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(71) Applicant *(for all designated States except CL)*: **NV BEKAERT SA** [BE/BE]; Bekaertstraat 2, 8550 Zwevegem (BE).

(71) Applicant *(for CL only)*: **INCHALAM SA - INDUSTRIAS CHILENAS DE ALAMBRE** [CL/CL]; Avenida Gran Bretana N°2675Casilla 7-d, Talcahuano (CL).

(72) Inventors: **CARRIEL SANHUEZA, Hugo**; Avenida Gran Bretana N° 2675Casilla 7-D, 4260000 Talcahuano (CL). **EULUFI VILLENA, Miguel**; Avenida Gran Bretana N° 2675Casilla 7-D, 4260000 Talcahuano (CL).

(74) Agent: **MESSELY, Marc**; Bekaertstraat 2, 8550 ZWEVEGEM (BE).

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(54) Title: PACKAGE OF STEEL WIRE MESH, METHOD AND APPARATUS FOR INSTALLING IT AGAINST TUNNEL WALLS

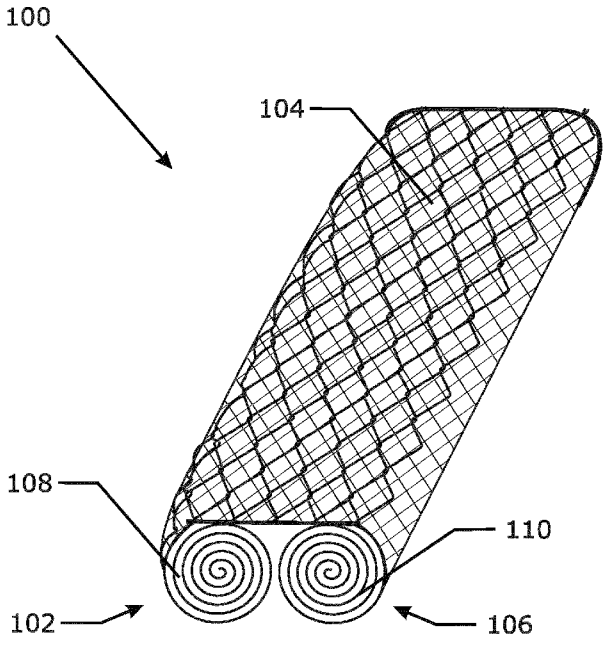



Fig. 1

(57) Abstract: A package (100) of steel wire mesh comprises a steel wire mesh. The steel wire mesh has consecutively along its length direction a first section (102), a second section (104) and a third section (106). The first section is coiled thereby providing a first roll (108) of steel wire mesh. The third section is coiled separately from the first section thereby providing a second roll (110) of steel wire mesh. The second section provides the transition between the first roll of steel wire mesh and the second roll of steel wire mesh. The invention also relates to an apparatus for unwinding such a package of steel wire mesh and to a method of lining a tunnel wall or ceiling with such a package of steel wire mesh.

*[Continued on next page]*

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— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*
— *of inventorship (Rule 4.17(iv))*

**Published:**

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# Title: Package of steel wire mesh, method and apparatus for installing it against tunnel walls

## Description

### Technical Field

[1] The invention relates to a particular make up of steel wire mesh, to a method of installing such steel wire mesh against tunnel walls and tunnel ceilings in order to function as protective nets; as well as to an apparatus for holding and unwinding the steel wire mesh and for performing the installation of the steel wire mesh against walls or ceilings of tunnels.

### Background Art

[2] Tunnels in underground mining or in other civil works have walls and ceilings. It is often necessary to install a web-like net or mesh along the walls and ceilings. The main role of the net or mesh is to prevent fragments of rock from falling from the ceiling or the walls. The mesh is traditionally provided as a roll of mesh material. The mesh or net can be anchored to the walls or ceiling by means of anchors or bolts. It is a challenge to unwind the of mesh material and install the mesh in a reliable, automatic and safe manner.

[3] US2011/150575A describes a method for lining tunnel walls or ceilings with protective nets. The web-shaped protective net material is unwound from a reel and is fastened to the tunnel walls or ceiling by means of tie bolts. The reel is rotatably arranged. The rotation of the reel about a shaft is controlled in order to unwind the protective net material. The shaft is mechanically moved in steps along the tunnel walls or ceiling together with the reel. The protective net material unwound in each step is preferably stretched and mechanically fastened by means of tie bolts.

[4] WO2017/207712A1 discloses an apparatus for lining tunnel ceilings or tunnel walls with protective nets. The apparatus comprises a main unit, a first movable arm, and a supporting panel. The first movable arm has a first end and a second end. The first end is provided for being attached to a main unit. The supporting panel is attached to the second end of the first

movable arm. The supporting panel is configured to have a curved surface and the supporting panel is provided for supporting an extended protective net. The protective net can be positioned against the tunnel walls while it is supported by the supporting panel, after which the protective net can be fixed onto the tunnel walls.

