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Laitteisto rakentamista varten
Anordning för att bygga
An apparatus for constructing

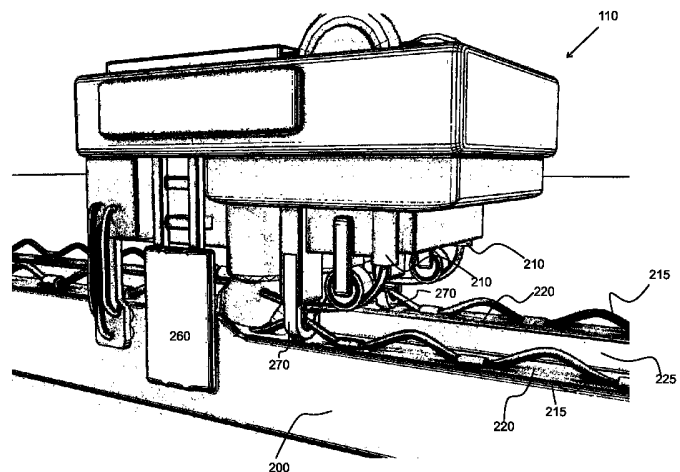
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WO 2005070657 A1, WO 2007050972 A2, US 2010257792 A1, WO 9408767 A1, GB 2488902 A

(57) Tiivistelmä - Sammandrag

The invention relates to an apparatus for constructing comprising at least feeding means for providing construction material in layers. The apparatus comprises at least first feeding means (340) for hardening material, second feeding means (350) for insulating material wherein said feeding means (340, 350) are configured to operate substantially concurrently so that a construction layer comprises materials from each feeding means (340, 350). The apparatus may also provide reinforcement substantially concurrently with the other materials.

Keksintö koskee rakentamiseen tarkoitettua laitteistoa, joka käsittää ainakin syöttöelimet rakennusmateriaalin järjestämiseksi kerroksittain. Laitteisto käsittää ensimmäiset syöttöelimet (340) kovettuvaa materiaalia varten, toiset syöttöelimet (350) eristysmateriaalia varten, jolloin mainitut syöttöelimet (340, 350) on järjestetty toimimaan oleellisesti samanaikaisesti siten, että rakennuskerros käsittää materiaaleja kaikista syöttöelimistä (340, 350). Laitteisto voi myös syöttää vahvistusta oleellisesti samanaikaisesti muiden materiaalien kanssa.



AN APPARATUS FOR CONSTRUCTING

Technical Field

5 The present solution generally relates to construction technology. In particular the present solution relates to an apparatus for constructing a construction element or a building.

Background

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Buildings, such as houses, are typically built by using building materials (bricks, timber, rock) or by using prefabricated wall elements. In both cases, the building and the prefabrication is manual work, where hardly no automation is used. Because of that, the house building is laborious and time consuming. Even though actual building process can be accelerated by using the prefabricated elements, the prefabrication of elements still needs time.

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Publication WO 2005070657 discloses an automated construction including robotic systems. A robotic system has a movable gantry robot including an overhead beam extending between and supported by at least two side members slidably mounted on a pair of rails. A nozzle assembly is movably coupled to the overhead beam for extrusion of a construction material.

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Publication WO 2007050972 discloses a nozzle for extruding a surface. The nozzle includes a first outlet configured to extrude a first unhardened material, a second outlet configured to extrude a second unhardened material, and a third outlet configured to extrude a third unhardened material. The third outlet is located between the first and the second outlet.

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Publication US 2010/0257792 discloses an automated extrusion construction system including an extrusion nozzle configured to extrude construction material in a horizontal direction. An extrusion nozzle may have a height adjustment mechanism configured to adjust the height of an outlet.

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Publication WO 94/08767 discloses a process for producing composite boards, where in a continuous process a core web is coated with a mortar layer reinforced with glass cloth or the like. Hardening mortar is applied in a

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fluid state of a specified viscosity for spreading and is subject to a controlled feed.

5 Publication GB 2488902 discloses a composite insulating panel comprising external and internal sheets with an insulating body in between.

Publication JP 2912116 discloses a solution for manufacturing three-dimensional welded reinforcing bar.

10 There is, therefore, a need for a solution by means of which time used for building e.g. house, can be shortened.

Summary

15 Now there has been invented an improved method and an apparatus implementing the method, by which the above need is fulfilled. Various aspects of the invention include a method and an apparatus, which are characterized by what is stated in the independent claims. Various embodiments of the invention are disclosed in the dependent claims.

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According to a first aspect, there is provided an apparatus for constructing, said apparatus comprising at least feeding means for providing construction material in layers. The apparatus comprises at least first feeding means for first material, second feeding means for second material and third feeding means for a third material, wherein said third feeding means are located in front of the first feeding means in operating direction, and wherein said third material is reinforcement wire. The apparatus comprises twining means configured to bond the reinforcement wire to a reinforcement wire of the previous construction layer. Said feeding means and said twining means are configured to operate substantially concurrently for a construction layer so that a construction layer comprises materials from each feeding means.

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According to an embodiment, the first material is a hardening material.

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According to an embodiment, the second material is an insulation material.

