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(54) Title: DEPLOYMENT AND POSITIONING DEVICE FOR PROTECTIVE NET

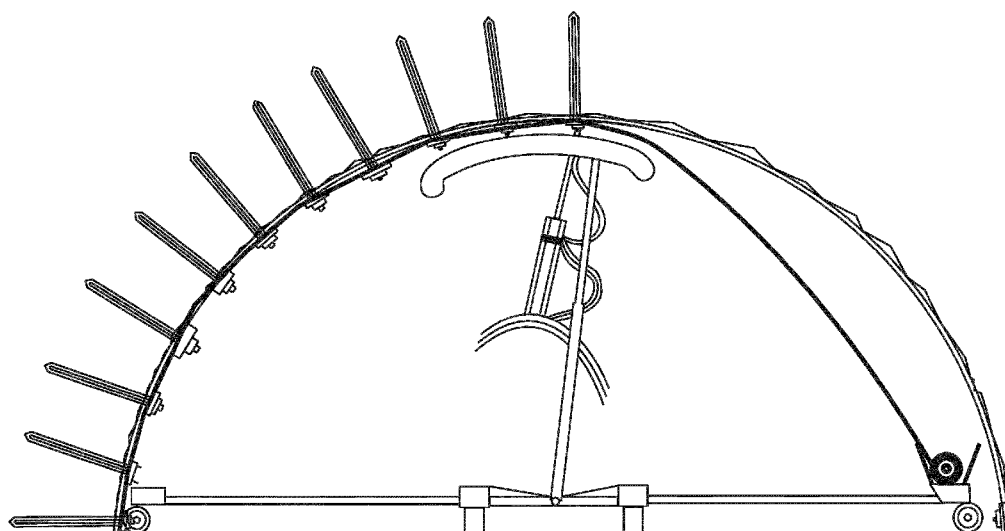


Fig. 6

(57) Abstract: An apparatus for deployment of a protective net for lining tunnel ceilings or tunnel walls, comprising: a first telescopic element for holding a roll of protective net for lining tunnel ceilings or tunnel walls, said roll of protective net having an end portion; a second telescopic element for supporting an extended protective net for lining tunnel ceilings or tunnel walls; a third telescopic element for fixing the end portion of said roll of protective net for lining tunnel ceilings or tunnel walls; wherein said first, second and third telescopic elements are assembled together on a stand and extendable to position the protective net onto the tunnel section.



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

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- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
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Published:

- *with international search report (Art. 21(3))*

Deployment and positioning device for protective net

Description

Technical Field

[0001] The present invention relates to an apparatus for deploying and positioning a protective net for lining tunnel ceilings or tunnel walls and a method for lining tunnel ceilings or tunnel walls with protective nets by application of such an apparatus.

Background Art

[0002] Underground mining or other kinds of civil works such as tunnelling, energy power plants, highways or metro lines contain a tunnel construction. One or more of the faces of a tunnel in an underground mine, such as ceilings or walls is primarily supported by anchors or “bolts”. In connection with the installation of these bolts, it is often necessary, desired or compulsory to install a web-shaped net or mesh along the corresponding face(s). The main role of protective net is to provide confinement transferring the energy to the bolts. It is especially recommended where poor ground conditions prevail, preventing fragments of rock and other minerals from falling from the roof and ribs in the spacing between reinforcing bolts.

[0003] Under the current approach, this supplemental protection afforded by net or mesh is separately applied to the roof and ribs of the mine passage, and oftentimes completed manually as part of the bolting operation.

[0004] Any manual approach suffers from being relatively complex in nature, and generally do not obviate the continued need for significant operator involvement. Specifically, an operator must still be involved to a significant extent in helping to initially support, expand, grab, elevate, position and fasten the net or mesh during installation. These requirements for frequent manual intervention expose the workers in a risky position under the tunnel where there is no reinforcement, increase the man hours and thus

limit the practical effectiveness and efficiency of the limited automation provided.

[0005] US patent no. 8662796 proposes the application of net or mesh through automated approach by having a roll of net or mesh in a reel carried by a mining machine and applied during the advance to form the mine passage.

[0006] Continued need is identified for an improved arrangement to facilitate the application of net or mesh to the ceiling or walls of a tunnel. As compared with past approaches, the arrangement would be relatively simple in construction and inexpensive to implement. Yet, it would bring a significant level of advancement in terms of the savings in time and cost realized from its use.

Disclosure of Invention

[0007] It is an objective of the present invention to provide a safer alternative for the reinforcing traditional manual method.

[0008] It is another objective of the present invention to provide a method having a low labour cost for lining tunnel ceilings or tunnel walls with protective nets.

[0009] It is still another objective of the present invention to have an autonomous and independent apparatus to facilitate the installation of protective nets.

[0010] It is yet another objective of the present invention to develop an apparatus for deployment of a protective net for lining tunnel ceilings or tunnel walls, which can work with any bolting machine currently existing on mines to install a protective net relatively fast.

[0011] According to the first aspect of the present invention, it is provided a method for lining tunnel ceilings or tunnel walls with protective nets, comprising the following steps:

(a) placing a roll of protective net on a first telescopic element, said roll of protective net having an end portion;

(b) opening, preferably manually, the protective net from the roll into an extended form;

- (c) placing, preferably manually, said extended protective net over a supporting panel held by a second telescopic element, and preferably the supporting panel is hidden to operate without interferences;
- (d) fixing the end portion of said roll of protective net on a fixation means on a third telescopic element so that the extended protective net is further extendable by adjusting the telescopic elements;
- (e) extending the first and third telescopic elements in opposite direction and along the width of the tunnel, and extending the second telescopic element to the ceiling of the tunnel to deploy said protective net;
- (f) securing said extended protective net on the tunnel ceiling or tunnel walls by implementing anchoring means, and preferably the anchoring means are implemented by an independent extra equipment, e.g. existing bolter.

[0012] After the anchoring operations (f) said method may further comprise a step of (g) pulling back the telescopic elements for continued lining tunnel ceilings or tunnel walls.