## Disclosure of Invention

[5] The first aspect of the invention is a package of steel wire mesh. The package comprises a steel wire mesh. The steel wire mesh has consecutively along its length direction a first section, a second section and a third section. The first section is coiled thereby providing a first roll of steel wire mesh. The third section is coiled separately from the first section thereby providing a second roll of steel wire mesh. The second section provides the transition between the first roll of steel wire mesh and the second roll of steel wire mesh.

[6] The invention has the benefit that manual handling of the steel wire mesh can be reduced to a bare minimum and that the steel wire mesh can be fixed onto the walls and ceiling of tunnels in a reliable manner. It is a further benefit that the invention allows to attach a steel mesh first with bolts at it is central part to the tunnel ceiling or walls. This way – and unlike when using prior art reel unwinding systems -, once the central part of the mesh is fixed with a small number of bolts, the team performing the bolting operation is free to interrupt the bolting operation of the wire mesh e.g. if they are required for maintenance or for other jobs.
It is a further benefit that the steel wire mesh can be easily installed in the correct position against tunnel ceilings and tunnel walls by positioning the second section of the steel wire mesh against the center of the tunnel ceiling. This cannot be done easily with traditional rolls or reels of steel wire mesh which would require extra material handling.

[7] In a preferable embodiment of the invention, the steel wire mesh has a breaking load in its length direction that is substantially equal over all the sections, i.e. over the first section, the second section and the third section. More particularly, although the second section may be subjected

to tensile forces exercised by the first and the third section that go in opposite directions, there is no need to reinforce this second section.

[8] Preferably, the steel wire mesh is coiled in the second roll in opposite direction from the direction of coiling of the steel wire mesh in the first roll.

[9] Preferably, the length of steel wire mesh in the first section is substantially equal to – and preferably equal to - the length of steel wire mesh in the third section.

[10] Preferably, the second section of the steel wire mesh comprises a part that is configured in a plane.

[11] Preferably, the axis of the first roll of steel wire mesh is parallel with the axis of the second roll of steel wire mesh.

[12] Preferably, the first roll of steel wire mesh touches the second roll of steel wire mesh. More preferably the first roll touches the second roll wherein the contact line or contact surface is parallel with the axes of the first roll and the second roll.

[13] Preferably, the steel wire mesh comprises a metallic coating. A more preferred steel wire mesh comprising a zinc metallic coating or a zinc-aluminum alloy metallic coating.

[14] Preferably, the steel wire mesh is a chain link steel wire mesh.

[15] The second aspect of the invention is an apparatus for unwinding a package of steel wire mesh as in any embodiment of the first aspect of the invention. The apparatus comprises a middle segment, a first set of arms at a first side of the middle segment and a second set of arms at the side of the middle segment opposite to the first side. The first set of arms and the second set of arms are provided to unfold such that the first set of arms, the middle segment and the second set of arms form a platform onto which the package of steel wire mesh can be unwound. A package of steel wire mesh as in any embodiment of the first aspect of the invention can be positioned on the middle segment with the second section of the steel wire mesh directed downwards on the middle segment. The package of steel wire mesh can be unwound on the platform. The first roll of steel wire mesh can unwind in one direction, and the second roll of steel wire

mesh can unwind in the direction opposite to the direction of unwinding of the first roll of steel wire mesh.

[16] A preferred apparatus comprises a gripper for gripping a package of steel wire mesh as in any embodiment of the first aspect of the invention, while the second section of the steel wire mesh is at the top of the steel wire mesh. The apparatus is provided for being turned upside down after gripping the package of steel wire mesh as in any embodiment of the first aspect of the invention, such that the package of steel wire mesh is positioned with its second section onto the middle segment of the apparatus - and more preferably with the second section on the middle of the middle segment. More preferably, the first set of arms and the second set of arms provide in combination the gripper.

[17] In a preferred embodiment, the apparatus is provided for being turned upside down after gripping the package of steel wire mesh as in any embodiment of the first aspect of the invention, such that the package of steel wire mesh is positioned with its second section onto the middle segment of the apparatus; and preferably with the second section on the middle of the middle segment. The first set of arms and the second set of arms are provided to unfold such that the first set of arms, the middle segment and the second set of arms form a platform onto which the package of steel wire mesh can be unwound. A package of steel wire mesh as in any embodiment of the first aspect of the invention can be positioned on the middle segment with the second section of the steel wire mesh directed downwards on the middle segment. The first set of arms as well as the second set of arms are oriented downwards with respect to the middle segment of the apparatus. This way, the first roll of steel wire mesh and the second roll of steel wire mesh can unwind by themselves by rolling over the first set of arms and the second set of arms respectively. The first roll of steel wire mesh can unwind in a first direction, and the second roll of steel wire mesh can unwind in the direction opposite to the direction of unwinding of the first roll of steel wire mesh. This way, an automatic, controlled and reliable unwinding of the package of steel wire mesh is obtained.

