



(51) International Patent Classification:

B60L 53/302 (2019.01)

B60L 53/31 (2019.01)

B60L 53/35 (2019.01)

(21) International Application Number:

PCT/EP2020/056431

(22) International Filing Date:

11 March 2020 (11.03.2020)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

19162307.3

12 March 2019 (12.03.2019)

EP

(71) Applicant: ABB SCHWEIZ AG [CH/CH]; Bruggerstrasse 66, 5400 Baden (CH).

(72) Inventor: UGUR, Ali; Exloostraat 91, 2545 XP Den Haag (NL).

(74) Agent: MICHALSKI HÜTTERMANN & PARTNER

PATENTANWÄLTE MBB; Speditionstraße 21, 40221 Düsseldorf (DE).

(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, 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, 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,

(54) Title: CHARGING ARRANGEMENT FOR SUPPLYING ELECTRICAL ENERGY TO AN ELECTRICAL VEHICLE

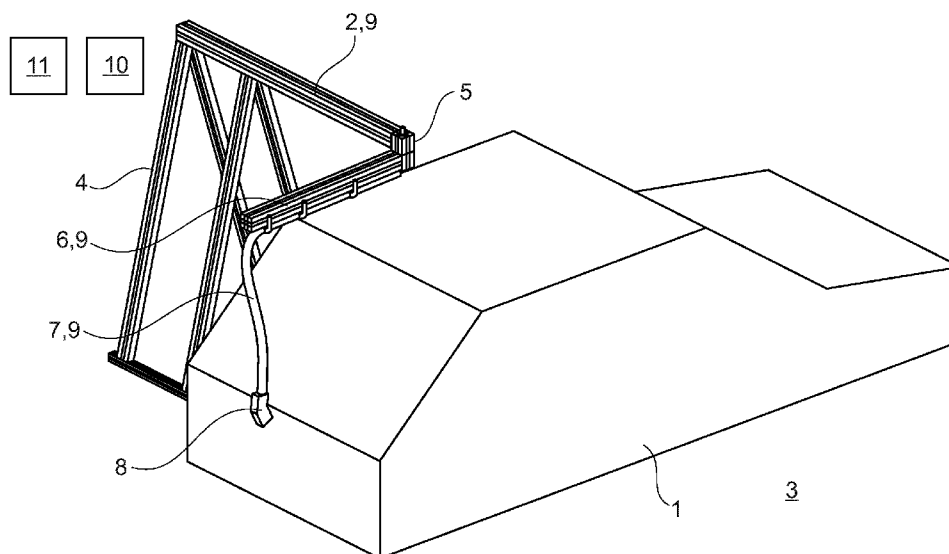


Fig. 1

(57) Abstract: The invention relates to a force assisted charging arrangement for supplying electrical energy to an electrical vehicle (1) via a first set of bus bars (2) and a second set of bus bars (6), comprising the first set of bus bars (2) arranged distant and fixed in respect to ground (3), the second set of bus bars (6) having a first end and a second end, the first end connected rotatably to the first set of bus bars (2) thereby allowing a rotation of the second end around a vertical rotation axis, a charging cable (7) having a first charging cable end and a second charging cable end, the second charging cable end connected to the second end of the second set of bus bars (6), and a charging connector (8) connected to the first charging cable end.



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))*

Description

Charging arrangement for supplying electrical energy to an electrical vehicle

Technical Field

[0001] The invention relates to a charging arrangement for supplying electrical energy to an electrical vehicle, comprising a charging cable having a first charging cable end and a charging cable second end and a charging connector connected to the first charging cable end. The invention further relates to an electric vehicle charge equipment, EVSE, comprising the force assisted charging arrangement and configured for connecting to an AC grid.

Background Art

[0002] Electric vehicle, EV, direct current, DC, fast charging systems and methods often use a so-called Combined Charging System, CCS, protocol according to IEC 61851-23 and SAE J1772 standard for charging electrical vehicles both in the US and in the European Union, EU. As charge currents increase, liquid cooled charging cables for connecting an Electric Vehicle Supply Equipment, EVSE, via a charging connector with the electrical vehicle are becoming more commonly used. High power charging requires charging cables which can carry 500A current at a voltage of 1000V. The liquid cooling allows conductors within the charging cable to become thinner, and thereby easier to use, because excessive heat due to high charge currents and charging cable internal resistances is taken care of.