[0013] In the method of the present invention, the protective net is first deployed and positioned and thereafter secured or installed on the tunnel ceiling or tunnel walls. On the one hand, this avoids applying a reel movable along the tunnel walls to extend the protective net and controlling rotational movement of a reel as in US8662796. Consequently, the machinery for installing is simplified, becomes lighter and it does not need a special machine available to connect the reel. On the other hand, the method for lining tunnel ceilings or tunnel walls with protective nets of the present invention is fully mechanized. Deploying and positioning the protective net in the present method makes the installation of the protective net faster and has better efficiency than the manual installation.

[0014] According to the method for lining tunnel ceilings or tunnel walls of the present invention, said implementing anchoring means may comprise drilling boreholes at the tunnel ceiling, inserting grout into the boreholes, bolting and installing fastened plates with nuts by an independent extra equipment full dedicated to these functions. Anchoring means may be implemented with individual equipment, e.g. any commercially available

bolter. Preferably, said anchoring means are implemented in the sequence of from one side of the tunnel wall to the other side of the tunnel wall.

[0015] According to the present invention, the protective net in a roll may have a length no less than the required length of protective net for a tunnel section. Preferably, the protective net in a roll have a length of the same as the required length of protective net for a tunnel section. As an example, said extended protective net placed over said supporting panel has two ends: one end is free on the roll of protective net on the first telescopic element and the other end is on the fixation means of the third telescopic element. As an example, the second telescopic element is located on the middle of the stand, and the first and the third telescopic elements are located at two sides respectively and extendable in opposite direction.

[0016] According to the second aspect of the present invention, it is provided an apparatus for deployment of a protective net for lining tunnel ceilings or tunnel walls, comprising:

a first telescopic element having a holding device for holding a roll of protective net for lining tunnel ceilings or tunnel walls, said roll of protective net having an end portion;

a second telescopic element having a supporting panel for supporting and elevating an extended protective net for lining tunnel ceilings or tunnel walls;

a third telescopic element having a fixation means for fixing the end portion of said roll of protective net for lining tunnel ceilings or tunnel walls;

wherein said first, second and third telescopic elements are assembled together on a stand.

There can be more telescopic elements in order to improve the present invention.

[0017] According to the present invention, the first telescopic element and the third telescopic element may be extendable in opposite directions. Preferably, the length of anyone of the fully extended telescopic elements

is about half width of the tunnel. And more preferably, the length of a fully extended second telescopic element is about the height of the tunnel. The first, second and third telescopic elements are assembled together on a stand that operates autonomously and remotely controlled from an outer machine. More preferably, said second telescopic element is supplemented with a supporting panel configured to have a curved surface with a curvature in the same direction of the tunnel ceilings or tunnel walls. The supporting panel may have a length in the range of 2 to 5 meter and a width in the range of 2 to 4 meter. The supporting panel can be made from tubes, e.g. from metal or steel, and preferably tubes made of material that having corrosion resistant and can be easy assembled and welded. The supporting panel may have a fasten means for grabbing said protective net.

- [0018] The first telescopic element may be supplemented with a means for holding the roll of protective net or supporting an axe of the roll. According to the present invention, said first telescopic element is suitable for holding, keeping and sustaining a roll of steel wire mesh for lining tunnel ceilings or tunnel walls. The steel wire mesh may be wound in a roll and said roll may be placed on the axe or unroller system. The roll of steel wire mesh may be installed manually on the holding device at the end of the first telescopic element. The wire mesh can be unwounded from a roll into an extended form. The first telescopic element and said third telescopic element may be extendable to support an extended protective net.
- [0019] The inventive apparatus for lining tunnel ceilings or tunnel walls with protective nets can be applied in a wide range of tunnels. For instance, the tunnels have a width in the range of 3 to 10 meters and have a height in the range of 2 to 15 meters, e.g. a width of 4 m and a height of 2 m, a width of 5 m and a height of 7 m, and a width of 8 m and a height of 12 m.
- [0020] The apparatus can be easily moved from one working place to another as it may be carried on a light truck until the place to reinforce with an extended protective net. In a tunnel, said apparatus can move by its own when it is finished a full section of the tunnel during installation of the extended protective net.

Brief Description of Figures in the Drawings

- [0021] The objects and advantages of the invention will be fully understood from the following more detailed description given by way of example with reference to the accompanying drawing in which:
- [0022] Figure 1 to 7 shows a perspective illustration of a method for lining tunnel ceilings or tunnel walls with protective nets according to the present invention.
- [0023] Figure 8 to 10 respectively shows the front view, upper view and side view of a supporting panel equipped in the apparatus for lining tunnel ceilings or tunnel walls with protective nets according to the present invention.
- [0024] Figure 11 shows a fastening system made to block and fasten the protective net on the supporting panel of the present invention.

Mode(s) for Carrying Out the Invention

- [0025] A method for lining tunnel ceilings or tunnel walls with protective nets is shown step by step in Fig. 1 to 7.
- [0026] Figure 1 shows a perspective illustration of an apparatus for lining tunnel walls and tunnel ceilings with protective nets, equipped with a supporting panel for supporting an unwound protective net. The apparatus as shown in Figure 1 comprises a stand 10, a first moveable telescopic element 11 attached to the stand 10 at one end, a second moveable telescopic element 12 attached to the middle portion of the stand 10 and at a low position, and a third moveable telescopic element 13 attached to the stand 10 at the other end. The other end of the second moveable telescopic element 12 has a supporting panel 15 for supporting an unwound protective net 16. Preferably at the end of the first moveable telescopic element locates a holding device for the axle of a roll of protective net that remains free. Preferably at the end of the third moveable telescopic element locates a fixation device 18 for fixing the end of the wire mesh. In a preferred embodiment, at the end portions of the first moveable telescopic element 11 and the third moveable telescopic element 13 locate individually two pairs of wheels 19 that can support the end portions in

particularly when the first moveable telescopic element 11 and the third moveable telescopic element 13 are in extended form.

