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(54) A SHOTCRETE APPLICATION SYSTEM AND AN ADAPTOR FOR MODIFYING AN EXCAVATOR CHASSIS TO OPERATE A SHOTCRETE SPRAY NOZZLE ASSEMBLY

(57) It is herein proposed a novel shotcrete application system (100) that includes an excavator chassis (110) and an articulated boom (120), which comprises an arm (121), a first joint (122) at a proximal end of the arm (121) that connects the arm (121) to the excavator chassis (110), a second joint (123) at a distal end of the arm (121), and a hydraulic actuator (124) that connects and facilitates the respective movement of the arm (121) and the excavator chassis (110) at the first joint (122).

The system further comprises a spray nozzle assembly (130) and an adaptor (140) which is configured to connect the spray nozzle assembly (130) to the articulated boom (120). The adaptor (140) comprises a mount (141), which is configured to connect the spray nozzle assembly (130) to the second joint (123) of the boom (120), and a reaction bar (144), which connects the mount (141) to the arm (121) so as to prevent movement of the mount (141) in respect to the arm (121) at the second joint (123).

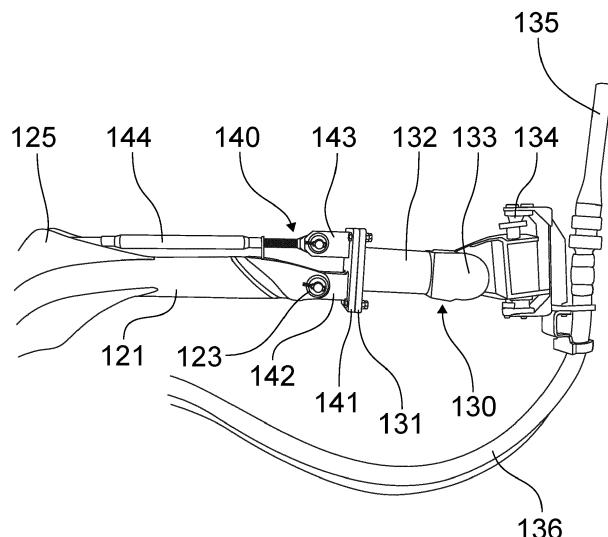


FIG. 2

Description

FIELD

[0001] The present disclosure relates to the sprayed application of concrete or reinforced concrete. In particular, the disclosure relates to a vehicular system for spraying shotcrete in tight underground spaces. More particularly, the disclosure relates to a shotcrete application system and adaptor for modifying an excavator chassis to operate a shotcrete spray nozzle according to the preambles of claims 1 and 8, respectively.

BACKGROUND

[0002] It is known in the field to spray concrete or reinforced concrete to the walls, ceiling, and floor of under-floor constructions, such as tunnels, for reinforcement thereof. The so called shotcrete may be sprayed manually or by using purpose built vehicles, such as those disclosed by US 5851580 A, JP 01198999 A, or DE 2361968 C3.

[0003] Shotcrete reinforcement is often required in cramped underground spaces such as old tunnels during renovation. The manual application of shotcrete is very laborious, whereby machine assisted application would be desired. Conventional shotcrete application vehicles, however, are typically too large to fit into such cramped spaces or they are, due to being purposely built, so expensive that manual application is favoured despite being exhausting.

[0004] It would therefore be desirable to provide a solution to the assisted application of shotcrete in cramped spaces.

SUMMARY OF THE INVENTION

[0005] According to the present proposition, assisted application of shotcrete is facilitated by an excavator chassis which is modified to operate a shotcrete spray nozzle.

[0006] According to a first aspect, a novel shotcrete application system is proposed that includes an excavator chassis and an articulated boom with an arm which is connected to the excavator chassis at a first joint. A hydraulic actuator connects and facilitates the respective movement of the arm and the excavator chassis at the first joint. An adaptor fits a spray nozzle assembly to the articulated boom with a mount that connects the spray nozzle assembly to a second joint of the boom opposing the first joint. A reaction bar of the adaptor connects the mount to the arm so as to prevent movement of the mount in respect to the arm at the second joint.

[0007] According to a second aspect, a novel adaptor is proposed for modifying an excavator chassis to operate a shotcrete spray nozzle assembly. The adaptor includes a flange that has a first side for connecting to a spray nozzle assembly. A second side of the flange fea-

tures a first bracket for connecting the flange to a reaction bar and a second bracket for connecting the flange of a joint of an articulated boom of the excavator chassis.

