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(54) DRIVING ARRANGEMENT FOR CONSTRUCTION MACHINE

(57) The present invention relates to a driving arrangement for a construction machine, preferably for an excavator, comprising a hydraulic pump for powering a working equipment and/or locomotion of the construction machine through a hydraulic circuit, an electric motor for driving the hydraulic pump, wherein power of the electric motor is transferable to the hydraulic pump via a connection means, a supporting device for mounting the driving arrangement to the construction machine, the supporting device supporting the hydraulic pump and the electric motor, and an adjustment mechanism for adjusting the positional relationship between the electric motor and the hydraulic pump to align both component with respect to each other.

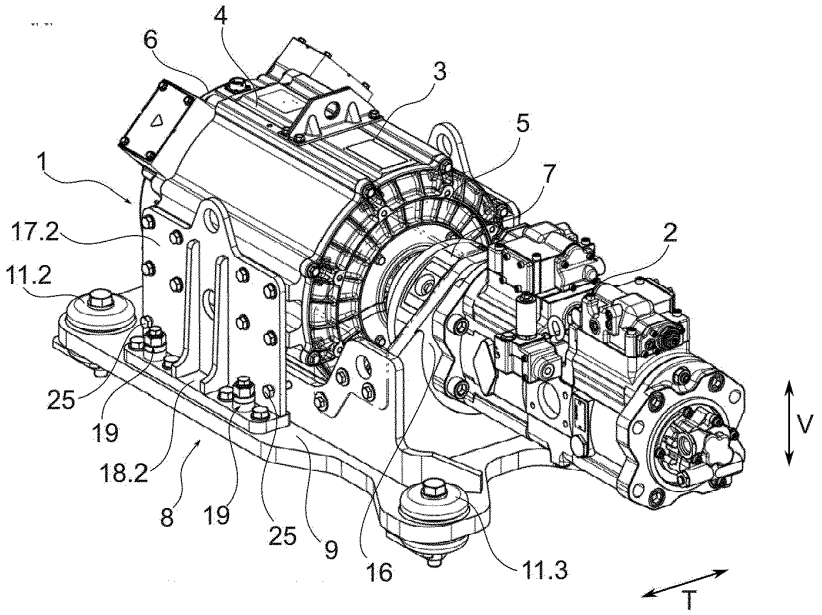

Fig. 2

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Description

TECHNICAL FIELD

[0001] The present invention relates to a driving arrangement for a construction machine, and to a construction machine comprising such a driving arrangement. The construction machine may be an excavator.

PRIOR ART

[0002] Electrical excavators are known, which comprise an electrical storage device for powering an electrical motor, the electrical motor driving a hydraulic pump via which hydraulic actuators of the excavator's boom may be actuated. CN 10 496 337 5 A relates to an excavator comprising an electric motor and a hydraulic pump.

SUMMARY OF THE INVENTION

[0003] The present invention relates to a driving arrangement for a construction machine. The construction machine may be an excavator or any other type of construction machine. The excavator may comprise an undercarriage and a superstructure, which is pivotably provided on the undercarriage. The undercarriage may comprise one or multiple tracks for locomotion of the excavator, i.e. for moving the excavator forwards, backwards and/or sidewards. The construction machine, e.g. the superstructure of the excavator, may comprise a boom with multiple arms, which are movable with respect to each other via hydraulic actuators. The hydraulic actuators may be part of a hydraulic circuit of the construction machine.

