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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

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.

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 know 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 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 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 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 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 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.

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.

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.

Thereto, 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 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 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 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 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 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.

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 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 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 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 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 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 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, 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 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 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 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 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.

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 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 controlled by controlling the speed of the first electric driven pump.

Optionally, hydraulic fluid flowing through the flow restriction can at least partly 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 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 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 elements, e.g. proportional pressure valves.

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.
- 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 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 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.

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 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.

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 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.

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.

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:

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;

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;

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;

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;

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

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

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.

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 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.

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 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 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 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.

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.

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 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 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.

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 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 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 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 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 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 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 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 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 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 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 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 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 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.

Herein, the invention is described with reference to specific examples of 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 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 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 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 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 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 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 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 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.

Conclusies

1. Hydraulisch systeem voor een voertuigtransmissie, waarbij de transmissie is voorzien van twee of meer frictie-elementen, en het hydraulisch systeem omvattende:

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

een eerste elektrisch aangedreven pomp, ingericht voor het toevoeren van hydraulisch fluïdum aan het eerste hydraulische circuit; en

een flowrestrictieaangebracht in het eerste hydraulische circuit tussen een uitgang van de eerste elektrisch aangedreven pomp en een reservoir om lekkage van hydraulisch fluïdum te voorzien in het reservoir.

2. Hydraulisch systeem volgens conclusie 1, verder omvattende:

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 toevoeren van hydraulisch fluïdum 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

een flowregelelement ingericht voor het regelen van de stroom en/of druk in het tweede hydraulische circuit, waarbij het flowregelelement wordt bediend met behulp van hydraulische druk uit het eerste hydraulische circuit.

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

een eerste hydraulisch circuit ingericht voor het actueren 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;

een eerste elektrisch aangedreven pomp, ingericht voor het toevoeren van hydraulisch fluïdum aan het eerste hydraulische circuit;

een tweede elektrisch aangedreven pomp ingericht voor het toevoeren van hydraulisch fluïdum aan het tweede hydraulische circuit, waarbij de eerste elektrisch aangedreven pomp is ingericht om een hogere druk te leveren dan de tweede elektrisch aangedreven pomp; en

een flowregelelement, ingericht voor het regelen van de stroom en/of druk in het tweede hydraulische circuit, waarbij het flowregelelement wordt bediend met behulp van hydraulische druk uit het eerste hydraulische circuit.

4. Hydraulisch systeem volgens conclusie 3, waarbij het eerste hydraulische circuit een flowrestrictie omvat voor het bepalen van een druk in het eerste hydraulische circuit, stroomopwaarts van de flowrestrictie, aangebracht tussen een uitgang van de eerste elektrisch aangedreven pomp en een reservoir om lekkage van het hydraulische fluïdum te voorzien in het reservoir.

5. Hydraulisch systeem volgens één van de conclusies 1 - 4, waarbij hydraulisch fluïdum dat door de flowrestrictie stroomt ten minste gedeeltelijk wordt gebruikt voor het actief smeren van transmissie-onderdelen.

6. Hydraulisch systeem volgens één van de conclusies 1 - 5, waarbij de flowrestrictie een vaste geometrie heeft.

7. Hydraulisch systeem volgens één van de conclusies 1 - 6, waarbij het eerste hydraulische circuit ten minste twee regelelementen omvat, ingericht voor het actueren van de twee of meer frictie-elementen, waarbij de regelelementen worden bediend met behulp van hydraulische druk uit het eerste hydraulische circuit.

8. Hydraulisch systeem volgens één van de conclusies 1 - 7, omvattende een controller ingericht voor het regelen van hydraulische druk in het eerste

hydraulische circuit door de stroom van hydraulisch fluïdum door de flowrestrictie te regelen.

9. Hydraulisch systeem volgens conclusie 8, waarbij de controller is ingericht voor het regelen van een snelheid van de eerste elektrisch aangedreven pomp.

10. Hydraulisch systeem volgens één van de conclusies 1 - 9, waarbij het eerste hydraulische circuit vrij is van een hydraulische fluïdumaccumulator.

11. Hydraulisch systeem volgens één van de conclusies 1 tot 10, waarbij het eerste hydraulische circuit vrij is van een overdrukventiel, ingericht voor het instellen van de hydraulische druk in het eerste hydraulische circuit.

12. Hydraulisch systeem volgens één van de conclusies 8 - 10, waarbij de controller is ingericht voor het draaien van de eerste elektrisch aangedreven pomp in slechts één richting.

13. Hydraulisch systeem volgens één van de voorgaande conclusies, waarbij het flowregelelement en/of de minstens twee regelelementen een elektrische regelingang omvat(ten).

14. Hydraulisch systeem volgens één van de conclusies 1 - 13, waarbij het eerste hydraulische circuit is ingericht voor het genereren van een lijndruk.

15. Hydraulisch systeem volgens één van de conclusies 1 - 14, waarbij een van de twee of meer hydraulische actuatoren is ingericht voor het aandrijven van een parklock systeem, waarbij genoemde hydraulische actuator hydraulisch in verbinding staat met het eerste hydraulische circuit voor directe actuatie van de hydraulische actuator met behulp van de lijndruk.

16. Hydraulisch systeem voor een voertuigtransmissie, omvattende:

een eerste hydraulisch circuit, ingericht voor het genereren van een lijndruk; en

een hydraulische actuator, ingericht voor het activeren van een parklock systeem, waarbij de hydraulische actuator hydraulisch in verbinding staat met het eerste hydraulische circuit voor directe actuatie van de hydraulische actuator met behulp van de lijndruk.

17. Hydraulisch systeem volgens conclusie 15 of 16, waarbij de hydraulische actuator is ingericht voor het in een parkeerstand brengen of houden van het parklock systeem wanneer de lijndruk lager is dan een vooraf bepaalde drukdrempel.

18. Hydraulisch systeem volgens conclusie 17, waarbij het eerste hydraulische circuit een ventiel omvat, ingericht voor het draineren van de hydraulische actuator wanneer de lijndruk lager is dan een vooraf bepaalde drukdrempel.

19. Hydraulisch systeem volgens conclusie 15 of 16, waarbij de hydraulische actuator is ingericht voor het in een niet-parkeerstand brengen of houden van het parklock systeem, wanneer de lijndruk lager is dan een vooraf bepaalde drukdrempel.

20. Hydraulisch systeem volgens conclusie 15 of 16, waarbij de hydraulische actuator een actuator omvat, ingericht voor het in een parkeerstand of niet-parkeerstand houden van het parklock systeem, volgens een laatste invoer van een bediener van het hydraulische systeem, wanneer de lijndruk lager is dan een vooraf bepaalde drukdrempel.

21. Hydraulisch systeem volgens één van de conclusies 15 - 20, omvattende een terugslagventiel omvat tussen de eerste hydraulische pomp en de hydraulische actuator.

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

23. Voertuigtransmissie volgens conclusie 22, voor zover afhankelijk van één van de conclusies 15 - 20, dat mechanische middelen omvat om het parklock systeem van een parkeerstand naar een niet-parkeerstand te brengen, wanneer de lijndruk lager is dan een vooraf bepaalde drukdrempel.

24. Werkwijze voor het genereren van een lijndruk in een voertuigtransmissie, dat een eerste hydraulisch circuit omvat, ingericht voor het actueren van twee of meer frictie-elementen, waarbij de werkwijze omvattende:

het toevoeren van hydraulisch fluïdum naar het eerste hydraulische circuit met behulp van een eerste pomp; en

het gebruik maken van een flowrestrictie aangebracht in het eerste hydraulische circuit tussen een uitgang van de eerste pomp en een reservoir om lekkage van hydraulisch fluïdum in het reservoir te voorzien voor het genereren van lijndruk.

25. Werkwijze volgens conclusie 24, omvattende het regelen van de lijndruk door het regelen van een stroomsnelheid van de eerste pomp.

26. Werkwijze volgens conclusie 24 of 25, omvattende het regelen van twee of meer actuatoren geassocieerd met de twee of meer frictie-elementen onder gebruikmaking van ten minste twee regelelement die worden bediend met behulp van de lijndruk.

27. Werkwijze volgens één van de conclusies 24 - 26, omvattende:

het koelen en/of smeren van de frictie-elementen, onder gebruikmaking van een tweede hydraulisch circuit dat een tweede pomp omvat die daarmee geassocieerd is, door stroom en/of druk te regelen in het tweede hydraulische circuit

onder gebruikmaking van een flowregelelement, waarbij het flowregelelement wordt bediend met behulp van de lijndruk.

28. Werkwijze voor het koelen en/of smeren van frictie-elementen van een voertuigtransmissie, waarbij de voertuigtransmissie omvat een eerste hydraulisch circuit, ingericht voor het actueren van twee of meer hydraulische actuatoren geassocieerd met twee of meer frictie-elementen, 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 toevoeren van hydraulisch fluïdum naar het eerste hydraulische circuit, en een tweede elektrisch aangedreven pomp, ingericht voor het toevoeren van hydraulisch fluïdum naar het tweede hydraulische circuit, waarbij de eerste elektrische pomp is ingericht voor het leveren van een hogere druk dan de tweede elektrische pomp,

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

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

het toevoeren van hydraulisch fluïdum naar het eerste hydraulische circuit onder gebruikmaking van een eerste elektrisch aangedreven pomp; en

het regelen van druk van het eerste hydraulische circuit door een flowrestrictie te verschaffen in het eerste hydraulische circuit tussen de eerste elektrische pomp en een reservoir om lekkage van hydraulisch fluïdum te voorzien in het reservoir en een snelheid van de eerste elektrisch aangedreven pomp te regelen.

30. Werkwijze volgens één van de conclusies 24 - 29, omvattende:

het vrijgeven van een parklock systeem onder gebruikmaking van een hydraulische actuator verbonden met het eerste hydraulische circuit, die de hydraulische actuator direct actueert met behulp van de lijndruk.

