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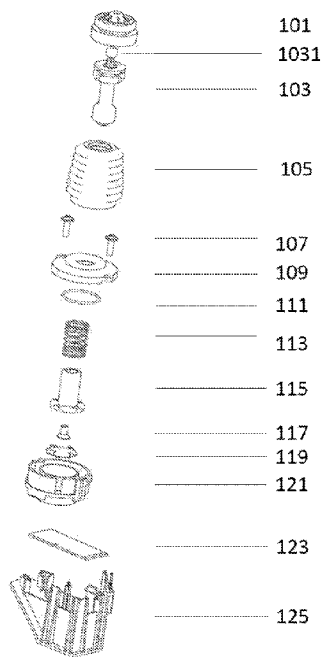


FIG. 2B

(57) Abstract: A lift detection arrangement in a robotic lawnmower for detecting a lift of a body (102) of the robotic lawnmower relative to a chassis (125) of the robotic lawnmower. The lift detection arrangement comprises a collision absorber (103); and a sensor arrangement comprising a spring (113), a movable part (115), a metal plate (119) and a sensor (123). The collision absorber (103) is rigidly attached to the movable part (115) and arranged to allow a displacement of the body (102) relative to the chassis (125) in a collision plane during a collision between an obstacle and the robotic lawnmower, but not in a vertical direction. The moveable part (115) is arranged to provide a displacement of the body (102) relative to the chassis (125) in a lift direction during a lift of the body (102). The sensor (123) is configured to sense the distance (d) to the metal plate (119) that is fixed to the moveable part (115) and to trigger a cut off of power to a cutting blade of the robotic lawnmower if the distance becomes greater than a predetermined distance.



LIFT DETECTION ARRANGEMENT IN A ROBOTIC LAWNMOWER

Technical field

[0001] The present invention relates generally to a lift detection arrangement in a robotic lawnmower. In particular, it relates to a lift detection arrangement for detecting a lift of a body of the robotic lawnmower relative to a chassis of the robotic lawnmower.

Background art

[0002] A lift detection arrangement in a robotic lawnmower is an important part to protect people from being injured by cutting blades if the robotic lawnmower is lifted during operation. When the lift of the body of the robotic lawnmower is detected, the lift detection arrangement is arranged to cut off the electricity supply to the cutting blades, thus stopping the rotation of the cutting blades.

[0003] There are lift detection arrangements in prior art, for example, US 9232692 B2 that discloses a lift detection arrangement in a robotic lawnmower which may absorb some collision forces. The lift detection arrangement comprises a lift sensor for detecting a change in a spacing between two sensor parts of which one is arranged on a lift element and the other one is arranged on a joystick member, wherein one of the two sensor parts may be a Hall effect sensor and the other of the two sensor parts is a magnet. When a lift displacement over a predetermined threshold is detected by the sensor parts, the rotation of the cutting blades is stopped.

[0004] One of the problems with US 9232692 is that the sensors and a Printed Board Circuit, PCB, connected thereto are not fully protected from water, even if a rubber coating can be arranged outside the PCB, the coating is easily damaged and may cause a water leakage which can damage the product.

[0005] Some other solutions having a joystick with a joint are complicated, expensive and take up much space. Thus, there is still room for improved lift detection arrangements.

Summary of invention

[0006] An object of the present invention is to provide an improved lift detection arrangement in a robotic lawnmower.

[0007] According to a first aspect, the lift detection arrangement in the robotic lawnmower for detecting a lift of the body of the robotic lawnmower relative to a chassis of the robotic lawnmower, comprises a collision absorber, and a sensor arrangement comprising a spring, a movable part, a metal plate and a sensor. The collision absorber is rigidly attached to the movable part and arranged to allow a displacement of the body relative to the chassis in a collision plane during a collision between an obstacle and the robotic lawnmower. The collision absorber is ball-shaped at one end that is facing the body and pivotally attached to a bowl-shaped snap connector, which is fixedly attached to the body. The moveable part is arranged to provide a displacement of the body relative to the chassis in a lift direction during a lift of the body, and the spring is arranged to exert a force on the moveable part such that there is a threshold force that needs to be exceeded before the moveable part starts to move in the lift direction. The sensor is arranged in the chassis and configured to sense the distance to the metal plate that is fixed to the moveable part and to trigger a cut off of power to a cutting blade of the robotic lawnmower if the distance becomes greater than a predetermined distance.