[0004] The driving arrangement of the present invention comprises a hydraulic pump for powering a working equipment and/or locomotion of the construction machine through a hydraulic circuit. According to an embodiment, the hydraulic pump is suitable for powering the above-described hydraulic circuit comprising the multiple hydraulic actuators for moving the multiple arms of the construction machine's boom. Additionally or alternatively, the hydraulic pump may be configured to power a further hydraulic circuit via which means for locomotion of the excavator, e.g. tracks, may be driven. Furthermore, the driving arrangement comprises an electric motor for driving the hydraulic pump via a connection means. The electric motor is configured, e.g. exhibits an output torque/power, suitable for driving the hydraulic pump. The electric motor may be a synchronous or asynchronous motor. According to an embodiment, the driving arrangement comprises only this one electric motor for driving the hydraulic pump, implying that the hydraulic pump is not driven by any other power source, in particular not by a combustion engine. The electric motor may be powered by an electrical storage unit, which may comprise multiple battery packs, wherein each battery pack may comprise multiple battery cells. Each of the battery packs may be configured to provide a current of multiple hundreds of Ampere, e.g. at a rated voltage of approximately 100V. In particular, the construction machine, e.g. the excavator, may be a pure electric excavator only comprising an electrical storage device as power source, in particular not comprising a combustion engine.

[0005] In addition, the driving arrangement comprises a supporting device suitable to mount the driving arrangement to the construction machine. The supporting device may be made from multiple components, which may be connected to each other via material bonding, e.g. welding, and/or bolts/screws or which may be integrally formed with each other. The supporting device may be made from steel. The supporting device supports the hydraulic pump and the electric motor. Specifically, the hydraulic pump and the electric motor are mounted to the supporting device. Furthermore, the driving arrangement comprises an adjustment mechanism for adjusting the positional relationship between the electric motor and the hydraulic pump to align both components with respect to each other. The adjustment mechanism may be provided by the supporting device and/or by a separate arrangement. The positional relationship may be adjusted by displacing the electric motor and the hydraulic pump with respect to each other in a linear fashion and/or by rotating both components with respect to each other.

[0006] The driving arrangement of the present invention is simple and easy to assemble, as the positional relationship between the hydraulic pump and the electric motor can be easily adapted, e.g. to align the shaft of the electric motor with the shaft of the hydraulic pump before coupling both parts together with the connection means. By providing the adjustment mechanism, costs of the driving arrangement can be decreased significantly, as larger tolerances are acceptable, for example.

[0007] According to an embodiment, the connection means is configured as an elastic coupling. The elastic coupling may be an elastic material which is elastically deformable by loads applied thereto during the intended use of the driving arrangement. The elastic coupling may be a mechanical or a hydraulic coupling. Configuring the connection means as an elastic coupling results in high operational stability, as disturbances applied to one of the components are not directly transferred to the other one via the connection means. Furthermore, if the connection means are configured as elastic coupling, the adjustment mechanism of the driving arrangement of the present invention is particularly advantageous, as it allows for an easy alignment of the shafts of electric motor and hydraulic pump with respect to each other.

[0008] The adjustment mechanism may be configured to allow for an adjustment of the positional relationship between the electric motor and the hydraulic pump in two different directions. Preferably, said two directions are oriented perpendicular to each other and/or correspond to the vertical and depth direction of the driving arrangement. The vertical direction may correspond to the vertical direction of the construction machine when the driv-

ing arrangement is mounted thereto in the intended fashion. Furthermore, a length direction of the driving arrangement may run parallel to the shaft of the electric motor and/or the hydraulic pump and/or may be perpendicular to the vertical direction. A depth direction may be defined as being perpendicular to both the length and vertical directions of the driving arrangement. This embodiment allows for an effective and precise alignment of the electric motor and the hydraulic pump.

[0009] According to an embodiment, the supporting device comprises a base portion, which may be formed in a plate-like shape. A plate-like shape may exhibit extensions in two directions, which are perpendicular to each other, which are significantly larger than the extension of the portion in a third direction, which is perpendicular to the other two directions. One of the hydraulic pump and the electric motor may be provided stationary with respect to the base portion and the other one of the hydraulic pump and the electric motor may be provided displaceable with respect to the base portion via the adjustment mechanism. Preferably, the hydraulic pump is fixedly connected to the base portion and the electric motor is provided in a displaceable fashion. This embodiment provides a driving arrangement with an adjustment mechanism exhibiting low complexity as only one of the components is provided displaceable.

