

(19)



(11)

EP 3 722 516 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
14.10.2020 Bulletin 2020/42

(51) Int Cl.:
E02F 9/20 (2006.01)
E02F 9/08 (2006.01)
E02F 9/22 (2006.01)

(21) Application number: **20168398.4**

(22) Date of filing: **07.04.2020**

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
 GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
 PL PT RO RS SE SI SK SM TR**
 Designated Extension States:
BA ME
 Designated Validation States:
KH MA MD TN

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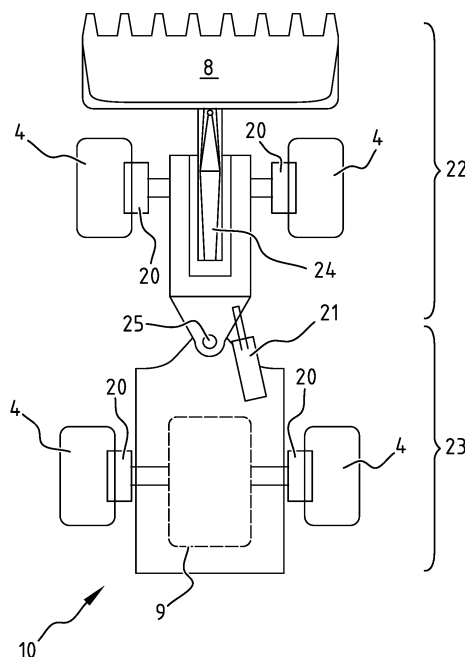
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(30) Priority: **11.04.2019 BE 201905237**

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(54) DRIVE SYSTEM FOR A WORK VEHICLE

(57) Drive system for a work vehicle (10) with at least two driven wheels (4) and at least one hydraulic actuator (21, 7, 26), wherein the drive system comprises a first electric motor (1A) which is mechanically coupled to a first hydraulic pump (2) for the purpose of driving the at least two wheels (4), and wherein the drive system comprises a second electric motor (1B) which is mechanically coupled to a second hydraulic pump (5) for the purpose of driving the at least one hydraulic actuator, wherein the first hydraulic pump is a two-way pump which is connected directly to two-way rotors at the wheels so that a rotation of the two-way pump is proportionally transmitted to the wheels, and wherein the first electric motor is provided with a controller for controlling the electric motor on the basis of a first input which relates to a desired displacement of the work vehicle.

**FIG. 3****EP 3 722 516 A1**

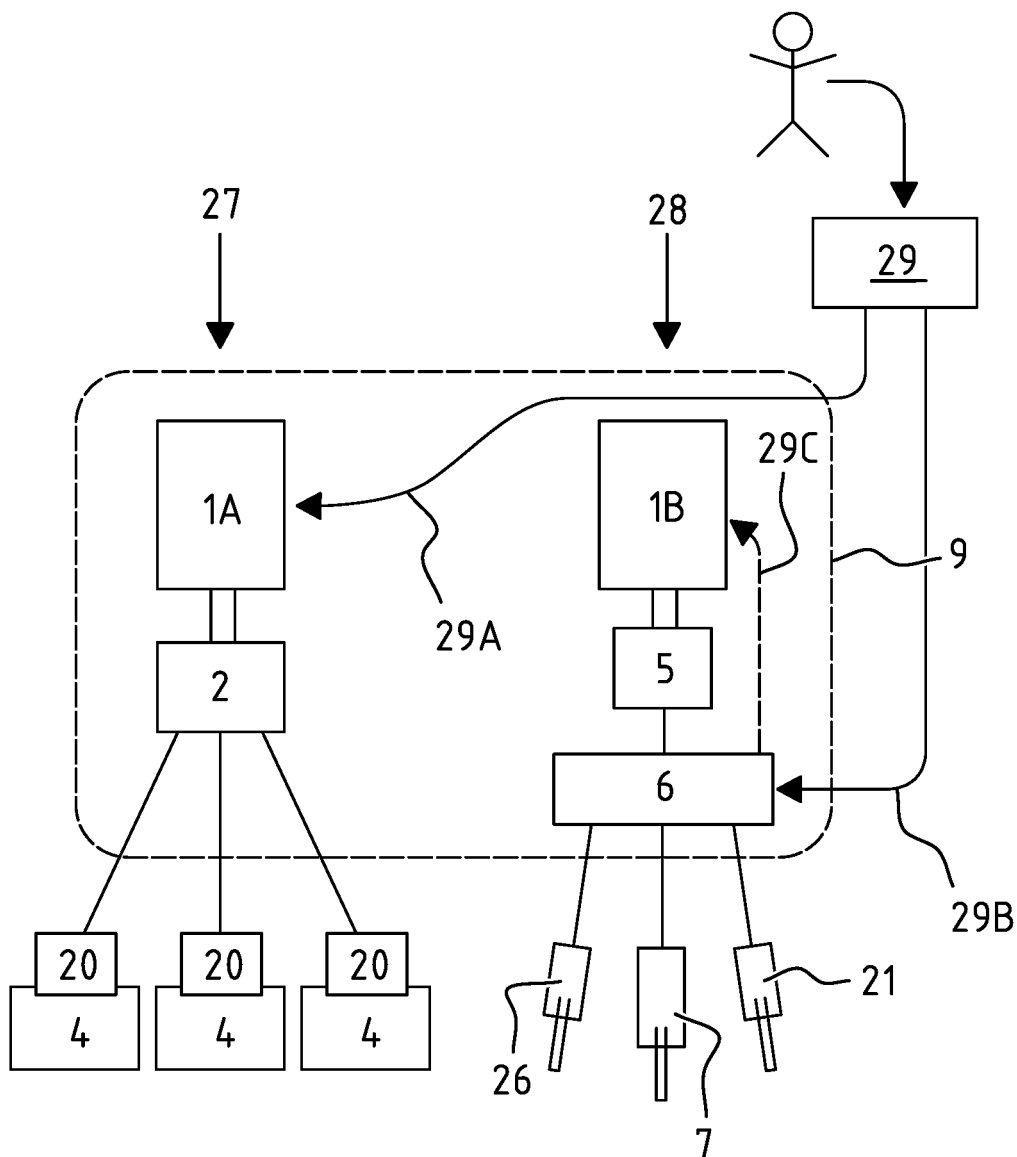


FIG. 4

Description

[0001] The present invention relates to a drive system for a work vehicle with at least two driven wheels and at least one hydraulic cylinder.

