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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
27 May 2021 (27.05.2021)

WIPO | PCT

(10) International Publication Number
WO 2021/099345 A1

(51) International Patent Classification:
B62D 1/04 (2006.01) *B62D 1/06* (2006.01)

(21) International Application Number:
PCT/EP2020/082467

(22) International Filing Date:
18 November 2020 (18.11.2020)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
10 2019 131 605.7
22 November 2019 (22.11.2019) DE

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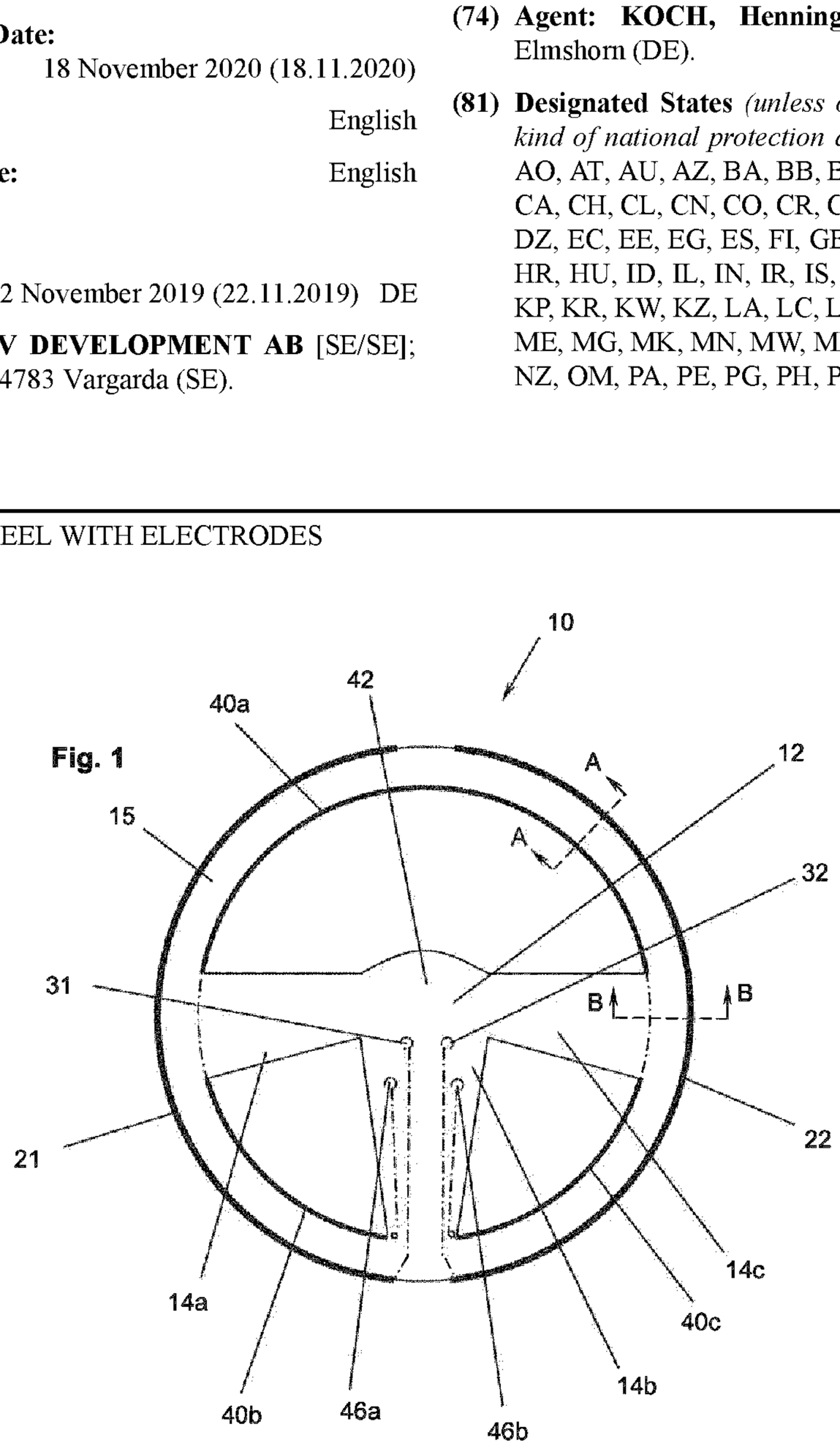
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS,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

(54) Title: STEERING WHEEL WITH ELECTRODES

Fig. 1



(57) Abstract: A steering wheel (10) for a vehicle is described. This steering wheel (10) comprises a hub (12), a rim (15) comprising a rim body and at least one spoke (14a-14c) connecting the rim (15) to the hub (12). A first area of the surface of the rim (15) is in form of or comprises a main electrically conductive element (21, 22) that comes into conducting contact to a first area of the skin of a hand of the driver when the hand of the driver holds the rim (15) at the position of the main electrically conductive element (21, 22). This main electrically conductive element (21, 22) is in electrical contact to a main contact point (31, 32) and serves for measuring electrical properties of the driver. In order to improve the quality of the measurement, a second area of the surface of the rim (15) being spaced from the first area, but positioned such that it comes into conducting contact to a second area of the skin of the hand of the driver when the hand of the driver holds the rim (15) at the position of the main electrically conductive element (21, 22), is in form of or comprises

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

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

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

an additional electrically conductive element (40a, 40b, 40c) being in electrical contact to a grounding point (46a, 46b) (Fig. 1).