[0010] For providing the displaceability, the supporting device may comprise a mounting portion, which is attached to the displaceable one of the hydraulic pump and the electric motor. The mounting portion is connected to the base portion in a displaceable manner, e.g. via an adjustment screw. By applying a torque to the adjustment screw, the positional relationship between the mounting portion and the base portion can be adjusted. The mounting portion may be integrally formed from a single component or from multiple components, which are connected to each other, e.g. via material bonding, in particular via welding. In this regard, it is further conceivable that the mounting portion is connected to the base portion via multiple adjustment screws. This embodiment provides a driving arrangement with an adjustment mechanism exhibiting low complexity and being easy to use. Specifically, to adjust a positional relationship between the hydraulic pump and the electric motor, only an adjustment screw must be turned.

[0011] The mounting portion may be connected to the base portion via a vertical adjustment screw for adjusting the vertical position of the electric motor and the hydraulic pump with respect to each other, and via a horizontal adjustment screw for adjusting the horizontal positions of the hydraulic pump and the electric motor with respect to each other. The horizontal positional relationship may be a positional relationship of both components in the depth direction of the driving arrangement. This embodiment provides an adjustment mechanism with high flexibility that is easy to use. Specifically, by providing the ability to adjust a positional relationship in vertical and horizontal directions, the electric motor and the hydraulic pump can be optimally aligned with respect to each other.

[0012] According to an embodiment, the supporting device comprises two of the above described mounting portions, which are provided on opposite sides of the displaceable one of the hydraulic pump and the electric motor. Both of the mounting portions can be connected to the base portion via one or multiple vertical and/or horizontal adjustment screws. The mounting portions can be provided in parallel to each other and substantially perpendicular to the base portion. This embodiment results in a driving arrangement with high stability as the electric motor or the hydraulic pump is supported on two opposing sides, thereby reducing stresses in the supporting device.

[0013] According to an embodiment, the supporting device comprises a pump mounting portion, which may be formed in a plate-like fashion. The pump mounting portion may be provided vertically/upright on the base portion. Furthermore, the pump mounting portion may be provided at one of the ends of the base portion and/or may comprise a first mounting surface facing away from the base portion. To said mounting surface, the hydraulic pump may be attached, e.g. via one or multiple bolts and/or screws. The electric motor may be provided on the other side of the pump mounting portion to be positioned above the base portion. Furthermore, the pump mounting portion may exhibit an opening, e.g. a through-hole, in which the connection means may be positioned via which the electric motor positioned on one side of the pump mounting portion and the hydraulic pump positioned on the other side of the pump mounting portion are connected. This embodiment results in a driving arrangement with high mechanical stability as the relatively heavy electric motor is provided above the base portion. Furthermore, it results in a driving arrangement that is particularly compact, as the space of the supporting device is minimized by arranging the hydraulic pump to extend away from the base portion.

[0014] According to an embodiment, the driving arrangement further comprises a damping device provided at the supporting device for mounting the driving arrangement to the construction machine via the damping device. The damping device may be provided between the base portion described above and the construction machine to which the driving arrangement is mounted. The damping device may be a mechanical and/or a hydraulic damping device. E.g. the damping device may comprise one or multiple hydraulic damping cylinders and/or one or multiple rubber pads. The damping device results in a high operational safety, as it damps shocks exerted on the driving arrangement through the construction machine, thereby minimizing loads exerted on the hydraulic pump and the electric motor.

[0015] The present invention further relates to a construction machine comprising a driving arrangement according to one of the above described embodiments. The construction machine may be an excavator having a configuration as described above.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

Fig. 1 shows a driving arrangement for a construction machine according to an embodiment of the present invention in a first perspective view.

Fig. 2 shows the driving arrangement of Fig. 1 in a further perspective view.

Fig. 3 shows a base element of a supporting device of the driving arrangement of Figs. 1 and 2.

Fig. 4 shows a partial sectional view for illustrating a connection of an electric motor to the base element of Fig. 3.

Figs. 5-6 show the configuration of a vertical adjustment screw of the driving arrangement of Figs. 1 and 2.

