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(54) **GRAB SYSTEM**

(57) A grab system (200) for hoisting one or more panels (500) of a temporary roadway comprising an arm assembly (210) comprising first and second grip members (220, 230) for engaging said one or more panels of the temporary roadway and an actuation system configured to adjust a separation distance between the first and second grip members for grabbing and releasing said one or more panels of the temporary roadway.

The grip members comprise a first aperture (700-705) configured to receive a respective grip insert for frictionally engaging the one or more panels of the temporary roadway and a grip insert attachment system configured to allow releasable attachment of the respective grip insert to the respective grip member. The first aperture is one of a plurality of apertures configured to receive a plurality of respective grip inserts. The plurality of apertures are arranged at different positions along a height of the respective first or second grip member.

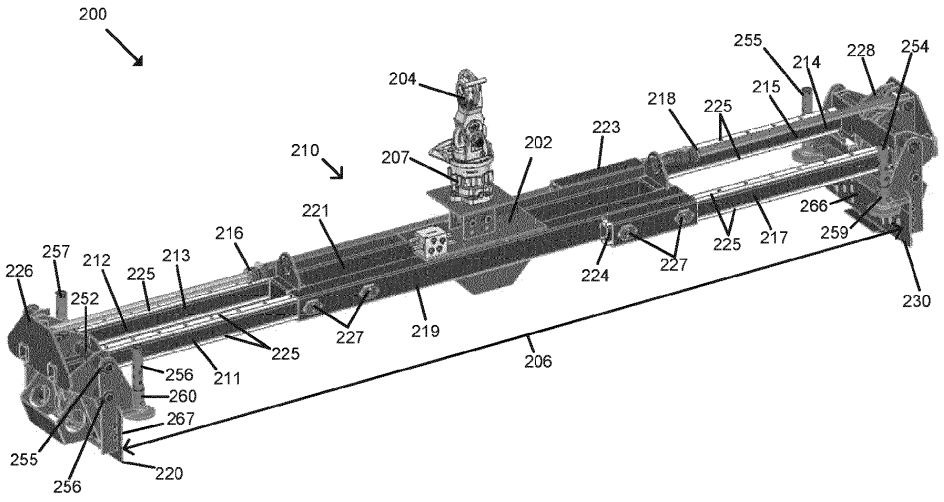


FIG. 2A

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Description

FIELD

[0001] The present invention relates to a grab system suitable for grabbing and releasing one or more objects. More particularly, the present invention relates to a grab system suitable for hoisting one or more panels of a temporary roadway during construction of the temporary roadway.

BACKGROUND

[0002] During construction of a temporary roadway for vehicle access, a grab system may be connected to a manipulator such as a crane and used to grab, hoist, move and place panels of the temporary roadway in desired locations. Fig. 1A and Fig. 1B schematically depict a side view and a perspective view of a known grab system 100. The known grab system 100 comprises an arm assembly 110 comprising opposing grip members 120, 130 for engaging a panel of a temporary roadway. The arm assembly 110 comprises two arms 112, 114 that extend in opposing directions from a central hub 102. The arm assembly 110 comprises an actuation system comprising first hydraulics 116, 118 configured to move the arms 112, 114 closer together or further apart to adjust a separation distance 106 between the first and second grip members 120, 130 for grabbing and releasing said one or more panels of the temporary roadway. The central hub 102 comprises a connector 104 for connecting the grab system 100 to a manipulator such as a crane (not shown).

[0003] An operator may use the crane to move the arm assembly 110 to a desired position (e.g. to align the arm assembly 110 with a panel that is to be hoisted by the known grab system 100). The operator may use the first hydraulics 116, 118 to bring the arms 112, 114 closer together such that the separation distance 106 between the grip members 120, 130 decreases until the grip members 120, 130 engage (i.e. come into frictional contact with) the panel, thereby grabbing the panel. The first hydraulics 116, 118 apply pressure between the grip members 120, 130 and the panel such that frictional forces between the grip members 120, 130 and the panel are large enough for the panel to be held by the known grab system 100 and manipulated (e.g. lifted and moved) by the crane. Once the operator has used the crane to move the panel to a desired location, the operator may use the first hydraulics 116, 118 to move the arms 112, 114 away from each other such that the separation distance 106 between the grip members 120, 130 increases until the grip members 120, 130 are no longer in contact with the panel, thereby releasing the panel. In this way, the panel is let go from the known grab system 100 at a desired location. The arm assembly 110 may be described as a scissor clamp due to the scissor-like closing and opening action of the arms 112, 114 when grabbing and releasing the panel. Another type of known grab system (not shown) is described as a beam clamp due to a solely linear closing and opening action of the arms (i.e. extension and retraction along a single axis) when grabbing and releasing the panel.

[0004] The known grab system 100 comprises a safety system comprising deployable catch surfaces 124, 134 adjacent the grip members 120, 130. A catch surface deployment system comprising second hydraulics 126, 128 acts to move the catch surfaces 124, 134 from a retracted configuration (not shown) to a deployed configuration. In the retracted configuration, the catch surfaces 124, 134 are stored behind their respective grip members 120, 130. In the deployed configuration, the catch surfaces 124, 134 project towards each other from an underside of their associated grip member 120, 130 (as shown in Figs. 1A and 1B). The catch surfaces 124, 134 rotate about pivot points and undergo solely rotational movement when deployed from the retracted configuration to the deployed configuration. If the known grab system 100 malfunctions (e.g. if first hydraulics 116, 118 fail) such that the grip members 120, 130 lost grip of the panel then the catch surfaces 124, 134 act to catch the panel to ensure that the panel does not fall to the ground. The catch surfaces 124, 134 thereby reduce the risk of injury or damage to people or items located underneath the panel when the panel is held by the known grab system 100. The catch surfaces 124, 134 act to catch the panel when actuation system of the arm assembly 110 fails. The catch surfaces 124, 134 are not intended to be a primary hoisting mechanism of the known grab system 100.

[0005] A problem with the known grab system 100 is that the arms 112, 114 of the arm assembly 110, and/or the grip members 120, 130 may become worn over time and/or may become damaged during use of the known grab system 100. Repairing any of these components involves taking the known grab system 100 out of service and transporting the known grab system 100 to a repair centre. Another problem with the known grab system 100 is that the grip members 120, 130 may not provide an adequate grip for objects formed from certain materials. A further problem with the known grab system 100 is that it is large, heavy and difficult to transport. Another problem with the known grab system 100 is that when the catch surfaces 124, 134 are deployed from their retracted configuration to their deployed configuration, the catch surfaces 124, 134 may scrape and thereby damage a surface from which the panel is hoisted (e.g. a grassed surface).

[0006] It is therefore an aim of the present disclosure to provide a grab system that addresses one or more of the problems above, or at least provides a useful alternative.

SUMMARY

[0007] According to a first aspect of the present disclo-

sure, there is provided a grab system for hoisting one or more panels of a temporary roadway. The grab system comprises an arm assembly. The arm assembly comprises first and second grip members for engaging said one or more panels of the temporary roadway. The arm assembly further comprises an actuation system configured to adjust a separation distance between the first and second grip members for grabbing and releasing said one or more panels of the temporary roadway. The grab system further comprises a grip member attachment system configured to allow releasable attachment of at least one of the first and second grip members to the arm assembly.

[0008] Known grab systems comprise grip members that are fixed to the arm assembly and cannot be releasably attached to the arm assembly. If a grip member of a known grab system requires repair or replacement, the entire known grab system has to be taken offline and transported to a repair centre. The grab system of the present disclosure comprises a grip member attachment system comprising a removable implement configured to allow releasable attachment of at least one of the first and second grip members from the arm assembly. The grip member attachment system advantageously allows a grip member to be easily removed and repaired or replaced by another grip member without having to take the entire grab system offline and/or transport the entire grab system to a repair centre.

[0009] The grip member attachment system is configured to allow reversible detachment of the at least one of the grip members without requiring any breakage and subsequent repair of one or more parts of the grab system. The grip member attachment system may be configured to allow manual releasable attachment of the at least one of the grip members (i.e. without requiring the use of any tools and/or machinery). The grip member attachment system may comprise one or more clamps configured to reversibly fasten the at least one of the first and second grip members to the arm assembly.

[0010] According to another aspect of the present disclosure, there is provided a grip member configured to form part of an arm assembly of the grab system of the first aspect.

[0011] According to a second aspect of the present disclosure, there is provided a grab system for hoisting one or more panels of a temporary roadway. The grab system comprises an arm assembly. The arm assembly comprises first and second grip members for engaging said one or more panels of the temporary roadway. The arm assembly further comprises an actuation system configured to adjust a separation distance between the first and second grip members for grabbing and releasing said one or more panels of the temporary roadway. One or both of the first and second grip members comprise a first aperture configured to receive a respective grip insert for frictionally engaging the one or more panels of the temporary roadway. The one or both first and second grip members further comprises a grip insert attachment system configured to allow releasable attachment of the respective grip insert to the respective grip member.

[0012] It is advantageous to be able to change the grip insert if it gets worn or damaged, without having to replace the grip member of which the grip insert forms part. In addition, it is also advantageous to be able to change the grip insert dependent on the properties of the one or more panels of the temporary roadway to be hoisted. For example, if the grab system can be used to hoist panels of different hardness. If hoisting a relatively soft panel, it may be advantageous to change the grip inserts so that they are also relatively soft so that they do not damage the relatively soft panel, as may occur if relatively hard grip inserts are used. For example, the grip insert may comprise polyurethane.

[0013] The grip insert attachment system is configured to allow reversible detachment of the respective grip insert without requiring any breakage and subsequent repair of one or more parts of the grab system. The grip insert attachment system may be configured to allow manual releasable attachment of the respective grip insert (i.e. without requiring the use of any tools and/or machinery). The grip insert attachment system may comprise one or more clamps configured to reversibly fasten the respective grip insert to the grip member.

[0014] According to another aspect of the present disclosure, there is provided a grip insert configured to be releasably attached to the respective grip member of the second aspect.

[0015] According to a third aspect of the present disclosure, there is provided a grab system for hoisting one or more panels of a temporary roadway. The grab system comprises an arm assembly. The arm assembly comprises first and second grip members for engaging said one or more panels of the temporary roadway. The arm assembly further comprises an actuation system configured to adjust a separation distance between the first and second grip members for grabbing and releasing said one or more panels of the temporary roadway. The grab system further comprises a connector for attaching the arm assembly to a manipulator. The grab system further comprises an arm assembly attachment system configured to allow releasable attachment of the arm assembly to the connector.

[0016] The arm assembly attachment system advantageously allows for quick and easy disassembly and transportation of the arm assembly without having to transport the entire grab system.

[0017] The connector may be a link, such as a crane link. The manipulator may be a crane, an excavator, or the like. The arm assembly attachment system is configured to allow reversible detachment of the arm assembly from the connector without requiring any breakage and subsequent repair of one or more parts of the grab system. The arm assembly attachment system may be configured to allow manual releasable attachment of the arm assembly to the connector (i.e. without requiring the use of any tools and/or machinery). The arm assembly at-

tachment system may comprise one or more clamps configured to reversibly fasten the arm assembly to the connector.

[0018] According to a fourth aspect of the present disclosure, there is provided a grab system for hoisting one or more panels of a temporary roadway. The grab system comprises an arm assembly. The arm assembly comprises first and second grip members for engaging said one or more panels of the temporary roadway. The arm assembly further comprises an actuation system configured to adjust a separation distance between the first and second grip members for grabbing and releasing said one or more panels of the temporary roadway. The grab system further comprises a first catch surface associated with the first grip member and a second catch surface associated with the second grip member. The grab system further comprises a catch surface deployment system configured to move the first and second catch surfaces between a retracted configuration and a deployed configuration in which the first and second catch surfaces project toward each other from an underside of their associated grip member for catching the one or more panels of a temporary roadway. The catch surface deployment system is configured to provide movement of the first and second catch surfaces which includes translation.

[0019] Known grab systems deploy the catch surfaces using rotational movement only (i.e. rotation about a pivot). This risks the catch surfaces of the known grab system scraping or otherwise damaging a surface from which a panel of a temporary roadway is hoisted. Using a catch surface deployment system to provide at least some translational movement of the catch surfaces advantageously reduces the risk of damage to a surface from which a panel is hoisted by the grab system (e.g. a grassed surface). The catch surface deployment system may be configured to provide movement of the first and second catch surfaces which also includes rotation.

[0020] Any of the first, second, third and fourth aspects of the present disclosure may be combined in any way. The grab system of the first aspect may comprise the first aperture and the grip insert attachment system of the second aspect and/or the connector and the arm assembly attachment system of the third aspect and/or the first and second catch surfaces and the catch surface deployment system of the fourth aspect. The grab system of the second aspect may comprise the grip member attachment system of the first aspect and/or the connector and the arm assembly attachment system of the third aspect and/or the first and second catch surfaces and the catch surface deployment system of the fourth aspect. The grab system of the third aspect may comprise the grip member attachment system of the first aspect and/or the first aperture and the grip insert attachment system of the second aspect and/or the first and second catch surfaces and the catch surface deployment system of the fourth aspect. The grab system of the fourth aspect may comprise the grip member attachment system of the first aspect and/or the first aperture and the grip insert attachment system of the second aspect and/or the connector and the arm assembly attachment system of the third aspect.

[0021] Any of the first, second, third and fourth aspects, and any combination thereof, may further include the following optional features.

[0022] A first optional feature is that the at least one of the first and second grip members may comprise an arm assembly connection portion. The arm assembly may comprise a grip member connection portion. The arm assembly connection portion and the grip member connection portion may co-operate to releasably attach the at least one of the first and second grip members to the arm assembly.

[0023] A second optional feature is that the grip member attachment system may comprise a first socket through the arm assembly connection portion. The grip member attachment system may comprise a second socket through the grip member connection portion. The grip member attachment system may comprise a removable implement. The removable implement may be configured to be reversibly inserted through both the first and second sockets simultaneously to releasably attach the at least one of the first and second grip members to the arm assembly. The removable implement may be an elongate member such as a pin, a bar, a rod, a bolt, etc.

[0024] A third optional feature is that the respective grip member may comprise a grip insert connection portion. The respective grip insert may comprise a grip member connection portion. The grip insert connection portion and the grip member connection portion may co-operate to releasably attach the respective grip insert to said respective first or second grip member.

[0025] A fourth optional feature is that the grip insert attachment system may comprise a first socket through the grip insert connection portion. The grip insert attachment system may comprise a second socket through the grip member connection portion. The grip insert attachment system may comprise a removable implement. The removable implement may be configured to be reversibly inserted through both the first and second sockets simultaneously to releasably attach the respective grip insert to said respective first or second grip member. The removable implement may be an elongate member such as a pin, a bar, a rod, a bolt, etc.

[0026] A fifth optional feature is that the first aperture may be one of a plurality of apertures configured to receive a plurality of respective grip inserts. The plurality of apertures may be arranged at different positions along a height of the respective first or second grip member. The distribution of apertures and grip inserts across the grip member advantageously allows different temporary roadway panels having different widths and/or different heights and/or irregular surfaces to be gripped by the grip member. The apertures may be arranged to allow grip at every possible grabbing height and/or width along the grip members.

[0027] A sixth optional feature is that the respective

grip insert may comprise a triangular grip member profile and/or a saw-tooth grip member profile for frictionally engaging said one or more panels of the temporary roadway. The grip member profile may be a cross-sectional profile in a plane that contains a surface normal to a grip member of the grip insert.

[0028] A seventh optional feature is that the respective grip insert may be interchangeable with a second grip insert by releasing the respective grip insert from the grip insert attachment system and releasably attaching the second grip insert to the grip insert attachment system. The respective grip insert and the second grip insert may comprise different materials and/or different grip member profiles for frictionally engaging said one or more panels of the temporary roadway. At least one of the grip inserts may comprise polyurethane.

[0029] An eighth optional feature is that the arm assembly attachment system may comprise a first part comprising a first connection portion configured to be releasably attached to the connector. The arm assembly attachment system may comprise a second part comprising a first connection portion configured to be releasably attached to the arm assembly. The first connection portion of the second part may comprise an actuation system connector configured to be connected to the actuation system of the arm assembly. The first part may further comprise a second connection portion configured to be releasably attached to a second connection portion of the second part. The first connection portion of the first part may comprise a link, e.g. a crane link. The actuation system connector may comprise a hydraulics connector and/or a control signal connector configured to be connected to hydraulics and/or a control system of the arm assembly.