[0008] The invention is defined by the features of the independent claims. Some specific embodiments are defined in the dependent claims.

[0009] Considerable benefits are gained with aid of the novel proposition. The ability to modify conventional excavator chassis to operate a shotcrete spray nozzle enables machine assisted application of shotcrete with inexpensive equipment which not only able to compete with manual labor but also compact enough to fit into cramped spaces. Mini or compact excavators, for example, that would otherwise be unsuitable for shotcrete application are applicable for the present purpose with a simple modification. Rental mini or compact excavators are readily and broadly available near construction sites or they can be easily transported on the site compared to larger conventional vehicles. The modification can even be performed *in situ* with elementary tools.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] In the following certain exemplary embodiments are described with reference to the accompanying drawings, in which:

FIGURE 1 illustrates a schematic perspective view of a shotcrete application system in accordance with at least some embodiments;

FIGURE 2 illustrates a schematic detail view of the boom, adaptor, and spray nozzle of the system of FIGURE 1, and

FIGURE 3 illustrates a schematic detail view of the adaptor of the system of FIGURE 1.

EMBODIMENTS

[0011] FIGURE 1 illustrates an exemplary shotcrete application system 100 in a perspective view. The system 100 is based on a modified excavator chassis 110. The excavator chassis 110 may be a mini or compact excavator such as a JCB 8014 or similar vehicle. The excavator chassis 110 is a self-propelled vehicle which includes a power supply, a hydraulic power source, a drive train, such as a crawler track, controls, and preferably seating for the operator. Such excavator chassis are known *per se*. An articulated boom 120 is also in the present shotcrete application system 100. The boom 120 includes conventional elements, such as an arm 121 which is connected at a proximal end to the excavator chassis 110 through a first joint 122. The arm 121 may be manipulated with a hydraulic manipulator 124 that is driven and controlled by the hydraulic system of the excavator chassis 110. As shown in FIGURE 1, the first joint 122 preferably provides two axes of movement,

namely a horizontal and vertical axis. The distal end of the arm 121, i.e. the end of the arm 121 opposing the end which is connected to the excavator chassis 110, is modified by replacing a secondary arm and a bucket (not illustrated) with a spray nozzle assembly 130 through an adaptor 140. It would, however, be possible to include a secondary or tertiary or more arms in the system, but such embodiment is not illustrated in the drawings for the sake of simplicity.

[0012] FIGURES 2 and 3 provide a more detailed illustration of the modification. An adaptor 140 connects the arm 121 of the boom 120 to the spray nozzle assembly 130. The spray nozzle assembly 130 itself is or may be a conventional commercial nozzle assembly. The spray nozzle assembly 130 includes a mount 141 which is typically a flange, specifically a quadrilateral flange. An arm 132 connects the mount 131 to a nozzle 135 through a manipulator for moving the nozzle 135 in respect to the mount 131. The manipulator features one or more joints for providing the necessary movement. In the illustrated example, the manipulator includes a first joint 133 for providing a first degree of freedom and a second joint 134 between the first joint 133 and the nozzle 135 for providing a second degree of freedom, whereby the nozzle 135 may be rotated quite flexibly. An inlet pipe 136 connects the head to a material container (not illustrated).

[0013] As mentioned above, the adaptor 140 provides for an interface between the boom 120 and the spray nozzle assembly 130. To connect to the spray nozzle assembly 130, the adaptor 140 includes a mount 141 which is compatible with the corresponding mount 131 of the spray nozzle assembly 130. In the illustrated example the mounts 131, 141 take the form of quadrilateral flanges with aligning attachment holes for accommodating attachment means, such as bolts and nuts. The adaptor 140 also includes brackets the flange on the side opposing the spray nozzle assembly 130. A first bracket 142 connects the mount 141 to the arm 121, namely to the second joint 123 thereof. The second joint 123 would be conventionally used to connect the first arm of the boom 120 to a second arm which is replaced by the spray nozzle assembly 130 in the present system. The first bracket 142 is specifically used in the illustrated example to attach to the lower part of the boom. The first bracket 142 may feature two protrusions that have openings aligned such to receive there between the distal end of the arm 121 of the boom 120. The arm 121 may be secured to the bracket 142 with a bolt and nut as shown.