[0003] A drawback of liquid cooled charging cables is that the charging cable becomes very stiff and heavy. In addition, weight of such high-power liquid cooled charging cables is increasing and is becoming too much for an ordinary person to handle. Besides that, charging connectors are

vulnerable components that are easily damaged if dropped or handled incorrectly and cooled charging cables only offer limited extensions to those power levels. Therefore, robotic systems have been developed for overcoming these disadvantages. However, such robotic systems are expensive and potentially dangerous for humans being too close to such robotic arms.

Summary of invention

[0004] It is therefore an object of the invention to provide a charging arrangement for connecting a liquid cooled charging cable to an electrical vehicle in a simple, cheap and secure manner independent of the weight and stiffness of the charging cable.

[0005] The object of the invention is solved by the features of the independent claims. Preferred embodiments are detailed in the dependent claims.

[0006] Thus, the object is solved by a force assisted charging arrangement for supplying electrical energy to an electrical vehicle via a first set of bus bars and a second set of bus bars, comprising

the first set of bus bars arranged distant and fixed in respect to ground,

the second set of bus bars having a first end and a second end, the first end connected rotatable to the first set of bus bars thereby allowing a rotation of the second end around a vertical rotation axis,

a charging cable having a first charging cable end and a second charging cable end, the second charging cable end connected to the second end of the second set of bus bars, and

a charging connector connected to the first charging cable end.

[0007] It is therefore a key point of the invention to provide a force assisted charging arrangement which absorbs weight of the charging cable thereby providing easy handling and connectability to different types of electrical vehicles independent of the weight and stiffness of the charging cable. As the charging cable is attached to the second set of bus bars and thus preferably held above ground, a human connecting the charging cable via

the charging connector to the electrical vehicle does not need to lift the cable from ground for connecting the cable to the electrical vehicle. Such way lifting a heavy and stiffy charging cable can be completely avoided.

[0008] The length of the charging cable is preferably dimensioned such that the first charging cable end respectively the charging connector is arranged adjacent to a socket of the electrical vehicle, into which the charging connector can be plugged for charging the electrical vehicle with electrical energy. Due to gravity the charging cable will hang down from the second set of bus bars and thus extend in vertical direction. Preferably, the charging cable is dimensioned such that neither the charging cable nor the charging connector hanging down from the second set of bus bars touches ground. Preferably, the charging cable is provided length-adjustable. Such way charging sockets having different heights in respect to ground can be connected without lifting the charging connector.

[0009] As the charging cable and the charging connector are rotatable around the vertical rotation axis, the charging connector can be easily rotated from one side to another side in respect to the electrical vehicle. Thus, charging sockets provided on an arbitrary side of an electrical vehicle can be connected by the charging connector without having the need to lift the charging connector or to move the charging cable over ground from one side to another side of the electrical vehicle. As due to the proposed solution weight of the charging cable does not matter anymore, and as the charging cable can be preferably freely rotated in respect to the first set of bus bars, even liquid cooled charging cables that are very stiff and heavy can be easily handled by any human with the proposed force assisted charging arrangement.

[0010] The bus bars and/or the charging cable preferably comprise DC conductors having a diameter of $\geq 25 \text{ mm}^2$, 50 mm^2 or 70 mm^2 and/or a length of $\geq 4 \text{ m}$, 5 m or $7,5 \text{ m}$ and $\leq 5 \text{ m}$, $7,5 \text{ m}$ or 10 m and/or are dimensioned for supplying in particular DC currents up to 500A or more at a DC voltage of 1000V or more. The electrical vehicle can be provided as an electrical car, an ebus, a truck or any other electrical vehicle means.

[0011] In a preferred implementation the second end is rotatable around 360° around the first end. Such way it does not matter on which side of the

electrical vehicle the charging socket is provided as the charging cable and the charging connector can be easily rotated towards a suitable position in regard the electrical vehicle. Preferably, the second set of bus bars can be rotated in a plane parallel to ground and/or in horizontal direction.