[0002] The invention relates particularly to hydraulic work vehicles, preferably compact hydraulic work vehicles, wherein the wheels are driven by means of hydraulic motors and at least one operating component is driven by a hydraulic actuator. An example of such a hydraulic work vehicle is an excavator with a bucket, a small crane, a forklift truck or other work vehicle. The hydraulic work vehicle is particularly an articulated loader. An articulated loader is a work vehicle with a rear segment and a front segment which are pivotable relative to each other round an upright shaft. The wheels in the rear segment are here connected substantially fixedly to this rear segment, and the wheels in the front segment are connected substantially fixedly to this front segment. Steering the work vehicle to the left and to the right is primarily realized by pivoting the front part relative to the rear part of the vehicle.

[0003] Such work vehicles typically have a drive system with a combustion engine. The combustion engine has an output shaft which is mechanically coupled to one or more hydraulic pumps. These hydraulic pumps produce oil pressure whereby hydraulic actuators, both rotors and cylinders, can be operated. For the purpose of operating the rotors and cylinders a hydraulic control system with controlled valves, pressure controllers and so on is provided. Such a hydraulic control system is also referred to as the hydraulic control mechanism and can be very complex and expensive. In a known control the input from the user, with which the user indicates desired movements of the various components and elements of the work vehicle, is converted by the hydraulic control means into movements of respective hydraulic actuators. The hydraulic pump is here provided to control the hydraulic power, while the hydraulic pump receives power from the combustion engine.

[0004] As is the case with commercial vehicles, in respect of work vehicles there is also commercial demand for electrically driven units. EP 2 444 555 describes a hydraulic system which is driven by two electric motors. The first electric motor supplies here energy for a primary group of actuators, and a second electric motor supplies energy for a secondary group of actuators. A drawback of this construction is that it is sub-optimal for smaller hydraulic work vehicles, more specifically for articulated loaders.

[0005] It is an object of the invention to provide a drive system for a work vehicle which can be given a compact construction and can be controlled in simple manner.

[0006] The invention provides for this purpose a drive system for a work vehicle with at least two driven wheels and at least one hydraulic actuator, wherein the drive system comprises a first electric motor which is mechanically coupled to a first hydraulic pump for the purpose

of driving the at least two wheels, and wherein the drive system comprises a second electric motor which is mechanically coupled to a second hydraulic pump for the purpose of driving the at least one hydraulic actuator, wherein the first hydraulic pump is a two-way pump which is connected directly to hydraulic two-way rotors at the wheels so that a rotation of the two-way pump is proportionally transmitted to the wheels, and wherein the first electric motor is provided with a controller for controlling the electric motor on the basis of a first input which relates to a desired displacement of the work vehicle.

[0007] The invention is based on the insight that the torque map of an electric motor is fundamentally different from the torque map of a combustion engine, which allows an electric motor to be used fundamentally differently in a hydraulic system than a combustion engine. In the drive system according to the invention a distinction is made between advancing the vehicle on the one hand and operating hydraulic actuators on the other. It will be apparent to the skilled person here that at least one hydraulic actuator, which is described as such in the claims, is a different actuator than the actuators that drive the wheels. This will be apparent from the context and structure of the claims. In other words, the drive system for the work vehicle according to the invention is divided into two drive lines.

[0008] A first drive line serves to drive the wheels for the purpose of advancing the work vehicle. A second drive line serves to operate the at least one hydraulic actuator. Because the drive lines are disconnected from each other, the first electric motor, which is provided in the first drive line, in particular can be used fundamentally differently than the second electric motor, which is provided in the second drive line. More specifically, the first electric motor will be coupled to a two-way pump. This two-way pump is directly connected to hydraulic two-way rotors at the wheels. The skilled person will appreciate that a rotation of the pump can hereby be converted directly into a proportional rotation of the rotors at the wheels. Owing to this construction, the complex hydraulic control mechanism, which is typically provided between the pump and the rotors at the wheels, can be substantially wholly dispensed with. This is because this specific construction allows a rotation of the electric motor to be transmitted directly to the wheels. This is possible because the electric motor which is coupled to the first hydraulic pump can supply a maximum torque from standstill. This is a feature which is known in electric motors and which can be optimally utilized in this context.

[0009] A direct mechanical coupling between the electric motor and the first hydraulic two-way pump allows the pump to be driven in two directions via the first electric motor. The skilled person will appreciate that the combination of direct coupling between the first electric motor and the two-way pump, and the direct connection between the two-way rotors and the pump, allows a rotation of the electric motor to be directly transmitted to the wheels. This construction allows the controlling of the

drive of the wheels to be done by directly controlling the drive of the electric motor. Electric motors can be controlled well and cheaply and reliably, whereby this has been found to be an optimal solution. The controller necessary for controlling the electric motor has been found to be more compact and notably cheaper than a similar hydraulic control mechanism for controlling the drive of the wheels.