- [0027] Figure 2 shows how the protective net 26 used in this invention can be any suitable web-shaped net. As an example, commercially available chain-linked steel wire meshes are used for lining the tunnel. The steel wire meshes preferably have corrosion resistant coating, e.g. zinc or zinc alloy coating. The wire mesh as received is wound in a roll 24 on an axle which can be installed manually on the holding device at the end of the first moveable telescopic element 21 as it is shown in Fig. 2.
- [0028] As shown in Fig. 2, the wire mesh 26 is first opened partially or fully and extended on the stand and placed over the supporting panel 25 that initially remains at a low position with no interferences. The area of intended lining, i.e. the length and width of wire mesh used for one tunnel section, is pre-determined and preferably the center portion of the extended wire mesh is placed on the supporting panel 25 leaving a final part of the roll hanging at the end of the third telescopic element.
- [0029] As an example, the supporting panel 15,25 is designed and optimised to have a particular shape as shown in Figs. 8, 9 and 10 which are respectively front view, upper view and side view of the supporting panel 15,25. The supporting panel 15,25 is preferably made from tubes having corrosion resistant material and being able to be easy assembled and welded. The supporting panel has a specifically designed shape to stably support the wire mesh: as shown in Figs. 8 and 9, two parallel straight tubes 131,141,142 with certain length are connected in their respective center with one curved connecting tube 133,143,153. Preferably, the curvature of the curved connecting tube 133,143,153 is equal or more than the curvature of the tunnel which is to be lined. Such assembled frame is reinforced or strengthened by another four curved reinforcement tubes 135,145, each of which has one end on the one of the two straight tubes 131,141,142 and the other end on the curved connecting tube 133,143,153. Thus, as shown in Fig. 9, the reinforcement tubes 135,145 together with the straight tubes 131,141,142 and the curved connecting tube 133,143,153 form stable triangular structures.

- [0030] In addition, in order to safely handle the protective net on the supporting panel, a fixation system 137,147 is preferably added on the supporting panel. As an example, a fixation system made by pin-cylinders to block and fasten the protective net is placed at each corner of the supporting panel as shown in Fig. 9. At an open position as shown in Fig. 11(a), the pins 161 of the fixation system are hidden and have no contact with the protective net. Thus, the protective net can be moved or removed freely from the supporting panel. While at the closed position as shown in Fig. 11(b), the pins 163 of the fixation system are expanded and the protective net on the supporting net is grabbed so that cannot be moved away from the supporting panel. The protective net is moved together with the supporting panel and held firmly by the supporting panel during operations, e.g. bolting. The pins can be switched between the open and close position via a control, e.g. via hydraulic control, from a remote control unit. When placing the wire mesh 16,26 on the supporting panel 15,25, the pins are hidden (Fig. 11(a)), which make the movement of wire mesh smoothly. While for the following steps, e.g. raising the supporting panel and bolting through the wire mesh, the pins are expanded (Fig. 11(b)) and grab the wire mesh on the supporting panel.
- [0031] As shown in Fig. 3, the first moveable telescopic element 31 and the third moveable telescopic element 33 are extended in opposite direction and their end portion almost reach the tunnel wall thanks to different pairs of wheels 39. The supporting panel 35 on which the middle portion 36 of a wire mesh is grabbed, is then raised from the contract position (as shown in Fig. 3) to the ceiling, preferably to the center of the ceiling, by the second telescopic element 42 as shown in Fig. 4. Preferably, the extended protective net placed over said supporting panel can be grabbed by fasten means like pin-cylinders position at the four corners of the supporting panel (as shown in Fig. 9). The fasten means can be operated by hydraulic control from a remote control. The two end portions of the wire mesh are hold respectively by the roll at the end portion of the first moveable telescopic element 31 and by the fixation device at the end portion of the third moveable telescopic element 38.

- [0032] As shown in Fig. 5, the wire mesh 56 is placed at the right position and to be fixed or installed with a separate bolter 57. One side of the ceiling of the tunnel may be desired to be first lined with the wire mesh. This is carried out by first placing the wire mesh at the right position, drilling through the wire mesh on the ceiling, then followed by inserting grout, bolting and installing the fastened plate. The drilling of boreholes can be carried out through wire meshes. As shown in Fig. 9, the open areas 148 in the supporting panel, which are not hidden by the tubes, can be used for passing through the drilling beam to make boreholes. The supporting panel is used to facilitate the installation of the wire mesh at different location. As shown in Fig. 6, the wire mesh is installed at one side of the ceiling of the tunnel. The cycle of drilling through the wire mesh on the walls of tunnel followed by inserting grout, bolting and installing the fastened plate, is repeated at the other side of the ceiling of the tunnel till the whole section of the tunnel is lined with the wire mesh with the facilitation of the supporting panel as shown in Fig. 7.
- [0033] After a piece of wire mesh is completely fixed on one section of the tunnel as shown in Fig. 7, the supporting panel moves to next section of the tunnel to be lined and is reloaded with another piece of wire mesh. The time required for installation of wire meshes according to the method of the present invention is comparably less than the traditional methods.

Claims

1. A method for lining tunnel ceilings or tunnel walls with protective nets fully mechanized, comprising the following steps:
 - (a) placing a roll of protective net on a first telescopic element, said roll of protective net having an end portion;
 - (b) opening the protective net from the roll into an extended form;
 - (c) placing said extended protective net over a supporting panel held by a second telescopic element;
 - (d) fixing the end portion of said roll of protective net on a fixation means on a third telescopic element so that the extended protective net is further extendable by adjusting the telescopic elements;
 - (e) extending the first and third telescopic elements in opposite direction and along the width of the tunnel, and extending the second telescopic element to the ceiling of the tunnel to deploy said protective net;
 - (f) securing said extended protective net on the tunnel ceiling or tunnel walls by implementing anchoring means.
2. A method for lining tunnel ceilings or tunnel walls with protective nets fully mechanized according to claim 1, wherein said method further comprises a step of (g) pulling back the telescopic elements for continued lining tunnel ceilings or tunnel walls.
3. A method for lining tunnel ceilings or tunnel walls with protective nets fully mechanized according to claim 1 or 2, wherein said implementing anchoring means comprise drilling boreholes at the tunnel ceiling, inserting grout into the boreholes, bolting and installing fastened plates with nuts.
4. A method for lining tunnel ceilings or tunnel walls with protective nets fully mechanized according to any one of the preceding claims, wherein said anchoring means are implemented in the sequence of from one side of the tunnel wall to the other side of the tunnel wall.
5. A method for lining tunnel ceilings or tunnel walls with protective nets fully mechanized according to any one of the preceding claims, wherein the protective net in a roll have a length no less than the required length of protective net for a tunnel section.

