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(54) Input device with a hollow handle

(57) The input device comprises a support (1) and a movable, hollow handle (2). A column (3) extends from the support into the handle (2), and an elastic coupling comprising a plurality of springs (5a, 5b, 5c) is arranged between the upper end of the column (3) and the handle (2). The position of the handle is determined by a measurement of the inductances of the springs (5a, 5b, 5c). The springs (5a, 5b, 5c) and measuring circuitry are fully enclosed by the handle and thereby protected by it. A plurality of stops within the handle restrict the movements in all degrees of freedom.

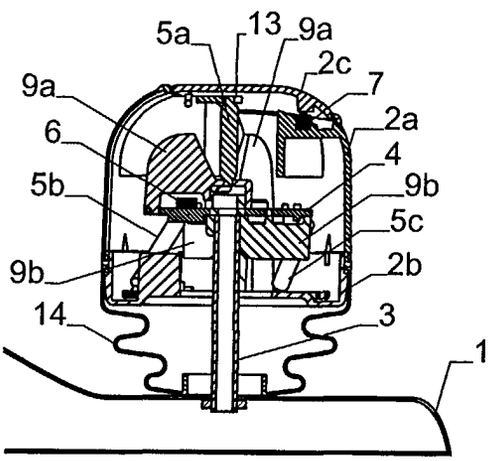

Fig. 2

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Description

[0001] The invention relates to a three dimensional input device according to the preamble of claim 1.

[0002] Such devices are used for controlling computer equipment and other apparatus, such as vehicles and robots.

[0003] WO 98/25193 describes various embodiments of such devices. One of them comprises a static support, a hollow handle and a column affixed to the support and extending into the handle. A plurality of springs form an elastic coupling connecting the support and the handle. The position of the handle is determined by measuring the inductances of the springs.

[0004] The problem to be solved by the present invention lies in providing a device of this type that is more robust.

[0005] This problem is solved by the device of claim 1. By arranging the springs within the hollow handle, they can be protected from the environment. At the same time, the set-up becomes more robust and compact.

[0006] While the handle surrounding the springs protects them mechanically, it can also provide electromagnetic protection if it comprises a conductive shielding.

[0007] In addition to the protection provided by this arrangement, placing the springs within the handle minimizes the torques that the user has to exert during translatory movements of the handle.

[0008] For making the device even more robust, it can be provided with mechanical stops restricting rotations and/or translations along and about vertical and/or horizontal axes. Advantageously, these stops are arranged within the handle, thereby making the arrangement even more compact.

[0009] Further preferred embodiments are described in the dependent claims as well as the following discussion of a preferred embodiment. This discussion makes reference to the annexed figures, which show:

Fig. 1 a side view of an embodiment of the invention,
Fig. 2 a sectional view along line II-II of Fig. 1,
Fig. 3 the cap of the handle alone as seen along the vertical axis from below,
Fig. 4 a view of the cap from above,
Fig. 5 a view of the cap from below,
Fig. 6 the bottom section of the handle alone, and
Fig. 7 the upper end of the columnar structure with plate and arms and with springs connecting the plate to the bottom section of the cap.

[0010] In this text as well as the claims expressions such as "top", "bottom", "upward", "downward", "vertical" and "horizontal" are used. The meaning of these expressions is not defined in respect to gravity but by the mutual arrangement of the handle, column and support of the device, namely we define that the handle is always on top, the support at the bottom and the column extends substantially vertically between them. In other words, even if the device is mounted to a wall or upside down, the handle is understood to be on top and the support at the bottom with the column extending vertically between them.

[0011] Figs. 1 and 2 show a three dimensional input device with six degrees of freedom as it can e.g. be used for controlling a computer. The device comprises a static support 1 and a handle 2. In most applications, support 1 will rest on a surface, such as a table, while handle 2 is operated by the user.

[0012] Handle 2 is hollow and consists of a cap 2a, 2c and a bottom section 2b. The cap 2a, 2c forms the top and central sections of the handle.