- [0012] In another preferred implementation the first set of bus bars and/or the second set of bus bars are provided as linear arms and/or extend in horizontal direction. The bus bars preferably comprise a linear extension of 2, 3, 4 or 5 meters and/or extend parallel to each other. In a further preferred implementation, the first end is connected rotatable to the first set of bus bars via a joint. The joint preferably comprises conductors for connecting the respective bus bars of the first set of bus bars and the second set of bus bars.
- [0013] In another preferred implementation the force assisted charging arrangement comprises a communication cable, which runs parallel to the first and a second set of bus bars and is connected to the charging connector. The communication cable may comprise further conductors, such as, for example, a Proximity Pilot, PP, line for a PP signal, a Control Pilot, CP, line for a CP signal line and/or a PE line for a PE signal. PP line, CP line and/or PE line and respectively signalling are preferably implemented according to the so-called Combined Charging System, CCS, protocol, in particular according to IEC 61851 or IEC 61851-23 standard. In a further preferred implementation, the communication cable is integrated within the charging cable.
- [0014] In another preferred implementation, the charging cable and/or the charging connector is liquid cooled. For cooling the charging cable and/or the charging connector, a cooling device can be provided, which is preferably arranged at an EVSE as described below and/or which is configured that the cooling liquid is conveyed from a first end to a second, opposite end of the charging cable towards the charging connector, and thereafter from the second end to the first end. The cooling liquid is preferably provided as an oil-based coolant thereby allowing that the cooling liquid comes into contact with unshielded copper conductors of the charging cable.

- [0015] In a further preferred implementation, the charging connector is provided as reverse plug. Provided as a reverse plug means preferably that the charging connector comprises, when plugged into the electrical vehicle, a bending upward so that the charging cable is inserted in vertical manner from above into the charging connector. Providing the charging connector as reverse plug simplifies handling when plugging the charging connector into the charging socket.
- [0016] In another preferred implementation the first set of bus bars and the second set of bus bars each comprise two or at least two bus bars and/or whereby the bus bars are isolated. Preferably, the joint comprises a respective number of conductors for connecting the respective bus bars of the first set of bus bars and the second set of bus bars. Further preferably, the bus bars isolated from each other.
- [0017] In a further preferred implementation, the force assisted charging arrangement comprises a support frame arranged on ground, which holds the first set of bus bars arranged distant and fixed in respect to ground. The support frame preferably comprises a hollow frame. Further preferably, the support frame comprises two triangles, which are arranged parallel and distant to each other with each one side attached to ground. The first set of two bus bars is preferably attached with one end to corners of the triangles opposite to ground thereby extending in linear direction. Preferably the support frame is dimensioned such that the electrical vehicle can be parked at least partly underneath the bus bars. Alternatively, the support frame and/or the first set of bus bars can be attached to or underneath a roof or any other overhang.
- [0018] In another preferred implementation the force assisted charging arrangement comprises the electrical vehicle, whereby the first set of bus bars and the second set of bus bars are arranged above the electrical vehicle such that the electrical vehicle can drive underneath the first set of bus bars and the second set of bus bars. Such way charging of the electrical vehicle becomes very easy as the electrical vehicle simply needs to be parked underneath the first set of bus bars. Once parked, the second set of bus bars is rotated until the charging cable and the charging connector rest close to charging socket of the electrical vehicle. Finally,

the charging connector is plugged into the charging socket such that charging can start.

[0019] The object is further solved by an electric vehicle charge equipment, EVSE, comprising the force assisted charging arrangement as described before and configured for connecting to an AC grid. The EVSE may comprise a transformer and/or a converter for connecting to respectively receiving electrical energy from the AC grid, which is transformed and/or converted to DC for being supplied to the first set of bus bars.

[0020] In another preferred implementation the EVSE is configured for charging the electrical vehicle by using a Combined Charge System, CCS, protocol according to IEC 61851-23 and/or SAE J1772 standard and/or whereby the charging connector and/or the charging cable are provided according to IEC 62196 standard. The Combined Charging System, CCS, protocol is a fast charging method for charging electric vehicles delivering high-voltage direct current via a charging connector derived from SAE J1772 standard (IEC Type 1) or IEC Type 2 connector. Automobile manufactures that support CCS include Jaguar, Volkswagen, General Motors, BMW, Daimler, Ford, FCA, Tesla and Hyundai. The CSS standard is controlled by the so called CharIN consortium. Besides other protocols such as, for example, CHAdeMO, as abbreviation of CHArge de Move, or GB/T, in particular according to 20234.3-2011 standard, can also be used with the described EVSE respectively the method. The EVSE and the charging arrangement are applicable to different type of electrical vehicles, including for examples electrical busses. Preferably, the EVSE and/or the charging arrangement is configured for charging the electrical vehicles with a DC input voltage up to 1500 V DC.