6. A method for lining tunnel ceilings or tunnel walls with protective nets fully mechanized according to any one of the preceding claims, wherein said extended protective net placed over said supporting panel has two ends, wherein one end is free on the roll of protective net on a first telescopic element and the other end is on the fixation means of the third telescopic element.
7. An apparatus for deployment of a protective net for lining tunnel ceilings or tunnel walls, comprising:
 - a first telescopic element having a holding device for holding a roll of protective net for lining tunnel ceilings or tunnel walls, said roll of protective net having an end portion;
 - a second telescopic element having a supporting panel for supporting and elevating an extended protective net for lining tunnel ceilings or tunnel walls;
 - a third telescopic element having a fixation means for fixing the end portion of said roll of protective net for lining tunnel ceilings or tunnel walls;wherein said first, second and third telescopic elements are assembled together on a stand.
8. An apparatus for deployment of a protective net for lining tunnel ceilings or tunnel walls according to claim 7, wherein the first telescopic element and the third telescopic element are extendable in opposite directions.
9. An apparatus for deployment of a protective net for lining tunnel ceilings or tunnel walls according to claim 7 or 8, wherein the length of any one of the fully extended telescopic elements is about half width of the tunnel.
10. An apparatus for deployment of a protective net for lining tunnel ceilings or tunnel walls according to any one of claims 7 to 9, wherein said second telescopic element is supplemented with a supporting device configured to provide a curved surface to the protective net with a curvature in the same direction of the tunnel ceilings or tunnel walls.
11. An apparatus for deployment of a protective net for lining tunnel ceilings or tunnel walls according to claim 10, wherein said supporting device has a fastening means for grabbing said protective net.
12. An apparatus for deployment of a protective net for lining tunnel ceilings or tunnel walls according to any one of claims 7 to 11, wherein said first

telescopic element is suitable for holding, keeping and sustaining a roll of steel wire mesh.

13. An apparatus for deployment of a protective net for lining tunnel ceilings or tunnel walls according to any one of claims 7 to 12, wherein said first, second and third telescopic elements are extendable to support an extended protective net.
14. An apparatus for deployment of a protective net for lining tunnel ceilings or tunnel walls according to any one of claims 7 to 13, wherein said apparatus is adapted to be carried on a light truck until the place to reinforce with the protective net.
15. An apparatus for deployment of a protective net for lining tunnel ceilings or tunnel walls according to any one of claims 7 to 14, wherein said apparatus is movable by its own when it is finished a full section of tunnel while installation of the protective net.