[0013] A columnar structure comprises a column 3 and a plate 4. Column 3 is at its lower end fixedly mounted to support 1. The upper end of column 3 is connected to plate 4, which extends transversally, preferably perpendicularly, to column 3. Plate 4 can e.g. be a printed circuit board carrying measuring electronics.

[0014] An arrangement of seven extension coil springs 5a, 5b, 5c... connects the upper end of the columnar structure to the handle. One spring 5a extends vertically and connects the upper end of column 3 with a hook 13 connected to the top of handle 2. Six coil springs 5b, 5c, 5d... connect plate 4 with bottom section 2b (see also Fig. 7). The spring 5a pulls handle 2 down, the springs 5b, 5c, 5d... pull it upward, such that the handle is held in an equilibrium position of the springs. Handle 2 can be moved out of this equilibrium position in three translatory and three rotatory degrees of freedom.

[0015] Springs 5b, 5c, 5d... are non-parallel and there is an unambiguous relation between their lengths and the mutual position of handle 2 and support 1. This allows a determination of the mutual position by measuring the lengths of the springs.

[0016] A detector 6 is arranged within the handle. The detector comprises at least one oscillator, the frequency of which is controlled by the inductance of at least one of the springs 5b, 5c, ..., as well as circuitry for counting the frequency. A suitable circuit is disclosed in Fig. 3 and the corresponding description of WO 98/25193, which are incorporated by reference herein. By counting the frequency of the oscillator, the inductance and therefrom the length of the corresponding spring can be measured. This allows an accurate determination of the position of the handle in all six degrees of freedom.

[0017] The hollow handle 2 encloses all the springs 5a, 5b, 5c..., which protects them from unintentional deformation. Furthermore, the whole inner surface of the handle carries a metal layer forming a conductive shielding (not visible in the drawings), which protects detector 6 and the springs from environmental electromagnetic noise.

[0018] The upper end of columnar structure 3, 4 as well as the handle 2 form a plurality of stops, which restrict movements in all degrees of freedom, thereby preventing the strings from excessive extensions. This is

shown in Figs. 3 - 7, which illustrate the design of the handle and the upper end of the columnar structure 3, 4.

[0019] Handle 2 consists of a cap 2a with a lid 2c arranged therein and the bottom section 2b. Lid 2c is resiliently mounted and acts as button. By pressing lid 2c, a microswitch 7 (see Fig. 2) can be actuated.

[0020] Cap 2a with lid 2c is fixedly connected to bottom section 2b. Cap 2a forms a top section of the handle above columnar structure 3, 4 and a central section of the handle extending around the upper end of columnar structure 3, 4. Bottom section 2b extends towards column 3 and comprises an opening 8 for receiving the same. The upper end of columnar structure 3, 4 has a larger diameter than opening 8, such that an upward movement of handle 2 is restricted by bottom section 2b abutting against parts of the columnar structure 3, 4. Similarly, a downward movement of handle 2 is restricted by the top section of handle 2 abutting against the top parts of the columnar structure.

[0021] The upper end of the columnar structure is formed by plate 4 as well as a plurality of arms 9a, 9b. These arms extend radially away from the vertical axis 10 of the device. They are formed by three vertical walls 9a attached to the top side of plate 4 and three vertical walls 9b attached to the bottom side of plate 4.

[0022] The arms 9a, 9b extend into gaps 11a and 11b between stopper members 12a, 12b of handle 2, which are shown in Figs. 3 and 6. The stopper members are formed by three pairs of upper, vertical walls 12a mounted to the top section of the handle and three lower, vertical projections 12b mounted to its bottom section 2b. Each pair of upper, vertical walls 12a encloses an angle of approximately 120° with its apex facing inwards.