[0030] A ninth optional feature is that the second connection portions of the first and second parts may comprise mating connectors configured to releasably attach the first part to the second part. For example, the second connection portion of the first part may comprise a male connector and the second connection portion of the second part may comprise a female connector configured to receive the male connector and thereby releasably attach the first part to the second part. The arm assembly attachment system may comprise a movable lock for releasably attaching the second connection portion of the first part to the second connection portion of the second part, thereby releasably attaching the arm assembly to the connector via the first and second parts of the arm assembly attachment system.

[0031] A tenth optional feature is that the arm assembly attachment system may be configured to transmit a control signal from the manipulator to the actuation system of the arm assembly. That is, an operator of the manipulator (e.g. a crane) may be able to control the actuation system (e.g. hydraulics) of the arm assembly by using controls belonging to the manipulator. The arm assembly attachment system may comprise a hydraulic and/or mechanic quick-change device. One example of a suitable quick-change device is a KM 506 HD SmartFlow offered by Kinshofer GmbH based in Germany.

[0032] An eleventh optional feature is that the first and second catch surfaces may each comprise a first portion attached to a mechanical linkage of the catch surface deployment system. The first and second catch surfaces may each comprise a second portion extending away from the first portion in an extension direction. The catch surface deployment system may be configured to hold the first and second catch surfaces in the retracted configuration such that the extension direction of the first catch surface is towards a plane of the first grip member, and the extension direction of the second catch surface is towards a plane of the second grip member. The catch surface deployment system may be configured such that an acute angle formed between the extension direction of the first catch surface and a normal to the plane of the first grip member reduces from less than about 90° in the retracted configuration to about 0° in the deployed configuration. The catch surface deployment system may be configured such that that an acute angle formed between the extension direction of the second catch surface and a normal to the plane of the second grip member reduces from less than about 90° in the retracted configuration to about 0° in the deployed configuration. The acute angles may reduce from about 70° in the retracted configuration to about 0° in the deployed configuration.

[0033] A twelfth optional feature is that the catch surface deployment system may comprise a first curved guide associated with the first grip member. The catch surface deployment system may comprise a second curved guide associated with the second grip member. The catch surface deployment system may comprise a first moveable follower attached to the first catch surface and mounted to the first curved guide. The catch surface deployment system may comprise a second moveable follower attached to the second catch surface and mounted to the second curved guide. The first moveable follower may be configured to move along the first curved guide to move the first catch surface between the retracted configuration and the deployed configuration. The second moveable follower may be configured to move along the second curved guide to move the second catch surface between the retracted configuration and the deployed configuration. The first and/or second curved guides may comprise a wear-resistant material such as, for example, phosphor bronze. The first and/or second movable followers may comprise a wear-resistant material such as, for example, phosphor bronze. The wear-resistant material advantageously increases an operational lifetime of the curved guides and/or movable followers.

[0034] A thirteenth optional feature is that the first and second moveable followers may be rotary followers. The first and second curved guides and the first and second moveable followers may be referred to as a cam system. The cam system provides a sweeping action that has a shallower angle of attack and/or a flatter trajectory when

the catch surfaces move from the retracted configuration to the deployed configuration compared to known grab systems. This advantageously reduces a risk of damage to the catch surfaces and/or a surface from which panels of a temporary roadway are hoisted and/or the panels of the temporary roadway.

[0035] A fourteenth optional feature is that the catch surface deployment system may be configured such that, when the first catch surface is moved from the retracted configuration to the deployed configuration, a smallest separation between a leading edge of the first catch surface and the underside of first grip member may be less than about 45 mm. The catch surface deployment system may be configured such that, when the second catch surface is moved from the retracted configuration to the deployed configuration, a smallest separation between a leading edge of the second catch surface and the underside of the second grip member may be less than about 45 mm. The smallest separations may be about 18 mm.

[0036] A fifteenth optional feature is that the catch surface deployment system may be configured such that, when in the deployed configuration, the first and second catch surfaces extend towards each other beyond planes of their associated grip members by about 35 mm or more.

[0037] A sixteenth optional feature is that the catch surface deployment system may be configured such that, when in the deployed configuration, the first and second catch surfaces each provide a catch surface area of about 4500 mm^2 or more for catching the one or more panels of the temporary roadway if the one or more panels were to fall from the first and second grip members. The catch surface area is a surface that is able to contact a panel of the temporary roadway if the panel falls on the first and second catch surfaces.

[0038] A seventeenth optional feature is that an underside of each of the first and second catch surfaces may comprise a roller configured to rotate about an axis that is substantially perpendicular to a direction of travel of the respective first and second catch surfaces. The roller may be configured to protect the first and second catch surfaces from impacts. For example, if, when moving from the retracted configuration to the deployed configuration, the first and second catch surfaces came close to contacting a grassed surface on which the one or more panels of temporary roadway were located, the rollers would contact the grassed surface first. The rollers would then roll along the grassed surface and deflect the first and second catch surfaces away from the grassed surface as the first and second catch surfaces moved into the deployed configuration, thereby avoiding damage to the grassed surface. The rollers may each comprise a suspension component (e.g. a spring) configured to compress and thereby allow movement of the rollers if the rollers come into contact with a surface (e.g. the grassed surface).

[0039] An eighteenth optional feature is that the catch surface deployment system may comprise a first moveable grip insert associated with the first catch surface. The catch surface deployment system may comprise a second movable grip insert associated with the second catch surface. The first grip member may comprise a first receiving aperture configured to receive the first movable grip insert. The second grip member may comprise a second receiving aperture configured to receive the second movable grip insert. The catch surface deployment system may be configured to move the first and second movable grip inserts in tandem with the first and second catch surfaces such that the first and second movable grip inserts are received in the first and second receiving apertures of the first and second grip members when the first and second catch surfaces reach the deployed configuration.

[0040] A nineteenth optional feature is that the arm assembly may comprise a stowed configuration in which the first and second grip members are fully retracted such that the separation distance between the first and second grip members is at a minimum. When in the stowed configuration, the grab system may have a maximum length parallel to the separation distance of about 2600 mm or less. The stowed configuration advantageously allows for easy, safe and secure transportation of the grab system. The maximum length may be about 2525 mm or less. The maximum length may be about 2505 mm or less. The maximum length may be about 2485 mm or less.

[0041] A twentieth optional feature is that the actuation system may be configured to increase the separation distance to a maximum of about 3200 mm or more. The maximum separation is greater than known grab systems. The maximum separation distance may be about 3500 mm or more. The maximum separation distance may be about 3700 mm or more. The maximum separation distance may be about 3900 mm or more. The maximum separation distance may be about 4100 mm.

[0042] A twenty-first optional feature is that the catch surface deployment system may be configured such that, when in the deployed configuration, the first and second catch surfaces may be configured to contact the one or more panels of the temporary roadway and assist the grab system in hoisting the one or more panels of the temporary roadway. The catch surfaces may be referred to as secondary grip members or lift members.

[0043] A twenty-second optional feature is that the first and second grip members may comprise a plurality of protruding strips for frictionally engaging the one or more panels of the temporary roadway. The protruding strips advantageously improve a grip of the grip members. The plurality of protruding strips may comprise metal, e.g. steel. The plurality of protruding strips may be located proximate lower ends of the grip surfaces of the grip members. The plurality of protruding strips may extend across an entire length of each grip member. That is, a length of each strip may be substantially equal to a length of the grip member. A height of each strip may be about

5 mm. A depth of each strip may be about 5 mm. The plurality of protruding strips may be substantially equally spaced apart along a height of each grip member. Each grip member may comprise three or more protruding strips.

[0044] According to a fifth aspect of the present disclosure, there is provided a kit of parts for a grab system. The kit of parts comprises a first grip insert. The first grip insert comprises a grip member profile for frictionally engaging one or more panels of a temporary roadway. The first grip insert further comprises a grip member connection portion for co-operating with a grip insert connection portion of a grip member of the grab system to releasably attach the first grip insert to the grip member. The kit of parts further comprises a second grip insert. The second grip insert comprises a grip member profile for frictionally engaging one or more panels of a temporary roadway. The second grip insert further comprises a grip member connection portion for co-operating with the grip insert connection portion to releasably attach the second grip insert to the grip member, wherein the first and second grip inserts comprise different materials and/or different grip member profiles.

[0045] According to a sixth aspect of the present disclosure, there is provided a method of using a grab system comprising releasably attaching at least one of first and second grip members to an arm assembly of the grab system. The method further comprises adjusting a separation distance between the first and second grip members of the arm assembly to grab one or more panels of a temporary roadway.

[0046] According to a seventh aspect of the present disclosure, there is provided a method of using a grab system comprising inserting a first grip insert into an aperture of a first grip member of an arm assembly of the grab system. The method further comprises releasably attaching the first grip insert to the first grip member. The method further comprises adjusting a separation distance between the first grip member and a second grip member of the arm assembly to grab one or more panels of a temporary roadway.

[0047] The method may further comprise releasing the first grip insert from the first grip member. The method may further comprise removing the first grip insert from the aperture of the first grip member. The method may further comprise inserting a second grip insert into the aperture of the first grip member. The method may further comprise releasably attaching the second grip insert to the first grip member, wherein the first and second grip inserts comprise different materials and/or different grip member profiles.

[0048] According to an eighth aspect of the present disclosure, there is provided a method of using a grab system comprising releasably attaching an arm assembly of the grab system to a connector of the grab system. The method further comprises adjusting a separation distance between first and second grip members of the arm assembly to grab one or more panels of a temporary roadway.

[0049] According to a ninth aspect of the present disclosure, there is provided a method of using a grab system comprising adjusting a separation distance between first and second grip members of an arm assembly of the grab system to grab one or more panels of a temporary roadway. The method further comprises deploying a first catch surface associated with the first grip member and a second catch surface associated with the second grip member from a retracted configuration to a deployed configuration in which the first and second catch surfaces project toward each other from an underside of their associated grip member. Deploying the first and second catch surfaces comprises translationally moving the first and second catch surfaces.

BRIEF DESCRIPTION OF THE DRAWINGS

[0050] Embodiments of the invention will now be described, by way of example only, with reference to the accompanying schematic drawings, in which:

- Fig. 1A schematically depicts a side view of a known grab system;
- Fig. 1B schematically depicts a perspective view of the known grab system of Fig. 1A;
- Fig. 2A schematically depicts a perspective view of a grab system according to an aspect of the present disclosure;
- Fig. 2B schematically depicts an exploded view of the grab system of Fig. 2A;
- Fig. 3A schematically depicts a side view of a grab system when the arm assembly is in a stowed configuration according to an aspect of the present disclosure;
- Fig. 3B schematically depicts a view from above the grab system of Fig. 3A;
- Fig. 4A schematically depicts a side view of a grab system when the arm assembly is in a grabbing configuration according to an aspect of the present disclosure;
- Fig. 4B schematically depicts a view from above the grab system of Fig. 4A;
- Fig. 5A schematically depicts a side view of a grab system according to an aspect of the present disclosure when the grab system is holding a single panel;
- Fig. 5B schematically depicts a view from above the grab system of Fig. 5A;
- Fig. 6A schematically depicts a side view of a grab system according to an aspect of the present disclosure when the grab system is holding multiple panels;
- Fig. 6B schematically depicts a view from above the grab system of Fig. 6A;
- Fig. 7A schematically depicts a perspective view of a grip member including a catch surface according to an aspect of the present disclosure;
- Fig. 7B schematically depicts a side view of the grab

system of Fig. 7A;

- Fig. 8A schematically depicts a perspective view from behind a grip member according to an aspect of the present disclosure;
- Fig. 8B schematically depicts a perspective view of a grip insert according to an aspect of the present disclosure;
- Fig. 9A schematically depicts a perspective view of part of a catch surface deployment system according to an aspect of the present disclosure;
- Fig. 9B schematically depicts a perspective view from behind a catch surface deployment system according to an aspect of the present disclosure;
- Fig. 10A schematically depicts a view from the side of a catch surface in a retracted configuration according to an aspect of the present disclosure;
- Fig. 10B schematically depicts a view from the side of the catch surface of Fig. 10A in a first position during movement from the retracted configuration to a deployed configuration according to an aspect of the present disclosure;
- Fig. 11A schematically depicts a view from the side of the catch surface of Fig. 10A in a second position during movement from the retracted configuration to the deployed configuration according to an aspect of the present disclosure;
- Fig. 11B schematically depicts a view from the side of the catch surface of Fig. 10A in the deployed configuration according to an aspect of the present disclosure;
- Fig. 12A shows a flowchart of a first method of using a grab system according to an aspect of the present disclosure;
- Fig. 12B shows a flowchart of a second method of using a grab system according to an aspect of the present disclosure;
- Fig. 12C shows a flowchart of a third method of using a grab system according to an aspect of the present disclosure;
- Fig. 12D shows a flowchart of a fourth method of using a grab system according to an aspect of the present disclosure;
- Fig. 13A schematically depicts a view from the side of an alternative grip member comprising a plurality of protruding strips; and,
- Fig. 13B schematically depicts a view of the front of the alternative grip member of Fig. 13A.

DETAILED DESCRIPTION

[0051] Fig. 2A and Fig. 2B schematically depict a perspective view and an exploded view of a grab system 200 according to an aspect of the present disclosure. The grab system 200 comprises an arm assembly 210 comprising first and second grip members 220, 230 members for engaging one or more panels of a temporary roadway (not shown). The arm assembly 210 comprises two arms 212, 214 that extend in opposing directions from a central hub 202. The central hub 202 comprises a connector 204 for attaching the arm assembly 210 to a manipulator such as a crane. The connector 204 may comprise a crane link 201 configured to allow the grab system 200 to be connected to a crane (not shown) and rotated in a controlled manner about a first axis 203. The grab system 200 may be rotated about the first axis 203 until the grab system 200 is in a correct grabbing orientation relative to a panel (not shown) to be hoisted by the grab system 200. The connector 204 may further comprise one or more dampers 205 (e.g. swing damper assemblies) configured to provide swing damping of the arm assembly 210 along one or more axes 203. The dampers 205 act to reduce unwanted swinging or rotation of the arm assembly 210. The dampers 205 improve a stability of the arm assembly 210, which is particularly advantageous when using the grab system 200 to install objects in complex and/or restricted installations environments that require accurate movements to navigate.

[0052] The central hub 202 further comprises an arm assembly attachment system 207. The arm assembly attachment system 207 is connected at one end to the connector 204 and at an opposing end to the arm assembly 210. The arm assembly attachment system 207 is located at a centre of an upper surface of the arm assembly 210. The arm assembly attachment system 207 is configured to allow releasable attachment of the arm assembly 210 to the connector 204. The arm assembly attachment system 207 is configured to allow reversible detachment of the arm assembly 210 from the connector 204 without requiring any breakage and subsequent repair of one or more parts of the grab system 200. The arm assembly attachment system 207 may be configured to allow manual releasable attachment of the arm assembly 210 to the connector 204 (i.e. without requiring the use of any tools and/or machinery). The arm assembly attachment system 207 may comprise one or more clamps (not shown) configured to reversibly fasten the arm assembly 210 to the connector 204.

[0053] The arm assembly attachment system 207 comprises a first part 209 comprising a first connection portion 222 configured to be releasably attached to the connector 204. In the example of Fig. 2A and Fig. 2B, the first connection portion 222 of the first part 209 comprises a crane link. The arm assembly attachment system 207 further comprises a second part 229 comprising a first connection portion 244 configured to be releasably attached to the arm assembly 210. The first connection portion 244 of the second part 229 comprises an actuation system connector (not shown) configured to be connected to an actuation system (e.g. first hydraulics 216, 218) of the arm assembly 210. The actuation system connector may comprise a hydraulics connector and/or a control signal connector configured to be connected to hydraulics 216, 218 and/or a control system (not shown) of the arm assembly 210. The arm assembly attachment system 207 is configured to transmit a control signal from the manipulator to the actuation system of the arm as-

sembly 210. That is, an operator of the manipulator (e.g. a crane) may be able to control the actuation system (e.g. first hydraulics 216, 218) of the arm assembly 210 by using controls belonging to the manipulator.

[0054] The first part 209 of the arm assembly attachment system 207 further comprises a second connection portion (not shown) configured to be releasably attached to a second connection portion (not shown) of the second part 229 of the arm assembly attachment system 207. The second connection portions of the first and second parts 209, 229 may comprise mating connectors configured to releasably attach the first part 209 to the second part 229. For example, the second connection portion of the first part 209 may comprise a male connector and the second connection portion of the second part 229 may comprise a female connector configured to receive the male connector and thereby releasably attach the first part 209 to the second part 229. The arm assembly attachment system 207 may comprise a movable lock (not shown) for releasably attaching the second connection portion of the first part 209 to the second connection portion of the second part 229. The moveable lock may thereby releasably attach the arm assembly 210 to the connector 204 via the first and second parts 209, 229 of the arm assembly attachment system 207.