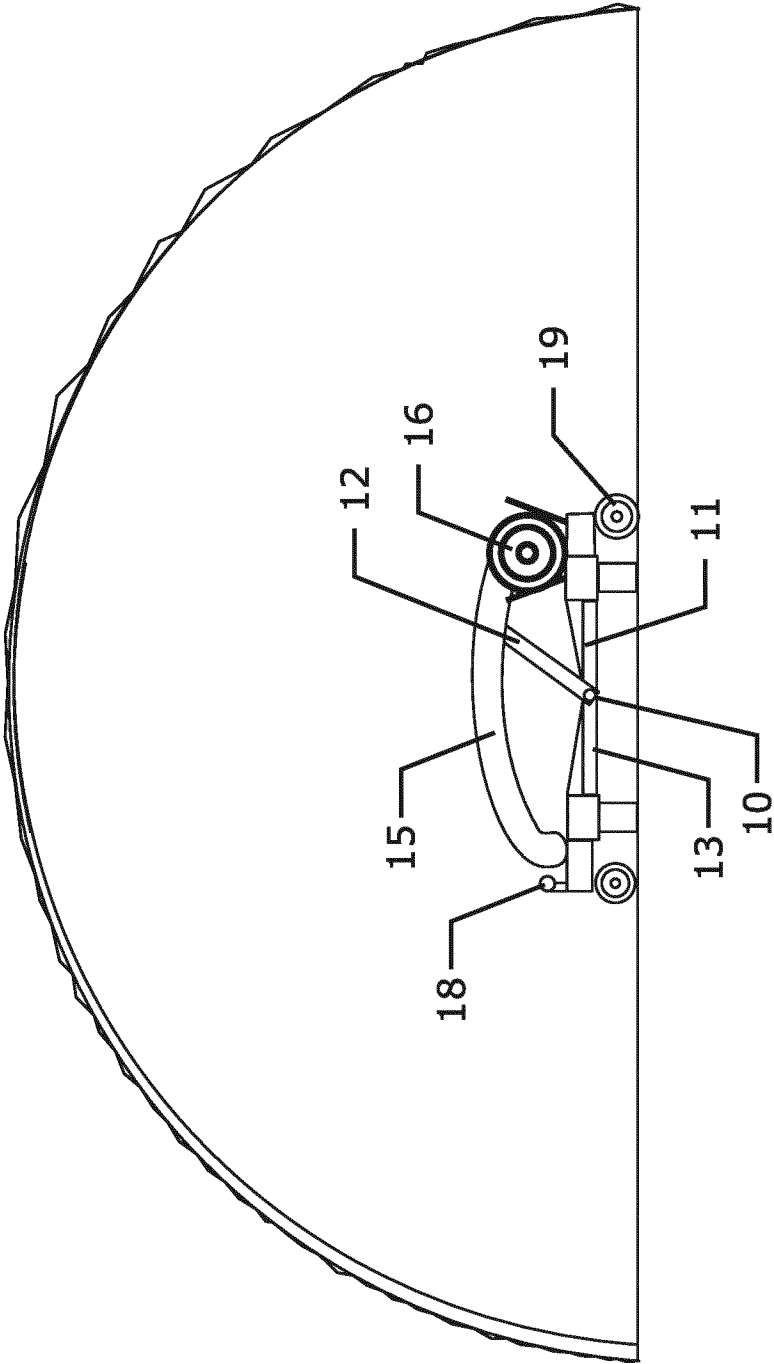


Fig. 1

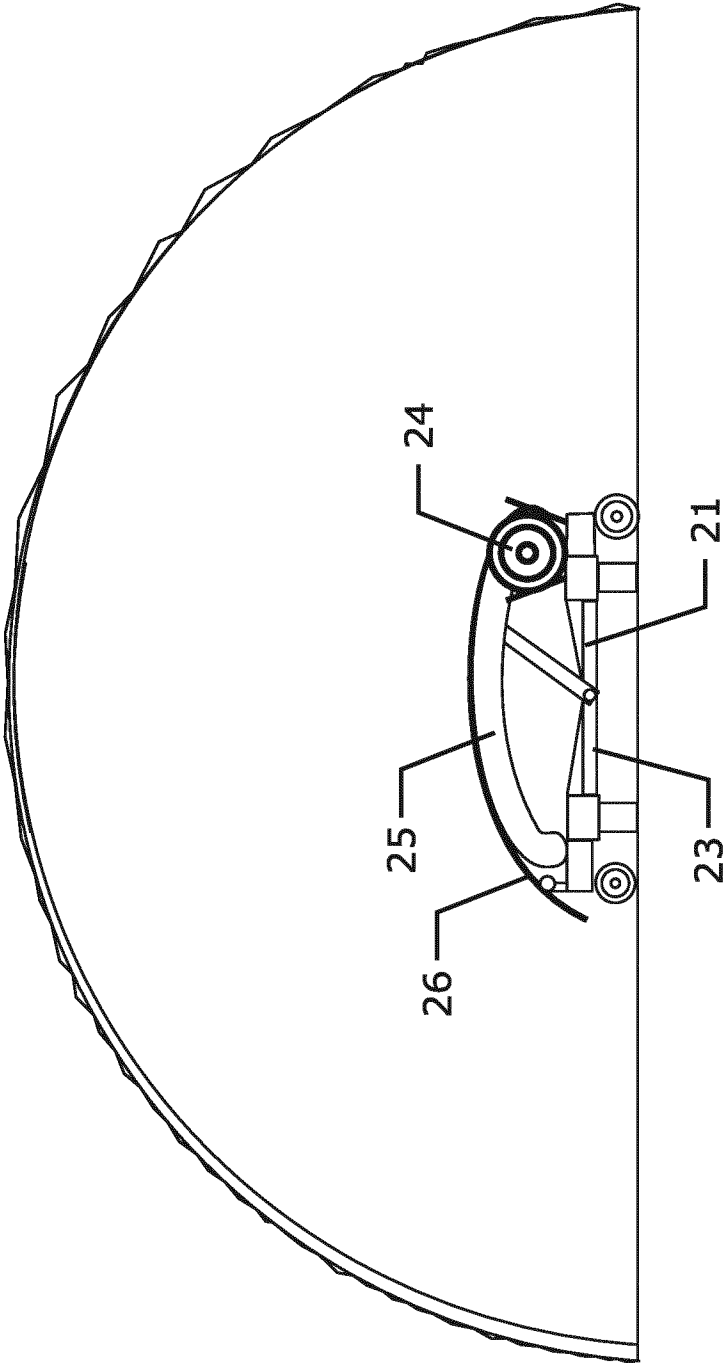


Fig. 2

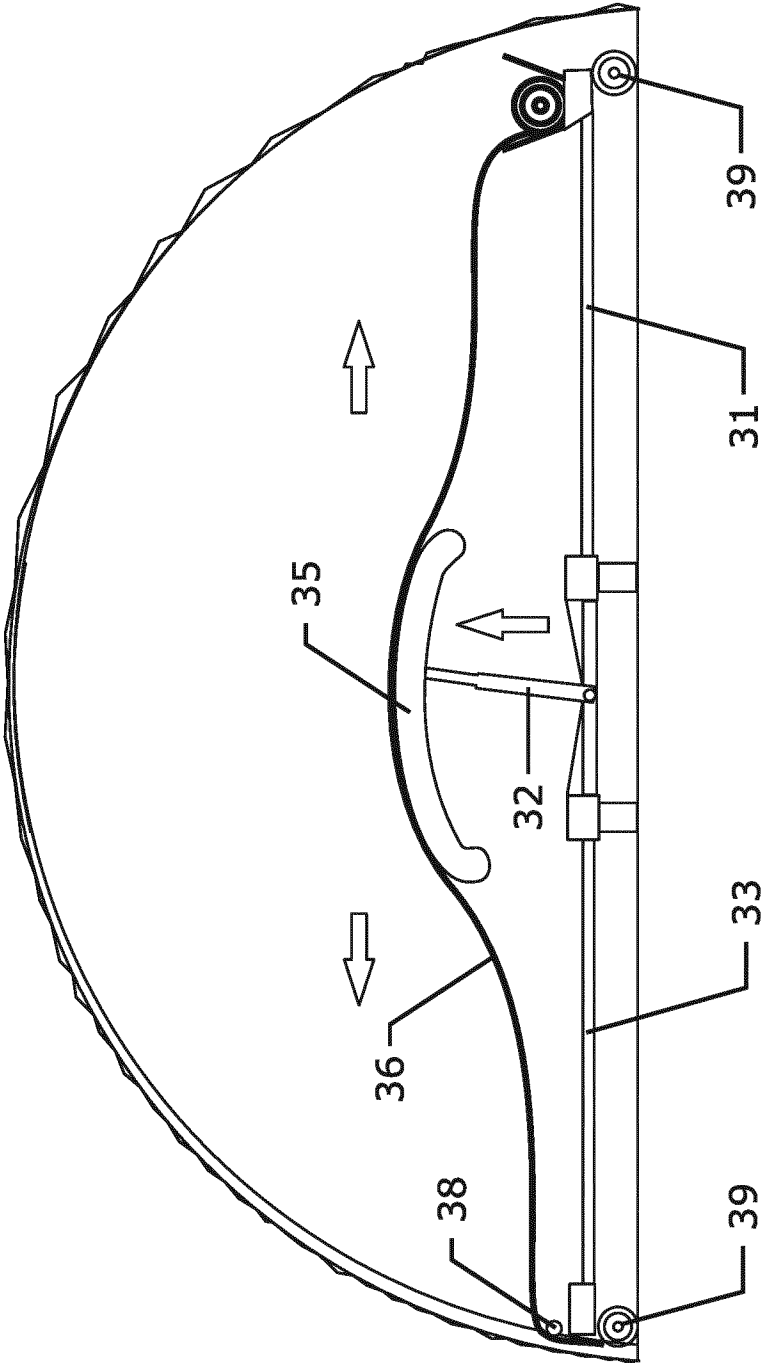


Fig. 3

