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(54) Fire fighting rescue cage

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Description

[0001] The present invention relates to a fire fighting rescue cage for a fire fighting vehicle, according to the preamble of claim 1.

[0002] Fire fighting rescue cages are known in various embodiments as part of the rescue equipment of fire engines. The rescue cage is mounted at the end of a rescue ladder that is usually embodied as a multiple-part turnable ladder set mounted on top of the vehicle. While the ladder set itself can be turned around a vertical axis and be extended along its lengthwise direction, it can also be pivoted upwardly to lift the rescue cage at the end of the ladder set upwards. The cage is connected to the end of the ladder by means of a suspension that enables a pivoting movement between the rescue cage and the ladder set around a horizontal axis. By this pivotable attachment, the bottom of the rescue cage can always be held in a horizontal position while the ladder is tilted into any desired angle. United States Patent specification US 6 145 619 discloses such fire fighting rescue cage. It may also be possible to tilt the ladder downwardly into an underfloor position in which the rescue cage is located below the plane on top of which the ladder is mounted. This means that the suspension for the rescue cage at the end of the ladder has to be very flexible.

[0003] There are several requirements to the flexibility of the construction of such fire fighting rescue cages. Among others, it is desired to store the rescue cage in a transport position when the vehicle is moving into its place of operation, so that the driver's sight is not obstructed by the rescue cage at the front end of the vehicle. With the known cages according to the state of the art, the cage design must always be adapted to the design of the ladder construction, the respective water supply incorporated therein and so on. For this reason it is not simply possible to exchange one cage construction against another in a certain cage/ladder concept, although this might be desired for certain reasons. For example, it might be required to exchange the cage mounted on top of one ladder set against a cage with improved equipment or safety features. One of these features is a collision preventing device to avoid collisions of the cage with interfering objects. It is not easy to implement such a feature and to combine it with the above mentioned flexibility requirements.

[0004] It is therefore one object of the present invention to provide a fire fighting rescue cage of the above kind with a flexible design that even enables a complete exchange of one rescue cage against another at the same ladder set. It is another object of the present invention to facilitate the implemention of a collision preventing device in the concept of a replaceable rescue cage.

[0005] These objects of the invention are provided by a fire fighting rescue cage comprising the features of claim 1.

[0006] The fire fighting rescue cage according to the present invention comprises an underfloor module that is inserted into the floor of the rescue cage by sliding it into a recession in the cage floor from the backside of the cage. This underfloor module is connected with the suspension to connect the framework of the rescue cage with the top of the ladder. For example, the underfloor module may be connected via an hinge to an upwardly tilted frame construction at its rear end. This frame can also comprise the actuating drive for pivoting the rescue cage with respect to the ladder.

[0007] The underfloor module according to the present invention provides a generally modular design of the rescue cage. Because multiple operational parts of the rescue cage are integrated into the underfloor module, it is possible to exchange the remaining framework of the rescue cage without exchanging the underfloor module, that remains hinged to the top of the ladder by the suspension. In fact the underfloor module can simply be pulled out at the back of the framework of the whole rescue cage and be pushed from behind into the bottom of another desired rescue cage with different specifications, so that it is possible to exchange the framework of the cage without replacing the major operational parts thereof.

[0008] Another advantage of this construction is that the provision of a collision preventing device is simplified to a great extend. Since the cage body and the underfloor module represent two construction units that are connected by pushing one into another, the suspension of the underfloor module within the recess could be provided to yield to mechanical shock or pressure due to a collision so that the cage can subside in a sliding movement on the module.This movement could also be detected so that the drive of the cage can react to this collision case, e.g. to stop moving the cage.

[0009] According to a preferred embodiment of the present invention, said underfloor module is provided with rolls at both sides of the underfloor module, said rolls being guided by roll guiding means provided at the floor at both sides of the recess.

[0010] Preferably the underfloor module is accomodated within its recess in a predetermined sliding position from which the underfloor module is deflectable to both sides in opposite sliding directions, and the underfloor module is provided with restoring means for elastically restoring said underfloor module from a deflected position back into said predetermined sliding position.

[0011] This construction represents a collision preventing system. In case the cage collides with an object, it is not necessarily damaged but rather deflected and replaced with regard to the underfloor module in one sliding direction. According to a preferred embodiment, the rescue cage according to the present invention comprises sensors for detecting a deflected position of said underfloor module.

[0012] The signals of these sensors can be used by the drive of the cage, e.g. to stop a driving movement of the cage in the case of a collision.

[0013] According to a another preferred embodiment, a water supply line leads from the ladder to water distri-

bution means mounted at the rescue cage, comprising a first section on the ladder side and a second section on the rescue cage side, said second section being conducted at least partially through the underfloor module and comprising a joint to be connected with the water distribution means at its end on the rescue cage side, said first section being connected with said second section by means of a rotary feedthrough enabling a pivoting movement of the second section with regard to the first section around the horizontal pivoting axis of the suspension.

[0014] By this water supply design a greater part of the supply line is integrated into the cage such that an obstruction of the rescue workers is no longer possible. Moreover, joining the water distribution devices to the end of the water supply is simplified. The rotary feedthrough enables an integrated connection between the different sections of the water supply line without obstructing the slewability of the rescue cage with respect to the ladder set.

[0015] According to a preferred embodiment of the present invention, the first section of the water supply line and its second section are provided as rigid pipes leading into the rotary feedthrough from opposite axial sides.

[0016] Because of the provision of the rotary feedthrough as a joint between the first and second sections of the water supply line, it is possible to provide these sections as stiff and rigid tubes or pipes that are conducted through the ladder construction and through the underfloor module, respectively. No elasticity or flexibility of the sections as such is required, because the rotary feedthrough allows the turning of the rescue cage together with underfloor module over a wide swiveling range without being obstructed by the provision of the water supply line.

[0017] According to another preferred embodiment of the present invention, the suspension comprises an actuating drive for pivoting the rescue cage with regard to the ladder. Preferably the pivoting range of this actuating drive is dimensioned such that in a generally horizontal position of the ladder, the underfloor module can be pivoted into a generally vertical erected transport position in which said rescue cage is put over the end of the ladder.

[0018] In this transport position, the cage as such is put over the ladder end while its bottom is standing in a generally vertical position, giving free sight to the driver of the fire engine.

[0019] Preferably the rescue cage according to the present invention comprises a rear wall portion that is pivotably attached to the underfloor module to be pivoted around a horizontal axis parallel or co-axial with the pivoting axis of the suspension, said rear wall portion being pivotable from an operating position in which it is erected on the plane of the underfloor module to a retracted position in which the rear wall portion is pivoted into the direction of the underfloor module.

[0020] In the operating position, the rear wall portion stands generally vertical on the plane of the underfloor module. It is noted that this does not necessary include the requirement of standing exactly vertical, i. e. forming a 90° angle with the plane of the floor of the rescue cage. Under practical aspects the rear wall portion can be tilted slidely outwards to include an angle of about 100° with the underfloor module. From this operating position, the rear wall portion can be folded in the direction of the plane of the underfloor module to include an acute angle with it. This feature of being pivotable inwards onto the underfloor module can help to take the transport position of the rescue cage on the top of the ladder, as described above.

[0021] It is further preferred to provide the rescue cage according to the present invention with a locking means for locking the rear wall portion in its operating position and with unlocking means for automatically unlocking the locking means when the rescue cage is pivoted in the transport position.

[0022] By the locking means, the rear wall portion is secured in its operating position so that there is no danger of an accidental opening of the rear wall of the cage in a rescue situation. The rear wall portion attached to the underfloor module can be unlocked automatically when the cage is swiveled upwards to be put over the end of the ladder. Preferably the locking means comprise a bolt being mounted axially slideable at the underfloor module, and a recess for receiving the bolt at the rear wall portion of the rescue cage, said bolt engaging the recess in the operating position of the rear wall portion and locking a pivoting movement of the rear wall portion with respect to the underfloor module, said unlocking means comprising retraction means for retracting the bolt from the recess automatically when the rescue cage is pivoted into its transport position.

[0023] In another preferred embodiment, the rear wall portion comprises at least one door wing being pivotably attached to a frame element of the rear wall by at least one hinge bearing.

[0024] This door wing allows or blocks the access to the rescue cage depending on its position in the rear wall portion. For example, there can also be a pair of door wings being attached at opposite sides of the frame element, for example, at opposite vertical supports forming a part of the rear wall portion.

[0025] Preferably this hinge bearing comprises a tubular sleeve into which an insertion element of the door wing is inserted axially downwards, said sleeve comprising a guide conduct winding helically around the sleeve, said insertion element being provided with a pin protruding from the periphery of the insertion element and being guided on or within the guide conduct.

[0026] This construction of the hinge bearing allows the door wing to close automatically because of the load of its own weight when no torque acts on the door wing, i. e. the door wing is not pushed into the opposite direction. The position of the pin at the lower end of the guide conduct can mark the closed position of the door wing in

this case. When the door wing is pushed, the pin can slide helically upwards, following the shape of the guide conduct. When the door wing is released again from this open position, the pin slides downwards along the guide conduct into its lower end position, closing the door again.

[0027] Preferably the lower end of the guide conduct is provided as a notch into which the pin engages when it reaches the lower end of the guide conduct.

[0028] This notch represents a locking means for locking the pin at the lower end of the guide conduct. When the pin is inserted into the notch, it is not possible to open the door by simply exerting a torque to the door wing and turning it. It is rather necessary to lift the door wing together with the pin so that the pin can further be pushed sidewards (following the rotary movement of the door wing) and being further conducted helically upwards within the guide conduct, so that the above described opening movement of the door wing is possible. This means that for opening the door wing, a combined movement of lifting the door wing and pushing it open is necessary, representing a locking mechanism. Preferably the hinge bearing further comprises a spring for biasing the insertion element axially to the sleeve.

[0029] This biasing means represents another safety mechanism to prevent the door wing from being opened accidentally. The spring makes it more difficult to lift the door wing from the lower end of the guide and to push it helically upwards. According to another preferred embodiment, the upper end of the guide conduct is flattened in the circumferential direction and forms an upper seat for the pin.

[0030] In this construction of the guide conduct, the pin can rest on the upper seat in an opened position of the door so that when the door wing is completely opened, it does not automatically slide back into the closed position. This means that no pushing force acting on the door wing is necessary to keep the door opened.

[0031] These and other aspects of the invention will be apparent from the following description with reference to the embodiments described hereinafter.

Fig. 1 is an exploded view of one embodiment of a fire fighting rescue cage according to the present invention;

Fig. 2 is a perspective view of an underfloor module as a part of a fire fighting rescue cage according to Fig. 1;

Fig. 3 to 6 are side views of the underfloor module of Fig. 2 suspended at the end of a rescue ladder in the front positions;

Fig. 7 is another perspective view of the underfloor module shown in Fig. 2 from another viewing angle;

Fig. 8 shows a detail of a locking mechanism for locking a rear wall portion of the rescue cage according to the embodiment shown in Fig. 1;

Fig. 9 is a perspective view of the rear wall portion of the rescue cage according to the embodiment shown in Fig. 1;

Fig. 10 is a detailed perspective view of Fig. 9;

Fig. 11 is another perspective view of the elements shown in

Fig. 9 in another operation position;

Fig. 12 is a perspective view of the underfloor module according to Fig. 2 with an opened rear wall portion; and

Fig. 13 is a perspective view of a rescue cage to the embodiment shown in the foregoing figures in its entirety.