[18] A preferred apparatus comprises means for mechanically attaching the apparatus to a device for lining a tunnel wall or tunnel ceiling with a web-like material. Advantageously, the device for lining a tunnel wall or tunnel ceiling onto which the preferred apparatus can be attached is a drilling jumbo, e.g. a conventional drilling jumbo. With a drilling jumbo is meant a rock drilling machine as is used for drilling tunnels and/or in underground mining.

[19] The third aspect of the invention is an equipment for lining a tunnel wall or tunnel ceiling with a steel wire mesh. The equipment comprises a main unit and an apparatus as in any embodiment of the second aspect of the invention. The main unit comprises a first moveable arm. Preferably, the first arm is telescopic. The apparatus is attached to the first moveable arm, such that a package of steel wire mesh as in any embodiment of the first aspect of the invention held in the apparatus can be unwound on the platform and attached onto a tunnel wall or tunnel ceiling. Advantageously, the main unit is a drilling jumbo, e.g. a conventional drilling jumbo. Advantageously, the main unit has a chassis.

[20] A preferred equipment is provided with actuators for moving the arms of the first set of arms and for moving the arms of the second set of arms of the apparatus of the second aspect of the invention. More preferably, the actuators are hydraulic actuators. Preferably, four actuators are provided, one for each arm of the first set of arms and one for each arm of the second set of arms.

[21] The main unit of a preferred equipment comprises a second movable arm – preferably telescopic – provided with an anchoring device for fastening the steel wire mesh onto a tunnel wall or a tunnel ceiling. Preferably, the steel wire mesh is fastened onto the tunnel wall or tunnel ceiling by means of anchoring bolts.

[22] The fourth aspect of the invention is a method of lining a tunnel wall or a tunnel ceiling with a steel wire mesh. A package of steel wire mesh is provided as in any embodiment of the first aspect of the invention. An apparatus is used as in any embodiment of the second aspect of the invention, or an equipment is used as in any embodiment of the third

aspect of the invention. The package of steel wire mesh as in any embodiment of the first aspect of the invention is unrolled on the platform. The unwound steel wire mesh is positioned onto the tunnel wall or tunnel ceiling.

[23] In a preferred method, the steel wire mesh is fastened onto the tunnel ceiling or tunnel wall. Preferably, the fastening is performed by means of anchoring bolts. In preferred embodiments of the method wherein an equipment is used as in any embodiment of the third aspect of the invention, the equipment comprises a second movable arm – preferably telescopic – provided with an anchoring device performing the fastening of the steel wire mesh onto a tunnel wall or a tunnel ceiling, preferably by means of anchoring bolts.

[24] A preferred method comprises the additional steps of
- gripping the package of steel wire mesh with the apparatus as in any embodiment of the second aspect of the invention while the second section of the steel wire mesh is at the top of the steel wire mesh;
- turning the apparatus upside down such that the package of steel wire mesh is positioned with its second section onto the middle segment – and preferably at the middle of the middle segment - of the apparatus; and
- unrolling the package of steel wire mesh on the platform. Preferably, the first roll and the second roll are each unrolled, thereby positioning the steel wire mesh on the platform.

[25] In a preferred method the apparatus turns upside down after gripping the package of steel wire mesh, such that the package of steel wire mesh is positioned with its second section onto the middle segment of the apparatus; and preferably with the second section on the middle of the middle segment. The first set of arms and the second set of arms are provided to unfold – preferably slowly - such that the first set of arms, the middle segment and the second set of arms form a platform onto which the package of steel wire mesh can be unwound. The package of steel wire mesh as in any embodiment of the first aspect of the invention is then positioned on the middle segment with the second section of the steel wire mesh directed downwards on the middle segment. After their unfolding, the first set of arms as well as the second set of arms are oriented

downwards with respect to the middle segment of the apparatus; allowing the first roll of steel wire mesh and the second roll of steel wire mesh to unwind by rolling over the first set of arms and the second set of arms respectively, the two rolls being unwound in opposite directions. An automatic, controlled and reliable unwinding of the package of steel wire mesh is obtained.

## Brief Description of Figures in the Drawings

[26] Figure 1 shows an example of a package of steel wire mesh of the first aspect of the invention.
Figures 2-7 illustrate an apparatus according to the second aspect of the invention and a method according to the fourth aspect of the invention.
Figure 8 shows an example of an apparatus according to the second aspect of the invention.