DETAILED DESCRIPTION OF EMBODIMENTS

[0017] Figs. 1 and 2 show a driving arrangement 1 for a construction machine according to an embodiment of the present invention in different perspective views. In the present embodiment, the construction machine is an excavator comprising an undercarriage and a superstructure, which is pivotably with respect to the undercarriage. On the superstructure of the excavator, an operator's cabin and a boom with a working equipment at its distal end are provided. The excavator may be a pure electric excavator, implying that the locomotion of the excavator, the actuation of the boom and the actuation of the swing drive between the undercarriage and the superstructure are powered by electrical energy only. The electrical energy for powering those devices may be stored in multiple battery modules provided on top of the excavator's superstructure, wherein said battery modules may function as the excavator's counterweight. The excavator may comprise one or multiple electric motors for powering tracks provided at the excavator's undercarriage to move the excavator backwards, forwards and sidewards. In addition, the excavator may comprise an additional electric motor for powering the excavator's swing drive.

[0018] The driving arrangement 1, which is shown in Figs. 1 to 2, may be mounted to the excavator's superstructure. The driving arrangement 1 of the present embodiment comprises a hydraulic pump 2 for powering multiple hydraulic cylinders of the excavator's boom via a hydraulic circuit. Specifically, the excavator comprises a boom with multiple arms, which are movable with respect to each other via hydraulic cylinders. The hydraulic cylinders are part of a hydraulic circuit, which is powered by the hydraulic pump 2 of the driving arrangement 1 of the present embodiment. Furthermore, the driving arrangement 1 comprises an electric motor 3, which is powered by electric energy of the excavator's battery modules. The electric motor 3 comprises a lateral surface 4, a front surface 5 and a back surface 6, wherein the motor's shaft is oriented symmetrically with respect to the lateral surface 4 and is accessible via the front surface 5. In addition, the driving arrangement 1 comprises a connection means 7, which is configured as an elastic coupling in the present embodiment. The connection means 7 is provided between the electric motor 3 and the hydraulic pump 2 for transferring power of the electric motor 3 to the hydraulic pump 2.

[0019] Furthermore, the driving arrangement 1 comprises a supporting device 8 for mounting the driving arrangement 1 to the construction machine. The supporting device 8 is configured to support the electric motor 3 and the hydraulic pump 2 as well as the connection means 7. The supporting device 8 comprises a base element 9, which is illustrated in Fig. 3. The base element 9 exhibits a substantially rectangular plate-like base portion 10 via which the driving arrangement 1 can be mounted to the construction machine. Specifically, the base portion 10 comprises a damping device with four damping units 11.1, 11.2, 11.3, 11.4, which are shown in Figs. 1 and 2, via which the driving arrangement 1 can be mounted to the construction machine. In the present embodiment, the damping units 11.1, 11.2, 11.3, 11.4 are configured as mechanical damping units, e.g. rubber plates, which are placed between the base portion 10 of the base element 9 and the construction machine, wherein the damping units are provided at the corners of the plate-like base portion 10. The base portion 10 is oriented horizontally when the driving arrangement 1 is attached to the construction machine in the intended fashion.

[0020] In addition, the base element 9 comprises a vertical plate-like pump mounting portion 12, which is provided upright on and in parallel to the short narrow side surfaces of the rectangular plate-like base portion 10. The pump mounting portion 12 is formed symmetrically and exhibits a through-hole 13, which is provided substantially centrally. Furthermore, as derivable from Fig. 3, the pump mounting portion 12 is situated offset and in proximity to one of the short narrow side surfaces of the base portion 10. Further, the base element 9 comprises a first strengthening portion 14.1 and a second strengthening portion 14.2, which respectively extend in parallel to the long narrow side surfaces of the base portion 10, are formed plate-like, and are provided upright in a vertical fashion on the base portion 10. The strengthening portions 14.1 and 14.2 extend approximately along the entire length of the base portion 10 and engage with the pump mounting portion 12. In the area, in which the supporting portions 14.1, 14.2 engage with the pump mounting portion 12, they respectively exhibit a protruding portion for increasing the surface contact between both parts. The pump mounting portion 12 and the strength-

ening portions 14.1, 14.2 are welded to each other, wherein all three parts are also respectively welded to the base portion 10. The strengthening portions 14.1, 14.2 serve as strengthening means for strengthening the connection between the pump mounting portion 12 and the base portion 10, thereby fixing the positional relationship between both parts. The entire base element 9 is made from steel.