31. Werkwijze voor het bedienen van een parklock systeem van een voertuigtransmissie, omvattende:

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

het vrijgeven van een parklock systeem onder gebruikmaking van een hydraulische actuator die hydraulisch in verbinding staat met het eerste hydraulische circuit, en die de hydraulische actuator direct actueert met behulp van de lijndruk.

32. Een voertuig omvattende een voertuigtransmissie volgens conclusie 22.

Fig. 1

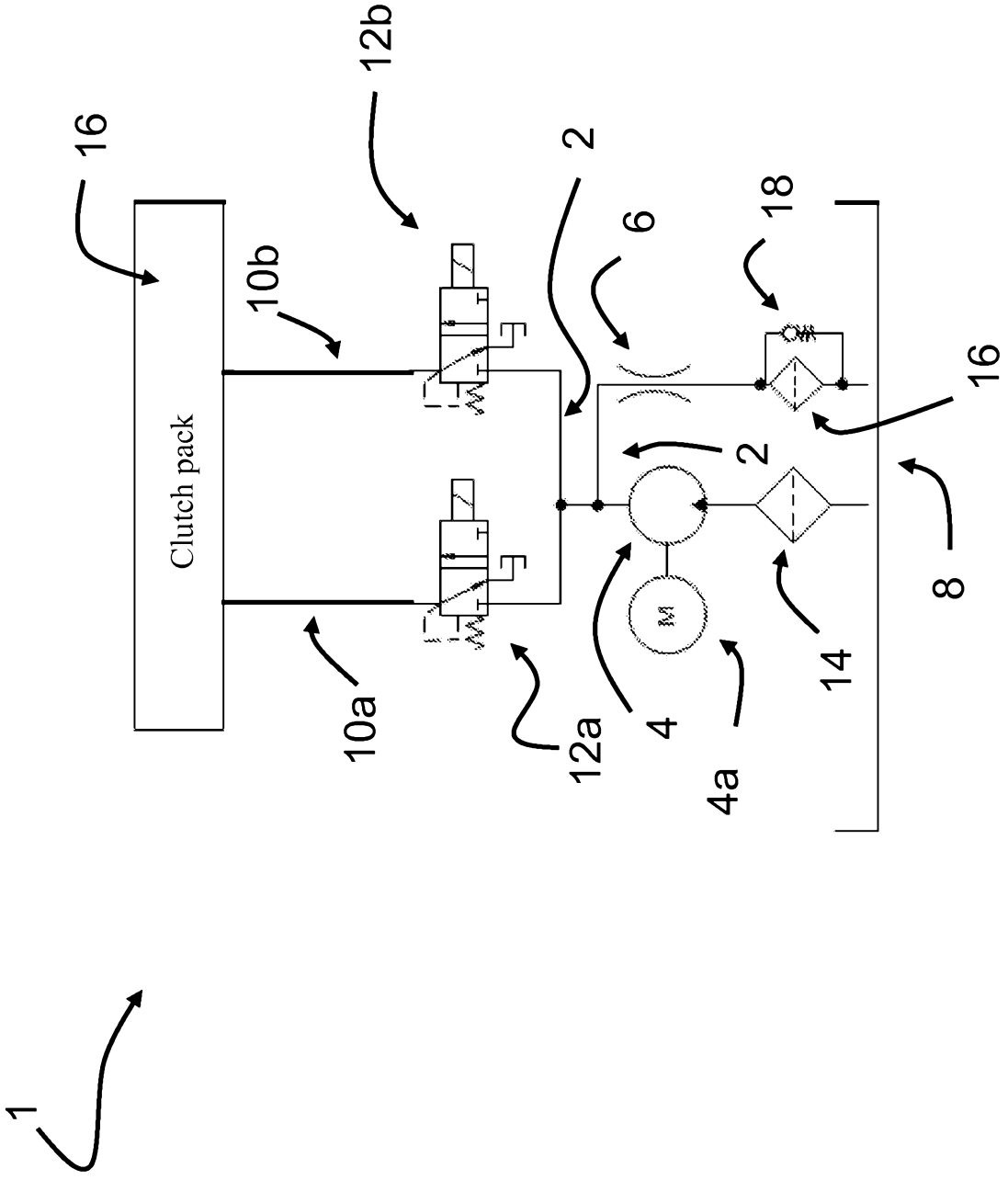


Fig. 2

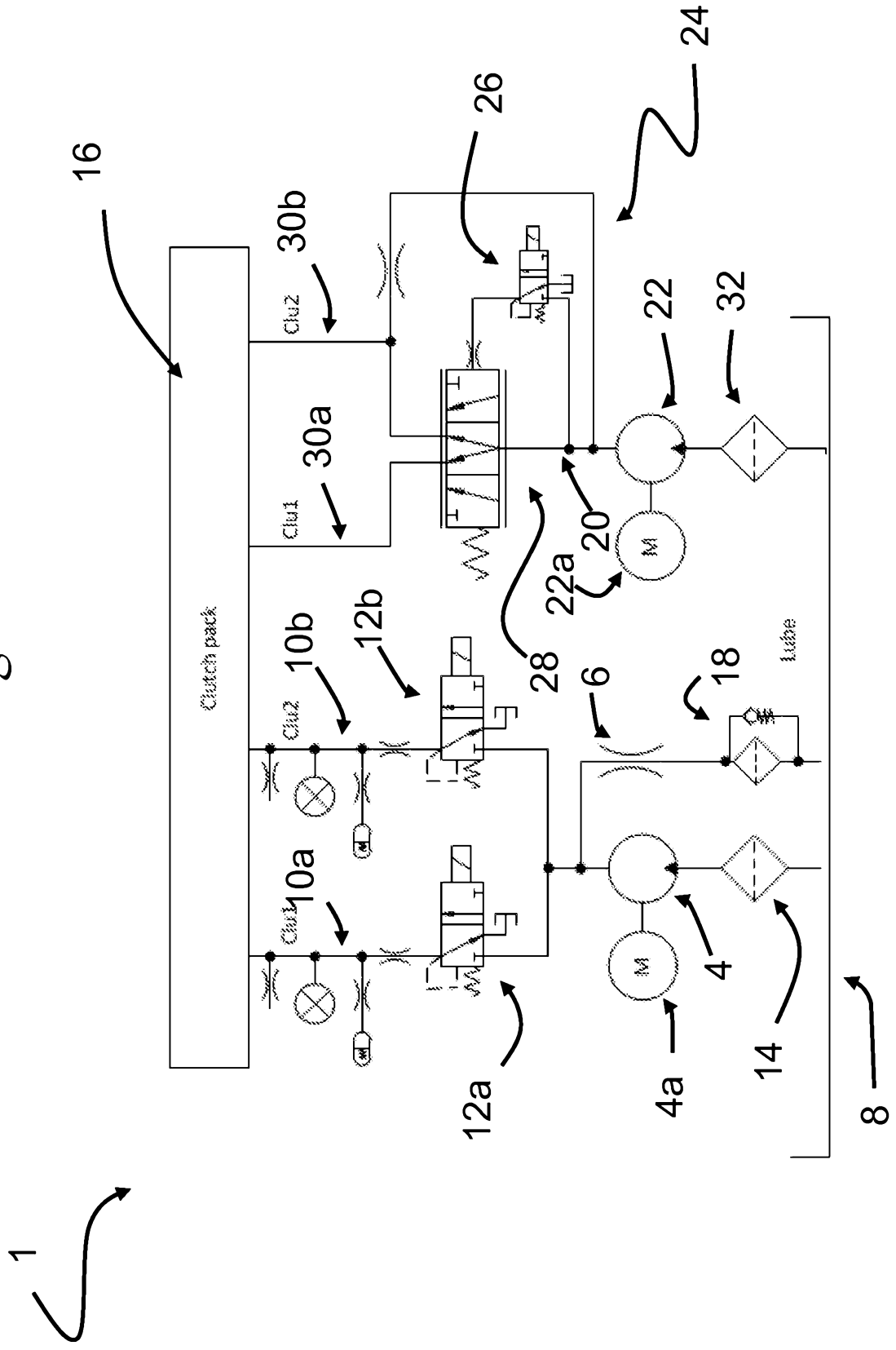

1
16
Clutch pack
30b
Clu2
30a
Clu1
26
24
22
32
20
22a
28
10b
12b
Clu2
10a
Clu1
6
18
Lube
4
4a
14
12a
8

