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54 **a hydraulic system for a vehicle, a vehicle transmission, and method for operating a vehicle transmission**

57 A hydraulic system for a vehicle transmission with at least two friction elements, the system comprising a first hydraulic circuit comprising a pump for supplying hydraulic fluid to the first hydraulic circuit. A flow restriction may be provided in the first hydraulic circuit between an output of the pump and a sump for providing leakage of hydraulic fluid into the sump. Further, a second hydraulic circuit comprising a second pump may be arranged, wherein the hydraulic pressure in the first circuit is higher compared to the second circuit. A flow control element operated using hydraulic pressure from the first circuit may be arranged for controlling flow/pressure in the second circuit. Further, the hydraulic system may be arranged for generating a line pressure, wherein an actuator for engaging a park lock system may be connected to the first hydraulic circuit for enabling direct actuation by means of the line pressure.

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Title: a hydraulic system for a vehicle, a vehicle transmission, and method for operating a vehicle transmission

5 FIELD OF THE INVENTION

The invention relates to a vehicle transmission and a hydraulic system for a vehicle transmission. The vehicle transmission comprises at least two friction elements. The invention further relates to methods for controlling and/or operating a hydraulic system of a vehicle transmission. Further, the invention relates to a method for generating a line pressure in a vehicle transmission, a method for cooling and/or lubricating friction elements of a vehicle transmission, a method for actuating hydraulic actuators, and a method for operating a park lock system of a vehicle transmission.

15 BACKGROUND TO THE INVENTION

A transmission enables a controlled application of engine power by conversion of speed and torque from a power source, such as for example an electric engine, internal combustion engine, a hybrid engine, etc. A hydraulic system of a vehicle transmission may provide for actuation of friction elements in the transmission for coupling the transmission input to a geartrain so as to transmit engine power to the wheels of the vehicle. For example a clutch module in an automatic transmission system can comprise two friction clutches for coupling the engine via the geartrain to the wheels by actuation of these clutches via said hydraulic system. In a variant one or more clutches can be made by using a powersplit mechanism with three rotational members where one member is connected to the input, one member is connected to the output and the third member can be connected to the transmission housing by means of actuation of a friction brake. Multiple configurations of these friction elements (clutch, brake) can be made resulting in various layouts of multi-friction transmissions. A transmission system of this type is known from e.g. US2013184119.

The brake and/or clutch elements can generate a considerable heat and the hydraulic system may also provide cooling fluid to each of the clutches and/or brakes of the transmission.

In a transmission system the friction element can be a wet clutch, which may be oil cooled. Typically, the electrohydraulic control of the transmission provides significant improved efficiency and performance, while maintaining the full shift comfort of traditional step automatics. A precise and fast control of the friction elements can be made possible by direct acting solenoids, which are electromechanically operated valves.

Fundamentally, a clutch of the transmission system can be of the wet clutch or the dry clutch design. A wet clutch design is preferably used for higher torque applications, whereas the dry clutch design is generally suited for smaller torque applications. Although the dry clutch variants of a transmission system may be limited in torque generation, compared to their wet clutch counterparts, the dry clutch variants may offer an improved fuel efficiency, mainly due to the cooling and lubrication. The wet clutch requires pumping transmission fluid in the clutch housing, which may results in losses. Therefore, additionally, the cooling system in a multiple friction transmission may play an important role for the overall efficiency of the transmission.

A layout of a transmission system with more than one friction element can be considered to be equivalent to having more than one transmissions in one housing which can be shifted and coupled independently, i.e. one power transmission assembly on each of the two input shafts together driving one output shaft, to enable uninterrupted gear shifting transmission in an automatic transmission form, while keeping high mechanical efficiency compared to a manual transmission.

Hence, an automated transmission with a plurality of friction elements using a wet clutch arrangements can be actuated and/or cooled/lubricated by means of a hydraulic system. Typically a higher pressure needs to be employed for actuation of friction elements than for lubrication/cooling of transmission elements. However, a higher flow is typically required for lubrication/cooling of transmission elements than for actuation of friction elements. Hence, from an efficiency point of view hydraulic separation of the two functions is advantageous for efficiency.

The system of US2004074732A1 comprises two electrically driven pumps. A hydraulic pump, actuated by an electric motor, provides lubrication via a first hydraulic line to transmission components at a possibly low pressure. A

second hydraulic pump, actuated by a second electric motor, provides oil to a second hydraulic line feeding pressure control valves at a higher pressure compared to the first hydraulic line. The second hydraulic line comprises additionally a hydraulic fluid accumulator, allowing the second electric pump to  
5 operate in a duty cycle according to the state of charge of the fluid accumulator.

Such a system requires the pump to drive at a pressure considerably higher than the required actuation pressure when in a state of charging the hydraulic fluid accumulator, having a possibly negative effect on the needed power output of the electric motor. An additional pressure sensor is needed to monitor the  
10 state of charge of the accumulator. The high pressure in the second hydraulic line furthermore introduces an increased level of leakage in the system, compromising efficiency.

In the hydraulic system of WO2016058735A1, low pressure lubrication flow is provided by a first hydraulic pump, driven by a first electric motor. A second  
15 hydraulic pump with a second electric motor provides directly pressurized fluid to a clutch arrangement via a hydraulic line by means of electric motor speed control and a predictable leakage flow from the hydraulic line via a leakage point. A negative speed is required from the hydraulic pump to fully release the friction element in dynamic conditions by drawing fluid from the piston of the friction  
20 element. In such a configuration, each additional friction element requiring pressurized fluid for actuation will require an additional hydraulic pump and electric motor. The necessity of reversing the hydraulic pump rotation direction on the actuation channels require the leakage point to be submerged in fluid under all conditions to avoid the hydraulic pump drawing air when operating in a negative  
25 speed. The hydraulic fluid from the leakage point hence has to be directed in a fluid sump and cannot be used for active lubrication to a transmission element.

So, there is a need for a hydraulic system for a multiple friction transmission that addresses at least one of the above mentioned drawbacks while maintaining the advantages.

### 30 SUMMARY OF THE INVENTION

It is an object of the invention to provide for a method and a system that obviates at least one of the above mentioned drawbacks.

It is an object of the invention to provide a system and a method that improves the efficiency of the hydraulic system of the transmission.

It is a further object of the invention to provide a system and method resulting in generally lower pressures and less leakage.

5 It is a further object of the invention to provide for a method and a system for reducing drag losses of friction elements in a transmission.

There to, according to a first aspect, is provided a hydraulic system for a vehicle transmission. The transmission includes two or more friction elements. The hydraulic system comprises a first hydraulic circuit which is arranged for actuating  
10 the two or more friction elements (e.g. pressurized oil exerts a force on the friction elements via a piston), and a first electric driven pump which is arranged for supplying hydraulic fluid to the first hydraulic circuit. Further, the hydraulic system comprises a flow restriction provided in the first hydraulic circuit between  
15 an output of the first electric driven pump and a reservoir to provide leakage of hydraulic fluid into the reservoir. In this way, a pressure relief can be obtained by providing a leakage. The leakage can be constant. The flow restriction can provide for a pressure drop over a flow restriction for controlling and/or regulating the hydraulic pressure in the first hydraulic circuit. In this way, control of the hydraulic pressure in the first circuit can be simplified. Advantageously, in this  
20 way, the rotational speed of the electric driven pump can be used for controlling the hydraulic pressure in the first circuit. In an example, the leaked flow can be further used for lubricating and/or cooling transmission parts.

Optionally, the flow restriction has a fixed geometry. Optionally, the flow restriction is an orifice. In an example, a fixed orifice is employed. An orifice  
25 can be used for providing a constant leakage. The flow from the flow restriction can be directed through a pressure filter which may optionally have a overpressure bypass valve.

Optionally, the reservoir is a sump.

Optionally, the hydraulic system further includes a second hydraulic  
30 circuit arranged for lubricating and/or cooling the two or more friction elements, and a second electric pump arranged for supplying hydraulic fluid to the second hydraulic circuit. The first electric pump is arranged for delivering a higher pressure than the second electric pump. Further, the hydraulic system includes a

flow control element arranged for controlling flow and/or pressure in the second hydraulic circuit. The flow control element is operated using hydraulic pressure from the first hydraulic circuit.

5 In this way, two electrically driven hydraulic pumps operating at an improved pressure range can be obtained. The regulated pressure can be chosen more optimally according to the demand from the friction element(s), since no hydraulic fluid accumulator or pressure relief valve is required in the pressure circuit. This may result in lower pressures and leakages. By leaving out an accumulator and means for sensing a hydraulic accumulator state of charge, a  
10 more cost-effective solution can be obtained.

Optionally, the flow control element comprises a proportional pressure valve. The proportional pressure valve can be configured to draw supply pressure from the first hydraulic circuit. The use of a proportional pressure valve being  
15 arranged for drawing fluid from the first hydraulic circuit instead of from the second hydraulic circuit reduced the requirement for high pressure in the second hydraulic circuit.

Hydraulic pressure from the first hydraulic circuit can be used for providing a pressure regulator with pressurized fluid by means of the proportional pressure valve, wherein the proportional pressure valve is arranged for controlling  
20 a directional valve of the flow control element. In an example, the directional valve is arranged for controlling flow in the second hydraulic circuit to one or more lubrication circuits. By drawing the pressurized hydraulic fluid for the pressure regulator obtained by means of the proportional pressure valve of the flow control element, from the first hydraulic circuit, the pressure in the second hydraulic  
25 circuit can be configured to operate at a lower value. This is beneficial for the efficiency of the hydraulic system, especially when the pressure of the second hydraulic circuit can be lowered and/or minimized.

Optionally, the directional valve of the flow control element is arranged for dividing the flow to one or more lubrication circuits. Further, by controlling the  
30 speed of the second hydraulic pump, the total supplied flow can be controlled, such that the magnitude of the flow provided to each friction element to be lubricated can be controlled. This concept making a cooling strategy possible to minimize drag

losses on friction elements while assuring thermal protection of the friction elements by means of fully proportional, independent flow control.

The pressure obtained by means of the first electric pump may be substantially higher than the pressure obtained by the second electric pump. For example, the pressure obtained by means of the first electric pump may be 1.5-25  
5 times higher than the pressure obtained by the second electric pump, preferably 3-10, more preferably 5-7. For example, actuation pressure may be in the range of 10-20 bar, and lubrication pressure in the range of 2-3 bar.

Optionally, the second hydraulic circuit is, alternatively or additionally,  
10 arranged to lubricate and/or cool other transmission components.

According to a further aspect, is provided a hydraulic system for a vehicle transmission, the transmission including two or more friction elements and two or more hydraulic actuators, wherein the hydraulic system comprises: a first hydraulic circuit arranged for actuating the two or more hydraulic actuators; a  
15 second hydraulic circuit arranged for lubricating and/or cooling the two or more friction elements; a first electric driven pump arranged for supplying hydraulic fluid to the first hydraulic circuit; a second electric driven pump arranged for supplying hydraulic fluid to the second hydraulic circuit, wherein the first electric driven pump is arranged for delivering a higher pressure than the second electric  
20 driven pump; and a flow control element arranged for controlling flow and/or pressure in the second hydraulic circuit, wherein the flow control element is operated using hydraulic pressure from the first hydraulic circuit.

Optionally, the first hydraulic circuit is arranged for actuating friction elements, a park lock, synchronizers, and the like. In an example, the first  
25 hydraulic circuit may also be arranged for actuating pistons. Optionally, additionally or alternatively, the second hydraulic circuit is arranged for lubricating and/or cooling other transmission components.

Optionally, the first electric driven pump is arranged for delivering a substantially higher pressure than the second electric driven pump. In this way, a  
30 higher hydraulic pressure can be obtained in the first hydraulic circuit than in the second hydraulic circuit.

Optionally, the flow control element is arranged for controlling flow distribution. For this purpose, the flow control element may further comprise a

directional valve. In an example, the flow control element comprises a proportional pressure valve and a directional valve, wherein the input of the proportional valve is connected with the first hydraulic circuit and the output of the proportional valve provides a pilot pressure to the directional valve.

5                   Optionally, the first hydraulic circuit includes a flow restriction for determining a pressure in the first hydraulic circuit upstream of the flow restriction. The flow restriction can be provided between an output of the first electric driven pump and a reservoir to provide leakage of hydraulic fluid into the reservoir, such as a sump. In an example, a constant leakage is provided. By  
10                   arranging a flow restriction in the first hydraulic circuit, a pressure drop is obtained for controlling the pressure in the first hydraulic circuit provided by the first electric driven pump. This may simplify the design of the hydraulic system of the transmission, while a good controllability of the pressure in the first hydraulic circuit can be obtained. The pressure in the first hydraulic circuit can be better  
15                   controlled by controlling the speed of the first electric driven pump.

                    Optionally, hydraulic fluid flowing through the flow restriction can at least partly be used for active lubrication of transmission components.

                    Optionally, the flow restriction has a fixed geometry. Advantageously, the rotational speed of the first electric driven pump can easily regulate pressure  
20                   obtained in the first hydraulic circuit. The pressure in the first hydraulic circuit can form line pressure for the hydraulics of the transmission system. Thus the first hydraulic circuit can be arranged for generating the line pressure. Optionally, the first hydraulic circuit includes at least two control elements arranged for actuating the two or more friction elements, wherein the control elements are operated using  
25                   hydraulic pressure from the first hydraulic circuit. Optionally, such control element comprises a proportional valve and/or a solenoid valve. Further, the line pressure can be controlled and/or regulated by means of the pump. The pressure provided to the one or more actuators can be controlled or regulated by means of the control  
30                   elements, e.g. proportional pressure valves.

30                   Optionally, the hydraulic system further includes a controller arranged for controlling hydraulic pressure in the first hydraulic circuit by controlling flow of hydraulic fluid through the flow restriction.

Optionally, the controller is arranged for controlling a speed of the first electric driven pump.

Optionally, the first hydraulic circuit is free from a hydraulic fluid accumulator. In this way, the hydraulic system can be simplified. Also the efficiency and/or reliability of the hydraulic system can be improved in this way.

Optionally, the first hydraulic circuit is free from a pressure relief valve arranged for setting the hydraulic pressure in the first hydraulic circuit. Instead, the flow restriction, e.g. having the fixed geometry, in the first hydraulic circuit is used for setting the hydraulic pressure in conjunction with the first pump.

Optionally, the controller is arranged for rotating the first electric driven pump in one direction only.

Optionally, the flow control element and/or the at least two control elements include(s) an electric control input. Said elements may include solenoid valves. Other electric hydraulic valves are also possible.

Optionally, one of the two or more hydraulic actuators is arranged for actuating a park lock system. The hydraulic actuator can be hydraulically connected to the first hydraulic circuit for direct actuation of the hydraulic actuator using the line pressure.

According to a further aspect, is provided a hydraulic system for a vehicle transmission, comprising: a first hydraulic circuit arranged for generating a line pressure; and a hydraulic actuator arranged for engaging a park lock system, wherein the hydraulic actuator is hydraulically connected to the first hydraulic circuit for direct actuation of the hydraulic actuator using the line pressure. The vehicle transmission can include two or more friction elements.

Optionally, the hydraulic actuator is arranged for bringing or maintaining the park lock system in a park position when the line pressure is below a predetermined pressure threshold. Alternatively or additionally, the hydraulic actuator is configured for bringing or maintaining the park lock system in a park position in case of no availability of electricity. Such embodiments may be particularly advantageous in view of safety norms.

Optionally, a locking element is connected to the hydraulic actuator configured for at least one of the two purposes:

- in order to keep a park lock unarmed when the line pressure accidentally drops (e.g. by a TCU reset) below a predetermined threshold and to keep the park lock unarmed for the purpose of safety.

5           - in order to keep the park lock armed when the line pressure accidentally increases above a predetermined threshold and to keep the park lock armed for the purpose of safety.

Optionally, the locking element is an electro-mechanical actuator (e.g. electrical solenoid). Optionally, the locking element is normally open, so in case  
10 there is no electricity available, the locking element will not lock the hydraulic actuator and the park lock will still get in an armed position in such case.

Optionally, there is an electronic control element for actuating the locking element. Optionally, this electronic control element (e.g. relay) is normally closed, so when there is an interruption of electricity for this control element due to  
15 a TCU (Transmission Control Unit) reset the control element still provides electricity to the locking element and it will keep locking the hydraulic actuator. When there is no availability of electricity (power failure) then there is no electricity to go through the control element and also no electricity for the locking element and the park-lock will be automatically armed.

20           Optionally there is an arming spring which exerts a force on the hydraulic actuator . Without hydraulic pressure the arming spring will move the intermediate body to move a cone which engages a park pawl. In case the park pawl cannot be engaged (tooth-to-tooth with the park gear), the engage spring is preloaded which is pushing to the cone. As soon as the vehicle starts rolling the  
25 park can be engaged by the cone engaging the park pawl. The arming spring is stronger than the engage spring.

The park is released by applying pressure to the piston, moving the intermediate body in the opposite direction, moving the cone away from the park pawl, where the park pawl is released from the park gear by a third spring.

30           The state of the intermediate body can be locked by the locking element assuring a state of release (non-park) or armed (park) independent of the current state of hydraulic pressure.

Optionally, the first hydraulic circuit includes a valve arranged for draining the hydraulic actuator when the line pressure is below a predetermined pressure threshold. Optionally, the valve is provided between the hydraulic actuator and the first pump. Optionally, the valve is arranged to drain the hydraulic actuator to a reservoir, such as a sump, when the line pressure is below the predetermined pressure threshold. Optionally, this is additionally or alternatively performed in case of no availability of electricity. A check valve may be arranged for allowing the pilot pressure to drop on actuating side of valve.

Optionally, the hydraulic actuator is arranged for bringing or maintaining the park lock system in a non-park position when the line pressure is below a predetermined pressure threshold and/or in case of no availability of electricity.

Optionally, the hydraulic actuator includes an actuator arranged for maintaining the park lock system in a park position or non-park position according to a last input of an operator of the hydraulic system when the line pressure is below a predetermined pressure threshold and/or in case of no availability of electricity. Optionally, the actuator is an (electro)mechanical actuator.

Optionally, the hydraulic system includes a non-return valve between the first hydraulic pump and the hydraulic actuator of the park lock system. Advantageously, this enables that the system can be set in park mode faster.

According to a further aspect is provided a vehicle transmission including the hydraulic system.

Optionally, the vehicle transmission includes mechanical means for bringing the park lock system from a park position to a non-park position when the line pressure is below a predetermined pressure threshold. Additionally or alternatively, the mechanical means can be used to bring the park lock system from a park position to a non-park position in case no electricity is available. This allows to revert the vehicle transmission to a non-park position, e.g. in case of an emergency.

According to an aspect is provided a park lock override system. Especially in the event the park lock is default engaged in case of absence of hydraulic pressure and/or electric power, there may be a need for an override

system, e.g. for allowing movement of a vehicle in the absence of hydraulic pressure and/or electric power, such as during towing or maintenance.