[0055] The arm assembly attachment system 207 may comprise a hydraulic and/or mechanic quick-change device. One example of a suitable quick-change device is a KM 506 HD SmartFlow offered by Kinshofer GmbH, a company based in Germany. The arm assembly attachment system 207 allows for quick and easy disassembly and transportation of the arm assembly 210 without having to transport the entire grab system 200. When the arm assembly 210 is attached to the grab system 200, the grab system 200 may weigh about 605 Kg. When the arm assembly attachment system 207 is used to disconnect the arm assembly 210 from the connector 204, the grab system 200 may weigh about 556 Kg.

[0056] The arm assembly 210 comprises an actuation system configured to adjust a separation distance 206 between the first and second grip members 220, 230 for grabbing and releasing one or more panels of the temporary roadway. In the example of Fig. 2A and Fig. 2B, the actuation system comprises first hydraulics 216, 218 configured to move the grip members 220, 230 closer together or further apart such that the separation distance 206 between the grip members 220, 230 increases or decreases. Each arm 212, 214 comprises a pair of beams 211, 213, 215, 217. A first pair of beams 211, 213 extend out of or retract into inner housings 219, 221 in response to the first hydraulics 216. A second pair of beams 215, 217 extend out of or retract into outer housings 223, 224 in response to the first hydraulics 218. The first hydraulics 218 may comprise one or more tubes formed from high strength steel. The first hydraulics 218 may be configured to apply pressures of about 355MPa or more. The first hydraulics 218 may be configured to apply pressures of about 500MPa or less. The first hydraulics 218 may be configured to apply pressures of about 420MPa.

[0057] The arm assembly 210 comprises anti-wear guides 225, 227 configured to reduce frictional wear of the arm assembly 210. A first set of anti-wear guides 225 comprises strips of anti-wear material formed on top and bottom surfaces of the beams 211, 213, 215, 217. A second set of anti-wear guides 227 comprises inserts of anti-wear material housed within sides of inner and outer housings 219, 221, 223, 224. The anti-wear guides 225, 227 may comprise anti-wear materials such as a ceramic filled ultra-high-molecular-weight polyethylene and/or phosphor bronze. The anti-wear guides advantageously increase a load rating of the arm assembly 210 and increase an operational lifetime of the arm assembly 210. The arm assembly 210 may comprise further guides, e.g. along the sides of the beams 211, 213, 215, 217 (not shown) configured to guide the inner and/or outer beams 211, 213, 215, 217.

[0058] The grab system 200 comprises a grip member attachment system configured to allow releasable attachment of at least one of the first and second grip members 220, 230 to the arm assembly 210. The arm assembly 210 comprises a grip member connection portion. In the example of Figs. 2A and 2B, the grip member connection portion comprises a pair of grip member holders 226, 228. A first grip member holder 226 is connected to an end of the first pair of beams 211, 213 and a second grip member holder 228 is connected to an end of the second pair of beams 215, 217. Each grip member holder 226, 228 comprises a first pair of sockets 231, 232. The first pair of sockets 231, 232 are separated by a gap 233 and are aligned with each other to form a first passage 234 through each grip member holder 226, 228. Each grip member holder 226, 228 further comprises a second pair of sockets 235, 236 that are also separated by the gap 233 and are aligned with each other to form a second passage 237 through each grip member holder 226, 228. The sockets 231, 232, 235, 236 through the grip member connection portion form part of the grip member attachment system.

[0059] The first and second grip members 220, 230 comprise an arm assembly connection portion. In the example of Figs. 2A and 2B, the arm assembly connection portion of each grip member 220, 230 comprises a first set of sockets 238, 239, 241. The first set of sockets 238, 239, 241 are separated by first and second gaps 242, 243 and are aligned with each other to form a third passage 245 through each grip member 220, 230. The arm assembly connection portion of each grip member 220, 230 further comprises a second set of sockets 246, 247, 248. The second set of sockets 246, 247, 248 are separated by the first and second gaps 242, 243 and are aligned with each other to form a fourth passage 249 through each grip member 220, 230. The sockets 238, 239, 241, 246-248 through the arm assembly connection portion form part of the grip member attachment system. The arm assembly connection portion and the grip member connection portion co-operate to releasably attach

first and second grip members 220, 230 to the arm assembly 210.

[0060] In the example of Figs. 2A and 2B, to attach a grip member 220, 230 to a grip member holder 226, 228 the first and third passages 234, 245 are aligned such that they are coincident and the second and fourth passages 237, 249 are aligned such that they are coincident. A removable implement is configured to be reversibly inserted through the sockets simultaneously to releasably attach the first and second grip members 220, 230 to the arm assembly 210. In the example of Figs. 2A and 2B, the removable implement comprises pins 250-253 which may be inserted through the coincident passages 234, 245, 237, 249 in order to attach the grip members 220, 230 to the grip member holders 226, 228 as shown in Fig. 2A. Tabs 255, 256, 259, 263 may be attached to ends of the pins 250-253 to lock the pins in place. To detach the grip members 220, 230 from the grip member holders 226, 228 the pins 250-253 are removed from the coincident passages 234, 245, 237, 249. The pins 250-253 and sockets 231, 232, 235, 236, 238, 239, 241, 246, 247, 248 may be referred to collectively as a grip panel attachment system. The grip member attachment system is configured to allow reversible detachment of the grip members 220, 230 without requiring any breakage and subsequent repair of one or more parts of the grab system 200. The grip member attachment system may be configured to allow manual releasable attachment of the grip members 220, 230 (i.e. without requiring the use of any tools and/or machinery). The grip member attachment system may comprise one or more clamps (not shown) configured to reversibly fasten the grip members 220, 230 to the arm assembly 210.

[0061] The arm assembly 210 comprises legs 254-257 that extend through sleeves 258-261 located on the grip members 220, 230. The legs 254-257 extend downwardly from the sleeves 258-26 in a direction that is substantially perpendicular to a normal of grip surfaces 266, 267 of the grip members 220, 230. The legs 254-257 and sleeves 258-260 (a fourth sleeve configured to receive leg 257 is not visible in Figs. 2A and 2B) comprise apertures that, once aligned with each other, may receive keys 262-265 in order to attach the legs 254-257 to the sleeves 262-265. Multiple apertures are provided along a length of the legs 254-257 such that a height setting of the legs 254-257 is adjustable. That is, by removing keys 262-265, sliding the legs 254-257 up or down within the sleeves 262-265 and reinserting keys 262-265 through a different leg aperture, a distance by which the legs 254-257 extend downwardly from the sleeves 262-265 may be adjusted. The legs 254-257 comprise planar feet 280-283 configured to contact an upper surface of a panel held by the grab system 200 and thereby secure and/or increase a stability of the panel held by the grab system 200. Alternatively, the legs 254-257 may comprise chamfered feet such that widths of the feet taper from greatest widths at an upper end of the feet to smaller widths at a lower end of the feet.

[0062] The grab system 200 comprises a safety system comprising deployable catch surfaces 268, 269 associated with the grip members 220, 230. A catch surface deployment system is configured to move the first and second catch surfaces 268, 269 between a retracted configuration and a deployed configuration for catching a panel held by the grab system 200. The catch surface deployment system comprises second hydraulics 270, 271 configured to move the catch surfaces 268, 269 between the retracted configuration (shown in Fig. 9B) and the deployed configuration (shown in Figs. 2A-8A). The catch surface deployment system is configured to provide movement of the first and second catch surfaces 268, 269 that includes translational movement and may include rotational movement. In the retracted configuration, the catch surfaces 268, 269 are stored behind their associated grip members 220, 230. In the deployed configuration, the catch surfaces 268, 269 project towards each other from underneath their respective grip members 220, 230. If the grab system 200 malfunctions (e.g. if first hydraulics 216, 218 fail) such that the grip members 220, 230 lose grip of a panel then the catch surfaces 268, 269 act to catch the panel to ensure that the panel does not fall to the ground. The catch surfaces 268, 269 thereby reduce the risk of injury or damage to people or items located underneath the panel. The grab system 200 comprises guards 272 (only one guard is visible in Figs. 2A and 2B) configured to protect the catch surfaces 268, 269 and the second hydraulics 270, 271 when the catch surfaces 268, 269 are in the retracted configuration.

[0063] The catch surface deployment system may be configured such that, when in the deployed configuration, the first and second catch surfaces 268, 269 contact the one or more panels of the temporary roadway and assist the grab system 200 in hoisting the one or more panels of the temporary roadway. The catch surfaces 268, 269 may play an integral role in lifting lighter materials, such as panels formed of plastic material.

[0064] An operator may use a crane to move the arm assembly 210 to a desired position (e.g. to align the arm assembly 210 with a panel of a temporary roadway that is to be hoisted using the grab system 200). The operator may then use the first hydraulics 216, 218 to bring the grip members 220, 230 closer together such that the separation distance 206 between the grip members 220, 230 decreases until the grip members 220, 230 engage (i.e. come into frictional contact with) the panel, thereby grabbing the panel. The first hydraulics 216, 218 apply pressure between the grip members 220, 230 and the panel such that frictional forces between the grip members 220, 230 and the panel are large enough for the panel to be held by the grab system 200 and manipulated (e.g. lifted and moved) by the crane. Once the operator has used the crane to move the panel to a desired location, first hydraulics 216, 218 may be used to move the grip members 220, 230 away from each other such that the separation distance 206 between the grip members 220, 230 increases until the grip members 220, 230 are no longer

in contact with the panel. In this way, the object is released from the grab system 200 at a desired location. The grip members 220, 230 may be formed from metal (e.g. aluminium and/or steel), plastic (e.g. polyethylene) or organic materials (e.g. wood). The grip members 220, 230 may have a width of about 10 mm or less, e.g. about 8 mm.

[0065] Fig. 3A and Fig. 3B schematically depict a side view and a view from above the grab system 200 when the arm assembly 210 is in a stowed configuration according to an aspect of the present disclosure. In the stowed configuration, the grip members 220, 230 are fully retracted such that the separation distance 302 between the first and second grip members 220, 230 is at a minimum. In the stowed configuration, the grab system 200 has a maximum length 300 (parallel to the separation distance 302 between the first and second grip members 220, 230) of about 2485 mm or more. The maximum length 300 in the stowed configuration may be about 2525 mm or less. The maximum length 300 in the stowed configuration may be about 2505 mm. The maximum separation 302 between the grip members 220, 230 when in the stowed configuration may be about 2087 mm. The stowed configuration advantageously allows for easy, safe and secure transportation of the grab system 200. The stowed configuration is compact enough to avoid the need for a large transportation vehicle and a specially trained driver to transport the grab system 200. For example, it may be possible to transport the grab system 200 using a light commercial vehicle when in the stowed configuration.

[0066] Fig. 4A and Fig. 4B schematically depict a side view and a view from above the grab system 200 when the arm assembly 210 is in a grabbing configuration according to an aspect of the present disclosure. In the example of Figs. 4A and 4B, the arms 212, 214 are fully extended such that the separation distance 402 between the first and second grip member 220, 230 is at a maximum. The maximum separation 402 between the grip members 220, 230 may be about 3500mm or more, e.g. about 4100mm. In comparison, known grab systems have a maximum separation distance between grip members of about 3100 mm. The maximum separation 402 of the grip members 220, 230 of the grab system 200 is larger than that of known grab systems, which advantageously allows the grab system 200 to grab larger panels than known grab systems. When the arms 212, 214 are fully extended, the grab system 200 may have a maximum length 400 (parallel to the separation distance 402 between the first and second grip members 220, 230) of about 4528 mm. The grip members 220, 230 may have a minimum separation of about 2300 mm when in the grabbing configuration.

[0067] Fig. 5A and Fig. 5B schematically depict a side view and a view from above the grab system 200 when the grab system 200 is holding a single panel 500. The panel 500 forms part of a temporary roadway for vehicle access, and may be formed from one or more metals, plastics, etc. Use of the legs 254-257 to provide additional stability of the object 500 is optional. As can be seen in Fig. 5A, a height setting of the legs 254, 256 has not been adjusted and the feet 280-283 do not come into contact with the panel 500. As such, there is space 502 for grabbing further panels if desired. Catch surfaces 268, 269 are in the deployed configuration in which they project toward each other from an underside of their associated grip member 220, 230. If the grab system 200 malfunctions such that the grip members 220, 230 lose grip of the panel 500 then the catch surfaces 268, 269 act to catch the panel 500 to prevent the panel 500 from falling to the ground.

[0068] Fig. 6A and Fig. 6B schematically depict a side view and a view from above the grab system 200 when the grab system 200 is holding multiple panels 600-603. The four panels 600-603 form part of a temporary track for vehicle access. In the example of Figs. 6A and 6B, a height setting of the legs 254, 256 has been adjusted such that the feet 280-283 of the legs 254-257 come into contact with an uppermost panel 600 held by the grab system 200. As such, the legs 254-257 provide additional stability of the panels 600-603 held by the grab system 200. The grab system 200 may be configured to grab and hold loads of up to about 1500 Kg. Catch surfaces 268, 269 are in the deployed configuration in which they project toward each other from an underside of their associated grip member 220, 230. If the grab system 200 malfunctions such that the grip members 220, 230 lose grip of the panels 600-603 then the catch surfaces 268, 269 act to catch the panels 600-603 to prevent the panels 600-603 from falling to the ground.

[0069] Fig. 7A and Fig. 7B schematically depict a perspective view and a side view of a grip member 220 including a catch surface 268 according to an aspect of the present disclosure. As previously discussed in relation to Fig. 2A and Fig. 2B, the grip member 220 comprises a first set of conduits 238, 239, 241. The first set of conduits 238, 239, 241 are separated by first and second gaps 242, 243 and are aligned with each other to form a third passage 245 through the grip panel 220. The grip panel 220 further comprises a second set of conduits 246, 247, 248. The second set of conduits 246, 247, 248 are separated by the first and second gaps 242, 243 and are aligned with each other to form a fourth passage 249 through the grip panel 220. The grip panel 220 further comprises sleeves 260, 261 for receiving legs (not shown) as previously described.

[0070] The grip panel 220 further comprises apertures 700-705 configured to receive one or more respective grip inserts 710-716 for frictionally engaging one or more panels of a temporary roadway held by the grab system 200. In the example of Fig. 7A, the grip member 220 comprises six sets of apertures 700-705. First, second, third and fourth sets of apertures 700, 701, 704, 705 are configured to receive first, second, third and fourth respective grip inserts 710, 720, 750, 760. An example of a grip insert 750 is shown in Fig. 8B. Fifth and sixth sets

of apertures 702, 703 are configured to receive fifth and sixth moveable grip inserts 730, 740 that are associated with the catch surface 268 and form part of the catch surface deployment system. The catch surface deployment system is configured to move the movable grip inserts 730, 740 in tandem with the catch surface 268 such that the movable grip inserts 730, 740 are received in the fifth and sixth sets of apertures 702, 703 of the grip member 220 when the catch surface 268 reaches the deployed configuration. That is, when the catch surface 268 is in the retracted configuration, the moveable grip inserts 730, 740 are not received in the fifth and sixth sets of apertures 702, 703. When the catch surface 268 is deployed from the retracted configuration to the deployed configuration, the moveable grip inserts 730, 740 move in tandem with the catch surface 268 such that the moveable grip inserts are received in the fifth and sixth sets of apertures 702, 703 when the catch surface 268 reaches the deployed configuration. An example of moveable grip inserts 730, 732, 740, 742 that form part of the catch surface deployment system are shown in Fig. 9A.

[0071] As can be seen in Fig. 7A, the sets of apertures 700-705 are distributed about the grip surface 267 of the grip member 220 such that the grip inserts 710-715 collectively provide grip across a range of widths 723 along the grip surface 267 of the grip member 220. As can be seen in Fig. 7B, the sets of apertures 700-705 are distributed about the grip surface 267 of the grip member 220 such that the grip inserts 710-715 collectively provide grip across a range of heights 736 along the grip surface 267 of the grip member 220. The distribution of apertures 700-705 and grip inserts 710-715 about the grip surface 267 of the grip member 220 advantageously allows different types of panel having different widths and/or different heights and/or irregular surfaces to be gripped and hoisted by the grip member 220. For example, whether the grab system 200 is carrying a single panel (e.g. as shown in Figs. 5A and 5B) or multiple panels (e.g. as shown in Figs. 6A and 6B) or panels having different heights, the arrangement of apertures 700-705 and grip inserts 710-715 provides sufficient frictional contact between the grip member 220 and the panel(s). In the example of Fig. 7A, there are three sets of apertures 700-702 housing four grip inserts 710, 720, 730, 732 on a first side of the grip member 220 and three sets of apertures 703-705 housing four grip inserts 740, 742, 750, 760 on adjacent side of the grip member 220.

