237977	A1	29-05-1997
			DE	69631487	T2	13-01-2005
			EP	0870296	A1	14-10-1998
			US	5805140	A	08-09-1998
			US	5929846	A	27-07-1999
			US	6201533	B1	13-03-2001
			US	2001020937	A1	13-09-2001
			US	2004164959	A1	26-08-2004
			WO	9719440	A1	29-05-1997

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

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- US 4763100 A **[0003]**