[0032] Fig. 1 shows a fire fighting rescue cage 10 that is connected to the end of a ladder set of a fire fighting vehicle. The ladder set and the vehicle are not shown in Fig. 1. The ladder set as such is known from the state of the art and comprises a plurality of ladder segments that are extractable and retractable with regard to each other to extend the operation range of the ladder set and to move the rescue cage 10 mounted at its top within a large operation space. To achieve that flexibility, the ladder can be turned around a vertical axis and tilted around a horizontal axis.

[0033] The rescue cage 10 in Fig. 1 comprises a framework generally denoted by reference number 12. This framework comprises multiple parts, for example, a bottom part 14 forming the bottom of the cage, poles 16 standing vertically on the plane of the bottom elements 14, a front plate 18, side plates 20 and left and right rear plates 22. The rescue cage 12 further comprises a support 24 for a water monitor (not shown in Fig. 1) for fire fighting. This monitor is only one example of a water distribution device. In particular the cage 10 may comprise a water spraying self protection device at the bottom of the cage. The water for supplying these water distribution means is supplied by a water supply line leading from the vehicle through the ladder set into the rescue cage 10, as will be explained in more detail in the following description. Further parts of the rescue cage, like, for example, the mounting parts for connecting the poles 16 to the bottom elements 14 and the plates 18 are not described in respect to Fig. 1, since they are not subject of the present invention. The cage 10 comprises an upper hand rail 24 enclosing the upper edges of the walls of the cage 10.

[0034] The framework 12 of the cage 10 as described above forms one portion of the rescue cage 10. Another portion is formed by an underfloor module 30 forming a part of the bottom of the rescue cage 10. As can be taken from Fig. 1, the bottom of the framework 12 of the rescue cage 10 comprises a rectangular recess 32 for receiving the underfloor module 30. This recess 32 is accessible from the backside of the cage 10. Moreover, the rear wall of the framework 12 comprises another recess 34 to be closed by a rear wall portion 36 mounted on top of the underfloor module 30 and standing in a mainly vertical position with respect to the plane of the bottom of the rescue cage 10 but being inclined slightly outwards so that it encloses an angle about 100° with respect to the

bottom plane. Details of this rear wall portion 36 shall be described hereinafter.

[0035] The underfloor module 30 as such has a mainly rectangular plate-like shape to be slidably inserted in the respective recess 32 in the floor from the backside of the cage 10. In Fig. 1 the plate-like body 38 of the underfloor module 30 is shown with an open top side. In the assembled state this top side will be closed by a floor covering that is not shown in Fig. 1 for reasons of clarity. Inside the body 38 of the underfloor module 30 there is a tube 40 running from the rear face of the underfloor module 30 to a front face thereof. This tube 40 is opened to both sides and is provided to be connected to other tube sections. In particular the front end of this tube 40 at the front side of the underfloor module 30 is provided to be connected with a distribution device like a water monitor, for example, or a water spraying self protection device. The rear end of the tube 40 is to be connected with another tube section, as will be explained in the following.

[0036] The underfloor module 30 is connected to the end of the ladder by means of a suspension 42 comprising a rigid connection element 44 with two parallel rods 46, the lower end of these rods 46 being connected to the rear end of the underfloor module 30 by a left and right pivot bearing 48, respectively. The pivoting axis A of the pivot bearings 48 (see Fig. 2) lies horizontally and parallel to the plane of the plate-like body 38 of the underfloor module 30 so that the underfloor module 30 can be pivoted around a horizontal axis with regard to the rigid rods 46 and consequently with regard to the ladder set. For actuating this pivoting movement, the suspension 42 further comprises an actuating drive 50 in form of two hydraulic cylinders being arranged at the outer sides of the rods 46. The upper end of the hydraulic cylinders 50 is pivotably attached to an upper portion of the respective rod 46, while the lower end of the hydraulic cylinder 50 is pivotably attached to a first end 52 of a link 54, the other end of this link 54 being pivotably attached to the rear end of the underfloor module 30. The underfloor module 30 as such is hinged, in turn, to the lower ends of the rods 46 via pivot bearings 48, so that the underfloor module 30 as pivotable with respect to the position of the rods 46, especially in an upward direction. The hinge axis A of these pivot bearings 48 lies slightly higher than the pivoting axis for connecting the link 54 with the underfloor module 30. Moreover, the link 54 is connected to the respective rods 46 by a short connection member 58, wherein one end of this connection member 58 is pivotably attached to an intermediate portion of the link 54, while its other end is pivotably attached to the rod 46. The pivoting axis for connecting the connection member 58 to the rod 46 lies parallel to the horizontal axis A around which the underfloor module 30 can be pivoted with respect to the rods 46 by means of the pivot bearings 48.

[0037] When the hydraulic cylinder 50 is extracted, the distance between its upper attachment point 62 and the end of the link 54 to which the lower end of the hydraulic cylinder 50 is attached increases, and consequently the link 54 performs a turning motion around the attachment point 60 between the connection member 58 and the rod 46 in a clockwise direction in Fig. 2. During this turning motion, the link 54 can also perform a rotary movement around the attachment point of the connection member 58 to the link 54. By pushing the link 54 in a clockwise direction (with regard to Fig. 2), the link 54 transmits the torque to the underfloor module 30 around the pivoting bearing 48 with regard to the rods 46 so that it is tilted upwardly from the horizontal position shown in Fig. 2. Fig. 2 shows further details of a water supply line 64 for supplying water from the ladder to water distribution devices located at the rescue cage 10. According to Fig. 2, this water supply line 64 comprises a first section 66 in form of a rigid pipe or tube leading to the horizontal pivoting axis defined by the turning axis of the pivot bearing 56. This first section 66 of the water supply line 64 is guided through different ladder steps 68, 70, 72 extending horizontally between the rods 46. In particular this first section is guided over an upper step 68 and under two lower steps 70 and 72 to reach the pivoting axis A of the pivot bearing 48 in a space between the parallel rods 46.

[0038] A second section 74 of the water supply line 64 is joined to this first section 66 and comprises a free portion 76 and the tubular portion 40 already described in connection with Fig. 1, being enclosed by the plate-like body 38 of the underfloor module 30. Fig. 2 shows the front end of this tubular section 40 that can be joined to any desired water distribution means located at the rescue cage 10. The free portion 76 of the second section 74 is joined to the tubular portion 40 by a respective flange connection.

[0039] The first section 66 and the second section 74 of the water supply line 64 are joined by a rotary feedthrough 78 located on the pivoting axis A of the suspension 42. The rotary axis of the rotary feedthrough 78 is coaxial to this pivoting axis A so that it enables a pivoting movement of the second section 74 of the water supply line 64 with respect to the first section 66 being fixed to the ladder. This means when the underfloor module 30 is pivoted around the rotary axis A upwards with respect to the rods 46, the second section 74 is rotated with respect to the first section 66. By this arrangement water can be supplied through the water supply line 64 in any position of the underfloor module 30 with respect to the ladder set. The sections of the water supply line 64 may not necessarily be flexible but can rather be formed by rigid pipes or tubes, like it is the case in the present embodiment, without deteriorating the flexibility of the water supply line 64 following the movements of the rescue cage 10.

[0040] The respective joining ends of the first section 66 and the second section 74 lead into the rotary feedthrough 78 from opposite axial sides on the pivoting axis A of the suspension 42.

[0041] Fig. 3 shows the arrangement of Fig. 2 in a side

view. It can be taken from this figure that the free portion 76 of the second section 74 of the water supply line 64 connects the rear wall of the plate-like body 38 of the underfloor module 30 with the rotary feedthrough 78 by a curved portion arranged behind the underfloor module 30 and below the inclined rods 46 of the suspension 42. It is also visible in Fig. 3 that the rotation axis of the rotary feedthrough 78 coinsides with the pivoting axis A of the suspension. At the lateral sides of the plate-like body 38 of the underfloor module 30, rolls 80,82 are arranged to allow a rolling and sliding movement of the underfloor module 30 into the bottom of the rescue cage 10. These rolls are received by roll guiding means provided at the floor of the cage 10 at both sides of the recess 32 (not shown). Between two rolls 82 on one side of the plate-like body 38, a restoring device 83 is arranged. This restoring device 83 comprises a shaft 83a extending in the sliding direction of the underfloor module 30, two end flanges 83b,83c arranged at each end of the shaft 83a, a block member 83d being slidable alog the shaft 83a and two helical springs 83e,83f wound around the shaft 83a, each spring 83e,83f separating the block member 83d from one of the end flanges 83b,83c. The block member 83d is fixed to the floor of the cage 10. When the underfloor module 30 is deflected to one sliding direction with respect to the cage 10 within the recess 32, the block member 83d is shifted along the shaft 83a, compressing one helical springs 83e or 83f. So the cage 10 can be deflected from a center position to one sliding direction with respect to the underfloor module 30 on which it is supported. However, due to the restoring force of the compressed spring 83e or 83f, the block member 83d is pushed back to remove the cage 10 into into its center position again. In case of a collision of the cage 10 with an object, it is replaced with regard to the underfloor module 30 to be deflected out of its center position but restored to this position by the helical springs 83e or 83f.

[0042] The rear wall portion 36 is inclined with regard to the upper plane surface 84 of the underfloor module 30 with an angle of 100° therebetween. That is, the rear wall portion 36 is inclined slightly outwards with regard to its vertical position. The inclination of the rods 46 with regard to the plane surface 84 is stronger so that the rods 46 are inclined with an angle of about 140° with regard to this plane 84. Fig. 3 also shows the horizontal position of the ladder 86 that is only shown schematically here. The upper portions of the rods 46 are fixed to the end of the ladder 86. Further parts of the water supply line 64 that are arranged along the ladder 86 are omitted here.

[0043] In Fig. 3, the underfloor module 30 and the ladder 86 are both in a horizontal position. When the ladder 86 is lifted, i. e. it is tilted upwardly, the underfloor module 30 can still be held in its horizontal position, as it is shown in Fig. 4. To keep its horizontal position the underfloor module 30 must be pivoted around the pivoting axis A of the suspension 42 by actuating the actuating drive 50. By retracting the hydraulic cylinder 50, the link 54 performs a rotary movement around its attachment end 52 to the hydraulic cylinder 50 in a counterclockwise direction so that the underfloor module 30 has to follow this movement and is pivoted with regard to the ladder 86. The end position wherein the hydraulic cylinder 50 is completely retracted is shown in Fig. 4. It can also be taken obviously from this figure that the second section 74 of the water supply line 64 keeps its position with regard to the underfloor module 30 to which it is fixed, but by means of the rotary feedthrough 78, a first section 66 of the water supply line 64 performs a turning movement around the pivoting axis A of this suspension 42 in a clockwise direction to compensate the changed tilting position of the ladder 86.

[0044] It is to be noted that the rear wall 36 keeps its position with regard to the underfloor module 30, i. e. it is still slightly inclined outwardly from a vertical position to enclose an angle of about 100° with the plane 84 of the underfloor module 30.