Steering wheel with electrodes

Description

The invention relates to a steering wheel for a vehicle according to the preamble of claim 1 and to vehicle comprising such a steering wheel according to claim 14.

All passenger cars, trucks, busses and the like have a steering wheel. In nearly all cases this steering wheel comprises a hub, a rim and at least one spoke connecting the rim to the hub. Often, the rim is comprised of a rim body and a cover being wrapped around the rim body. This cover is often in form of a piece of leather or artificial leather.

For example from generic US 2012/0006 147 A1 it is known to provide parts of the surface of the rim of a steering wheel with electrodes and to connect those electrodes to a controller of the vehicle. These electrodes are partially in form of conductive threads. From this document it is also known to provide two separated electrodes in such a way that when the driver grabs the steering wheel with both hands, one hand is in contact to a first electrode and the other hand is in contact to a second electrode. By means of those electrodes the controller can measure certain electrical properties of the driver and can use the same, for example for evaluating the driver's condition.

Starting from this prior art it is the object of the invention to improve a steering wheel in such a way that the quality of the measurement can be improved.

This task is solved by a steering wheel with the features of claim 1. A vehicle comprising such a steering wheel and a controller is defined in claim 14.

As is known from generic US 2012 006 147 A1, a first area of the surface of the rim is in form of or comprises a main electrically conductive element that comes into

conducting contact to a first area of the skin of a hand of the driver when the hand of the driver holds the rim at the position of the main electrically conductive element.

It has been found out that the quality of the electrical measurement can be improved when at least one hand of the driver is grounded during the measurement. So, a second area of the surface of the rim being spaced from the first area, but positioned such that it comes into conducting contact to a second area of the skin of the hand of the driver when the hand of the driver holds the rim at the position of the main electrically conductive element, is in form of or comprises an additional electrically conductive element being in electrical contact to a grounding point.

In a preferred geometry, the main electrically conductive element is located on the radially outer side of the rim and that the additional electrically conductive element is located on the radially inner side of the rim. This has the advantage that the main electrically conductive element and the additional electrically conductive element have an optimum distance from one another and that the main electrically conductive element is optically not dominant on the front side of the rim that faces the driver.

Especially in the case of the just described geometry, the additional electrically conductive element can be in form of at least one seam securing a cover to the rim body. In this case this seam comprises at least one electrically conductive thread being connected to the grounding point. In this case the additional electrically conductive element has a double function. The advantage of this embodiment is to provide a grounding invisible for the driver.

It is preferred to design this seam such that the cover is tensioned around the rim body by means of this seam. For this purpose, the seam comprises a first stitching line consisting of a first thread, a second stitching line extending along to the first stitching line, said second stitching line consisting of a second thread, and a connecting thread connecting the first thread to the second thread. At least one of these threads needs to be conductive, and it is especially advantageous if the

connecting thread is conductive. The first stitching line usually extends along a first edge of the cover and the second stitching line extends along a second edge of the cover. The advantage of the embodiment in which the three thread are conductive is that it improves the functional safety by having three threads which are grounded in a simple way; breakage of one, two or three threads does not necessarily lead to a loss of the function. Even if a three thread stitching is preferred, other seam configurations can be used.

Because the radially inner side of the rim is usually divided into sections by the spokes, it is often necessary to provide at least two seam sections are provided, each of them could comprise a first stitching line with a first thread and a second stitching line with a second thread. In order to ease the production, it is preferred to use a common connecting thread for both seam sections in this case. Between the two seam sections the common connecting thread can be located inside a groove in the rim body so that it cannot be felt by the driver's hand.

As it has already been mentioned, the connecting thread can be used to tension the cover around the rim body. For this purpose it is preferred that the at least one end of the connecting thread is held by a tensioning element, which preferably also constitutes a grounding point.

The main electrically conductive element can be a rigid part, especially being comprises of a molded plastic part and a conductive coating.

Best measurement results can be achieved if two main electrically conductive elements are provided, namely a first main electrically conductive element and a second main electrically conductive element, especially when the main electrically conductive elements are positioned such that that when the left hand of the driver holds the rim on the left side and the right hand of the driver holds the rim on the right side, the first main conductive element and the additional conductive element are in electrical conducting contact to the left hand and the second main conductive element and the additional conductive element are in electrical conductive contact to the right hand. In this case it is preferred that each main electrically

conductive element is electrically connected to a separate contact point and each contact point is electrically connected to a separate input of a controller of the vehicle.

The invention will now be described by means of a preferred embodiment in view of the figures. The figures show:

Figure 1 a schematic plan view onto a steering wheel as it is basically seen by the driver,

Figure 2 the grounding of the grounding points of Figure 1 in a schematic representation,

Figure 3 a controller being connected to the main contact points of Figure 1, also in a schematic representation,

Figure 4 a cross sectional view taken along plane A-A in Figure 1,

Figure 5 a plan view onto a detail of Figure 4 from direction R_1,

Figure 6 a sectional view taken along plane B-B in Figure 1,

Figure 7 a plan view onto a detail of Figure 6 from direction R_2, but without a cover, and

Figure 8 the tensioning element of a grounding point and an end of a common connection thread.