Brief description of drawings

[0021] These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

[0022] In the drawings:

[0023] Fig. 1 shows a force assisted charging arrangement for supplying electrical energy to an electrical vehicle according to a preferred embodiment in a perspective schematic view,

[0024] Fig. 2 shows the force assisted charging arrangement according to Fig. 1 in another perspective schematic view, and

[0025] Fig. 3 shows the force assisted charging arrangement according to Fig. 2 in another perspective schematic view.

Description of embodiments

[0026] Figs. 1 to 3 show a force assisted charging arrangement for supplying electrical energy to an electrical vehicle 1 according to a preferred embodiment in different perspective schematic views. The charging arrangement comprises a first set of two linear bus bars 2, which are arranged distant and fixed in respect to ground 3 on a hollow support frame 4. The support frame 4 comprise two triangles arranged parallel and distant to each other with each one side on ground 3. The first set of two bus bars 2 is attached with one end to corners of the triangles opposite to ground 3 thereby extending in linear direction such that the electrical vehicle 1 can be positioned underneath the other opposite end of the first set of two linear bus bars 2. The first set of bus bars 2 comprises a linear extension between the opposite ends of 4 meters.

[0027] At the other opposite end, a joint 5 is provided for rotatably connecting the first set of bus bars 2 with a second set of two linear bus bars 6, of which a first end is attached to the joint 5. Such way the second set of bus bars 6 extend horizontal in respect to ground 3, whereby a second opposite end of the second set of bus bars 6 is rotatable by 360° around a rotation axis extending in vertical direction and defined by the joint 5, as can be seen from Figs. 2 and 3 showing the second opposite end in different positions.

The second set of bus bars 6 comprises a linear extension between the first and second end of 2 meters and is provided as an arm. Both the first set of bus bars 2 and the second set of bus bars 6 comprise two bus bars for supplying DC current to the electrical vehicle 1, whereby the respective bus bars are isolated from each other.

[0028] The charging arrangement further comprises a liquid cooled charging cable 7 having a first charging cable end and a second charging cable end. The second charging cable end is connected to the second end of the second set of bus bars 6. Due to gravity and weight of the liquid cooling, the liquid cooled charging cable 7 “hangs” down from the second end of the second set of bus bars 6 in a vertical manner and comprises a length such that a charging connector 8 connected to the first charging cable end can be easily plugged by a human into a respective socket of the electrical vehicle 1 without the need to lift the charging connector 8. For facilitating easy connection, the charging connector 8 is provided as a reverse plug. Provided as a reverse plug means that the charging connector 8 comprises, when plugged into the electrical vehicle 1, a bending upward such that the charging cable 7 is inserted in vertical manner from above into the charging connector 8.

[0029] The first set of bus bars 2, the second set of bus bars 6, the liquid cooled charging cable 7 and liquid cooled charging connector 8 are dimensioned to charge the electrical vehicle with a current of 500A DC at a voltage of 1000V DC. For exchanging charging information between the electrical vehicle 1, a communication cable 9 is provided, which runs parallel to the first and to the second set of bus bars 2, 6 and is connected to the charging connector 8. The communication cable 9 is integrated into the charging cable 7 as additional conductors to the conductors carrying the charging currents.

[0030] For receiving electrical energy to charge the electrical vehicle 1 with a respective DC current, the charging arrangement is connected to an electric vehicle charge equipment, EVSE, 10. The EVSE 10 is connected via a transformer and a converter to an AC grid 11. The EVSE 10 is configured for charging the electrical vehicle 1 by using a Combined Charge System, CCS, protocol according to IEC 61851-23 and/or SAE

J1772 standard, thereby allowing said charging currents of 500A DC or more at 1000V DC or more. In an equal manner the charging connector 8 and the charging cable 7 are provided according to IEC 62196 standard.