[0045] While Fig. 4 shows the extreme top position of the rescue cage 10, an extreme low position is shown in Fig. 5, wherein the ladder 86 is tilted slightly downwards with regard to the horizontal orientation shown in Fig. 3. In the whole tilting range from the position in Fig. 3 to the position in Fig. 5, the underfloor module 30 can be held in its horizontal position, as it is also demonstrated in Fig. 5. To compensate the downward tilting movement of the ladder 86, the actuating drive 50, i. e. the horizontal cylinder has to be extracted to turn the underfloor module 30 with regard to the ladder 86. Again, the second section 66 of the water supply line 64 follows the tilting movement of the ladder 86, while the second section 74 stays fixed to the underfloor module 30. While the foregoing Fig. 1 to 5 show operation positions of the rescue cage 10 in which the underfloor module 30 is kept in a horizontal position, the rescue cage 10 can also take a transport position in which the cage 10 is put over the end of the ladder 86. The respective position of the underfloor module 30 is demonstrated in Fig. 6. The framework 12 of the rescue cage 10 is omitted in Fig. 6, but it can be imagined that the framework 12 encloses the end of the ladder 86 together with the suspension 42, especially the actuating drive 50 in the transport position. The position of the rescue cage 10 is elevated in Fig. 6 compared to a horizontal position of the ladder 86 where the rescue cage 10 is in an operating position, like it is the case in Fig. 2. This provides the advantage that the driver of the fire fighting vehicle carrying the ladder set has a better view through the windshield on the road, and his side is not obstructed by the rescue cage 10 protruding from the front end of the vehicle. For taking the transport position, the underfloor module 30 has to be turned from his operating position in Fig. 2 into a vertical position in a clockwise direction with respect to the figures. The turning angle from the operation position to the transport position is about 90°. This turning movement can also be performed by actuating the actuating drive 50, i. e. extracting the hydraulic cylinder 50 to push the underfloor module 30 upwardly via the link 54. To avoid that this movement

is obstructed by parts of the rear wall of the rescue cage 10, the rear wall portion 36 is pivotably attached to the underfloor module 30 to be pivoted around a horizontal axis being identical (coaxial) to the pivoting axis A of the suspension 42. By this pivoting attachment, the rear wall can yield to the construction parts at the end of the ladder 86 onto which the rescue cage 10 is folded. This means that when the turning movement into the transport position is performed, the rear wall portion 36 is folded onto the underfloor module 30 into a retracted position wherein it only encloses an angle of about 45° with the floor plane 84 of the underfloor module 30. Fig. 2 shows the pivoting hinges 88 around which the rear wall portion 36 is pivoted with regard to the underfloor module 30 into its retracted position. These hinges lie on the pivoting axis A of the suspension 42.

[0046] Fig. 7 shows the underfloor module 30 with the suspension 42 and the rear wall portion 36 from another perspective. It is clear from Fig. 7 that when the underfloor module 30 is turned around its pivoting axis A with regard to the rods 46, the rear wall portion 36 interferes with the steps 68,70,72 connecting the rods 46 and is therefore automatically folded into its retracted position, as described with regard to Fig. 6.

[0047] The rear wall portion 36 is attached to the underfloor module 30 in a way that it can perform this folding movement automatically but keeps a rigid erected operating position when the rescue cage 10 is in use. This is achieved by locking means for locking the rear wall 36 in its operating position. These locking means will release automatically when the rescue cage 10 is pivoted into the transport position in Fig. 6.

[0048] Fig. 8 shows details of these locking means 90, comprising a bolt 92 that is mounted axially slidable at a vertical element 94 protruding upwardly from the underfloor module 30. The moving axis of this bolt 92 mainly coincides with the plane in which the rear wall portion 36 is located. Fig. 8 also shows a hinge suspension 88 for pivoting the rear wall portion 36 with regard to the underfloor module 30.

[0049] The rear wall portion 36 comprises a flange-like element 96 comprising a recess 98 for receiving the end of the bolt 92. In the operating position of the rear wall 36, shown in Fig. 8, the end of the bolt engages the recess 98 so that the pivoting movement of the rear wall 36 with regard to the underfloor module 30 is locked. The bolt 92 is biased into this engaging position within the recess 98 in its operating position. However, it is possible to retract the bolt 92 from the recess 98 by means of unlocking means. These unlocking means may comprise retraction elements, for example, a cable that draws the bolt 92 from the recess 98 downwardly. The other end of the cable may be fixed to a lever that is operated automatically by a cam block that is fixed on the outer sides of the rods 46 when the rods 46 pass the rear wall of the cage 10. By this mechanism the bolt 92 is automatically retracted (unlocked) when the rear wall of the cage 10 is pushed into the direction of the rods 46. However, this construction is only one example for an unlocking mechanism of the bolt 92 that can be adapted to the specific construction of the rescue cage 10.

[0050] Fig. 9 is a general view of the rear wall portion 36 without the underfloor module 30. The rear wall portion 36 comprises a frame 100 consisting of two vertical rods 102,104 and a horizontal bar 106 connecting these vertical rods 102,104. At the horizontal bar 106, the elements 96 comprising the recesses 98 for receiving the bolts 92 (see Fig. 8) are attached. The rear wall portion 36 further comprises two door wings 108,110 being pivotably attached to the frame 100. Each door wing 108,110 is attached to one vertical bar 102,104.

[0051] Each door wing 108,110 is formed by a tube that is bended to form a mainly rectangular door wing element. The ends 112,114 of the tube are inserted each into a tubular sleeve 116,118 being fixed to the vertical element 102,104 such that an open portion of the tubular sleeve 116,118 is disposed on the top side of the tubular sleeve 116,118. The bottom of the tubular sleeve 116,118 prevents the respective insertion end 112,114 of the tube to slide further downwards into the sleeve 116,118.

[0052] As can be taken in detail from Fig. 10, the upper edge of the tubular sleeve 116,118 comprises a portion 120 that is helically winding between its lower end 122 and its upper end 124. The lower end 122 and the upper end 124 are disposed on opposite sides on the circumference of the tubular sleeve 116,118. The lower end 122 is formed as a notch extending downwardly. This notch 122 is disposed at an inner side of the sleeve 116,118 with respect to the general construction of the rear wall portion 36.

[0053] The insertion end 112,114 of the respective door wing 108,110 is provided with a pin 126 protruding from the periphery of the insertion end 112,114. This pin 126 can slide on the helical portion 120 viewing a turning movement of the door wing 108,110 from its closed position, as shown in Fig. 9 and 10, to an opened position, as demonstrated in Fig. 11. At its upper end 124, the upper edge of the sleeve 116,118 is flattened to form a flat seat for the pin 126. That is, at its end the upper edge portion is not winding helically but only extends in the circumferential direction of the sleeve 116,118 without further ascending.

[0054] Together with the notch 122 at its lower end and the seat 124 in its upper end, the helical portion 120 of the upper edge of the sleeve 167,118 forms a guide conduct for the pin 126 during a turning movement of the door wing 108,110 from its closed position to an opened position, as will be described in the following.

[0055] In the closed position in Fig. 10, the pin 126 lies within the notch 122 so that it blocks a swiveling movement of the door wing 108,110 in a circumferential direction. To perform such a swiveling movement, the door wing 108,110 has to be lifted slightly upwards so that the pin 126 slips out of the notch 122 and can further follow the path of the helical portion 120 on the upper edge of

the sleeve 116,118. This turning movement has to be performed against the load of the weight of the door wing 108,110, because when the door wing 108,110 is released in a half-open position where the pin 126 lies onto the helical portion 120, it slides downwards towards the end of the helical portion 120 into the notch 122. This means that the door wing 108,110 is closing automatically when no torque acts on the door wing 108,110. This self-closing effect is supported by a helical spring 128 winding around a shaft 130 fixed to the door wing 108,110 and protruding from the respective insertion end 112,114 through the bottom of the sleeve 116,118 downwardly and being provided with a flange 132 at its end for supporting the spring 128. When the door wing 108,110 is lifted from the position in Fig. 10, the spring 128 is compressed so that the insertion end 112,114 is pushed downwardly to perform the sliding movement of the pin 126 towards the notch 122, as described above.

[0056] In Fig. 11 the pin 126 has reached the seat 124 to rest on its flat portion. Although the spring 128 is compressed to bias the door wing 108,110 downwardly, supporting the gravity effect to pull the door wing 108,110 back downwards around its turning axis, no torque is applied to the door wing 108,110 because the seat 124 does not have an ascending slope. Further turning of the door wing 108,110 is prevented by a lateral stopping edge 134 to which the pin 126 abuts when the seat 124 is reached.

[0057] Fig. 12 shows that the opened door wings 108,110 are automatically closed when the underfloor module 30 is folded into its transport position. Just before the unlocking mechanism unlocks the rear wall portion 36 to be folded inwardly onto the underfloor module 30, deflectors 136 mounted on top of the vertical rods 46 interfere with the door wings 108,110 to push them in their closing direction so that the respective pins 126 slide from their seats 124 onto the helical guiding portion 120. Then the doors 108,110 close automatically, letting the pins 126 slide downwards on the helical portion 120 to reach the notches 122.

[0058] Fig. 13 gives a general overview of the rescue cage 10 with the underfloor module 30 inserted, the rear wall portion 36 closing the rear wall of the rescue cage 10. Further moveable or pivotable parts left and right to the central rear wall portion 36 can be provided to avoid an interference with other parts when swiveling into the transport position.

Claims

1. Fire fighting rescue cage (10), comprising a suspension (42) for connecting the rescue cage (10) with one end of a ladder mounted on a fire fighting vehicle to be pivotable around a horizontal axis (A), **characterized in that** said rescue cage (10) comprises a plate-like underfloor module (30) being slidably inserted into a recess (32) in the floor from the backside of the rescue cage (10) and being connected to said suspension (42).

2. Rescue cage according to claim 1, **characterized in that** said underfloor module (30) is provided with rolls (80) at both sides of the underfloor module (30), said rolls (80) being guided by roll guiding means provided at the floor at both sides of the recess (32).

3. Rescue cage according to claim 1 or 2, **characterized in that** said underfloor module (30) is accomodated within said recess (32) in a predetermined sliding position from which said underfloor module (30) is deflectable to both sides in opposite sliding directions, said underfloor module (30) being provided with restoring means (83e,83f) for elastically restoring said underfloor module (30) from a deflected position back into said predetermined sliding position.

4. Rescue cage according to claim 3, **characterized by** sensors for detecting a deflected position of said underfloor module (30).

5. Rescue cage according to one of the preceding claims, **characterized by** a water supply line (64) leading from the ladder to water distribution means mounted at the rescue cage (10), said water supply line (64) comprising a first section (66) on the ladder side and a second section (74) on the rescue cage side, said second section (74) being conducted at least partially through the underfloor module (30) and comprising a joint to be connected with the water distribution means at its end on the rescue cage side, said first section (66) being connected with said second section (74) by means of a rotary feedthrough (78) enabling a pivoting movement of the second section (74) with regard to the first section (66) around the horizontal pivoting axis (A) of the suspension (42).

6. Rescue cage according to claim 5, **characterized in that** said first section (66) and said second section (74) are provided as rigid pipes leading into the rotary feedthrough (78) from opposite axial sides.

7. Rescue cage according to according to one of the preceding claims, **characterized in that** said suspension (42) comprises an actuating drive (50) for pivoting the rescue cage (10) with regard to the ladder.