The invention is now described by means of a preferred embodiment. It should be noted that all figures are strongly schematic and not necessarily drawn to scale. In the cross sectional views of Figures 4 and 6 some elements are drawn with a distance to other elements for clarity reasons, but it should be noted that some ele-

ments are of course in contact to one another. In Figure 1, not visible elements are shown in broken lines.

Figure 1 shows a steering wheel 10. As usual, this steering wheel 10 comprises a hub 12, a rim 15 and spokes (here three spokes 14a to 14c) connecting the rim 15 to the hub 12. As will be described later, the rim 15 comprises a rim body 16 and a cover 19 covering the rim body 16. The cover is often made of leather or artificial leather.

Two main electrically conductive elements 21, 22 are provided at the outer surface of the rim 15 at radially outer positions. These two main electrically conductive elements 21, 22 are also referred to as first and second electrodes 21, 22. In the embodiment shown these electrodes 21, 22 are placed onto the cover 19. Preferably those two electrodes 21, 22 are molded plastic parts with a conductive coating. Both electrodes 21, 22 extends almost from the 6 o´clock to the 12 o´clock position, but gaps are provided on the 6 o´clock and on the 12 o´clock position, such that the two electrodes are not electrically connected to one another. If the driver grabs the steering wheel with both hands when driving straight on, an area of the skin of the left hand is in contact to the first electrode 21 and an area of skin of the right hand is in contact to the second electrode 22.

The left electrode 21 is electrically connected to a first main contact point 31 and the second electrode 22 is electrically connected to a second main contact point 32. As it is schematically shown in Figure 3, the first main contact point 31 is connected to a first input 51 of a controller 50 and the second main contact point 32 is in electrically contact to a second input 52 of this controller 50. This controller can be positioned on the steering wheel or at another place of the vehicle.

According to the invention, a grounding is provided on the steering wheel such that when a hand that grabs the steering wheel and is in contact to one of the electrodes 21, 22 it is also in contact to this grounding. This grounding is connected to the electrical vehicle ground via grounding points 46a, 46b (Figure 1, Figure 2). Depending of the grounding configuration, only one grounding point 46a, 46b

may be sufficient. Off course, there is only one vehicle ground such that grounding points 46a and 46b are at the same electric potential.

In the embodiment shown this grounding is in form of a conductive seam being placed at the radially inner surface of the rim 15. Because in the shown embodiment three spokes 14a to 14c are provided, this conductive seam is separated into three sections 40a to 40c. Of course, these three sections could also be three completely separate seams, but in case of a single common thread is provided for all sections (this will be described in detail later), the three sections are looked at as belonging to one seam.

An embodiment of the structure of the sections 40a - 40c of the conductive seam is now described in detail using the example of the first section 40a. The other sections can be designed identically.

As it is shown in Figures 4 and 5 a first thread 41 extends along a first edge 19a of the cover 19 and thus forms a first stitching line, and a second thread 42 extends along the second edge 19b of the cover and thus forms a second stitching line. These two stitching lines can be formed on the cover before its wrapping on the rim body 16. A connection thread, here a common connecting thread 44 connects the first thread 41 and the second thread 42 in a zigzag way. At least this common connecting thread 44 is electrically conductive and has an electrically conductive surface. This common connecting thread 44 can for example consists of a silver coated plastic thread. The plastic can for example be made of polyamide.

As it is shown in Figures 6 and 7, the sections of this common connecting thread 44 between the sections 40a to 40c of the conductive seam can be placed in grooves 18 extending into the rim body 16. By this means, this common connecting thread 44 is precisely guided. An additional advantage is that these sections of the common connecting thread 44 cannot be felt under the cover 19. In order to secure the common connecting thread 44 in the grooves 18, a wall 18a can extend through each groove 18 with the common connecting thread 44 extending

through this wall 18a. This wall 18a can be so thin that it can be stitched through during the sewing process.

One end or preferably both ends of the common connecting thread 44 are each connected to a grounding point 46a, 46b as it has already been described in view of Figures 1 and 2. The advantage to have both ends connected to the grounding point is to keep the grounding of the driver all along the rim even if the common connecting thread 44 is cut in one point during the vehicle life. At least one of these grounding points 46a, 46b is in form of a tensioning element as shown in Figure 8. This tensioning element 48 is basically in form of a swirl of an electric guitar, wherein an end of a common connecting thread 44 extends through a hole or a slit in the body of this tensioning element. This tensioning element 48 is connected to the body of the steering wheel in a swiveling manner such that by turning the tensioning element, the common connecting thread 44 is tensioned. By connecting both ends of the common connecting thread 44 to a grounding point 46a, 46b the electrical resistance is reduced and additionally the safety is enhanced because of the redundancy.

A first alternative to the tensioning element 48 is to attach one or both ends of the connecting thread 44 with a knot to a washer or terminal being connected to the ground. In order to secure the thread before the knot, the thread can be perforated through the rim body 16 when it is at least partly made of foam (PU foam for example).

A second alternative to the to the tensioning element 48 is to perforate with one or both ends of the connecting thread a piece of conductive fabric connected to the ground; the connection to the ground can be made by any way like crimping onto a terminal, brazing of a conductive wire. Advantageously, this piece of conductive fabric is part of another electric device wrapped on the rim like a capacitive sensor or a heating element. The grounding is simplified as all the electric functions of this electric device are connected in one time with one plug to the vehicle.