The park lock override system can use a separate override actuator. The separate override actuator can be arranged to maintain the park lock in an unengaged position. The park lock override system can be arranged to be switched to override using a control unit of the vehicle. This can e.g. provide the advantage that the override cannot be activated without user control of the control unit. Hence, e.g. theft or unsafe situations may be avoided. The park lock override system can be arranged to be switched out of override, i.e. back to normal behaviour, using the control unit of the vehicle. This can e.g. provide the advantage that the override cannot be deactivated without user control of the control unit. Hence, e.g. unsafe situations may be avoided. Optionally, the park lock override system is arranged for maintaining the park lock in override, i.e. maintaining the park lock unengaged, without power consumption. Hence, the park lock can be maintained in override for prolonged periods of time, e.g. during towing, without draining vehicle power.

According to an aspect is provided a vehicle transmission, for instance including a hydraulic system as described herein, comprising a park lock system arranged to engage park lock when line pressure is below a predetermined threshold and/or electric power is off, and an override means for overriding the park lock system such that the park lock system can be selectively disengaged in case line pressure is below a predetermined threshold and/or electric power is off.

Optionally, the override means is arranged to be switched out of override; bringing the park lock system back from a unengaged position to normal behavior.

Optionally, the override means uses a separate override actuator. Optionally, the override means and the park lock system use one and the same actuator for maintaining the park lock system in a park position or non-park position and for overriding the park lock system.

Optionally, the override means include retaining means for mechanically preventing releasing of the override means upon deactivating of the override means.

Optionally, the override system is arranged to maintain the park lock in a non-park position. Optionally, the override system is arranged to maintain the park lock in a non-park position without using an electric power.

5      Optionally, the override system is arranged to be switched to override using a control unit of the vehicle.

    According to a further aspect, is provided a method for generating a line pressure in a vehicle transmission. The vehicle transmission includes a first hydraulic circuit arranged for actuating two or more friction elements. The method includes supplying hydraulic fluid to the first hydraulic circuit using a first pump; and using a flow restriction provided in the first hydraulic circuit between an output of the first pump and a reservoir, such as a sump, to provide leakage of hydraulic fluid into the reservoir for generating the line pressure.

15      Optionally, the pump is an electrically driven pump. Optionally, the flow restriction is a fixed geometry flow restriction.

    Optionally, the method further includes controlling the line pressure by controlling a flow speed of the first pump.

    Optionally, the method further includes controlling two or more actuators associated with the two or more friction elements using at least two control elements which are operated using the line pressure. A control element may be a proportional valve and/or a solenoid valve.

20      Optionally, the method further includes cooling and/or lubricating the friction elements, using a second hydraulic circuit having a second pump associated therewith, by controlling flow and/or pressure in the second hydraulic circuit using a flow control element, wherein the flow control element is operated using the line pressure. The second pump may be an electric driven pump. Optionally the flow distribution and/or pressure in the second hydraulic circuit is controlled.

    According to a further aspect, is provided a method for cooling and/or lubricating friction elements of a vehicle transmission, the vehicle transmission including a first hydraulic circuit arranged for actuating two or more hydraulic actuators associated with two or more friction elements, a second hydraulic circuit arranged for lubricating and/or cooling the two or more friction elements and/or other transmission components, a first electric pump arranged for supplying hydraulic fluid to the first hydraulic circuit, and a second electric driven pump

arranged for supplying hydraulic fluid to the second hydraulic circuit, wherein the first electric pump is arranged for delivering a higher pressure than the second electric pump, the method including cooling and/or lubricating the friction elements by controlling flow (and/or flow distribution) and/or pressure in the second hydraulic circuit using a flow control element, wherein the flow control element is operated using hydraulic pressure from the first hydraulic circuit.

Optionally, the first electric pump is arranged for delivering a substantially higher pressure than the second electric pump.

According to a further aspect, is provided a method for actuating hydraulic actuators associated with two or more friction elements of a vehicle transmission using a first hydraulic circuit, the method including supplying hydraulic fluid to the first hydraulic circuit using a first electric driven pump; and controlling pressure of the first hydraulic circuit by providing a flow restriction in the first hydraulic circuit between the first electric pump and a reservoir to provide leakage of hydraulic fluid into the reservoir and controlling a speed of the first electric driven pump.

Optionally, the method further includes releasing a park lock system using a hydraulic actuator hydraulically connected to the first hydraulic circuit, and directly actuating the hydraulic actuator using the line pressure.

The invention further relates to a method for operating a park lock system of a vehicle transmission, including: generating, using a first hydraulic circuit, a line pressure; and releasing a park lock system using a hydraulic actuator hydraulically connected to the first hydraulic circuit, and directly actuating the hydraulic actuator using the line pressure.

It will be appreciated that any one or more of the above aspects, features and options described in view of the methods apply equally to the vehicle and the transmission system. It will also be clear that any one or more of the above aspects, features and options can be combined.

### BRIEF DESCRIPTION OF THE DRAWING

The invention will further be elucidated on the basis of exemplary embodiments which are represented in a drawing. The exemplary embodiments are given by way of non-limitative illustration. It is noted that the figures are only

schematic representations of embodiments of the invention that are given by way of non-limiting example.

In the drawing:

5 Fig. 1 shows a schematic diagram of an embodiment of a hydraulic transmission system;

Fig. 2 shows a schematic diagram of an embodiment of a hydraulic transmission system;

Fig. 3 shows a schematic diagram of an embodiment of a hydraulic transmission system;

10 Fig. 4 shows a schematic diagram of an embodiment of a hydraulic transmission system;

Fig. 5 shows a schematic diagram of an embodiment of a hydraulic transmission system;

15 Fig. 6 shows a schematic diagram of an embodiment of a hydraulic transmission system;

Fig. 7 shows a schematic diagram of an embodiment of a hydraulic transmission system;

Fig. 8 shows a schematic diagram of an embodiment of a park lock system;

20 Fig. 9 shows a schematic diagram of an embodiment of a park lock system;

Fig. 10 shows a schematic diagram of an embodiment of a hydraulic transmission system;

25 Fig. 11 shows a block diagram for a method for generating a line pressure in a vehicle transmission;

Fig. 12 shows a block diagram for cooling and/or lubricating friction elements of a vehicle transmission;

Fig. 13 shows a block diagram for actuating hydraulic actuators; and

30 Fig. 14 shows a block diagram for operating a park lock system of a vehicle transmission;

Fig. 15 shows a schematic diagram of a first embodiment of a park lock system comprising an override function;

Fig. 16 shows a schematic diagram of a second embodiment of a park lock system comprising an override function;

Fig. 17 shows a schematic diagram of a third embodiment of a park lock system comprising an override function;

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#### DETAILED DESCRIPTION

Fig. 1 shows a schematic diagram of an embodiment of a hydraulic transmission system 1 according to the present invention. The hydraulic transmission system 1 is arranged for use with a vehicle transmission including two or more friction elements, such as for example a clutch element and a brake element. The system 1 comprises a first hydraulic circuit 2 which is arranged for actuating the two or more friction elements of the transmission. The system 1 further comprises a first electric driven pump 4 arranged for supplying hydraulic fluid to the first hydraulic circuit 2. The system 1 also comprises a flow restriction 6 provided in the first hydraulic circuit 2 between an output of the first electric driven pump 4 and a reservoir 8, here a sump, to provide leakage of hydraulic fluid into the reservoir 8.

The first electric driven pump 4 may be a pressure pump which is arranged to supply pressurized hydraulic fluid to first hydraulic circuit 2 via a pressure pump outlet line. In the embodiment of fig. 1, two hydraulic lines for actuation of clutch elements, i.e. a first clutch actuation line 10a and a second clutch actuation line 10b, are each connected with the first hydraulic circuit 2 with control elements 12a, 12b arranged therebetween. In this example the control elements 12a, 12b are solenoid valves 12a, 12b. Advantageously, direct acting solenoid valves 12a, 12b are arranged in the hydraulic system 1. In this example each of the one or more hydraulic actuation lines 10a, 10b of the hydraulic system 1 is connected to a respective friction element, such as a clutch. The friction elements of the transmission may be arranged in a clutch pack or in any other arrangement within the transmission 16, connected to the hydraulic system 1 by means of the first clutch actuation line 10a and the second clutch actuation line 10b. Other arrangements with other friction elements are also possible. For example, more friction elements may be employed. Also, instead of a clutch, a brake may also be used as a friction element of the transmission. The pressure pump 4 can be driven

by an electric motor 4a. The electric motor 4a may also be integrated with the pump, such that the electric driven pump 4 comprises the electric motor 4a. Such unitary arrangement allows a more compact and robust means for providing pressurized hydraulic fluid to the first hydraulic circuit 2. Furthermore, an inlet of the pump 4 is connected to the reservoir 8. A filter 14 may be arranged in the hydraulic system 1 for filtering the fluid entering the pump 4. In some cases such a filter is not necessary.

In an exemplary embodiment, the flow restriction 6 is formed by an orifice 6. Such an orifice 6 may provide a constant leakage. For example, a fixed orifice 6 may be employed. The flow from the flow restriction 6 can optionally be directed through a pressure filter 16 which may optionally have a overpressure bypass valve 18.

In the embodiment of fig. 1, the direct acting solenoid valves 12a, 12b (control elements) arranged respectively in the wet friction element actuation lines 10a, 10b are normally closed directional control valves. The control valves 12a, 12b in this example are proportional valves. The valves 12a, 12b may have a finite number or infinite number of positions from closed to open. The solenoid valves can be electromechanically operated by an electrical current. The control elements 12a, 12b, or the direct acting solenoid valves 12a, 12b, are spring biased to the first position, wherein the valve is closed. Said direct acting solenoid valves 12a, 12b can be switched to the second position, or open position, when the solenoid is energized. Other types of control elements, e.g. valves, can also be employed for connecting the first hydraulic circuit 2 with the first and second friction element actuation lines 10a and 10b.

Fig. 2 shows a schematic diagram of an embodiment of a hydraulic system 1 of a transmission system, the hydraulic system further including a second hydraulic circuit 20 arranged for lubricating and/or cooling the two or more friction elements of the transmission system 1, and/or other transmission components (not shown). A second electric pump 22 is arranged for supplying hydraulic fluid to the second hydraulic circuit 20. Here, the first electric pump 4 is arranged to deliver a (substantially) higher pressure than the second electric pump 22. Further, a flow control element 24 is arranged for controlling flow and/or pressure in the second hydraulic circuit 20. The flow control element 24 comprises a pressure regulator 26

and a directional valve 28, wherein the pressure regulator 26 is arranged to provide a pilot pressure for operating the directional valve 28. In this exemplary embodiment, the directional valve 28 has three ports and three positions. In a first position, lubricating and/or cooling is only provided to the first friction element (e.g. first clutch element) of the transmission via a first cooling/lubricating line 30a. In a second position, lubricating and/or cooling is provided to the first and second friction element (e.g. first and second clutch element) of the transmission via a first cooling/lubricating line 30a and a second cooling/lubricating line 30b. In a third position lubricating and/or cooling is provided only to the second friction element (e.g. second clutch element) of the transmission via the second cooling/lubricating line 30b. More positions are possible. In this example the directional valve 28 is a proportional valve, such that distribution of the flow of hydraulic fluid into the first and second cooling/lubricating lines 30a, 30b can be regulated in a finite number of steps/positions (discretely) or infinite number of steps/positions (continuously). In this way more flow can be guided to one of the two cooling/lubricating lines, for example a flow distribution of 10/90, 20/80, 30/70, 40/60, 50/50, 60/40, etc. to the first/second cooling lubricating line 30a/30b, in a discrete or continuous distribution. Hence, the directional valve 28 may be arranged to have infinite positions so as to provide a fully variable distribution of hydraulic fluid. Other cooling/lubricating lines may also be arranged for cooling/lubricating other friction elements and/or components of the transmission. The output of the second electric pump 22 is connected to the input of the directional valve 28. The output of the pump 22 also branches off to the pressure regulator 26 which provides a pilot pressure to the directional valve 28 by means of a pilot pressure line for operating the directional valve 28 (which is spring biased). The pressure regulator 26 is a solenoid valve and can be electromechanically operated by means of an electrical current. The pressure regulator 26 can be a direct acting solenoid valve which is spring biased to a first position, wherein the valve is closed. This direct acting solenoid valve 26 can be switched to the second position, or open position, when the solenoid is energized by means of an electrical current. Other types of valves may also be arranged in the hydraulic system 1 for operating the directional valve 28. In this embodiment, the flow control element 24 comprises a plurality of valves. However, it is also envisaged that the flow control element 24 is formed by other

components, such as only one valve, or a plurality of valves cooperating such as to control the flow of hydraulic fluid in the second hydraulic circuit for lubricating and/or cooling the two or more friction elements and/or other transmission components of the transmission system 1. Additionally, a filter 32 may be arranged for filtering the hydraulic fluid supplied to the inlet of the second electric pump 22. A filter 32 and filter 14 may be combined to one filter in an arrangement having optionally two outlets. The pump 22 is actuated by means of an electric motor 22a. As described earlier, the electric motor 22a of the second electrically driven pump 22 may also be integrated to form a unitary unit.

Fig. 3 shows a schematic diagram of an embodiment of a hydraulic system 1 for a vehicle transmission system. In the shown embodiment, the vehicle transmission comprises two friction elements each having a hydraulic actuator. The hydraulic system 1 comprises a first hydraulic circuit 2 which is arranged for actuating the two hydraulic actuators of the transmission, such as e.g. a friction element, a park lock, a synchronizer, etc. Further, the hydraulic system 1 comprises a second hydraulic circuit which is arranged for lubricating and/or cooling the two friction elements and/or other transmission components. Additionally, the hydraulic system 1 comprises a first electric driven pump 4 arranged for supplying hydraulic fluid to the first hydraulic circuit 2, and a second electric driven pump 22 arranged for supplying hydraulic fluid to the second hydraulic circuit 20, wherein the first electric driven pump 4 is arranged for delivering a (substantially) higher pressure than the second electric driven pump 22. The hydraulic system 1 further comprises a flow control element 24 being arranged for controlling flow and/or pressure in the second hydraulic circuit 20. The control element is operated using hydraulic pressure from the first hydraulic circuit 2.

In the exemplary embodiment of fig. 3, the flow control element 24 comprises a pressure regulator 26 formed by a proportional valve 26, and a directional valve 28. Hence, the flow control element 24 comprises two components in this embodiment, namely a proportional valve 26 and a directional valve 28. The first hydraulic circuit 2 is connected to an input of the proportional valve 26. The output of the proportional valve 26 is connected to a pilot pressure line for providing a pilot pressure the directional valve 28. The use of proportional pressure

valves drawing fluid from a hydraulic line, instead of actuating directly via a hydraulic pump by means of an electric motor, may result in a better dynamic pressure control on the friction elements of the transmission. Therefore, it is advantageous to use pressure from the first hydraulic circuit to provide a pressure regulator 26 with pressurized fluid. This pressure regulator 26 controls the directional valve 28, controlling flow in the second hydraulic circuit 20 to one or more lubrication circuits of the hydraulic system 1. In this exemplary embodiment, the hydraulic system 1 comprises a first cooling/lubricating line 30a and a second cooling/lubricating line 30b. Advantageously, by drawing the pressurized fluid for the pressure regulator 26 from the first hydraulic circuit, the pressure in the second hydraulic circuit 20 can be designed to a minimum value for efficiency. By having a directional valve 28 dividing the flow to one or more lubrication/cooling circuits 30a, 30b, and a speed controlled hydraulic pump controlling the supply flow of hydraulic fluid, the magnitude of the flow of hydraulic fluid to each friction element of the transmission can be controlled or regulated. Flow through both lubrication/cooling circuits 30a, 30b can be stopped by halting the pump 22. This concept allows a cooling strategy for the transmission for minimizing drag losses on friction elements of the transmission while thermal protection of the friction elements may be assured by means of fully proportional independent flow control in the hydraulic system 1.

Fig. 4 shows a schematic diagram of an embodiment of a hydraulic system 1 for a vehicle transmission system. The hydraulic system 1 comprises additional features with respect to the embodiment of fig. 3. In particular, the first hydraulic circuit 2 further includes a flow restriction 6 for determining a pressure in the first hydraulic circuit 2 upstream of the flow restriction, provided between an output of the first electric driven pump 4 and the reservoir 8 to provide leakage of hydraulic fluid into the reservoir. Preferably, the reservoir 8 is a sump.

Further, optionally, a sensor 34 may be arranged in the first and second friction element actuation lines 10a and 10b for measuring the pressure in said lines 10a, 10b. Advantageously, the pressure characteristics in the first pressure circuit 2 can be assessed by opening either one of the direct acting solenoid valves 12a, 12b, which are arranged in the clutch actuation line 10a, 10b, and measure the pressure with the pressure sensor 34 on each of said lines 10a, 10b. Also,

optionally, a damper 36 may be arranged in the clutch actuation lines 10a, 10b so as to increase the pressure stability in said hydraulic lines 10a, 10b. For instance, adverse pressure peaks and/or pressure fluctuations can at least partially be smoothed out by the dampers 36 in the actuation lines 10a, 10b.

5            In an advantageous embodiment, the flow restriction 6 has a fixed geometry. In this way, the speed of the first electric driven pump 4 can control or regulate the pressure in the first hydraulic circuit 2. The speed or rotational speed of the pump 4 may be an advantageous control parameter for the pressure of the first hydraulic pressure circuit. In this way, the controllability of the pressure of  
10 the hydraulic system 1 can be improved.

In an exemplary embodiment, a controller (not shown) is arranged for controlling the hydraulic pressure in the first hydraulic circuit 2 by controlling flow of the hydraulic fluid through the flow restriction 6. Optionally, the controller can be arranged for controlling a speed of the first electric driven pump 4.

15 Advantageously, the hydraulic system 1 can be arranged to be free from a hydraulic fluid accumulator. Additionally or alternatively, the first hydraulic circuit 2 is free from a pressure relief valve arranged for setting the hydraulic pressure in the first hydraulic circuit 2. Further, additionally or alternatively, the controller can be arranged for rotating the first electric driven pump 4 in one  
20 direction only.

In the shown embodiment of fig. 4, the flow control element 24 and/or the at least two control elements 12a, 12b include an electric control input.

Fig. 5 shows a schematic diagram of an embodiment of a hydraulic transmission system 1. The first hydraulic circuit 2 further includes a relief valve  
25 38 for controlling the pressure in the first hydraulic circuit 2. The pressure relief valve 38 connects the first hydraulic circuit 2 with the injection inlet of the first electric driven pump 4 of the first hydraulic circuit 2. The pressure relief valve 38 comprises a pressure biasing element, such as a spring, which is configured so that the pressure of fluid communicated to the inlet of the valve can be limited, taking  
30 into account the pressure at the inlet. Further, the pressure relief valve 38 comprises a sensing port which communicates with the hydraulic line connected to the inlet of the valve, which hydraulic line is in fluid communication with the

reservoir 8 with a filter 14 therebetween. In some cases the filter 14 may be omitted.