According to an embodiment, during the construction the third feeding means are followed by the first and the second feeding means.

5 According to an embodiment, the first feeding means comprises at least two nozzles for providing the first material on the opposite sides of the construction layer.

10 According to an embodiment, the second feeding means are configured to feed the second material between the first material layers on opposite sides of the construction layer.

15 According to an embodiment, the third feeding means comprises at least two nozzles for providing the third material, which at least two nozzles are located in front of the nozzles of the first feeding means in operation direction.

According to an embodiment, the apparatus comprises coating means configured to perform coating of the first material on at least one side of the construction.

20 According to an embodiment, wherein the coating is one of the following: solar cell coating, smart film, touch sensitive film, paintwork, grout, plaster, carrier rib, laminate, wirings.

25 According to an embodiment, the apparatus is configured to construct a building or a wall element.

30 Description of the Drawings

In the following, various embodiments of the invention will be described in more detail with reference to the appended drawings, in which

35 Fig. 1 shows an apparatus according to an embodiment for constructing a building;

- Fig. 2 shows an apparatus according to an embodiment;
- Fig. 3 shows an apparatus of Figure 2 from another perspective;
- 5 Fig. 4 shows an example of a working direction of an apparatus when constructing an element;
- Fig. 5 shows an example of a working direction of an apparatus when constructing a building;
- 10 Fig. 6 shows twining according to an embodiment; and
- Fig. 7 shows an example of a coating element.

15 Description of Example Embodiments

In the following, several embodiments of the invention will be described in the context of building houses. It is to be noted, however, that the invention is not limited to house building. In fact, the different embodiments have applications in any building environment where constructing is needed. In the following materials such as concrete, insulation material and reinforcement are given as examples. However, it is appreciated that instead of these materials other materials can be used. For example, instead of concrete, any hardening material in a liquid form can be used, for example plastic or mixture of stone materials. Also, the insulation material can be polyurethane, however, other materials can be used instead. The reinforcement can be reinforcement bar or reinforcement wire, or a reinforcing composite. Also, when reinforcement is not used, the hardening material can be a combination of concrete and reinforcement.

30 The embodiments, according to an example, relate to a concrete printing apparatus, which is used in automatic on-the-spot construction. The apparatus extrudes, hardens, prints and connects materials which then create a house or house element. The apparatus is configured to build base structures but also complete buildings of combination of concrete and insulation material and alternatively also with reinforcement. In addition, the apparatus is able to laminate and spread different materials (e.g. solar cell coating) with coating

means. The apparatus according to embodiments is configured to feed reinforcement within the wall during the construction. Due to that the wall under construction will become ready for the living purposes. In addition, the constructed wall meets the requirements of construction code also in countries having varying weather conditions. The embodiments of the invention are disclosed in more detailed manner next.

Figure 1 illustrates an apparatus 110 for constructing a house or a construction element according to an embodiment. The element may be a wall element for a house or for any other building. In some cases, the element may be a floor element or a roof element. In this embodiment, the apparatus is configured to construct a house.

The apparatus 110 shown in Figure 1 constructs a house frame of layers of materials. In this example, the house is constructed from ground towards the sky, however, the embodiments may be utilized when constructing a wall element sideways. In this embodiment, the apparatus is connected to a material container 150 via material passing tubes 155. The apparatus 110 is configured to be guided by guiding trails 170 or guiding frame 175 or both.

As is shown in Figure 1 and will be disclosed in more detailed manner with reference to Figures 2 and 3, the building or an element is constructed of material layers, where, according to an embodiment, each layer comprises hardening material (e.g. concrete) 101, insulation material (e.g. polyurethane) 102 and reinforcement (e.g. steel) 103. The concrete 101 with reinforcement 103 is located in opposite sides of the wall/wall element, and the insulation material 102 is located between the opposite sides of the wall element.

In Figure 1, a first layer (i.e. the basis) for the house has been constructed by applying a layer of concrete. This means that the nozzles for the reinforcement and insulation of the apparatus have been closed temporarily. The first layer of concrete is provided with a reinforcement loop into which the reinforcement of the following layer will be fixed. After the first layer of concrete, the apparatus 100 begins to feed the reinforcement layer followed by the concrete layer and the insulation layer.

The material layers can deviate from the previous example. According to an embodiment, only concrete layer with reinforcement may be enough. According to an embodiment, the insulation layer can be composed on more than one insulation materials. According to an embodiment, the reinforcement is not needed, if the hardening material is composed of the hardening material and the reinforcing material. In that case each material layer comprises the hardening material and the insulation. Yet further, according to an embodiment, the order and/or amount of the materials at each layer may be different. For example, there may be additional layer of concrete within the insulation material, or there may be additional wirings.

As mentioned, the apparatus is discussed in more detailed manner with reference to Figures 2 and 3. The apparatus 110 comprises nozzles for providing layers of construction materials for the wall element/wall. The apparatus comprises groups of nozzles, the amount of which may correspond to the different materials being used for the wall element or the structure of the wall element. Each group of nozzles comprises at least one nozzle.