8. Rescue cage according to claim 7, **characterized in that** the pivoting range of the actuating drive (50) is dimensioned such that in a generally horizontal position of the ladder, said underfloor module (30) can be pivoted into a generally vertical erected transport position in which said rescue cage (10) is put over the end of the ladder.

9. Rescue cage according to one of the preceding claims, **characterized by** a rear wall (36) being pivotably attached to the underfloor module (30) to be pivoted around a horizontal axis parallel or coaxial to the pivoting axis (A) of the suspension (42), said rear wall (36) being pivotable from an operating position in which it is erected on the plane of the underfloor module (30) to a retracted position in which the rear wall (36) is pivoted into the direction of the underfloor module (30).

10. Rescue cage according to claim 9, **characterized by** locking means for locking the rear wall (36) in its operating position and by unlocking means for automatically unlocking the locking means when the rescue cage (10) is pivoted into the transport position.

11. Rescue cage according to claim 10, **characterized in that** said locking means comprise a bolt (92) being mounted axially slidable at the underfloor module (30), and a recess (98) for receiving the bolt at the rear wall (36) of the rescue cage, said bolt (92) engaging the recess in the operating position of the rear wall (36) and locking a pivoting movement of the rear wall (36) with respect to the underfloor module (30), said unlocking means comprising retraction means for retracting the bolt (92) from the recess (98) automatically when the rescue cage is pivoted into its transport position.

12. Rescue cage according to one of claims 9 to 11, **characterized in that** said rear wall (36) comprises at least one door wing (108, 110) being pivotably attached to a frame element of the rear wall (36) by at least one hinge bearing.

13. Rescue cage according to claim 12, **characterized in that** said hinge bearing comprises a tubular sleeve (116, 118) into which an insertion element (112, 114) of the door wing (108, 110) is inserted axially downwards, said sleeve (116, 118) comprising a guide conduct (120) winding helically around the sleeve (116, 118), said insertion element (112, 114) being provided with a pin (126) protruding from the periphery of the insertion element (112, 114) and being guided on or within the guide conduct (120).

14. Rescue cage according to claim 13, **characterized in that** the lower end of the guide conduct (120) is provided as a notch (122) into which the pin (126) engages when it reaches the lower end of the guide conduct (120).

15. Rescue cage according to claim 13 or 14, **characterized in that** said hinge bearing comprises a spring (128) for biasing the insertion element (112, 114) axially into the sleeve (116, 118).

16. Rescue cage according to one of claims 13 to 15, **characterized in that** the upper end of the guide conduct (120) is flattened in the circumferential direction and forms an upper seat (124) for the pin (126).

Patentansprüche

1. Brandbekämpfungs-Rettungskorb (10), mit einer Aufhängung (42) zur Verbindung des Rettungskorbs (10) mit einem Ende einer Leiter, die an einem Brandbekämpfungsfahrzeug befestigt ist, so dass sie um eine horizontale Achse (A) schwenkbar ist, **dadurch gekennzeichnet, dass** der Rettungskorb (10) ein plattenartiges Unterbodenmodul (30) umfasst, das verschiebbar in eine Ausnehmung (32) in dem Boden von der Rückseite des Rettungskorbs (10) eingesetzt und mit der Aufhängung (42) verbunden ist.

2. Rettungskorb nach Anspruch 1, **dadurch gekennzeichnet, dass** das Unterbodenmodul (30) mit Rollen (80) an beiden Seiten des Unterbodenmoduls (30) versehen ist, wobei die Rollen (80) durch ein Rollenführungsmittel geführt sind, das an dem Boden an beiden Seiten der Ausnehmung (32) vorgesehen ist.

3. Rettungskorb nach einem der Ansprüche 1 oder 2, **dadurch gekennzeichnet, dass** das Unterbodenmodul (30) in der Ausnehmung (32) in einer vorbestimmten Verschiebeposition untergebracht ist, aus der das Unterbodenmodul (30) zu beiden Seiten in entgegengesetzten Verschieberichtungen verlagerbar ist, wobei das Unterbodenmodul (30) mit einem Rückstellmittel (83e, 83f) zum elastischen Rückstellen des Unterbodenmoduls (30) von einer verlagerten Position zurück in die vorbestimmte Verschiebeposition versehen ist.

4. Rettungskorb nach Anspruch 3, **gekennzeichnet durch** Sensoren zur Detektion einer verlagerten Position des Unterbodenmoduls (30).

5. Rettungskorb nach einem der vorhergehenden Ansprüche, **gekennzeichnet durch** eine Wasserversorgungsleitung (64), die von der Leiter zu einem Wasserverteilungsmittel führt, das an dem Rettungskorb (10) montiert ist, wobei die Wasserversorgungsleitung (64) ein erstes Teil (66) an der Leiterseite und ein zweites Teil (74) an der Rettungskorbseite umfasst, wobei das zweite Teil (74) zumindest teilweise **durch** das Unterbodenmodul (30) geführt ist und eine Kopplung zur Verbindung mit dem Wasserverteilungsmittel an seinem Ende auf der Rettungskorbseite umfasst, wobei das

erste Teil (66) mit dem zweiten Teil (74) mittels einer Dreh-Durchführung (78) verbunden ist, die eine Schwenkbewegung des zweiten Teils (74) in Bezug auf das erste Teil (66) um die horizontale Schwenkachse (A) der Aufhängung (42) ermöglicht.

6. Rettungskorb nach Anspruch 5, **dadurch gekennzeichnet , dass** das erste Teil (66) und das zweite Teil (74) als starre Rohre vorgesehen sind, die von entgegengesetzten axialen Seiten in die Dreh-Durchführung (78) führen.

7. Rettungskorb nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet , dass** die Aufhängung (42) einen Betätigungsantrieb (50) zum Schwenken des Rettungskorbs (10) in Bezug auf die Leiter umfasst.

8. Rettungskorb nach Anspruch 7, **dadurch gekennzeichnet , dass** der Schwenkbereich des Betätigungsantriebs (50) so dimensioniert ist, dass in einer allgemein horizontalen Position der Leiter das Unterbodenmodul (30) in eine allgemein vertikale aufgerichtete Transportposition geschwenkt werden kann, in der der Rettungskorb (10) über das Ende der Leiter aufgesetzt ist.

9. Rettungskorb nach einem der vorhergehenden Ansprüche, **gekennzeichnet durch** eine Rückwand (36), die schwenkbar an dem Unterbodenmodul (30) befestigt ist, so dass sie um eine horizontale Achse parallel oder koaxial zu der Schwenkachse (A) der Aufhängung (42) geschwenkt werden kann, wobei die Rückwand (36) von einer Betriebsposition, in der sie an der Ebene des Unterbodenmoduls (30) aufgerichtet ist, zu einer zurückgezogenen Position schwenkbar ist, in der die Rückwand (36) in die Richtung des Unterbodenmoduls (30) geschwenkt ist.

10. Rettungskorb nach Anspruch 9, **gekennzeichnet durch** ein Verriegelungsmittel zum Verriegeln der Rückwand (36) in ihre Betriebsposition und **durch** ein Entriegelungsmittel zum automatischen Entriegeln des Verriegelungsmittels, wenn der Rettungskorb (10) in die Transportposition geschwenkt ist.

11. Rettungskorb nach Anspruch 10, **dadurch gekennzeichnet , dass** das Verriegelungsmittel einen Bolzen (92), der axial verschiebbar an dem Unterbodenmodul (30) montiert ist, und eine Ausnehmung (98) zur Aufnahme des Bolzens an der Rückwand (36) des Rettungskorbs umfasst, wobei der Bolzen (92) mit der Ausnehmung in der Betriebsposition der Rückwand (36) in Eingriff steht und eine Schwenkbewegung der Rückwand (36) in Bezug auf das Unterbodenmodul (30) verriegelt, wobei das Entriegelungsmittel ein Rückzugsmittel zum automatischen Rückzug des Bolzens (92) aus der Ausnehmung 98 umfasst, wenn der Rettungskorb in seine Transportposition geschwenkt ist.

12. Rettungskorb nach einem der Ansprüche 9 bis 11, **dadurch gekennzeichnet , dass** die Rückwand (36) zumindest einen Türflügel (108, 110) umfasst, der schwenkbar an einem Rahmenelement der Rückwand (36) durch zumindest ein Gelenklager befestigt ist.

13. Rettungskorb nach Anspruch 12, **dadurch gekennzeichnet , dass** das Gelenklager eine Rohrhülse (116, 118) umfasst, in die ein Einsetzelement (112, 114) des Türflügels (108, 110) axial abwärts eingesetzt ist, wobei die Hülse (116, 118) eine Führung (120) umfasst, die schraubenförmig um die Hülse (116, 118) gewunden ist, wobei das Einsetzelement (112, 114) mit einem Stift (126) versehen ist, der von dem Umfang des Einsetzelementes (112, 114) vorragt und an oder in der Führung (120) geführt ist.

14. Rettungskorb nach Anspruch 13, **dadurch gekennzeichnet , dass** das untere Ende der Führung (120) als eine Kerbe (122) vorgesehen ist, in die der Stift (126) eingreift, wenn er das untere Ende der Führung (120) erreicht.

15. Rettungskorb nach einem der Ansprüche 13 oder 14, **dadurch gekennzeichnet , dass** das Gelenklager eine Feder (128) zum axialen Vorspannen des Einsetzelementes (112, 114) in die Hülse (116, 118) umfasst.

16. Rettungskorb nach einem der Ansprüche 13 bis 15, **dadurch gekennzeichnet , dass** das obere Ende der Führung (120) in der Umfangsrichtung abgeflacht ist und einen oberen Sitz (124) für den Stift (126) bildet.

Revendications

1. Cage de sauvetage anti-incendie (10), comprenant une suspension (42) pour raccorder la cage de sauvetage (10) à une extrémité d'une échelle montée sur un véhicule anti-incendie afin de pouvoir pivoter autour d'un axe horizontal (A), **caractérisée en ce que** ladite cage de sauvetage (10) comprend un module de plancher en forme de plaque (30) inséré en coulissant dans un évidement (32) du plancher par l'arrière de la cage de sauvetage (10) et raccordé à ladite suspension (42).

2. Cage de sauvetage selon la revendication 1, **carac-**

térisée en ce que ledit module de plancher (30) est pourvu de rouleaux (80) des deux côtés du module de plancher (30), lesdits rouleaux (80) étant guidés par des moyens de guidage de rouleaux fournis au plancher des deux côtés de l'évidement (32).

3. Cage de sauvetage selon la revendication 1 ou 2, **caractérisée en ce que** ledit module de plancher (30) est logé à l'intérieur dudit évidement (32) à une position coulissante prédéterminée de laquelle ledit module de plancher (30) peut être écarté des deux côtés dans des directions coulissantes opposées, ledit module de plancher (30) étant pourvu de moyens de rétablissement (83e, 83f) pour remettre élastiquement ledit module de plancher (30) d'une position écartée à ladite position coulissante prédéterminée.

4. Cage de sauvetage selon la revendication 3, **caractérisée par** des capteurs pour détecter une position écartée dudit module de plancher (30).