[0014] A second bracket 143 fixes the adaptor 140 to the arm 121 such to prevent movement between the two. The adaptor 140 therefore includes a reaction bar 144 that connects the second bracket 143 to the arm 121, specifically to third joint 125 on the upper part of the arm. The third joint 125 would normally be used for hydraulics for moving the presently omitted second arm (not illustrated) in respect to the first arm 121. The reaction bar 144 is configured to prevent movement between the third joint 125 and the mount 141. The reaction bar 144 is,

however, preferably adjustable in length so as to adjust the angle between the arm 121 and the mount 141. The second bracket 143 may be similar to the first bracket 142 in construction. The reaction bar 144 may be attached to the arm 121 and to the second bracket 143 with a simple bolt and nut connection.

[0015] The proposed system is very beneficial for a renovation application. Because the brackets 142, 143 may be attached with simple tools, a conventional excavator chassis 110 may be modified *in situ* by replacing the bucket and/or articulated arms of the boom with a spray nozzle assembly 130 through the novel adaptor 140.

[0016] It is to be understood that the embodiments of the invention disclosed are not limited to the particular structures, process steps, or materials disclosed herein, but are extended to equivalents thereof as would be recognized by those ordinarily skilled in the relevant arts. It should also be understood that terminology employed herein is used for the purpose of describing particular embodiments only and is not intended to be limiting.

REFERENCE SIGNS LIST

| No. | Feature |
|-----|------------------------------|
| 100 | shotcrete application system |
| 110 | excavator chassis |
| 120 | boom |
| 121 | arm |
| 122 | first joint |
| 123 | second joint |
| 124 | hydraulic actuator |
| 125 | third joint |
| 130 | spray nozzle assembly |
| 131 | mount |
| 132 | arm |
| 133 | first joint |
| 134 | second joint |
| 135 | spray nozzle |
| 136 | inlet pipe |
| 140 | adaptor |
| 141 | mount |
| 142 | first bracket |
| 143 | second bracket |
| 144 | reaction bar |

CITATION LIST

[0017]

US 5851580 A

JP 01198999 A

DE 2361968 C3

Claims

1. A shotcrete application system (100), comprising:

- an excavator chassis (110),
- an articulated boom (120) comprising:
 - an arm (121),
 - a first joint (122) at a proximal end of the arm (121) connecting the arm (121) to the excavator chassis (110),
 - a second joint (123) at a distal end of the arm (121), and
 - a hydraulic actuator (124) connecting and facilitating the respective movement of the arm (121) and the excavator chassis (110) at the first joint (122),
- a spray nozzle assembly (130), and
- an adaptor (140) configured to fit the spray nozzle assembly (130) to the articulated boom (120),

characterized in that the adaptor (140) comprises:

- a mount (141) which is configured to connect the spray nozzle assembly (130) to the second joint (123) of the boom (120), and
- a reaction bar (144) which connects the mount (141) to the arm (121) so as to prevent movement of the mount (141) in respect to the arm (121) at the second joint (123).

2. The shotcrete application system (100) according to claim 1, wherein the excavator chassis (110) is a mini or compact excavator chassis.

3. The shotcrete application system (100) according to claim 1 or 2, wherein the spray nozzle assembly (130) comprises:

- a mount (131), which is attached to the mount (141) of the adaptor (140),
- a spray nozzle (135), and
- a manipulator (133, 134) which is configured to move the nozzle (135) in respect to the mount (131) of the spray nozzle assembly (130).

4. The shotcrete application system (100) according to any one of the preceding claims, wherein the manipulator (133, 134) is configured to turn the nozzle

(135) in respect to the mount (131) of the spray nozzle assembly (130) about two different axes.

5. The shotcrete application system (100) according to any one of the preceding claims, wherein the mount (141) of the adaptor (140) is a flange.

6. The shotcrete application system (100) according to any one of the preceding claims, wherein:

- the mount (141) comprises a first side and a second side opposing the first side, which first side is connected to the spray nozzle assembly (130),
- the adaptor (140) comprises a first bracket (142) which connects the second side of the mount (141) to the second joint (123) of the arm (121), and
- the adaptor (140) comprises a second bracket (143) which connects the second side of the mount (141) to the reaction bar (144).

7. The shotcrete application system (100) according to any one of the preceding claims, wherein the reaction bar (144) comprises an adjustment mechanism for adjusting the length thereof.