Turning back to Figure 4 one can see an example of how the electrodes (here the second electrode 22) can be attached to the rim body 16. A conductive pin 34 ex-

tends from this electrode 22 into a conductive bushing 17 being located inside the rim body 16. This conductive bushing 17 is in electrical contact to a conductor 36 extending to one of the main contact points, here the second main contact point 32. The whole part being comprised of the electrode and the pin can be a one-pieced molded plastic part with a conductive coating. Additionally, glue can be applied for example between the electrode and the cover 19.

One can see that providing the grounding does not cause a substantial amount of extra work, since the cover needs to be secured to the rim body anyway. So, the benefit of the grounding is gained at low cost.

List of reference signs

10	Steering wheel
12	hub
14a-c	spoke
15	rim
16	rim body
17	bushing
18	groove
18a	wall in groove
19	cover
19a, b	edge
21	first main electrically conductive element (first electrode)
22	second main electrically conductive element (second electrode)
31	first main contact point
32	second main contact point
34	pin
36	conductor
40a-40c	sections of additional electrically conductive element (conductive seams)
41	first thread
42	second thread
44	common connecting thread
46a, b	grounding point
48	tensioning element of grounding point
50	controller
51	first input
52	second input

Claims

1. Steering wheel (10) for a vehicle, said steering wheel (10) comprising
a hub (12),
a rim (15) comprising a rim body (16) and
at least one spoke (14a-14c) connecting the rim (15) to the hub (12),
wherein a first area of the surface of the rim (15) is in form of or comprises a main electrically conductive element (21, 22) that comes into conducting contact to a first area of the skin of a hand of the driver when the hand of the driver holds the rim (15) at the position of the main electrically conductive element (21, 22), said main electrically conductive element (21, 22) being in electrical contact to a main contact point (31, 32),
characterized in that
a second area of the surface of the rim (15) being spaced from the first area, but positioned such that it comes into conducting contact to a second area of the skin of the hand of the driver when the hand of the driver holds the rim (15) at the position of the main electrically conductive element (21, 22), is in form of or comprises an additional electrically conductive element (40a, 40b, 40c) being in electrical contact to a grounding point (46a, 46b).

2. Steering wheel according to claim 1, characterized in that the main electrically conductive element (21, 22) is located on the radially outer side of the rim (16) and that the additional electrically conductive element (40a-40c) is located on the radially inner side of the rim (16).

3. Steering wheel according to claim 1 or claim 2, characterized in that the additional electrically conductive element (40a-40c) is at least one seam securing a cover (19) to the rim body (16), said seam comprising at least one electrically conductive thread, wherein it is preferred that both ends of the at least one electrically conductive thread are in electrical contact to a grounding point (46a, 46b).

4. Steering wheel according to claim 3, characterized in that the at least one seam comprises
a first stitching line consisting of a first thread (41),
a second stitching line extending along to the first stitching line, said second stitching line consisting of a second thread (42), and
a connecting thread (44) connecting the first thread (41) to the second thread (42),
wherein at least one of the threads is conductive and wherein it is preferred that all threads are conductive.

5. Steering wheel according to claim 4, characterized in that
at least two seam sections are provided, each seam section comprising a first stitching line with a first thread (41) and a second stitching line with a second thread (42) and
a common connecting thread (44) for both seam sections is provided.

6. Steering wheel according to claim 5, characterized in that between the two seam sections the common connecting thread (44) is at least partially located inside a groove (18) in the rim body (16).

7. Steering wheel according to claim 6, characterized in that a wall (18a) extends through the groove (18) and the common connecting thread (44) extends through said wall (18a).

8. Steering wheel according to one of the claims 4 to 7, characterized in that at least one end of the connecting thread (44) is held by a tensioning element (48), which preferably also constitutes a grounding point (46a, 46b).

9 Steering wheel according to one of the preceding claims, characterized in that the main electrically conductive element (21, 22) is a rigid part.

10. Steering wheel according to claim 9, characterized in that the rigid part comprises a molded plastic part and a conductive coating.

11. Steering wheel according to one of the preceding claims, characterized in that two main electrically conductive elements are provided, namely a first main electrically conductive element (21) and a second main electrically conductive element (22).