[0021] As derivable from Figs. 1 and 2, the hydraulic pump 2 is connected to a mounting surface 16 of the pump mounting portion 12, which is facing away from the base portion 10. In the present embodiment, the hydraulic pump 2 is attached to the pump mounting portion 12 with multiple bolts and/or screws, as shown in Fig. 2, for fixing the positional relationship between the base element 9 and the hydraulic pump 2. The connection means 7, which is coupled with the shaft of the hydraulic pump 2, is fixed in the through-hole 13 of the pump mounting portion 12. The electric motor 3 is positioned above the base portion 10 and between the strengthening sections 14.1, 14.2 of the base element 9. As derivable from Fig. 3, the base portion 10 exhibits a cut-out 15 between the damping units 11.3, 11.4 provided on the mounting surface 16 side of the mounting portion 12 for allowing good accessibility to the hydraulic pump 2. Further, as derivable from Fig. 3, the base portion 10 exhibits a central cut-out 30 for accommodating the bottom portion of the electric motor 3, thereby allowing for a compact design of the driving arrangement 1.

[0022] In addition, the driving arrangement 1 comprises an adjustment mechanism for adjusting the positional relationship between the electric motor 3 and the base portion 10 of the base element 9. Specifically, the adjustment mechanism of the present embodiment is configured to adjust the positional relationship between those two parts in vertical direction V and in depth direction T of the driving arrangement 1. As the connection means 7 and the hydraulic pump 2 are provided stationary with respect to the base portion 10 of the base element 9, the adjustment mechanism allows for an adjustment of the positional relationship between the electric motor 3 and the hydraulic pump 2 in vertical direction V and in depth direction T.

[0023] In the present embodiment, the adjustment mechanism is embodied by the supporting device 8. For that purpose, the supporting device 8 comprises two plate-like mounting portions 17.1, 17.2, which are provided upright and in vertical fashion on the base portion 10. The mounting portion 17.1, 17.2 are attached to the right and left sides of the lateral surface 4 of the electric motor 3 via multiple bolts and/or screws, as shown in Fig. 4. Furthermore, as derivable from Fig. 4, the mounting portion 17.1, 17.2 are oriented in parallel to the strengthening portions 14.1, 14.2 of the base element 9. In depth direction T of the driving arrangement 1, the mounting portions 17.1, 17.2 are respectively provided outside of the strengthening portions 14.1, 14.2, as shown in Fig. 4. At their bottom end, the mounting portions 17.1, 17.2 respectively exhibit a plate-like lip portion 18.1, 18.2, which is oriented perpendicular to the remaining mounting portions 17.1, 17.2 such that the entire mounting portions 17.1, 17.2 exhibit a substantially L-shaped cross section. The lip portions 18.1, 18.2 are provided horizontally and parallel to the base portion 10 of the base element 9.