Fig. 3

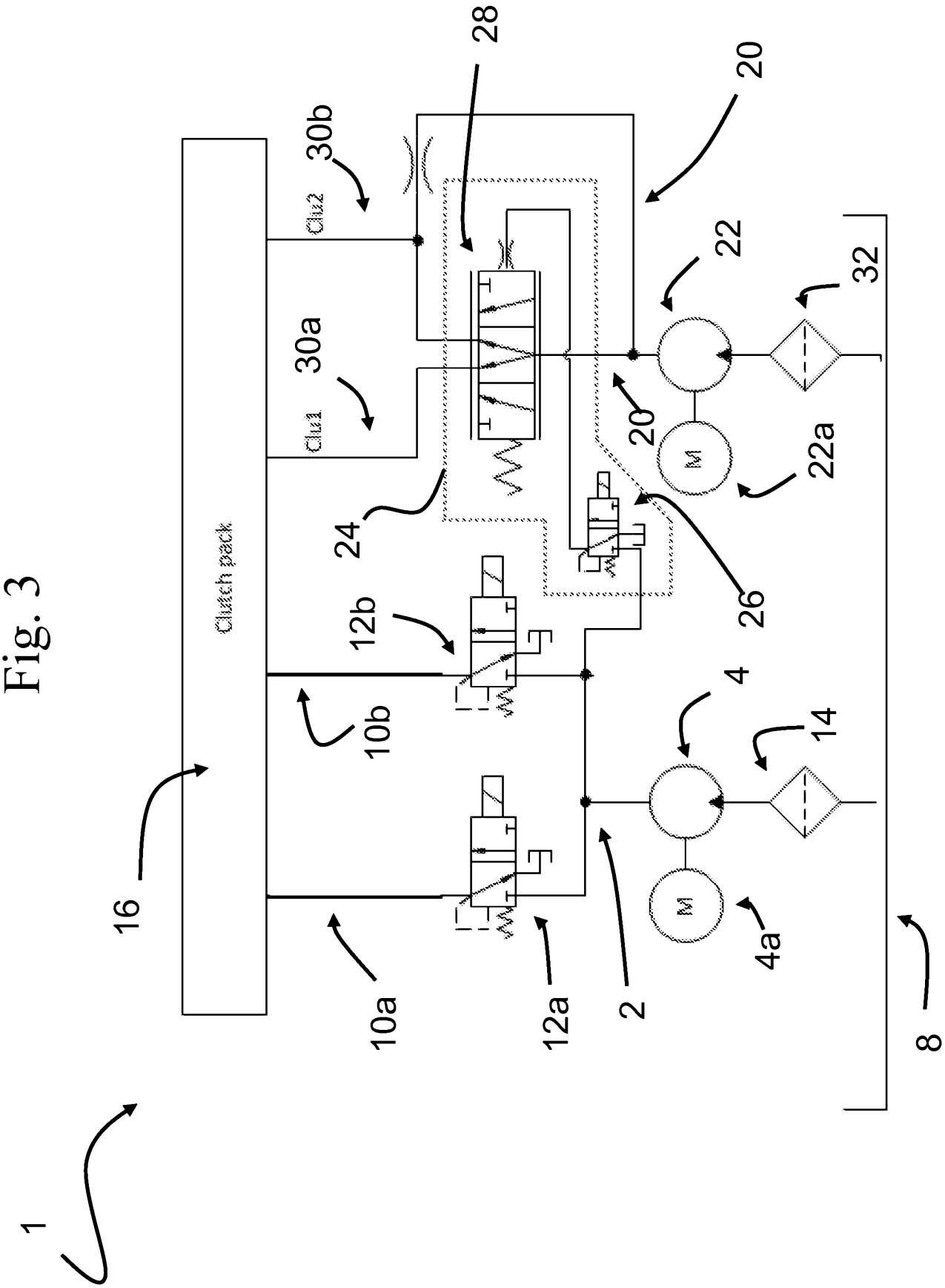

1
16
Clutch pack
Clu2
Clu1
30b
30a
28
20
22
32
22a
24
26
12b
10b
4
14
4a
10a
12a
2
8

Fig. 4

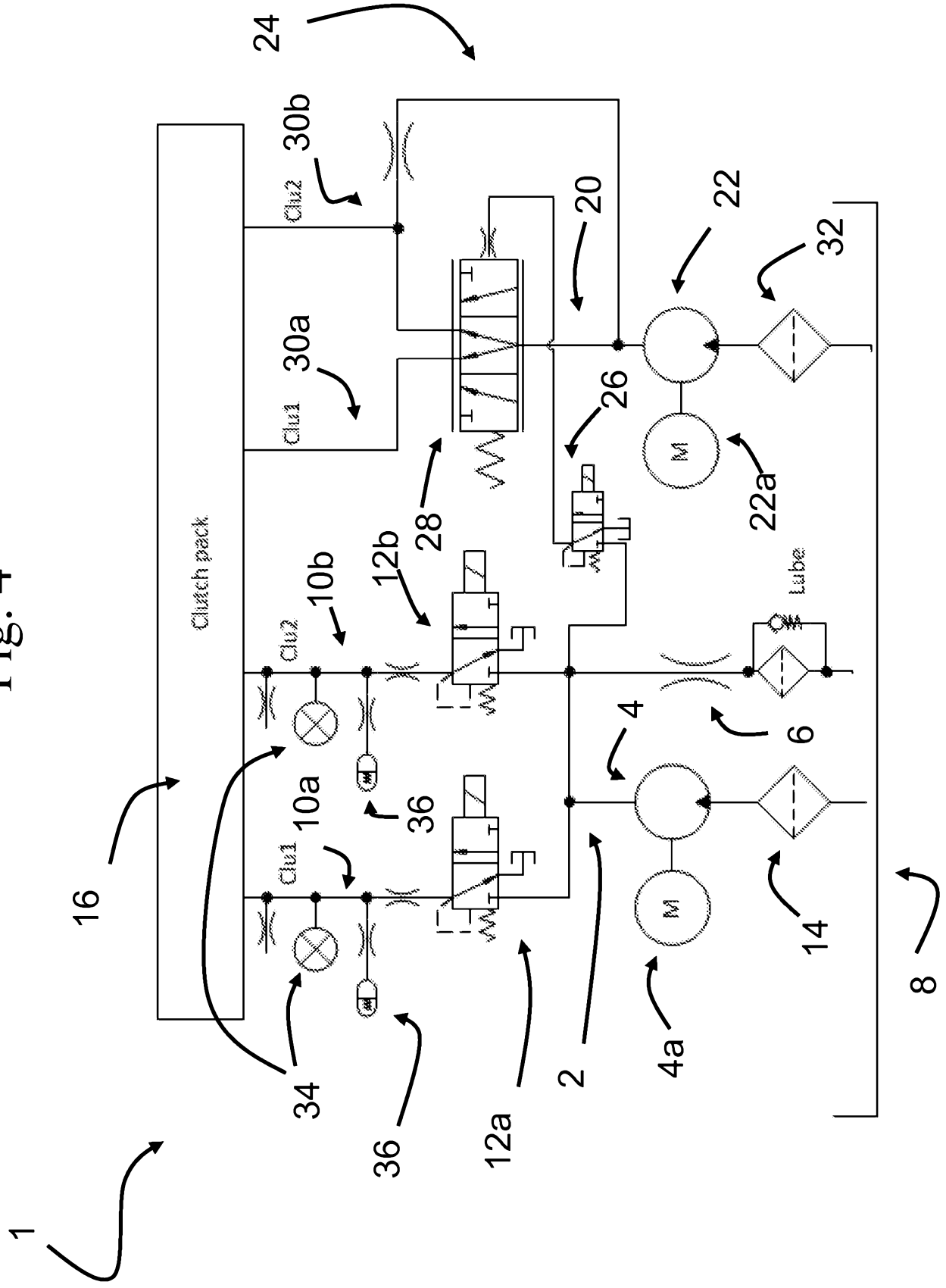
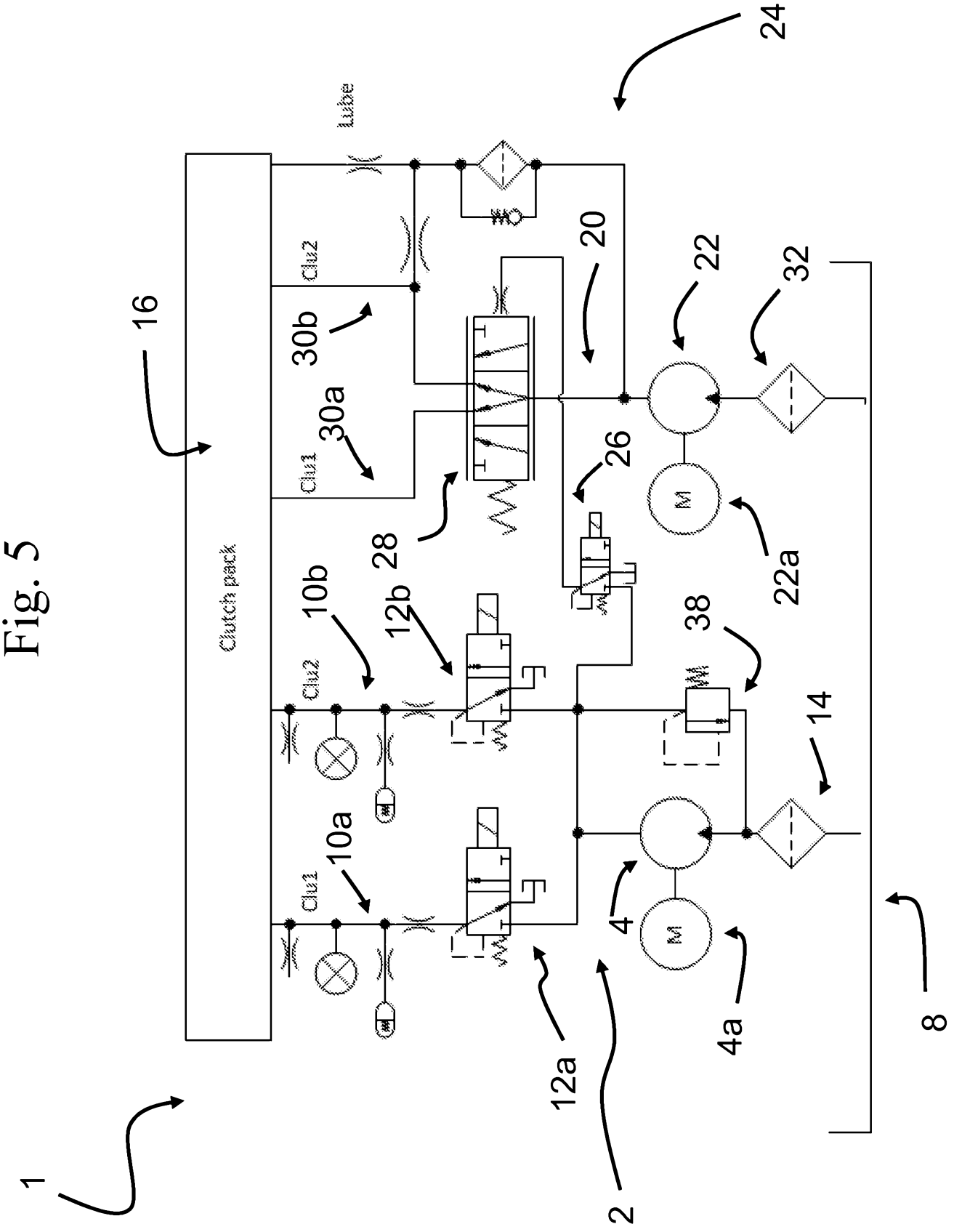