[0023] As can best be seen from Fig. 2, the outer contours of the arms 9a, 9b are at a fixed distance from the inner surface of handle 2 when the latter is in its equilibrium position. When translating handle 2 in any direction, the arms 9a, 9b alone will already restrict all translatory degrees of freedom. In addition to this, opening 8 also restricts horizontal translatory degrees of freedom, while the stopper members 12a, 12b restrict vertical translatory degrees of freedom as well as, together with the arms 9a, 9b, any rotatory degrees of freedom about vertical axis 10. Furthermore, horizontal tilting is restricted by arms 9a, 9b abutting against handle 2 or stopper members 12a, 12b or opening 9 abutting against plate 4 or column 3 respectively.

[0024] As can be seen by Figs. 1 and 2, an expandable bellows protecting opening 8 is arranged around column 3 between handle 2 and support 1. It is made of flexible material with a plurality of horizontal folds and has substantially frustoconical shape with a wider and a narrower end 14a, 14b respectively. The wider end 14a extends around bottom section 2b of handle 2, while the narrower end 14b rests loosely against support 1 and can be rotated against it about vertical axis 10. Placing the narrower end 14b loosely against support 1 reduces the angular momentum generated by friction during a rotation between handle 2 and support 1.

Claims

1. A three dimensional input device comprising

a static support (1),
a hollow handle (2) movable in respect to said support (1),
a columnar structure (3, 4) fixed at a first end to said static support (1) and extending into said handle (2),
an elastic coupling comprising a plurality of springs (5a - 5e) extending between a second end of said columnar structure (3, 4) and said handle (2), and
a detector for detecting a position of said handle (2) from inductances of said springs,

characterized in that all said springs are arranged within said hollow handle (2).

2. The input device of claim 1 wherein said handle (2) comprises a conductive shielding for shielding said springs from electromagnetic noise.

3. The input device of claim 2 wherein said shielding comprises a conductive layer arranged on said handle (2).

4. The input device of any one of the preceding claims wherein said columnar structure (3, 4) defines a vertical axis extending between said support (1) and said handle (2) and wherein said input device further comprises mechanical stops (8, 9a, 9b, 12a, 12b) within said handle (2) for restricting at least one of the following movements between handle (2) and said columnar structure (3, 4):

rotation about said vertical axis,
rotation about horizontal axes perpendicular to said vertical axis,
translation along said vertical axis, and
translation perpendicular to said vertical axis.

5. The input device of claim 4 wherein said stops comprise

a plurality of stopper members (12a, 12b) arranged on said handle (2) and
a plurality of arms (9a, 9b) affixed to said second end and extending radially away from said vertical axis into gaps (11a, 11b) between said stopper members,

wherein a rotation of said handle (2) around said vertical axis is restricted by said arms (9a, 9b)

abutting against said stopper members (12a, 12b) and a translation perpendicular to said vertical axis is restricted by said arms (9a, 9b) abutting against said handle (2) and/or said stopper members (12a, 12b) abutting against said upper end of said columnar structure (3, 4).

6. The input device of claim 5 wherein at least part of said arms (9a, 9b) are extending axially along said vertical axis upwards from said column structure such that a downward translation of said handle (2) along said vertical axis towards said support (1) is restricted by said handle (2) abutting against said arms.

7. The input device of any one of the claims 5 or 6 wherein said columnar structure (3, 4) comprises a plate (4) arranged at said second end transversally to said vertical axis and wherein said arms (9a, 9b) are arranged on an first and a second side of said plate (4).

8. The input device of any one of the preceding claims wherein said handle (2) comprises

a top section, a central section and a bottom section (2b), wherein said top section is arranged above said second end, said central section around said second end, and said bottom section (2b) extends towards said column structure (3, 4) between said first and second ends, and
an opening (8) in said bottom section (2b), wherein said column structure (3, 4) extends through said opening (8), and

wherein said second end has a diameter exceeding a diameter of said opening (8) such that said bottom section limits a upward movement of said handle (2).

9. The input device of any one of the claims 5 to 7 and of claim 8 wherein said stopper members comprise projections (12b) extending upwards from said bottom section (2b) between at least part of said arms (9a, 9b) to restrict rotation about said vertical axis.