[0024] The mounting portions 17.1, 17.2 are connected to the base portion 10 via vertical adjustment screws 19. Specifically, each lip portion 18.1, 18.2 is connected to the base portion 8 via two vertical adjustment screws 19. As derivable from Figs. 5 and 6, the vertical adjustment screws 19 exhibit a hexagonal head 20 for turning of the screw and a cylindrical portion 21 with an outer thread. At the end opposite to the hexagonal head 20, the vertical adjustment screws 19 exhibit a planar engagement surface 22. The planar engagement surface 22 of the vertical adjustment screws 19 engages with the top surface of the base portion 10 to form a planar contact. Furthermore, the outer thread of the cylindrical portion 21 of the vertical adjustment screws 19 engages with an inner thread formed in the respective lip portion 18.1, 18.2 of the mounting portions 17.1, 17.2. By applying a torque to the hexagonal head 20 of the vertical adjustment screw 19, the outer thread 21 is turned relatively to the inner thread of the lip portion 18.1, 18.2, thereby moving the lip portion 18.1, 18.2 in vertical direction V with respect to the base portion 10, as the front surface 22 of the vertical adjustment screw 19 is in planar engagement with the base portion 10. As the electric motor 3 is mounted to the lip portions 18.1, 18.2 via the mounting portions 17.1, 17.2, turning of the vertical adjustments screws 19 displaces the electric motor 3 with respect to the base portion 10 and therefore with respect to the hydraulic pump 2 in vertical direction V.

[0025] Furthermore, as derivable from Fig. 4, the mounting portions 17.1, 17.2 are respectively connected to the strengthening portions 14.1, 14.2 of the base element 9 with two horizontal adjustment screws 25. By loosening the horizontal adjustment screws 25 of one of the mounting portions 17.1 and tightening the adjustment screws 25 of the other one of the mounting portions 17.2, the mounting portions 17.1, 17.2 and therefore the electric motor 3 may moved with respect to the base portion 10 and thus with respect to the hydraulic pump 2 in depth direction T.

Claims

1. A driving arrangement (1) for a construction machine, preferably for an excavator, comprising
   a hydraulic pump (2) for powering a working equipment and/or locomotion of the construction machine through a hydraulic circuit;
   an electric motor (3) for driving the hydraulic pump (2), wherein power of the electric motor (3) is transferable to the hydraulic pump (2) via a connection

means (7);
a supporting device (8) for mounting the driving arrangement (1) to the construction machine, the supporting device (8) supporting the hydraulic pump (2) and the electric motor (3); and
an adjustment mechanism for adjusting the positional relationship between the electric motor (3) and the hydraulic pump (2) to align both component with respect to each other.

2. The driving arrangement (1) according to claim 1, wherein the connection means (7) is configured as an elastic coupling.

3. The driving arrangement (1) according to one the preceding claims, wherein the adjustment mechanism allows for an adjustment of the positional relationship in two different directions, which are preferably orthogonal to each other and/or correspond to the vertical (V) and depth directions (T) of the driving arrangement (1).

4. The driving arrangement (1) according to one the preceding claims, wherein the supporting device (8) comprises a base portion (10) for mounting the driving arrangement (1) to the construction machine, wherein one of the hydraulic pump (2) and the electric motor (3) is displaceable with respect to the base portion (10) via the adjustment mechanism and the other one is provided stationary with respect to the base portion (10).

5. The driving arrangement (1) according to claim 4, wherein the supporting device (8) comprise a mounting portion (17.1; 17.2) to which the displaceable one of the hydraulic pump (2) and the electric motor (3) is mounted, the mounting portion (17.1; 17.2) being connected to the base portion (10) via an adjustment screw (19; 25) for adjusting the positional relationship between the mounting portion (17.1; 17.2) and the base portion (10).

6. The driving arrangement (1) according to claims 3 and 5, wherein the mounting portion (17.1; 17.2) is connected to the base portion (10) via a vertical adjustment screw (19) for adjusting the vertical positions and a horizontal adjustment screw (25) for adjusting the horizontal positions of the hydraulic pump (2) and the electric motor (3) with respect to each other.

7. The driving arrangement (1) according to claim 5 or 6, wherein the supporting device (8) comprises two of such mounting portions (17.1, 17.2), which are provided on opposite sides of the displaceable one of the hydraulic pump (2) and the electric motor (3).

8. The driving arrangement (1) according to one of claims 4 to 7, wherein the supporting device (8) comprises a pump mounting portion (12) at one of the ends of the base portion (10), the electric motor (3) being provided displaceable above the base portion (10) and the hydraulic pump (2) being mounted to the pump mounting portion (12) to extend away from the base portion (10).