1
16
Clutch pack
Clu2
Clu1
10b
10a
12b
12a
28
30b
30a
20
22
22a
26
32
24
34
36
36
2
4
4a
6
14
8
Lube
M
M

Fig. 5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2
4
4a
8
10a
10b
12a
12b
14
16
20
22
22a
24
26
28
30a
30b
32
38
Clutch pack
Clu1
Clu2
Lube
M

Fig. 6

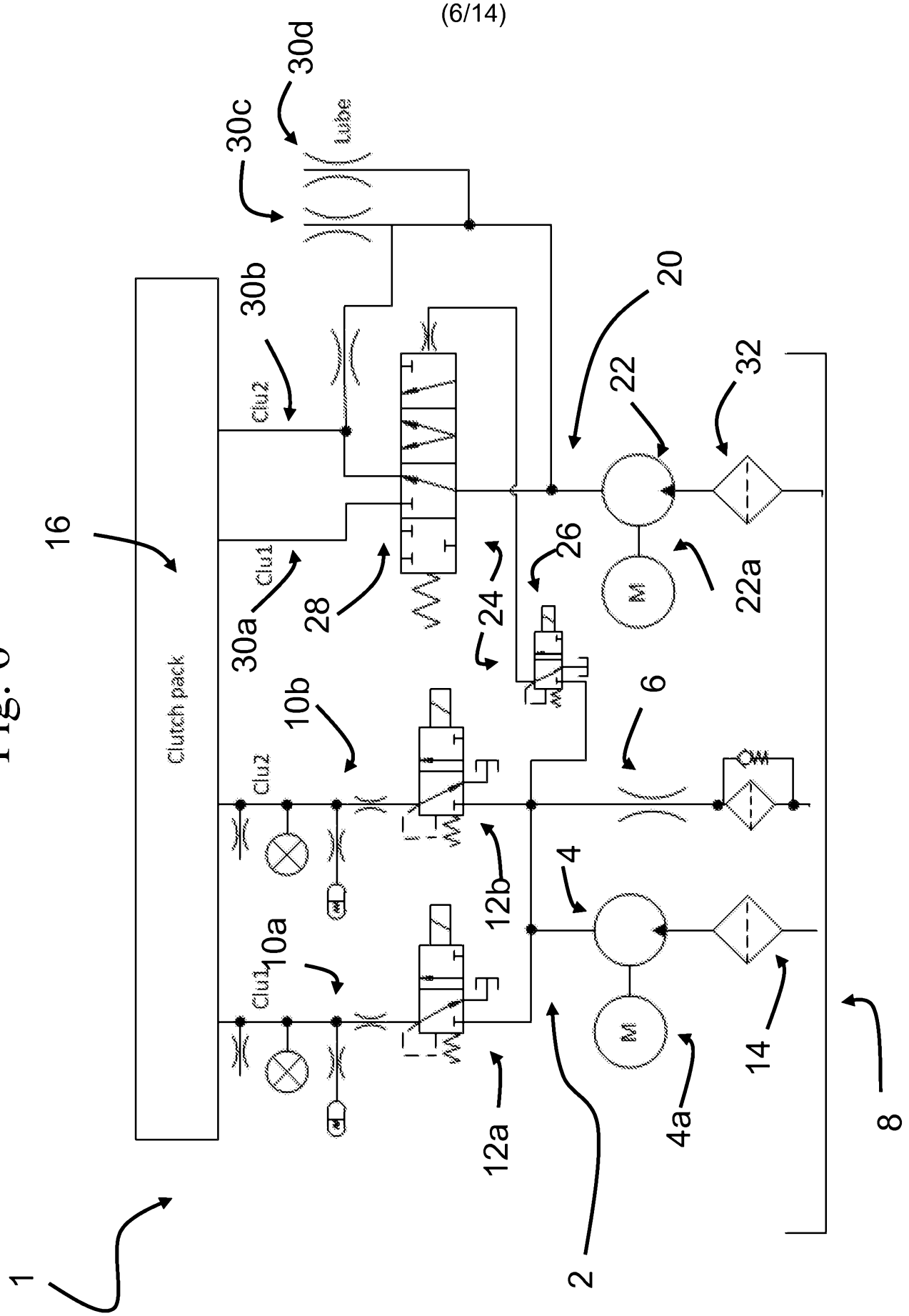

1
2
4
4a
6
8
10a
10b
12a
12b
14
16
20
22
22a
24
26
28
30a
30b
30c
30d
32
Clutch pack
Clu1
Clu2
Lube
M