5. Cage de sauvetage selon l'une quelconque des revendications précédentes, **caractérisée par** une conduite d'alimentation d'eau (64) s'étendant de l'échelle à un moyen de distribution d'eau monté au niveau de la cage de sauvetage (10), ladite conduite d'alimentation d'eau (64) comprenant une première section (66) sur le côté d'échelle et une deuxième section (74) sur le côté de cage de sauvetage, ladite deuxième section (74) étant conduite au moins partiellement à travers le module de plancher (30) et comprenant un raccord à raccorder au moyen de distribution d'eau à son extrémité sur le côté de cage de sauvetage, ladite première section (66) étant raccordée à ladite deuxième section (74) au moyen d'un raccord traversant rotatif (78) permettant un mouvement pivotant de la deuxième section (74) par rapport à la première section (66) autour de l'axe pivotant horizontal (A) de la suspension (42).

6. Cage de sauvetage selon la revendication 5, **caractérisée en ce que** ladite première section (66) et ladite deuxième section (74) sont fournies sous forme de tuyaux rigides s'étendant dans le raccord traversant rotatif (78) depuis des côtés axiaux opposés.

7. Cage de sauvetage selon l'une quelconque des revendications précédentes, **caractérisée en ce que** ladite suspension (42) comprend un entraînement d'actionnement (50) pour faire pivoter la cage de sauvetage (10) par rapport à l'échelle.

8. Cage de sauvetage selon la revendication 7, caractérisée la portée de pivotement de l'entraînement d'actionnement (50) est dimensionnée de sorte que, à une position généralement horizontale de l'échelle, ledit module de plancher (30) peut être pivoté à une position de transport déployée généralement verticale à laquelle ladite cage de sauvetage (10) est placée sur l'extrémité de l'échelle.

9. Cage de sauvetage selon l'une quelconque des revendications précédentes, **caractérisée par** une paroi arrière (36) attachée de manière à pouvoir pivoter au module de plancher (30) pour pivoter autour d'un axe horizontal parallèle ou coaxial à l'axe pivotant (A) de la suspension (42), ladite paroi arrière (36) pouvant pivoter d'une position de fonctionnement à laquelle elle est déployée dans le plan du module de plancher (30) à une position rétractée à laquelle la paroi arrière (36) est pivotée dans la direction du module de plancher (30).

10. Cage de sauvetage selon la revendication 9, **caractérisée par** un moyen de verrouillage pour verrouiller la paroi arrière (36) à sa position de fonctionnement et par un moyen de déverrouillage pour déverrouiller automatiquement le moyen de verrouillage lorsque la cage de sauvetage (10) est pivotée à la position de transport.

11. Cage de sauvetage selon la revendication 10, **caractérisée en ce que** ledit moyen de verrouillage comprend un boulon (92) monté axialement de manière à pouvoir coulisser au niveau du module de plancher (30), et un évidement (98) pour recevoir le boulon à la paroi arrière (36) de la cage de sauvetage, ledit boulon (92) se mettant en prise avec l'évidement à la position de fonctionnement de la paroi arrière (36) et verrouillant un mouvement pivotant de la paroi arrière (36) par rapport au module de plancher (30), ledit moyen de déverrouillage comprenant un moyen de rétraction pour rétracter le boulon (92) de l'évidement (98) automatiquement lorsque la cage de sauvetage est pivotée à sa position de transport.

12. Cage de sauvetage selon l'une quelconque des revendications 9 à 11, **caractérisée en ce que** ladite paroi arrière (36) comprend au moins un vantail de porte (108, 110) attaché de manière à pouvoir pivoter à un élément d'encadrement de la paroi arrière (36) par au moins un palier de charnière.

13. Cage de sauvetage selon la revendication 12, **caractérisée en ce que** ledit palier de charnière comprend une douille tubulaire (116, 118) dans laquelle un élément d'insertion (112, 114) du vantail de porte (108, 110) est inséré axialement vers le bas, ladite douille (116, 118) comprenant un conduit de guidage (120) s'enroulant hélicoïdalement autour de la douille (116, 118), ledit élément d'insertion (112, 114) étant pourvu d'une goupille (126) faisant saillie de la périphérie de l'élément d'insertion (112, 114) et étant guidé sur ou à l'intérieur du conduit de gui-

dage (120).

14. Cage de sauvetage selon la revendication 13, **caractérisée en ce que** l'extrémité inférieure du conduit de guidage (120) est fournie sous forme d'encoche (122) dans laquelle la goupille (126) se met en prise lorsqu'elle atteint l'extrémité inférieure du conduit de guidage (120)

15. Cage de sauvetage selon la revendication 13 ou 14, **caractérisée en ce que** ledit palier de charnière comprend un ressort (128) pour contraindre l'élément d'insertion (112, 114) axialement dans la douille (116, 118).

16. Cage de sauvetage selon l'une quelconque des revendications 13 à 15, **caractérisée en ce que** l'extrémité supérieure du conduit de guidage (120) est aplatie dans la direction circonférentielle et forme un siège supérieur (124) pour la goupille (126).

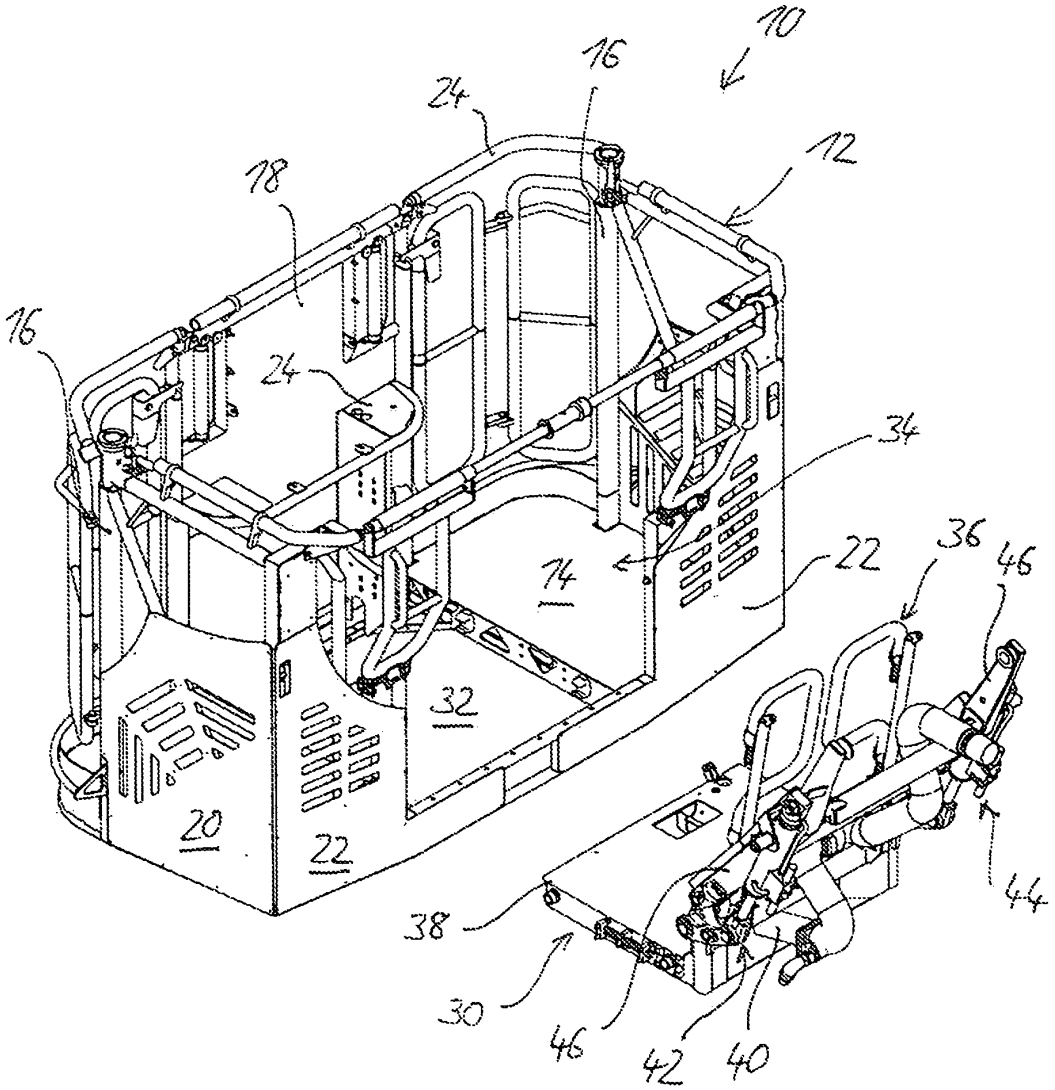

Fig. 1

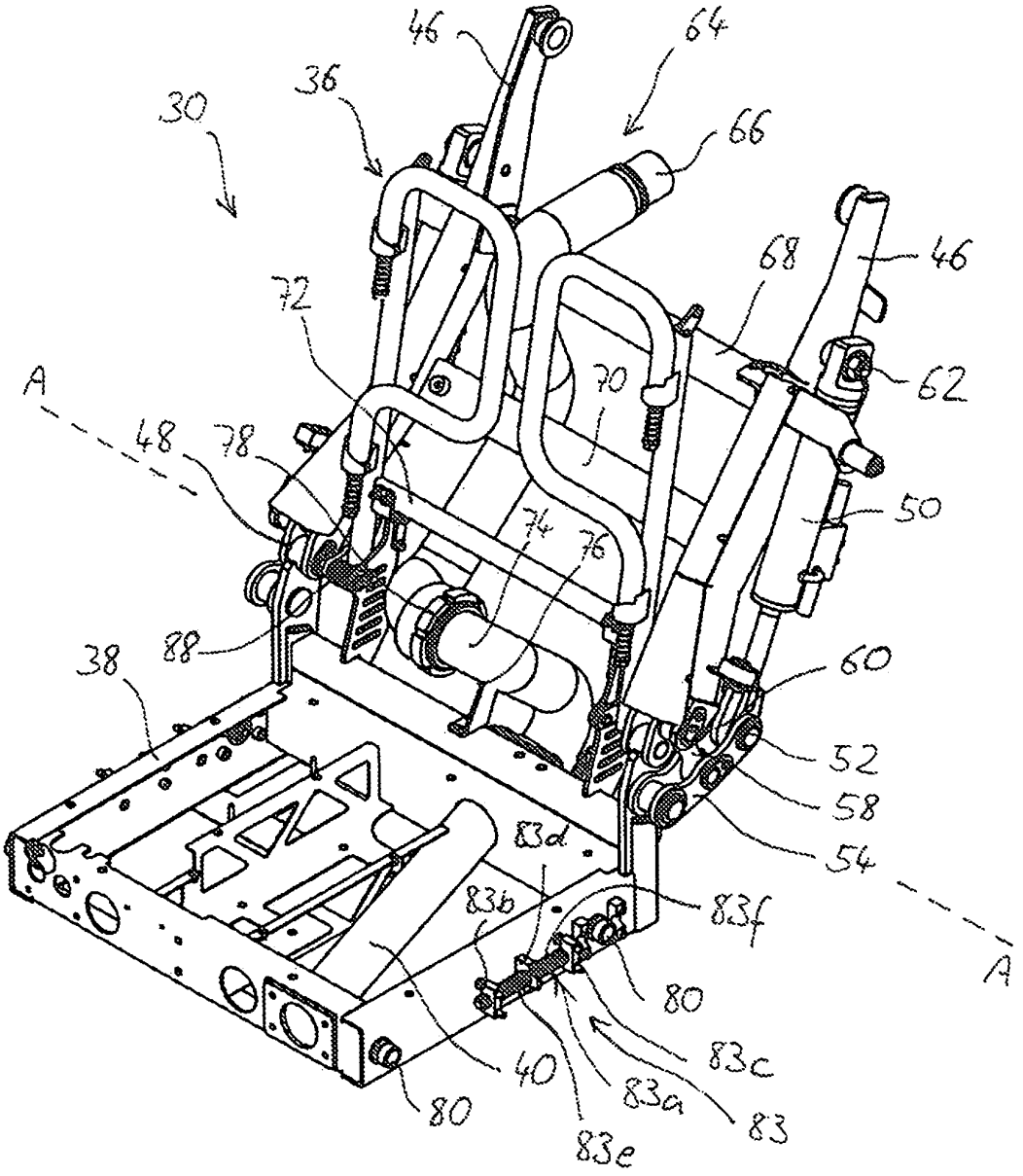
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Fig. 2