## Mode(s) for Carrying Out the Invention

[27] Figure 1 shows an example of a package 100 of steel wire mesh of the first aspect of the invention. The package comprises a chain link steel wire mesh. The steel wire mesh has consecutively along its length direction a first section 102, a second section 104 and a third section 106. The first section is coiled providing a first roll 108 of steel wire mesh. The third section is coiled separately from the first section providing a second roll 110 of steel wire mesh. The steel wire mesh is coiled in the second roll in the opposite direction of the direction of coiling of the steel wire mesh in the first roll. The axis of the first roll of steel wire mesh is parallel with the axis of the second roll of steel wire mesh. The length of steel wire mesh in the first section is equal to the length of steel wire mesh in the third section. The second section provides the transition between the first roll of steel wire mesh and the second roll of steel wire mesh. The second section comprises a part that is configured in a plane.

[28] Figures 2-7 illustrate an apparatus 220 according to the second aspect of the invention and a method according to the fourth aspect of the invention. The apparatus comprises a middle segment 222, a first set of arms 224 at

a first side of the middle segment and a second set of arms 226 at the side of the middle segment opposite to the first side. The exemplary apparatus comprises a gripper for gripping a package of steel wire mesh 200 of the first aspect of the invention while the second section of the steel wire mesh is at the top of the steel wire mesh. The first set of arms and the second set of arms provide in combination the gripper of the exemplary apparatus. The apparatus comprises means 230 for mechanically attaching the apparatus to a device for lining a tunnel wall or tunnel ceiling with a web-like material. The device for lining a tunnel wall or tunnel ceiling onto which the preferred apparatus can be attached is a drilling jumbo. The apparatus is turned upside down after gripping the package of steel wire mesh, such that the package of steel wire mesh is positioned with its second section onto the middle segment of the apparatus, at the middle of the middle segment; and with the second section of the steel wire mesh downwards on the middle segment. The first set of arms and the second set of arms subsequently unfold such that the first set of arms, the middle segment and the second set of arms form a platform. After their unfolding, the first set of arms as well as the second set of arms are oriented downwards with respect to the middle segment of the apparatus; allowing the first roll of steel wire mesh and the second roll of steel wire mesh to unwind by rolling over the first set of arms and over the second set of arms respectively. This way, an automatic, controlled and reliable unwinding of the package of steel wire mesh is obtained. The apparatus can then be lifted such that the platform (and the unrolled steel wire mesh) is positioned onto the tunnel wall or tunnel ceiling. The steel wire mesh can then be fastened to the tunnel ceiling and tunnel walls by means of anchoring bolts. The anchoring can be started from the middle of the steel wire mesh, working further toward both sides.

[29] Figure 2 shows the apparatus 220 and the package of steel wire mesh 200 before the package is taken up by the apparatus.

[30] Figure 3 shows the apparatus 220 being moved towards the package 200 of steel wire mesh in order to grip it.

[31] Figure 4 shows the package 200 of steel wire mesh being gripped by the first set of arms 224 and by the second set of arms 226 of the apparatus 220.

[32] Figure 5 shows the apparatus 220 turned upside down; and the first set of arms 224 and the second set of arms 226 starting to unfold.

[33] Figure 6 shows the apparatus 220 after the first set of arms 224 and over the second set of arms are completely unfolded.

[34] Figure 7 shows the steel wire mesh 240 after the first roll and the second roll of the package of steel wire mesh have uncoiled on the platform of the apparatus 220.

[35] Figure 8 shows an example of another type of apparatus 320 according to the second aspect of the invention. The apparatus comprises a middle segment 322, a first set of arms 324 at a first side of the middle segment and a second set of arms 326 at the side of the middle segment opposite to the first side. The first set of arms and the second set of arms are provided to unfold such that the first set of arms, the middle segment and the second set of arms form a platform onto which the package of steel wire mesh can be unwound. The exemplary apparatus comprises a gripper 340 for gripping - when the apparatus is turned down for the gripper to be able to grip - a package of steel wire mesh of the first aspect of the invention while the second section of the steel wire mesh is at the top of the steel wire mesh. After turning the apparatus upside down and after opening the gripper, the package of steel wire mesh (e.g. the package shown in figure 1) can be positioned on the middle segment with the second section of the steel wire mesh downwards on the middle segment. The package of steel wire mesh can be unwound on the platform in the similar way as illustrated in figures 5 – 7.

## Claims

1. Package of steel wire mesh,
comprising a steel wire mesh;
wherein the steel wire mesh has consecutively along its length direction a first section, a second section and a third section;
wherein the first section is coiled thereby providing a first roll of steel wire mesh;
wherein the third section is coiled separately from the first section thereby providing a second roll of steel wire mesh; and
wherein the second section provides the transition between the first roll of steel wire mesh and the second roll of steel wire mesh.