Fig. 7

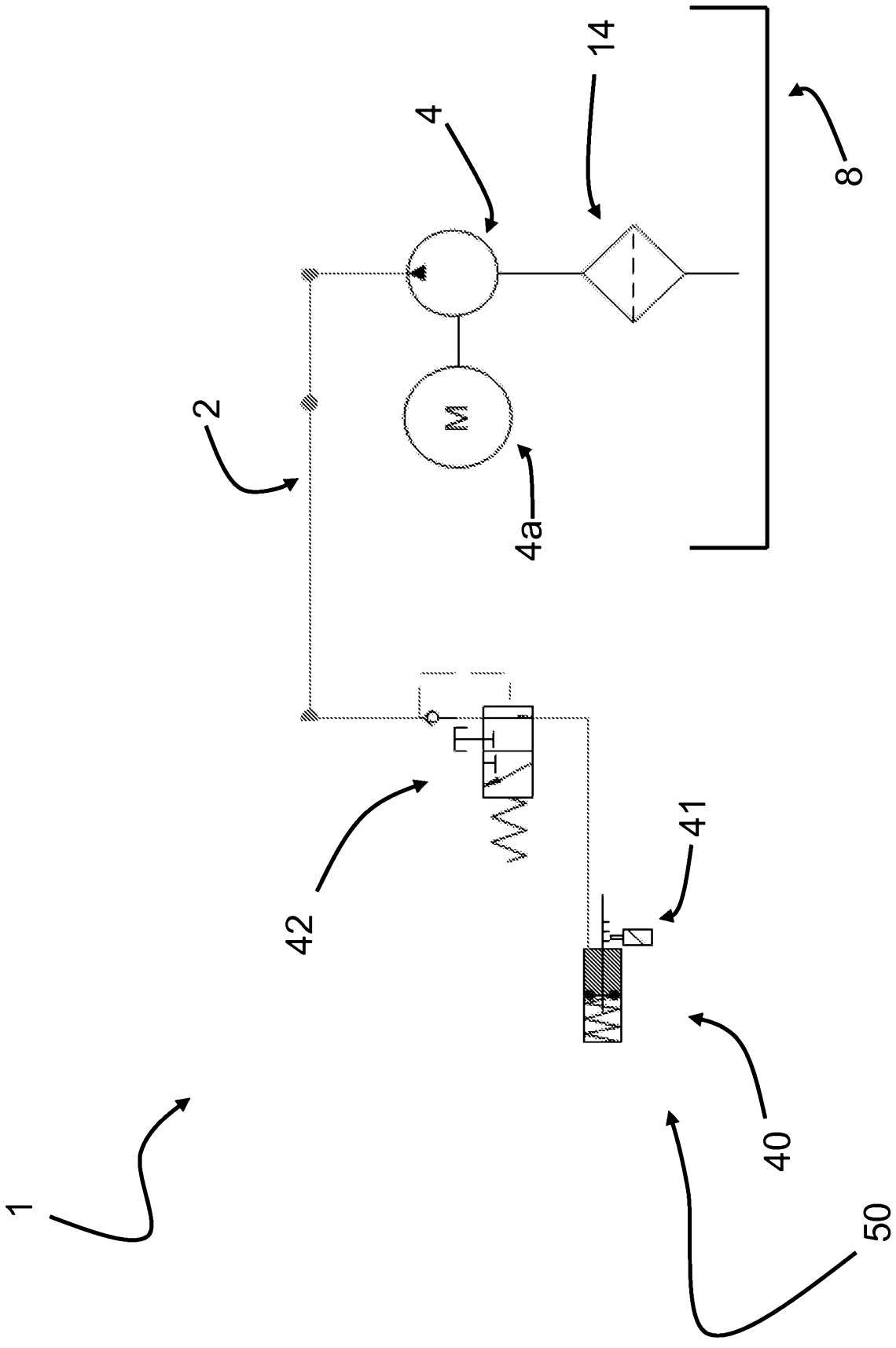


Fig. 8

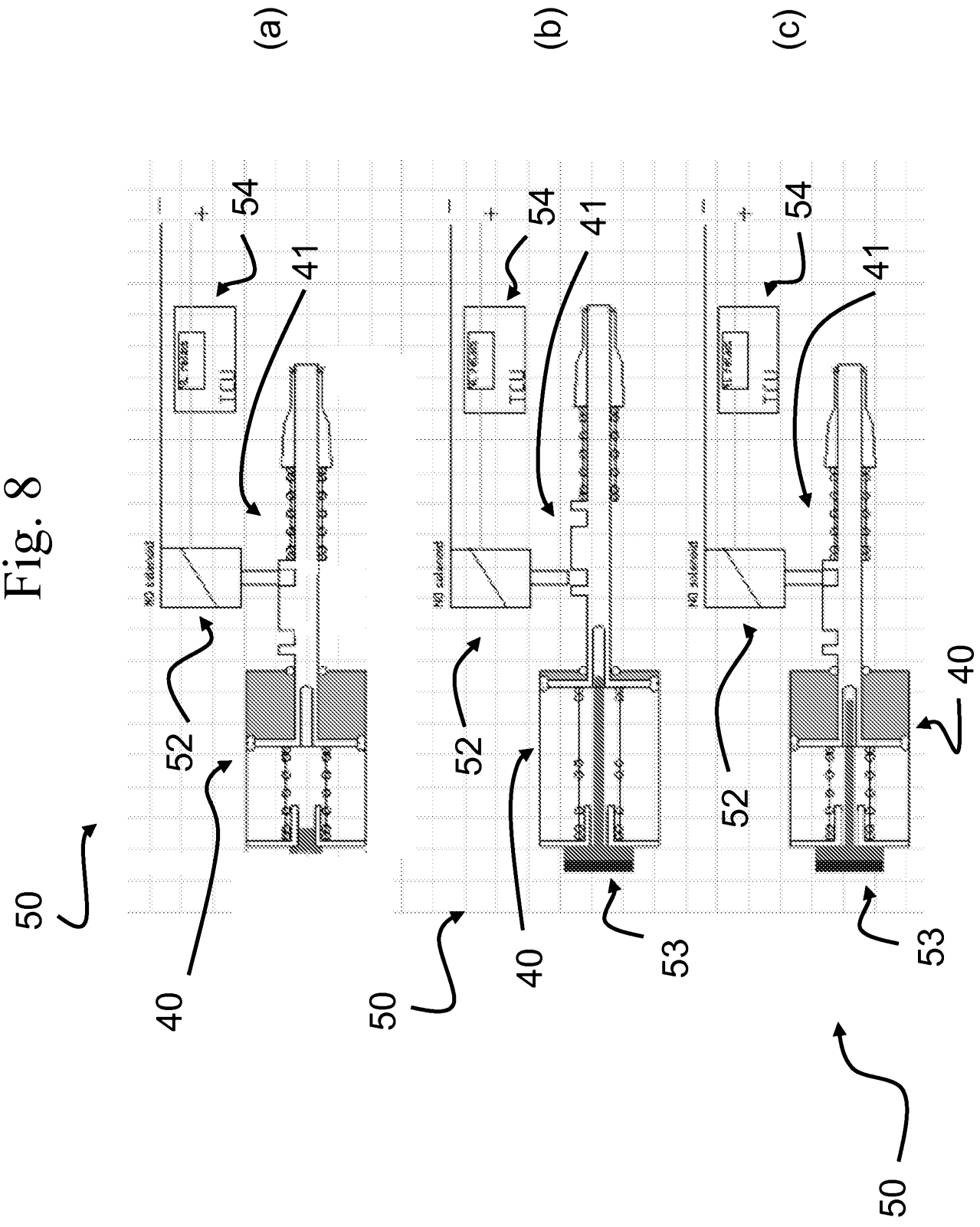


Fig. 9

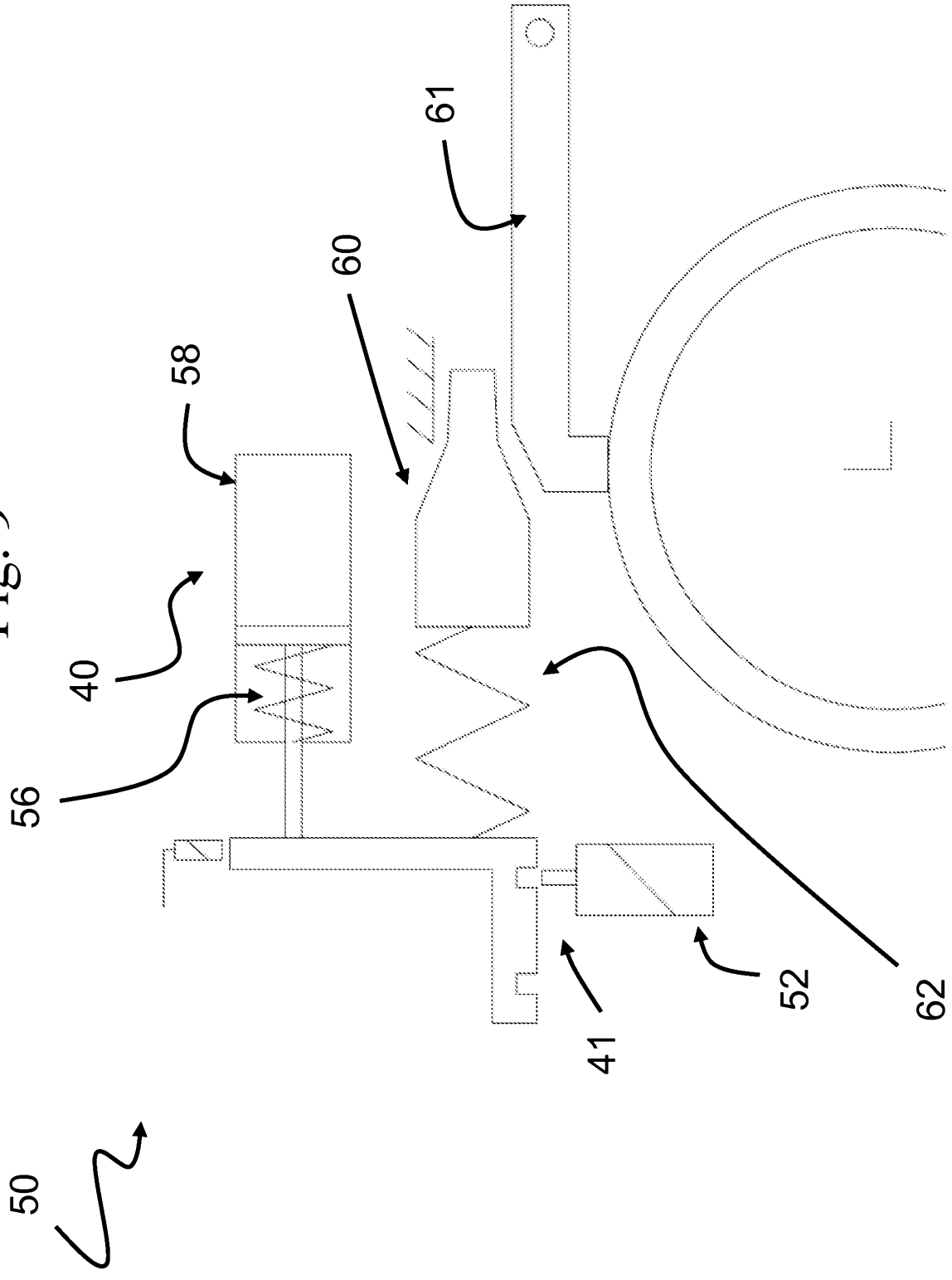


Fig. 10

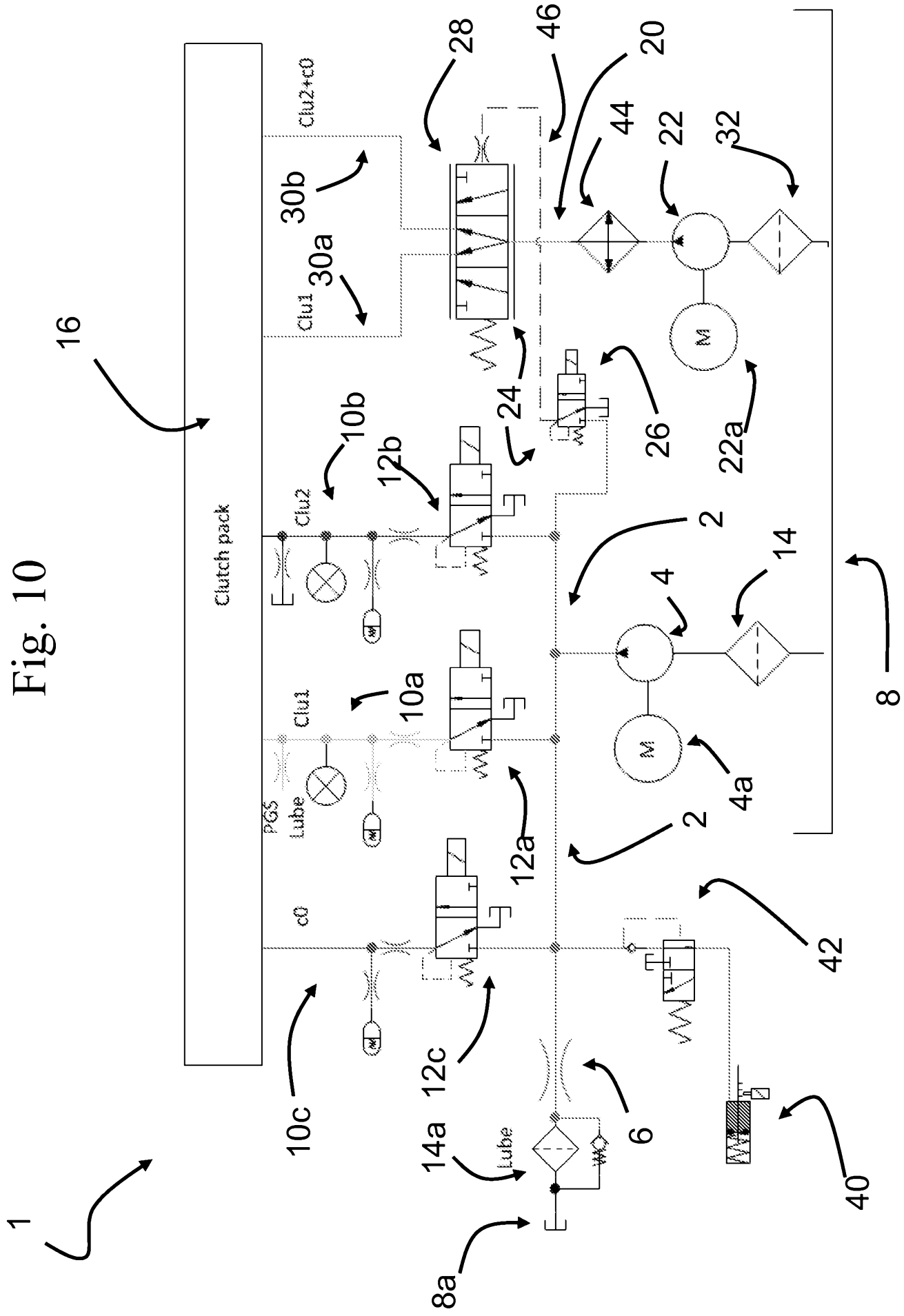

1
16
Clutch pack
Clu2+cO
30b
Clu1
30a
28
46
20
44
22
32
M
22a
24
26
10b
Clu2
12b
2
14
4
10a
Clu1
PGS
Lube
M
4a
8
12a
2
cO
42
10c
12c
14a
Lube
6
8a
40