[0008] According to some embodiments herein, the sensor is a HALL sensor or an inductive sensor.

[0009] According to other embodiments the lift detection arrangement may further comprise a fastening cap, which together with a chassis connector secures the spring, the movable part and the metal plate to the chassis by means of fastening means.

[0010] In another embodiment the sensor in the lift detection arrangement is arranged on a **Printed Circuit Board**, PCB, positioned in the chassis.

[0011] Preferably, the collision absorber is made of rubber and the metal plate is made of aluminum.

[0012] In yet another embodiment the lift detection arrangement further comprises a protective bellows, which encloses the collision absorber, said protective bellows is fixedly attached to the bowl-shaped snap connector at a top end and fixedly attached to the fastening cap at a bottom end.

[0013] Preferably the movable part is made of plastic and the spring is arranged around the periphery of the movable part.

[0014] Since the sensor is kept inside the chassis without having any extra holes for cables the design of the lift detection arrangement is kept simpler and can even be used in situations with limited space. As the chassis is waterproof the safety of both the people and the product will be ensured. Especially when the sensor is an inductive sensor, the accuracy to distinguish between the lift and the collision signals will be increased.

Brief description of drawings

[0015] The invention is now described, by way of example, with reference to the accompanying drawings, in which:

[0016] FIG. 1 is a schematic view of a lift detection arrangement provided between a body and a chassis of a robotic lawnmower.

[0017] FIG. 2A is an exploded view of the lift detection arrangement.

[0018] FIG. 2B is another exploded view of the lift detection arrangement

[0019] FIG. 3 is sectional view of the lift detection arrangement in a normal position.

[0020] FIG. 4 is a sectional view of the lift detection arrangement during a lift.

Description of embodiments

[0021] In the following, a detailed description of the lift detection arrangement is described.

[0022] As can be seen in FIG. 1 the lift detection arrangement is provided between a body 102 and a chassis 125 of the robotic lawnmower.

[0023] FIG.2A and FIG.2B depict, schematically and by way of example, exploded views of a lift detection arrangement in a robotic lawnmower according to some embodiments herein. The lift detection arrangement comprises a bowl-shaped snap connector 101, a collision absorber 103, a protective bellows 105, fastening means 107, 117, fastening cap 109, an O-ring, a spring 113, a moveable part 115, a metal plate 119, a chassis connector 121 and a sensor 123.

[0024] The lift detection arrangement has two different functions, firstly it is to detect vertical movement, i.e. detect if someone tries to lift the robotic lawnmower and secondly to absorb horizontal movement, such that horizontal movements do not induce vertical movement in the lift detection arrangement. With other words, if the robotic lawnmower for example collides with a tree, the vertical forces that the body 102 of the robotic lawnmower is subjected to should be absorbed. If such forces are not absorbed the lift detection arrangement would falsely trigger cutoff of the cutting blades.

[0025] The snap connector 101 is fixedly secured to the body 102 or hood of the robotic lawnmower. A collision absorber 103 has a ball-shaped top 1031, i.e. at an end that is facing the body 102 and the snap connector 101. The ball-shaped top 1031 is adapted to be pivotally attached to or inserted in the snap connector 101. The collision absorber 103 allows a displacement of the body 102 of the robotic lawnmower relative to the chassis 125 in a collision plane during a collision of the robotic lawnmower, but limited in a vertical plane. The collision plane is substantially parallel with the lawn to be mowed, i.e. substantially a horizontal plane. A protective bellows 105 may optionally be arranged to enclose the collision absorber 103, such that it is protected from dust and the like of the outside environment.