Fig. 6 shows a schematic diagram of an embodiment of a hydraulic system 1 for a vehicle transmission system. The flow control element 24 comprises a pressure regulator 26 and a directional valve 28, wherein the pressure regulator is arranged to provide a pilot pressure to the directional valve 28 by means of a pilot pressure line. By means of the pilot pressure, the directional valve 28 can be operated. The flow control element 24 is arranged for controlling flow (distribution) and/or pressure in the second hydraulic circuit 20. The control element 24 is operated using hydraulic pressure from the first hydraulic circuit 2, wherein the pressure regulator is connected to the first hydraulic circuit 2. In this embodiment, the directional valve 28 has three ports and four positions (instead of e.g. three positions in the exemplary embodiment of fig. 4). It is also possible to have infinite positions as described in view of fig. 4. In a first position, lubricating and/or cooling is blocked and is therefore not provided to any one of the friction elements (i.e. first and second friction element). In a second position, lubricating and/or cooling is only provided to the first friction element (e.g. first clutch element) of the transmission via a first cooling/lubricating line 30a. In a third position, lubricating and/or cooling is provided to the first and second friction element (e.g. first and second clutch element) of the transmission via a first cooling/lubricating line 30a and a second cooling/lubricating line 30b. In a fourth position lubricating and/or cooling is provided only to the second friction element (e.g. second clutch element) of the transmission via the second cooling/lubricating line 30b. In this embodiment, the cooling/lubricating lines 30a, 30b are used for cooling. Additional lubricating lines 30c, 30d are arranged in the second hydraulic circuit 20 for providing lubrication to the friction elements of the vehicle transmission.

Fig. 7 shows a schematic diagram of an embodiment of a hydraulic system 1 for a vehicle transmission system. The hydraulic system 1 is arranged for use with a vehicle transmission including two or more friction elements (not shown). The system 1 comprises a first hydraulic circuit 2 which is arranged for actuating the two or more friction elements of the transmission. The system 1 further comprises a first electric driven pump 4 arranged for supplying hydraulic fluid to the first hydraulic circuit 2. The electric driven pump 4 may comprise an

electric motor 4a. Advantageously, the pump 4 and motor 4a may form an integrated unit. The hydraulic system 1 is arranged for generating a line pressure. Furthermore, the hydraulic system 1 comprises a hydraulic actuator 40 which is arranged for engaging a park lock system 50. The park lock system 50 comprises a park lock. The hydraulic actuator 40 is hydraulically connected to the first hydraulic circuit 2 for direct actuation of the hydraulic actuator 40 using the line pressure.

Advantageously, the hydraulic actuator can be arranged for bringing or maintaining the park lock system in a park position when the line pressure is below a predetermined pressure threshold and/or in case of no availability of electricity. For this purpose, according to the shown embodiment of fig. 7, the first hydraulic circuit 2 includes a valve 42 which is provided between the hydraulic actuator 40 and the first electric driven pump 4. The valve 42 is arranged for draining the hydraulic actuator 40 to a sump or reservoir when the line pressure is below a predetermined pressure threshold and/or in case of no availability of electricity. A check valve may be arranged for allowing pilot pressure to drop on an actuating side of the valve. In an advantageous embodiment, the hydraulic actuator 40 is arranged for bringing or maintaining the park lock system in a non-park position when the line pressure is below a predetermined pressure threshold and/or in case of no availability of electricity. The hydraulic actuator may include an ((electro)mechanical) actuator 41 which is arranged for maintaining the park lock system in a park position or non-park position according to a last input of an operator of the hydraulic system 1 when the line pressure is below a predetermined pressure threshold and/or in case of no availability of electricity. Additionally, the hydraulic system 1 may include a non-return valve between the first hydraulic pump 4 and the hydraulic actuator 40. In this way, it may be possible to bring the park lock system faster in a park position.

Fig. 8 shows a schematic diagram of an embodiment of a park lock system 50. Here the park lock system is arranged to be in non-park position when pressurized (unarmed). A locking element 41 is connected to the hydraulic actuator 40. The locking element 41 is arranged for keeping the park lock system 50 unarmed in case of a pressure drop (e.g. an unexpected or accidental pressure drop). This may be the case when the line pressure drops below a predetermined

threshold. Such a pressure drop may be caused by a TCU (Transmission Control Unit) reset. However, other circumstances may also lead to such a pressure drop. Advantageously, in this way, the park lock system 50 can stay unarmed for the purpose of safety.

5                    Additionally or alternatively, the locking element 41 may be arranged for keeping the park lock system 50 armed when the line pressure accidentally increases above a predetermined threshold so that the park lock system 50 may remain armed for safety purposes.

10                    The locking element 41 is formed by an electro-mechanical actuator comprising an electrical solenoid 52. Preferably, the locking element 41 is normally open, so when there is no availability of line pressure and electricity the locking element will not lock the hydraulic actuator 40 and the park lock system 50 will still get in the armed position in such case. An (electronic) control element 54 is arranged for actuating the locking element 41. The electronic control element 54  
15                    may comprise a relay. Other types of control elements 54 may also be employed for this purpose. Preferably, the electronic control element 54 is normally closed, so that when there is an interruption of electricity for this electronic control element 54, for example due to a TCU reset, the electronic control element still provides electricity to the locking element 41 and it may keep locking the hydraulic  
20                    actuator. Similar alternatives may also be employed for obtaining this result. When there is no availability of electricity (e.g. as a result of a power failure), there is no electricity to go through the (electronic) control element 54 and also no electricity for the locking element 41 and the park-lock system 50 can be automatically armed.

25                    In fig. 8b the park lock system includes (electro)mechanical means 53 for bringing the park lock system 50 from a park position to a non-park position when the line pressure is below a predetermined pressure threshold, e.g. in case of line pressure loss. Additionally or alternatively, the mechanical means 53 can be used to bring the park lock system 50 from a park position to a non-park position in  
30                    case no electricity is available. This allows to revert the vehicle transmission to a non-park position, e.g. in case of an emergency. In fig. 8c the mechanical means 53 is actuated to revert the park lock system 50 from the park position (fig. 8b) to the non-park position (fig. 8c).

Fig. 9 shows a schematic diagram of an embodiment of a park lock system 50. In the shown embodiment, the park lock system 50 is normally closed (armed) by a spring. The park lock system 50 can be released by hydraulic pressure. Further, the park lock system 50 comprises means for releasing the park lock system 50 in case of failure. A locking mechanism may be arranged for securing a current state of the park lock system 50. An arming spring 56 is arranged which exerts a force on the hydraulic actuator 40 comprising a piston 58. In the absence of hydraulic pressure, the arming spring 56 will move the intermediate body 72 to move a cone 60 which engages the park pawl 61. In case the park pawl 61 cannot be engaged (tooth-to-tooth with the park gear), an engage spring 62 is preloaded which is pushing to the cone 60. As soon as the vehicle (not shown) starts rolling the park can be engaged by the cone 60 engaging the park pawl 61. The arming spring 56 is stronger than the engage spring 62. The park lock system 50 is released by applying pressure to the piston 58, moving the intermediate body 72 in the opposite direction, moving the cone 60 away from the park pawl 61, where the park pawl 61 is released from the park gear by a third spring (not shown). The state of the intermediate body can be locked by the locking element 41 assuring a state of release (non-park) or armed (park) independent of the current state of hydraulic pressure.

Advantageously, the park lock can be armed in case of electric power failure and the park can be overruled (engage/disengage, lock/release) by means of a dedicated arrangement.

Fig. 10 shows a schematic diagram of an embodiment of a hydraulic system 1 for a vehicle transmission system. The embodiment of fig. 10 comprises features relating to at least the embodiments of figs. 4 and 7. This exemplary embodiment comprises three hydraulic lines for actuation 10a, 10b, 10c of hydraulic actuators, such as hydraulic actuators of friction elements, or an hydraulic actuator of a park lock system. Further, the hydraulic system 1 comprises two cooling/lubricating lines 30a, 30b. The second cooling/lubricating line 30b relates to the friction elements of the transmission. Additionally, optionally a cooler 44 is arranged in the second hydraulic circuit 20 for cooling the wet friction elements via the cooling/lubricating lines 30a, 30b. The pressure regulator 26 provides a pilot pressure to the directional valve 28 by means of a pilot pressure

line 46. The pressure regulator 26 may be operated electrically (e.g. solenoid valve). Hydraulic fluid under pressure is supplied to the pressure regulator 26 coming from the first hydraulic circuit 2. Therefore the first (electric) pump 4 feeds the pressure regulator 26 with hydraulic fluid. The directional valve 28 is arranged to  
5 direct the flow between the two cooling/lubricating lines 30a, 30b. In this way the flow of hydraulic fluid obtained by means of the second (electric) pump 22 in the second hydraulic circuit 20 can be distributed, for example depending on the cooling/lubrication needs.

Fig. 11 shows a block diagram of a method 1000 for generating a line  
10 pressure in a vehicle transmission including a first hydraulic circuit arranged for actuating two or more friction elements. In a first step 1001, hydraulic fluid is supplied to the first hydraulic circuit 2 using a first pump 4. Preferably, the first pump 4 is an electric driven pump. In a second step 1002, a flow restriction 6 provided in the first hydraulic circuit 2 between an output of the first pump 4 and a  
15 reservoir 8 is used for providing leakage of hydraulic fluid into the reservoir 8 for generating a line pressure. Advantageously, the line pressure is controlled by controlling a flow speed of the first pump 4. Preferably the reservoir is a sump. Furthermore, the flow restriction 6 may be a fixed geometry flow restriction. This may allow improved control of the pressure in the first hydraulic circuit 2 provided  
20 by the first (electric driven) pump 4.

Fig. 12 shows a block diagram of a method 2000 for cooling and/or lubricating friction elements of a vehicle transmission. The vehicle transmission includes a first hydraulic circuit 2 arranged for actuating two or more hydraulic actuators associated with two or more friction elements, a second hydraulic circuit  
25 20 is arranged for lubricating and/or cooling the two or more friction elements and/or other transmission components, a first (electric) pump 4 is arranged for supplying hydraulic fluid to the first hydraulic circuit 2, and a second (electric) pump 22 is arranged for supplying hydraulic fluid to the second hydraulic circuit 20. The first electric pump 4 is arranged for delivering a (substantially) higher  
30 pressure than the second electric pump 22. In a first step 2001 friction elements are cooled and/or lubricated by means of controlling the flow and/or pressure in the second hydraulic circuit 20 using a flow control element 24. Controlling the flow may also involve controlling a flow distribution to different hydraulic lines, for

example by means of a directional valve 28. In a second step 2002, the flow control element 24 is operated using hydraulic pressure from the first hydraulic circuit 2. As described above, the flow control element 24 may comprise a plurality of components, such as a pressure regulator 26 and a directional valve 28, wherein  
5 the pressure regulator 26 is arranged in the first hydraulic circuit 2, providing pilot pressure to the directional valve 28 which is arranged in the second hydraulic circuit 20. A pilot pressure line 46 may be arranged between the pressure regulator 26 and the directional valve 28, see inter alia in the embodiments of fig. 10.

Fig. 13 shows a block diagram of a method 3000 for actuating hydraulic  
10 actuators associated with two or more friction elements of a vehicle transmission using a first hydraulic circuit 2. In a first step 3001, hydraulic fluid is supplied to the first hydraulic circuit 2 using a first electric driven pump 4. In a second step 3002, pressure in the first hydraulic circuit is controlled by providing a flow restriction in the first hydraulic circuit 2 between the first electric pump 4 and a  
15 reservoir. In this way, leakage of hydraulic fluid into the reservoir is provided, see third step 3003. In a fourth step 3004, a speed of the first electric driven pump is controlled. Preferably the reservoir is a sump.

Fig. 14 shows a block diagram of a method 4000 for operating a park  
lock system of a vehicle transmission. In a first step 4001, a line pressure is  
20 generated using a first hydraulic circuit 2. In a second step 4002, a park lock system is released or disengaged using a hydraulic actuator. The hydraulic actuator is hydraulically connected to the first hydraulic circuit 2. In a third step 4003, the hydraulic actuator is directly actuated using the line pressure.

Fig. 15 shows a schematic diagram of a first exemplary embodiment of a  
25 park lock system 50 provided with an override system comprising an override element 70. In addition to the functions, and advantages thereof, provided by an exemplary embodiment comprising a park lock, as described e.g. under Fig. 9, the present exemplary embodiment further provides a park lock override function to the park lock system 50. Especially in the event the park lock is default engaged in  
30 case of absence of hydraulic pressure and/or electric power, there may be a need for an override function, e.g. for allowing movement of a vehicle in the absence of hydraulic pressure and/or electric power, such as during towing or maintenance.

In this example, override actuator 71 provides switching of the override element 70 between an engaged (prevent park lock function) and an unengaged position (normal park lock operation). The engaged override element 70 will lock into a retainer feature 72a provided on intermediate body 72. When the  
5 intermediate body 72 and the override element 70 are locked together, the position of the intermediate body 72 will be fixed. Hence preventing the park lock system 50 from going into an engaged position.

In this example, the override actuator 71 is arranged to be extended, into engaged position, when actuated, here by applying electric current to a  
10 solenoid of the override actuator. The override actuator is arranged to be retracted when not actuated, here when no electric current is applied to the solenoid.

In this example, the override actuator 71 includes the override element 70. Here the override element 70 takes the form of a retainer. It will be appreciated that the override element 70 engages with a matching retainer feature 72a of the  
15 intermediate body when extended. It will also be appreciated that if, when engaged, the override actuator 71 is switched from an actuated to a non-actuated mode, the override element 70 and retainer feature 72a prevent the override actuator from retracting, and thus from disengaging. Thus, it is provided that the override remains actuated even in case power is interrupted. For disengaging the  
20 override actuator, here a small movement of the intermediate body suffices to disengage the override element 70 from the retainer feature 72a and allow the override actuator 71 to retract.

In one aspect of the present embodiment, the override element 70 may be switched by a control unit of the vehicle (not shown), for example a TCU unit  
25 (not shown). This has the advantageous effect that the control unit remains in control, whereas solutions employing mechanical override can cause unintended roll away of the vehicle. In addition, an advantageous aspect of TCU control over switching of override function is theft prevention.

According to an other aspect, the provided override system may be  
30 arranged to maintain the park lock in an unengaged position. Optimally, in override the override system consumes no power. In the example this is i.a. achieved by use of the override element 70 and retainer feature 72a. Hence, the

park lock can be maintained in override for prolonged periods of time, e.g. during towing, without draining vehicle power.

In an other aspect the override system may be arranged to be switched out of override, i.e. returning the park lock system back to normal behaviour, using  
5 the control unit of the vehicle (not shown), here, for actuating the intermediate body 72. This can e.g. provide an advantage in that the override function cannot be deactivated without user control of the control unit. Hence, e.g. unsafe situations may be avoided.

In the present embodiment the park lock override system comprises a  
10 separate override actuator 71. An advantageous aspect of using a separate override actuator is that it provides robustness. In this example, the normal position of override actuator 71 is in the unengaged position. As already explained, here the override actuator 71 comprises an electrical solenoid.

An override function of the present override system can comprise the  
15 following sequence of steps; using hydraulic pressure to hydraulic actuator 40 to revert an engaged park lock to an unengaged state; engaging the override actuator 71; reducing the hydraulic pressure, thereby engaging the override element 70 and retainer feature 72a; and subsequently disengaging the override actuator 71. The override function will then remain enabled because the override element 70 is  
20 locked into intermediate body 72.

Switching the override element 70 back to an unengaged position from an engaged position, thereby bringing the park lock system back to standard park function, comprises applying hydraulic pressure to hydraulic actuator 40 while the  
25 override actuator 71 is in an unengaged state. This allows the override element 70 and retainer feature 72a to disengage, and in turn the override actuator 71 to retract.

Advantageously, the override system can be armed in case of electric power failure by means of a dedicated arrangement.

Fig. 16 shows a schematic diagram of a second exemplary embodiment  
30 of a park lock system 50 provided with an override system comprising an override element 70. In contrast to the first embodiment, the second exemplary embodiment comprises an override element 70 that acts not on actuation member 72, but rather on park pawl 61. For this purpose, a position may be provided onto park pawl 61

onto which the engaged override element 70 may act, resulting in locking the position of park pawl 61. Hence preventing activation of the parking lock. In this embodiment, space requirements, for a package containing override element 70 and actuator 71, are shifted from a location near actuation member 72 and piston 58 to a location near park pawl 61 due to the different position of the override element,

Other aspects and advantages regarding, functionality and robustness, relating to the addition of an override function, as described in the first exemplary embodiment, also apply to the present embodiment.

Fig. 17 shows a schematic diagram of a third embodiment of a park lock system 50 provided with an override system comprising a switching element 70. In contrast to the first and second exemplary embodiment of park lock systems comprising an override system, the present embodiment comprises a switching element 70 that combines the functions of a locking element and an override element. It is one aspect of the present embodiment that the use of a single switching element 70 is actuated by a single actuator 52. In this example, actuator 52 comprises an electrical solenoid. Advantageous aspects of using a single actuator 52 as well as the combined use of a single switching element 70 comprise; reducing the number of used components, improving packaging, and providing an integrated solution.

Switching element 70 may be switched between an engaged and unengaged position by switching actuator 52 between engaged and unengaged states. In a procedure similar to the one applicable to the embodiment described in respect of Fig 9, the state of the intermediate body 72 may be locked by the switching element 70, assuring a state of release (non-park) or armed (park) independent of the current state of hydraulic pressure. In addition to enabling released and armed states to the park lock system, the switching element 70 also may also provide park lock override function to the system. Override function may be engaged when the switching element 70 is locked to a retaining feature 72a on intermediate element 72. Since in the present embodiment, switching element 70 must be enabled to connect to three spatially separated features provided on intermediate body 72, also piston 40 is also provided to be able to switch between three positions.

An override function of the present embodiment of a park lock system comprising a combined locking and override element can comprise the following sequence of steps; using hydraulic pressure to hydraulic actuator 40 to revert an engaged park lock to an unengaged state; further increasing the hydraulic pressure to move intermediate body 72 to the locking position; engaging the actuator 52; 5 reducing the hydraulic pressure and subsequently unengaging the actuator. The override function will remain enabled because the switching element 70 is locked into the locking position provided by the retaining feature 72a on intermediate body 72.

10 Switching the switching element 70 back to an unengaged position from an engaged position, thereby bringing the system back to standard park function, comprises applying hydraulic pressure to hydraulic actuator 40 while the override actuator is in an unengaged state.

Herein, the invention is described with reference to specific examples of 15 embodiments of the invention. It will, however, be evident that various modifications and changes may be made therein, without departing from the essence of the invention. For the purpose of clarity and a concise description features are described herein as part of the same or separate examples or embodiments, however, alternative embodiments having combinations of all or 20 some of the features described in these separate embodiments are also envisaged.