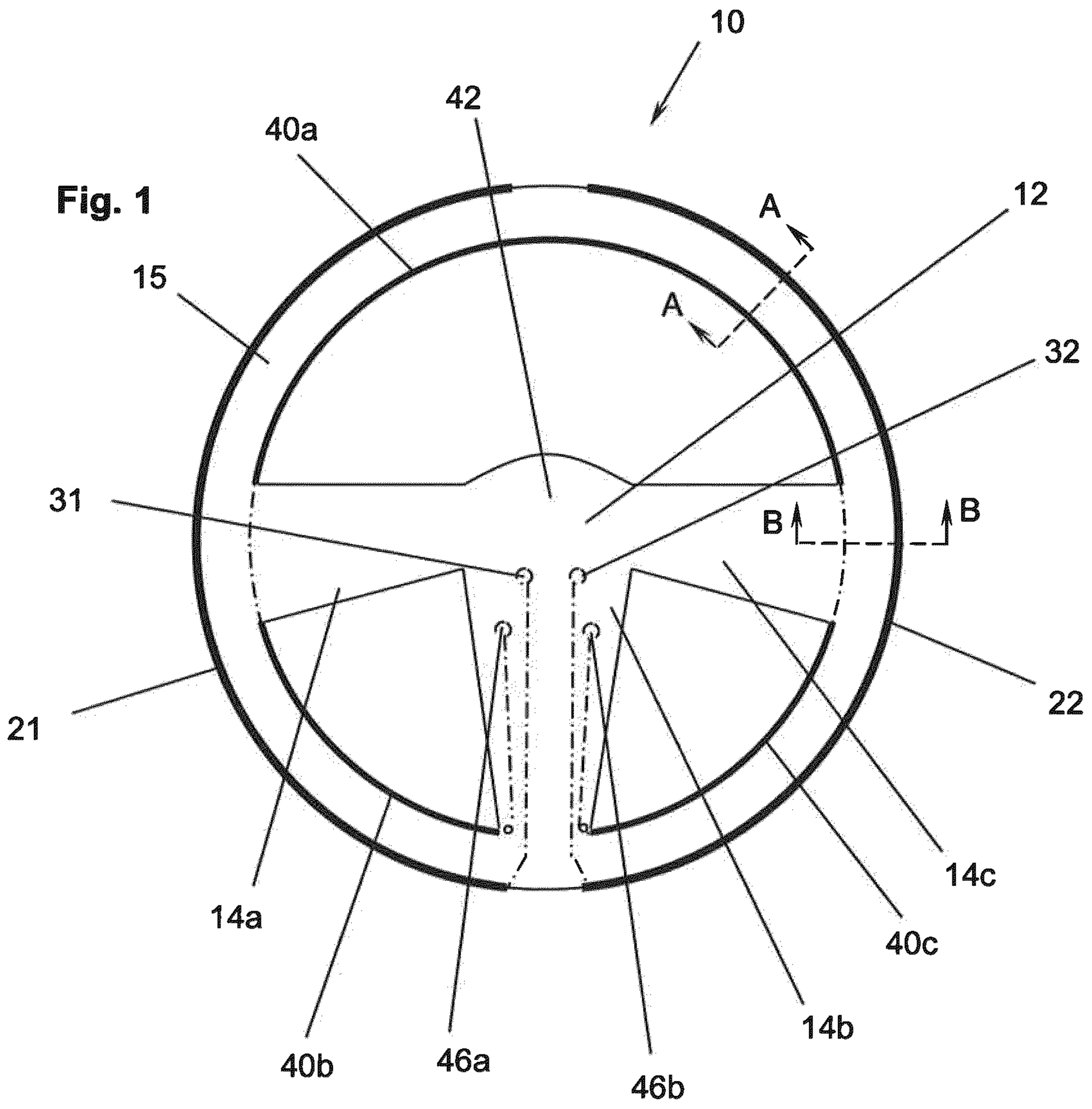
12. Steering wheel according to claim 11, characterized in that the main electrically conductive elements (21, 22) are positioned such that that when the left hand of the driver holds the rim (16) on the left side, and the right hand of the driver holds the rim (16) on the right side, the first main conductive element (21) and the additional conductive element (40a, 40b) are in electrical conducting contact to the left hand and the second main conductive element (22) and the additional conductive element (40a, 40c) are in electrical conducting contact to the right hand.

13. Steering wheel according to claim 12, characterized that the first main electrically conductive element (21) is in electrical contact to a first main contact point (31) and that the second main electrically conductive element (22) is in electrical contact to a second main contact point (32).

14. Vehicle comprising a steering wheel (10) according to one of the preceding claims, wherein the main contact point (40, 42) is electrically connected to an input (51, 52) of a controller (50) of the vehicle.

15. Vehicle according to claim 14 as long as referring to claim 13, characterized that the main contact points (31, 32) are connected to different inputs (52, 52) of the controller (50).