[0031] The proposed solution provides a force compensating mechanism that provides for an easy and simple possibility for connecting the charging connector 8 to different types of electrical vehicles 1 without having the need of lifting a heavy and stiff charging cable 7. As the second set of bus bars 6 in form of an arm can freely rotated by 360° in respect to the first set of bus bars 2, it does not matter on which side of the electrical vehicle 1 the charging socket is provided. For connecting the charging connector 8 to the electrical vehicle 1, the second set of bus bars 6 is rotated around the electrical vehicle until the charging connector 8 becomes close to the charging socket.

[0032] While the invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive; the invention is not limited to the disclosed embodiments. Other variations to be disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word “comprising” does not exclude other elements or steps, and the indefinite article “a” or “an” does not exclude a plurality. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. Any reference signs in the claims should not be construed as limiting scope.

Reference signs list

- [0033]
- | | |
|----|-----------------------------------|
| 1 | electrical vehicle |
| 2 | first set of bus bars |
| 3 | ground |
| 4 | support frame |
| 5 | joint |
| 6 | second set of bus bars |
| 7 | charging cable |
| 8 | charging connector |
| 9 | communication cable |
| 10 | Electric vehicle charge equipment |
| 11 | AC grid |

Claims

1. Force assisted charging arrangement for supplying electrical energy to an electrical vehicle (1) via a first set of bus bars (2) and a second set of bus bars (6), comprising
 - the first set of bus bars (2) arranged distant and fixed in respect to ground (3),
 - the second set of bus bars (6) having a first end and a second end, the first end connected rotatable to the first set of bus bars (2) thereby allowing a rotation of the second end around a vertical rotation axis,
 - a charging cable (7) having a first charging cable end and a second charging cable end, the second charging cable end connected to the second end of the second set of bus bars (6), and
 - a charging connector (8) connected to the first charging cable end.
2. Force assisted charging arrangement according to the previous claim, whereby the second end is rotatable around 360° around the first end.
3. Force assisted charging arrangement according to any of the previous claims, whereby the first set of bus bars (2) and/or the second set of bus bars (6) are provided as linear arms and/or extend in horizontal direction.
4. Force assisted charging arrangement according to any of the previous claims, whereby the first end is connected rotatable to the first set of bus bars (2) via a joint (5).
5. Force assisted charging arrangement according to any of the previous claims, comprising a communication cable (9), which runs parallel to the first and to the second set of bus bars (2, 6) and is connected to the charging connector (8).
6. Force assisted charging arrangement according to the previous claim, whereby the communication cable (9) is integrated within the charging cable (7).

7. Force assisted charging arrangement according to any of the previous claims, whereby the charging cable (7) and/or the charging connector (8) is liquid cooled.

8. Force assisted charging arrangement according to any of the previous claims, whereby the charging connector (8) is provided as reverse plug.

9. Force assisted charging arrangement according to any of the previous claims, whereby the first set of bus bars (2) and the second set of bus bars (6) each comprise two or at least two bus bars and/or whereby the bus bars are isolated.

10. Force assisted charging arrangement according to any of the previous claims, comprising a support frame (4) arranged on ground (3), which holds the first set of bus bars (2) arranged distant and fixed in respect to ground (3).

11. Force assisted charging arrangement according to any of the previous claims, comprising the electrical vehicle (1), whereby the first set of bus bars (2) and the second set of bus bars (6) are arranged above the electrical vehicle (1) such that the electrical vehicle (1) can drive underneath the first set of bus bars (2) and the second set of bus bars (6).

12. Electric vehicle charge equipment, EVSE, (10) comprising the force assisted charging arrangement according to any of the previous claims and configured for connecting to an AC grid (11).

13. EVSE (10) according to the previous claim, whereby the EVSE (10) is configured for charging the electrical vehicle (1) by using a Combined Charge System, CCS, protocol according to IEC 61851-23 and/or SAE J1772 standard and/or whereby the charging connector (8) and/or the charging cable (7) are provided according to IEC 62196 standard.