The transmission system may be implemented in a vehicle, such as cars, recreational vehicles, trucks, buses, bicycles, motorcycles, lawn mowers, agricultural vehicles, construction vehicles, golf carts, trolleys and robotic vehicles. Other vehicles are possible as well. The shown embodiments involved vehicles 25 comprising four wheels, however vehicles with a different number of wheels can be utilized. It also perceivable that a plurality of transmission systems are included in a vehicle.

Actuation of the coupling members may be performed by means of a hydraulic actuation system. However other embodiments may include actuation by 30 means of mechanical, electromechanical or electro-hydraulic systems. A combination of actuation systems for the different components of the transmission are also envisaged.

The motor or engine of the vehicle comprising the transmission system according to the current invention may include any combination of an internal combustion engine and an electric motor. Other motors and engines are possible as well such as a fuel-cell motor. In some embodiments, the motor is a hybrid engine and/or could include multiple types of engines and/or motors. For instance, a gas-electric hybrid car could include a gasoline engine and an electric motor. Other examples are possible.

It will be appreciated that the methods may include computer implemented steps. Embodiments may comprise computer apparatus, wherein processes performed in computer apparatus. The invention also extends to computer programs, particularly computer programs on or in a carrier, adapted for putting the invention into practice. The program may be in the form of source or object code or in any other form suitable for use in the implementation of the processes according to the invention. The carrier may be any entity or device capable of carrying the program. For example, the carrier may comprise a storage medium, such as a ROM, for example a semiconductor ROM or hard disk. Further, the carrier may be a transmissible carrier such as an electrical or optical signal which may be conveyed via electrical or optical cable or by radio or other means, e.g. via the internet or cloud.

Some embodiments may be implemented, for example, using a machine or tangible computer-readable medium or article which may store an instruction or a set of instructions that, if executed by a machine, may cause the machine to perform a method and/or operations in accordance with the embodiments.

Various embodiments may be implemented using hardware elements, software elements, or a combination of both. Examples of hardware elements may include processors, microprocessors, circuits, application specific integrated circuits (ASIC), programmable logic devices (PLD), digital signal processors (DSP), field programmable gate array (FPGA), logic gates, registers, semiconductor device, microchips, chip sets, et cetera. Examples of software may include software components, programs, applications, computer programs, application programs, system programs, machine programs, operating system software, mobile apps, middleware, firmware, software modules, routines, subroutines, functions, computer implemented methods, procedures, software interfaces, application

program interfaces (API), methods, instruction sets, computing code, computer code, et cetera.

Herein, the invention is described with reference to specific examples of embodiments of the invention. It will, however, be evident that various  
5 modifications, variations, alternatives and changes may be made therein, without departing from the essence of the invention. For the purpose of clarity and a concise description features are described herein as part of the same or separate embodiments, however, alternative embodiments having combinations of all or  
10 some of the features described in these separate embodiments are also envisaged and understood to fall within the framework of the invention as outlined by the claims. The specifications, figures and examples are, accordingly, to be regarded in an illustrative sense rather than in a restrictive sense. The invention is intended to embrace all alternatives, modifications and variations which fall within the spirit and scope of the appended claims. Further, many of the elements that are  
15 described are functional entities that may be implemented as discrete or distributed components or in conjunction with other components, in any suitable combination and location.

In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim. The word 'comprising' does not exclude the  
20 presence of other features or steps than those listed in a claim. Furthermore, the words 'a' and 'an' shall not be construed as limited to 'only one', but instead are used to mean 'at least one', and do not exclude a plurality. The mere fact that certain measures are recited in mutually different claims does not indicate that a combination of these measures cannot be used to an advantage.

25

Conclusies

1. Hydraulisch systeem voor een voertuigtransmissie, waarbij de transmissie twee of meer frictie-elementen omvat, waarbij het hydraulisch systeem omvat:

5 een eerste hydraulisch circuit ingericht voor het aandrijven van de twee of meer frictie-elementen;

een eerste elektrisch aangedreven pomp ingericht voor het verschaffen van hydraulische vloeistof aan het eerste hydraulische circuit; en

10 een stroomrestrictie verschaft in het eerste hydraulische circuit tussen een output van de eerste elektrisch aangedreven pomp en een reservoir om lekkage van hydraulische vloeistof in het reservoir te verschaffen.

2. Hydraulisch systeem volgens conclusie 1, verder omvattende:

15 een tweede hydraulisch circuit ingericht voor het smeren en/of koelen van de twee of meer frictie-elementen;

een tweede elektrische pomp ingericht voor het verschaffen van hydraulische vloeistof aan het tweede hydraulische circuit, waarbij de eerste elektrische pomp is ingericht voor het leveren van een hogere druk dan de tweede elektrische pomp; en

20 een stroomregelement ingericht voor het regelen van stroom en/of druk in het tweede hydraulische circuit, waarbij het stroomregelement wordt bediend onder gebruikmaking van hydraulische druk van het eerste hydraulische circuit.

25

3. Hydraulisch systeem voor een voertuigtransmissie, waarbij de transmissie twee of meer frictie-elementen omvat en twee of meer hydraulische actuatoren, waarbij het hydraulische systeem omvat:

een eerste hydraulisch circuit ingericht voor het aandrijven van de twee of meer hydraulische actuatoren;

een tweede hydraulisch circuit ingericht voor het smeren en/of koelen van de twee of meer frictie-elementen;

5 een eerste elektrisch aangedreven pomp ingericht voor het leveren van hydraulische vloeistof aan het eerste hydraulische circuit;

een tweede elektrisch aangedreven pomp ingericht voor het leveren van hydraulische vloeistof aan het tweede hydraulische circuit, waarbij de eerste elektrisch aangedreven pomp is ingericht voor het  
10 leveren van een hogere druk van de tweede elektrisch aangedreven pomp;  
en

een stroomregelement ingericht voor het regelen van stroom en/of druk in het tweede hydraulische circuit, waarbij het stroomregelement wordt bediend onder gebruikmaking van hydraulische druk van  
15 het eerste hydraulische circuit.

4. Hydraulisch systeem volgens conclusie 3, waarbij het eerste hydraulische circuit een stroomrestrictie omvat voor het bepalen van een druk in het eerste hydraulische circuit stroomopwaarts van de  
20 stroomrestrictie, voorzien tussen een output van de eerste elektrisch aangedreven pomp en een reservoir om lekkage van hydraulische vloeistof in het reservoir te verschaffen.

5. Hydraulisch systeem volgens één van de conclusies 1 tot 4, waarbij hydraulische vloeistof die door de stroomrestrictie vloeit ten  
25 minste gedeeltelijk wordt gebruikt voor het actief smeren van transmissie-onderdelen.

6. Hydraulisch systeem volgens één van de conclusies 1 tot 5, waarbij de stroomrestrictie een vaste geometrie heeft.  
30

7.       Hydraulisch systeem volgens één van de conclusies 1 tot 6, waarbij het eerste hydraulische circuit ten minste twee regelementen omvat, ingericht voor het aandrijven van de twee of meer frictie-elementen, waarbij de regelementen worden bestuurd onder  
5 gebruikmaking van hydraulische druk van het eerste hydraulische circuit.
8.       Hydraulisch systeem volgens één van de conclusies 1 tot 7, omvattende een regelaar ingericht voor het regelen van hydraulische  
10 druk in het eerste hydraulische circuit door stroom van hydraulische vloeistof te regelen door de stroomrestrictie.
9.       Hydraulisch systeem volgens conclusie 8, waarbij de regelaar is ingericht voor het regelen van een snelheid van de eerste elektrisch  
15 aangedreven pomp.
10.      Hydraulisch systeem volgens één van de conclusies 1 tot 9, waarbij het eerste hydraulisch circuit vrij is van een hydraulische vloeistofaccumulator.  
20
11.      Hydraulisch systeem volgens één van de conclusies 1 tot 10, waarbij het eerste hydraulische circuit vrij is van een drukventiel ingericht voor het instellen van de hydraulische druk in het eerste hydraulische circuit.  
25
12.      Hydraulisch systeem volgens één van de conclusies 8 tot 10, waarbij de regelaar is ingericht voor het roteren van de eerste elektrisch aangedreven pomp in slechts één richting.
13.      Hydraulisch systeem volgens één van de voorgaande conclusies, waarbij het stroomregelement en/of de ten minste twee regelementen een elektrische regelinput omvat(ten).  
30

14.     Hydraulisch systeem volgens één van de conclusies 1 tot 13, waarbij het eerste hydraulische circuit is ingericht voor het genereren van een lijndruk.
- 5       15.     Hydraulisch systeem volgens één van de conclusies 1 tot 14, waarbij één van de twee of meer hydraulische actuatoren is ingericht voor het aandrijven van een park lock systeem, waarbij genoemde hydraulische actuator hydraulisch is verbonden met het eerste hydraulische circuit voor directe aandrijving van de hydraulische
- 10      actuator onder gebruikmaking van de lijndruk.
16.     Hydraulisch systeem voor een voertuigtransmissie, omvattende een eerste hydraulisch circuit ingericht voor het genereren van de lijndruk; en
- 15             een hydraulische actuator ingericht voor het inschakelen van een park lock systeem, waarbij de hydraulische actuator hydraulisch is verbonden met het eerste hydraulische circuit voor directe aandrijving van de hydraulische actuator onder gebruikmaking van de lijndruk.
- 20      17.     Hydraulisch systeem volgens conclusie 15 of 16, waarbij de hydraulische actuator is ingericht om het park lock systeem in een parkeerpositie te brengen of te houden, wanneer de lijndruk zich onder een vooraf bepaalde drukgrens bevindt.
- 25      18.     Hydraulisch systeem volgens conclusie 17, waarbij het eerste hydraulische circuit een klep omvat, ingericht voor het leegmaken van de hydraulische actuator wanneer de lijndruk zich onder een vooraf bepaalde drukgrens bevindt.
- 30      19.     Hydraulisch systeem volgens conclusie 15 of 16, waarbij de hydraulische actuator is ingericht om het park lock systeem in een niet-

parkeerpositie te brengen of te houden, wanneer de lijndruk zich onder een vooraf bepaalde drukgrens bevindt.

5 20. Hydraulisch systeem volgens conclusie 15 of 16, waarbij de hydraulische actuator een actuator omvat, ingericht om het park lock systeem in een parkeerpositie of niet-parkeerpositie te houden volgens ten minste een laatste input van een operator van het hydraulische systeem wanneer de lijndruk zich onder een vooraf bepaalde drukgrens bevindt.

10 21. Hydraulisch systeem volgens één van de conclusies 15 tot 20, omvattende een terugslagklep tussen de eerste hydraulische pomp en de hydraulische actuator.

15 22. Voertuigtransmissie, omvattende een hydraulisch systeem volgens één van de conclusies 1 tot 21.

20 23. Voertuigtransmissie volgens conclusie 22, voor zover afhankelijk van één van de conclusies 15 tot 20, omvattende mechanische middelen om het park lock systeem van een parkeerpositie naar een niet-parkeerpositie te brengen wanneer de lijndruk zich onder een vooraf bepaalde drukgrens bevindt.

25 24. Voertuigtransmissie, bijvoorbeeld omvattende een hydraulisch systeem volgens één van de conclusies 1-21, omvattende een park lock systeem ingericht voor het inschakelen van park lock wanneer lijndruk zich onder een vooraf bepaalde drukgrens bevindt en/of de elektrische stroom is uitgeschakeld, en een opheffingsmiddel voor het omzeilen van het park lock-systeem 30 zodanig dat het park lock-systeem selectief kan worden uitgeschakeld wanneer de lijndruk zich onder een vooraf bepaalde grens bevindt en/of de elektrische stroom is uitgeschakeld.

25. Voertuigtransmissie volgens conclusie 24, waarbij het opheffingsmiddel is ingericht om uit de opheffingstoestand te schakelen, waardoor het park lock-systeem van een niet-ingeschakelde positie wordt teruggebracht naar normaal gedrag.
- 5
26. Voertuigtransmissie volgens conclusie 24 of 25, waarbij het opheffingsmiddel een afzonderlijke opheffingsactuator gebruikt.
27. Voertuigtransmissie volgens conclusie 24 of 25, waarbij het opheffingsmiddel en het park lock-systeem eenzelfde actuator gebruiken om het park lock-systeem in een parkeerpositie of een niet-parkeerpositie te houden en voor het omzeilen van het park lock-systeem.
- 10
28. Voertuigtransmissie volgens één van de conclusies 24-27, waarbij het opheffingsmiddel vasthoudmiddelen omvat voor het mechanisch voorkomen van het vrijgeven van de opheffingsmiddelen bij het deactiveren van de opheffingsmiddelen.
- 15
29. Voertuigtransmissie volgens één van de conclusies 24-28, waarbij het opheffingssysteem is ingericht om de park lock in een niet-parkeerpositie te houden.
- 20
30. Voertuigtransmissie volgens conclusie 29, waarbij het opheffingssysteem is ingericht om de park lock in een niet-parkeerpositie te houden zonder elektrische stroom te gebruiken.
- 25
31. Voertuigtransmissie volgens één van de conclusies 24-30, waarbij het opheffingssysteem is ingericht om naar de opheffingstoestand te worden geschakeld onder gebruikmaking van een regeleenheid van het voertuig.
- 30
32. Werkwijze voor het genereren van een lijndruk in een voertuigtransmissie omvattende een eerste hydraulisch circuit ingericht voor het

aandrijven van twee of meer frictie-elementen, waarbij de werkwijze omvat:

het leveren van hydraulische vloeistof aan het eerste hydraulische circuit onder gebruikmaking van een eerste pomp; en

5 het gebruiken van een stroomrestrictie verschaft in het eerste hydraulische circuit tussen een output van de eerste pomp en een reservoir om lekkage van hydraulische vloeistof in het reservoir te verschaffen voor het genereren van de lijndruk.

10 33. Werkwijze volgens conclusie 32 omvattende het regelen van de lijndruk door het regelen van de stroomsnelheid van de eerste pomp.

34. Werkwijze volgens conclusie 32 of 33, omvattende het regelen van twee of meer actuatoren verbonden met de twee of meer frictie-  
15 elementen, onder gebruikmaking van ten minste twee regelementen die worden bediend onder gebruikmaking van de lijndruk.

35. Werkwijze volgens één van de conclusies 32 tot 34, omvattende:  
het koelen en/of smeren van de frictie-elementen, onder  
20 gebruikmaking van een tweede hydraulisch circuit waarmee een tweede pomp is verbonden, door het regelen van stroom en/of druk in het tweede hydraulische circuit onder gebruikmaking van een stroomregelement, waarbij het stroomregelement wordt bediend onder gebruikmaking van de lijndruk.

25

36. Werkwijze voor het koelen en/of smeren van frictie-elementen van een voertuigtransmissie, waarbij de voertuigtransmissie een eerste hydraulisch circuit omvat, ingericht voor het aandrijven van twee of meer hydraulische actuatoren verbonden met twee of meer frictie-elementen,  
30 een tweede hydraulisch circuit ingericht voor het smeren en/of koelen van de twee of meer frictie-elementen, een eerste elektrische pomp ingericht voor het leveren van hydraulische vloeistof aan het eerste hydraulische

circuit, en een tweede elektrisch aangedreven pomp ingericht voor het leveren van hydraulische vloeistof aan het tweede hydraulische circuit, waarbij de eerste elektrische pomp is ingericht voor het leveren van een hogere druk dan de tweede elektrische pomp,

5                   waarbij de werkwijze omvat het koelen en/of smeren van de frictie-elementen door het regelen van stroom en /of druk in het tweede hydraulische circuit onder gebruikmaking van een regelement, waarbij het regelement wordt bediend onder gebruikmaking van hydraulische druk van het eerste hydraulische circuit.

10

37.       Werkwijze voor het aandrijven van hydraulische actuatoren verbonden met twee of meer frictie-elementen van een voertuigtransmissie onder gebruikmaking van een eerste hydraulisch circuit, waarbij de werkwijze omvat

15                   het leveren van hydraulische vloeistof aan het eerste hydraulische circuit onder gebruikmaking van een eerste elektrisch aangedreven pomp; en

                  het regelen van druk van het eerste hydraulische circuit door een stroomrestrictie te verschaffen in het eerste hydraulische circuit tussen  
20                   de eerste elektrische pomp en een reservoir om lekkage van hydraulische vloeistof in het reservoir te verschaffen en een snelheid van de eerste elektrisch aangedreven pomp te regelen.

38.       Werkwijze volgens één van de conclusies 32 tot 37, omvattende:  
25                   het vrijgeven van een park lock-systeem onder gebruikmaking van een hydraulische actuator die hydraulisch verbonden is met het eerste hydraulische circuit, en het direct aandrijven van de hydraulische actuator onder gebruikmaking van de lijndruk.

30                   39.       Werkwijze voor het bedienen van een park lock-systeem van een voertuigtransmissie, omvattende:

het genereren, onder gebruikmaking van een eerste hydraulisch circuit, van een lijndruk; en

5 het vrijgeven van een park lock-systeem onder gebruikmaking van een hydraulische actuator die hydraulisch is verbonden met het eerste hydraulische circuit, en het direct aandrijven van de hydraulische actuator onder gebruikmaking van de lijndruk.