[0072] As can be seen in Fig. 7B, the catch surface 268 comprises one or more rollers 740, 745 configured to protect the catch surface 268 from impacts. In the example of Fig. 7B, the catch surface 268 comprises two rollers 740, 745 that extend downwardly from an underside of the catch surface 268. The rollers 740, 745 are configured to rotate axes that are substantially perpendicular to a direction of travel of the catch surface 268. When the catch surface 268 is deployed from the retracted configuration to the deployed configuration, there is a risk that the catch surface 268 could impact and thereby damage (e.g. scrape) a surface from which the panel is hoisted by the grab system 200. The rollers 740, 745 act to protect the catch surface 268 and/or the surface (e.g. a grassed surface) from such impacts. For example, if, when moving from the stored configuration to the deployed configuration, the catch surface 268 came close to contacting a grassed surface on which the one or more panels of temporary roadway were located, the rollers 740, 745 would contact the grassed surface before the catch surface 268. The rollers 740, 745 would then roll along the grassed surface as the catch surface 268 continued moving into the deployed configuration, thereby avoiding damage to the grassed surface. The rollers 740, 745 may each comprise a suspension component (e.g. a spring) configured to compress and thereby allow movement of the rollers 740, 745 if the rollers 740, 745 come into contact with the grassed surface.

[0073] Fig. 8A schematically depicts a perspective view from behind a grip member 220 according to an aspect of the present disclosure. The grip member 220 comprises a grip insert attachment system configured to allow releasable attachment of a grip insert 750, 760 to the grip member 220. In the example of Fig. 8A, grip inserts 750, 760 have been reversibly detached from the grip member 220 via the grip insert attachment system. In the example of Fig. 8A, the grip insert attachment system comprises a lock and pin system that forms part of a backside of the grip member 220 (i.e. the reverse side of the grip surface of the grip member 220). The grip member 220 comprises a grip insert connection portion. In the example of Fig. 8A, the grip insert connection portion comprises three flanges 830-832 located on the backside of the grip member 220.

[0074] Fig. 8B schematically depicts a perspective view of a grip insert 750 according to an aspect of the present disclosure. The grip insert 750 comprises a plurality of grip features 860-862 arranged longitudinally on a front side 865 of the grip insert 750. Spaces 863, 864 are arranged between consecutive grip features 860-862. As can be seen in Fig. 7A, the grip features 860-862 may be configured to protrude from apertures 704 in the grip member 220 to provide frictional contact with a panel that is to be grabbed and hoisted using the grab system 200. When the grip inserts 750 are formed from a resilient material, such as an elastomer, the grip features 860-862 may be compressed by a grabbed panel such that the grip features 860-862 come into alignment with a grip surface of the grip panels 220, 230 rather than protruding from the apertures 704. In the example of Fig. 8B, each grip feature 860-862 comprises a triangular grip member profile. The grip member profile may be a cross-sectional profile in a plane that contains a surface normal to the grip surface of the grip member 220. The grip features 860-862 may comprise a different grip member profile, e.g. a saw-tooth grip member profile. Different grip features 860-862 may comprise different grip member profiles. A periodicity and/or depth of the grip member profile of the grip features 860-862 may be

selected to improve an ability of the grab system 200 to grip different materials.

[0075] The grip insert 750 comprises a grip member connection portion. In the example of Fig 8B, the grip member connection portion comprises pin-receiving sockets 870-873 on a backside 875 of the grip insert 750. The pin-receiving sockets 870-873 allow the grip insert 750 to be attached to the grip panel 220 in different configurations. Each pin-receiving socket 870-873 may correspond to a different height setting of the grip insert 750 relative to the grip member 220. The grip insert connection portion of the grip member 220 and the grip member connection portion of the grip insert 750 co-operate to releasably attach the grip insert 750 to the grip member 220. The grip insert attachment system comprises three removable implements 810-812 (e.g. pins), the three sets of sockets 820-822 through the flanges 830-832 of the grip insert connection portion and the pin-receiving sockets 870-873 on a backside 875 of the grip insert 750. The removable implements 810-812 are configured to be reversibly inserted through both the sockets 820-822, 870-873 simultaneously to releasably attach the grip insert 750 to the grip member 220.

[0076] With reference to both Fig. 8A and Fig. 8B, the grip insert 750 may be releasably attached to the grip member 220 using the grip insert attachment system as follows. Grip features 860-862 of the grip insert 750 may be aligned with apertures (not visible in Fig. 8A) of the grip member 220. If the grip member 220 comprises apertures configured to allow the grip insert 750 to be attached at a plurality of different height settings, then the grip insert 750 may be attached at a desired height setting by aligning the sockets 870-873 through the grip member connection portion with the sockets 820-822 through the grip insert connection portion. Once a desired alignment between the grip insert 750 and the grip member 220 has been achieved, pins 810-812 may be reversibly inserted through the sockets 870-873 through the grip member connection portion and the sockets 820-822 through the grip insert connection portion simultaneously. The pins 810-812 are held in place by the sockets 820-822 through the grip insert connection portion. The grip insert 750 is held in place by the pins 810-812 abutting the sockets 870-873 through the grip member connection portion of the grip insert 750. The pins 810-812 may be secured to the grip member 220 by attaching tabs 813-815 to ends of the pins 810-812. The grip insert 750 may be removed from the grip member 220 by removing tabs 813-815 from the pins 810-812 and sliding the pins 810-812 out of the sockets 820-822 through the grip insert connection portion.

[0077] The grip insert 750 is interchangeable with a second grip insert (not shown) by releasing the grip insert 750 from the grip insert attachment system and releasably attaching the second grip insert to the grip insert attachment system. The grip insert 750 and the second grip insert may be formed from different materials and/or comprise different grip member profiles for grabbing panels formed from various materials. That is, a first grip insert formed from a first material and/or having a first grip member profile may provide the best grip for a first panel formed from a first material. A second grip insert formed from a different material and/or having a different grip member profile to the first grip insert may provide the best grip for a different panel formed from a different material. For example, the grip insert 750 may be formed from a metal (e.g. steel, aluminium, etc.), an organic material (e.g. wood), an elastomer (e.g. rubber) and/or a plastic material (e.g. PVC, HDPE, etc.). The grip insert 750 may be formed from polyurethane. The grip insert attachment system allows the easy replacement of one grip insert with a different grip insert, thereby improving an adaptability of the grab system 200 to grab different materials compared to known grab systems. The first and second grip inserts comprising different materials and/or different grip member profiles may form part of a kit of parts.

[0078] The grip inserts 750, 760 may allow for a width of the grip members 220, 230 to be reduced compared to known grab systems. The materials and grip member profiles of the grip inserts 750 may be selected to improve a frictional grip between the grip members 220, 230 and a panel of a temporary roadway, thereby improving a lifting safety performance compared to known grab systems. Improving a grip between the grip members 220, 230 and the panel advantageously reduces the risk of the grab system 200 losing grip of the panel. Reducing a width of the grip panels 220, 230 advantageously eases access around and within the grip members 220, 230 for reconfiguration and/or maintenance purposes.

[0079] Fig. 9A schematically depicts a perspective view of a part of a catch surface deployment system 900 according to an aspect of the present disclosure. The catch surface deployment system 900 comprises two parallel flanges 902, 904 extending perpendicularly to the catch surface 268. The flanges 902, 904 comprise a first set of bolts 910 and nuts 912 for attaching grip inserts 730, 732, 740, 742 to the catch surface deployment system 900. The flanges 902, 904 comprise a second set of bolts 914 and nuts 916 for attaching moveable followers 920-923 (two of the moveable followers are not visible in Fig. 9A). In the example of Fig. 9A, the catch surface deployment system 900 comprises a first set of rotary followers 920-922 arranged in a triangular formation on the first flange 904, and a second set of rotary followers 923 that mirror the first set of rotary followers 920-922 on the second flange 902.

[0080] Fig. 9B schematically depicts a perspective view from behind a catch surface deployment system 900 attached to a grip member 220 according to an aspect of the present disclosure. In the example of Fig. 9B, the grip inserts have been removed from the catch surface deployment system 900. The grip member 220 comprises two curved guides 950, 952 that form part of the catch surface deployment system 900. The first set of rotary followers 920-922 are mounted on a first curved

guide 950 and the second set of rotary followers 923 (two of the second set of rotary followers are not visible in Fig. 9B) are mounted on a second curved guide 952. The rotary followers 920-923 are mounted on the curved guides 950, 952 such that the rotary followers 920-923 can roll along the curved guides 950, 952 and thereby change a position of the catch surface 268 with respect to the grip member 220. Rolling the rotary followers 920-923 along the curved guides 950, 952 in a generally upward direction moves the catch surface 268 to its stored configuration. Rolling the rotary followers 920-922 from a first end 960 of the curved guides 950, 952 to a second end 962 of the curved guides 950, 952 (i.e. in a generally downward direction) moves the catch surface 268 from the retracted configuration to the deployed configuration. The catch surface 268 moves from the retracted configuration to the deployed configuration using at least some translational movement (e.g. along an arching path) that reduces a risk of damage to a surface from which a panel is hoisted by the grab system 200 compared to solely rotational movement. The rotary followers 920-923 and curved guides 950, 952 may be collectively referred to as a cam system. An alternative cam system involves replacing the two rotary followers 921, 922 on an inner surface of the curved guide 950 with a single piece (not shown) having a curved surface configured to move along the inner surface of the curved guide 950. The rotary followers 920-923 and/or curved guides 950, 952 may comprise a wear-resistant material such as, for example, phosphor bronze.

[0081] A curvature of the curved guides 950, 952 with respect to the grip member 220 may define a profile of attack of the catch surface 268 as the catch surface 268 moves from the retracted configuration to the deployed configuration. The curvature of the curved guides 950, 952 may cause the catch surface 268 to have a shallow angle of attack (i.e. a flatter trajectory) when approaching and reaching the active configuration compared to known grab systems. This advantageously reduces a risk of damage to the catch surface 268 and/or a surface from which a panel of a temporary roadway is hoisted (e.g. a grassed surface).

[0082] Fig. 10A schematically depicts a view from the side of a catch surface 268 in a retracted configuration according to an aspect of the present disclosure. The catch surface 268 is associated with a grip member 230. A catch surface deployment system is configured to move the catch surface 269 between the retracted configuration and a deployed configuration in which the catch surface 269 projects towards an opposing catch surface (not shown) associated with an opposing grip member 9not shown) from an underside 940 of the grip member 230. The catch surface deployment system comprises second hydraulics 271 and the cam system (not shown) described above with regard to Fig. 9A and Fig. 9B.

[0083] The catch surface 269 comprises a first portion 942 attached to a mechanical linkage 945 of the catch surface deployment system. The catch surface 269 further comprises a second portion 944 extending away from the first portion 942 in an extension direction 946. The catch surface deployment system is configured to hold the catch surface 269 in the retracted configuration such that the extension direction 946 of the catch surface 269 is towards a plane 948 of the grip member 230. That is, the extension direction 946 of the catch surface 269 intersects the plane 948 of the grip member 230 when the extension direction 946 and the plane 948 are sufficiently extended. The plane 948 of the grip member 230 may correspond to a plane of the grip surface 266 of the grip member 230 from which grip member profiles protrude.

[0084] The extension direction 946 of the catch surface 269 may correspond to a plane 932 of the catch surface 269.

[0085] When the catch surface 269 is in the retracted configuration, an acute angle 930 is formed between the extension direction 946 (i.e. the plane 932) of the catch surface 269 and a surface normal 934 to the plane 948 of the grip member 230. In the example of Fig. 10A, the acute angle 930 between the extension direction 946 of the catch surface 269 and the surface normal 934 to the plane 948 of the grip member 230 is about 70°. The catch surface deployment system is configured such that the acute angle 930 reduces from less than about 90° in the retracted configuration to about 0° in the deployed configuration. An example of this movement is shown across Figs. 10A-B and 11A-B.

[0086] Fig. 10B schematically depicts a view from the side of the catch surface 269 of Fig. 10A in a first position during movement from the retracted configuration to the deployed configuration according to an aspect of the present disclosure. The catch surface deployment system is configured to provide at least some translational movement of the catch surface 269 as the catch surface 269 moves from the retracted configuration to the deployed configuration. That is, the catch surface 269 undergoes at least some arc motion when moving from the retracted configuration to the deployed configuration, rather than solely undergoing a rotational pivot motion as is the case with known grab systems 100. In the example of Fig. 10B, the acute angle 930 between the extension direction 946 of the catch surface 269 and the surface normal 934 to the plane 948 of the grip member 230 has reduced to about 50°.

[0087] Fig. 11A schematically depicts a view from the side of the catch surface 269 of Fig. 10A in a second position during movement from the retracted configuration to the deployed configuration according to an aspect of the present disclosure. In the example of Fig. 11A, the acute angle 930 between the extension direction 946 of the catch surface 269 and the surface normal 934 to the plane 948 of the grip member 230 has reduced to about 20°. As the catch surface 269 moves from the retracted configuration to the deployed configuration, a leading edge 938 of the catch surface 269 sweeps under the underside 940 of the grip member 230. A separation (i.e.

a shortest distance) between the leading edge 938 of the catch surface 269 and the underside 940 of the grip member 930 decreases, reaches a smallest value and then increases again as the catch surface 269 moves from the retracted configuration to the deployed configuration. The catch surface deployment system is configured such that the smallest separation 936 between the leading edge 938 of the catch surface 269 and the underside 940 of the grip member 230 is less than about 45 mm. In the example of Figs. 10A-11B, the smallest separation 936 is about 18 mm.

[0088] Fig. 11B schematically depicts a view from the side of the catch surface 269 of Fig. 10A in the deployed configuration according to an aspect of the present disclosure. In the example of Fig. 11B, the acute angle between the extension direction 946 of the catch surface 269 and the surface normal 934 to the plane 948 of the grip member 230 has reduced to about 0°. The catch surface deployment system is configured such that, when in the deployed configuration, the catch surface 269 extends towards the opposing catch surface (not shown) beyond the plane 948 of the grip member 230 by an extension distance 939 of about 35 mm or more. In the example of Fig. 11B, the catch surface 269 extends towards the opposing catch surface (not shown) beyond the plane 948 of the grip member 230 by an extension distance 939 of about 50 mm. The catch surface deployment system is configured such that the catch surface 269 offers a catch surface area of about 4500 mm^2 or more in the active configuration for catching the one or more panels of the temporary roadway held by the grab system 200. The catch surface area is a surface that is able to contact a panel of the temporary roadway if the panel falls on the first and second catch surfaces. In the example of Fig. 11B, the catch surface area is formed between the extension distance 939 and a width of the catch panel 269 that extends into the page. The catch panel 268 may have a width of about 270 mm. In the example of Fig. 11B, the catch surface 269 offers a catch surface area of about 13500 mm^2 in the deployed configuration.

[0089] Fig. 12A shows a flowchart of a first method of using a grab system according to an aspect of the present disclosure. A first step 970 of the first method comprises releasably attaching at least one of first and second grip members to an arm assembly of the grab system. The first step 970 may comprise using the grip member attachment system as previously described. A second step 971 of the first method comprises adjusting a separation distance between the first and second grip members of the arm assembly to grab one or more panels of a temporary roadway.

[0090] Fig. 12B shows a flowchart of a second method of using a grab system according to an aspect of the present disclosure. A first step 972 of the second method comprises inserting a first grip insert into an aperture of a first grip member of an arm assembly of the grab system. A second step 973 of the second method comprises releasably attaching the first grip insert to the first grip member. The second step 973 may comprise using the grip insert attachment system as previously described. A third step 974 of the second method comprises adjusting a separation distance between the first grip member and a second grip member of the arm assembly to grab one or more panels of a temporary roadway. An optional fourth step 975 of the second method comprises releasing the first grip insert from the first grip member. An optional fifth step 976 of the second method comprises removing the first grip insert from the aperture of the first grip member. An optional sixth step 977 of the second method comprises inserting a second grip insert into the aperture of the first grip member. An optional seventh step 978 of the second method comprises releasably attaching the second grip insert to the first grip member. The first and second grip inserts comprise different materials and/or different grip member profiles.