1/3

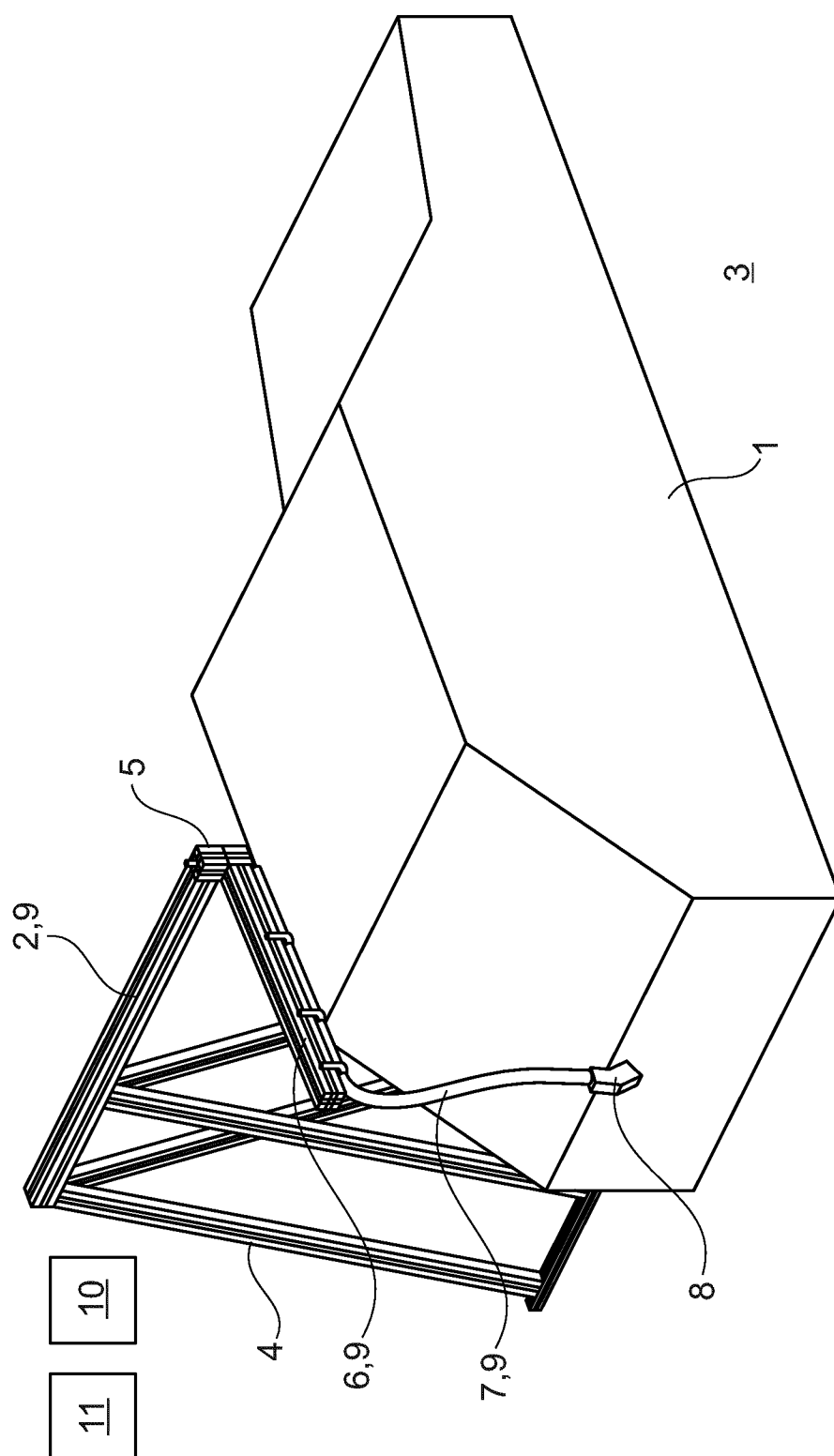


Fig. 1

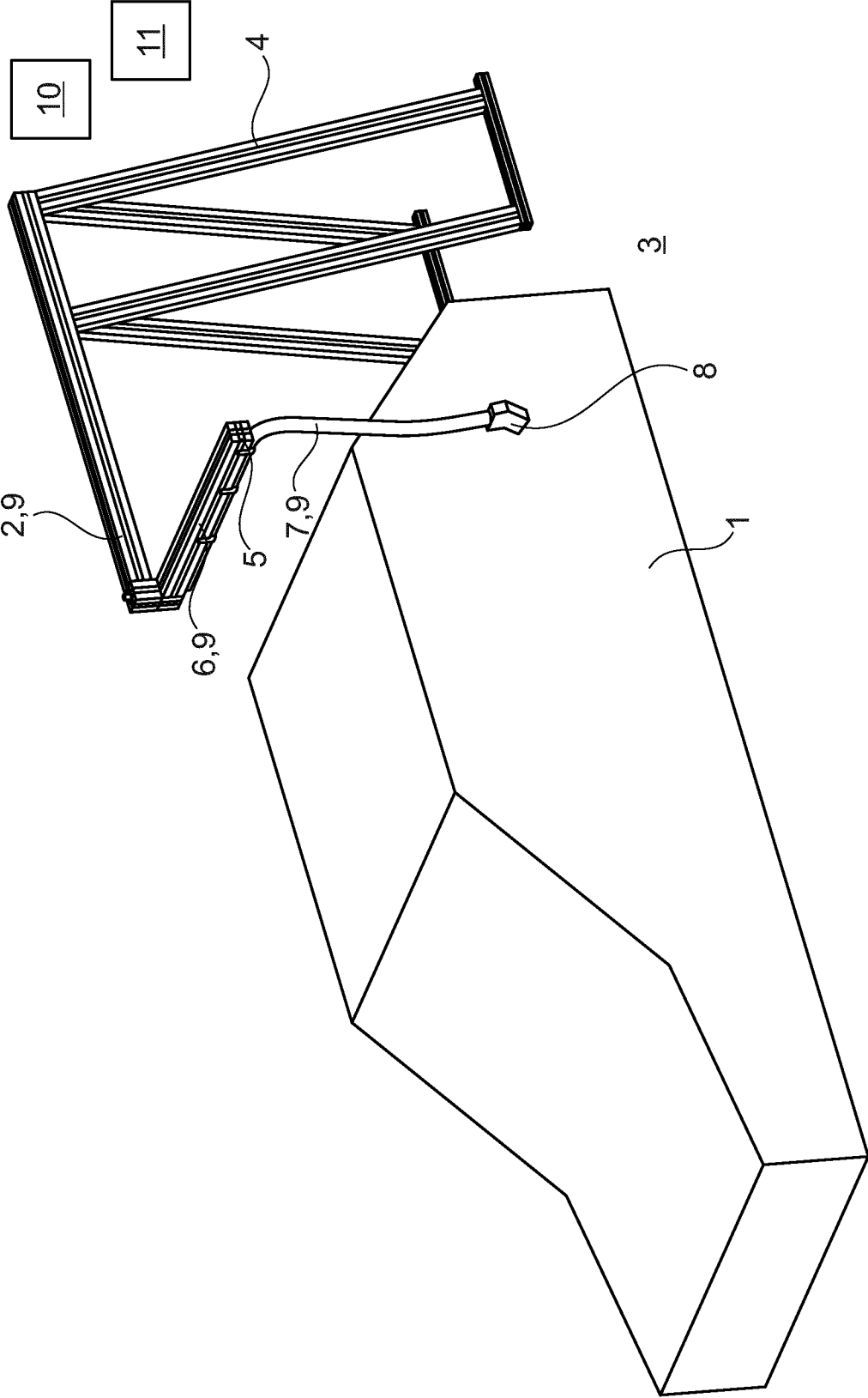


Fig. 2

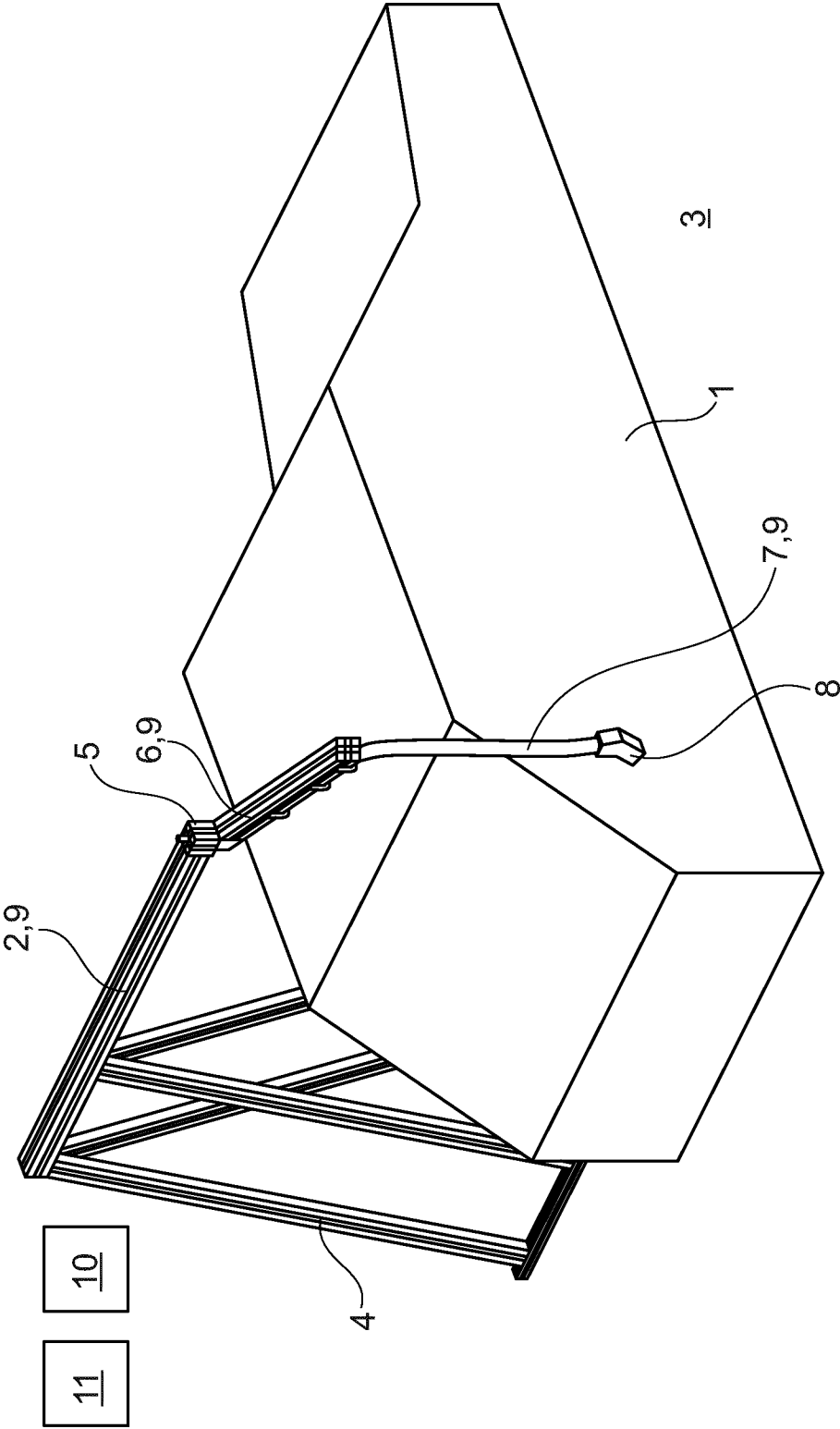


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2020/056431

A. CLASSIFICATION OF SUBJECT MATTER
INV. B60L53/302 B60L53/35 B60L53/31
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)
B60L

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	DE 10 2009 024721 A1 (BIENEK ERWIN [DE]) 16 December 2010 (2010-12-16)	1-6,8-13
Y	paragraph [0057]; figures 21,22 -----	7