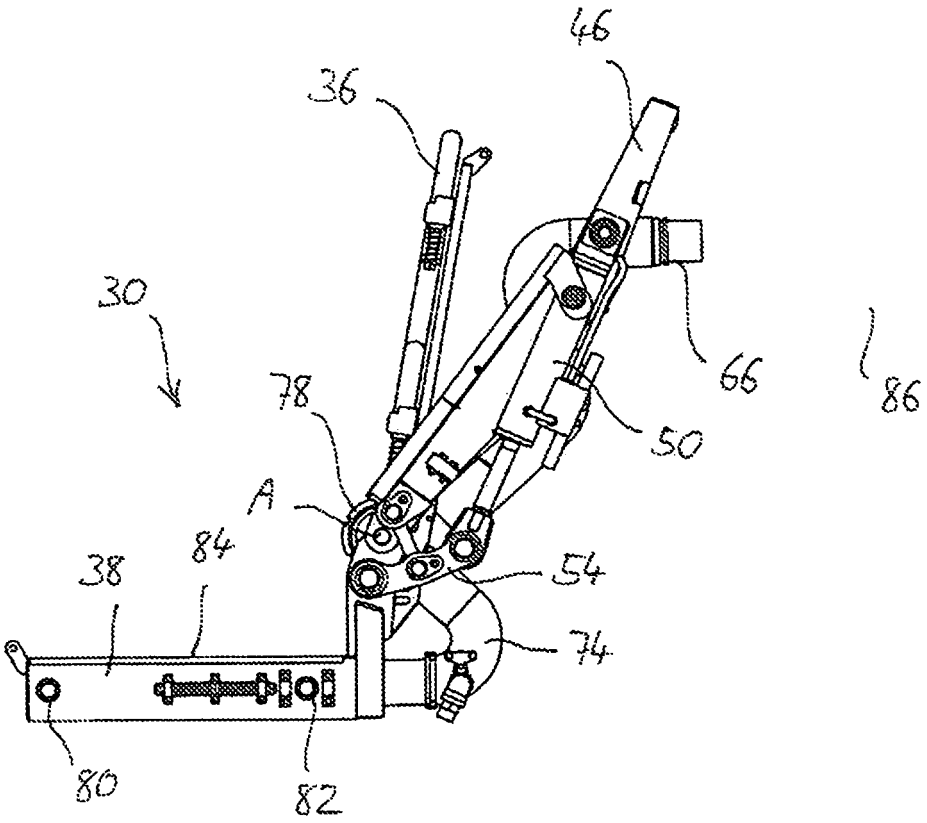

Fig. 3

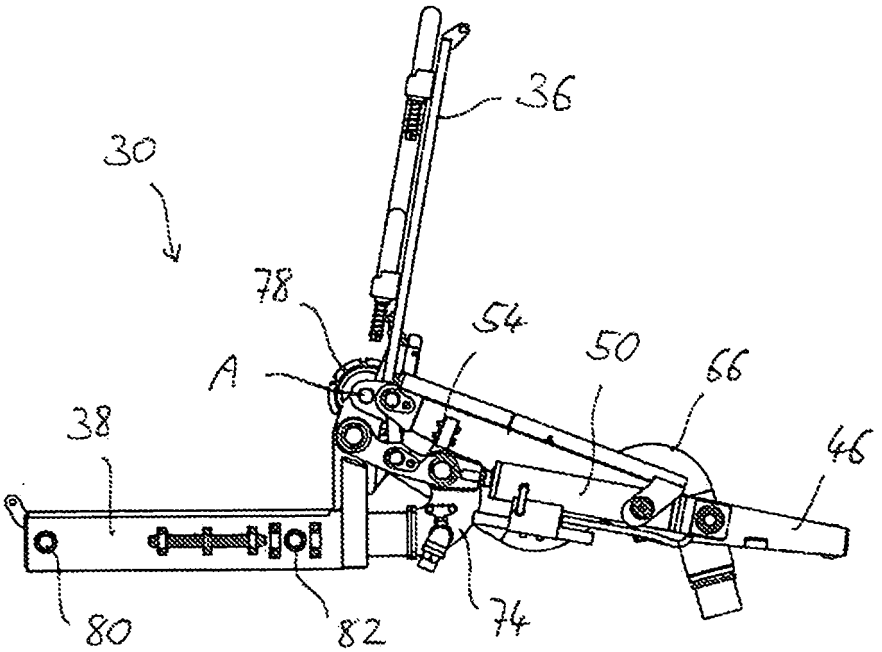

Fig. 4

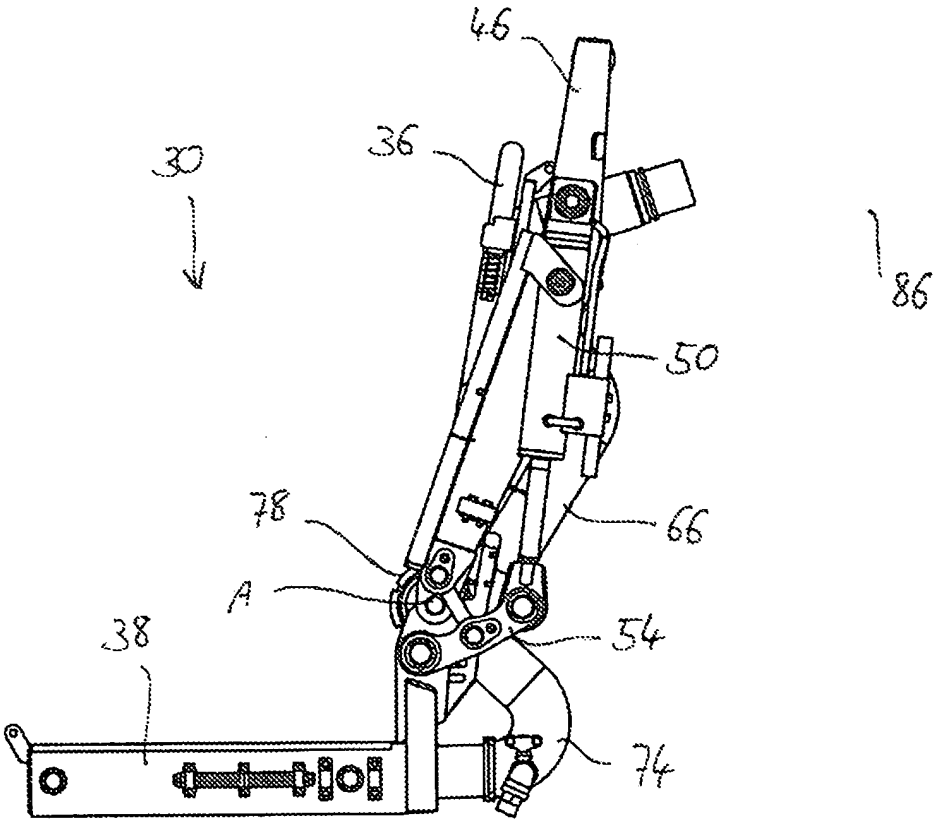

Fig. 5

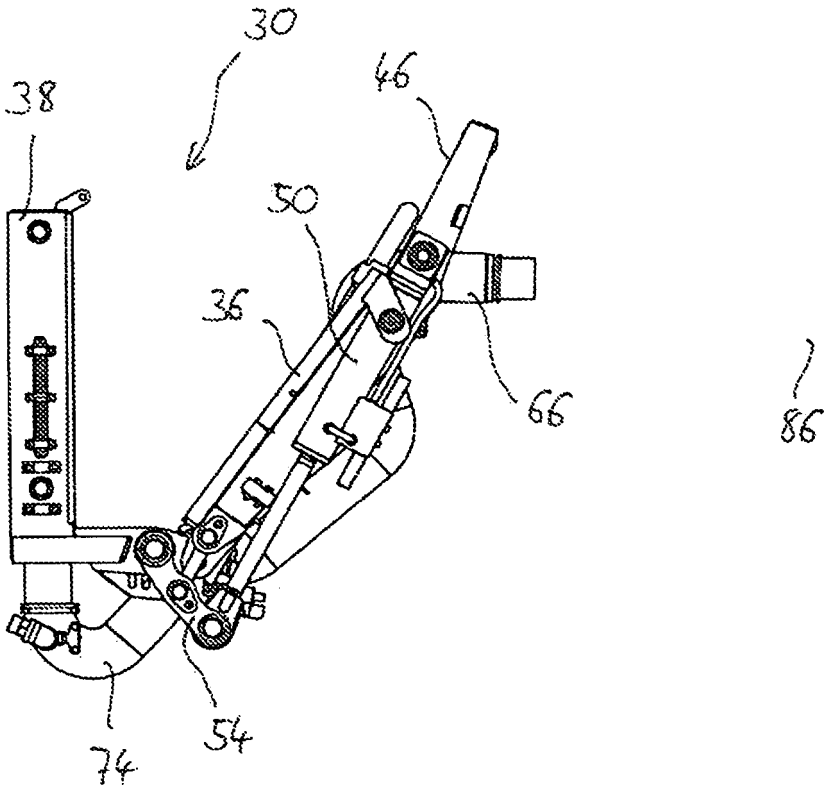

Fig. 6