[0091] Fig. 12C shows a flowchart of a third method of using a grab system according to an aspect of the present disclosure. A first step 979 of the third method comprises releasably attaching an arm assembly of the grab system to a connector of the grab system. The first step 979 may comprise using the arm assembly attachment system as previously discussed. A second step 980 of the third method comprises adjusting a separation distance between first and second grip members of the arm assembly to grab one or more panels of a temporary roadway.

[0092] Fig. 12D shows a flowchart of a fourth method of using a grab system according to an aspect of the present disclosure. A first step 981 of the fourth method comprises adjusting a separation distance between first and second grip members of an arm assembly of the grab system to grab one or more panels of a temporary roadway. A second step 982 of the fourth method comprises deploying a first catch surface associated with the first grip member and a second catch surface associated with the second grip member from a retracted configuration to a deployed configuration in which the first and second catch surfaces project toward each other from an underside of their associated grip member. The second step 982 may comprise using the catch surface deployment system as previously discussed. Deploying the first and second catch surfaces comprises translationally moving the first and second catch surfaces. Deploying the first and second catch surfaces may also comprise rotationally moving the first and second catch surfaces.

[0093] Fig. 13A schematically depicts a view from the side of an alternative grip member 273 comprising a plurality of protruding strips 274-276 for frictionally engaging one or more panels of a temporary roadway that is to be hoisted by the grab system. The protruding strips 274-276 advantageously improve a grip of the grip member 273. The plurality of protruding strips 274-276 may comprise a metal such as, for example, steel. The plurality of protruding strips 274-276 may be located proximate a lower end 277 of a grip surface 278 of the grip member 273.

[0094] Fig. 13B schematically depicts a view of the front of the alternative grip member 273 of Fig. 13A. The plurality of protruding strips 274-276 extend across an entire width 723 of the grip surface 278 of the grip member 273. That is, a length of each protruding strip 274-276 may be substantially equal to a width 723 of the grip surface 278 of the grip member 273. A height of each protruding strip 274-276 may be about 5 mm. A depth of each protruding strip may be about 5 mm. The plurality of protruding strips 274-276 may be substantially equally spaced apart along a height of the grip surface 278 of the grip member 273. In the example of Fig. 13A and 13.B, the grip member 278 comprises three protruding strips 274-276. The grip members 273 may comprise a greater number of protruding strips 274-276.

[0095] In the example of Fig. 13.B, the legs 254, 255 comprise chamfered feet 281, 282 such that widths of the feet 281, 282 taper from greatest widths at an upper end of the feet 281, 282 to smaller widths at a lower end of the feet 281, 282. The grip member comprises four connection sections 291-294 configured to connect to the beams 211, 213, 215, 217 of the arm assembly. Outer perimeters 311-314 and inner perimeters 321-324 of said sections 291-294 may comprise wear-resistant material such as, for example, phosphor bronze. The wear-resistant material advantageously increases a load rating of the connection sections 291-294 and increase an operational lifetime of connection sections 291-294.

[0096] While specific embodiments of the invention have been described above, it will be appreciated that the invention may be practiced otherwise than as described. The descriptions above are intended to be illustrative, not limiting. Thus, it will be apparent to one skilled in the art that modifications may be made to the invention as described without departing from the scope of the claims set out below.

Claims

1. A grab system for hoisting one or more panels of a temporary roadway comprising:

an arm assembly comprising:

first and second grip members for engaging said one or more panels of the temporary roadway, and,
an actuation system configured to adjust a separation distance between the first and second grip members for grabbing and releasing said one or more panels of the temporary roadway,

wherein one or both of the first and second grip members comprise:

a first aperture configured to receive a respective grip insert for frictionally engaging the one or more panels of the temporary roadway; and,
a grip insert attachment system configured to allow releasable attachment of the respective grip insert to the respective grip member,

wherein the first aperture is one of a plurality of apertures configured to receive a plurality of respective grip inserts, wherein the plurality of apertures are arranged at different positions along a height of the respective first or second grip member.

2. The grab system of claim 1, wherein the respective grip member comprises a grip insert connection portion and the respective grip insert comprises a grip member connection portion such that the grip insert connection portion and the grip member connection portion co-operate to releasably attach the respective grip insert to said respective first or second grip member, and wherein the grip insert attachment system comprises:

a first socket through the grip insert connection portion;
a second socket through the grip member connection portion; and,
a removable implement, wherein the removable implement is configured to be reversibly inserted through both the first and second sockets simultaneously to releasably attach the respective grip insert to said respective first or second grip member.

3. The grab system of any preceding claim, wherein the respective grip insert comprises a triangular grip member profile and/or a saw-tooth grip member profile for frictionally engaging said one or more panels of the temporary roadway.

4. The grab system of any preceding claim, wherein the respective grip insert is interchangeable with a second grip insert by releasing the respective grip insert from the grip insert attachment system and releasably attaching the second grip insert to the grip insert attachment system, wherein the respective grip insert and the second grip insert comprise different materials and/or different grip member profiles for frictionally engaging said one or more panels of the temporary roadway.

5. The grab system of any preceding claim, comprising:

a first catch surface associated with the first grip member;
a second catch surface associated with the sec-

ond grip member; and,
a catch surface deployment system configured to move the first and second catch surfaces between a retracted configuration and a deployed configuration in which the first and second catch surfaces project toward each other from an underside of their associated grip member for catching the one or more panels of the temporary roadway, wherein the catch surface deployment system is configured to provide movement of the first and second catch surfaces which includes translation; wherein optionally
the first and second catch surfaces each comprise:

a first portion attached to a mechanical linkage of the catch surface deployment system; and,
a second portion extending away from the first portion in an extension direction, wherein the catch surface deployment system is configured to hold the first and second catch surfaces in the retracted configuration such that the extension direction of the first catch surface is towards a plane of the first grip member, and the extension direction of the second catch surface is towards a plane of the second grip member;

and/or wherein the catch surface deployment system is configured such that:

an acute angle formed between the extension direction of the first catch surface and a normal to the plane of the first grip member reduces from less than about 90° in the retracted configuration to about 0° in the deployed configuration; and,
an acute angle formed between the extension direction of the second catch surface and a normal to the plane of the second grip member reduces from less than about 90° in the retracted configuration to about 0° in the deployed configuration;

and/or wherein the catch surface deployment system comprises:

a first curved guide associated with the first grip member;
a second curved guide associated with the second grip member;
a first moveable follower attached to the first catch surface and mounted to the first curved guide; and,
a second moveable follower attached to the second catch surface and mounted to the second curved guide,
wherein the first moveable follower is configured to move along the first curved guide to move the first catch surface between the retracted configuration and the deployed configuration, and the second moveable follower is configured to move along the second curved guide to move the second catch surface between the retracted configuration and the deployed configuration;
and/or wherein the catch surface deployment system is configured such that:

when the first catch surface is moved from the retracted configuration to the deployed configuration, a smallest separation between a leading edge of the first catch surface and the underside of first grip member is less than about 45 mm; and,
when the second catch surface is moved from the retracted configuration to the deployed configuration, a smallest separation between a leading edge of the second catch surface and the underside of the second grip member is less than about 45 mm;

and/or wherein the catch surface deployment system is configured such that, when in the deployed configuration, the first and second catch surfaces extend towards each other beyond planes of their associated grip members by about 35 mm or more;
and/or wherein the catch surface deployment system is configured such that, when in the deployed configuration, the first and second catch surfaces each provide a catch surface area of about 4500 mm^2 or more for catching the one or more panels of the temporary roadway if the one or more panels were to fall from the first and second grip members;
and/or wherein an underside of each of the first and second catch surfaces comprises a roller configured to rotate about an axis that is substantially perpendicular to a direction of travel of the respective first and second catch surfaces;
and/or wherein the catch surface deployment system comprises:

a first moveable grip insert associated with the first catch surface; and,
a second movable grip insert associated with the second catch surface,

wherein the first grip member comprises a first receiving aperture configured to receive the first movable grip insert and the second grip member comprises a second receiving aperture configured to receive the second movable grip insert, wherein the catch surface deployment system is configured to move the first and second mov-

able grip inserts in tandem with the first and second catch surfaces such that the first and second movable grip inserts are received in the first and second receiving apertures of the first and second grip members when the first and second catch surfaces reach the deployed configuration,
and/or wherein the catch surface deployment system is configured such that, when in the deployed configuration, the first and second catch surfaces are configured to contact the one or more panels of the temporary roadway and assist the grab system in hoisting the one or more panels of the temporary roadway.

6. The grab system of any preceding claim, wherein the first and second grip members comprise a plurality of protruding strips for frictionally engaging the one or more panels of the temporary roadway.

7. A grab system for hoisting one or more panels of a temporary roadway comprising:

an arm assembly comprising:

first and second grip members for engaging said one or more panels of the temporary roadway; and,
an actuation system configured to adjust a separation distance between the first and second grip members for grabbing and releasing said one or more panels of the temporary roadway,

wherein the grab system further comprises:

a first catch surface associated with the first grip member;
a second catch surface associated with the second grip member; and,
a catch surface deployment system configured to move the first and second catch surfaces between a retracted configuration and a deployed configuration in which the first and second catch surfaces project toward each other from an underside of their associated grip member for catching the one or more panels of a temporary roadway, wherein the catch surface deployment system is configured to provide movement of the first and second catch surfaces which includes translation.

8. The grab system of claim 7, wherein the first and second catch surfaces each comprise:

a first portion attached to a mechanical linkage of the catch surface deployment system; and,
a second portion extending away from the first portion in an extension direction, wherein the catch surface deployment system is configured to hold the first and second catch surfaces in the retracted configuration such that the extension direction of the first catch surface is towards a plane of the first grip member, and the extension direction of the second catch surface is towards a plane of the second grip member.

9. The grab system of claim 7 or claim 8, wherein the catch surface deployment system is configured such that:

an acute angle formed between the extension direction of the first catch surface and a normal to the plane of the first grip member reduces from less than about 90° in the retracted configuration to about 0° in the deployed configuration; and,
an acute angle formed between the extension direction of the second catch surface and a normal to the plane of the second grip member reduces from less than about 90° in the retracted configuration to about 0° in the deployed configuration.

10. The grab system of any of claims 7 to 9, wherein the catch surface deployment system comprises:

a first curved guide associated with the first grip member;
a second curved guide associated with the second grip member;
a first moveable follower attached to the first catch surface and mounted to the first curved guide; and,
a second moveable follower attached to the second catch surface and mounted to the second curved guide,
wherein the first moveable follower is configured to move along the first curved guide to move the first catch surface between the retracted configuration and the deployed configuration, and the second moveable follower is configured to move along the second curved guide to move the second catch surface between the retracted configuration and the deployed configuration.

11. The grab system of any of claims 7 to 10, wherein the catch surface deployment system is configured such that:

when the first catch surface is moved from the retracted configuration to the deployed configuration, a smallest separation between a leading edge of the first catch surface and the underside of first grip member is less than about 45 mm;

and,
when the second catch surface is moved from the retracted configuration to the deployed configuration, a smallest separation between a leading edge of the second catch surface and the underside of the second grip member is less than about 45 mm;
and/or wherein the catch surface deployment system is configured such that, when in the deployed configuration, the first and second catch surfaces extend towards each other beyond planes of their associated grip members by about 35 mm or more;
and/or wherein the catch surface deployment system is configured such that, when in the deployed configuration, the first and second catch surfaces each provide a catch surface area of about 4500 mm^2 or more for catching the one or more panels of the temporary roadway if the one or more panels were to fall from the first and second grip members.

12. The grab system of any of claims 7 to 11, wherein an underside of each of the first and second catch surfaces comprises a roller configured to rotate about an axis that is substantially perpendicular to a direction of travel of the respective first and second catch surfaces.

13. The grab system of any of claims 7 to 12, wherein the catch surface deployment system comprises:

a first moveable grip insert associated with the first catch surface; and,
a second movable grip insert associated with the second catch surface,
wherein the first grip member comprises a first receiving aperture configured to receive the first movable grip insert and the second grip member comprises a second receiving aperture configured to receive the second movable grip insert,
wherein the catch surface deployment system is configured to move the first and second movable grip inserts in tandem with the first and second catch surfaces such that the first and second movable grip inserts are received in the first and second receiving apertures of the first and second grip members when the first and second catch surfaces reach the deployed configuration.

14. The grab system of any of claims 7 to 13, wherein the catch surface deployment system is configured such that, when in the deployed configuration, the first and second catch surfaces are configured to contact the one or more panels of the temporary roadway and assist the grab system in hoisting the one or more panels of the temporary roadway.

15. A method of using a grab system comprising:

adjusting a separation distance between first and second grip members of an arm assembly of the grab system to grab one or more panels of a temporary roadway; and,
deploying a first catch surface associated with the first grip member and a second catch surface associated with the second grip member from a retracted configuration to a deployed configuration in which the first and second catch surfaces project toward each other from an underside of their associated grip member,
wherein deploying the first and second catch surfaces comprises translationally moving the first and second catch surfaces.