According to an embodiment, there are three groups of nozzles, one for concrete (Fig. 3: 340), one for insulation material (Fig. 3: 350) and one for reinforcement (Fig. 2: 210). The groups of nozzles are arranged in the apparatus in such a manner that they can operate concurrently. This means that when constructing the layers other than the base layer and the layer at room height, the apparatus is at first configured to feed the reinforcement, e.g. steel wire 215. The reinforcement feeding is followed with group of nozzles extruding a layer of concrete 220 on opposite sides of the wall element, and another group of nozzles extruding a layer of insulation 225 between the opposite concrete layers 220. This means that for such embodiment, the nozzles 210, 340, 350 are arranged to the apparatus so that at first in the moving direction, there are nozzles 210 for the reinforcement, which are then followed by the nozzles 340, 350 for concrete and insulation material.

It is appreciated that together with or instead of the reinforcement feed, the apparatus may provide heating cables within the construction. These can be powered by any known system, and therefore also by solar energy that can be obtained via solar cell coating of the construction.

According to an embodiment, the apparatus further comprises coating means 260. There may be coating means 260 on the both sides of the apparatus so that they are able to perform coating for the both internal and external sides of the wall element. The coating means may also be located only on one side of the apparatus.

According to an embodiment, the coating means are configured to produce a final surface to the wall. The coating means may comprise one or more different coating components. There can be a coating component for paintwork, for plaster, for grout, for carrier rib, for laminate, for direct write technology, for wirings, for smart film, for touch sensitive coating. The coating means for the external side of the wall can also provide the solar cell coating for the wall from a corresponding coating element. According to an embodiment, shown in Figure 7, there are four coating components 715, 716, 717, 718. A first coating component 715 is configured to provide the carrier rib from a roller. A second coating component 716 is configured to tighten the rib from the first coating component 715 to be even. A third coating component 717 is a spraying component being configured to provide e.g. a plaster. A fourth coating component 718 is configured to perform the grouting and finalize the surface. It is appreciated that Figure 7 is given for illustration purposes, and the amount, the order and the functions of the coating components may vary.

According to an embodiment, the apparatus also comprises twining means 270, such as two twiners (Fig. 2). According to an embodiment, there is a twiner between a reinforcement nozzle and a concrete nozzle. The purpose of the twining means 270 is to twine a reinforcement wire to the reinforcement wire of the previous layer before the concrete is extruded. By this, the reinforcement for both sides of the wall becomes stronger. Figure 2 illustrates the twining means 270 in operation. Instead of twining, the twining means 270 may press or weld or staple the reinforcement wires together.

Figure 3 shows the result of a wall layer after the apparatus has operated. It is realized that the layer has all the materials needed for the wall. It has exteriors made of concrete 200, it has insulation material 225 between the concrete exteriors 200, and it has reinforcement 215 within the concrete. It is to be noticed that the reinforcement wire is partly over the extrusion level of the concrete. This is because when the next layer is constructed, the reinforce-

ment wiring of the next layer is easily twined to the reinforcement layer of the present layer.

5 It is to be noticed that in some embodiments, the twining can be made horizontally. This means that the reinforcement would extend between different sides of the wall/wall element over the insulation material. Such twining would generate even more strong construction. The idea of such twining is given with Figure 6 showing a horizontal twining in very simplified manner.

10 Figures 4 and 5 shows in simplified manner, the working directions of the apparatus. Figure 4 shows construction of a wall element, where the apparatus is configured to operate in both directions (see the arrow 410). Figure 5 shows a construction of a building, where the apparatus 110 is configured to move to one direction (pointed by the arrow). In addition, for complete building,
15 the apparatus may also construct separating walls within the building. For that purpose (and also for the corners in the building), the apparatus has a joint, by means of which turning is made possible. The apparatus is also configured to construct pillars, and also vertical elements.

20 The embodiments also relate to a method, wherein hardening material, insulating material and reinforcement are fed for a layer. The feeding of the materials occurs substantially concurrently, so that – according to embodiment - the reinforcement feeding is followed by the feeding of hardening material and feeding of insulating material. Therefore, a construction layer after one
25 round of apparatus's execution comprises all the needed materials for a wall or a wall element.

The apparatus may be controlled by a control software. Such a control software can be executed by a computer comprising memory and processing
30 means. The memory stores computer code to implement the control of the construction apparatus. For example, the code may cause the apparatus to temporally shut down certain nozzle groups, the code may cause the apparatus to change a material feeding, the code may cause the apparatus to perform construction of different sizes, or different shapes. The computer code
35 may also receive user input to control the construction apparatus. The computer code may also control the construction apparatus based on commands determined by a client software. The client software may be provided for cus-

5 tomer ordering a house. By means of such client software, the customer may
select a complete house, or outline a house by means of different house
modules. The software has functionalities for receiving user input for a sketch
and for giving proposals on the sketch according e.g. a construction legisla-
10 tion. Such software are executed in a computer having a process and a
memory. The software comprises computer instructions for carrying out vari-
ous functions. The client software may communicate with a server software,
which in turn may control the control software for the construction apparatus.
The client software can be a customer software, while the server software
10 may be house provider's software. The control software is for the apparatus.

