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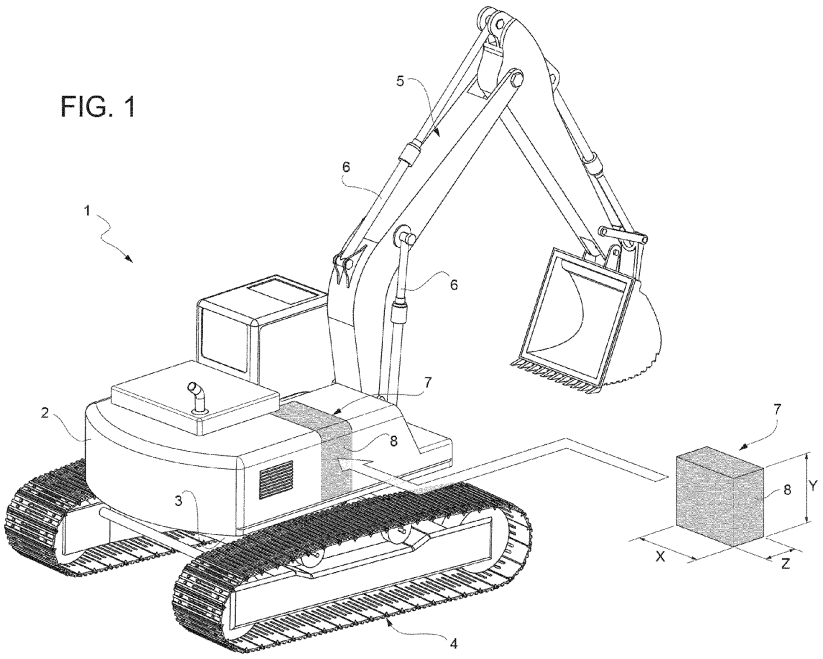
(54) **IMPROVED HYDRAULIC ASSEMBLY FOR ENERGY RECOVERY HYDRAULIC SYSTEMS IN WORK VEHICLES**

(57) Hydraulic assembly (7) for a work vehicle (1) provided with an energy recovery system, comprising a tank (11) configured to store the hydraulic oil to be used by the hydraulic circuits of the work vehicle (1), at least an accumulator (10) and a controller (12), the accumulator (10) and the controller (12) being part of the energy recovery system of the work vehicle (1),
the hydraulic assembly (7) extending over a width direction (X), a vertical direction (Y) and a thickness direction (Z),
the tank (11) extending entirely over the width and vertical directions (X, Y) and part of the thickness direction (Z), the at least one accumulator (10) and the controller (12) extending on the remaining at least part of the thickness adjacent to the tank (11) and on at least part of the disposable space over the width and the vertical directions (X, Y).

FIG. 1



EP 4 101 993 A1

Description

TECHNICAL FIELD

[0001] The present invention concerns a hydraulic assembly, in particular for providing an energy recovery functionality in a work vehicle.

[0002] The present invention finds its preferred, although not exclusive, application in vehicles provided by a hydraulic actuated boom.

BACKGROUND OF THE INVENTION

[0003] Work vehicles such as scrapers, i.e. vehicles provided with a hydraulic actuated boom, may be provided with so-called energy recovery systems.

[0004] Energy recovery systems are configured to reduce the energy consumption during the movement of a boom that is controlled via a hydraulic actuator. Indeed, when the boom is controlled to be lowered, the fluid discharged by hydraulic actuator is stored to be used then the boom is controlled to be lifted.

[0005] Such systems foresees the presence of accumulators to allow the storing of the fluid discharged by the actuator and a control block configured to manage the fluid flow between the accumulators and the actuator.

[0006] However, the accumulators and the control block needs a storing space that is not negligible on work machines.

[0007] Accordingly, it is known from US10167612 B2 or CN102943496 to store the accumulators together with or in substitution of counterweights of the work vehicle.

[0008] However, such solution needs long high pressure conduits between the counterweight, that are usually placed opposite to the boom, and the boom itself.