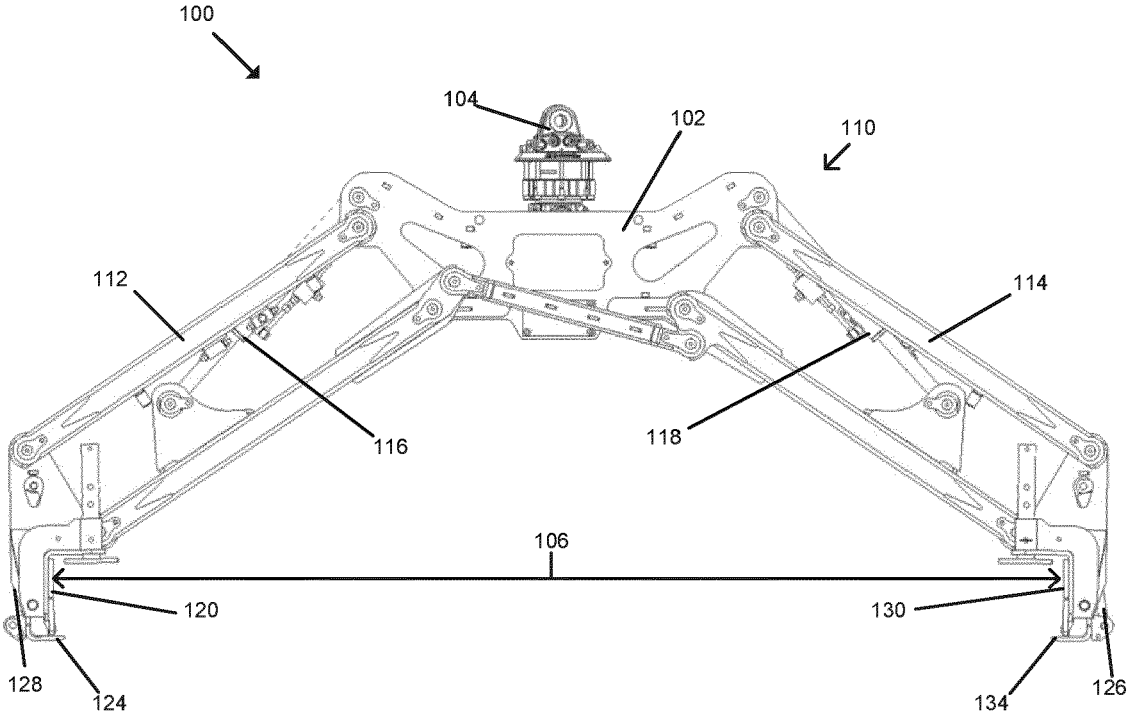

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FIG. 1A

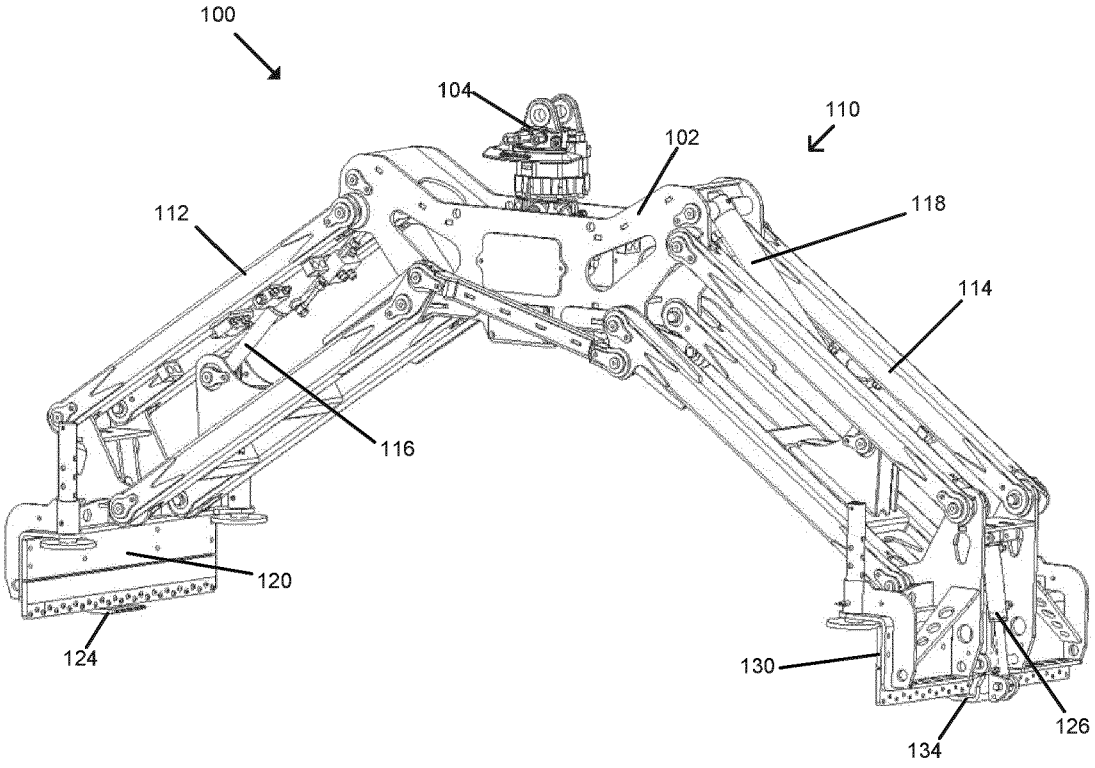

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FIG. 1B

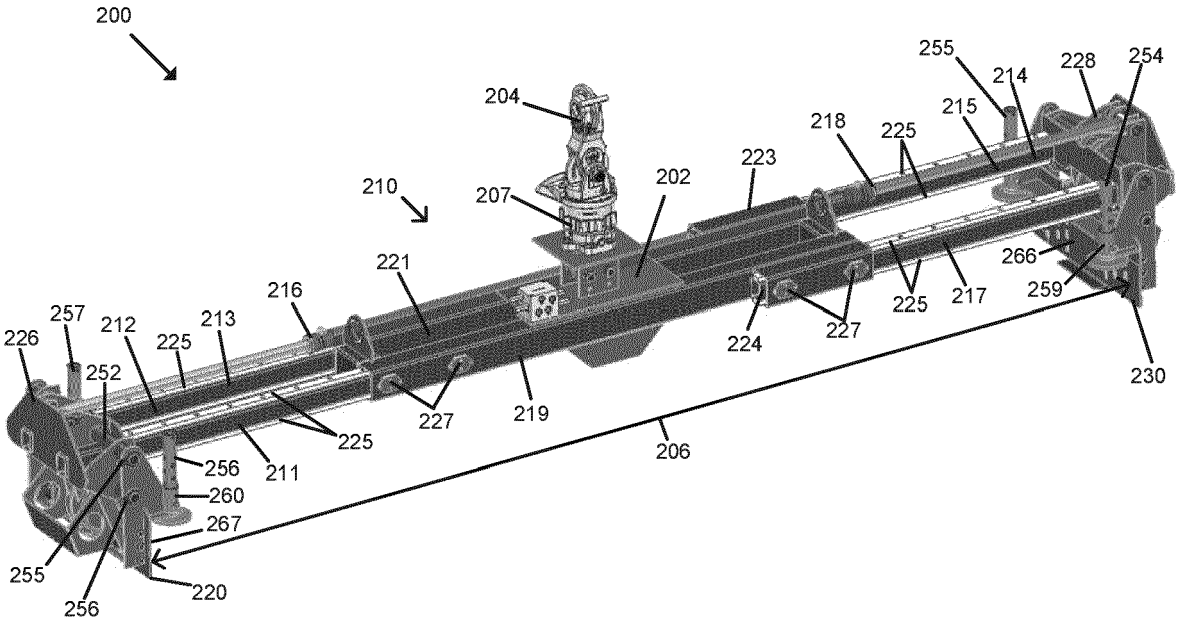

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FIG. 2A

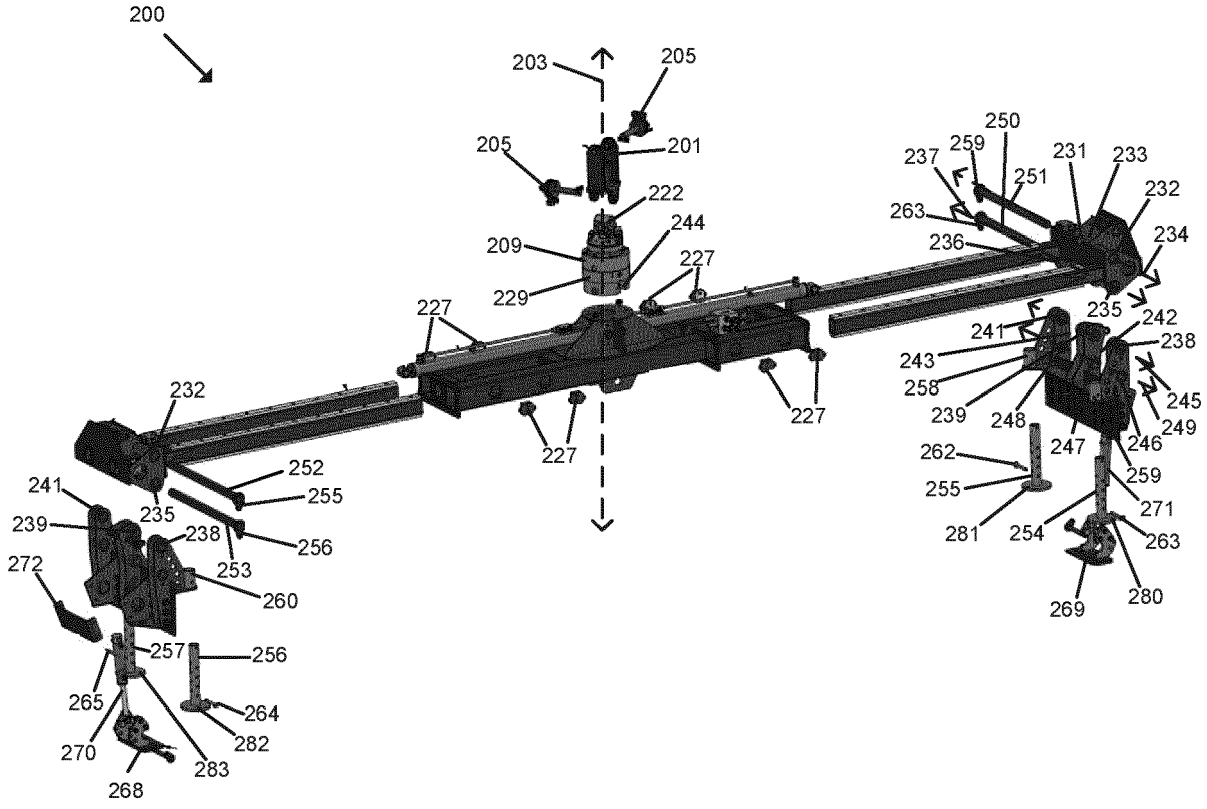

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FIG. 2B

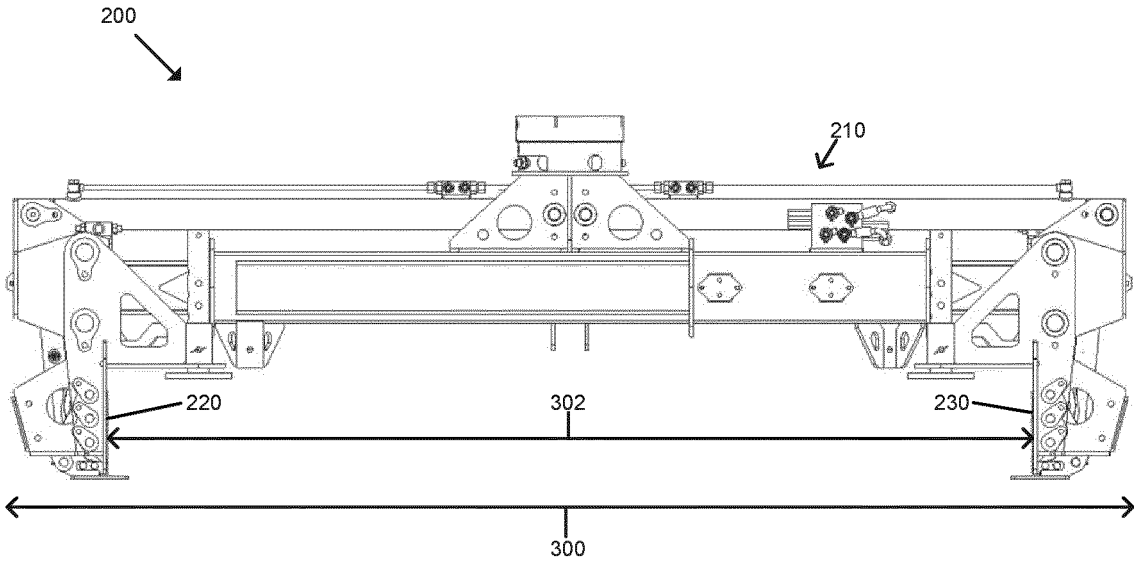


FIG. 3A

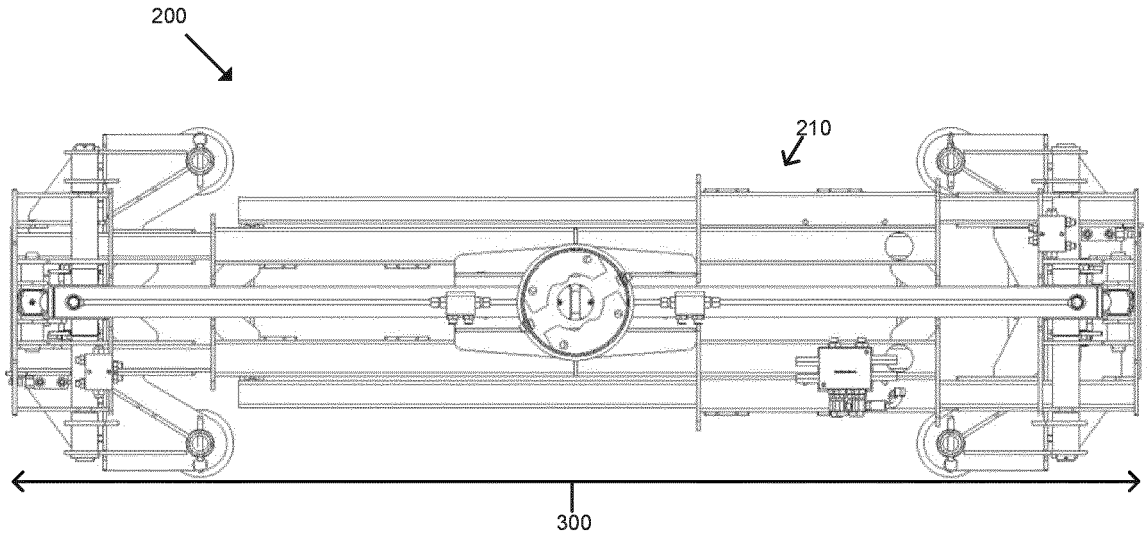


FIG. 3B

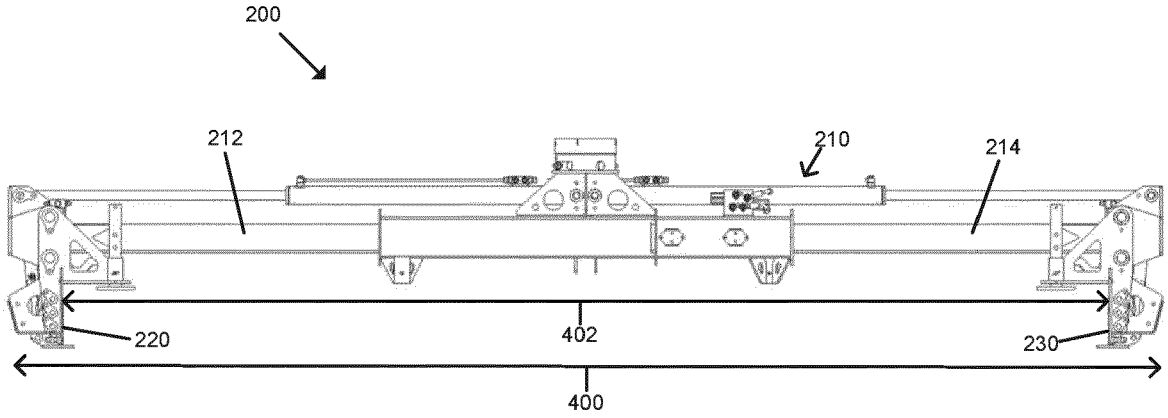


FIG. 4A

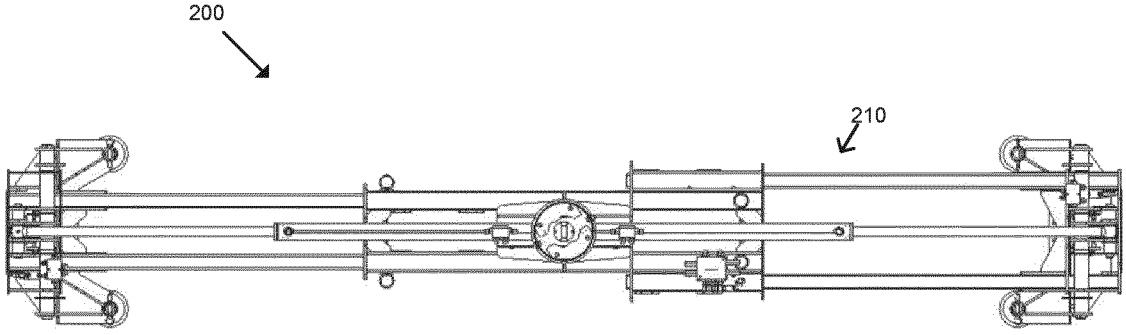


FIG. 4B

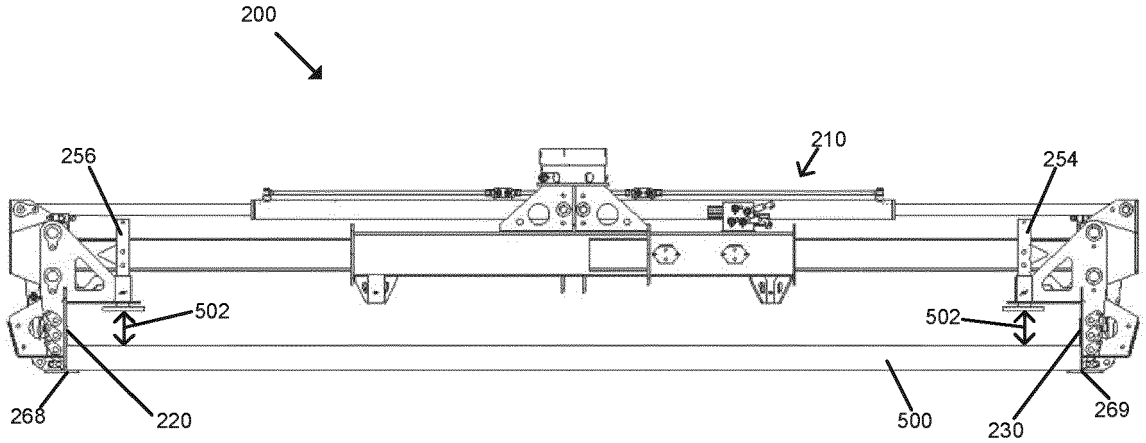

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FIG. 5A

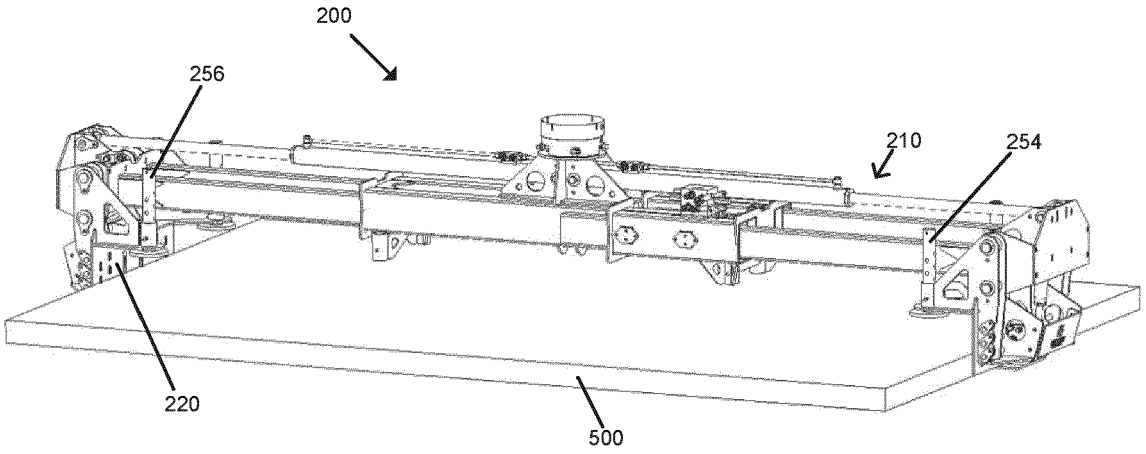

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FIG. 5B

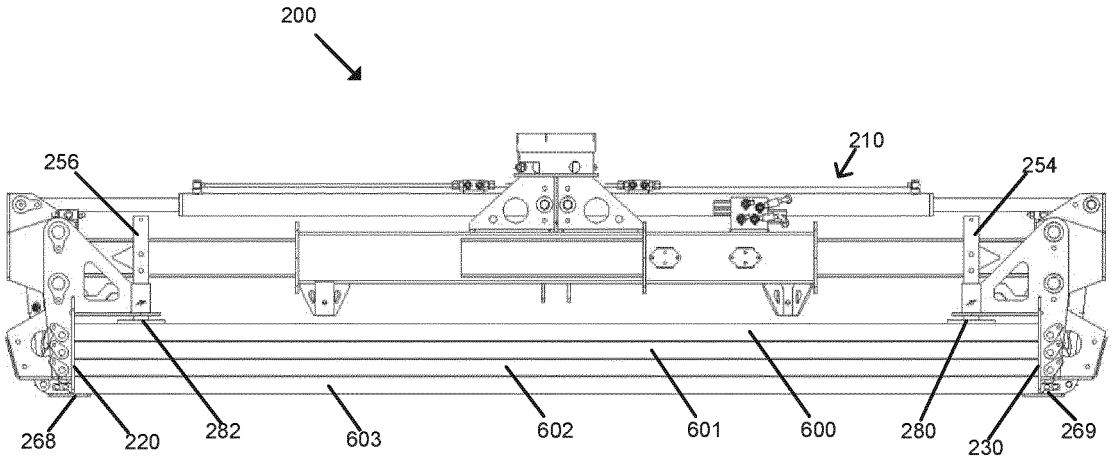

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FIG. 6A

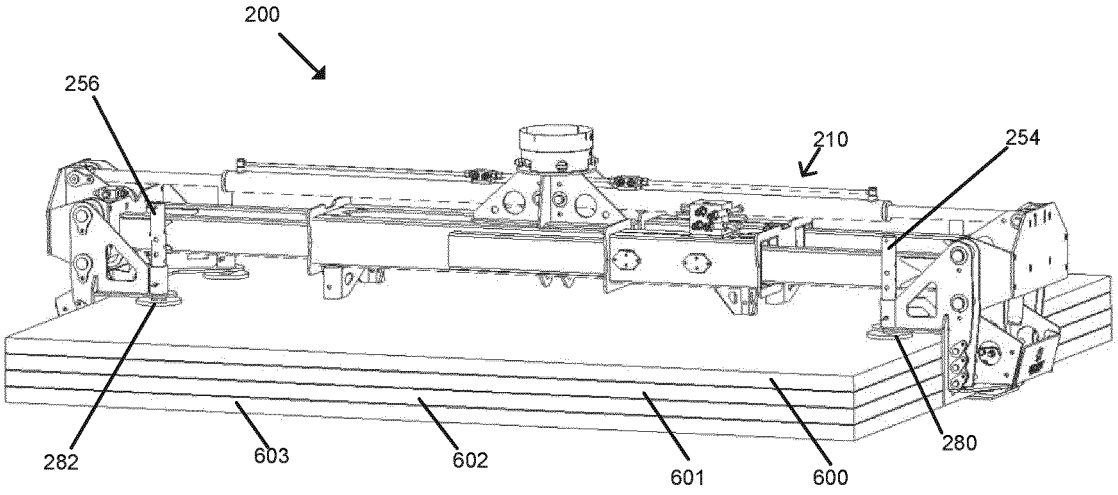