40. Een voertuig omvattende een voertuigtransmissie volgens één van de conclusies 22-31.

Fig. 1

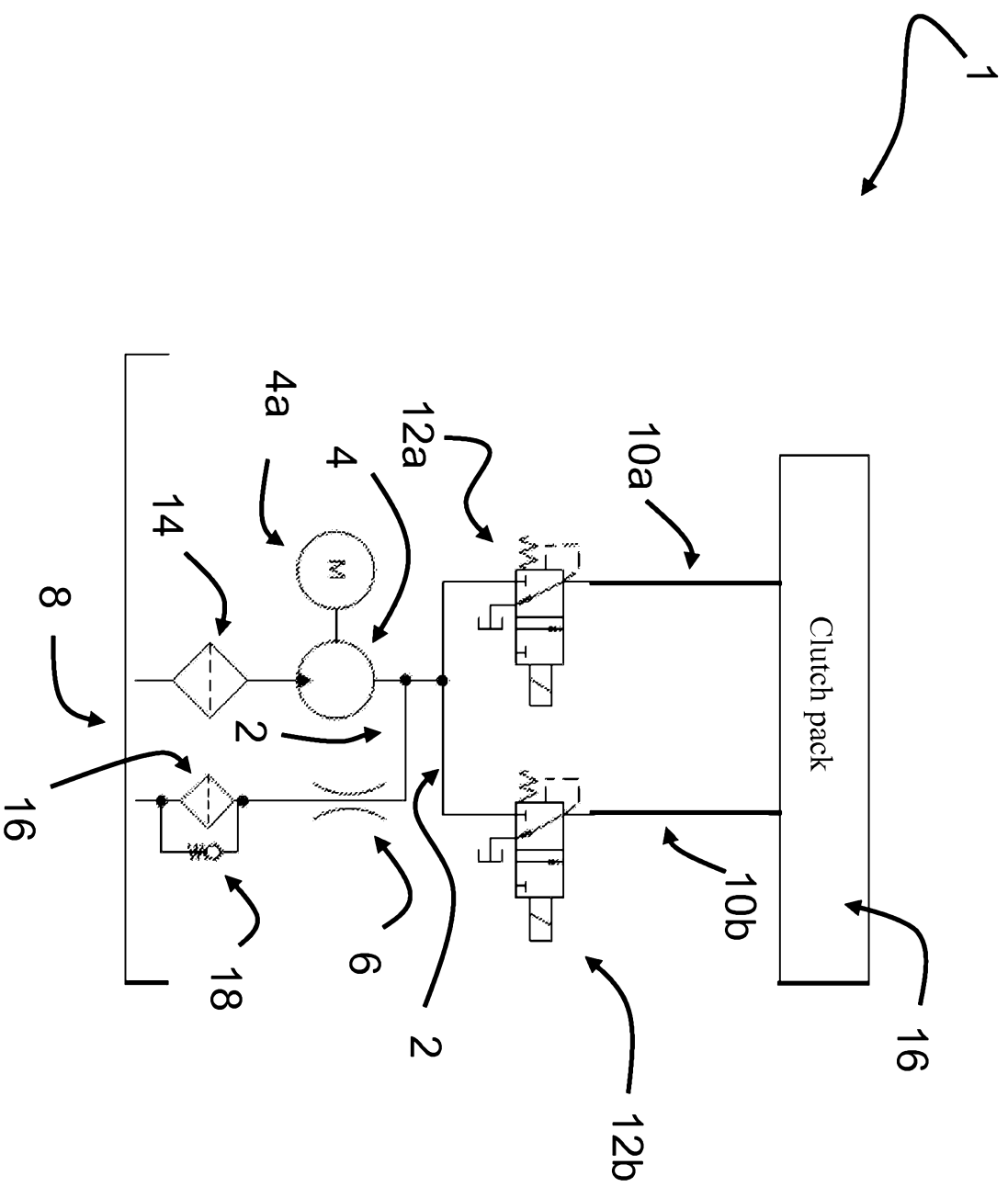


Fig. 2

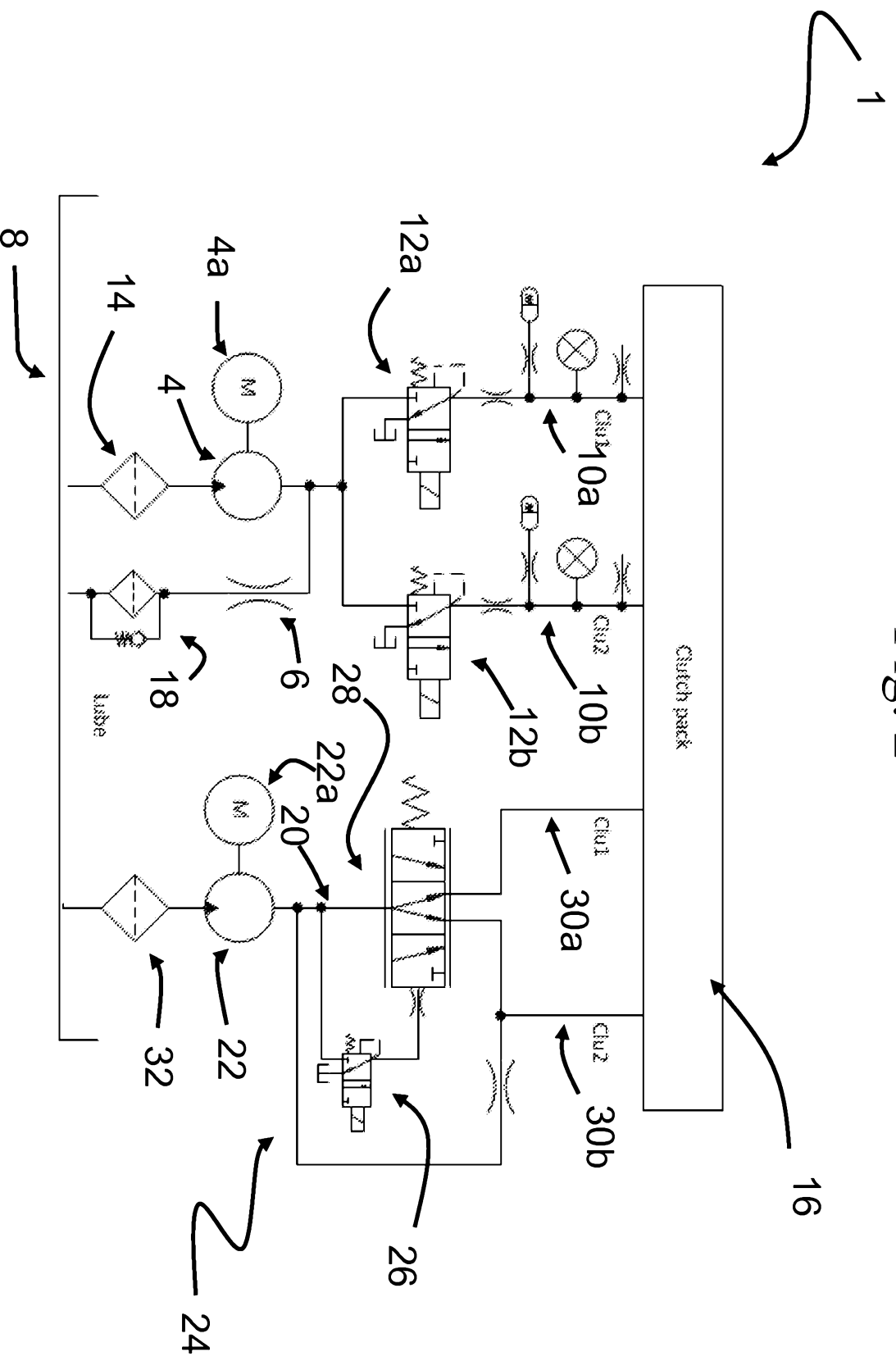






Fig. 5

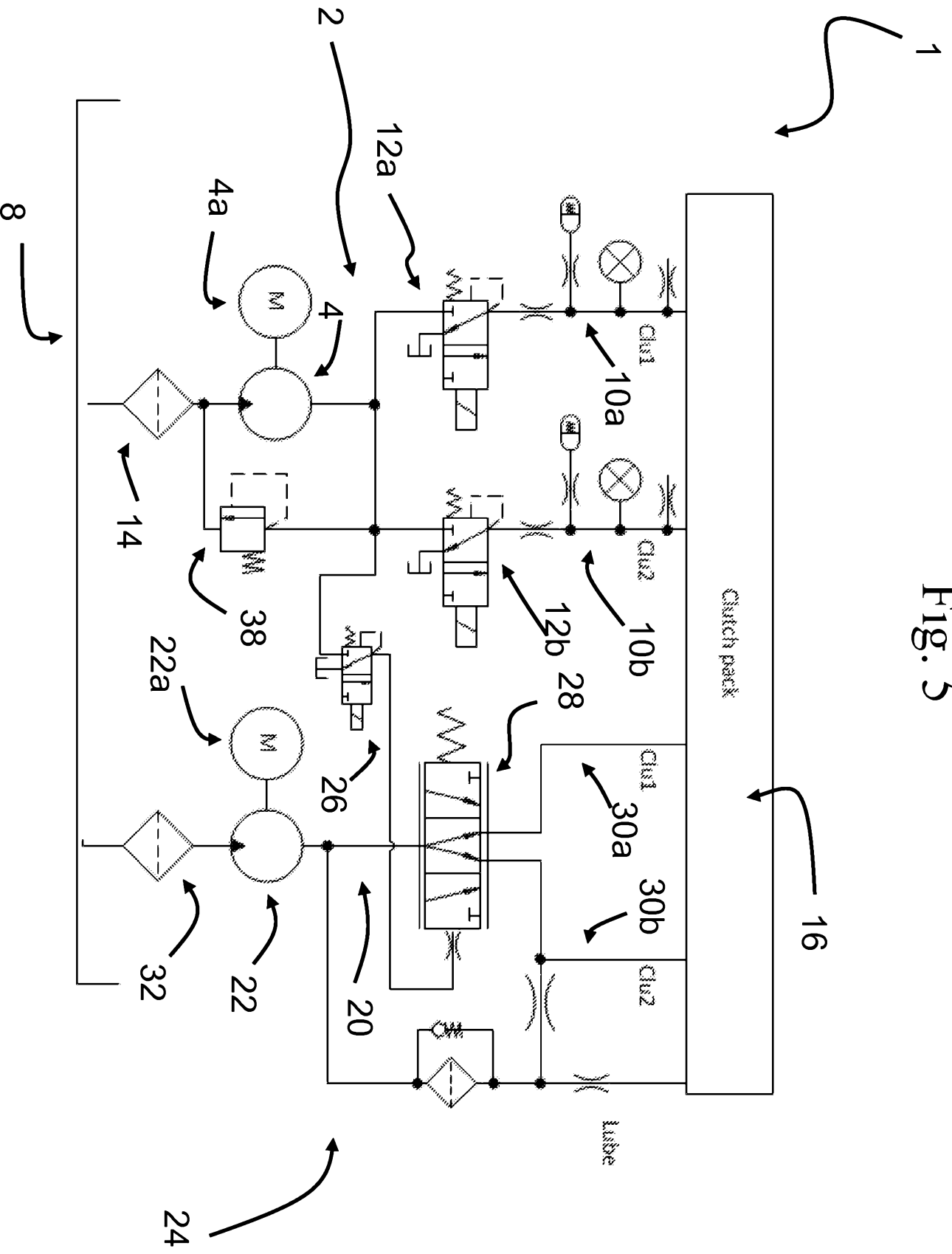


Fig. 6

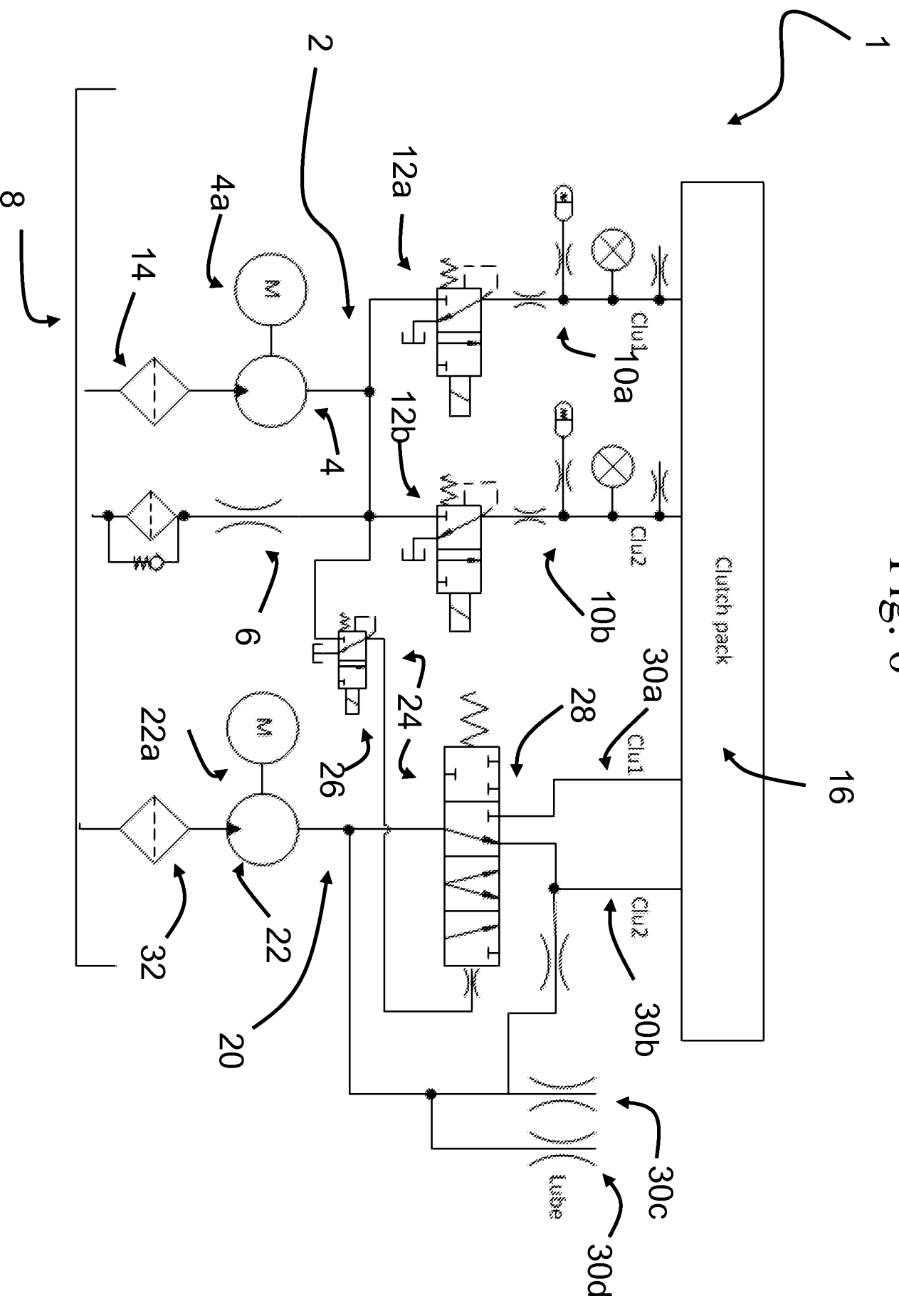


Fig. 7