[0010] The second drive line comprises a second electric motor with a second hydraulic pump, which supplies oil pressure for at least one hydraulic actuator. The control of the second drive line can here be constructed in a more traditional manner. This means that an input by the user will primarily be processed by hydraulic control means in order to realize a movement in the relevant hydraulic actuator. This will influence the oil pressure, which is compensated by the second hydraulic pump. The second hydraulic pump can here control the second electric motor.

[0011] Tests have shown that providing one electric motor for driving the wheels, which one electric motor is coupled via a two-way pump to hydraulic rotors at the wheels, is cheaper and more reliable than providing each wheel with one electric motor. Hydraulic rotors have been found better able to withstand the rough operating conditions in which a work vehicle operates. Hydraulic rotors are further more compact than electric motors of comparable power. Hydraulic rotors can be provided with known techniques in a robust and reliable manner for the purpose of driving the wheels.

[0012] The first electric motor and the first hydraulic pump preferably form a first drive line which is primarily controlled by the electric motor on the basis of a first input. The input comes from a user and relates to a desired displacement of the vehicle. This first input is supplied to the first electric motor. Owing to the construction of the first drive line, rotation of the first electric motor will directly result in a corresponding displacement of the work vehicle. This allows a simple control and provides for a reliable system.

[0013] The first input preferably comprises a displacement speed and a displacement direction, and the controller preferably comprises a function for determining a rotation speed and a rotation direction of the electric motors on the basis of the displacement speed and the displacement direction. The work vehicle can be moved forward or rearward, and a user can determine the desired speed of the vehicle. The speed can be determined in absolute terms or can be determined in relative terms in that a predetermined acceleration is requested over a predetermined time. This input of the displacement speed and the displacement direction can be directly converted by a controller into a rotation speed and rotation direction of the electric motor. Because the electric motor is coupled directly, via the hydraulic two-way pump, to the hydraulic two-way rotors at the wheels, the rotation speed and rotation direction of the electric motor will directly cause a corresponding displacement speed and

displacement direction of the work vehicle. This can be implemented in a function, preferably a mathematical function, typically a linear function, by the controller.

[0014] Hydraulic control means are preferably provided between the second hydraulic pump and the at least one hydraulic actuator for the purpose of controlling the at least one hydraulic actuator on the basis of a second input which relates to a desired movement of the at least one hydraulic actuator. The second drive line comprises hydraulic control means between the second hydraulic pump and the at least one hydraulic actuator. Hydraulic control means provided for the control of the hydraulic actuator on the basis of an input from the user, referred to here as the second input.

[0015] The second hydraulic pump is preferably operatively coupled to the second electric motor for the purpose of controlling it. The second hydraulic pump requests an operation from the second electric motor to request the required energy. Other than in the first drive line, where the electric motor is driven by a controller on the basis of the first input, in the second drive line the electric motor will be controlled by the hydraulic pump. In other words, in the first drive line the electric motor determines the movements and pressures in the first drive line, while in the second drive line the hydraulic control means together with the pump determine the pressures and movement in the second drive line. In the second drive line the electric motor receives control signals from its load and is thereby a slave (master-slave) to its load. In the first drive line the first electric motor is controlled by the controller on the basis of the first input, and no noticeable feedback is provided from the load, being the first hydraulic pump and the hydraulic two-way rotors at the wheels, to the first electric motor. This means that the first electric motor is a master to its load.

[0016] The first hydraulic pump is preferably of the displacement type, such that an input rotation supplied by the motor is converted into a proportional amount of displaced oil. When the first hydraulic pump is of the displacement type, a substantially linear ratio can be determined between the rotation of the electric motor on the one hand and the oil which is displaced by the first hydraulic pump on the other. This allows a simple control of displacement of the work vehicle by controlling the first electric motor. The first hydraulic pump is and/or the rotors are preferably provided here in order to set a variable flow rate. By variably setting a flow rate the above stated linear ratio can be set and/or changed during use.

[0017] Each driven wheel preferably comprises a wheel slip sensor which is operatively coupled to a valve between the first hydraulic pump and the two-way rotor of the respective wheel, so that slip can be minimized by operating the valve. The skilled person will appreciate that under normal operating conditions the valves have no noticeable influence on the speed and direction and movement of the vehicle, and are intended only to intervene when wheel slip occurs. The valve forms a mechanism for reducing the power that is supplied to the wheel

when this power cannot be transmitted to a ground surface. In vehicles this is known as traction control in acceleration and anti-lock braking system (ABS) in deceleration. The skilled person will appreciate that the valve between the hydraulic pump and the two-way rotor is typically fully open such that the valve does not influence the operation of the drive, until wheel slip is detected, after which valves can be operated on the basis of rules and/or algorithms in order to compensate for and minimize the wheel slip.

[0018] The at least one hydraulic cylinder preferably comprises a steering cylinder which controls an angle of at least a front wheel relative to at least a rear wheel. The work vehicle can be steered left-right via the steering cylinder. By providing a left-right steering via the steering cylinder all wheels can be connected in parallel to a hydraulic two-way pump. This is because steering is realized primarily by the position of the steering cylinder and not by rotation differences between left-hand and right-hand wheels.

[0019] A desired forward displacement preferably corresponds with a rotation of the first electric motor in a first rotation direction, while a desired rearward displacement corresponds with a rotation of the first electric motor in a second rotation direction, which is opposite to the first rotation direction. A desired speed further preferably corresponds with a rotation speed of the first electric motor. As described above, the direct coupling of the electric motor via the hydraulic pump and hydraulic rotors to the wheels of the vehicle allows the speed and direction of movement of the vehicle to be controlled by a corresponding speed and rotation direction of the first electric motor.