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FIG. 6B

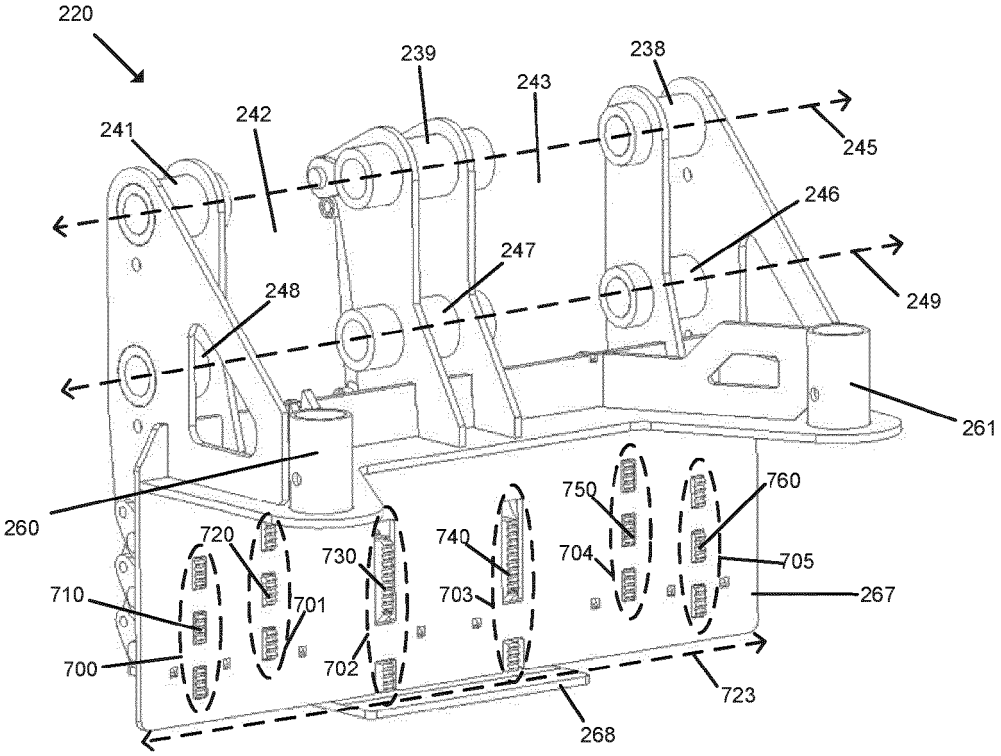

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268

FIG. 7A

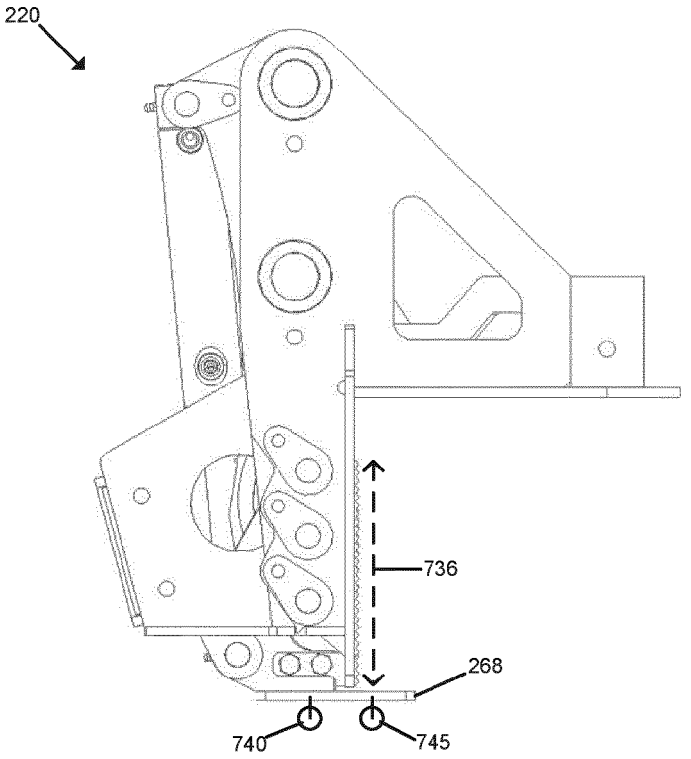

220
736
268
740
745

FIG. 7B

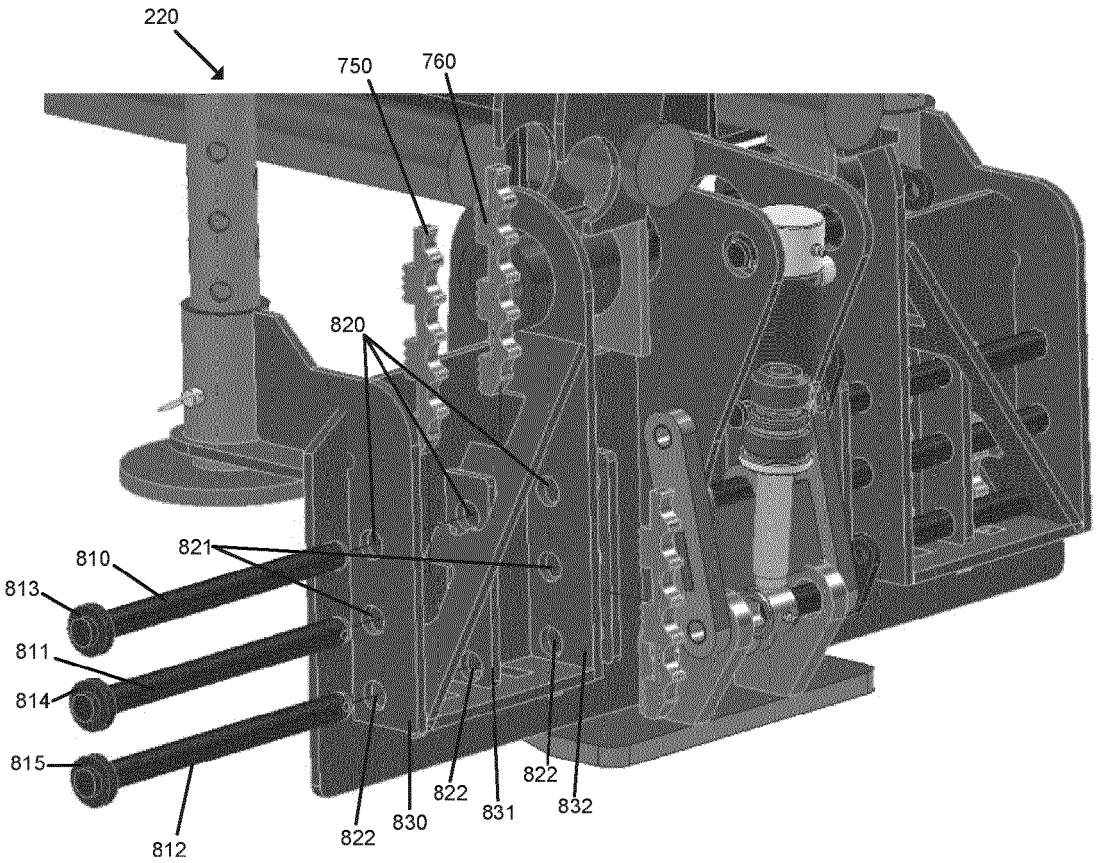

220
750
760
820
821
810
813
811
814
815
812
822
830
822
831
822
832

FIG. 8A

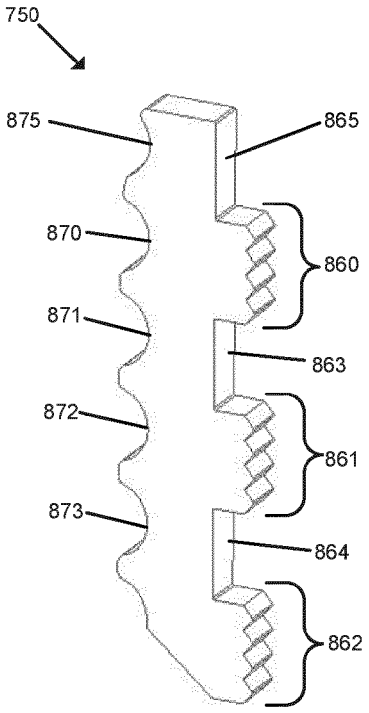

750
875
865
870
860
871
863
872
861
873
864
862

FIG. 8B

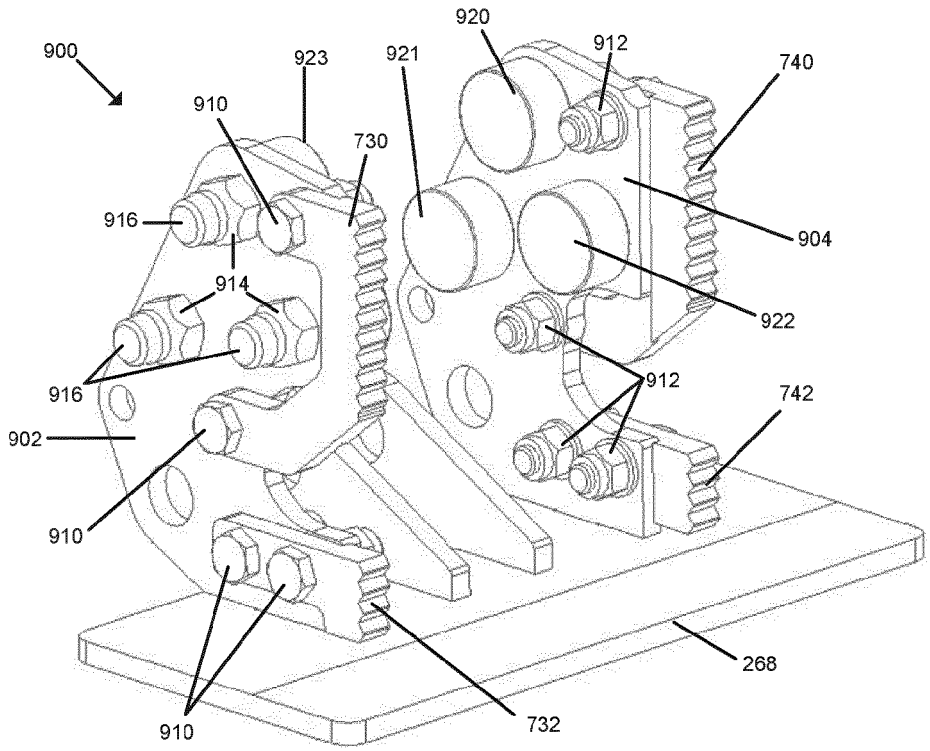

900
923
921
920
912
740
910
730
916
904
914
922
916
912
742
902
910
268
910
732

FIG. 9A

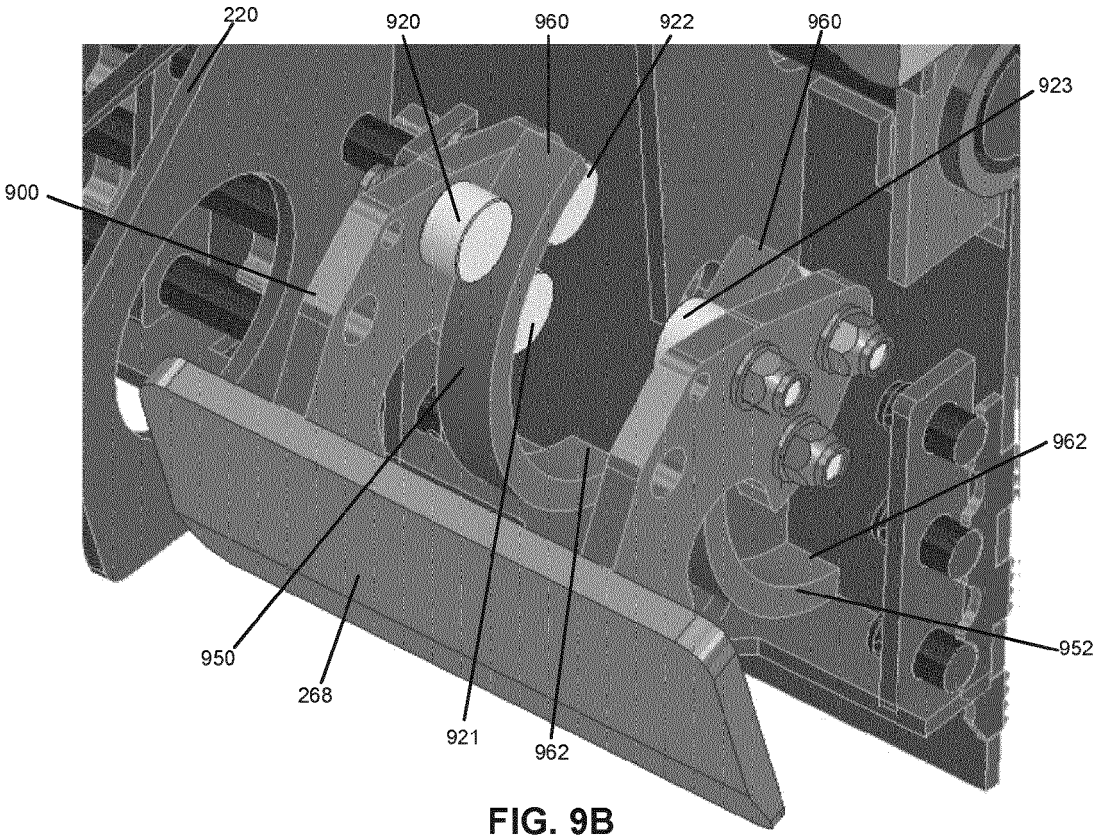

220
920
960
922
960
923
900
962
950
952
268
921
962

FIG. 9B

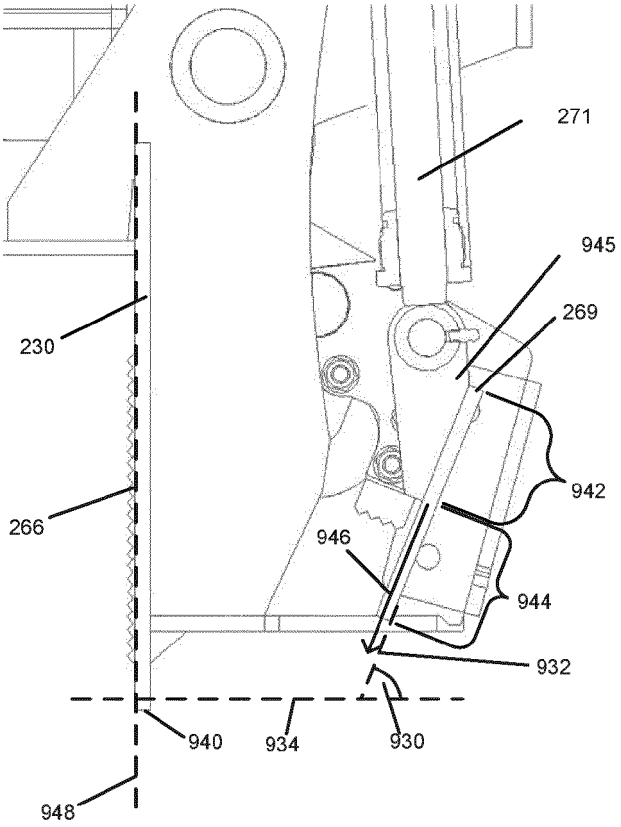


FIG. 10A

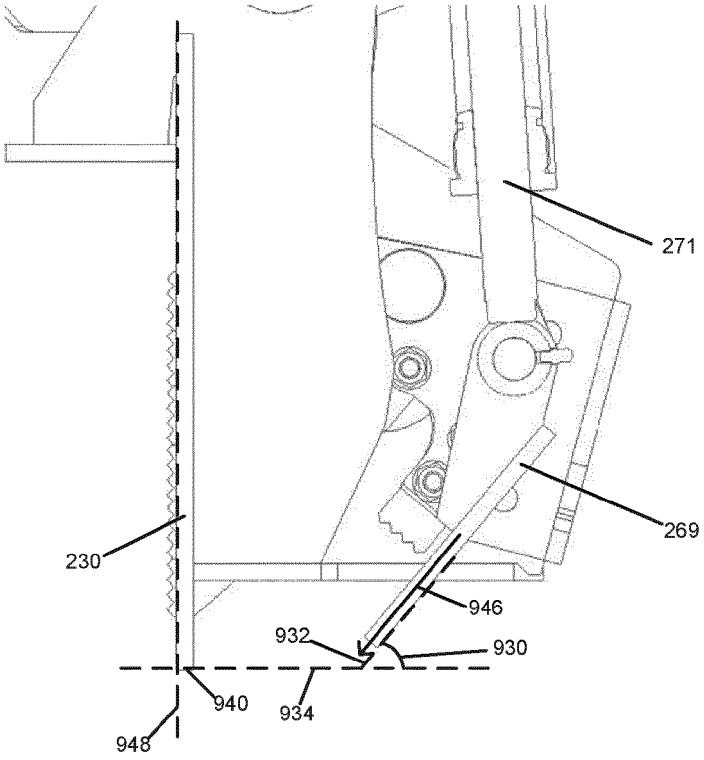


FIG. 10B

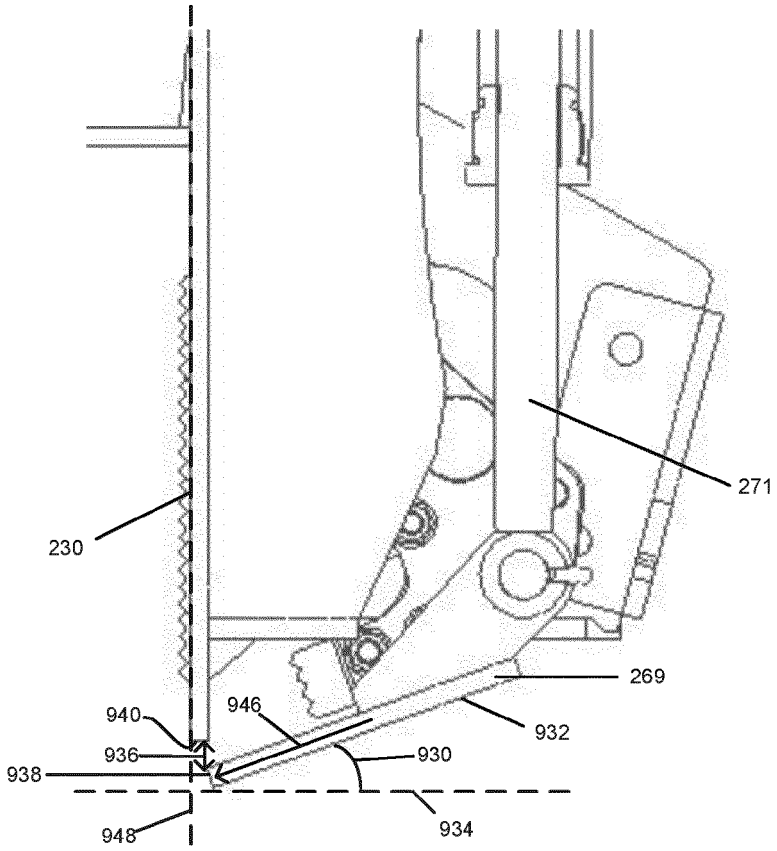


FIG. 11A

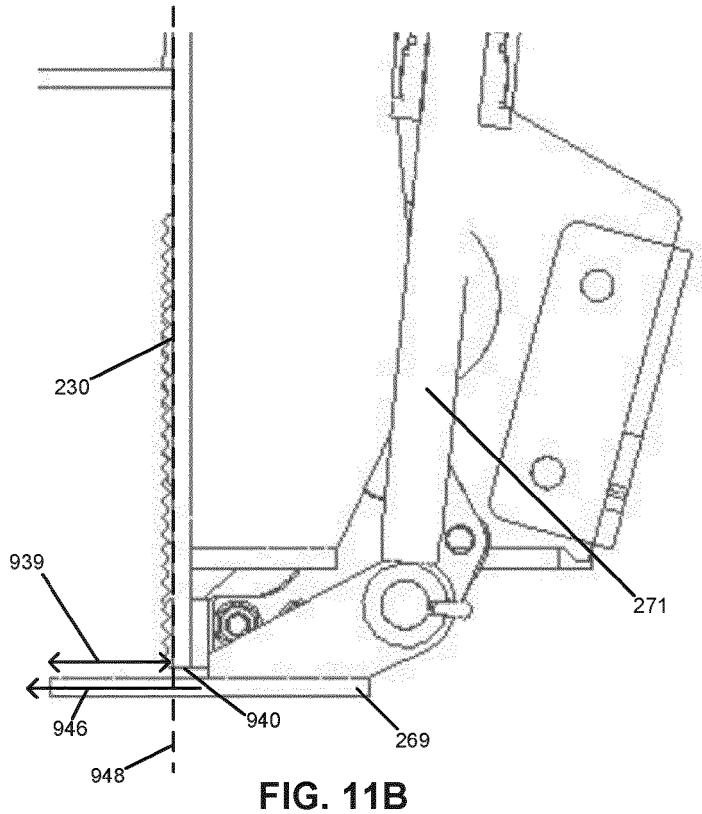


FIG. 11B

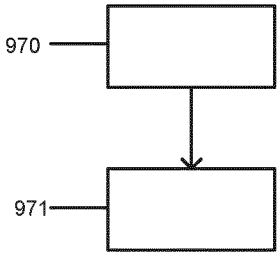


FIG. 12A

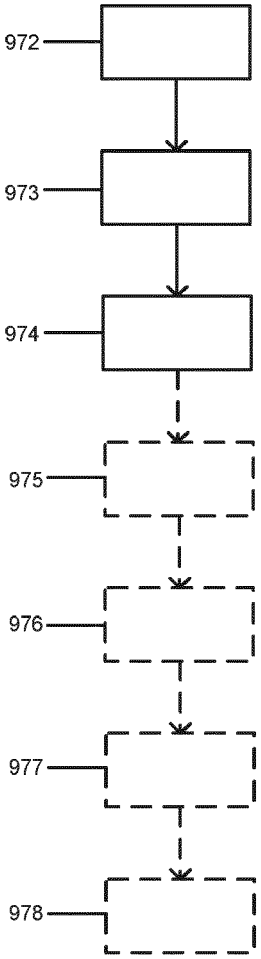