Fig. 11

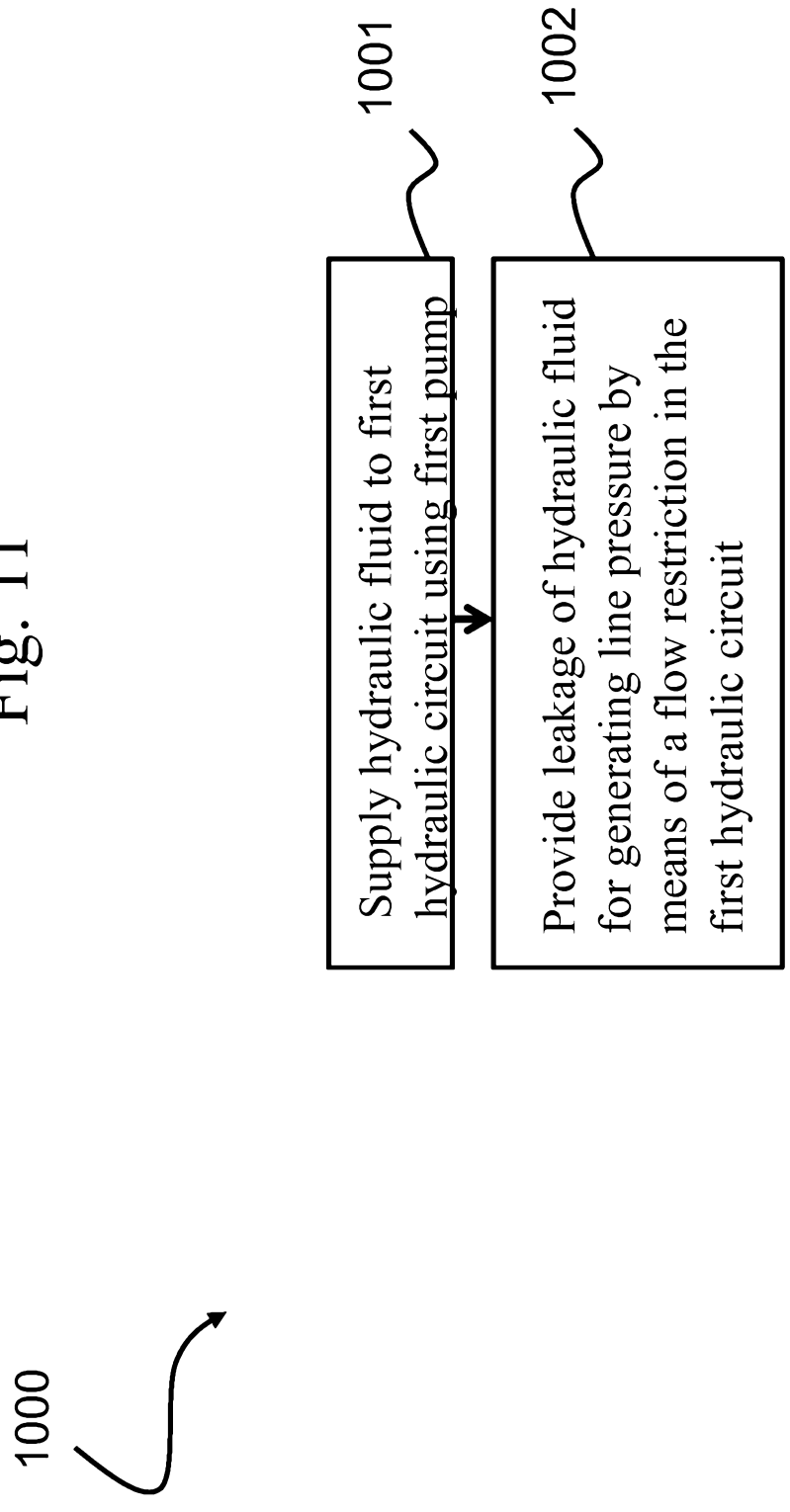

1000
1001
Supply hydraulic fluid to first hydraulic circuit using first pump
1002
Provide leakage of hydraulic fluid for generating line pressure by means of a flow restriction in the first hydraulic circuit

Fig. 12

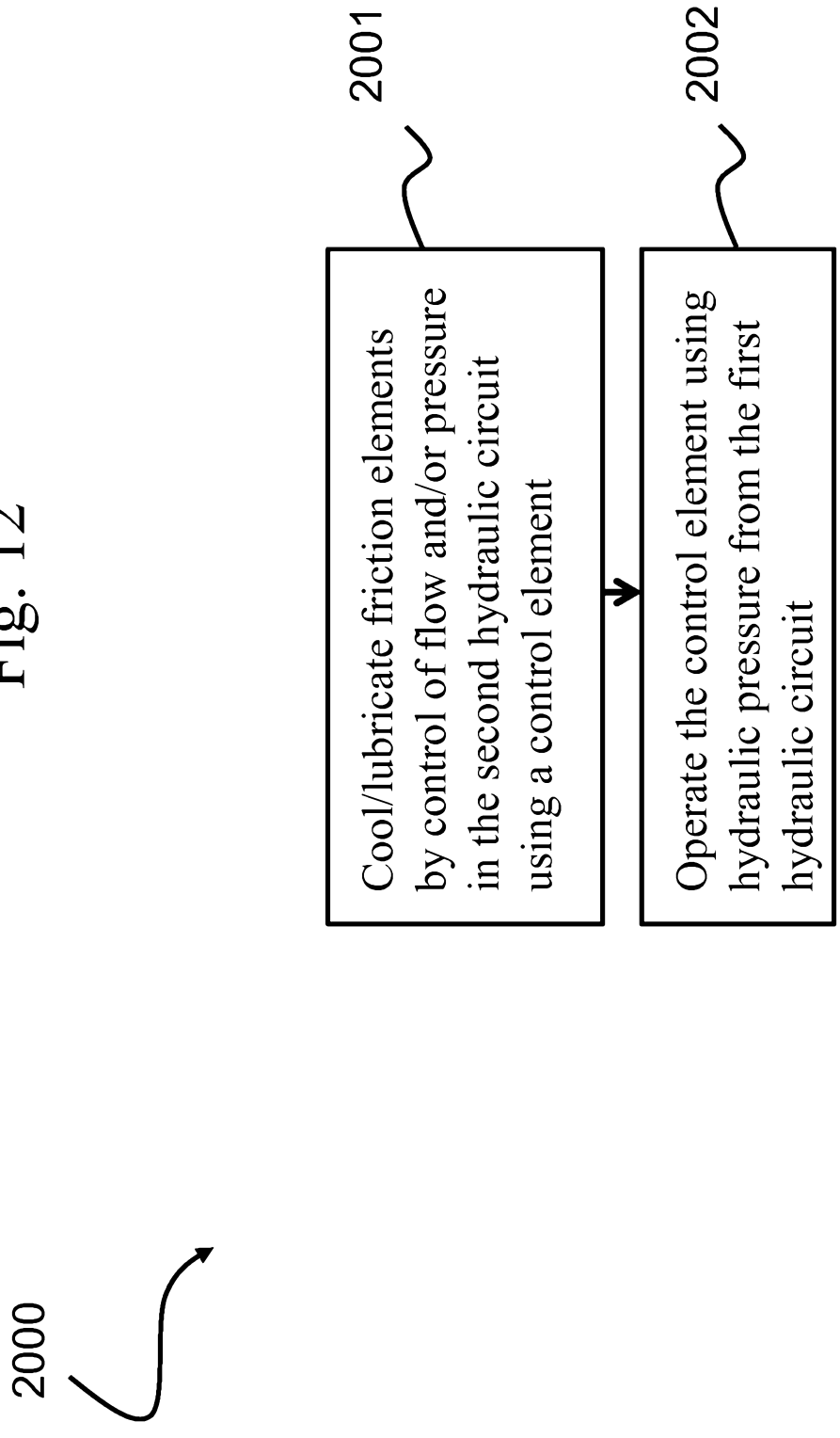

2000
2001
Cool/lubricate friction elements by control of flow and/or pressure in the second hydraulic circuit using a control element
2002
Operate the control element using hydraulic pressure from the first hydraulic circuit