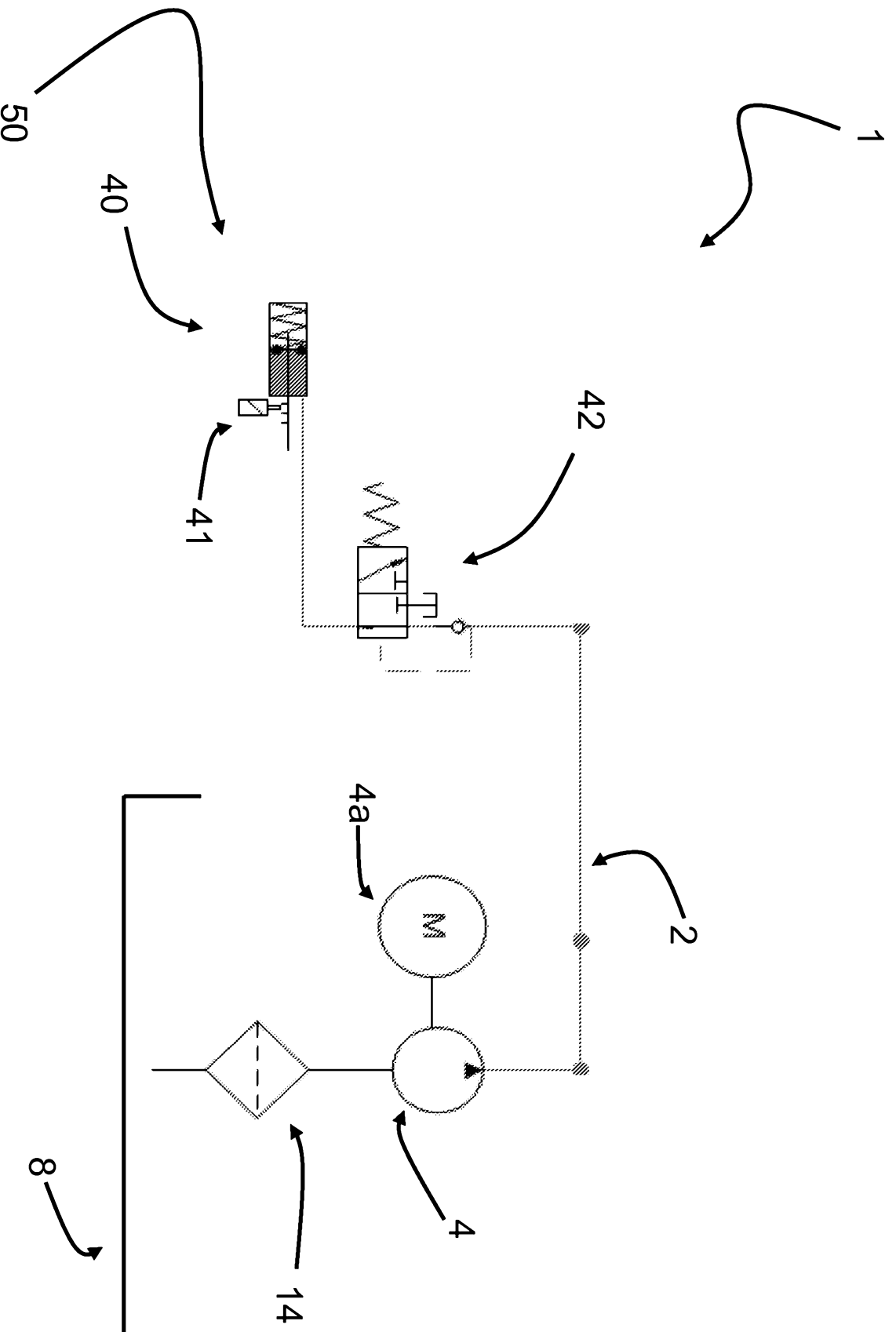


Fig. 8

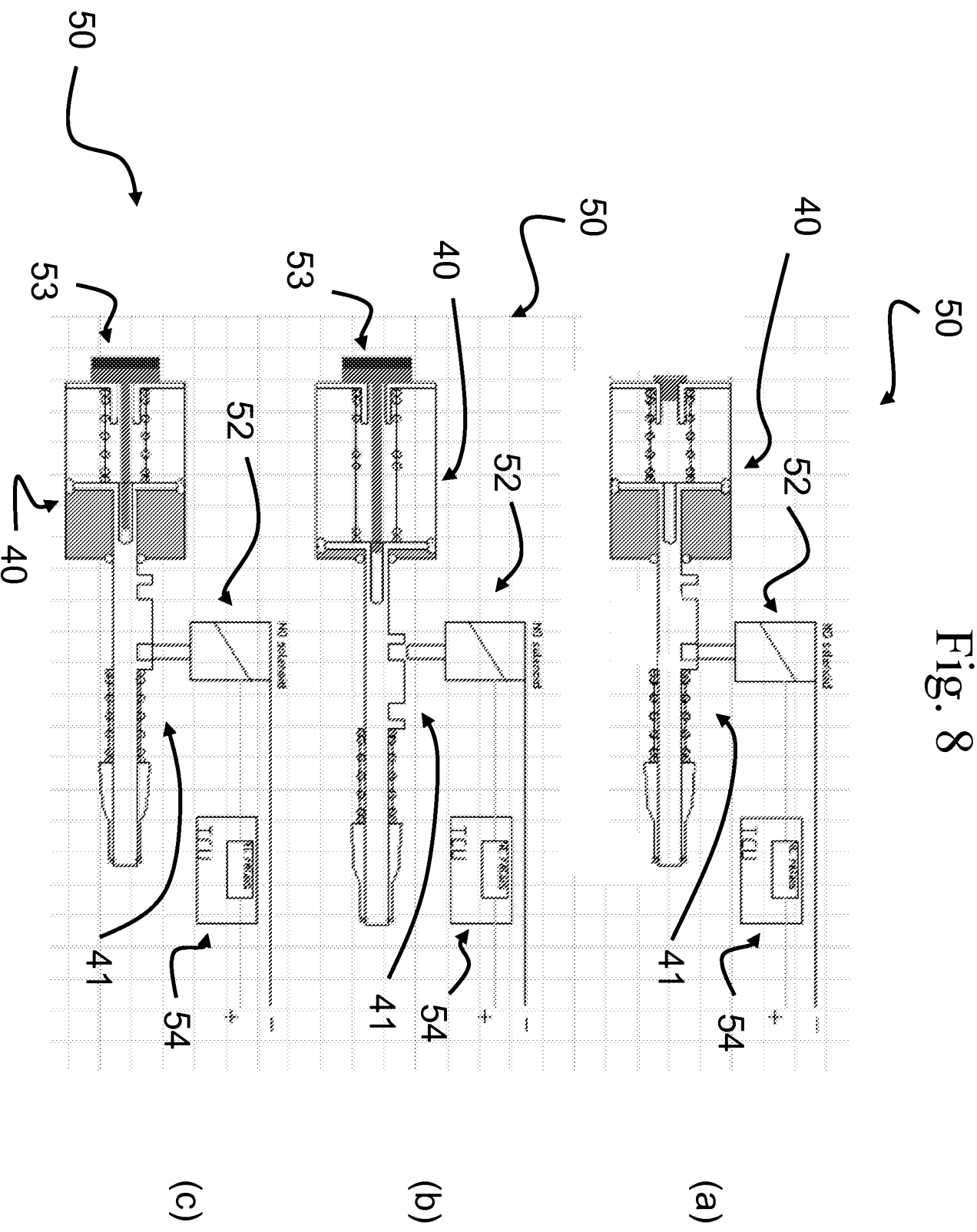
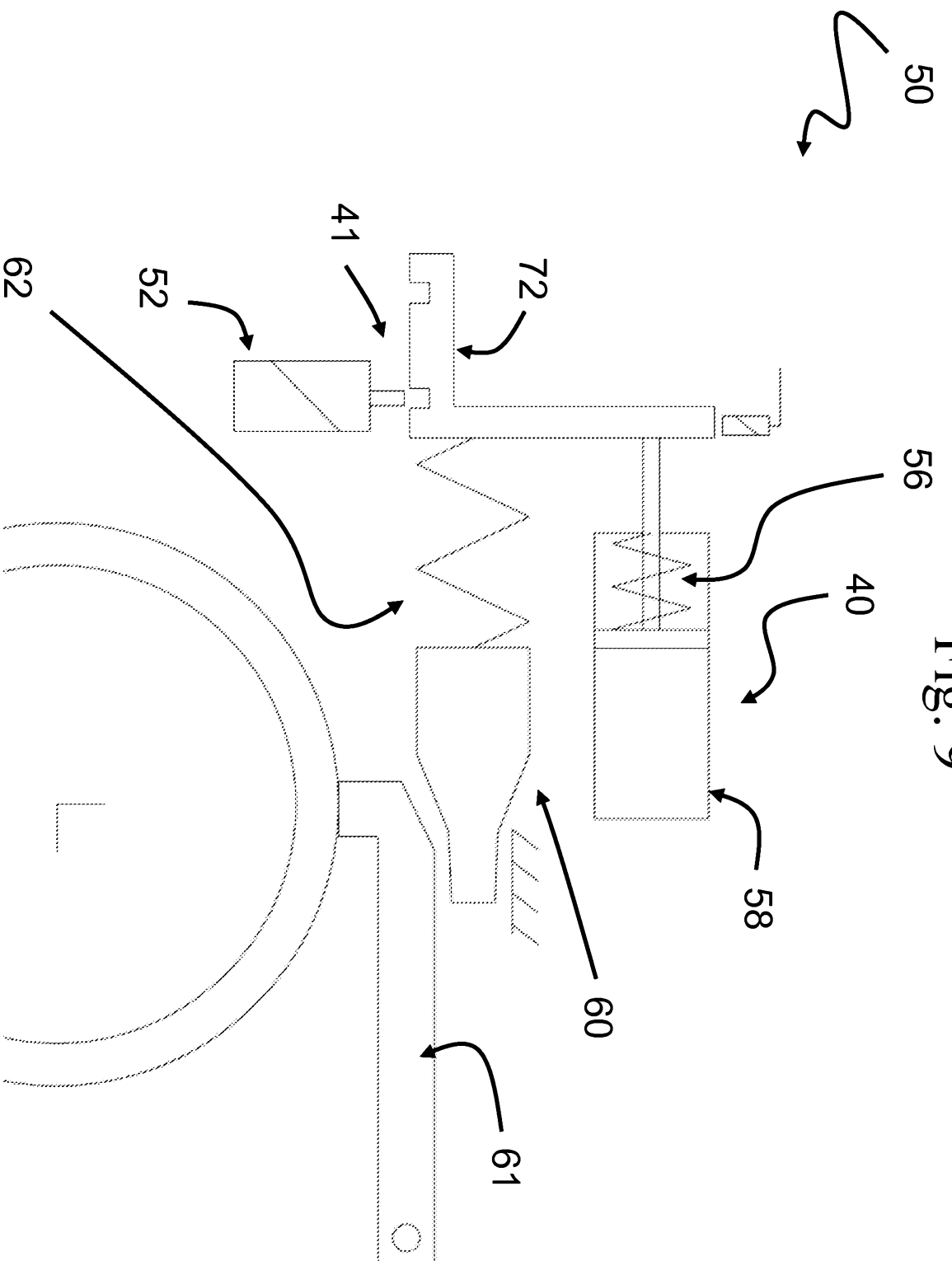


Fig. 9

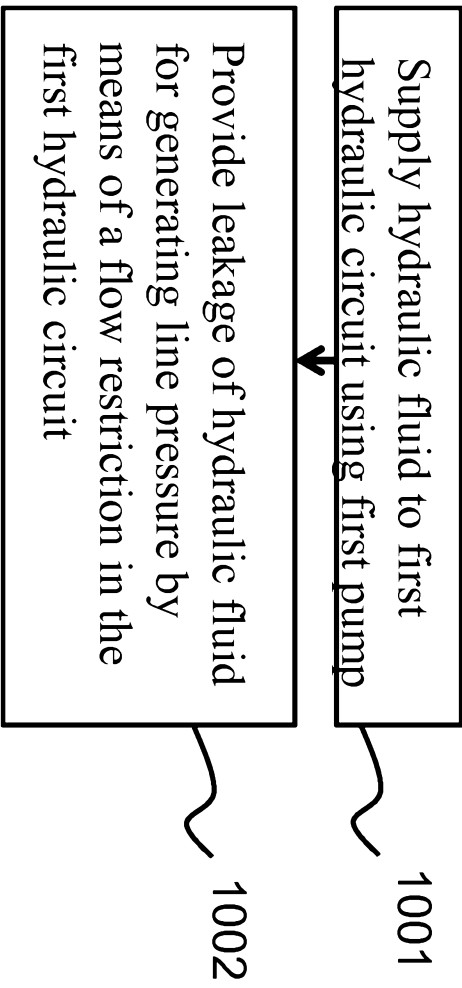




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Fig. 11



2000

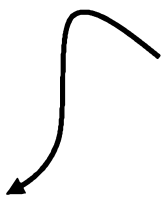
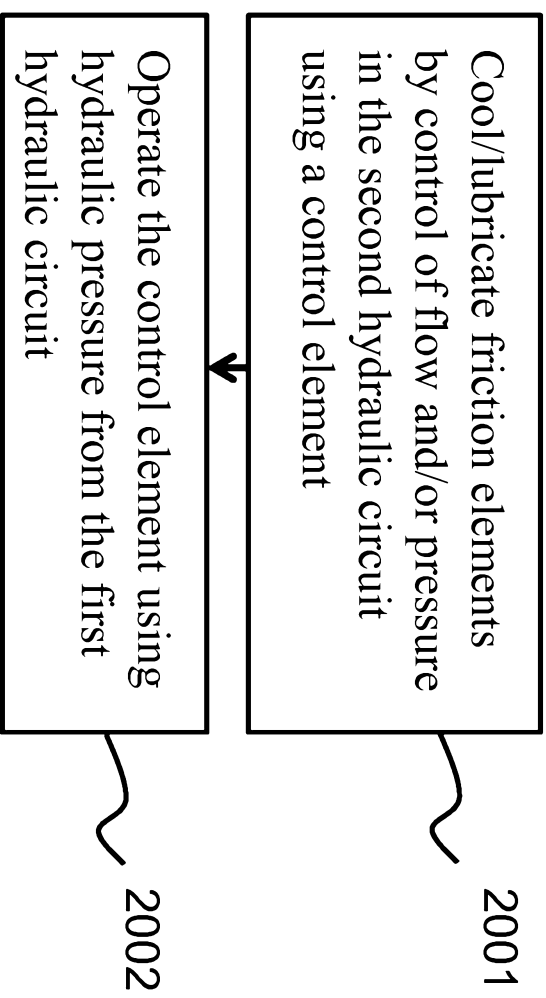