[0020] At least one battery is preferably provided for the purpose of supplying power to the first electric motor and to the second electric motor. The at least one battery can be a high-tension battery or can be a different battery or combination of batteries as known in the prior art.

[0021] The second hydraulic pump is preferably operatively connected to a hydraulic circuit which forms the direct connection between the two-way pump and the hydraulic two-way rotors and is provided to supply a predetermined operating pressure to the hydraulic circuit. When the first hydraulic pump is directly connected to the rotors and can drive them in two directions, an external element is provided in order to supply an operating pressure in the hydraulic circuit extending between the first hydraulic pump and the rotors. This operating pressure is preferably supplied by the second hydraulic pump. The hydraulic control means in the second drive line more preferably comprises a mechanism and coupling to the hydraulic circuit for the purpose of supplying a predetermined operating pressure. Alternatively, an accumulator is provided in the hydraulic circuit in order to supply an operating pressure.

[0022] The invention further relates to a hydraulic work vehicle with a drive system according to the invention. The first and second electric motor and the first and sec-

ond hydraulic pump are preferably provided in a motor compartment, and the hydraulic pumps are preferably operatively connected via hydraulic conduits to the at least one hydraulic actuator and the two-way rotors. This construction allows a hydraulic work vehicle to be given a modular construction in the sense that the end customer is able to choose between driving by a combustion engine or by the drive system according to the invention. In both drive systems the hydraulic actuators are connected via hydraulic conduits to two-way rotors at the wheels from the motor compartment. This construction is therefore significantly advantageous in the production and marketing of the hydraulic work vehicles.

[0023] The invention will now be further described with reference to an exemplary embodiment shown in the drawing.

[0024] In the drawing:

figure 1 shows a hydraulic work vehicle according to the prior art;

figure 2 shows a hydraulic work vehicle according to an embodiment of the invention;

figure 3 shows a top view of a hydraulic vehicle according to a further embodiment of the invention; and
figure 4 shows a working diagram of a drive according to an embodiment of the invention.

[0025] The same or similar elements are designated in the drawing with the same reference numerals.

[0026] Figure 1 shows a vehicle in which a combustion engine 11 is coupled via a shaft to a hydraulic pump 12. Hydraulic pump 12 provides hydraulics for driving of wheels 4, for advancement of the vehicle, and for driving of systems 17, for operation of the vehicle.

[0027] Hydraulic pump 12 is connected via hydraulic control means 13 to wheels 14. Pump 12 supplies a pressure while control means 13 determine the flow rate and the flow direction to wheels 14. Hydraulic actuators, particularly rotors (not shown in figure 1), are provided at the position of wheels 14.

[0028] Hydraulic pump 12 is further connected via hydraulic control means 16 to the actuators 17, only one cylinder of which is shown by way of example. Pump 12 supplies a pressure while control means 16 determine the flow rate and the flow direction to actuators 17. This construction allows a prior art vehicle to move and operate. More specifically, wheels 14 can be rotated in a rotation direction and at a speed requested by a user. This rotation direction and speed are provided by control means 13. Hydraulic operating elements 17 can also be operated by a user, wherein control means 16 control operating elements 17 on the basis of a user input.

[0029] Figure 2 shows an embodiment of the invention for driving a similar vehicle using an electric motor. The final stage of the drive is similar to the traditional construction. In particular, the wheels are still driven hydraulically and the actuators are still driven hydraulically. Tests have shown that this is optimal.

[0030] Two electric motors 1A and 2A are provided in the drive according to the invention. First electric motor 1A is here connected mechanically to the first hydraulic pump 2. First hydraulic pump 2 can take the form of a single pump or a double pump. When the first hydraulic pump takes a single form, all driven wheels will be connected to the one pump. When the first hydraulic pump takes a double form, half of the driven wheels will be connected to the one and the other half of the driven wheels to the other of the double pump. The first hydraulic pump 2 is a two-way pump, preferably of the displacement type. This means that the pump is mechanically driveable in a first direction in order to move the oil in a first direction and that the pump is mechanically driveable in a second direction in order to move the oil in a second direction. Because an electric motor can be driven in two rotation directions in simple manner and can develop a maximum torque from standstill, first hydraulic pump 2 is coupled directly to the rotors at wheels 4. In principle, a control mechanism similar to prior art control mechanism 13 is no longer necessary here. This is a great advantage in practice.

[0031] A valve (not shown) can optionally be provided between first hydraulic pump 2 and each of the rotors at the wheels 4. In normal operation this valve will be fully open and thus have no influence on the driving of wheels 4. When wheel slip is detected, the valve can be activated in order to reduce the power to the slipping wheel and thus minimize or compensate for the slip. Even when such a valve is placed between the rotors at wheels 4 and the first hydraulic pump 2, the rotors will still be deemed directly connected to the pump, because the valve has no direct influence on the operation under normal conditions. In order to reduce the chance of wheel slip a plurality of rotors can be placed hydraulically in series.

[0032] In order to provide independent operation of the hydraulic actuators, one cylinder 7 of which is shown, a second electric motor 1B is provided, which is coupled to the second hydraulic pump 5. Second hydraulic pump 5 can take the form of a single or double pump. This pump 5 is connected via control means 6 to cylinders 7 in conventional manner. Control means 6 are similar to known control means 16 for controlling cylinder 7, which is similar to operating elements 17.

[0033] This construction of the invention as shown in figure 2 is a simplification relative to the existing construction as shown in figure 1 because the control means 13, which are complex and expensive, are unnecessary. The robustness and flexibility during operation however remain high. It has also been found that controlling of the wheels can be realized in simple manner by controlling first electric motor 1A.