8. An adaptor (140) for modifying an excavator chassis (100) to operate a shotcrete spray nozzle assembly (130), **characterized by**:

- a mount (141) comprising a first side and a second side opposing the first side, which first side is configured to connect the mount (141) to a spray nozzle assembly (130),
- a first bracket (142) provided to the second side of the mount (141), which first bracket (142) is configured to connect the mount (141) to a reaction bar (144), and by
- a second bracket (143) provided to the second side of the mount (141), which second bracket (143) is configured to connect the mount (141) to a joint (123) of an articulated boom (120) of the excavator chassis (110).

9. The adaptor (140) according to claim 8, wherein the mount (141) is a flange.

10. The adaptor (140) according to claim 8 or 9, wherein the adaptor (140) comprises a reaction bar (144) which is configured to connect the second bracket (143) of the mount (141) to a boom (120) of an excavator so as to prevent movement between the mount (141) and the boom (120).

11. The adaptor (140) according to claim 10, wherein the reaction bar (144) is adjustable in length.

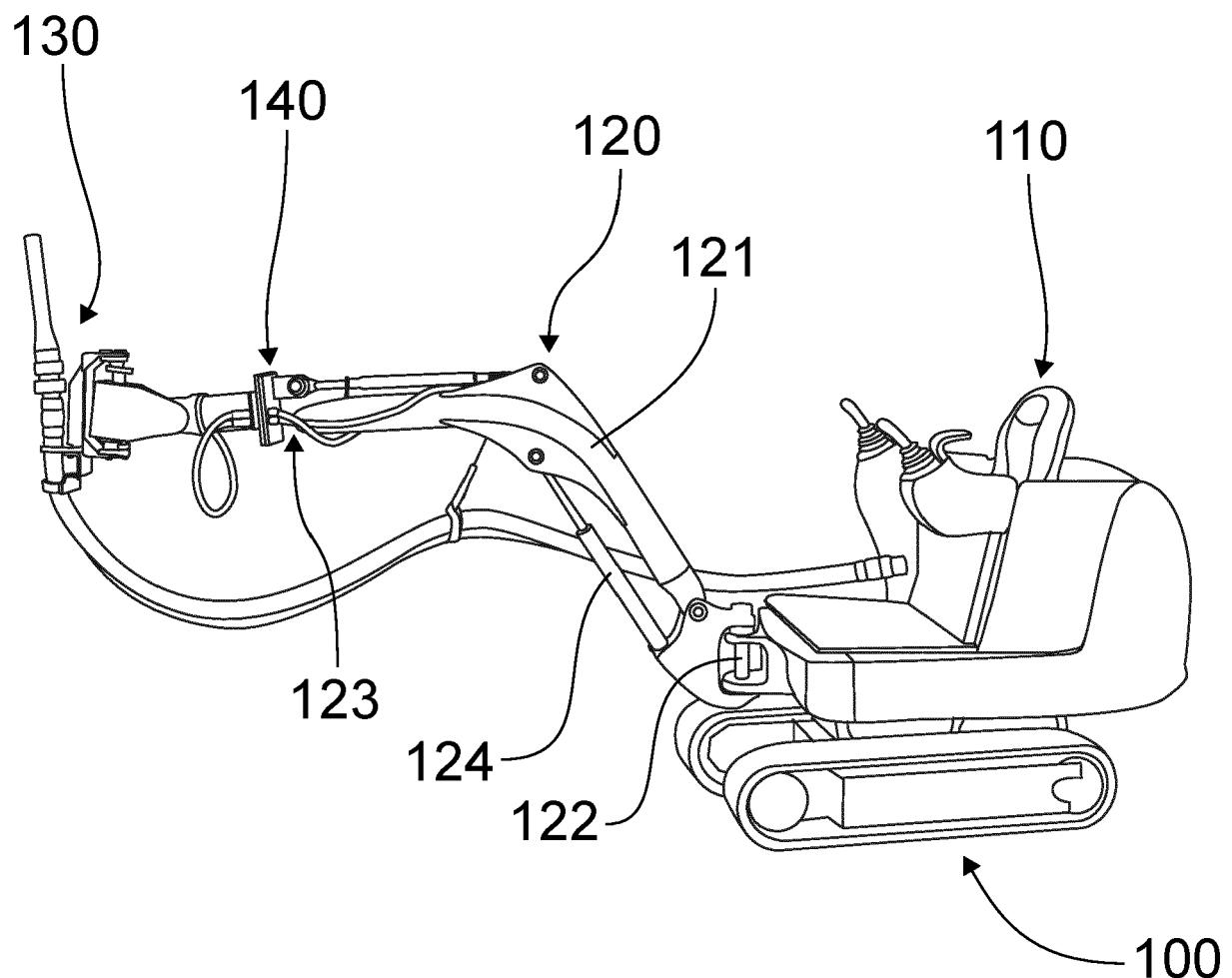


FIG. 1

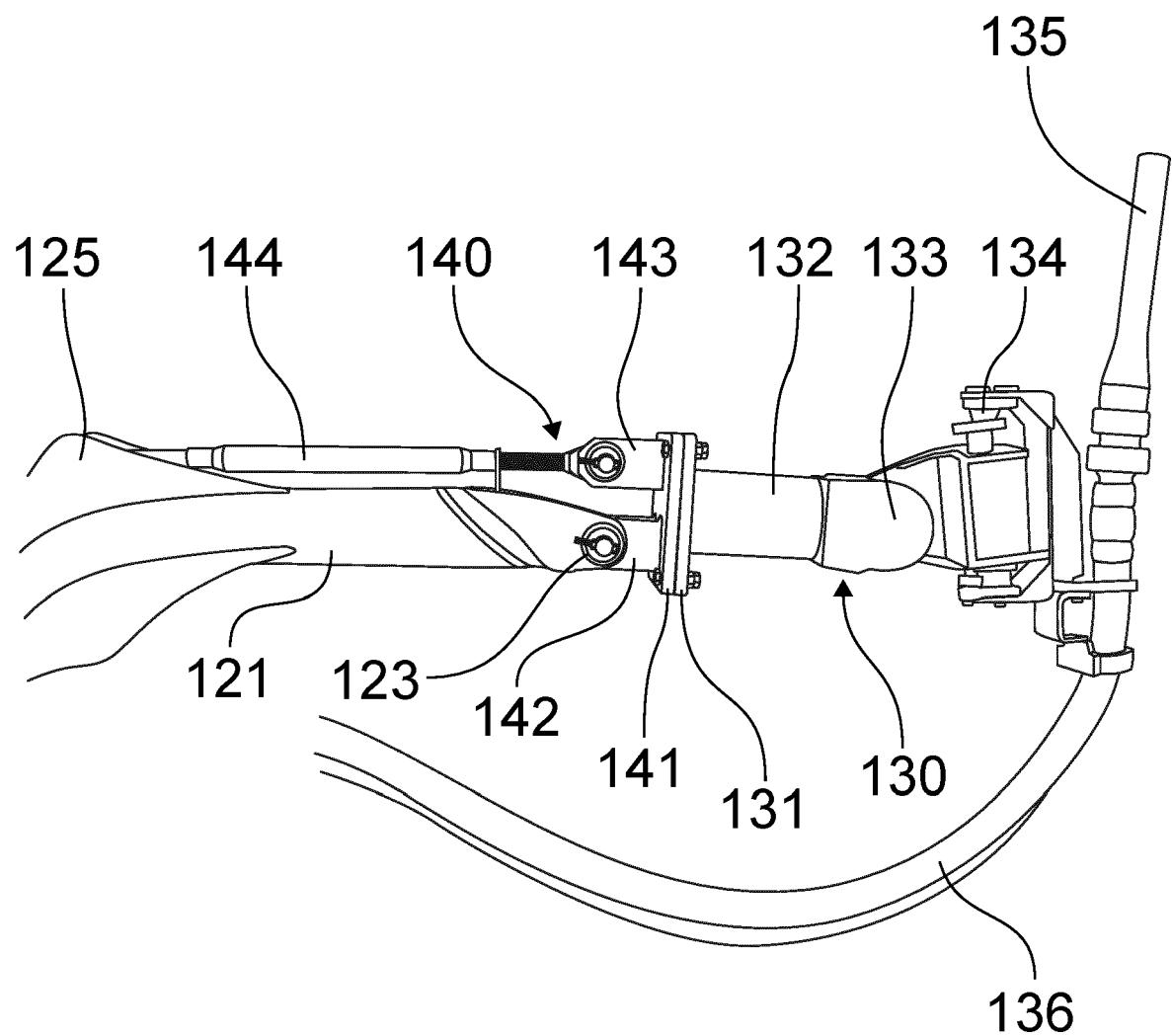


FIG. 2

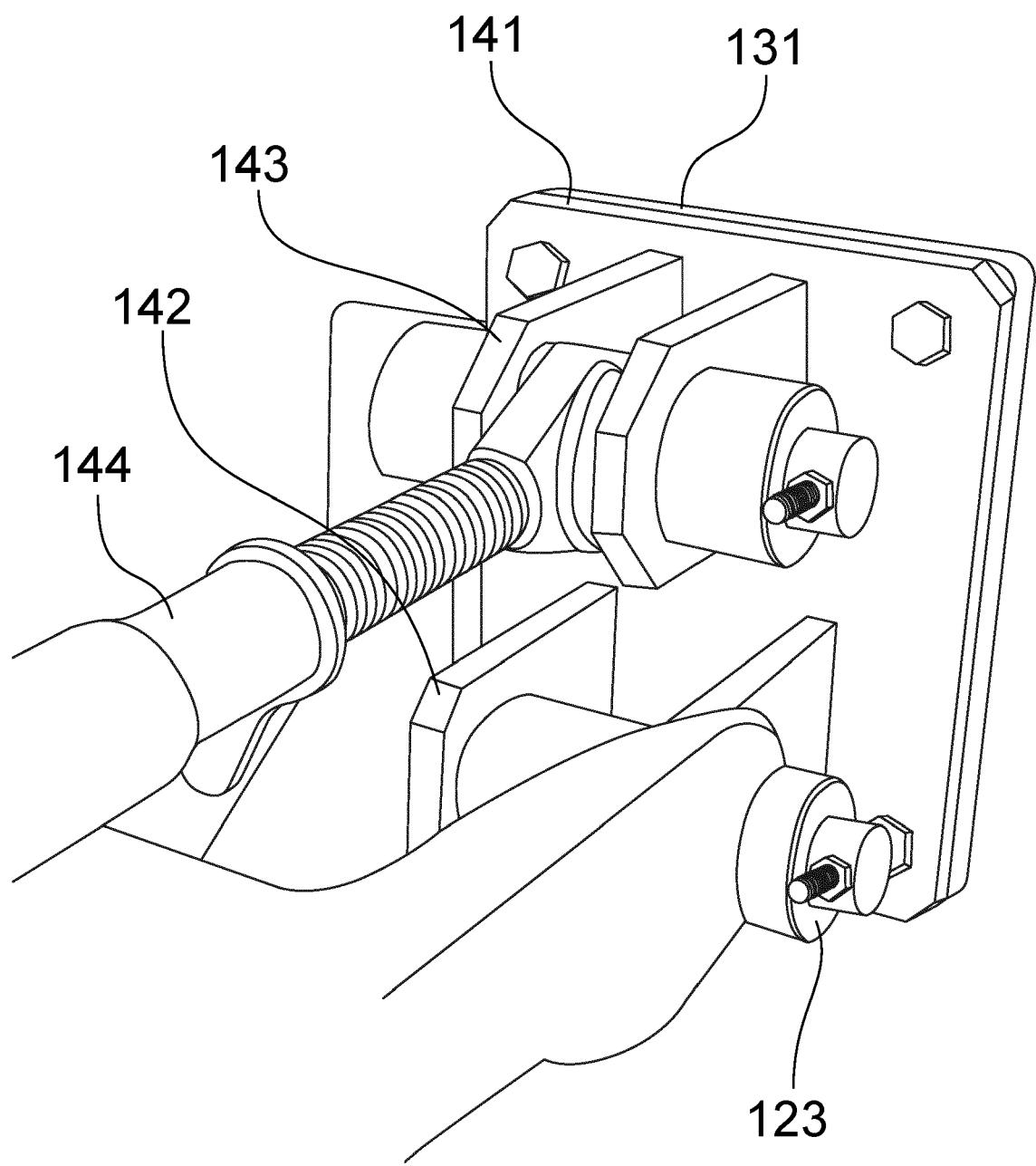


FIG. 3



EUROPEAN SEARCH REPORT

Application Number

EP 20 15 6375

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| DOCUMENTS CONSIDERED TO BE RELEVANT | | | |
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| 50 1 | The present search report has been drawn up for all claims | | |
| 55 | Place of search The Hague | Date of completion of the search 22 June 2020 | Examiner Brassart, P |
| CATEGORY OF CITED DOCUMENTS | | T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document | |
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REFERENCES CITED IN THE DESCRIPTION

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