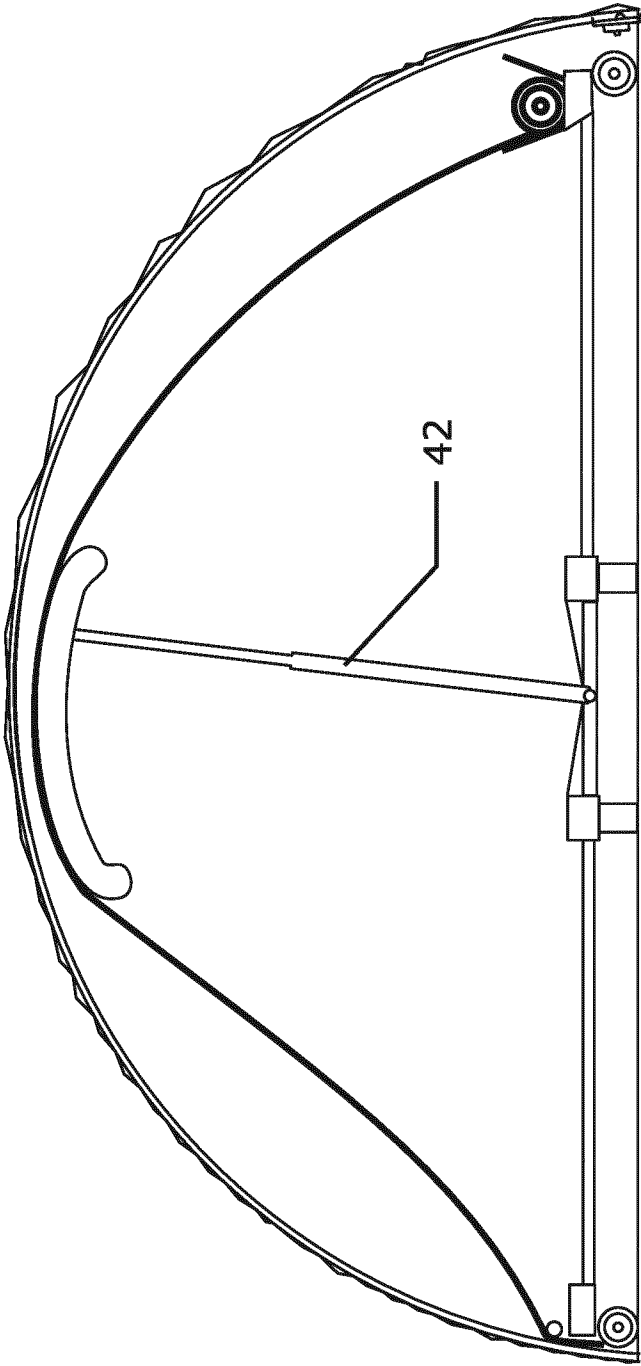


Fig. 4

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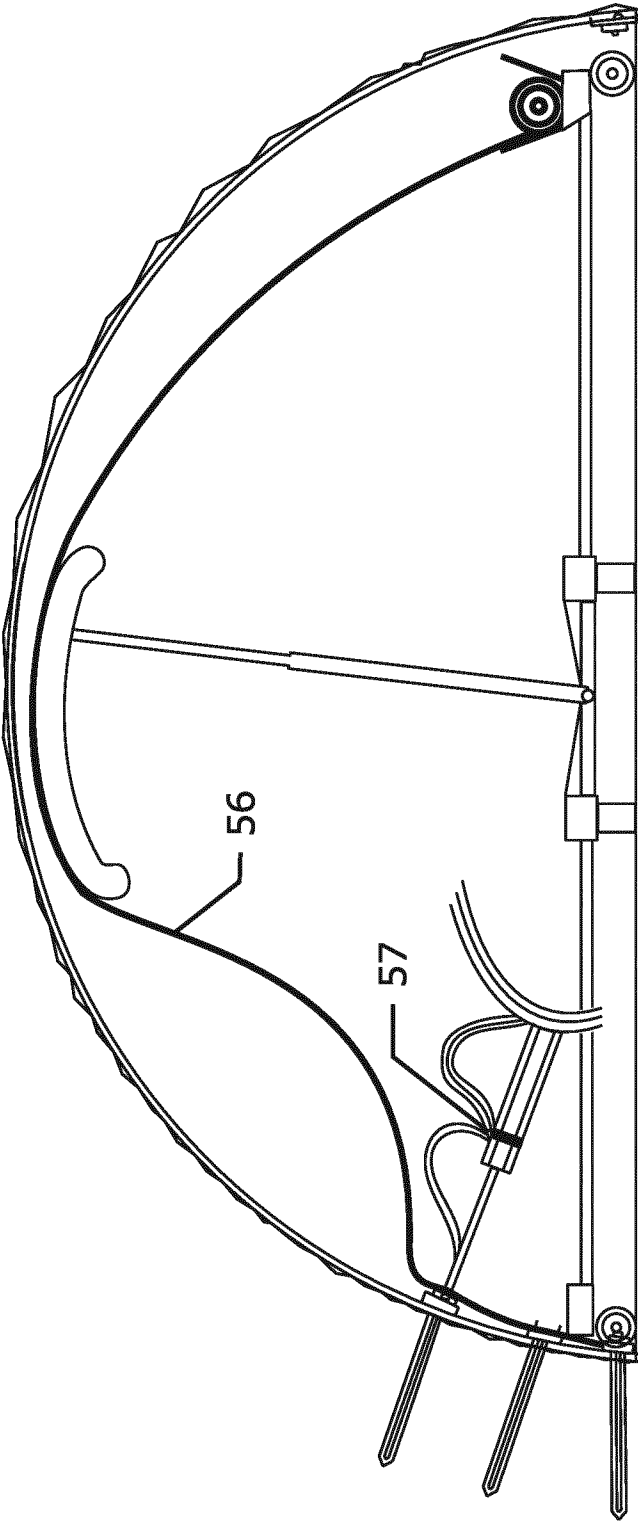