10. The input device of any one of the claims 8 or 9 wherein a plurality of said springs (9b - 9e) is arranged between said second end and said bottom section.

11. The input device of any one of the claims 8 to 10 wherein at least one spring (9a) is arranged between said second end and said top section.

12. The input device of any one of the preceding claims wherein said handle (2) is movable in six degrees of freedom in respect to said support (1).

13. The input device of any one of the preceding claims further comprising an expandable bellows (14) extending between said handle (2) and said support (1), wherein said bellows has substantially frustoconical shape with a wider (14a) and a narrower (14b) end, wherein said wider end (14a) is affixed to said handle (2), and in particular wherein the narrower end (14b) rests rotatively free against said support (1).

14. The input device of any one of the preceding claims wherein at least part of the detector (6) is arranged in the handle (2),

and in particular wherein the detector (6) comprises at least one oscillator the frequency of which is given by the inductance of at least one of said springs, wherein the oscillator is arranged within the handle (2).

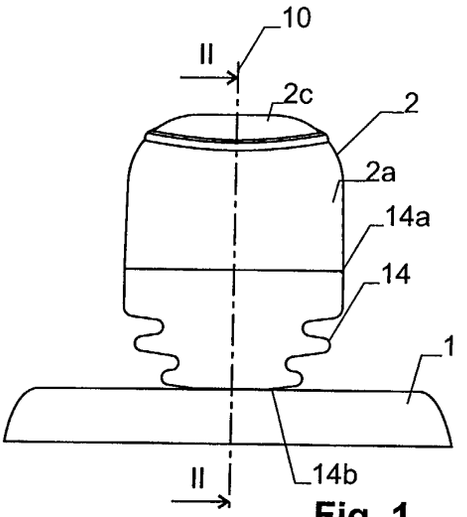

Fig. 1

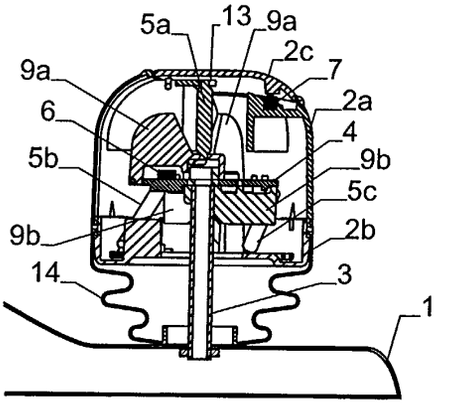

Fig. 2

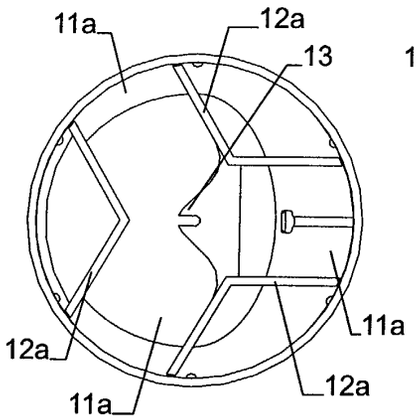

Fig. 3

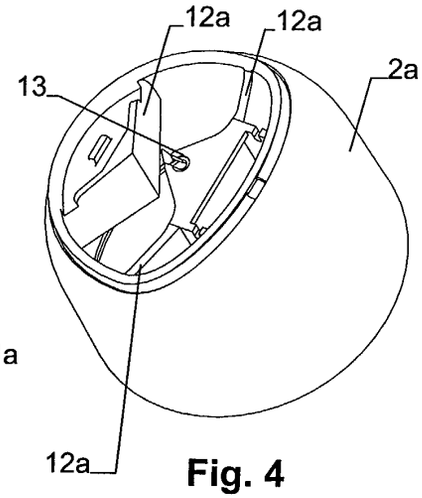

Fig. 4

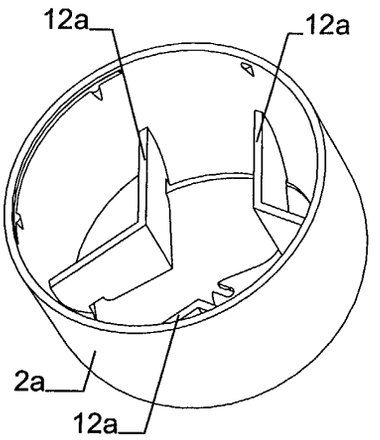

Fig. 5

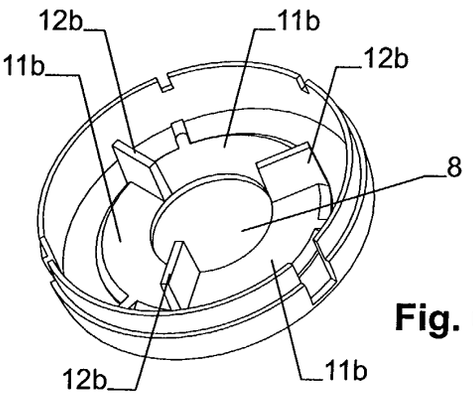

Fig. 6

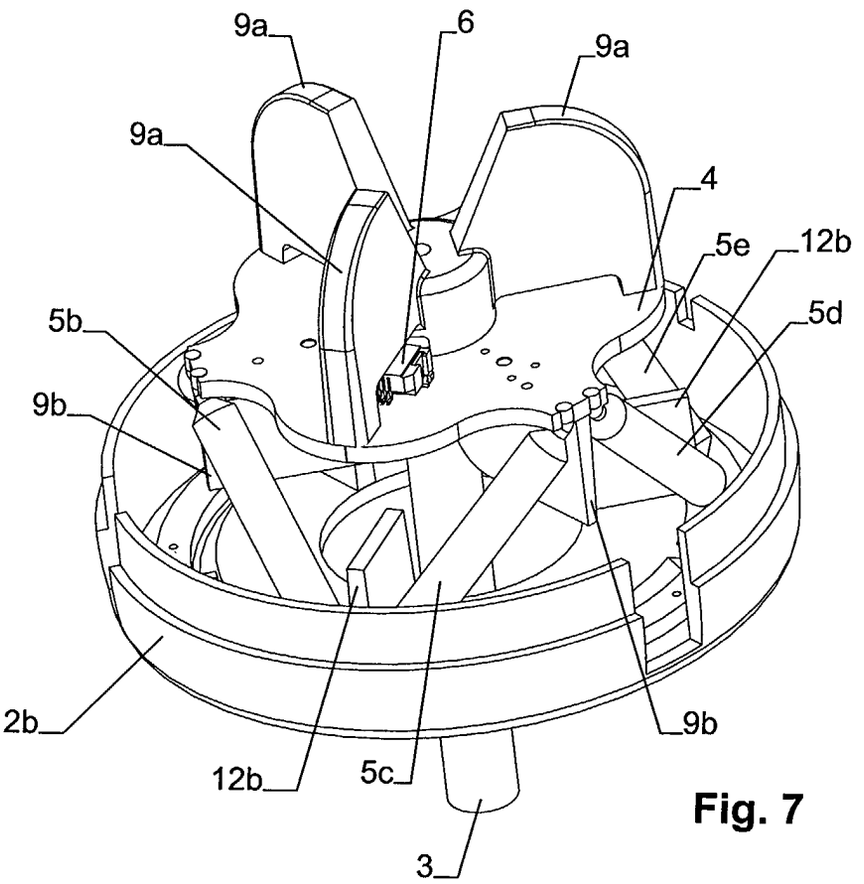

Fig. 7

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Application Number
EP 01 11 8763

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			TECHNICAL FIELDS SEARCHED (Int.Cl.7) G05G A63F G06K B64C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	19 October 2001	J. Giráldez Sánchez

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