Fig. 1



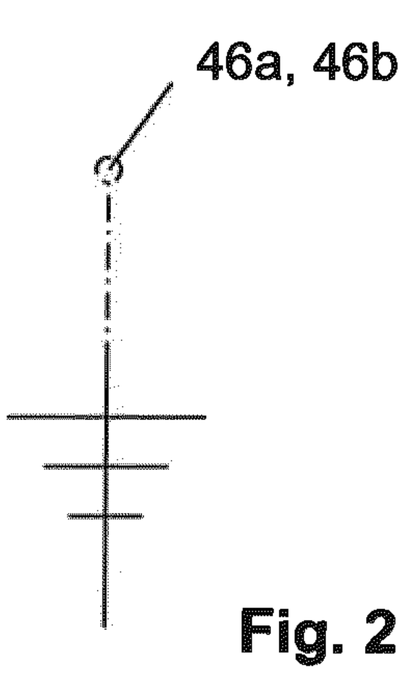


Fig. 2

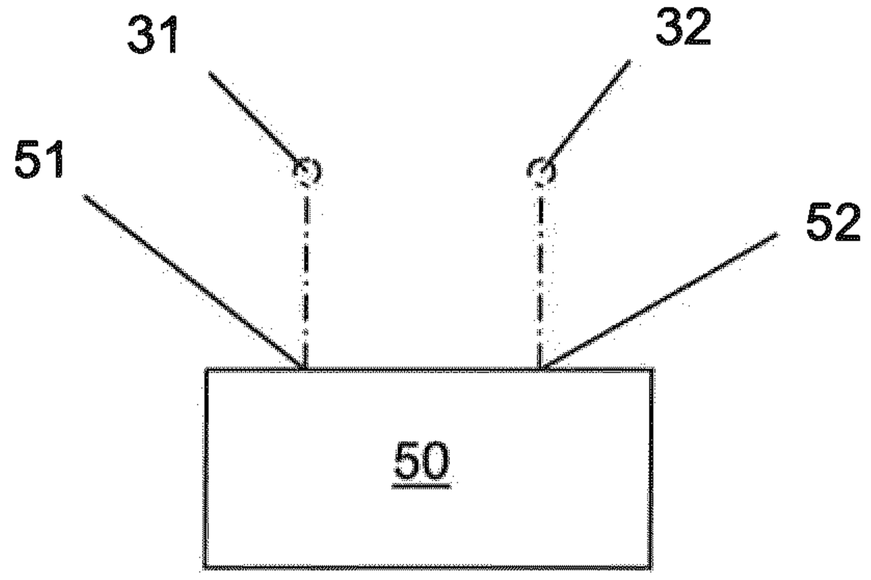


Fig. 3

Fig. 4

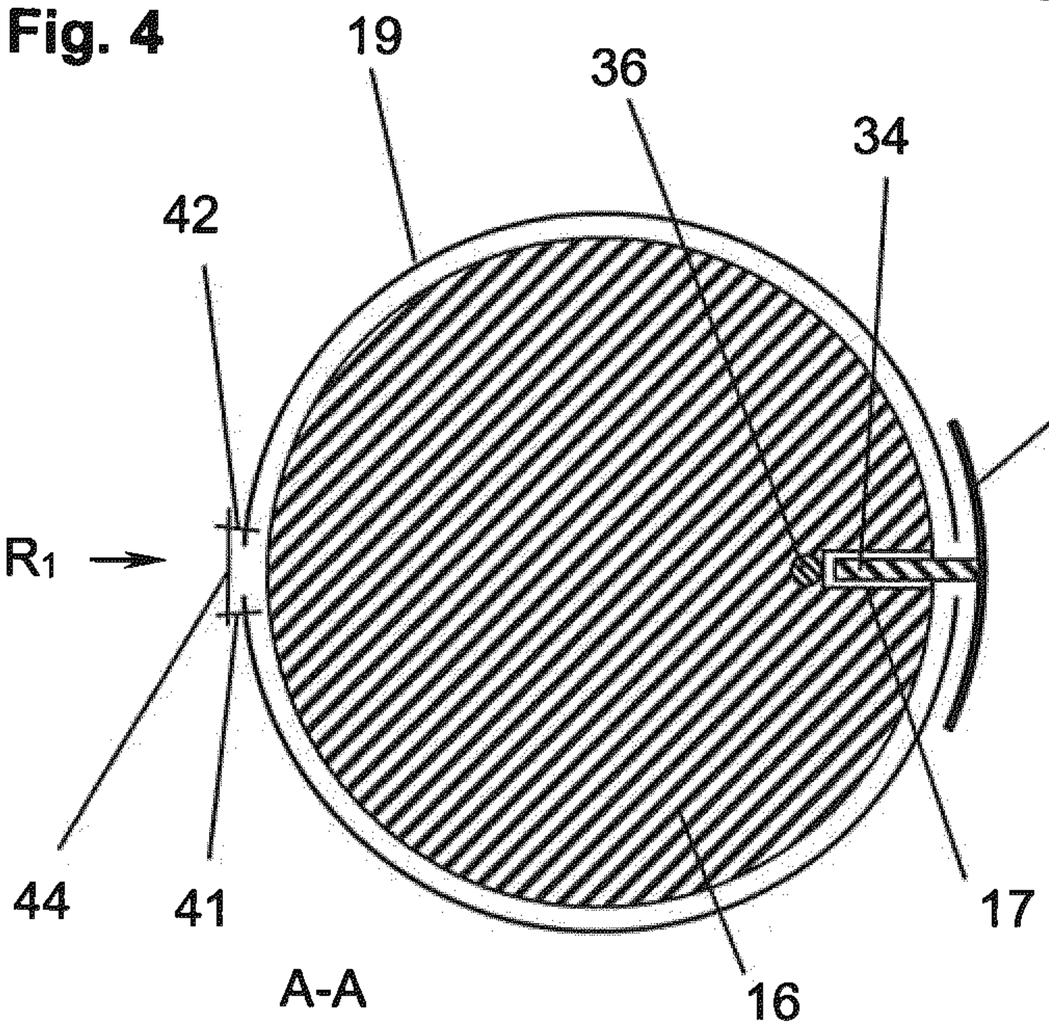
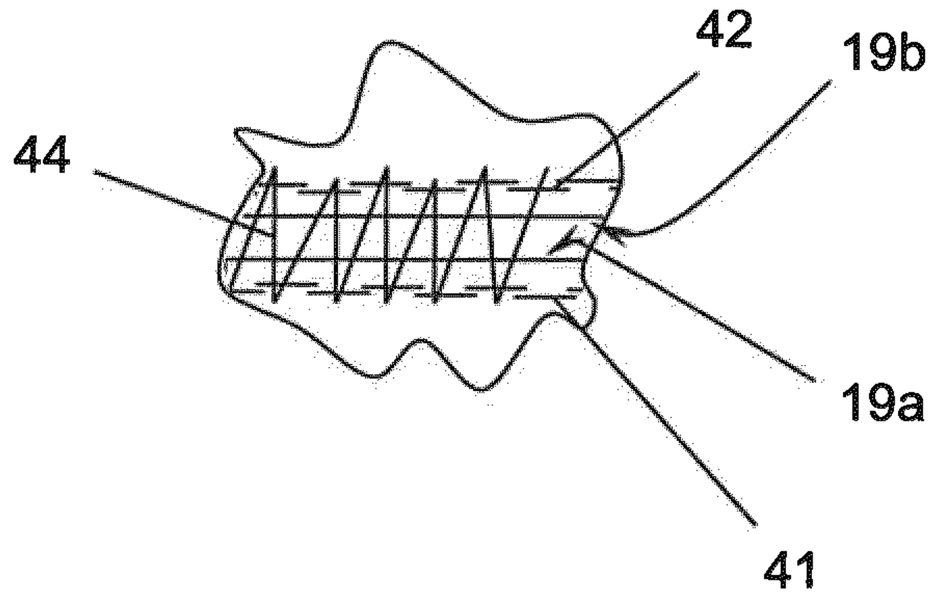