[0009] Furthermore, in case of lighter work vehicles, the presence of the accumulators increases the weight of the work vehicle thereby increasing its fuel consumption and partially waster the results achievable thanks to the energy recovery system.

[0010] Therefore, the need is felt to allow to use an energy recovery system on a work vehicle without using additional spaces and increasing weights on work vehicles.

[0011] An aim of the present invention is to satisfy the above mentioned needs in a cost effective and optimized manner.

SUMMARY OF THE INVENTION

[0012] The aforementioned aim is reached by a hydraulic assembly and a work vehicle as claimed in the appended set of claims.

BRIEF DESCRIPTION OF DRAWINGS

[0013] For a better understanding of the present invention, a preferred embodiment is described in the following, by way of a non-limiting example, with reference to the attached drawings wherein:

- Figure 1 is a perspective schematic view of a work vehicle comprising a hydraulic assembly according to the present invention;
- Figures 2A to 2D are perspective schematized views of respective alternative embodiments of the hydraulic assembly according to the invention; and
- Figure 3 is a hydraulic schematic of a hydraulic circuit of the work vehicle provided with the hydraulic assembly of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0014] Figure 1 discloses a work vehicle 1, e.g. a scraper, provided with a body 2 that is carried by an undercarriage 3 that is movable on the ground thanks to traction means 4, e.g. crawlers.

[0015] The work vehicle 1 comprises advantageously a boom 5 configured to be operated by hydraulic actuators 6 controlled by a related hydraulic circuit (not shown for sake of clarity) on the base of a control provided by a user of the vehicle 1.

[0016] The vehicle 1 is provided with an energy recovery system that is hydraulically coupled to the hydraulic actuators 6 for providing an energy recovery functionality.

[0017] The work vehicle 1 further comprises a hydraulic assembly 7 that is configured to be carried by the body 2.

[0018] The hydraulic assembly 7 may be advantageously arranged within a housing 8 having a parallelepiped shape and configured to define a space to house the elements described hereunder.

[0019] In particular, the hydraulic assembly 7 has a compact dimension, suitable for being substituted to tanks already existing on work vehicles for storing the hydraulic oil for allowing the operation of all hydraulic circuits of the vehicle.

[0020] In particular, the hydraulic assembly 7 has a width, X, a height, Y, and a thickness, Z that are dimensioned so that about 30-40% of the total volume of the oil of the work vehicle 1 may be stored in the tank and the 70-60% of the volume of the oil is contained in the hydraulic circuits of the work vehicle 1.

[0021] For sake of the example the following values may be determined for the following vehicle's weighs:

- 1800 kg vehicle X= 500 mm, Y=400 mm, Z=160 mm;
- 13000 kg vehicle X= 525 mm, Y=870 mm, Z=380 mm;
- 20000 kg vehicle X= 790 mm, Y=900 mm, Z=513 mm;
- 35000 kg vehicle X= 800 mm, Y=830 mm, Z=575 mm.

[0022] Clearly, the aforementioned width X, height Y and thickness Z are referred to three axis perpendicular

one with respect to the other, i.e. according to a Cartesian reference.

[0023] The hydraulic assembly 7 comprises part of the energy recovery system, i.e. at least an accumulator 10, and a controller 12, and a tank 11 that are all fluidly connected together and preferably arranged within the housing 8.

[0024] The tank 11 is configured to allow to store the drain oil of all the hydraulic circuits of the work vehicle 1.

[0025] In figures 2A to 2D four different exemplificative embodiments are disclosed.

[0026] In all the exemplificative embodiments, the tank 11 has a height and a weight that occupy the entire respective space of the hydraulic assembly 7 while the thickness of the tank is part, in the peculiar disclosed examples the half, of the available thickness of the hydraulic assembly 7.

[0027] According to a first embodiment, shown in figure 2A, the hydraulic assembly 7 comprises a tank 11, a controller 12 and three accumulators 10. In particular, the tank 11 extends all over the eight and the width of the hydraulic assembly 7 and the half of the thickness of the hydraulic assembly 7. According to such embodiment, the controller 12 extends along the entire width of the hydraulic assembly 7 and occupies the remaining part of the thickness of this latter. The three accumulators 10 are housed vertically above the controller 12 and extends, each, for the remaining part of the height of the hydraulic assembly 7. The three accumulators 10 are housed one adjacent with the other in the width direction and are preferably realized as cylinders. On the thickness direction they are in contact with tank 11.