[0034] In the invention two electric motors 1A and 1B are provided in a work vehicle 10, wherein the first electric motor 1A serves to drive the wheels 4 via a hydraulic two-way pump 2. Hydraulic control systems are here unnecessary in the drive because rotation of the first electric

motor 1A is transmitted directly via hydraulic pump 2 to the rotors at wheels 4.

[0035] Shown in both figure 1 and figure 2 is a motor compartment 9. Constructing vehicle 10 with a motor compartment 9 has the advantage that a drive according to the invention can be replaced with a traditional drive, and vice versa. This is because hydraulic conduits depart from motor compartment 9 both to the rotors at wheels 4, 14 and to the hydraulic operating elements 7, 17.

[0036] Figure 2 further shows an operative connection 19 between the second drive line and the first drive line. More specifically, the hydraulic control means 6 are connected to the hydraulic circuit extending between the first hydraulic pump 2 and the rotors at wheels 4. With this connection an operating pressure can be supplied by second hydraulic pump 5 to the hydraulic circuit. This connection further allows oil in the hydraulic circuit to be changed and/or flushed and/or cleaned. Cooling of oil can further be provided for via operative connection 19.

[0037] Figure 3 shows a top view of a preferred embodiment of the invention. Figure 3 shows particularly a top view of the work vehicle which is highly suitable for application of the drive according to the invention. The work vehicle of figure 3 has a front segment 22 and a rear segment 23 which can pivot relative to each other round and upright pivot point 25. A work vehicle with such a construction is also referred to as an articulated vehicle or, when a loading shovel or a bucket 8 is provided, an articulated loader. In an articulated vehicle or articulated loader the wheels 4 of front segment 22 are connected fixedly to the chassis of that segment. The wheels 4 in rear segment 23 are connected fixedly to the chassis of that segment. Rotation of the vehicle takes place primarily by pivoting the segments 22 and 23 relative to each other round shaft 25. A steering cylinder 21 is typically provided for this purpose. The advantage of such a construction is that the wheel speed of the different wheels remains substantially the same. This is different when all wheels are provided fixedly on the same rigid chassis, wherein the right-hand wheels are forcibly driven faster than the left-hand wheels or vice versa in order to force turning of the vehicle. The invention can preferably be applied in all types of vehicle wherein turning of the vehicle is done by a steering mechanism or steering cylinder and not by forcibly driving determined wheels faster/more slowly. Such constructions are known to the skilled person and are therefore not elucidated further in this description.

[0038] The top view of figure 3 shows how each of the wheels 4 has a rotor 20. This rotor 20 is a two-way rotor and drives wheels 4. Each two-way rotor 20 is in liquid connection with motor compartment 9 via hydraulic conduits. Figure 3 further also shows the bucket cylinder 24 used to tilt bucket 8.

[0039] Figure 4 shows in principle how the drive according to the invention is constructed and can be controlled. Figure 4 illustrates here that the drive has a first drive line 27 and a second drive line 28. First drive line

27 comprises first electric motor 1A, first hydraulic two-way pump 2 and the two-way rotors 20 that drive wheels 4. Only three wheels 4 are shown in figure 4. It will be apparent to the skilled person that embodiments can be envisaged wherein front segment 22 or rear segment 23, as shown in figure 3, is provided with only one centrally positioned wheel 4. In first drive line 27 the hydraulic operating pressure is primarily supplied by an element other than the first hydraulic pump 2. First hydraulic pump 2 primarily controls the flow speed and flow direction of the oil in first drive line 27. The hydraulic operating pressure in first drive line 27 is primarily controlled by an actuator or by coupling with second drive line 28 (not shown in figure 4). It will be apparent to the skilled person that first hydraulic pump 2 does provide pressure in first drive line 27, particularly when rotors 20 produce counterpressure.

[0040] Second drive line 28 comprises the second electric motor 1B which is mechanically coupled to the second hydraulic pump 5. Second hydraulic pump 5 is coupled to the hydraulic control means 6 which drive the hydraulic operating elements 21, 7, 26. Figure 4 shows steering cylinder 21, shows hydraulic cylinder 7 for moving the arm with the bucket 8 up and downward, and further shows a hydraulic cylinder 26. The further hydraulic cylinder 26 can for instance be used for providing a clamp at the front end of the vehicle for the purpose of clamping goods. Alternatively or additionally, the further hydraulic cylinder 26 can be used to tilt bucket 8. It will be apparent to the skilled person that further hydraulic actuators can be provided. In second drive line 28 the second hydraulic pump 5 will primarily supply the operating pressure. The flow speed and flow direction of the oil in second drive line 28 is primarily controlled by control means 6.

[0041] Figure 4 illustrates how a user can operate the vehicle. Provided for this purpose is user input 29 which sends control signals 29A, 29B to the different components of the vehicle. When the user requests a displacement of the vehicle, control signals 29A will be sent to first electric motor 1A. First electric motor 1A is driven in a direction which corresponds directly to the requested displacement. Owing to the direct mechanical coupling between first electric motor 1A, hydraulic pump 2 and rotors 20, a rotation of electric motor 1A is transmitted directly to wheels 4. The control signals of user interface 29, which relate to the forward movement of the vehicle, will therefore be sent to first electric motor 1A in the first drive line 27.

[0042] When a user requests an operation from a hydraulic operating element 7, 21, 26 via user input 29, control signals 29 are primarily sent to the hydraulic control means 6. Hydraulic control means 6 operate the hydraulic operating elements and can initiate and control the movement requested by the user. Because hydraulic control means 6 require power for this purpose, typically in the form of oil pressure, control means 6 will control the second electric motor 1B directly or indirectly. Control means 6 can control the second electric motor 1B directly

when intelligence is provided in the control means 6 for determining the necessary power, and by controlling the rotation speed of the second electric motor on the basis of the necessary power. Alternatively, control means 6 will use oil, whereby the oil pressure changes, which is sensed by the second hydraulic pump 5. Second hydraulic pump 5 can request an operation from second electric motor 1B when more or less power is necessary. Both options are shown schematically in the figure with arrow 29C.