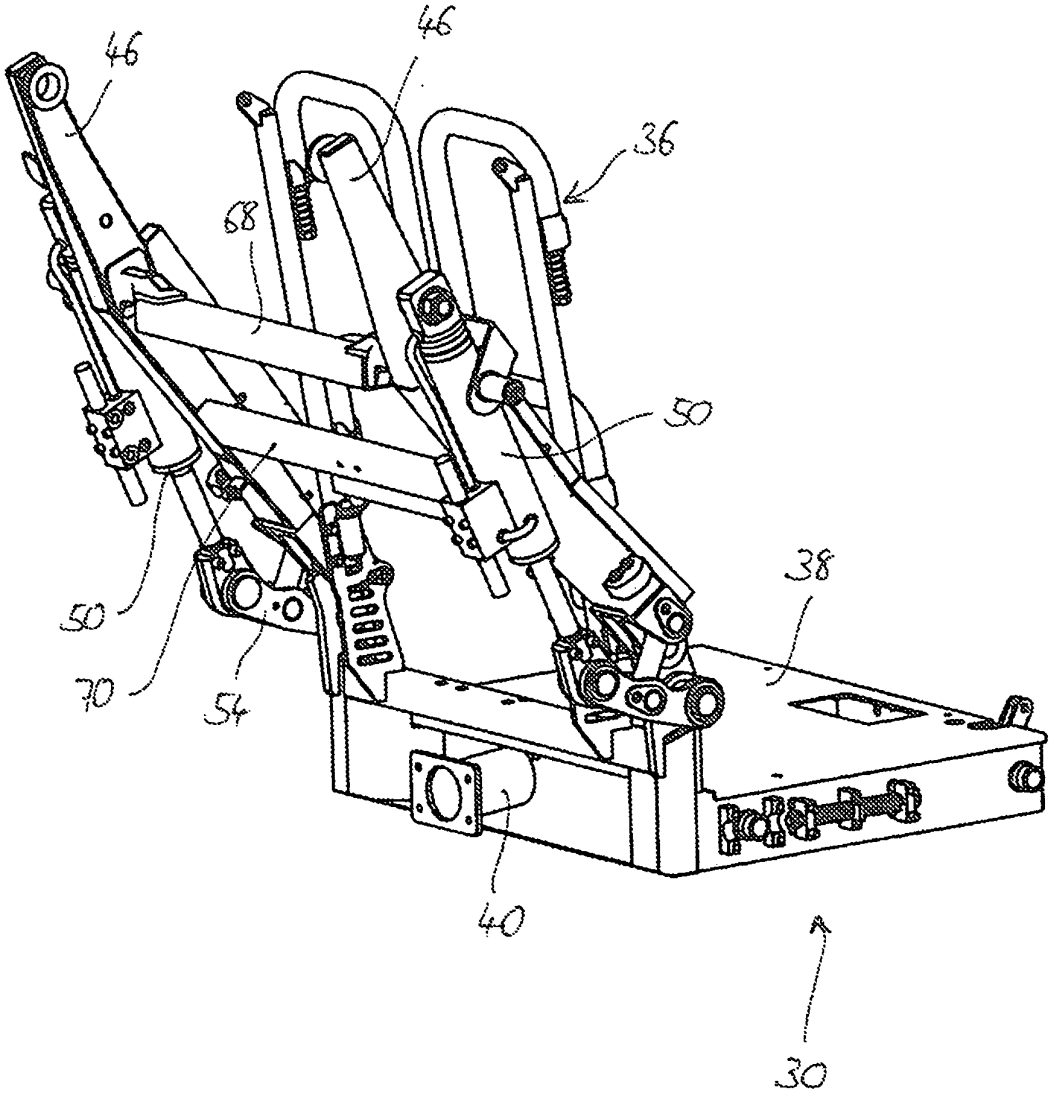

Fig. 7

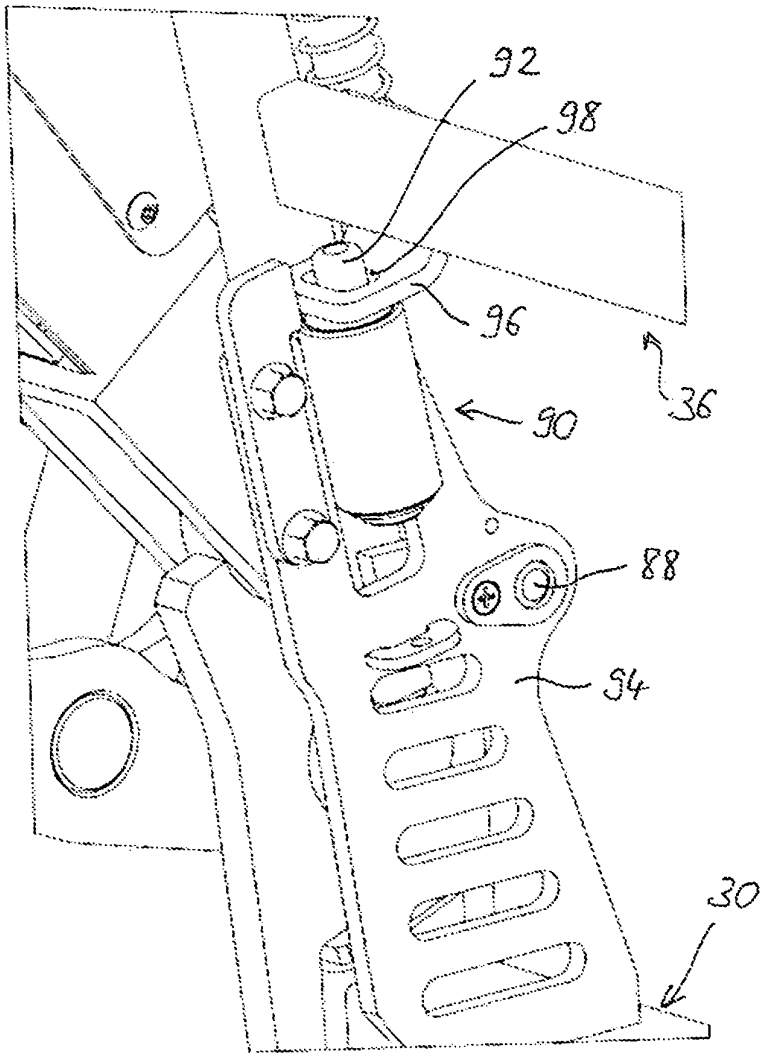

Fig. 8

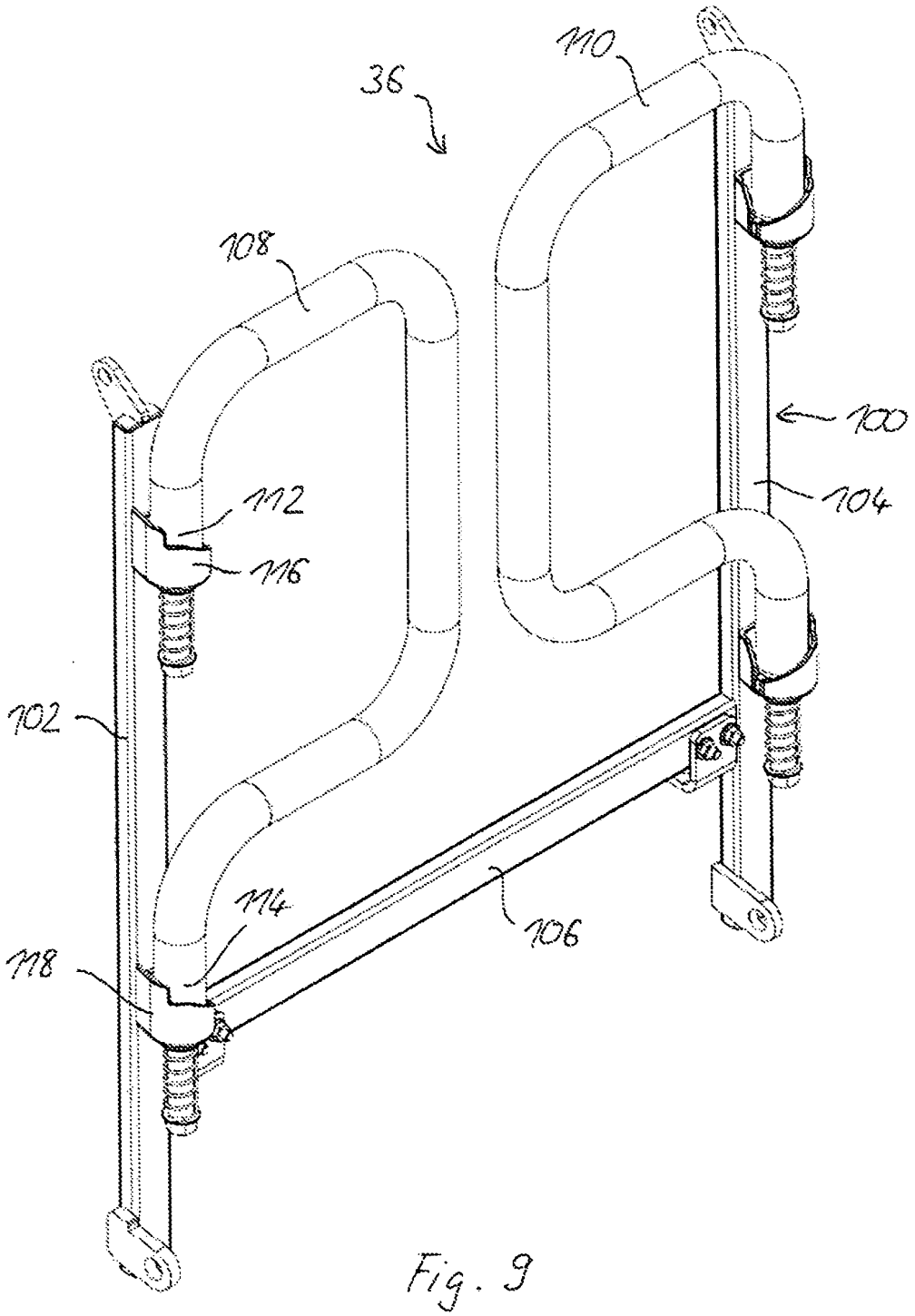

Fig. 9

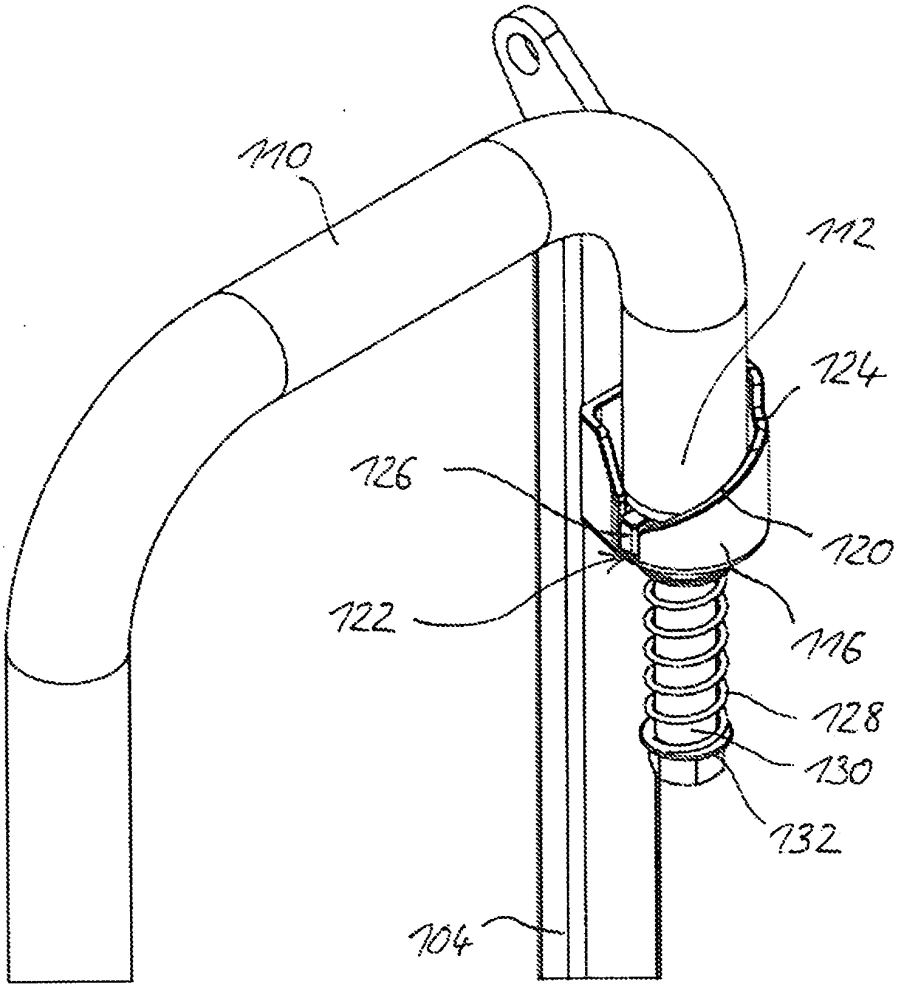

Fig. 10

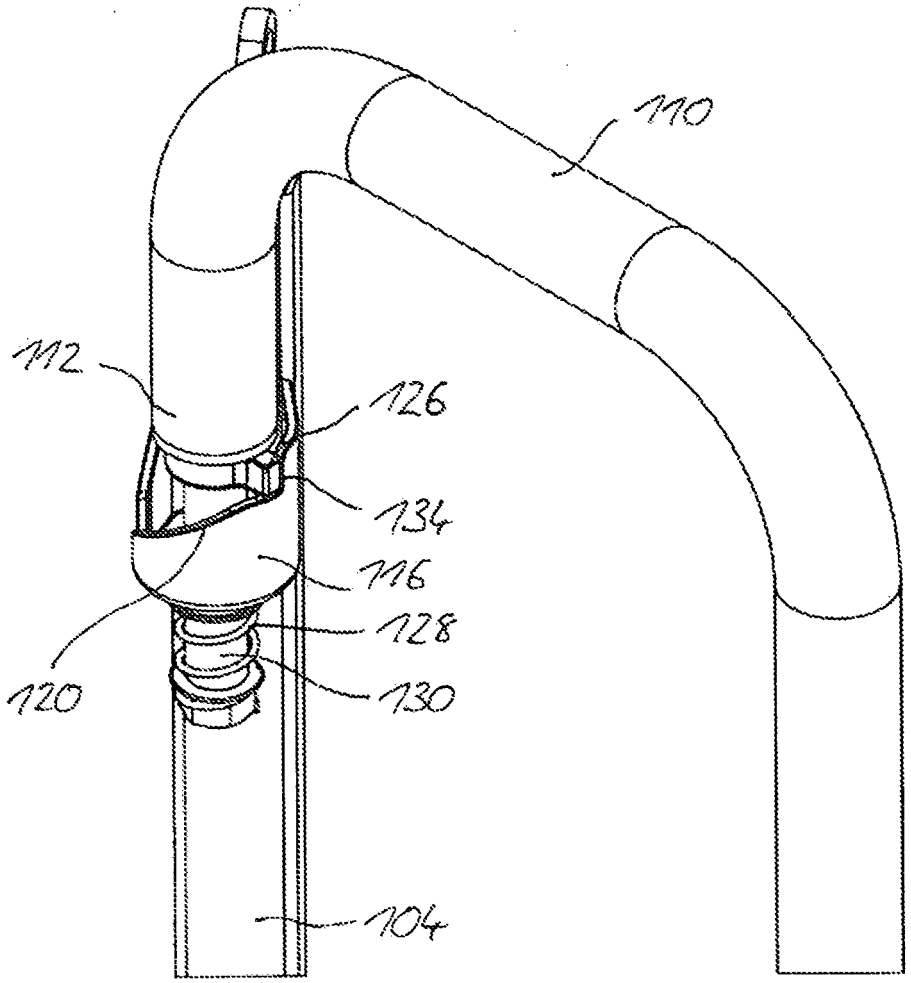