The various embodiments may provide advantages. This improved technolo-
gy provides a functional solution, which is both fast and economical. By
means of the present embodiments, individualized and modifiable houses
15 and house elements and construction elements are achieved. In addition, the
constructions made with the present apparatus fulfil the requirements of the
construction regulations, because the constructions have insulation material
between the concrete, and is not only a cell structure.

20 It is obvious that the present invention is not limited solely to the above-
presented embodiments, but it can be modified within the scope of the ap-
pended claims.

Claims:

- 5 1. An apparatus for constructing comprising at least feeding means for providing construction material in layers, wherein the apparatus comprises first feeding means (340) for first material and second feeding means (350) for second material, **characterized** in that, the apparatus further comprises at least
- 10 • third feeding means (210) for a third material, said third feeding means (210) being located in front of the first feeding means (340) in operation direction, and wherein said third material is reinforcement wire; and
 - 15 • twining means (270) configured to bond the reinforcement wire to a reinforcement wire of a previous construction layer; wherein said feeding means (210, 340, 350) and said twining means (270) are configured to operate substantially concurrently for a construction layer so that the construction layer comprises materials from each feeding means (210, 340, 350).
- 20 2. The apparatus according to claim 1, **characterized** in that during the construction the third feeding means (210) are followed by the first and the second feeding means (340, 350).
- 25 3. The apparatus according to claim 1 or 2, **characterized** in that the first material is a hardening material.
- 30 4. The apparatus according to any of the claims 1 to 3, **characterized** in that the second material is an insulation material.
- 35 5. The apparatus according to any of the claims 1 to 4, **characterized** in that the first feeding means (340) comprises at least two nozzles for providing first material on the opposite sides of the construction.
6. The apparatus according to claim 5, **characterized** in that the second feeding means (350) are configured to feed second material between the first material layers on opposite sides of the construction.

- 5 7. The apparatus according to any of the claims 5 to 6, **characterized** in that the third feeding means (210) comprises at least two nozzles for providing the third material, which at least two nozzles are located in front of the nozzles of the first feeding means (340) in operation direction.
- 10 8. The apparatus according to any of the claims 1 to 7, **characterized** in that the apparatus further comprises coating means (260) configured to perform coating of the first material on at least one side of the construction.
- 15 9. The apparatus according to claim 8, **characterized** in that the coating is one of the following: solar cell coating, smart film, touch sensitive film, paintwork, grout, plaster, carrier rib, laminate, wirings.
10. The apparatus according to any of the claims 1 to 9, **characterized** in that the apparatus is configured to construct a building or a wall element.

Patenttivaatimukset:

- 5 1. Laitteisto rakentamista varten, joka laitteisto käsittää ainakin syöttöelimet rakennusmateriaalin järjestämiseksi kerroksittain, jolloin laitteisto käsittää ensimmäiset syöttöelimet (340) ensimmäistä materiaalia varten ja toiset syöttöelimet (350) toista materiaalia varten, **tunnettu** siitä, että laitteisto käsittää lisäksi ainakin
- 10 • kolmannet syöttöelimet (210) kolmatta materiaalia varten, jotka kolmannet syöttöelimet (210) sijaitsevat käyttösuunnassa ensimmäisten syöttöelinten (340) edessä, ja jolloin mainittu kolmas materiaali on vahvistuslanka; ja
- 15 • sidontaelimet (270), jotka on järjestetty sitomaan vahvistuslanka aiemman rakennuskerroksen vahvistuslankaan; jolloin mainitut syöttöelimet (210, 340, 350) ja mainitut sidontaelimet (270) on järjestetty toimimaan olennaisesti samanaikaisesti rakennuskerrosta varten siten, että rakennuskerros käsittää materiaaleja kaikista syöttöelimistä (210, 340, 350).
- 20 2. Patenttivaatimuksen 1 mukainen laitteisto, **tunnettu** siitä, että rakentamisen aikana kolmansiä syöttöelimiä (210) seuraavat ensimmäiset ja toiset syöttöelimet (340, 350).
- 25 3. Patenttivaatimuksen 1 tai 2 mukainen laitteisto, **tunnettu** siitä, että ensimmäinen materiaali on kovettuva materiaali.
- 30 4. Jonkin patenttivaatimuksen 1–3 mukainen laitteisto, **tunnettu** siitä, että toinen materiaali on eristysmateriaali.
- 35 5. Jonkin patenttivaatimuksen 1–4 mukainen laitteisto, **tunnettu** siitä, että ensimmäiset syöttöelimet (340) käsittävät ainakin kaksi suutinta ensimmäisen materiaalin syöttämiseksi rakenteen vastakkaisille puolille.
6. Patenttivaatimuksen 5 mukainen laitteisto, **tunnettu** siitä, että toiset syöttöelimet (350) on järjestetty syöttämään toista materiaalia rakenteen vastakkaisilla puolilla olevien ensimmäisten materiaalikerrosten väliin.