Y	DE 20 2017 100174 U1 (ELEKTRO-BAUELEMENTE GMBH [DE]) 5 April 2017 (2017-04-05) paragraph [0013]; figure 1 -----	7
A	WO 2018/014721 A1 (CAO MINGLI [CN]; CAO ZHUIYANG [CN]) 25 January 2018 (2018-01-25) the whole document -----	1-13
A	DE 10 2014 109068 A1 (STEINSIEK LARS [DE]) 31 December 2015 (2015-12-31) the whole document -----	1-13
	----- -/-	



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

28 May 2020

Date of mailing of the international search report

08/06/2020

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Berkus, Frank

INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2020/056431

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 205 509 450 U (GUANGDONG CHENYU ELECTRICITY DESIGN CONSULTANCY CO LTD) 24 August 2016 (2016-08-24) the whole document -----	1-13

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2020/056431

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 102009024721 A1	16-12-2010	NONE	
DE 202017100174 U1	05-04-2017	DE 202017100174 U1 EP 3312045 A1	05-04-2017 25-04-2018
WO 2018014721 A1	25-01-2018	CN 106143199 A WO 2018014721 A1	23-11-2016 25-01-2018
DE 102014109068 A1	31-12-2015	NONE	
CN 205509450 U	24-08-2016	NONE	