FIG. 12B

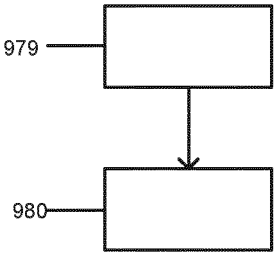


FIG. 12C

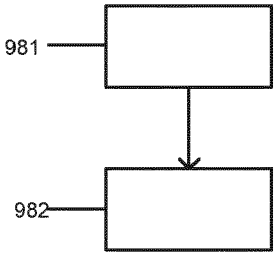


FIG. 12D

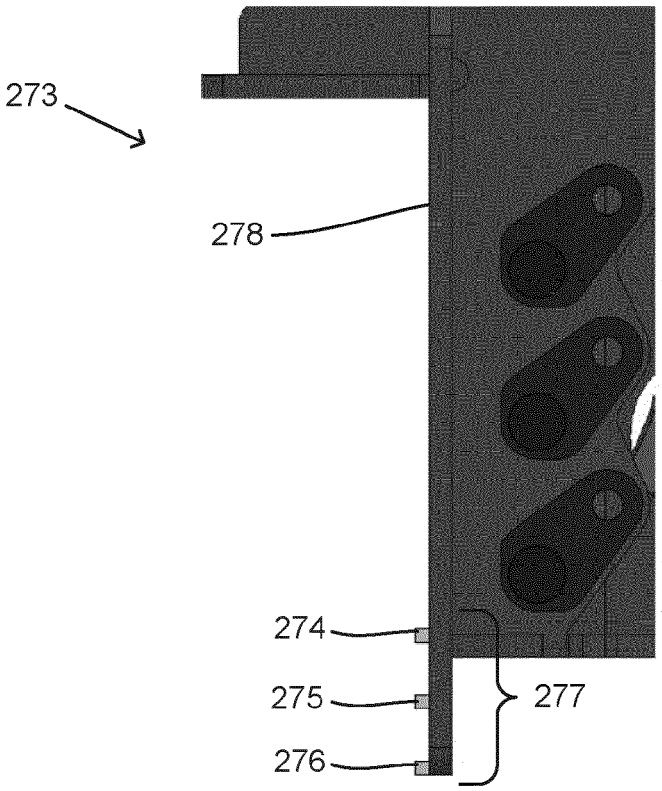


FIG. 13A

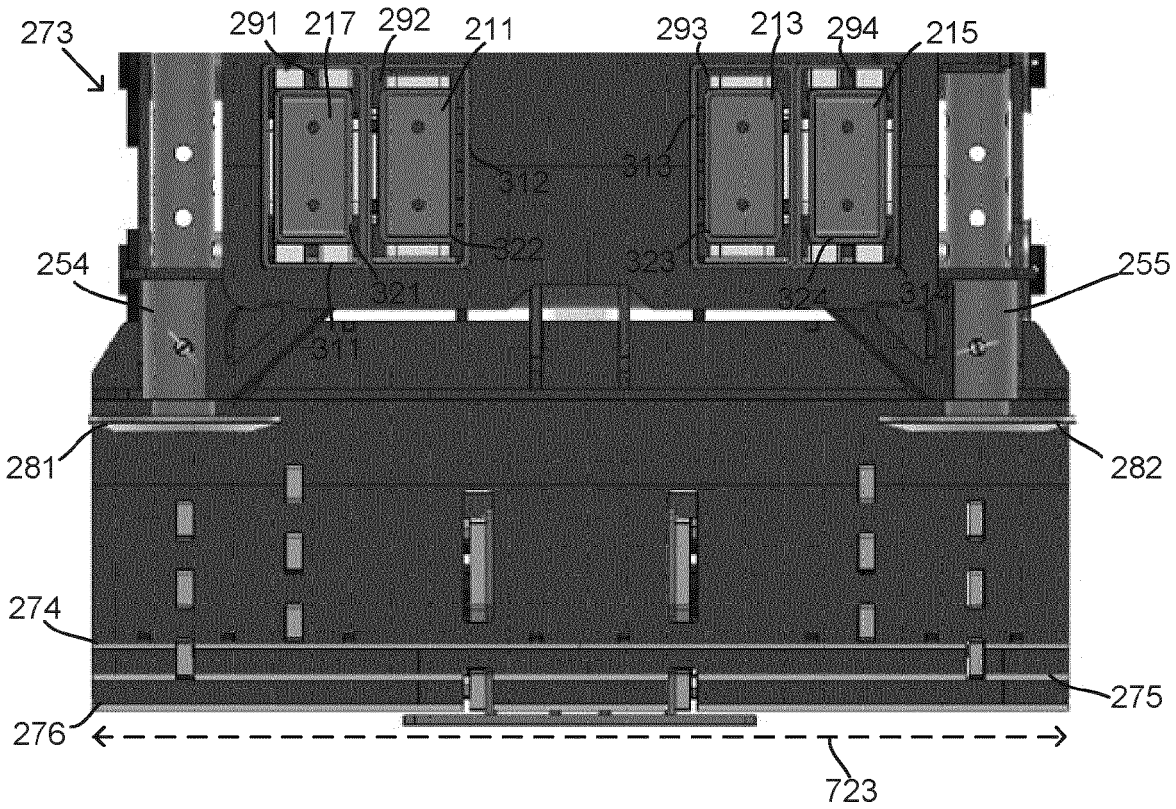


FIG. 13B

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EUROPEAN SEARCH REPORT

Application Number
EP 21 20 6743

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	DE 10 2019 204538 A1 (AUDI HUNGARIA ZRT [HU]; GGK GULYAS GEPGYARTO ES KERESKEDELMI KFT [HU]) 1 October 2020 (2020-10-01)	1,6	INV. B66C1/44 B66C1/32
Y	* the whole document *	3,4	
A		7,15	

X	US 10 800 045 B1 (JONAS JUDE ROYSTON [US] ET AL) 13 October 2020 (2020-10-13)	7	
A	* column 1 - column 8, line 3 *	1,8-15	

Y	US 8 226 140 B1 (DIETRICH MATT [US] ET AL) 24 July 2012 (2012-07-24)	3,4	
A	* abstract; figures * * column 1 - column 7, line 5 *	1,7,15	

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	21 March 2022	Verheul, Omiros

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