- 5 7. Jonkin patenttivaatimuksen 5–6 mukainen laitteisto, **tunnettu** siitä, että kolmannet syöttöelimet (210) käsittävät ainakin kaksi suutinta kolmannen materiaalin syöttämiseksi, jotka ainakin kaksi suutinta on sijoitettu käyttösuunnassa ensimmäisten syöttöelimien (340) suutinten eteen.
- 10 8. Jonkin patenttivaatimuksen 1–7 mukainen laitteisto, **tunnettu** siitä, että laitteisto käsittää lisäksi päällystyselimet (260), jotka on järjestetty suorittamaan ensimmäisen materiaalin päällystäminen ainakin rakenteen yhdellä sivulla.
- 15 9. Patenttivaatimuksen 8 mukainen laitteisto, **tunnettu** siitä, että päällyste on jokin seuraavista: aurinkokennopäällyste, älykalvo, kosketuskalvo, maali, laasti, kipsi, reunuslaippa, laminaatti, langoitus.
- 20 10. Jonkin patenttivaatimuksen 1–9 mukainen laitteisto, **tunnettu** siitä, että laitteisto on järjestetty rakentamaan rakennus tai seinäelementti.

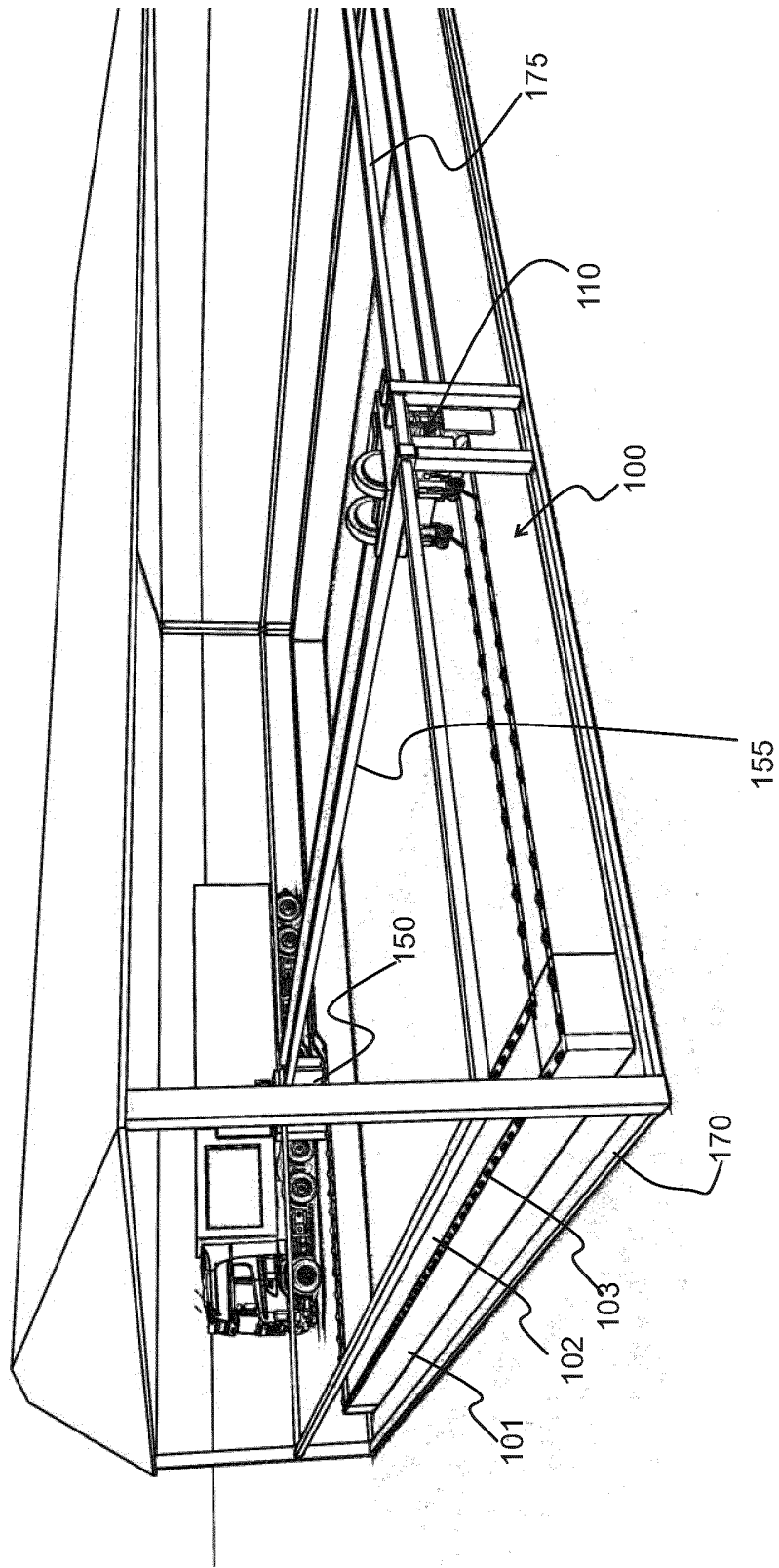