2. The package of steel wire mesh according to claim 1,
said steel wire mesh having a breaking load in its length direction that is substantially equal over said first section, said second section and said third section.

3. The package of steel wire mesh as in claim 1 or claim 2,
wherein the steel wire mesh is coiled in the second roll in the opposite direction from the direction of coiling of the steel wire mesh in the first roll.

4. The package of steel wire mesh an in any of the preceding claims, wherein the length of steel wire mesh in the first section is substantially equal to the length of steel wire mesh in the third section.

5. The package of steel wire mesh as in any of the preceding claims, wherein the second section comprises a part wherein the steel wire mesh is configured in a plane.

6. The package of steel wire mesh as in any of the preceding claims, wherein the steel wire mesh is a chain link steel wire mesh.

7. Apparatus for unwinding a package of steel wire mesh as in any of the preceding claims 1 - 6;
the apparatus comprises a middle segment, a first set of arms at a first side of the middle segment and a second set of arms at the side of the middle segment opposite to the first side;
wherein the first set of arms and the second set of arms are provided to unfold such that the first set of arms, the middle segment and the second set of arms form a platform;
wherein a package of steel wire mesh as in any of the preceding claims 1 - 5 can be positioned on the middle segment with the second section of the steel wire mesh downwards on the middle segment; and wherein the package of steel wire mesh can be unwound on the platform.

8. The apparatus as in claim 7,
wherein the apparatus comprises a gripper for gripping a package of steel wire mesh as in any of the preceding claims 1 to 6 while the second section of the steel wire mesh is at the top of the steel wire mesh;
and wherein the apparatus is provided for being turned upside down after gripping the package of steel wire mesh as in any of the preceding claims 1 to 6, such that the package of steel wire mesh is positioned with its second section onto the middle segment of the apparatus.

9. The apparatus as in claim 8, wherein the first set of arms and the second set of arms provide in combination the gripper.

10. The apparatus as in any of the preceding claims 7 to 9, wherein the apparatus comprises means for mechanically attaching the apparatus to a device for lining a tunnel wall or tunnel ceiling with a web-like material.

11. Equipment for lining a tunnel wall or tunnel ceiling with a steel wire mesh; comprising
- a main unit; and
- an apparatus as in any of the preceding claims 7 to 10,

wherein the main unit comprises a first moveable arm – preferably telescopic -;
wherein the apparatus is attached to the first moveable arm, such that a package of steel wire mesh as in any of the preceding claims 1 to 6 held in the apparatus can be unwound on the platform and attached onto a tunnel wall or tunnel ceiling.

12. The equipment as in claim 11;
wherein the equipment is provided with actuators – preferably with hydraulic actuators – for moving the arms of the first set of arms and for moving the arms of the second set of arms of the apparatus.

13. Method of lining a tunnel wall or a tunnel ceiling with a steel wire mesh;
wherein a package of steel wire mesh is provided as in any of the claims 1 to 6;
wherein an apparatus is used as in any of the preceding claims 7 to 10, or
wherein an equipment is used as in any of the preceding claims 11 to 12;
wherein the package of steel wire mesh is unrolled on the platform;
wherein the unwound steel wire mesh is positioned onto the tunnel wall or tunnel ceiling.

14. The method as in claim 13, wherein the steel wire mesh is fastened onto the tunnel ceiling or tunnel wall, preferably by means of anchoring bolts.

15. The method as in any of the preceding claims 13 or 14; wherein the method additionally comprises the steps of
- gripping the package of steel wire mesh with the apparatus as in any of the preceding claims 6 - 9 while the second section of the steel wire mesh is at the top of the steel wire mesh;
- turning the apparatus upside down such that the package of steel wire mesh is positioned with its second section onto the middle segment – and preferably at the middle of the middle segment - of the apparatus; and
- unrolling the package of steel wire mesh on the platform.