[0028] According to a second embodiment, shown in figure 2B, the hydraulic assembly 7 comprises a tank 11, a controller 12 and three accumulators 10. In particular, the tank 11 extends all over the eight and the width of the hydraulic assembly 7 and the half of the thickness of the hydraulic assembly 7. According to such embodiment, the controller 12 extends along only part of the width of the hydraulic assembly 7 and occupies the remaining part of the thickness of this latter. The three accumulators 10 are housed one adjacent with the other in the width direction and are preferably realized as cylinders. On the thickness direction they are in contact with tank 11. On the vertical direction, the two of the accumulators 10 extends over the controller 12 to occupy the remaining vertical possible extension while a third accumulator extends all other the vertical extension of the hydraulic assembly 7 and is adjacent to the controller 12. In particular, in width, such third accumulator occupies the space not occupied by the controller 12.

[0029] According to a third embodiment, shown in figure 2C, the hydraulic assembly 7 comprises a tank 11, a controller 12 and two accumulators 10. In particular, the tank 11 extends all over the eight and the width of the hydraulic assembly 7 and the half of the thickness of the hydraulic assembly 7. According to such embodiment, the controller 12 extends along only part of the width of the hydraulic assembly 7 and occupies all the vertical extension of the latter. The three accumulators 10 are housed one adjacent with the other in the width direction and are preferably realized as cylinders. Both the accumulator 12 vertically extends along all the vertical extension of the hydraulic assembly 7. According to the preceding, one of the two accumulators 10 is adjacent to controller 12 and in width direction the two accumulators 10 occupies all the space remaining from the controller 12.

[0030] According to a fourth embodiment, shown in figure 2D, the hydraulic assembly 7 comprises a tank 11, a controller 12 and two accumulators 10. In particular, the tank 11 extends all over the eight and the width of the hydraulic assembly 7 and the half of the thickness of the hydraulic assembly 7. According to such embodiment, the controller 12 extends along the entire width of the hydraulic assembly 7 and occupies the remaining part of the thickness of this latter. The two accumulators 10 are housed vertically above the controller 12 and extends, each, for the entire width of the hydraulic assembly 7 and vertically adjacent one above the other. The two accumulators 10 are preferably realized as cylinders and, on the thickness direction they are in contact with tank 11.

[0031] As schematically shown in figure 3, the at least one accumulator 10 (exemplarily disclosed three accumulators 10) are fluidly connected to the controller 12, to the tank 11 and to the hydraulic actuator 6.

[0032] In particular, the controller 12 comprises a charging module 12a and a balancing module 12b fluidly connected between the charging module 12a, the hydraulic actuator 6, the tank 11 and the accumulators 10. The charging module 12a and the balancing module 12b are configured to regulate the fluid passage between accumulators 10, tank 11 and actuator 6 and may be realized according to different hydraulic schematics in function of the dimensions of the work vehicle 1.

[0033] In all possible embodiments, the hydraulic assembly 7 may further comprise an electronic control unit, ECU, of the vehicle housed together with the controller 12.

[0034] The operation of the above hydraulic assembly 7 according to the invention is the following.

[0035] When the user imparts a control to lower boom 5, then the actuators 6 are discharged to allows such lowering and the fluid flows to accumulators 10 thanks to the action of the controller 12. Conversely, when the user imparts a control to lift the boom 5, then the actuators 6 are recharged also thanks to the accumulators 10 that empts thereby saving energy.

[0036] During the use of the vehicle 1, the tank 11 solves to its function of reservoir of a sufficient quantity of oil to allow the operation of all the hydraulic circuits of the vehicle 1.

[0037] In view of the foregoing, the advantages of a hydraulic assembly 7 according to the invention are apparent.

[0038] The proposed hydraulic assembly 7 provides in

a single compact space both the tank 11 of the vehicle and the energy recovery systems, i.e. accumulators 10 and controller 12.