Fig. 13

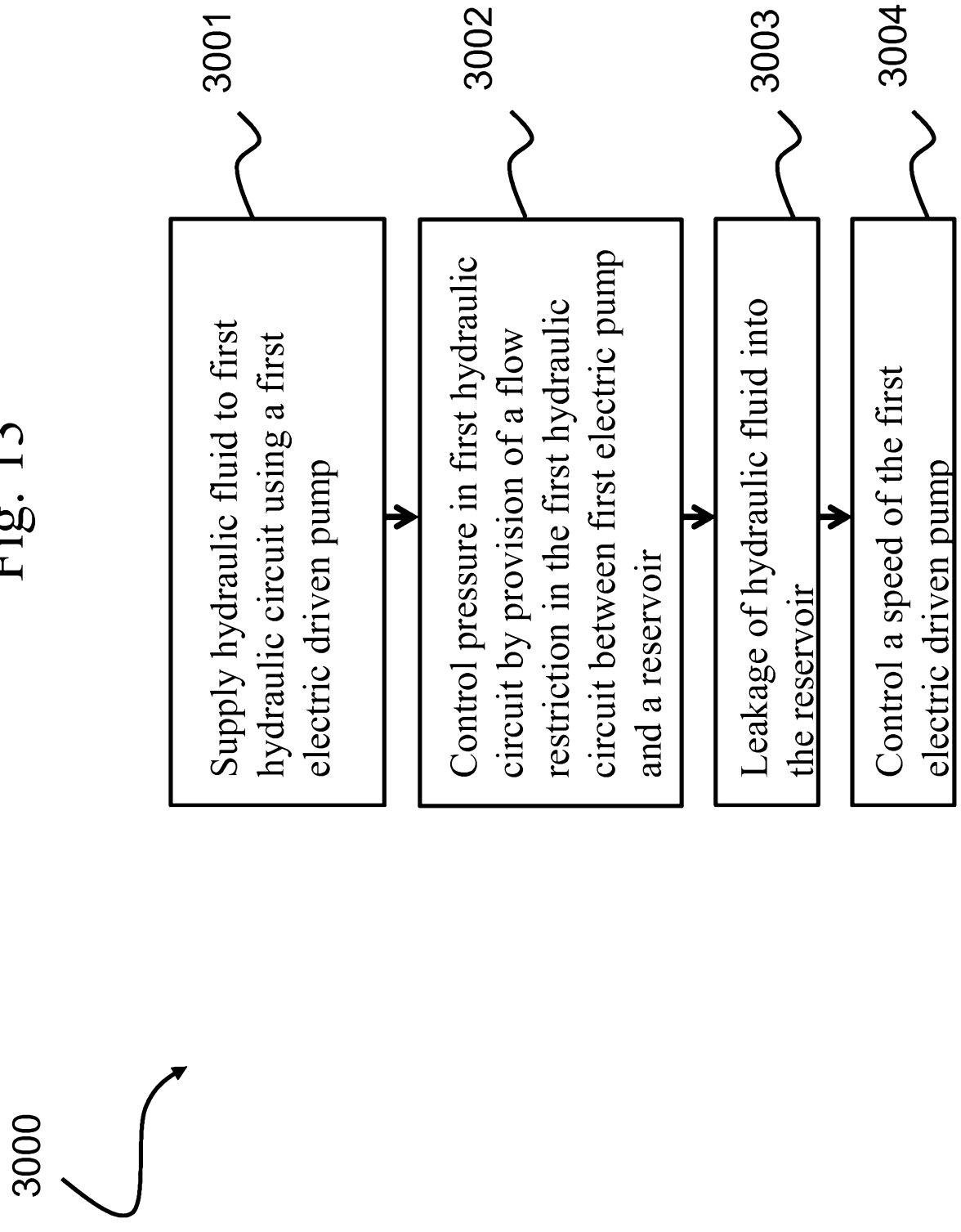
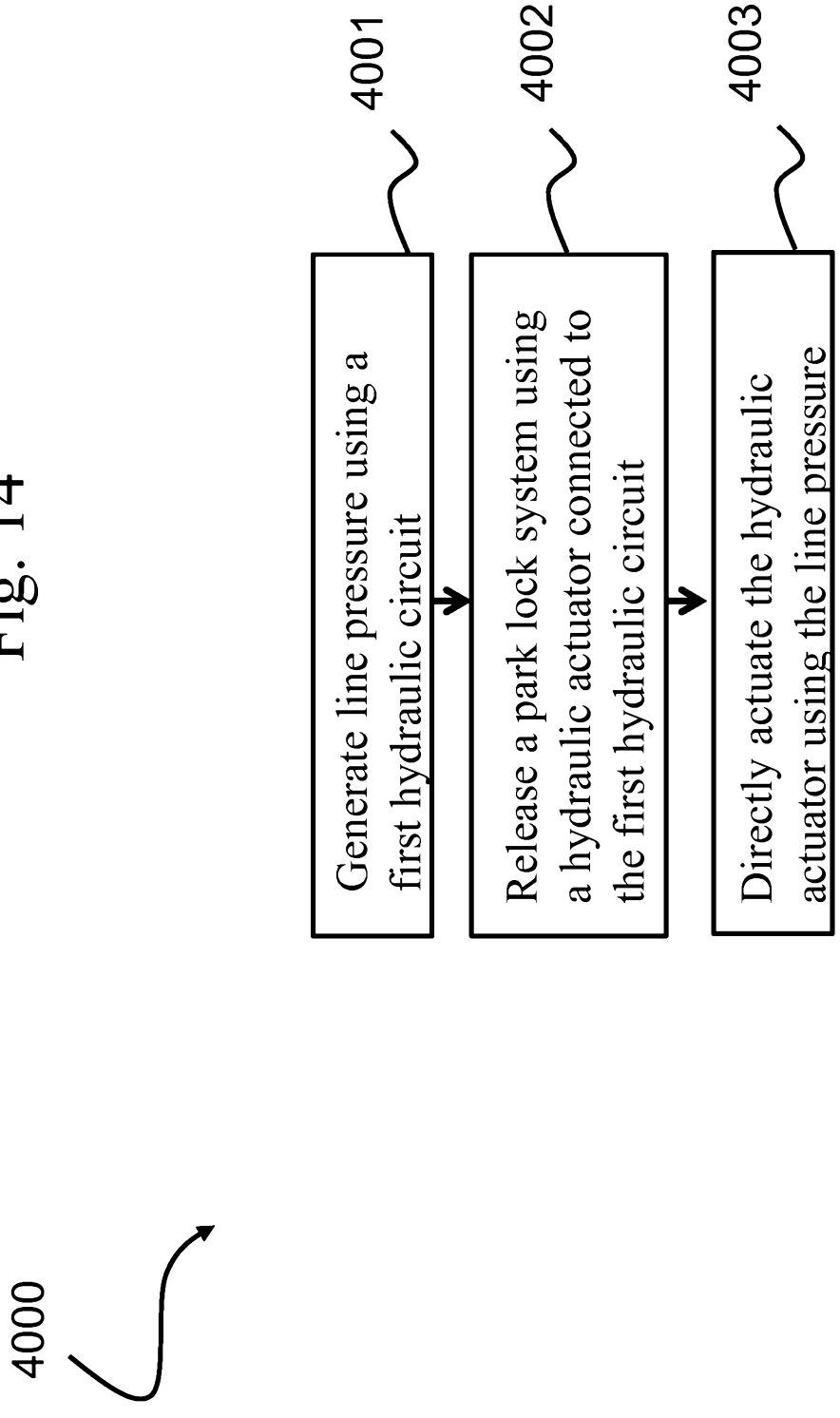

3000
3001
Supply hydraulic fluid to first hydraulic circuit using a first electric driven pump
3002
Control pressure in first hydraulic circuit by provision of a flow restriction in the first hydraulic circuit between first electric pump and a reservoir
3003
Leakage of hydraulic fluid into the reservoir
3004
Control a speed of the first electric driven pump

Fig. 14


4000
4001
Generate line pressure using a first hydraulic circuit
4002
Release a park lock system using a hydraulic actuator connected to the first hydraulic circuit
4003
Directly actuate the hydraulic actuator using the line pressure

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

Abstract

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.

SAMENWERKINGSVERDRAG (PCT)

RAPPORT BETREFFENDE NIEUWHEIDSONDERZOEK VAN INTERNATIONAAL TYPE

IDENTIFICATIE VAN DE NATIONALE AANVRAGE	KENMERK VAN DE AANVRAGER OF VAN DE GEMACHTIGDE
	P115227NL00
Nederlands aanvraag nr. **2018732**	Indieningsdatum **18-04-2017**
	Ingeroepen voorrangsdatum
Aanvrager (Naam) **Punch Powertrain N.V.**	
Datum van het verzoek voor een onderzoek van internationaal type **09-09-2017**	Door de Instantie voor Internationaal Onderzoek aan het verzoek voor een onderzoek van internationaal type toegekend nr. **SN69622**

I. CLASSIFICATIE VAN HET ONDERWERP (bij toepassing van verschillende classificaties, alle classificatiesymbolen opgeven)

Volgens de internationale classificatie (IPC)

F16H61/00;F16H61/02;F16H63/34;F16H57/04;F16H61/12

II. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte minimumdocumentatie

Classificatiesysteem	Classificatiesymbolen
IPC	**F16H**

Onderzochte andere documentatie dan de minimum documentatie, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

III.	X	**GEEN ONDERZOEK MOGELIJK VOOR BEPAALDE CONCLUSIES**	(opmerkingen op aanvullingsblad)
IV.	X	**GEBREK AAN EENHEID VAN UITVINDING**	(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 2018732

A. CLASSIFICATIE VAN HET ONDERWERP
INV. F16H61/00 F16H61/02 F16H63/34
ADD. F16H57/04 F16H61/12

Volgens de Internationale Classificatie van octrooien (IPC) of zowel volgens de nationale classificatie als volgens de IPC.