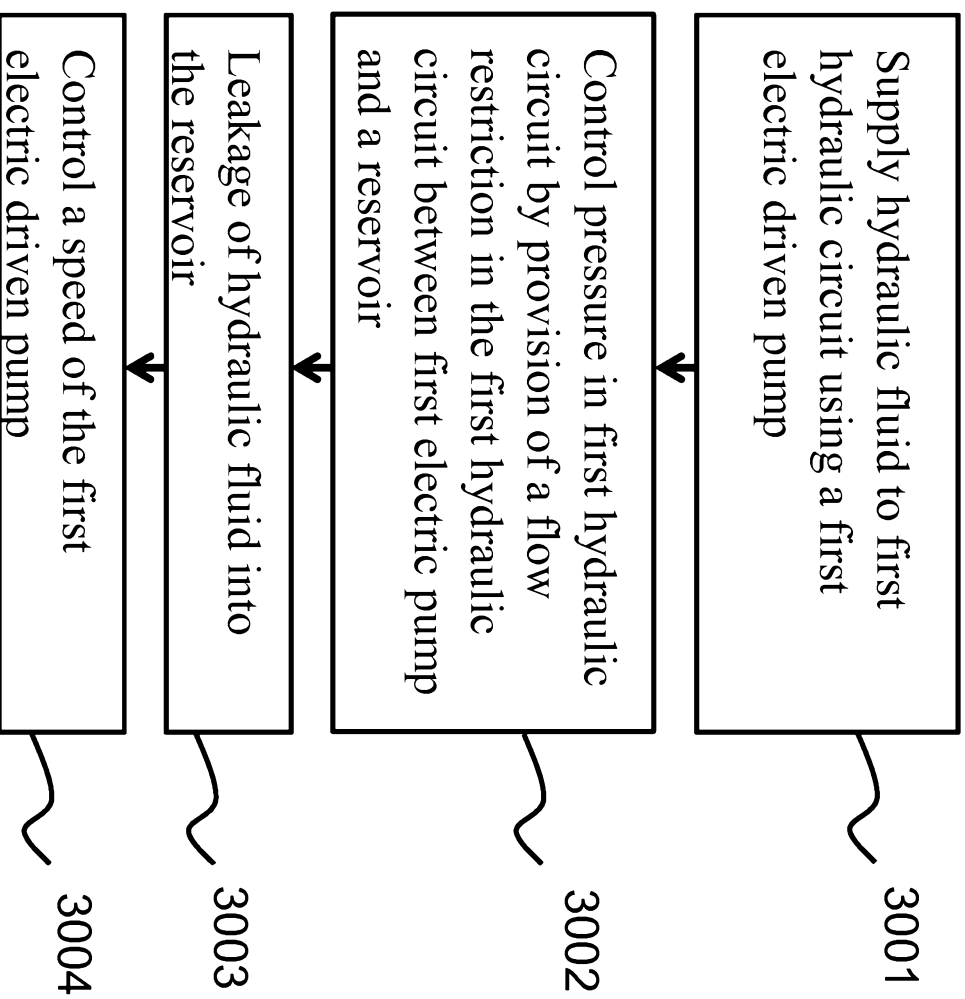
Fig. 12



3000



Fig. 13



4000

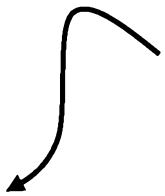


Fig. 14

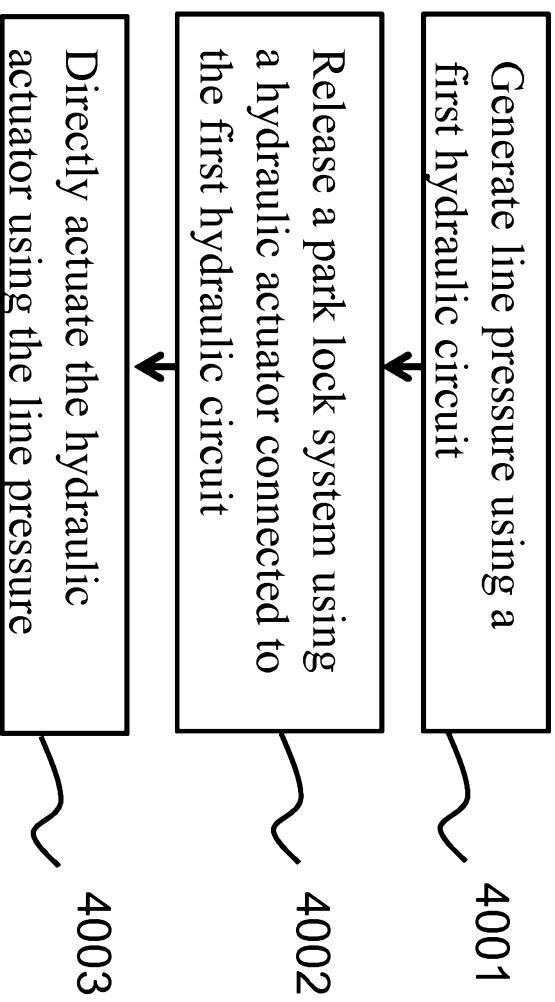


Fig. 15

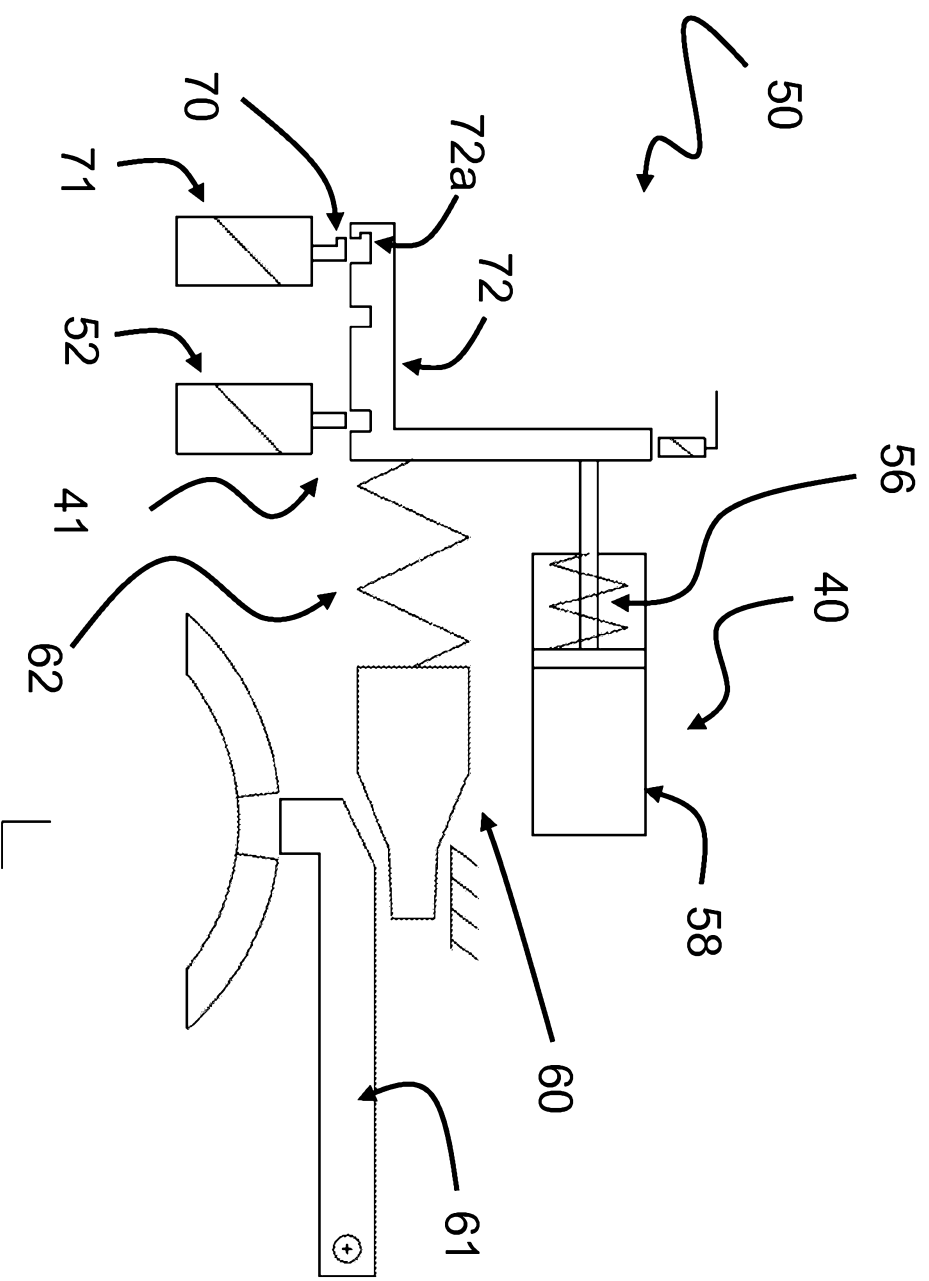


Fig. 16

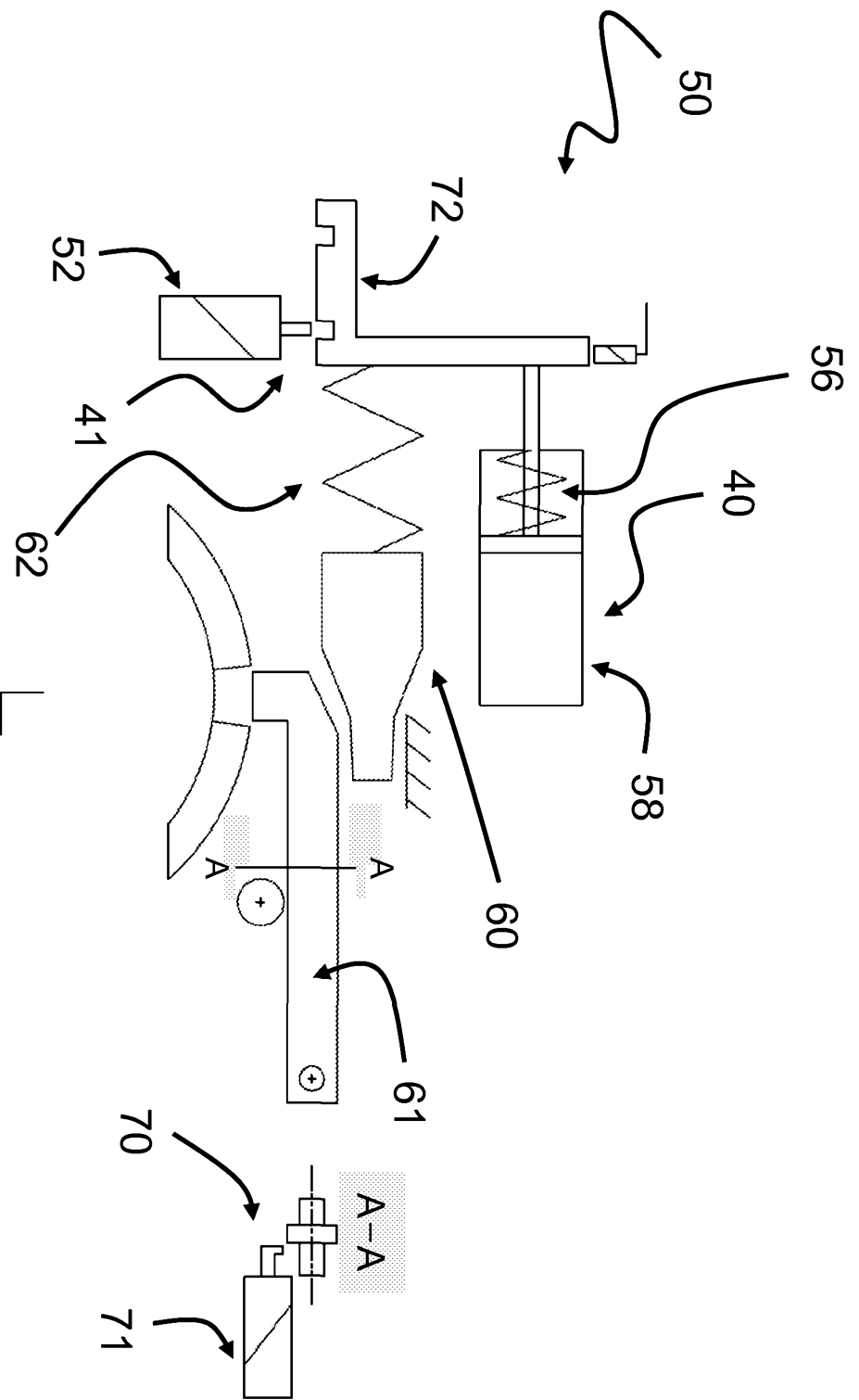
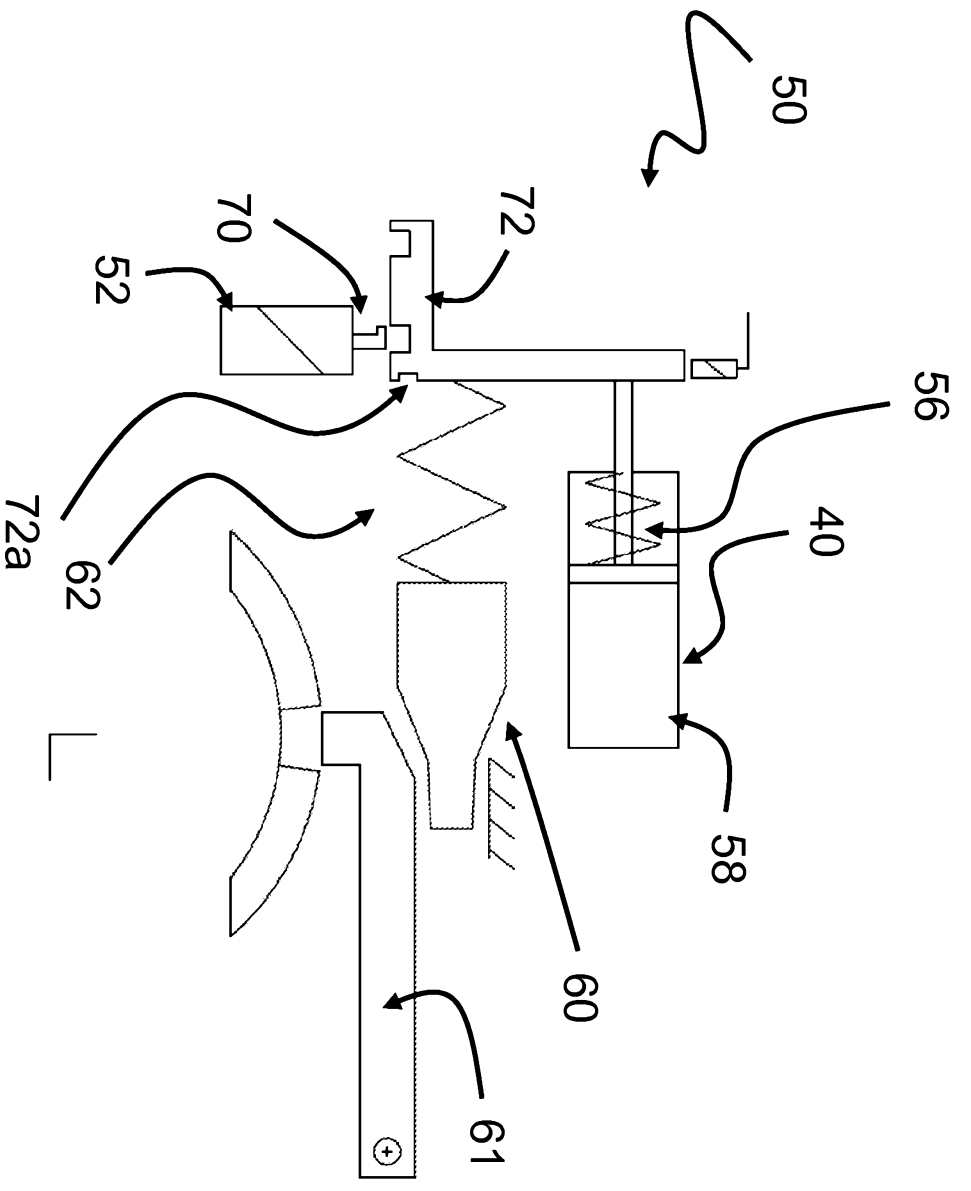


Fig. 17



Title: a hydraulic system for a vehicle, a vehicle transmission, and method for operating a vehicle transmission

Abstract

5

A hydraulic system for a vehicle transmission with at least two friction elements, the system comprising a first hydraulic circuit comprising a pump for supplying hydraulic fluid to the first hydraulic circuit. A flow restriction may be provided in the first hydraulic circuit between an output of the pump and a sump for providing  
10 leakage of hydraulic fluid into the sump. Further, a second hydraulic circuit comprising a second pump may be arranged, wherein the hydraulic pressure in the first circuit is higher compared to the second circuit. A flow control element operated using hydraulic pressure from the first circuit may be arranged for controlling flow/pressure in the second circuit. Further, the hydraulic system may  
15 be arranged for generating a line pressure, wherein an actuator for engaging a park lock system may be connected to the first hydraulic circuit for enabling direct actuation by means of the line pressure.

## SAMENWERKINGSVERDRAG (PCT)

### RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

IDENTIFICATIE VAN DE NATIONALE AANVRAGE	KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE
	<b>P115227NL10</b>
Nederlands aanvraag nr.	Indieningsdatum
<b>2020576</b>	<b>13-03-2018</b>
	Ingeroepen voorrangdatum
	<b>18-04-2017</b>
Aanvrager (Naam)	
<b>Punch Powertrain N.V.</b>	
Datum van het verzoek voor een onderzoek van internationaal type	Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr.
<b>23-06-2018</b>	<b>SN71471</b>
<b>I. CLASSIFICATIE VAN HET ONDERWERP</b> (bij toepassing van verschillende classificaties, alle classificatiesymbolen opgeven)	
Volgens de internationale classificatie (IPC)	
<b>F16H61/00;F16H61/02;F16H63/34;F16H57/04;F16H61/12</b>	
<b>II. ONDERZOCHE GEBIEDEN VAN DE TECHNIEK</b>	
Onderzochte minimumdocumentatie	
Classificatiesysteem	Classificatiesymbolen
<b>IPC</b>	<b>F16H</b>
Onderzochte andere documentatie dan de minimum documentatie, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen	
<b>III.</b> <input checked="" type="checkbox"/> <b>GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES</b>	(opmerkingen op aanvullingsblad)
<b>IV.</b> <input checked="" type="checkbox"/> <b>GEBREK AAN EENHEID VAN UITVINDING</b>	(opmerkingen op aanvullingsblad)

**ONDERZOEKSRAPPORT BETREFFENDE HET  
RESULTAAT VAN HET ONDERZOEK NAAR DE STAND  
VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE**

Nummer van het verzoek om een onderzoek naar  
de stand van de techniek

NL 2020576

<p>A. CLASSIFICATIE VAN HET ONDERWERP                  INV. F16H61/00 F16H61/02 F16H63/34                  ADD. F16H57/04 F16H61/12</p>		
<p>Volgens de internationale Classificatie van octrooien (IPC) of zowel volgens de nationale classificatie als volgens de IPC.</p>		
<p>B. ONDERZOCHETE GEBIEDEN VAN DE TECHNIEK</p> <p>Onderzochte minimum documentatie (classificatie gevolgd door classificatiesymbolen)                  F16H</p>		
<p>Onderzochte andere documentatie dan de minimum documentatie, voor dergelijke documenten, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen</p>		
<p>Tijdens het onderzoek geraadpleegde elektronische gegevensbestanden (naam van de gegevensbestanden en, waar uitvoerbaar, gebruikte trefwoorden)</p> <p>EPO-Internal, WPI Data</p>		
<p>C. VAN BELANG GEACHTE DOCUMENTEN</p>		
<p>Categorie<sup>1)</sup></p>	<p>Gepoeteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages</p>	<p>Van belang voor conclusie nr.</p>
<p>X</p> <p>Y</p> <p>A</p>	<p>EENHEID VAN UITVINDING ONTBREEKT                  zie aanvullingsblad B                  ONVOLLEDIG ONDERZOEK                  zie aanvullingsblad C                  -----                  EP 2 696 111 A1 (GETRAG GETRIEBE ZAHNRAD                  [DE]) 12 februari 2014 (2014-02-12)</p> <p>* figuur 3 *</p> <p>* alineas [0073], [0074], [0077],                  [0079], [0102], [0104], [0107], [0108]                  *</p> <p>* alineas [0110], [0113] *</p> <p>-----                  -/--</p>	<p>1,5,6,                  10,11,                  14,22,                  32,37,40                  34                  2,8,9,                  12,33,35</p>
<p><input checked="" type="checkbox"/> Verdere documenten worden vermeld in het vervolg van vak C. <input checked="" type="checkbox"/> Leden van dezelfde octrooifamilie zijn vermeld in een bijlage</p>		
<p><sup>1)</sup> Speciale categorieën van aangehaalde documenten</p> <p>"A" niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft</p> <p>"D" in de octrooiaanvraag vermeld</p> <p>"E" eerdere octrooi(aanvraag), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven</p> <p>"L" om andere redenen vermelde literatuur</p> <p>"O" niet-schriftelijke stand van de techniek</p> <p>"P" tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur</p> <p>"T" na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvraag, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding</p> <p>"X" de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur</p> <p>"Y" de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere gepoeteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht</p> <p>"&amp;" lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie</p>		
<p>Datum waarop het onderzoek naar de stand van de techniek van internationaal type werd voltooid</p> <p>3 juli 2018</p>		<p>Verzenddatum van het rapport van het onderzoek naar de stand van de techniek van internationaal type</p>
<p>Naam en adres van de instantie</p> <p>European Patent Office, P.B. 5818 Patentlaan 2                  NL - 2280 HV Rijswijk                  Tel. (+31-70) 340-2040                  Fax: (+31-70) 340-3016</p>		<p>De bevoegde ambtenaar</p> <p>Gubovits, János</p>

**ONDERZOEKSRAPPORT BETREFFENDE HET  
RESULTAAT VAN HET ONDERZOEK NAAR DE STAND  
VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE**

Nummer van het verzoek om een onderzoek naar  
de stand van de techniek

NL 2020576

C. (Vervolg). VAN BELANG GEACHTE DOCUMENTEN		
Categorie *	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
X	US 2013/306431 A1 (RUEHLE GUENTER [DE] ET AL) 21 november 2013 (2013-11-21)	1,6,7, 11,14, 22,32, 37,40
Y	* figuren 1, 3, 4 * * alinea's [0002], [0064] - [0068], [0070], [0076], [0078] *	13
Y	US 2013/118852 A1 (SCHULLER DIETMAR [DE] ET AL) 16 mei 2013 (2013-05-16) * figuur 1 * * alinea's [0042], [0044], [0045] *	13,34
A	DE 10 2015 012345 A1 (DAIMLER AG [DE]) 23 maart 2017 (2017-03-23) * figuur 1 *	2
A	US 2015/167835 A1 (HWANG JIN YOUNG [KR]) 18 juni 2015 (2015-06-18) * figuur 1 *	2

**ONVOLLEDIG ONDERZOEK  
AANVULLINGSBLAD C**

Octrooiaanvraag Nr.:

SN 71471  
NL 2020576

Dit verslag van het onderzoek heeft geen betrekking op bepaalde conclusies omdat deze betrekking hebben op delen van de nationale aanvraag die niet voldoen aan de voorgeschreven vereisten, en wel in die mate dat geen zinvol nieuwheidsonderzoek verricht kan worden, in het bijzonder:

Volledig onderzoekbare conclusie(s):

1, 2, 5-35, 37-40

Niet onderzochte conclusie(s):

3, 4, 36

Reden voor de beperking van het onderzoek:

1 Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1.1 The first invention (see reasoning on non-unity of the application) of the present application contains 22 claims, of which 5 are independent claims (claims 1 and 3 belong to the category of apparatus claims, claims 32, 36 and 37 belong to the category of method claims).

1.2 There is no clear distinction between the independent claims 1 and 3 because of their overlapping scope and they are drafted in such a way that the claims as a whole or combined with dependent claims 2 and 4 are not in compliance with the provisions of clarity and conciseness, as it is particularly burdensome for a skilled person to establish the subject-matter for which protection is sought.

1.3 Similarly, there is no clear distinction between independent claims 32, 36 and 37, where the subject-matter of claim 36 seems to be drafted as a combination of the subject-matters of independent claim 32 and dependent claim 33, furthermore, the subject-matter of independent claim 37 shows only minor modifications over that of independent claim 32 and therefore it would be reasonable to draft it as a dependent claim on independent claim 32.

1.4 The non-compliance with the substantive provisions is to such an extent, that the search was performed taking into consideration the non-compliance in determining the extent of the search.

1.5 The search was based on the subject-matter that, as far as can be understood, could reasonably be expected to be claimed later in the procedure, and the corresponding claims, namely independent claims 1, 32 and 37 as well as dependent claims 2, 5-14, 22, 33-35 and 40 depending on said independent claims.

## GEBREK AAN EENHEID VAN UITVINDING

Octrooiaanvraag Nr.:

SN 71471

NL 2020576

### AANVULLINGSBLAD B

De instantie belast met het uitvoeren van het onderzoek naar de stand van de techniek heeft vastgesteld dat deze aanvraag meerdere uitvindingen bevat, te weten:

1. conclusies: 1-14, 32-37(compleet); 22, 40(gedeeltelijk)

A flow restriction for determining line pressure provided in a hydraulic circuit. A method for the generation of line pressure in said hydraulic circuit.

---

2. conclusies: 15-21, 23-31, 38, 39(compleet); 22, 40(gedeeltelijk)

A parklock actuator arranged for activating a parklock system by means of the line pressure of a hydraulic circuit. Method of operating said parklock system.

---

Het vooronderzoek werd tot het eerste onderwerp beperkt.

1 The application lacks of unity.

1.1 The Search Division considers, that there are two groups of inventions covered by the claims indicated as follows:

1. Group I: claims 1-14, 22, 32-37, 40

A flow restriction for determining line pressure provided in a hydraulic circuit. A method for the generation of line pressure in said hydraulic circuit.

2. Group II: claims 15-31, 38-40

A parklock actuator arranged for activating a parklock system by means of the line pressure of a hydraulic circuit. Method of operating said parklock system

Dependent claims 22 and 40 are not unambiguously linked to any of the inventions, therefore they can form part of each of them.

Although dependent claim 15 is drafted to be dependent on claim 1, the subject matter of claim 15 renders a reference to group II of inventions. As independent claim 1 does not fulfil the requirements of novelty over document D1 (see below), claim 15 renders non-compliance with the requirements of unity, too.

1.2 Since claim 16 does not contain all the features of claim 1 and vice versa, they are considered to be two independent claims.

The common concept of the two inventions (see point 1.1) is as follows:

- A hydraulic system for a vehicle transmission comprising a first hydraulic circuit.

Furthermore, the feature of:

- the first hydraulic circuit being arranged to generate a line pressure can be regarded as present both in claim 1 (implicitly through the feature of a first electrically driven pump arranged for supplying hydraulic fluid to the first hydraulic circuit ) and in claim 16 (explicitly), therefore this feature can be regarded as part of the common concept of the two inventions, too.

Although, these technical features are known from the prior art represented by document D1 (see below).

1.3 Document D1 discloses (the references in parentheses applying to this document, especially to figure 3):

- a hydraulic system for a vehicle (see paragraph [0073]), comprising

**GEBREK AAN EENHEID VAN UITVINDING**

Octrooiaanvraag Nr.:

SN 71471

NL 2020576

**AANVULLINGSBLAD B**

De instantie belast met het uitvoeren van het onderzoek naar de stand van de techniek heeft vastgesteld dat deze aanvraag meerdere uitvindingen bevat, te weten:

- a first hydraulic circuit fed by the pump 32A? (see paragraphs [0107]-[0113]).

1.4 Since document D1 contains all the common features of claim 1 and claim 16, these inventions do not comprise common special technical features.

1.5 Furthermore, said groups can not be linked by any further features fulfilling the requirements of a single general inventive concept, because of the differences between the problems they intend to solve:

Group I: Determining line pressure provided in a hydraulic circuit.

Group II: A parklock actuator actuated by means of the line pressure of a hydraulic circuit.

1.6 Considering that groups I and II show neither common special technical features (see point 1.4) nor corresponding special technical features linking them to a single general inventive concept (see point 1.5), there is no technical relationship between the two inventions. Thus, the requirements of unity of the application are not fulfilled.