[0043] In master-slave terms, the first electric motor will be the master in first drive line 27, while the hydraulic pump and rotors 20 are slaves. In second drive line 28 the hydraulic control means 6 will be the master and the second hydraulic pump 5 and second electric motor 1B will be slaves. The two drive lines are thereby controlled in different ways. This has been found to significantly simplify the drive according to the invention.

[0044] The skilled person will appreciate on the basis of the above description that the invention can be embodied in different ways and on the basis of different principles. The invention is not limited here to the above described embodiments. The above described embodiments and the figures are purely illustrative and serve only to increase understanding of the invention. The invention is not therefore limited to the embodiments described herein, but is defined in the claims.

Claims

1. Drive system for a work vehicle with at least two driven wheels and at least one hydraulic actuator, wherein the drive system comprises a first electric motor which is mechanically coupled to a first hydraulic pump for the purpose of driving the at least two wheels, and wherein the drive system comprises a second electric motor which is mechanically coupled to a second hydraulic pump for the purpose of driving the at least one hydraulic actuator, wherein the first hydraulic pump is a two-way pump which is connected directly to hydraulic two-way rotors at the wheels so that a rotation of the two-way pump is proportionally transmitted to the wheels, and wherein the first electric motor is provided with a controller for controlling the electric motor on the basis of a first input which relates to a desired displacement of the work vehicle.
2. Drive system according to the foregoing claim, wherein the first electric motor and the first hydraulic pump form a first drive line which is primarily controlled by the electric motor on the basis of the first input.
3. Drive system according to any one of the foregoing claims, wherein the first input comprises a displacement speed and a displacement direction, and

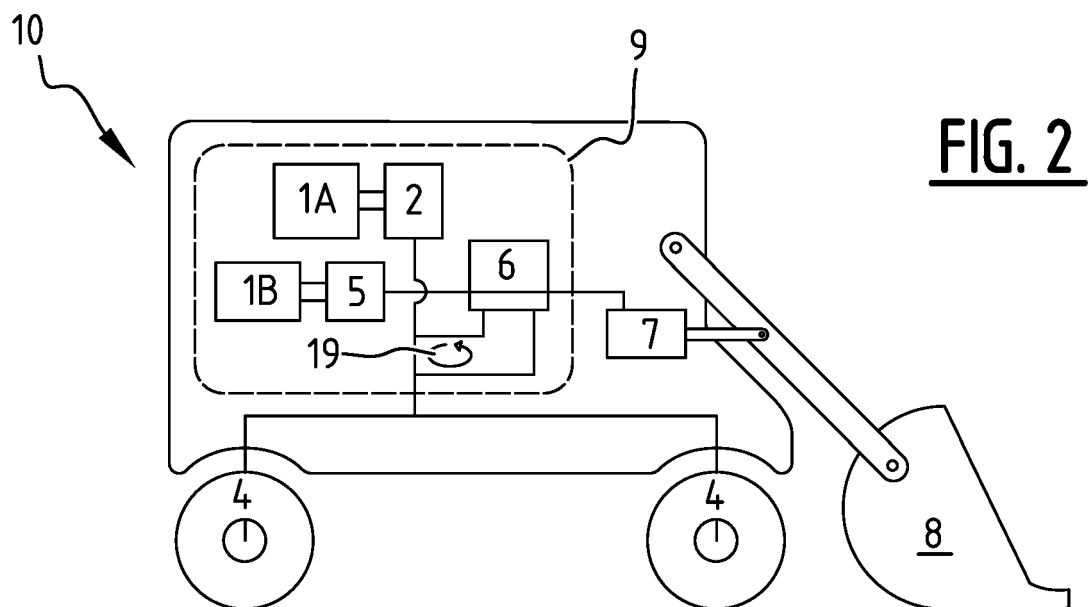
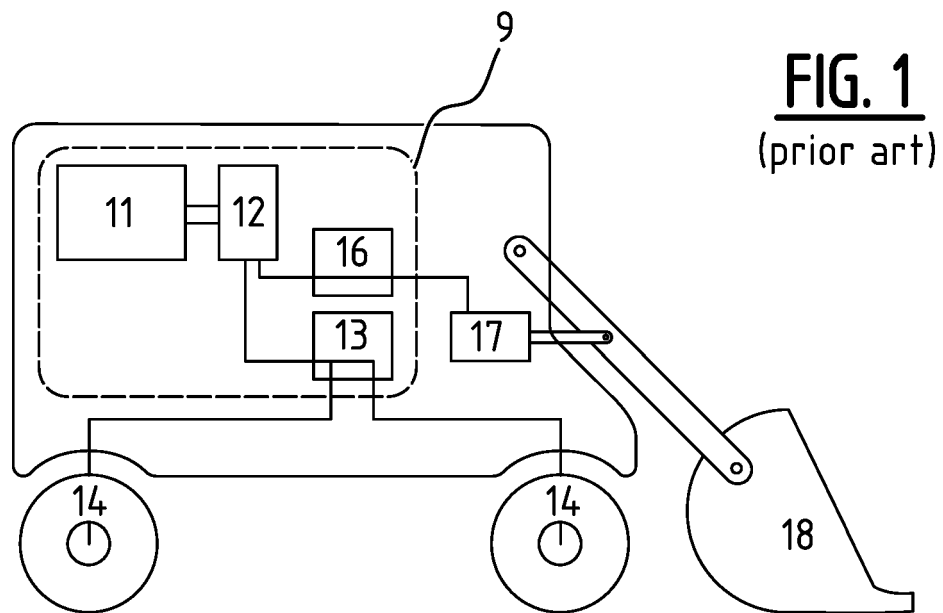
wherein the controller comprises a mathematical function for determining a rotation speed and a rotation direction of the electric motor on the basis of the displacement speed and the displacement direction.