B. ONDERZOCHTE GEBIEDEN VAN DE TECHNIEK

Onderzochte minimum documentatie (classificatie gevolgd door classificatiesymbolen)
F16H

Onderzochte andere documentatie dan de minimum documentatie, voor dergelijke documenten, voor zover dergelijke documenten in de onderzochte gebieden zijn opgenomen

Tijdens het onderzoek geraadpleegde elektronische gegevensbestanden (naam van de gegevensbestanden en, waar uitvoerbaar, gebruikte trefwoorden)
EPO-Internal, WPI Data

C. VAN BELANG GEACHTE DOCUMENTEN

Categorie *	Geciteerde documenten, eventueel met aanduiding van speciaal van belang zijnde passages	Van belang voor conclusie nr.
	EENHEID VAN UITVINDING ONTBREEKT zie aanvullingsblad B ONVOLLEDIG ONDERZOEK zie aanvullingsblad C -----	
X	EP 2 696 111 A1 (GETRAG GETRIEBE ZAHNRAD [DE]) 12 februari 2014 (2014-02-12)	1,5,6, 10,11, 14,22, 24,29,32
Y	* figuur 3 *	26
A	* alineas [0073], [0074], [0077], [0079], [0102], [0104], [0107], [0108] *	2,9
	* alineas [0110], [0113] * -----	
	-/--	

[X] Verdere documenten worden vermeld in het vervolg van vak C.

[X] Leden van dezelfde octrooifamilie zijn vermeld in een bijlage

* Speciale categorieën van aangehaalde documenten

"A" niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft

"D" in de octrooiaanvrage vermeld

"E" eerdere octrooi(aanvrage), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven

"L" om andere redenen vermelde literatuur

"O" niet-schriftelijke stand van de techniek

"P" tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur

"T" na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvrage, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding

"X" de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur

"Y" de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht

"&" lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

Datum waarop het onderzoek naar de stand van de techniek van internationaal type werd voltooid	Verzenddatum van het rapport van het onderzoek naar de stand van de techniek van internationaal type
3 januari 2018	

Naam en adres van de instantie	De bevoegde ambtenaar
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Gubovits, Jânos

1

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 2018732

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) * figuren 3, 4 * * alineas [0002], [0064] - [0068], [0070], [0076], [0078] * -----	1,6,11, 14,22, 24,29,32
Y	US 2013/118852 A1 (SCHULLER DIETMAR [DE] ET AL) 16 mei 2013 (2013-05-16) * figuur 1 * * alineas [0042], [0045] * -----	26
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

1

ONVOLLEDIG ONDERZOEK
AANVULLINGSBLAD C

Octrooiaanvrage Nr.:
SN 69622
NL 2018732

Dit verslag van het onderzoek heeft geen betrekking op bepaalde conclusies omdat deze betrekking hebben op delen van de nationale aanvrage 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, 5-14, 22, 24-27, 29, 32

Niet onderzochte conclusie(s):
3, 4, 28

Reden voor de beperking van het onderzoek:

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 24, 28 and 29 belong to the category of method claims).
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.
Similarly, there is no clear distinction between independent claims 24, 28 and 29, where the subject-matter of claim 28 seems to be drafted as a combination of the subject-matters of independent claim 24 and dependent claim 25, furthermore, the subject-matter of independent claim 29 shows only minor modifications over that of independent claim 24 and therefore it would be reasonable to draft it as a dependent claim on independent claim 24.
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.
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, 24 and 29 as well as dependent claims 5-14, 22, 25-27 and 32 depending on said independent claims.

GEBREK AAN EENHEID VAN UITVINDING

Octrooiaanvrage Nr.:
SN 69622
NL 2018732

AANVULLINGSBLAD B

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

1. conclusies: 1-14, 24-29(compleet); 22, 32(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, 30, 31(compleet); 22, 32(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 Lack of unity of invention
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:

Group I: claims 1-14, 22, 24-29, 32

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

Group II: claims 15, 16-23, 30-32

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 32 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 As 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 adapted to supply 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).

GEBREK AAN EENHEID VAN UITVINDING

Octrooiaanvrage Nr.:
SN 69622
NL 2018732

AANVULLINGSBLAD B

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

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 As document D1 contains all the common features of claim 1 and claim 15, 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.

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 2018732

In het rapport genoemd octrooigeschrift	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.	Filing date *(day/month/year)*	Priority date *(day/month/year)*	Application No.
SN69622	18.04.2017		NL2018732

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

Application number

WRITTEN OPINION

NL2018732

Box No. I Basis of this opinion

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:

Application number

WRITTEN OPINION

NL2018732

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

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, 28, 30, 31(compleet); 22, 32(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, 28, 30, 31(compleet); 22, 32(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.

Box No. IV Lack of unity of invention

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

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

1. Statement

Novelty	Yes:	Claims	2, 7-9, 12, 13, 25-27
	No:	Claims	1, 5, 6, 10, 11, 14, 24, 29(compleet); 22, 32(gedeeltelijk)
Inventive step	Yes:	Claims	2, 7-9, 12, 13, 25, 27
	No:	Claims	1, 5, 6, 10, 11, 14, 24, 26, 29(compleet); 22, 32(gedeeltelijk)
Industrial applicability	Yes:	Claims	1, 2, 5-14, 24-27, 29(compleet); 22, 32(gedeeltelijk)
	No:	Claims	

2. Citations and explanations

see separate sheet

Box No. VIII Certain observations on the application

see separate sheet

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 24, 28 and 29 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 24, 28 and 29, where the subject-matter of claim 28 seems to be drafted as a combination of the subject-matters of independent claim 24 and dependent claim 25, furthermore, the subject-matter of independent claim 29 shows only minor modifications over that of independent claim 24 and therefore it would be reasonable to draft it as a dependent claim on independent claim 24.

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, 24 and 29 as well as dependent claims 5-14, 22, 25-27 and 32 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, 24-29, 32

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, 16-23, 30-32

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 32 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 adapted to supply 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 15, 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 VIII

Certain observations on the application

1 The present application does not fulfil the requirements of clarity, because at least some of the dependencies of claims 5, 6, 8, 12, 13, 14 and 15 on other claims are not clear.

1.1 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.

1.2 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.

1.3 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.

1.4 Claim 13 determines its subject-matter as being dependent on one of the claims 1-12, however it defines *the flow restriction*, 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 regulatory elements*, which are only mentioned in claim 7.
Therefore claim 13 can not be dependent on any of the claims 1-12.

1.5 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.

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 februari 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 mei 2013 (2013-05-16)

D4 DE 10 2015 012345 A1 (DAIMLER AG [DE]) 23 maart 2017 (2017-03-23)

D5 US 2015/167835 A1 (HWANG JIN YOUNG [KR]) 18 juni 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):

Hydraulic system for a vehicle transmission (see paragraph [0073]), *wherein the transmission is provided with two or more friction elements* (see clutches (16) and (16A) and parklock (24')), *and 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 the actuation of the two or more friction elements* (see clutch (16) and parklock (24'));
a first electrically driven pump (32A', see paragraphs [0102] and [0108]), *adapted to supply hydraulic fluid to the first hydraulic circuit; and*
a flow restriction (48A') *applied in the first hydraulic circuit between an output of the first electrically driven pump* (32A') *and a reservoir* (40) *to provide leakage of hydraulic fluid in 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 marks below 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, 6, 10, 11, 14, 22, 32**

Notwithstanding the above-mentioned lack of clarity (see item VIII), dependent claims 5, 6, 10, 11, 14, 22 and 32 do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of novelty and/or inventive step, 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 10:**

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

3.4 **Claim 11:**

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

3.5 **Claim 14:**

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

3.6 **Claim 22:**

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

3.7 **Claim 32:**

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

4 **Independent claim 24**

The present application does not meet the criteria of patentability, because the subject-matter of claim 24 is not new.

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

A method for the generation of a line pressure in a vehicle transmission, comprising a first hydraulic circuit arranged for the actuation of two or more friction elements (see paragraphs [0074] and [0104]), *the method comprising:*
the introduction of hydraulic fluid to the first hydraulic circuit with the aid of a first pump (see paragraph [0108]); *and*
the use of 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 in the reservoir to provide for the generation of line pressure (see paragraph [0110]).

The subject-matter of claim 24 is therefore not new.

4.2 Additionally it is pointed out, that document D2 also shows a method for the generation of a line pressure in a vehicle transmission with all the features according to claim 24, see marks below for (the references in parentheses applying to this document, especially to figures 3 and 4):

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

5 **Dependent claim 26**

Dependent claim 26 does not contain any features which, in combination with the features of any claim to which it refers, meet the requirements of an inventive step, see marks below for (the references in parentheses applying to document D3, especially to figure 1):

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

6 **Independent claim 29**

The present application does not meet the criteria of patentability, because the subject-matter of claim 29 is not new.

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

> *A method for the actuation of hydraulic actuators associated with two or more friction elements of a vehicle transmission using a first hydraulic circuit* (see paragraphs [0074] and [0104]), *wherein the method comprises*
> *the introduction of hydraulic fluid to the first hydraulic circuit using a first electrically driven pump* (see paragraph [0108]); *and*
> *regulating pressure of the first hydraulic circuit by a flow restriction provided in the first hydraulic circuit between the first electric pump and a reservoir through leaking hydraulic fluid to the reservoir* (see paragraph [0110]) *and by controlling the velocity of said first electrically driven pump* (see paragraph [0077]).

The subject-matter of claim 29 is therefore not new.

7 **Dependent claims 2, 7-9, 12, 13, 25, 27**

The subject-matters of dependent claims 2, 7-9, 12, 13, 25, 27 contain some features which, in combination with claims to which they refer seem to be neither known not rendered obvious by the available prior art (D1-D5) and therefore they seem to meet the requirements of novelty and inventive step.