Fig. 1

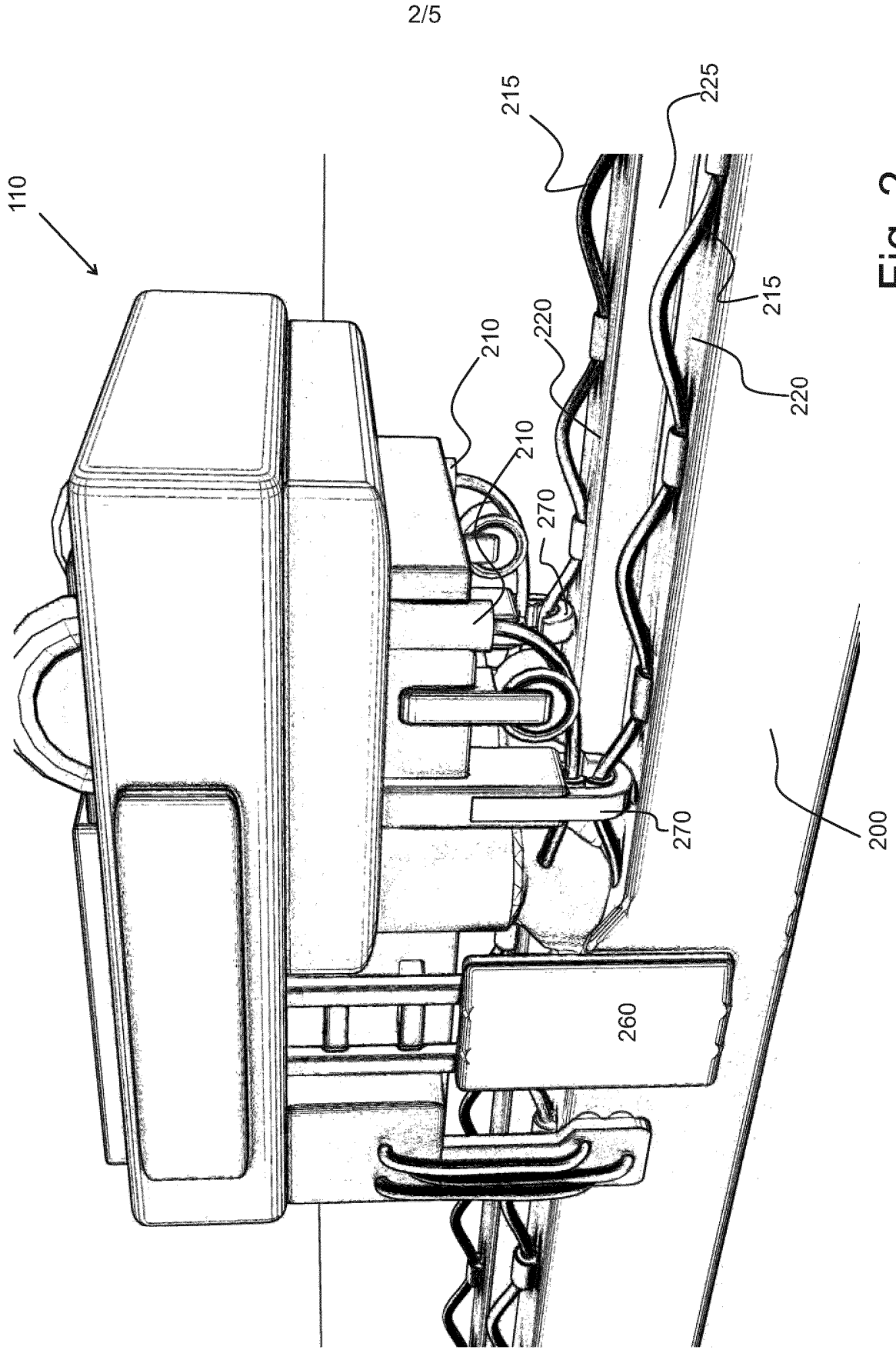


Fig. 2

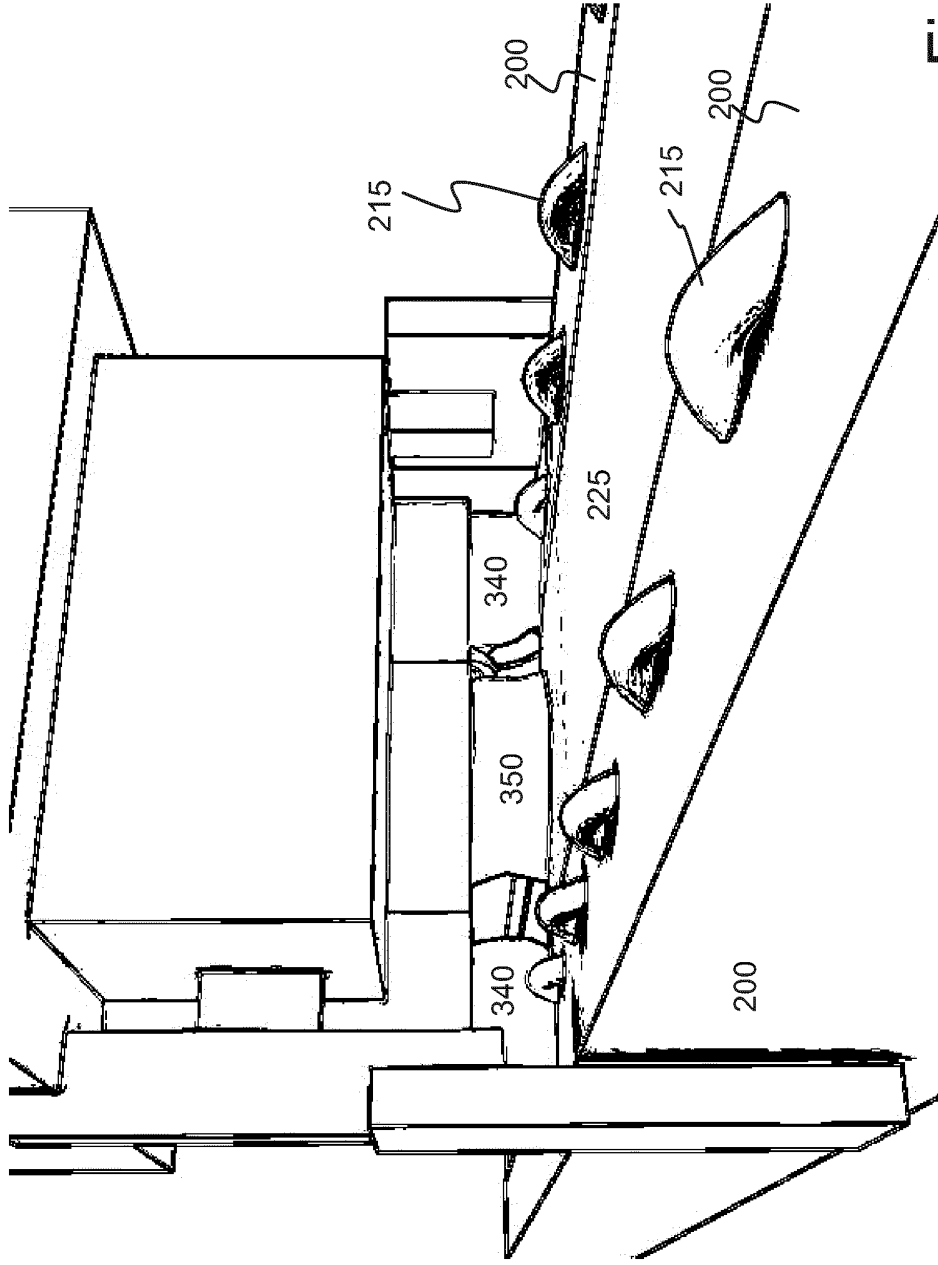


Fig. 3

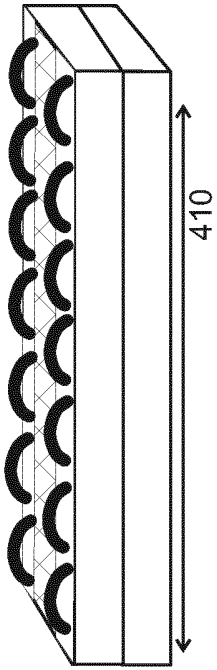


Fig. 4

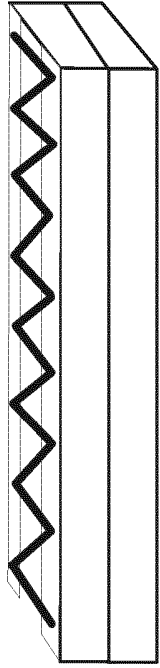


Fig. 6

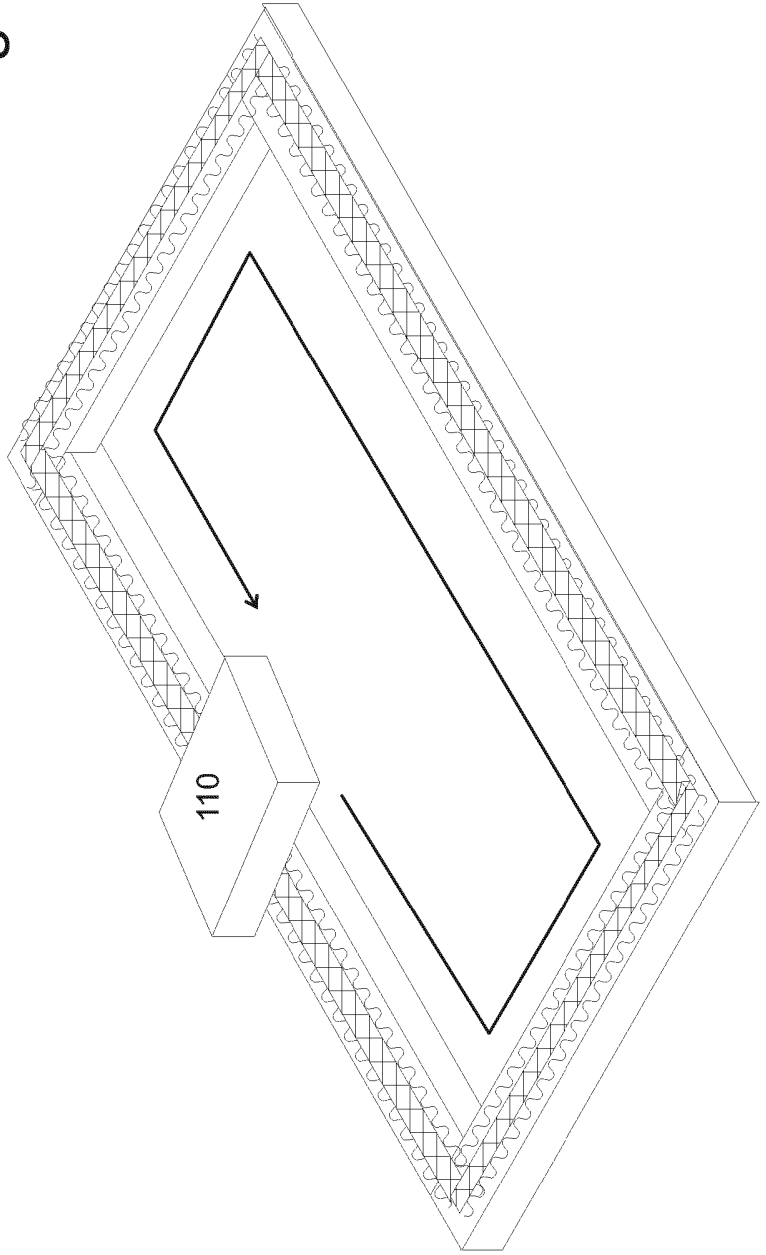


Fig. 5

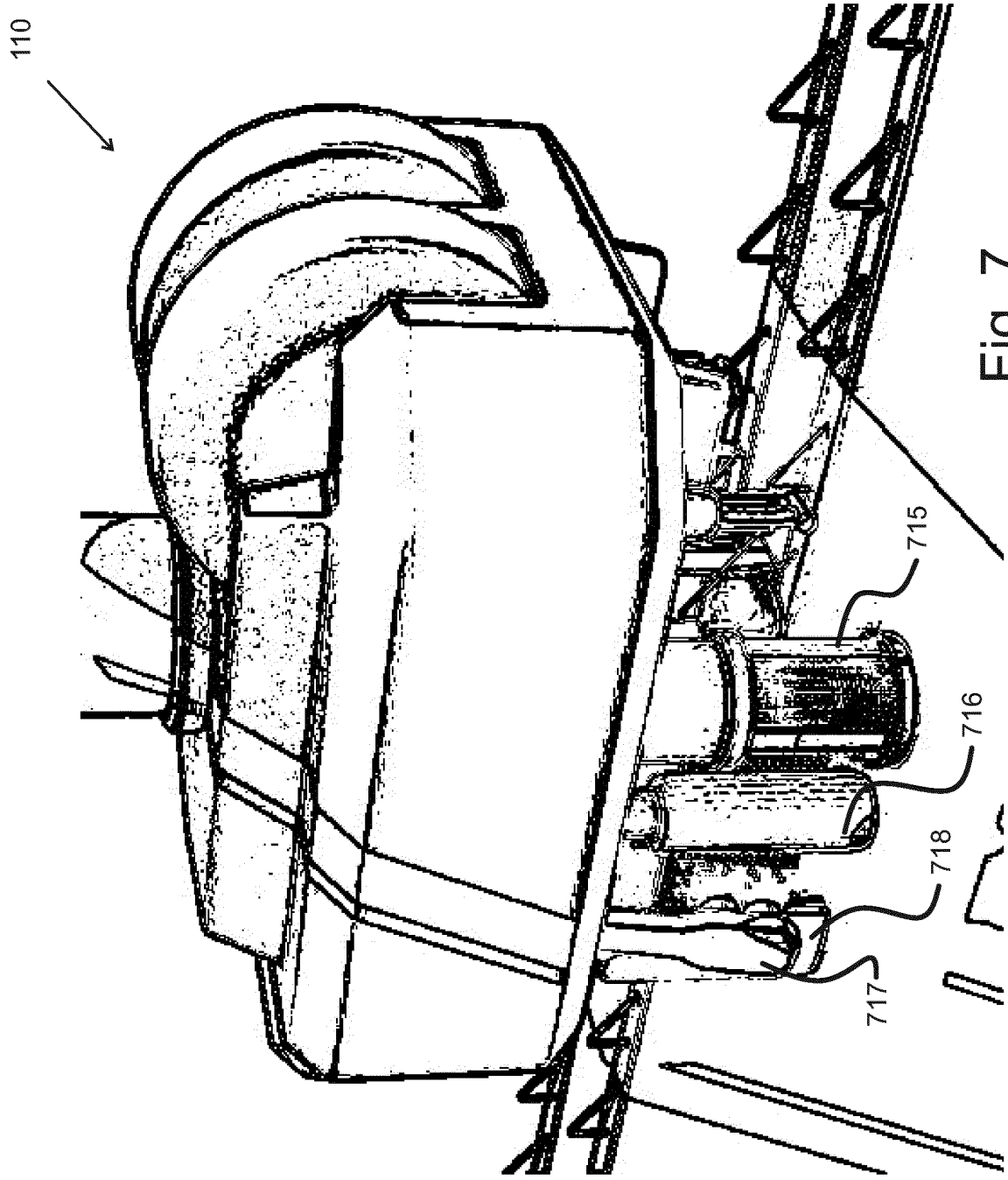


Fig. 7