9. The driving arrangement (1) according to one the preceding claims, further comprising a damping device (11.1, 11.2, 11.3, 11.4) provided at the supporting device (8) for mounting the driving arrangement (1) to the construction machine via the damping device (11.1, 11.2, 11.3, 11.4).

10. Construction machine, preferably excavator, comprising a driving arrangement (1) according to one the preceding claims.

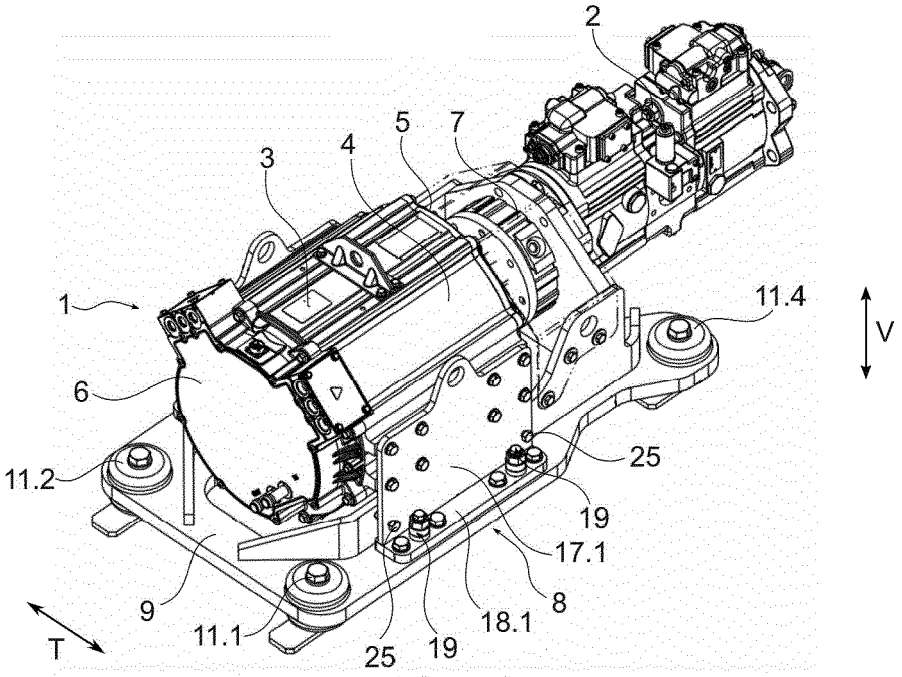
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Fig. 1

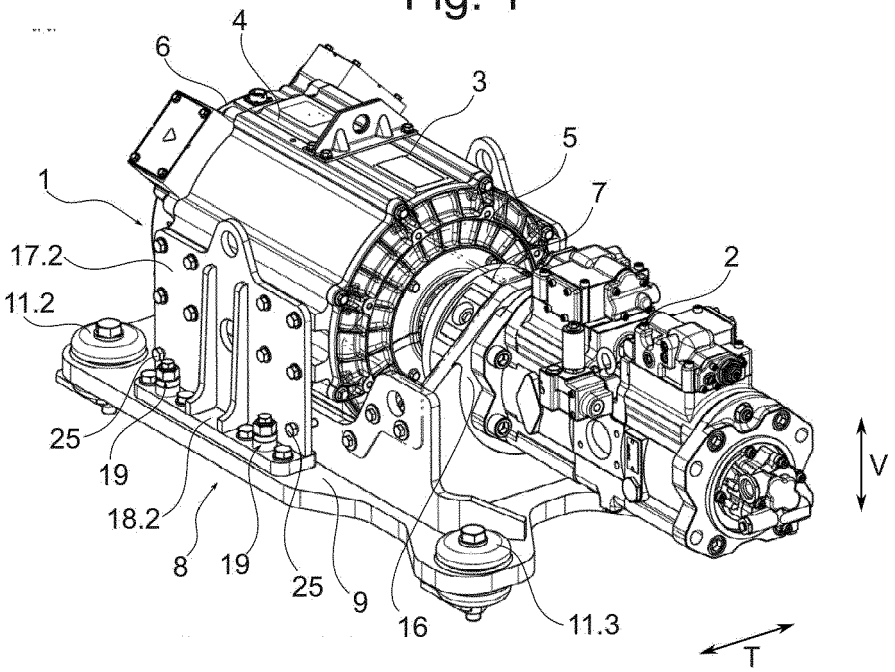
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Fig. 2