[0039] In particular, the dimensions of the tank 11 have been optimized to reduce the quantity of stored oil till the minimum to guarantee the operation, in any condition, of the work vehicle and such space reduction has been used to house the accumulators and the controller of the energy recovery system.

[0040] In this way, the hydraulic connections between accumulators 10, controller 12 and tank 11 needs short piping therefore reducing, costs, weight and probabilities of failures.

[0041] In particular, the reduced space of the tank 11 with respect to existing one allows to place the entire hydraulic assembly 7 in the space occupied by the known tank. Indeed, tank 11 is about 50% in volume smaller than existing tanks.

[0042] However, since oil is usually contained 50% in the tank and 50% in the hydraulic circuits, in known work vehicle, the 50% reduction and the new distribution of oil between tank and hydraulic circuits does not affect the operation of the hydraulic circuits. Indeed the remaining volume of the tank is sufficient to allows its storing function.

[0043] Accordingly, the hydraulic assembly 7 does not need to occupies other space in the vehicle and may be provided also in existing vehicles as a kit.

[0044] Furthermore, the hydraulic assembly 7 may be easily mounted, therefore reducing industrialization costs and allows an easy maintain in the field since all components are easily accessible.

[0045] As said, since the hydraulic assembly 7 may be housed instead of existing tanks, no modification on the general layout or design of existing machines is needed.

[0046] Furthermore, since accumulators 11 are placed between the tank and bonnets of the vehicle and may be covered by a housing 8, the driver is protected from the latter.

[0047] It is clear that modifications can be made to the described hydraulic assembly 7 which do not extend beyond the scope of protection defined by the claims.

[0048] For example, as demonstrated, the accumulators 10 may be placed in different orientation with respect to the tank 11. Similar consideration may be applied to controller 12.

Claims

1. Hydraulic assembly (7) for a work vehicle (1) provided with an energy recovery system, said hydraulic assembly (7) comprising a tank (11) configured to store the hydraulic oil to be used by the hydraulic circuits of said work vehicle (1), at least an accumulator (10) and a controller (12), the accumulator (10) and the controller (12) being part of the energy recovery system of said work vehicle (1),
   said hydraulic assembly (7) extending other a width direction (X), a vertical direction (Y) and a thickness direction (Z),
   said tank (11) extending entirely over said width and said vertical directions (X, Y) and part of said thickness direction (Z), said at least one accumulator (10) and said controller (12) extending on the remaining at least part of said thickness adjacent to said tank (11) and on at least part of the disposable space over said width and said vertical directions (X, Y).

2. Hydraulic assembly according to claim 1, further comprising a housing (8) defining a space to arrange said tank (11), said at least one accumulator (10) and said controller (12) .

3. Hydraulic assembly according to claim 1 or 2, wherein the width direction (X), the vertical direction (Y) and the thickness direction (Z) are dimensioned so that for a specific weight of the vehicle, 30%-40% of the total volume oil of the work vehicle (1) can be contained in the tank (11) and the remaining 60%-70% of the volume oil can be contained in hydraulic circuits of said work vehicle (1).

4. Hydraulic assembly according to any of claims 1 to 3, wherein:
   - if said vehicle's weight is about 1800 kg, said extension in width direction (X) is 500 mm, said extension in vertical direction (Y) is 400 mm and said extension in thickness direction (Z) is 160 mm;
   - if said vehicle's weight is about 13.000 kg, said extension in width direction (X) is 525 mm, said extension in vertical direction (Y) is 870 mm and said extension in thickness direction (Z) is 513 mm;
   - if said vehicle's weight is about 20.000 kg, said extension in width direction (X) is 790 mm, said extension in vertical direction (Y) is 900 mm and said extension in thickness direction (Z) is 513 mm; and
   - if said vehicle's weight is about 35.000 kg, said extension in width direction (X) is 800 mm, said extension in vertical direction (Y) is 830 mm and said extension in thickness direction (Z) is 575 mm.

5. Hydraulic assembly according to any of the preceding claims, wherein said controller (12) extends all over said vertical direction.