4. Drive system according to any one of the foregoing claims, wherein hydraulic control means are provided between the second hydraulic pump and the at least one hydraulic actuator for the purpose of controlling the at least one hydraulic actuator on the basis of a second input which relates to a desired movement of the at least one hydraulic actuator. 5
5. Drive system according to the foregoing claim, wherein the second electric motor, the second hydraulic pump and the hydraulic control means form a second drive line which is primarily controlled by the hydraulic control means on the basis of the second input. 10
6. Drive system according to any one of the foregoing claims, wherein the second hydraulic pump is operatively coupled to the second electric motor for the purpose of controlling it. 15
7. Drive system according to any one of the foregoing claims, wherein the first hydraulic pump is of the displacement type, such that an input rotation supplied by the motor is converted into a proportional amount of displaced oil. 20
8. Drive system according to any one of the foregoing claims, wherein each driven wheel comprises a wheel slip sensor which is operatively coupled to a valve between the first hydraulic pump and the two-way rotor of the respective wheel, so that slip can be minimized by operating the valve. 25
9. Drive system according to any one of the foregoing claims, wherein the at least one hydraulic actuator comprises a steering cylinder which controls an angle of at least one front wheel relative to at least one rear wheel. 30
10. Drive system according to any one of the foregoing claims, wherein a desired forward displacement preferably corresponds with a rotation of the first electric motor in a first rotation direction, while a desired rearward displacement corresponds with a rotation of the first electric motor in a second rotation direction, which is opposite to the first rotation direction. 35
11. Drive system according to any one of the foregoing claims, wherein at least one battery is further provided for the purpose of supplying power to the first electric motor and to the second electric motor. 40

12. Drive system according to any one of the foregoing claims, wherein the second hydraulic pump is operatively connected to a hydraulic circuit which forms the direct connection between the two-way pump and the hydraulic two-way rotors and is provided to supply a predetermined operating pressure to the hydraulic circuit. 45

13. Hydraulic work vehicle with a drive system according to any one of the foregoing claims. 50

14. Hydraulic work vehicle according to the foregoing claim, wherein the first and second electric motor and the first and second hydraulic pump are provided in a motor compartment, and wherein the hydraulic pumps are operatively connected via hydraulic conduits to the at least one hydraulic actuator and to the two-way rotors. 55