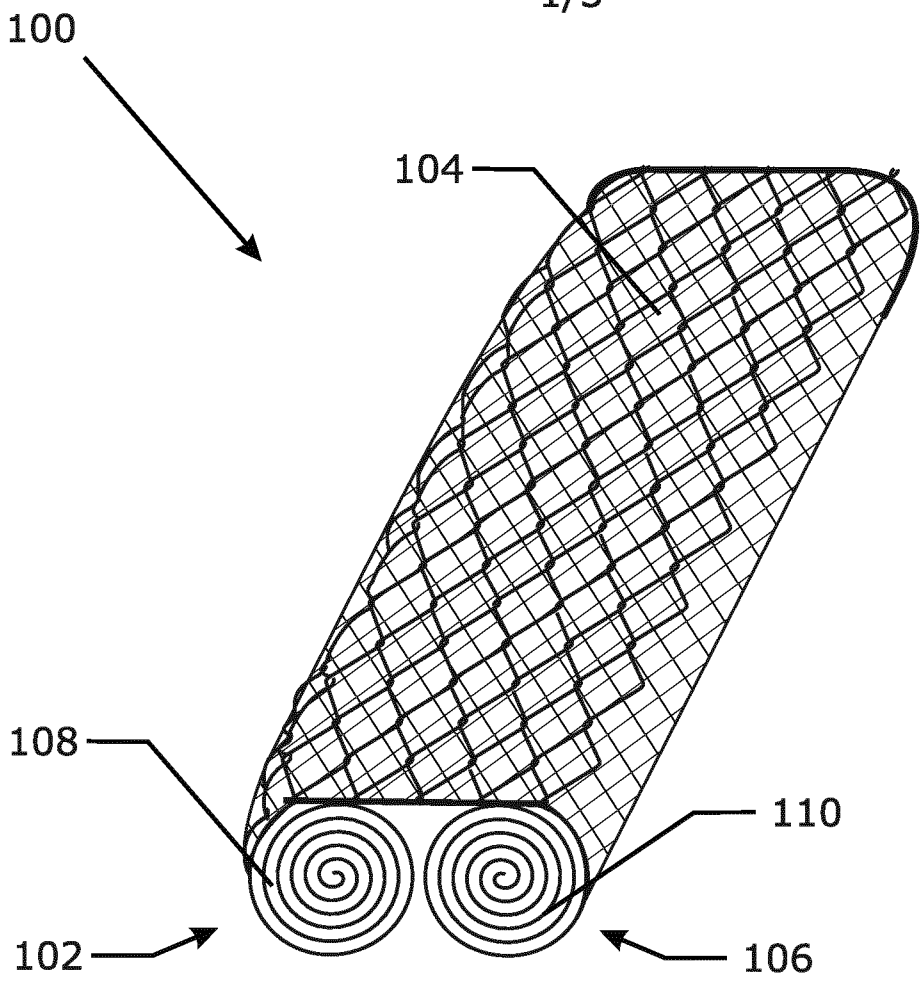



Fig. 1

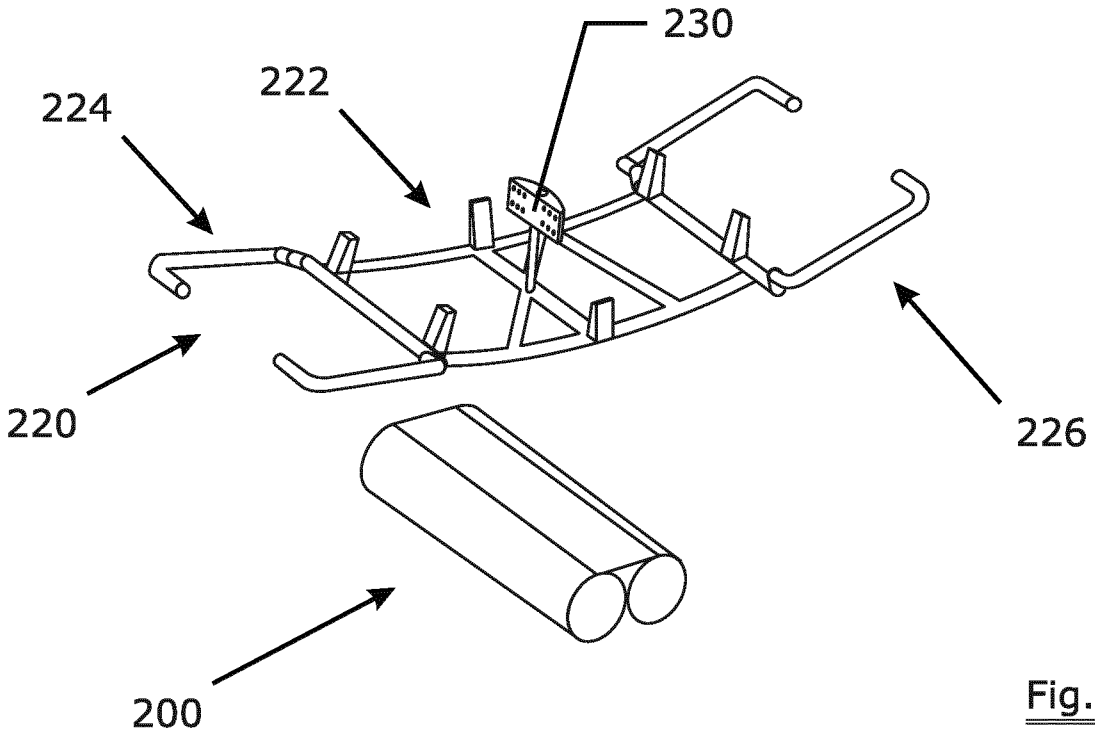



Fig. 2

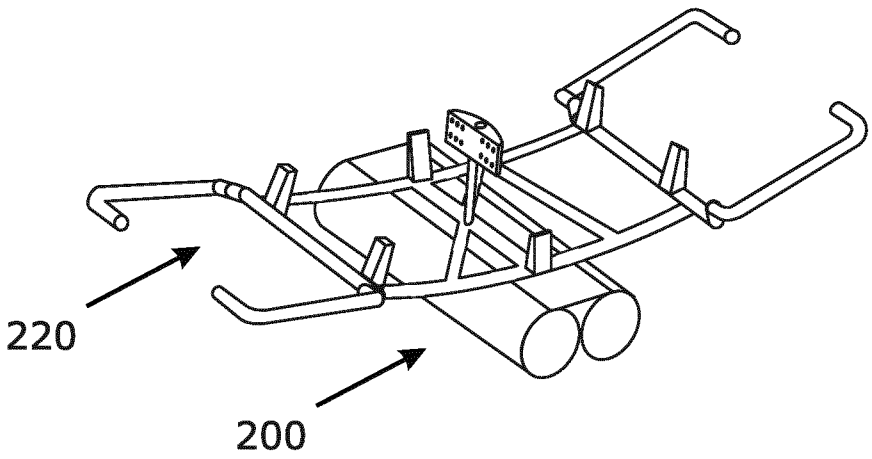



Fig. 3

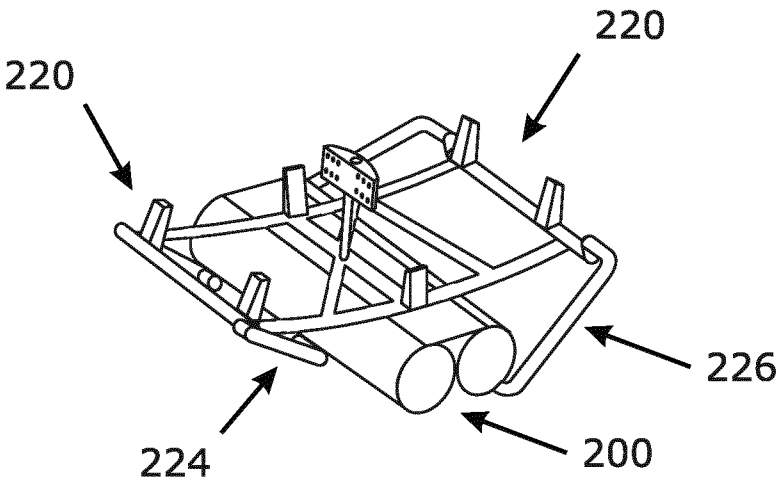



Fig. 4

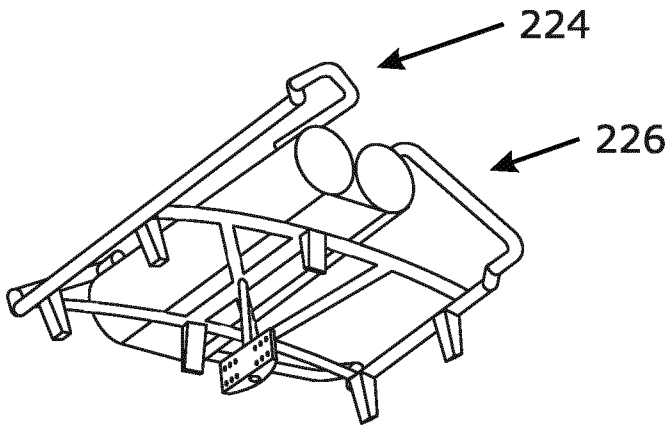



Fig. 5

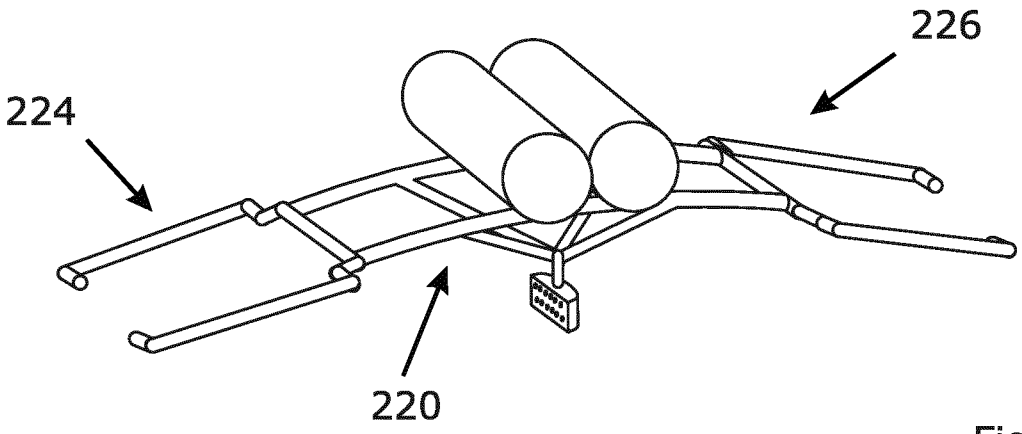



Fig. 6

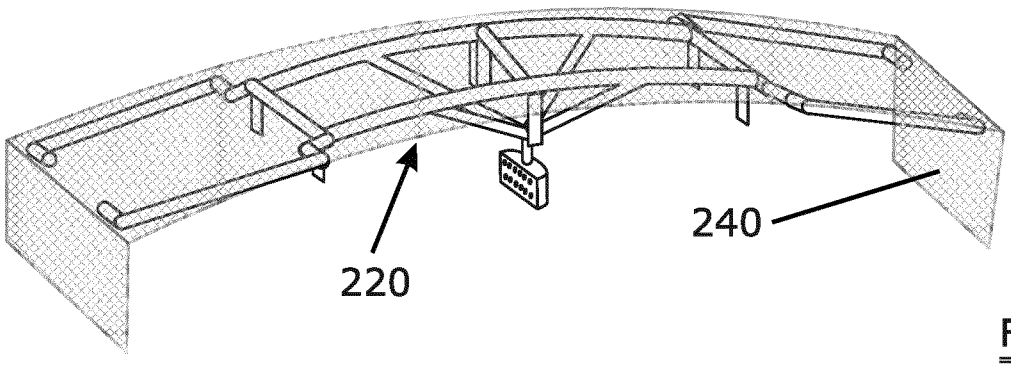



Fig. 7

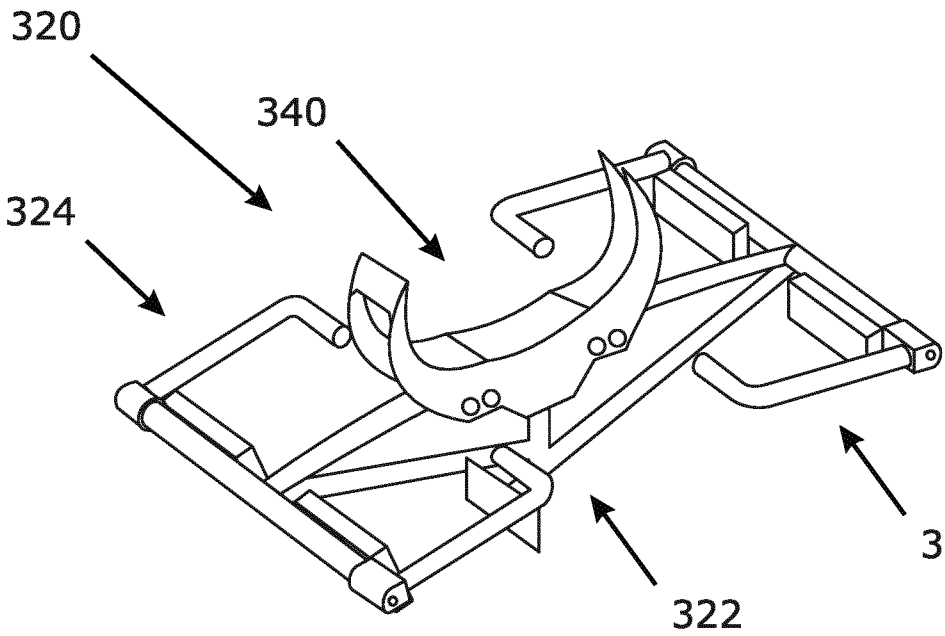



Fig. 8

# INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2020/065353

A. CLASSIFICATION OF SUBJECT MATTER
INV. B21F33/00 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)
B21F E21C 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 | DE 34 41 336 A1 (ROESLER SOEST DRAHT GMBH [DE]) 5 June 1985 (1985-06-05) | 1-6 |
| Y | page 13, line 14 - line 23<br>page 18, line 1 - line 10; claims 1,20,21;<br>figures 1,2,16,17 | 13-15 |
| | ----- | |
| X | NO 20 161 065 A1 (ANLEGGSUPPORT AS [NO])<br>28 December 2017 (2017-12-28) | 7-12 |
| Y | paragraph [0001]<br>paragraph [0017]<br>paragraph [0041] - paragraph [0042]<br>paragraph [0048]<br>paragraph [0050] - paragraph [0051]<br>paragraph [0057]<br>paragraph [0065]<br>paragraph [0071]<br>paragraph [0073]<br>paragraph [0120]; figures 3-5 | 13-15 |
| | ----- | |

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

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

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2020/065353

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