Fig. 5

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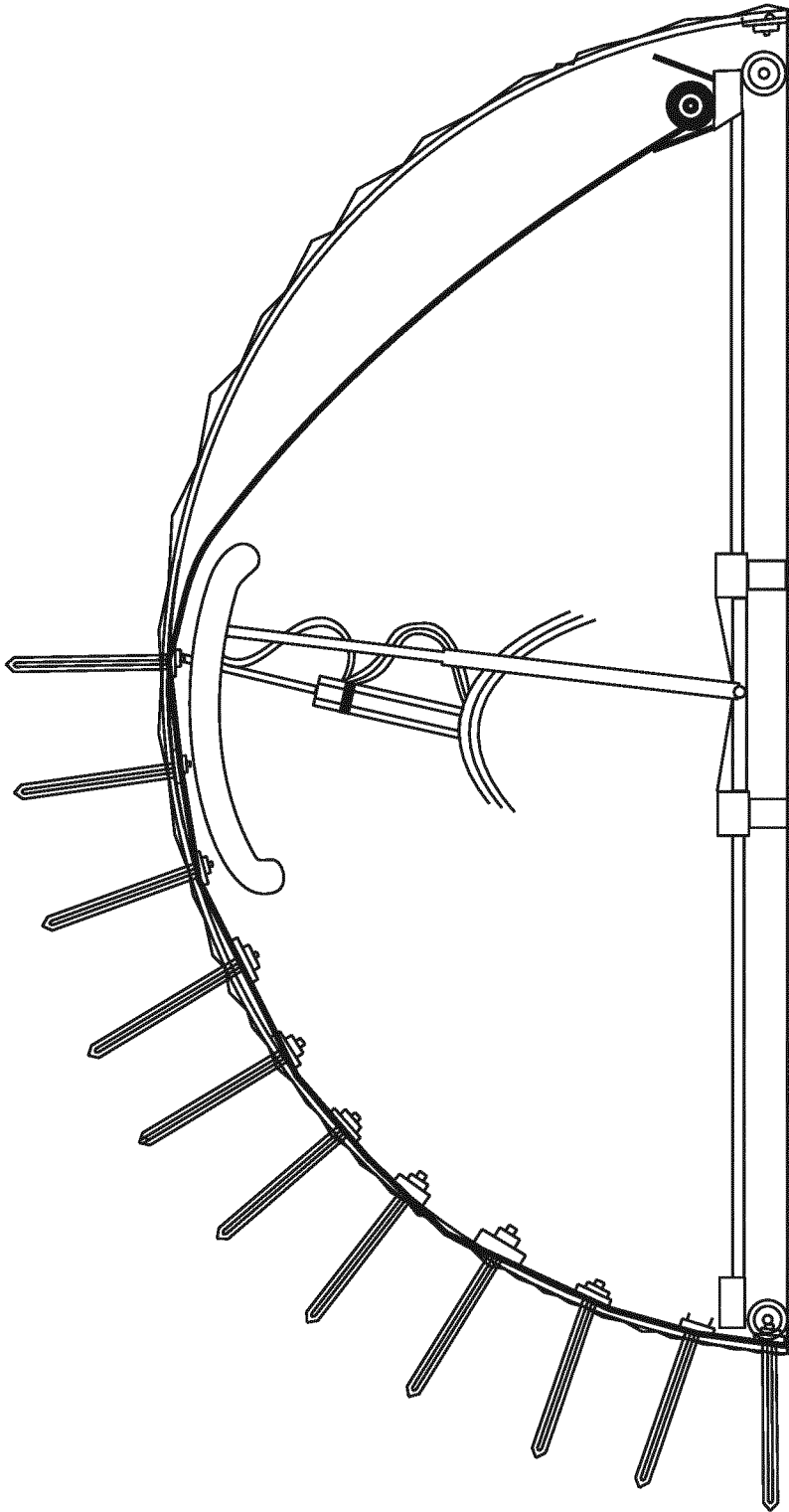


Fig. 6

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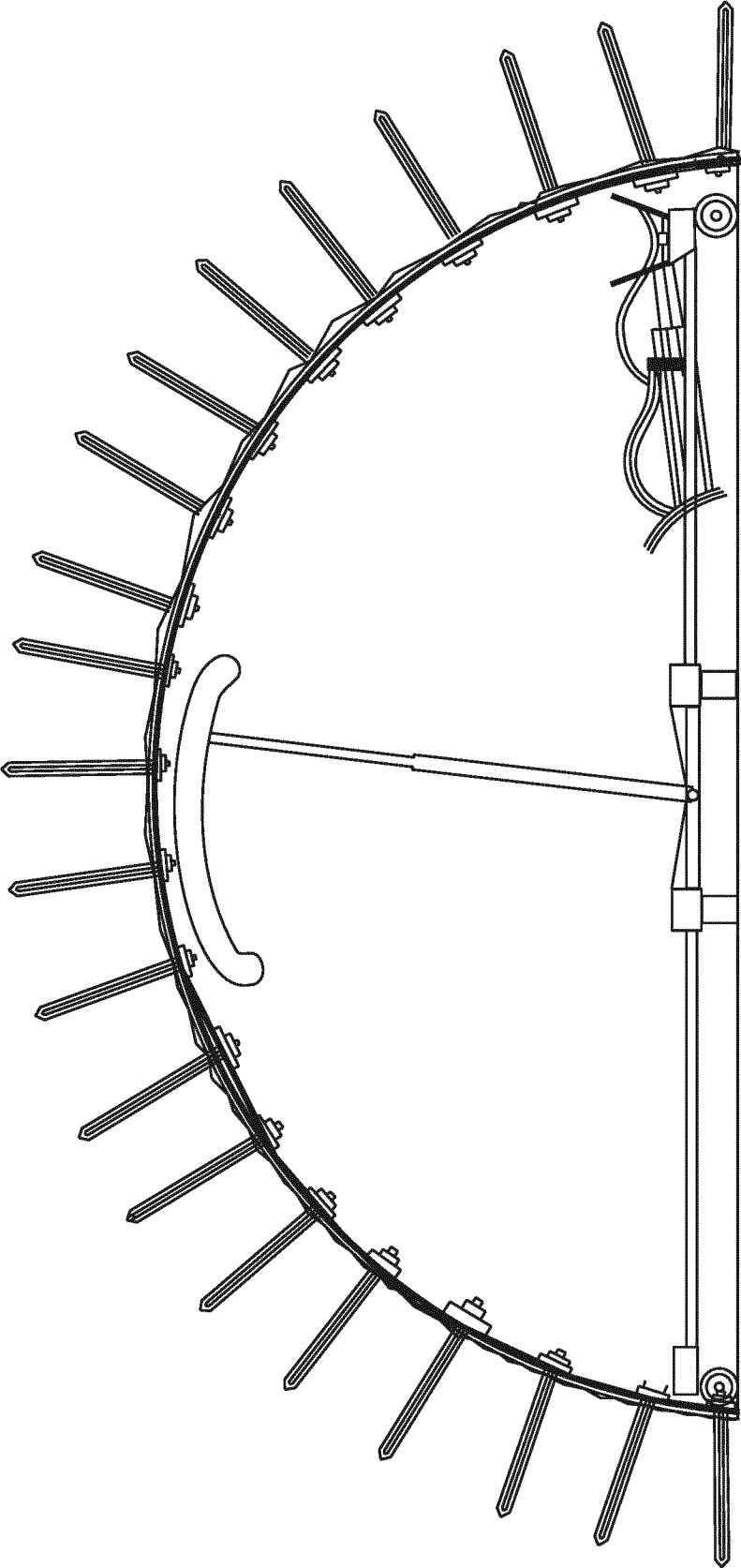