**ONDERZOEKSRAPPORT BETREFFENDE HET  
RESULTAAT VAN HET ONDERZOEK NAAR DE STAND  
VAN DE TECHNIEK VAN HET INTERNATIONALE TYPE**

Informatie over leden van dezelfde octrooifamilie

Nummer van het verzoek om een onderzoek naar  
de stand van de techniek

NL 2020576

In het rapport genoemd octrooigeeschrift	Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie
EP 2696111	A1	12-02-2014	CN 103574023 A 12-02-2014
			DE 102012016235 A1 13-02-2014
			EP 2696111 A1 12-02-2014
			US 2014041986 A1 13-02-2014
US 2013306431	A1	21-11-2013	CN 103423442 A 04-12-2013
			DE 102012010172 A1 21-11-2013
			EP 2664826 A1 20-11-2013
			US 2013306431 A1 21-11-2013
US 2013118852	A1	16-05-2013	CN 102777592 A 14-11-2012
			DE 102011100857 A1 08-11-2012
			EP 2520832 A2 07-11-2012
			US 2013118852 A1 16-05-2013
DE 102015012345	A1	23-03-2017	DE 102015012345 A1 23-03-2017
			WO 2017050402 A1 30-03-2017
US 2015167835	A1	18-06-2015	CN 104728430 A 24-06-2015
			DE 102014114965 A1 18-06-2015
			KR 20150071610 A 26-06-2015
			US 2015167835 A1 18-06-2015

## WRITTEN OPINION

File No. SN71471	Filing date (day/month/year) 13.03.2018	Priority date (day/month/year) 18.04.2017	Application No. NL2020576
International Patent Classification (IPC) INV. F16H61/00 F16H61/02 F16H63/34 ADD. F16H57/04 F16H61/12			
Applicant Punch Powertrain N.V.			

This opinion contains indications relating to the following items:

- Box No. I Basis of the opinion
- Box No. II Priority
- Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- Box No. IV Lack of unity of invention
- Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- Box No. VI Certain documents cited
- Box No. VII Certain defects in the application
- Box No. VIII Certain observations on the application

Examiner Gubovits, János
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## WRITTEN OPINION

Application number

NL2020576

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### Box No. 1 Basis of this opinion

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1. This opinion has been established on the basis of the latest set of claims filed before the start of the search.
2. With regard to any **nucleotide and/or amino acid sequence** disclosed in the application and necessary to the claimed invention, this opinion has been established on the basis of:
  - a. type of material:
    - a sequence listing
    - table(s) related to the sequence listing
  - b. format of material:
    - on paper
    - in electronic form
  - c. time of filing/furnishing:
    - contained in the application as filed.
    - filed together with the application in electronic form.
    - furnished subsequently for the purposes of search.
3.  In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
4. Additional comments:

## WRITTEN OPINION

Application number  
NL2020576

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### Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

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The questions whether the claimed invention appears to be novel, to involve an inventive step, or to be industrially applicable have not been examined in respect of

- the entire application
- claims Nos. 3, 4, 15-21, 23-31, 36, 38, 39(compleet); 22, 40(gedeeltelijk)

because:

- the said application, or the said claims Nos. relate to the following subject matter which does not require a search (*specify*):
- the description, claims or drawings (*indicate particular elements below*) or said claims Nos. are so unclear that no meaningful opinion could be formed (*specify*):
- the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed (*specify*):
- no search report has been established for the whole application or for said claims Nos. 3, 4, 15-21, 23-31, 36, 38, 39(compleet); 22, 40(gedeeltelijk)
- a meaningful opinion could not be formed as the sequence listing was either not available, or was not furnished in the international format (WIPO ST25).
- a meaningful opinion could not be formed without the tables related to the sequence listings; or such tables were not available in electronic form.
- See Supplemental Box for further details.

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### Box No. IV Lack of unity of invention

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1. The requirement of unity of invention is not complied with for the following reasons:  
**see separate sheet**
2. This report has been established in respect of the following parts of the application:
  - all parts.
  - the parts relating to claims Nos. (see Search Report)

## WRITTEN OPINION

Application number

NL2020576

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**Box No. V Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

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1. Statement

Novelty	Yes: Claims	2, 7-9, 12, 13, 33-35
	No: Claims	1, 5, 6, 10, 11, 14, 32, 37(compleet); 22, 40(gedeeltelijk)
Inventive step	Yes: Claims	2, 8, 9, 12, 33, 35
	No: Claims	1, 5-7, 10, 11, 13, 14, 32, 34, 37(compleet); 22, 40(gedeeltelijk)
Industrial applicability	Yes: Claims	1, 2, 5-14, 32-35, 37(compleet); 22, 40(gedeeltelijk)
	No: Claims	

2. Citations and explanations

**see separate sheet**

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**Box No. VII Certain defects in the application**

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**see separate sheet**

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**Box No. VIII Certain observations on the application**

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**see separate sheet**

**Re Item VIII**

**Certain observations on the international application**

Claims 5, 6, 8, 12, 13, 15, 24 and 33 are not clear.

- 1 Claim 5 and claim 6 determine their subject-matters as being dependent on one of the claims 1-4 and 1-5 respectively, however they define *the flow restriction*, which is not mentioned in independent claim 3, therefore claims 5 and 6 can not be dependent on claim 3.
- 2 Claim 8 determines its subject-matter as being dependent on one of the claims 1-7, however it defines *the flow restriction*, which is neither mentioned in independent claim 3 nor in dependent claim 7 (or in all the combinations rendered by the dependencies of claim 7), therefore claim 8 can not be dependent on claim 3 or claim 7.
- 3 Claim 12 determines its subject-matter as being dependent on one of the claims 8-10, however it defines *the controller*, which is not mentioned in dependent claim 10 (or in all the combinations rendered by the dependencies of claim 10), therefore claim 12 can not be dependent on claim 10.
- 4 Claim 13 defines its subject-matter with reference to *any one of the preceding*, thereby rendering its dependency unclear (is it dependent on a claim or only on a some features of a claim?).  
Claims can only be dependent on whole claims, therefore claim 13 should refer back to (a) specific claim(s).
- 5 Claim 13 determines its subject-matter as being dependent on one of the claims 1-12, however it defines *the flow control element*, which is neither mentioned in independent claim 3 nor in dependent claims 7, 10, 11 or 12 (or in all the combinations rendered by the dependencies of these claims).  
Furthermore, claim 13 defines *the at least two control elements*, which are only mentioned in claim 7.
- 6 Claim 15 determines its subject-matter as being dependent on one of the claims 1-14, however it defines *one of the two or more hydraulic actuators*, which are only mentioned in claims 3 (explicitly) and 4 (implicitly, through its dependency on claim 3), not in any other claim (neither by all the combinations rendered by their dependencies), therefore claim 15 can only be dependent on claims 3 or 4.

- 7 Claim 24 defines its subject-matter by *for instance including a hydraulic system according to any one of the claims 1-21*, however the expression "for instance" renders said dependency of claim 24 as merely optional, and the subject-matter of claim 24 is thereby not clear.
- 8 Claim 33 defines the feature of *controlling a flow speed of the first pump*, however it is not clear what is meant under "flow speed of a pump" as only fluids seem to have flow speed.  
This unclear feature will be interpreted during the present prosecution as covering the speed of the pump.

### **Re Item III**

#### **Non-establishment of opinion with regard to novelty, inventive step and industrial applicability**

- 1 The first invention (see reasoning on non-unity of the application) of the present application contains 22 claims, of which 5 are independent claims (claims 1 and 3 belong to the category of apparatus claims, claims 32, 36 and 37 belong to the category of method claims).
  - 1.1 There is no clear distinction between the independent claims 1 and 3 because of their overlapping scope and they are drafted in such a way that the claims as a whole or combined with dependent claims 2 and 4 are not in compliance with the provisions of clarity and conciseness, as it is particularly burdensome for a skilled person to establish the subject-matter for which protection is sought.
  - 1.2 Similarly, there is no clear distinction between independent claims 32, 36 and 37, where the subject-matter of claim 36 seems to be drafted as a combination of the subject-matters of independent claim 32 and dependent claim 33, furthermore, the subject-matter of independent claim 37 shows only minor modifications over that of independent claim 32 and therefore it would be reasonable to draft it as a dependent claim on independent claim 32.
  - 1.3 The non-compliance with the substantive provisions is to such an extent, that the search was performed taking into consideration the non-compliance in determining the extent of the search.

- 1.4 The search was based on the subject-matter that, as far as can be understood, could reasonably be expected to be claimed later in the procedure, and the corresponding claims, namely independent claims 1, 32 and 37 as well as dependent claims 2, 5-14, 22, 33-35 and 40 depending on said independent claims.

**Re Item IV**

**Lack of unity of invention**

- 1 The application lacks of unity.
- 1.1 The Search Division considers, that there are two groups of inventions covered by the claims indicated as follows:

1. Group I: claims 1-14, 22, 32-37, 40

A flow restriction for determining line pressure provided in a hydraulic circuit. A method for the generation of line pressure in said hydraulic circuit.

2. Group II: claims 15-31, 38-40

A parklock actuator arranged for activating a parklock system by means of the line pressure of a hydraulic circuit. Method of operating said parklock system

Dependent claims 22 and 40 are not unambiguously linked to any of the inventions, therefore they can form part of each of them.

Although dependent claim 15 is drafted to be dependent on claim 1, the subject matter of claim 15 renders a reference to group II of inventions. As independent claim 1 does not fulfil the requirements of novelty over document D1 (see below), claim 15 renders non-compliance with the requirements of unity, too.

- 1.2 Since claim 16 does not contain all the features of claim 1 and vice versa, they are considered to be two independent claims.

The common concept of the two inventions (see point 1.1) is as follows:

- A hydraulic system for a vehicle transmission comprising a first hydraulic circuit.

Furthermore, the feature of:

- the first hydraulic circuit being arranged to generate a line pressure

can be regarded as present both in claim 1 (implicitly through the feature of a *first electrically driven pump arranged for supplying hydraulic fluid to the first hydraulic circuit*) and in claim 16 (explicitly), therefore this feature can be regarded as part of the common concept of the two inventions, too.

Although, these technical features are known from the prior art represented by document D1 (see below).

1.3 Document D1 discloses (the references in parentheses applying to this document, especially to figure 3):

- a hydraulic system for a vehicle (see paragraph [0073]), comprising
- a first hydraulic circuit fed by the pump 32A\* (see paragraphs [0107]-[0113]).

1.4 Since document D1 contains all the common features of claim 1 and claim 16, these inventions do not comprise common special technical features.

1.5 Furthermore, said groups can not be linked by any further features fulfilling the requirements of a common inventive concept, because of the differences between the problems they intend to solve:

Group I: Determining line pressure provided in a hydraulic circuit.

Group II: A parklock actuator actuated by means of the line pressure of a hydraulic circuit.

1.6 Considering that groups I and II show neither common special technical features (see point 1.4) nor corresponding special technical features linking them to a common inventive concept (see point 1.5), there is no technical relationship between the two inventions.

Thus, the requirements of unity of the application are not fulfilled.

### **Re Item V**

#### **Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1 Reference is made to the following documents:

- |    |  |
|----|--|
| D1 | EP 2 696 111 A1 (GETRAG GETRIEBE ZAHNRAD [DE]) 12 February 2014 (2014-02-12) |
| D2 | US 2013/306431 A1 (RUEHLE GUENTER [DE] ET AL) 21 November 2013 (2013-11-21)  |

- D3 US 2013/118852 A1 (SCHULLER DIETMAR [DE] ET AL) 16 May 2013 (2013-05-16)
- D4 DE 10 2015 012345 A1 (DAIMLER AG [DE]) 23 March 2017 (2017-03-23)
- D5 US 2015/167835 A1 (HWANG JIN YOUNG [KR]) 18 June 2015 (2015-06-18)

## 2 Independent claim 1

The present application does not meet the criteria of patentability, because the subject-matter of claim 1 is not new.

- 2.1 D1 discloses (the references in parentheses applying to this document, especially to figure 3):

*A hydraulic system for a vehicle transmission (see paragraph [0073]), the transmission including two or more friction elements (see clutches (16) and (16A) and parklock (24')), the hydraulic system comprising: a first hydraulic circuit (see circuit from the pump (32A') to the clutch (16A) and to the parklock (24') through section (104), see paragraph [0113]) arranged for actuating the two or more friction elements (see clutch (16) and parklock (24'));*  
*a first electric driven pump (32A', see paragraphs [0102] and [0108]), arranged for supplying hydraulic fluid to the first hydraulic circuit; and a flow restriction (48A') provided in the first hydraulic circuit between an output of the first electric driven pump (32A') and a reservoir (40) to provide leakage of hydraulic fluid into the reservoir (40, see paragraph [0110]).*

The subject-matter of claim 1 is therefore not new.

- 2.2 Additionally it is pointed out, that document D2 also shows a hydraulic system for a vehicle transmission with all the features according to claim 1, see reasoning below and references in the Search Report for (the references in parentheses applying to this document, especially to figures 3 and 4):

- a hydraulic system for a vehicle transmission (see paragraph [0002]);
- two friction elements (17' and 30', see paragraphs [0076] and [0078]);

- a first hydraulic circuit (the circuit between the pump port (67') and the two friction elements (17') and (30'));
- a first electrically driven pump (62', see paragraph [0076]);
- a flow restriction (68, 78, 86 or 94; see paragraphs [0064]-[0068]).

**3 Dependent claims 5-7, 10, 11, 13, 14, 22, 40**

Notwithstanding the above-mentioned lack of clarity (see item VIII), dependent claims 5-7, 10, 11, 13, 14, 22 and 40 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of novelty, see documents D1-D3 and the cited passages in the search report:

**3.1 Claim 5:**

- see D1, fig. 3 for the hydraulic fluid flowing through the flow restriction (48A') and being used to lubricate transmission parts (16) and (16A) through a cooling arrangement (50, see paragraph [0079]).

**3.2 Claim 6:**

- see D1, fig. 3 for the flow restriction (48A') with a fixed geometry.

**3.3 Claim 7:**

- see D2, fig.1 for two friction elements (16, 18).

**3.4 Claim 10:**

- see D1, fig. 3 for hydraulic circuits being free from a hydraulic accumulator.

**3.5 Claim 11:**

- see D1, fig. 3 for a hydraulic circuit being free from a pressure relief valve.

3.6 **Claim 13:**

- see D3, fig. 1 for the control elements (121, 121') including electric control input (see paragraph [0044]).

3.7 **Claim 14:**

- see D1, fig. 3 for the first hydraulic circuit being arranged for generating a line pressure (by the pump (32A')).

3.8 **Claim 22:**

- see D1, paragraph [0002] for the vehicle transmission.

3.9 **Claim 40:**

- see D1, paragraph [0002] for the vehicle.

4 **Independent claim 32**

The present application does not meet the criteria of patentability, because the subject-matter of claim 32 is not new.

4.1 D1 discloses (the references in parentheses applying to this document, especially to figure 3):

*A method for generating a line pressure in a vehicle transmission, including a first hydraulic circuit arranged for actuating two or more friction elements (see paragraphs [0074] and [0104]), the method including:*

*supplying hydraulic fluid to the first hydraulic circuit using a first pump (see paragraph [0108]); and*

*using a flow restriction provided in the first hydraulic circuit between an output of the first pump and a reservoir to provide leakage of hydraulic fluid into the reservoir for generating the line pressure (see paragraph [0110]).*

The subject-matter of claim 32 is therefore not new.

4.2 Additionally it is pointed out, that document D2 also shows a method for generating a line pressure in a vehicle transmission with all the features according to claim 32, see reasoning below and references in the Search Report for (the references in parentheses applying to this document, especially to figures 3 and 4):

- supplying hydraulic fluid to the first hydraulic circuit using a first pump (see paragraph [0076]);
- using a flow restriction in the first circuit between an output of the first pump and a reservoir to provide leakage of hydraulic fluid for the generating the line pressure (see paragraph [0070]).

**5 Dependent claim 34**

Dependent claim 34 does not contain any features which, in combination with the features of any claim to which it refers, meet the requirements of novelty and/or inventive step, see document D3 and the cited passages in the search report for:

- the control elements (101) and (101'), two friction elements with actuators (K1) and (K2) (see paragraphs [0042] and [0045]).

**6 Independent claim 37**

The present application does not meet the criteria of patentability, because the subject-matter of claim 37 is not new.

6.1 D1 discloses (the references in parentheses applying to this document, especially to figure 3):

*A method for the actuating hydraulic actuators associated with two or more friction elements of a vehicle transmission using a first hydraulic circuit (see paragraphs [0074] and [0104]), the method including for supplying hydraulic fluid to the first hydraulic circuit using a first electrically driven pump (see paragraph [0108]); and controlling pressure of the first hydraulic circuit by providing a flow restriction in the first hydraulic circuit between the first electric pump and a reservoir to provide leakage of hydraulic fluid into the reservoir (see paragraph [0110]) and controlling a speed of the first electric driven pump (see paragraph [0077]).*

The subject-matter of claim 37 is therefore not new.

**7 Dependent claims 2, 8, 9, 12, 33, 35**

The subject-matters of dependent claims 2, 8, 9, 12, 33, 35 contain some features which, in combination with claims to which they refer seem to be neither known from nor rendered obvious by the available prior art (D1-D5). The reasons are as follows:

**7.1 Claim 2:**

The feature of:

- a flow control element controlling flow and/or pressure in a second hydraulic circuit and being operated using hydraulic pressure from the first hydraulic circuit

is neither known from nor rendered obvious by the available prior art (D1-D5).

**7.2 Claim 8:**

The feature of:

- a controller arranged for controlling hydraulic pressure in the first hydraulic circuit by controlling flow of hydraulic fluid through the flow restriction

is neither known from nor rendered obvious by the available prior art (D1-D5).

**7.3 Claim 9:**

Claims 9 is dependent on claim 8 whose subject-matter is considered as being new and inventive, as discussed above, and as such said dependent claim also meets the requirements of the patentability with respect to novelty and inventive step.

**7.4 Claim 12:**

Claims 12 is dependent on claim 8 (see item VIII, point 3) whose subject-matter is considered as being new and inventive, as discussed above, and as such said dependent claim also meets the requirements of patentability with respect to novelty and inventive step.

**7.5 Claim 33:**

The feature of:

- controlling the line pressure by controlling the speed of the first pump (see Item VIII, point 8)

is neither known from nor rendered obvious by the available prior art (D1-D5).

**7.6 Claim 35:**

The feature of:

- a flow control element controlling flow and/or pressure in a second hydraulic circuit and being operated using line pressure from the first hydraulic circuit

is neither known from nor rendered obvious by the available prior art (D1-D5).

**Re Item VII**

**Certain defects in the application**

- 1 The statements in the description on page 13, lines 25-28, on page 30, lines 15-20 and on page 32, lines 3-24 imply that the subject-matter for which protection is sought may be different to that defined by the claims, thereby resulting in lack of clarity when used to interpret them.
- 2 The relevant background art disclosed in D1 and D2 is not mentioned in the description, nor are these documents identified therein.