Fig. 11

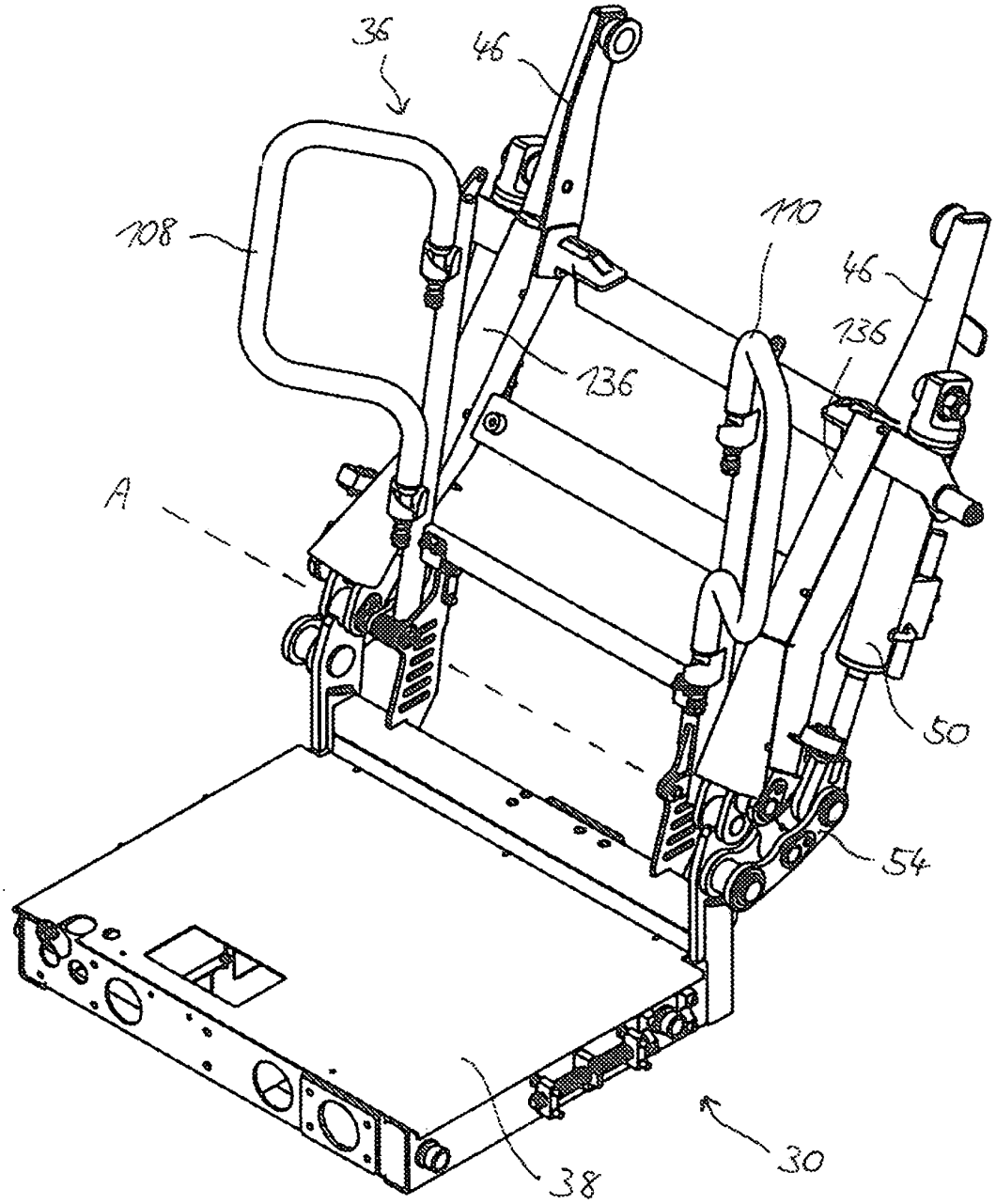

Fig. 12

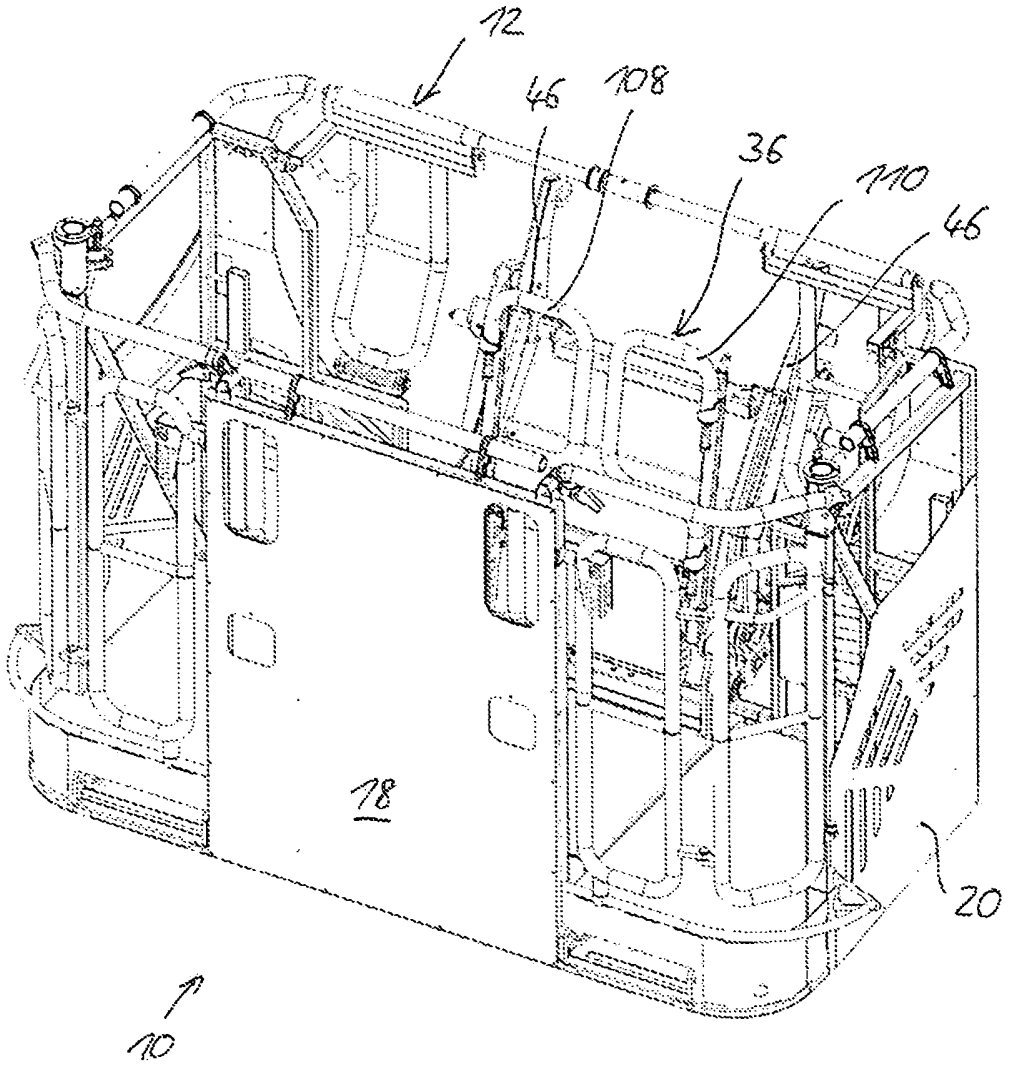

Fig. 13

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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