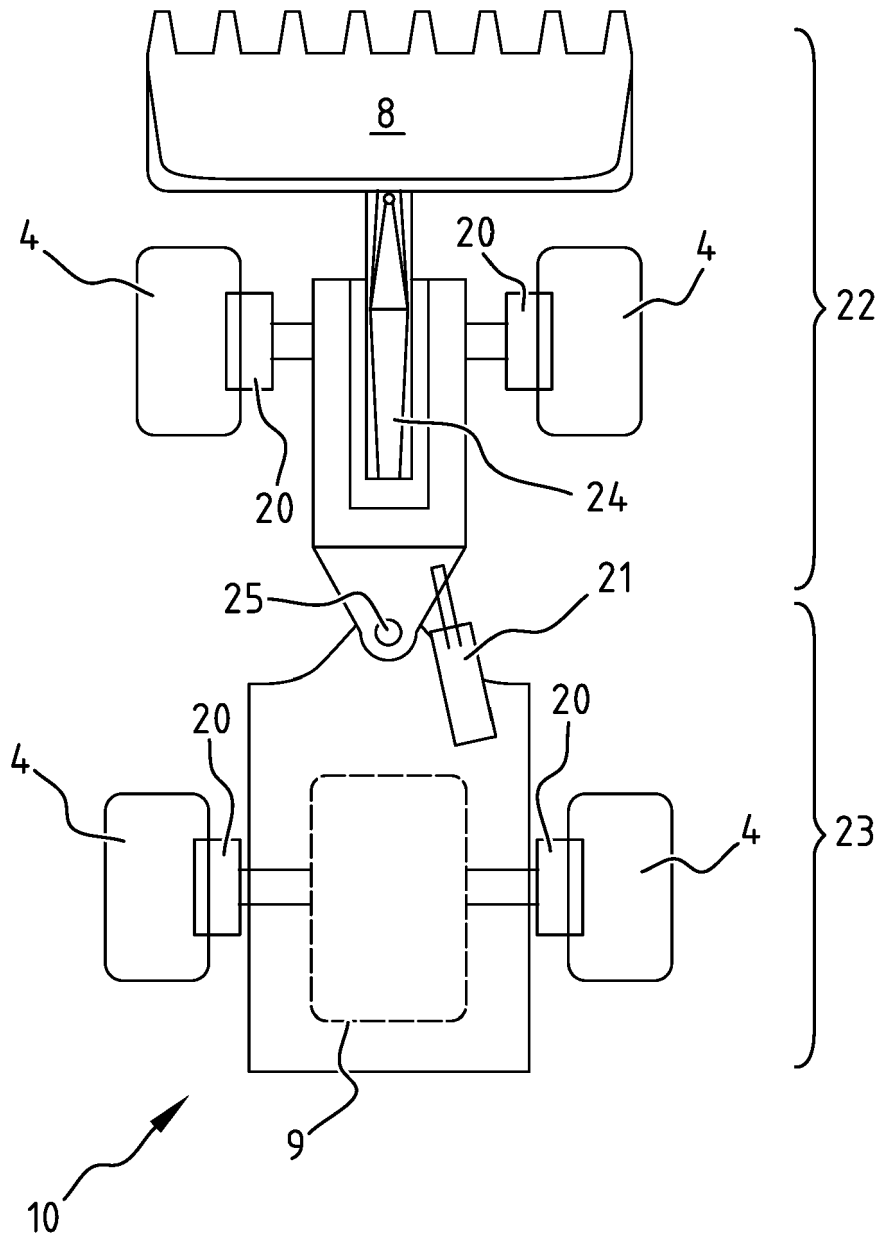


FIG. 3

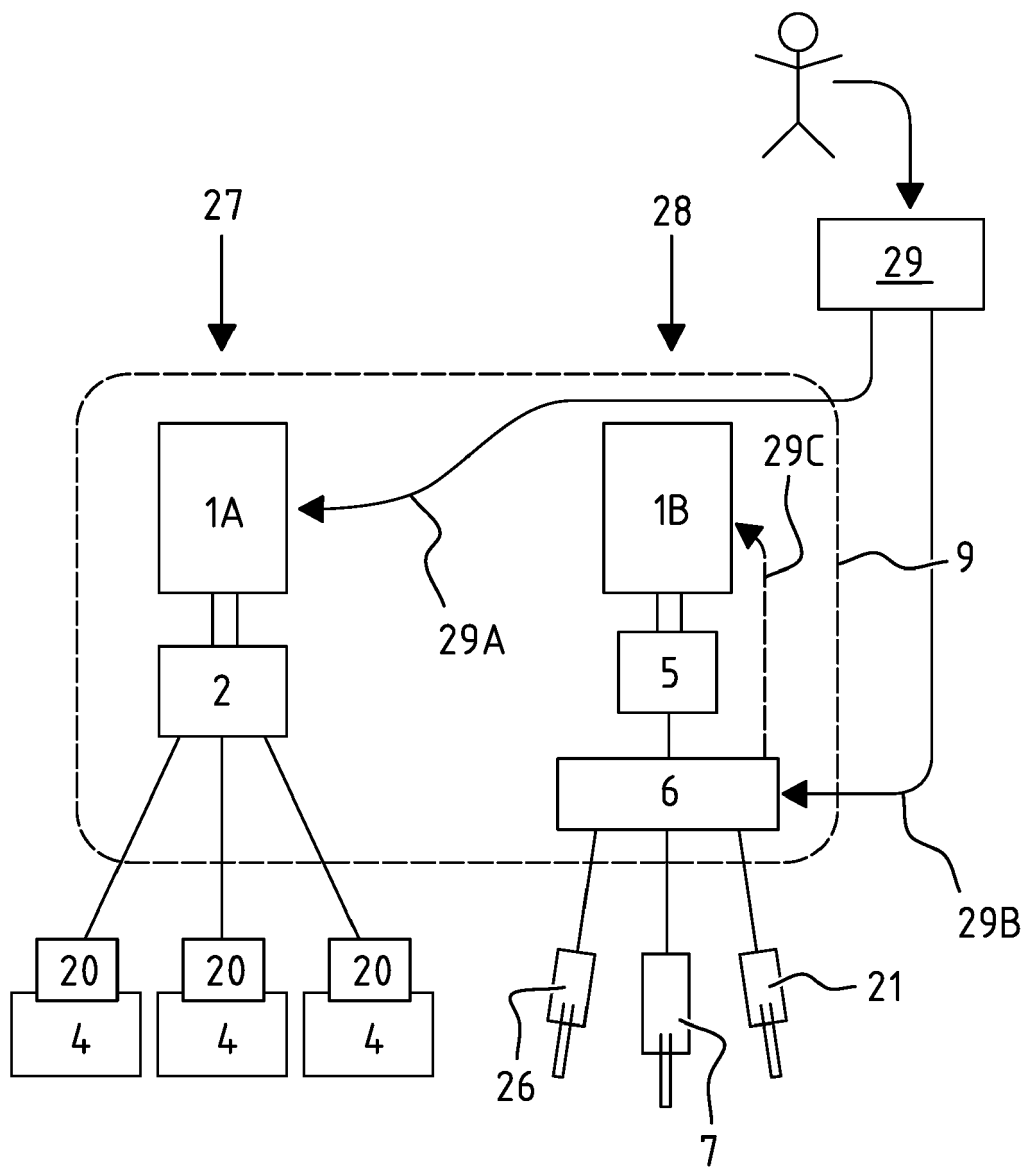


FIG. 4



EUROPEAN SEARCH REPORT

Application Number
EP 20 16 8398

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2013/312399 A1 (HIRAKU KENJI [JP] ET AL) 28 November 2013 (2013-11-28)	1-7, 10-14	INV. E02F9/20 E02F9/22 E02F9/08
Y	* figures 1-4 * * paragraph [0046] * * paragraph [0047] * * paragraph [0092] *	8	
Y	JP 2008 215504 A (HITACHI CONSTRUCTION MACHINERY) 18 September 2008 (2008-09-18) * figures 1, 2 *	1-10,13	
Y	US 2007/166168 A1 (VIGHOLM BO [SE] ET AL) 19 July 2007 (2007-07-19) * figure 1 and 7 * * paragraph [0110] * * paragraph [0111] *	1-10,13	
Y	US 2015/233094 A1 (MAIYUR SUDARSHAN ARAVAMUTHAN [US]) 20 August 2015 (2015-08-20) * figure 3 * * paragraph [0027] * * paragraph [0028] * * paragraph [0032] * * paragraph [0033] *	8	TECHNICAL FIELDS SEARCHED (IPC) E02F
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 13 July 2020	Examiner Bultot, Coralie
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document 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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