[0026] In order to detect vertical displacement of the body 102, the moveable part 115 is allowed to move in relation to the chassis 125 in a lift direction during a lift. The movable part 115 is fixed to the collision absorber 103 via fastening

means 117, such as a screw or the like. In one embodiment, a threaded metallic part can be molded into the bottom of the collision absorber 103, which metallic part is adapted to receive the fastening means 117. The fastening means 117 is positioned between the movable part 115 and the metal plate 119. The spring 113 is arranged around the periphery of the movable part 115 and is arranged to exert a force on the moveable part 115 such that there is a threshold force that needs to be exceeded before the moveable part 115 starts to move. The biasing force of the spring 113 is determined such that it more or less prevents displacement of the moveable part 115 when the robotic lawnmower rides over small bumps and the like during operation, but allows displacement of the moveable part 115 during a lifting operation. The metal sheet 119 is fixed at the bottom of the movable part 115.

[0027] Since the metal plate 119 is fixed to the moveable part 115 it will move in the vertical direction together with the movable part 115. According to some embodiments herein, the metal plate 119 is an aluminum plate. The sensor 123 is arranged in and fixed to the chassis 125. The sensor 123 is configured to sense the distance d to the metal plate 119 that is fixed to the moveable part 115. If the distance becomes greater than a predetermined distance the sensor 123 will trigger a cut off of the power to the cutting blades of the robotic lawnmower. The sensor 123 may be any type of sensor that able to detect the distance d to the metal plate 119, such as a magnetic sensor, inductive sensor or a Hall effect sensor. The trigger signal from the sensor 123 may be sent to a control device (not shown in the figures) handling the operation of the robotic lawnmower. According to some embodiments herein, the sensor is arranged on a PCB positioned in the lower part of the chassis 125.

[0028] The lift detection arrangement further comprises the fastening cap 109 which together with the chassis connector 121 and fastening means 107, such as screws, secures the lift detection arrangement to the chassis 125. In one embodiment there is also provided the O-ring 111, such that the lift detection arrangement is properly sealed.

[0029] Turning now to FIG. 3 and 4, which are sectional views of the lift detection arrangement. Fig. 3 shows the lift detection arrangement in a normal position, i.e. when there is no lift and the metal plate 119 is in the vicinity of the sensor 123. In this state the spring 113 is in unstrained. When the body 102 of robotic lawnmower is lifted, the movable part 115 together with the collision absorber 103 will move upwards relative to the chassis 125 and the spring 113 is compressed. The metal plate 119 at the bottom moveable part 115 will also move upwards and the sensor 123 will detect the changing distance between the sensor 123 and the metal plate 119. Thus, the lift of the body 102 of the robotic lawnmower is detected. As the distance d reaches a predetermined distance the sensor 123 will send a trigger signal to a control device controlling the operation of the lawnmower, which will stop the power supply to the cutting blades.

[0030] Although, the present invention has been described above with reference to specific embodiments, it is not intended to be limited to the specific form set forth herein. Rather, the invention is limited only by the accompanying claims.

[0031] In the claims, the term “comprises/comprising” does not exclude the presence of other elements or steps. Furthermore, although individually listed, a plurality of means or elements may be implemented by e.g. a single unit or processor. Additionally, although individual features may be included in different claims, these may possibly advantageously be combined, and the inclusion in different claims does not imply that a combination of features is not feasible and/or advantageous. In addition, singular references do not exclude a plurality. The terms “a”, “an”, “first”, “second” etc do not preclude a plurality. Reference signs in the claims are provided merely as a clarifying example and shall not be construed as limiting the scope of the claims in any way.

CLAIMS

1. A lift detection arrangement in a robotic lawnmower for detecting a lift of a body (102) of the robotic lawnmower relative to a chassis (125) of the robotic lawnmower, comprising:

a collision absorber, (103); and

a sensor arrangement comprising a spring (113), a movable part (115), a metal plate (119) and a sensor (123);

wherein the collision absorber (103) is rigidly attached to the movable part (115) and arranged to allow a displacement of the body (102) relative to the chassis (125) in a collision plane during a collision between an obstacle and the robotic lawnmower,

wherein the collision absorber (103) is ball-shaped at one end (1031) facing the body (102) and pivotally attached to a bowl-shaped snap connector (101), which is fixedly attached to the body (102),

wherein the moveable part (115) is arranged to provide a displacement of the body (102) relative to the chassis (125) in a lift direction during a lift of the body (102),

wherein the spring (113) is arranged to exert a force on the moveable part (115) such that there is a threshold force that needs to be exceeded before the moveable part 115 starts to move in the lift direction, and

wherein the sensor (123) is arranged in the chassis (125) and configured to sense the distance (d) to the metal plate (119) that is fixed to the moveable part (115) and to trigger a cut off of power to a cutting blade of the robotic lawnmower if the distance becomes greater than a predetermined distance (d).