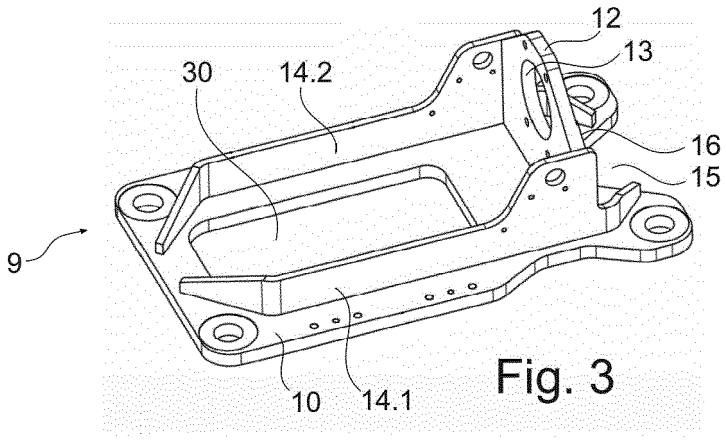

Fig. 3

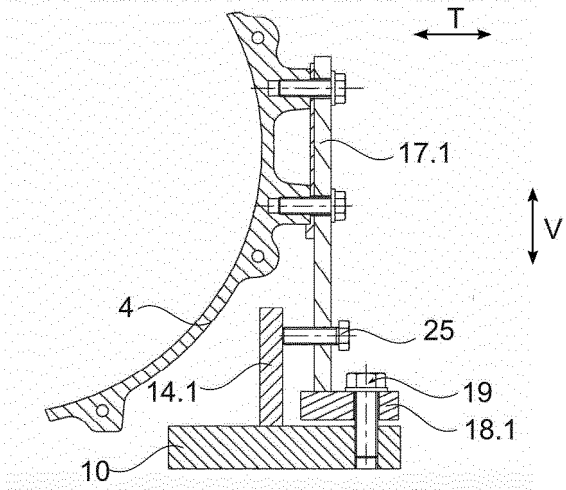

Fig. 4

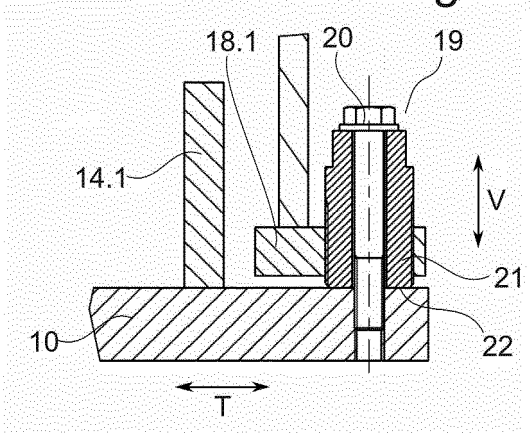

Fig. 5

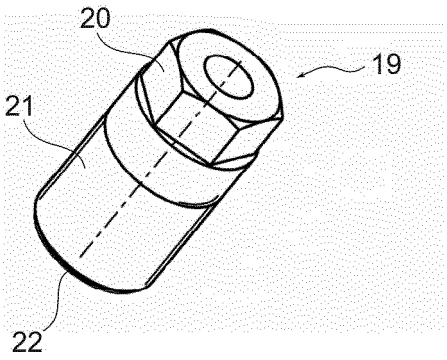

Fig. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 20 19 2463

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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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
Munich	14 January 2021	Clarke, Alister

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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