6. Hydraulic assembly according to any of the preceding claims, wherein said at least one accumulator (10) extends all over said vertical direction.

7. Hydraulic assembly according to any of the preceding claims, wherein said controller (12) extends all over said width direction.

8. Hydraulic assembly according to any of the preceding claims, wherein said at least one accumulator (10) extends all over said width direction.

9. Hydraulic assembly according to any of the preceding claims, wherein said at least one accumulator (10) is laterally or vertical adjacent with respect to said controller (12) .

10. Hydraulic assembly according to any of the preceding claims, wherein said at least one accumulator (10) is placed above with respect to said controller (12).

11. Hydraulic assembly according to any of the preceding claims, wherein said controller (12) integrates an electronic control unit, ECU, of said work vehicle (1).

12. Work vehicle (1) comprising a body (2) movable on the ground and a boom (5) actuated by a hydraulic actuator (6) and an energy recovery system comprising at least one accumulator (10) and a controller (12), said at least one accumulator (10) and said controller (12) being arranged into a hydraulic assembly (7) realized according to any of said preceding claims.

13. Work vehicle according to claim 12, wherein said hydraulic assembly (1) is integrated into said body (2).

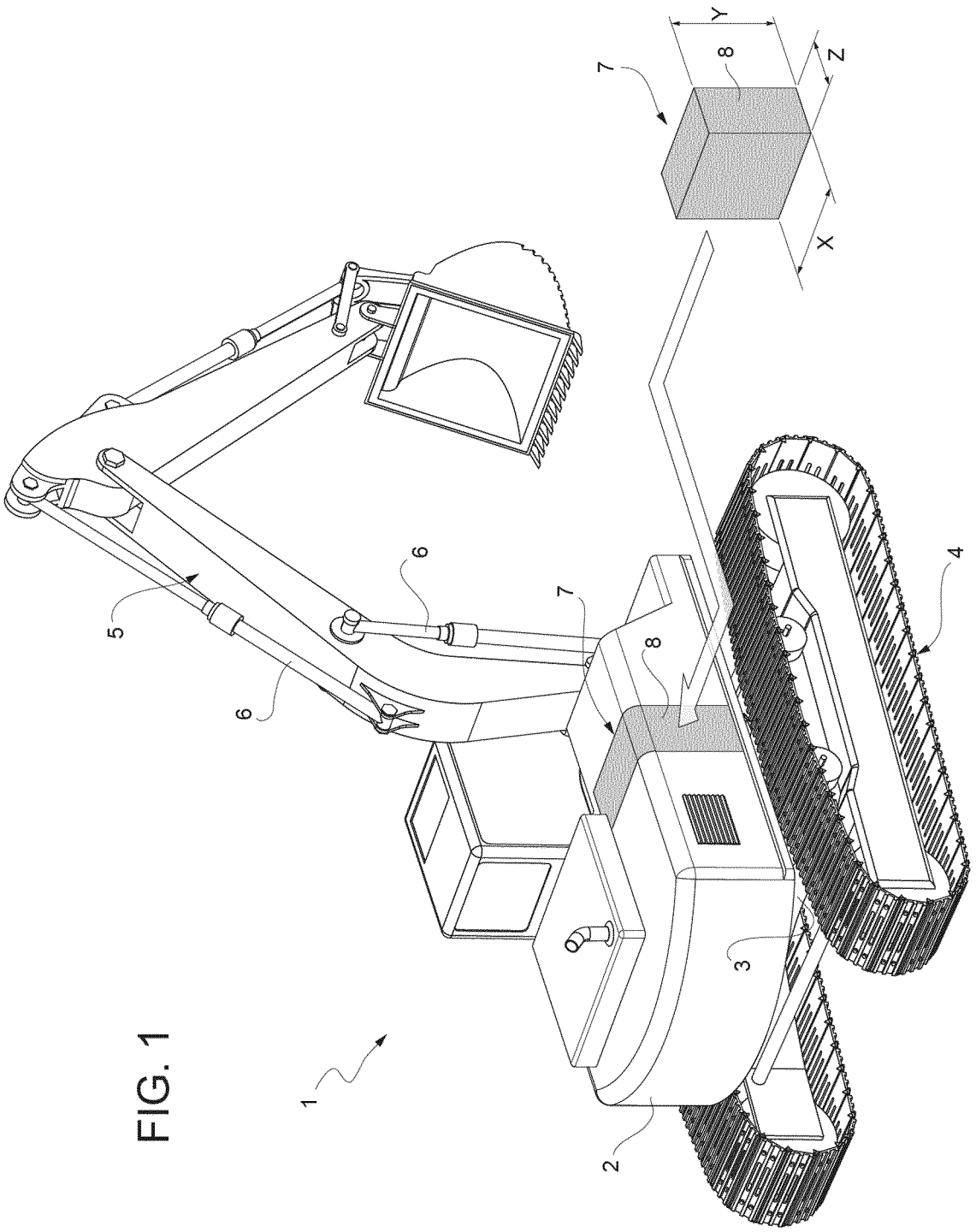


FIG. 1

FIG. 2D

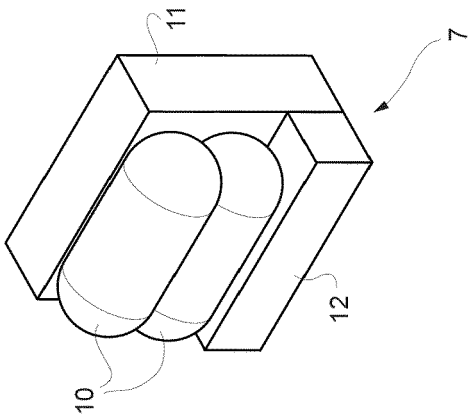


FIG. 2C

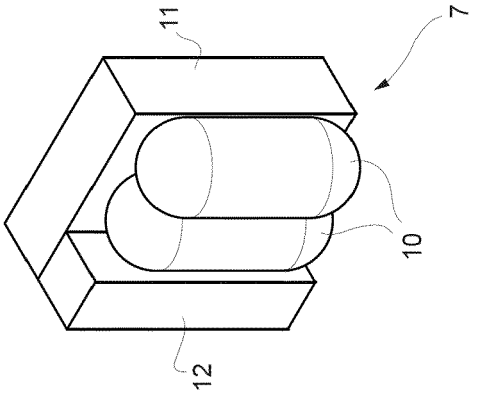


FIG. 2B

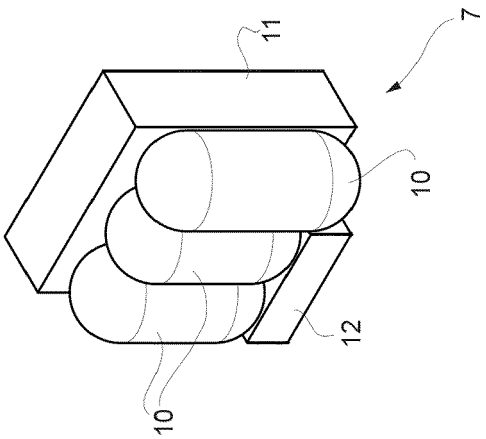


FIG. 2A

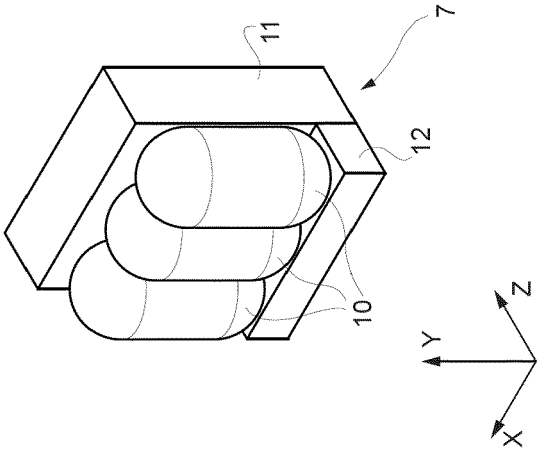
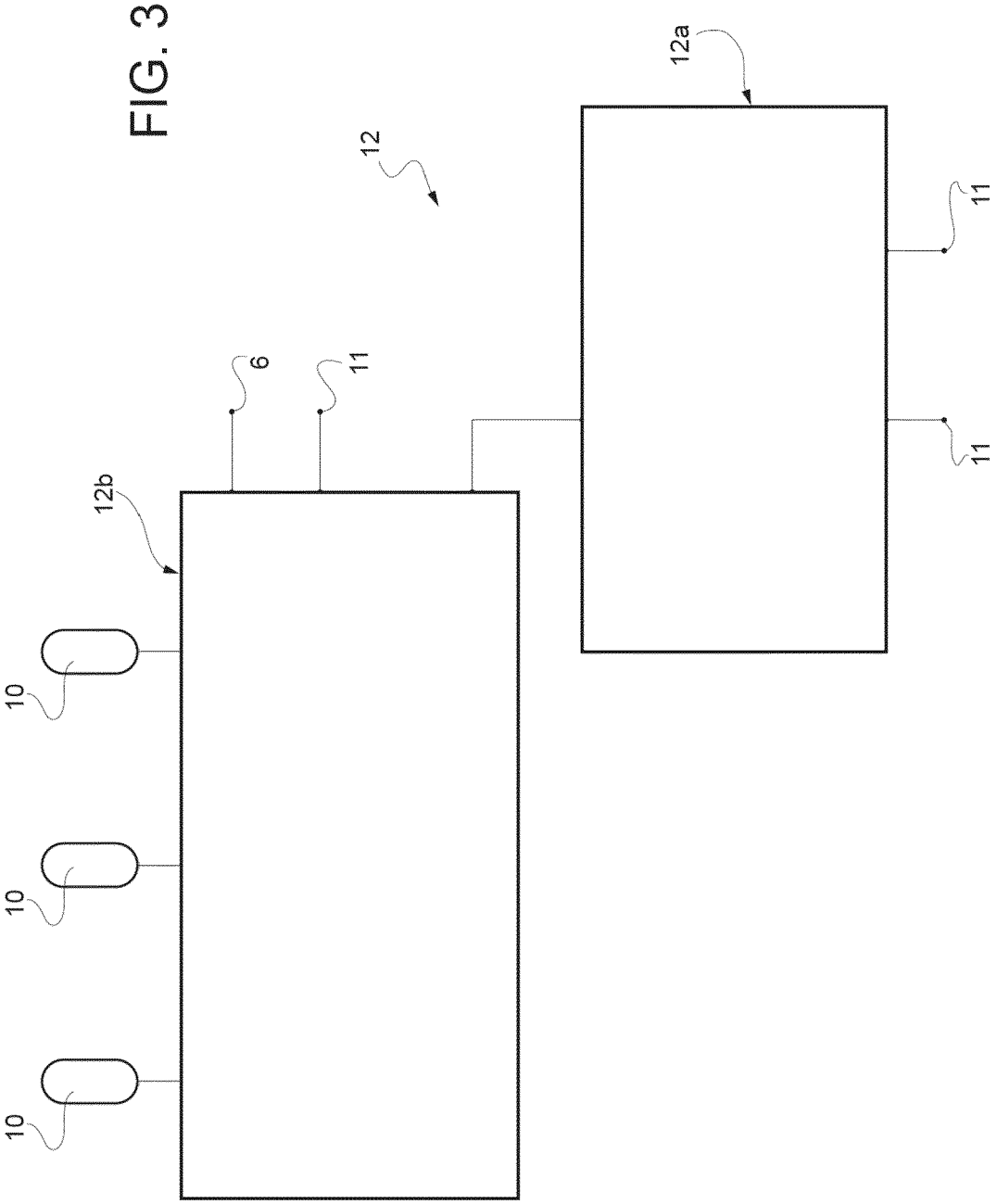


FIG. 3



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EUROPEAN SEARCH REPORT

Application Number
EP 22 17 7413

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Place of search	Date of completion of the search	Examiner
Munich	27 September 2022	Papadimitriou, S

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