2. The lift detection arrangement according to claim 1, wherein the sensor (123) is a HALL sensor or an inductive sensor.

3. The lift detection arrangement according to claim 1, wherein the lift detection arrangement further comprises a fastening cap (109), which together with a chassis connector (125) secures the spring (113), the movable part (115) and the metal plate (119) to the chassis (125) by means of fastening means (107).
4. The lift detection arrangement according to claim 2, wherein the sensor (123) is arranged on a **Printed Circuit Board**, PCB, positioned in the chassis (125).
5. The lift detection arrangement according to any of claims 1 to 4, wherein the collision absorber (103) is made of rubber.
6. The lift detection arrangement according to any of claims 4 to 5, wherein the lift detection arrangement further comprises a protective bellows (105), which encloses the collision absorber (103), said protective bellows (105) is fixedly attached to the bowl-shaped snap connector (101) at a top end and fixedly attached to the fastening cap (109) at a bottom end.
7. The lift detection arrangement according to claim 1, wherein the movable part (115) is made of plastic and the spring (113) is arranged around the periphery of the movable part (115).
8. The lift detection arrangement according to claim 8, wherein the metal plate (119) is made of aluminum.

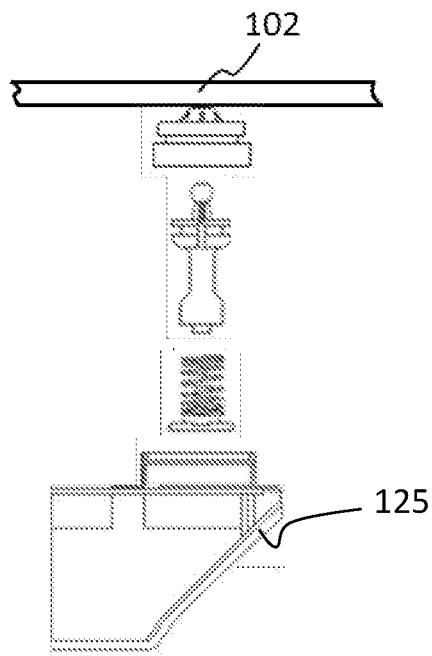


FIG. 1

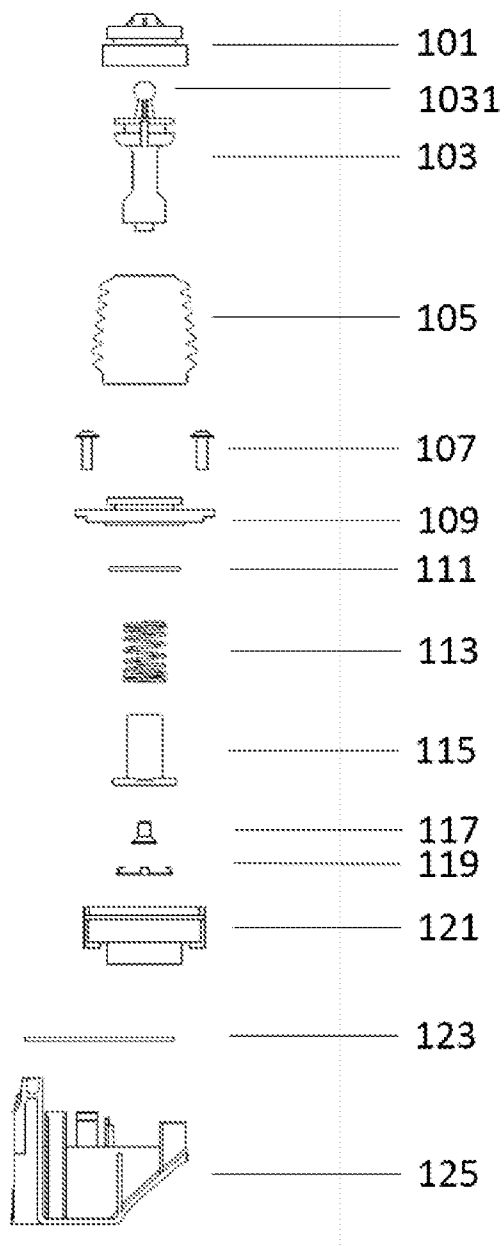


FIG. 2A

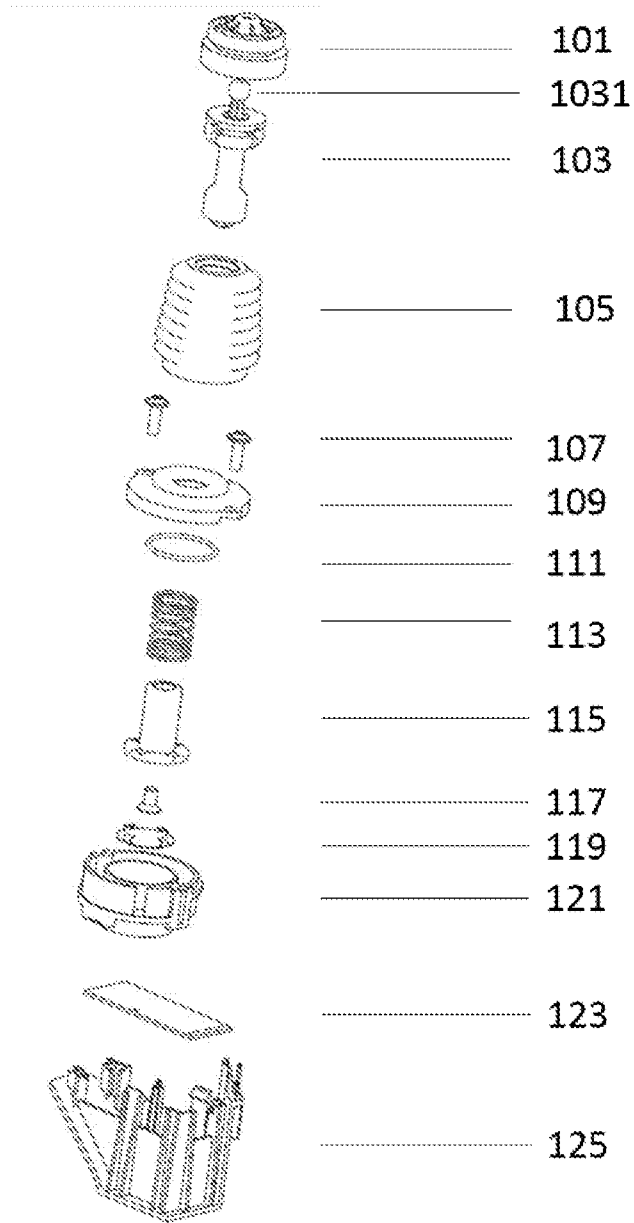


FIG. 2B

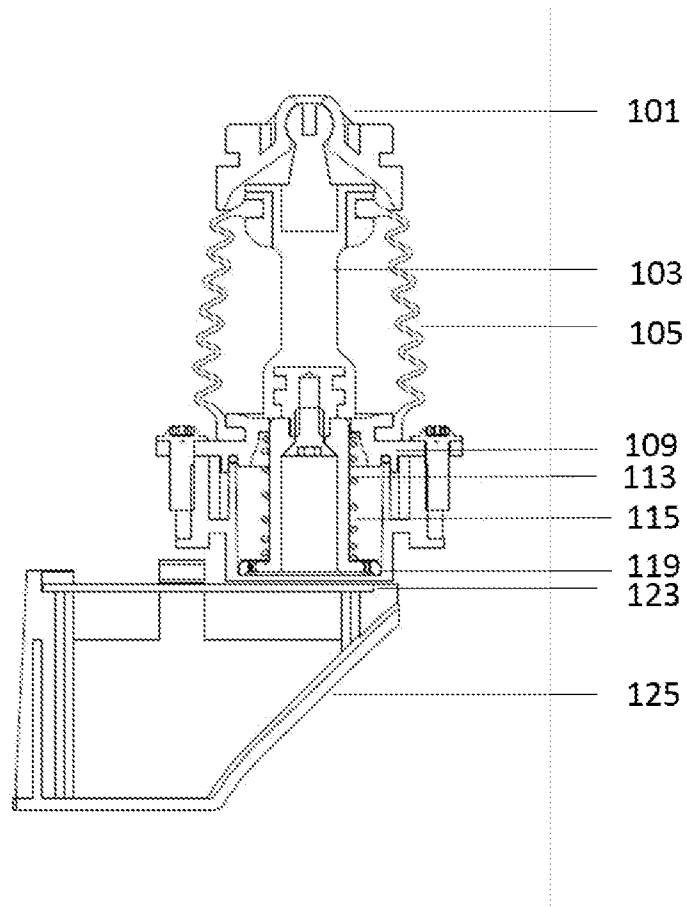


FIG. 3

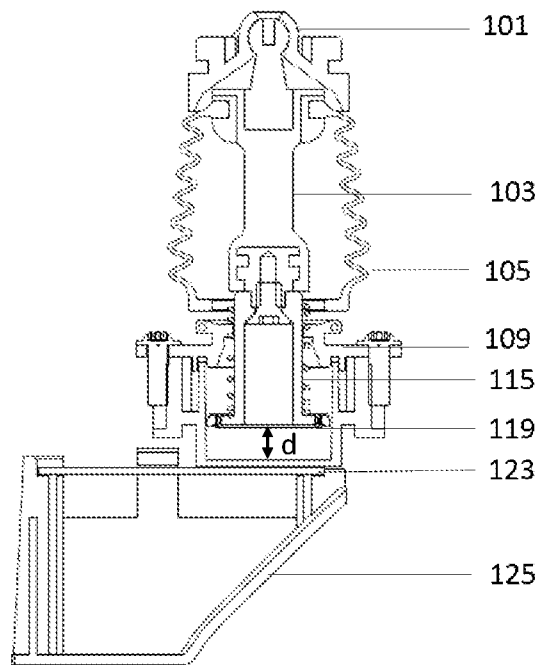


FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2018/078149

A. CLASSIFICATION OF SUBJECT MATTER A01D 34/00(2006.01)i 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) A01D 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) CNABS;CNKI;VEN:lift,lawn,mower,chassis,sensor,collision,detect+		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2014373497 A1 (HUSQVARNA AB) 25 December 2014 (2014-12-25) paragraphs [0035]-[0045], figures 1A-1C	1-8
A	CN 107404839 A (HUSQVARNA AB) 28 November 2017 (2017-11-28) the whole document	1-8
A	CN 201557392 U (HANGZHOU NORMAN INNOVATION & TECHNOLOGY CO LTD) 25 August 2010 (2010-08-25) the whole document	1-8
A	CN 202009583 U (TAIZHOU TIANCHEN INTELLIGENCE & ELECTRICS CO LTD) 19 October 2011 (2011-10-19) the whole document	1-8
A	EP 2425700 A2 (GGP ITALY SPA) 07 March 2012 (2012-03-07) the whole document	1-8
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> 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 23 November 2018		Date of mailing of the international search report 19 December 2018
Name and mailing address of the ISA/CN STATE INTELLECTUAL PROPERTY OFFICE OF THE P.R.CHINA 6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088 China		Authorized officer XU, Yuan
Facsimile No. (86-10)62019451		Telephone No. 86-10-62089943

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2018/078149

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
US	2014373497	A1	25 December 2014	EP	2816886	A4	14 October 2015
				EP	2816886	A1	31 December 2014
				EP	3342266	A1	04 July 2018
				CN	104135846	B	19 October 2016
				US	9232692	B2	12 January 2016
				CN	104135846	A	05 November 2014
				EP	2816886	B1	22 November 2017
				WO	2013125995	A1	29 August 2013
CN	107404839	A	28 November 2017	WO	2016150510	A1	29 September 2016
				US	2018107224	A1	19 April 2018
				US	10108198	B2	23 October 2018
				EP	3273764	A1	31 January 2018
CN	201557392	U	25 August 2010	None			
CN	202009583	U	19 October 2011	None			
EP	2425700	A2	07 March 2012	DE	102010044276	A1	08 March 2012
				DE	102010044276	B4	06 August 2015
				EP	2425700	A3	31 October 2012