Fig. 5



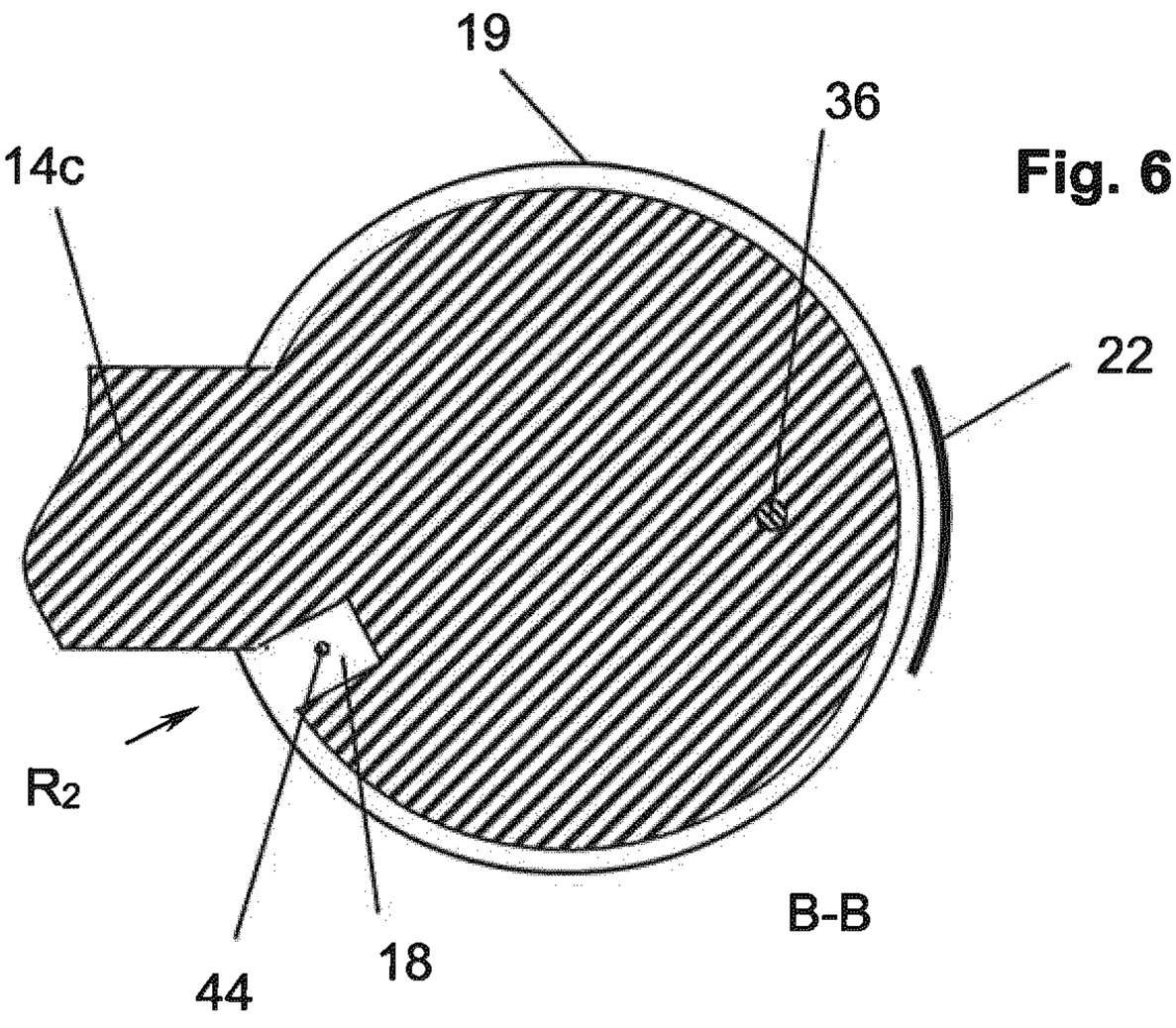


Fig. 6

Fig. 7

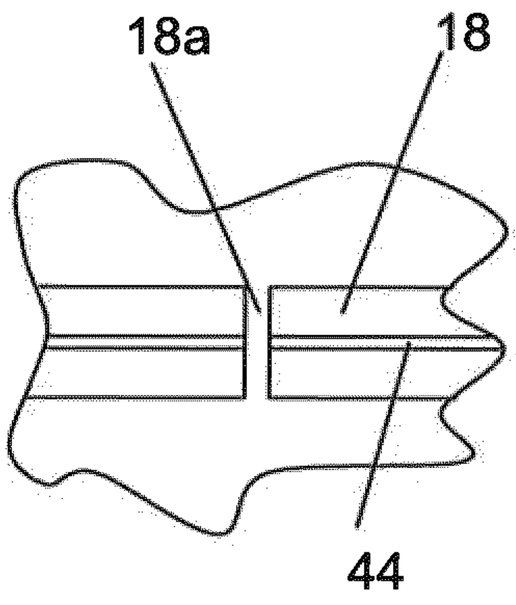
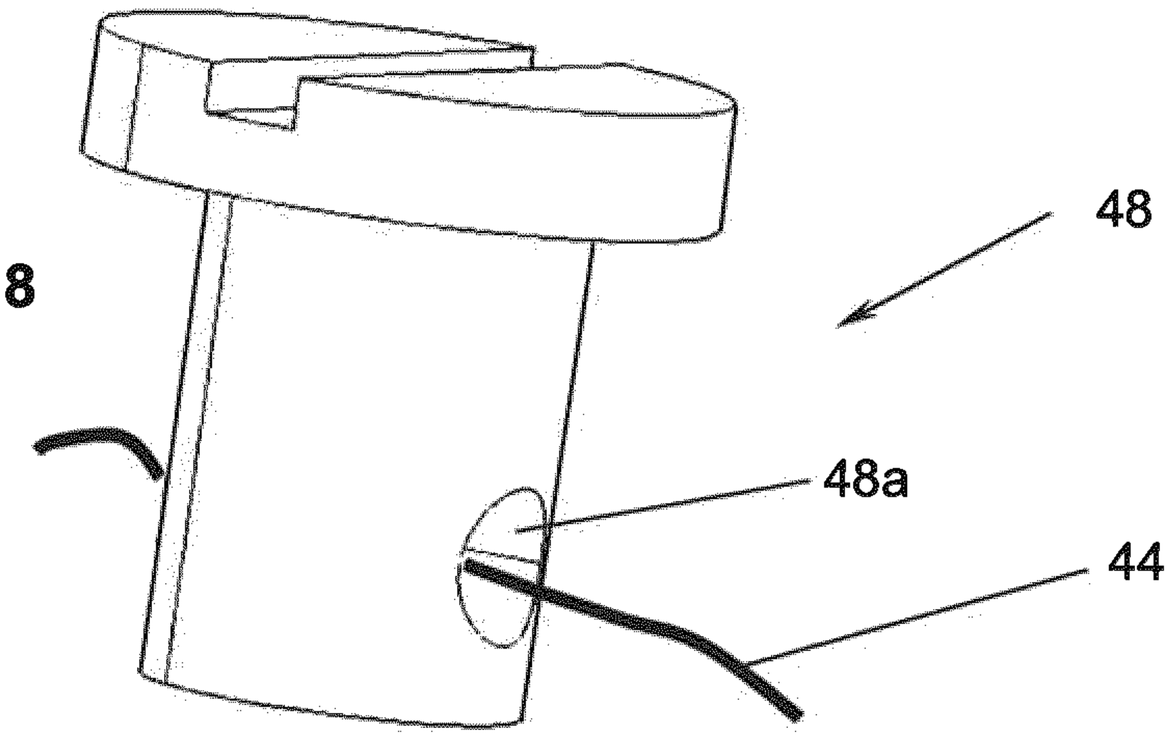


Fig. 8



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2020/082467

A. CLASSIFICATION OF SUBJECT MATTER
INV. B62D1/04 B62D1/06
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B62D

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2006/078098 A1 (LEE MOON KOO [KR]) 27 July 2006 (2006-07-27) claim 1; figures 1,2,3,4 page 7, line 11 - page 8, line 1 -----	1-5,9-14
X	US 4 572 207 A (YOSHIMI TOMOHISA [JP] ET AL) 25 February 1986 (1986-02-25) claim 4; figures 1,3-4 column 1, line 63 - column 2, line 9 column 4, line 7 - line 16 -----	1,9-11, 14,15
X	US 2011/245643 A1 (LISSEMAN JASON [US] ET AL) 6 October 2011 (2011-10-06) figures 1-6 paragraphs [0018], [0023], [0025], [0026], [0042] -----	1,2,9-15

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
20 January 2021	28/01/2021
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2020/082467

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2006078098 A1	27-07-2006	CN 101098810 A	02-01-2008
		US 2009268365 A1	29-10-2009
		WO 2006078098 A1	27-07-2006
US 4572207 A	25-02-1986	JP S59214429 A	04-12-1984
		US 4572207 A	25-02-1986
US 2011245643 A1	06-10-2011	DE 102011006649 A1	15-03-2012
		JP 5759230 B2	05-08-2015
		JP 2011219084 A	04-11-2011
		US 2011245643 A1	06-10-2011