Fig. 7

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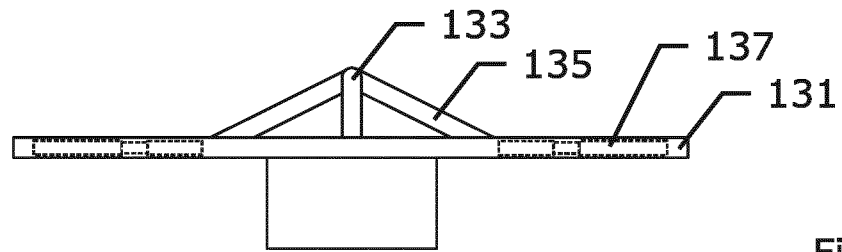


Fig. 8

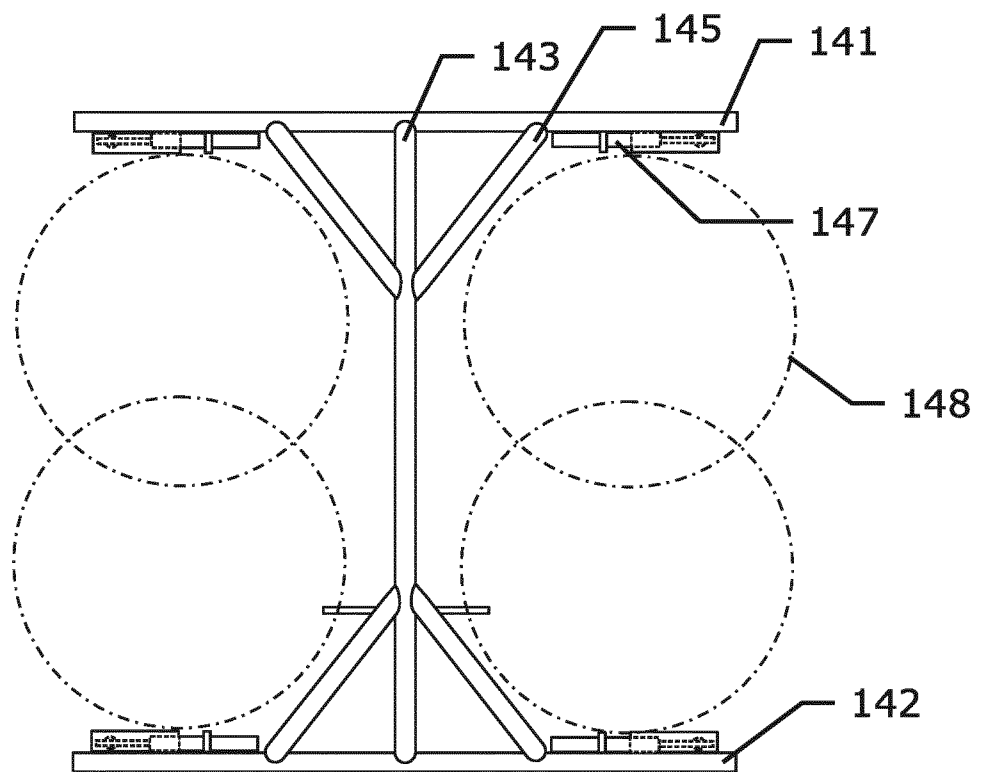


Fig. 9

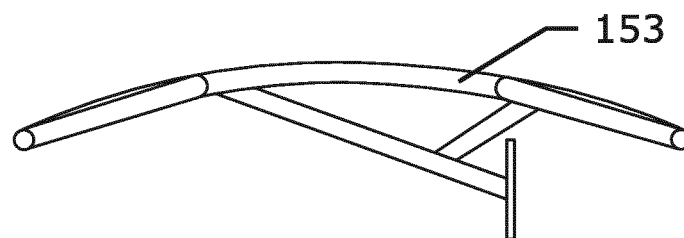


Fig. 10

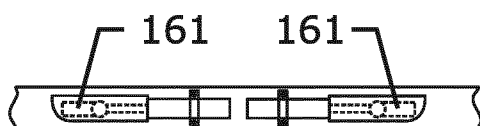


Fig. 11a

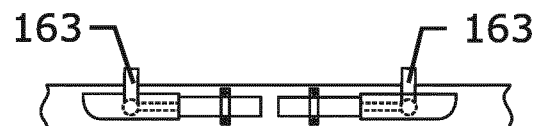


Fig. 11b

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2017/080928

A. CLASSIFICATION OF SUBJECT MATTER

INV. E21D11/15 E21D11/38 E21D11/40
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)
E21D

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	US 8 137 033 B1 (HINSHAW GREGORY E [US] ET AL) 20 March 2012 (2012-03-20) column 4, lines 1-44; figures 2,2a-c,4,4a-c,6a,6b column 5, line 34 - column 6, line 30 column 7, lines 20-36 claims 3,12,17 the whole document column 7, lines 39-43 -----	7,9-15
A	DE 28 36 659 A1 (EBELING WOLFGANG DIPL ING) 6 March 1980 (1980-03-06) claim 14; figures 1,2,6 the whole document -----	1,7,8
A	US 4 505 622 A (ASSZONYI CSABA [HU] ET AL) 19 March 1985 (1985-03-19) the whole document -----	1



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

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Date of mailing of the international search report

09/02/2018

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2017/080928

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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