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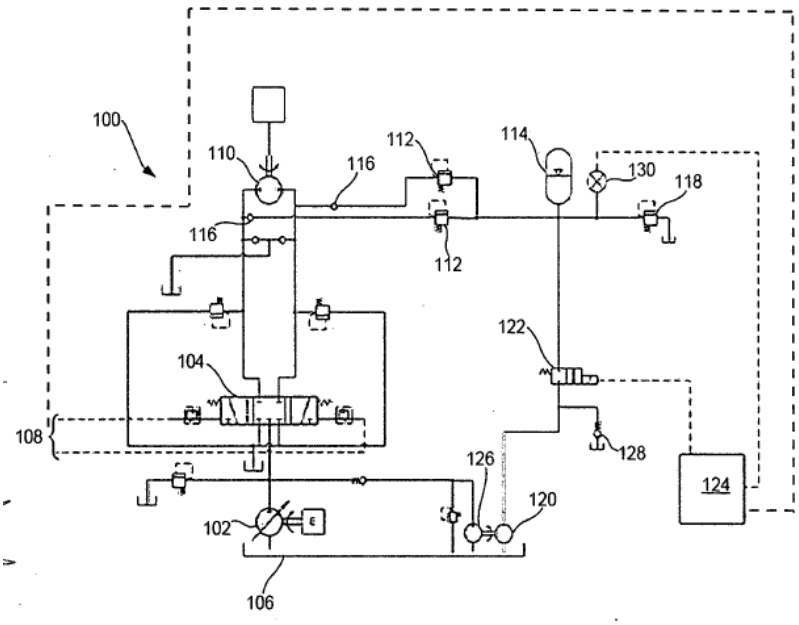
(54) Title: A HYDRAULIC HYBRID SYSTEM FOR OFF-HIGHWAY MACHINES

(57) Abstract: According to an embodiment of the invention, a hydraulic hybrid arrangement 100 for recovering energy from a swing system of an off-highway machine is disclosed. The hybrid hydraulic arrangement 100 may include a primary pump 102 to supply a fluid from a fluid reservoir 106 to a swing motor 110 through a swing control arrangement 104. The arrangement 100 may further comprise of an accumulator 114, a hydraulic control system 124 and a hybrid hydraulic motor 120. The hybrid hydraulic motor 120 may be configured to drive a hybrid hydraulic pump 126. The high pressure fluid from the swing motor 110 stored in the accumulator 114 may be supplied to the hybrid hydraulic motor 120 which may convert the hydraulic energy into mechanical energy and transfer it to the hybrid hydraulic pump 126 so that the demand for power required to rotate the off-highway machine components is reduced.



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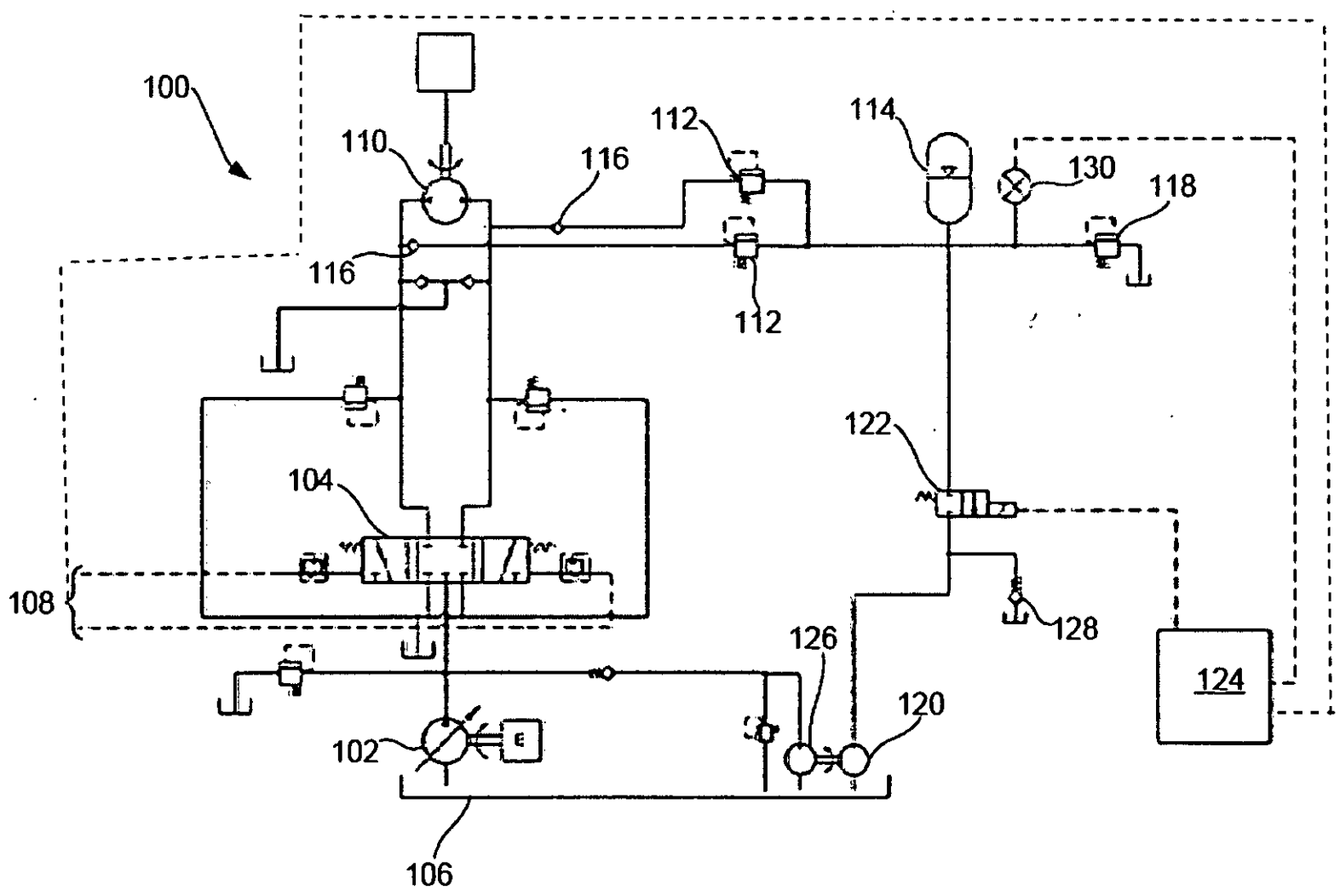
A HYDRAULIC HYBRID SYSTEM FOR OFF- HIGHWAY MACHINES

ABSTRACT

According to an embodiment of the invention, a hydraulic hybrid arrangement 100 for recovering energy from a swing system of an off-highway machine is disclosed. The hybrid hydraulic arrangement 100 may include a primary pump 102 to supply a fluid from a fluid reservoir 106 to a swing motor 110 through a swing control arrangement 104. The arrangement 100 may further comprise of an accumulator 114, a hydraulic control system 124 and a hybrid hydraulic motor 120. The hybrid hydraulic motor 120 may be configured to drive a hybrid hydraulic pump 126. The high pressure fluid from the swing motor 110 stored in the accumulator 114 may be supplied to the hybrid hydraulic motor 120 which may convert the hydraulic energy into mechanical energy and transfer it to the hybrid hydraulic pump 126 so that the demand for power required to rotate the off-highway machine components is reduced.



We claim:

1. A hydraulic hybrid arrangement 100 for recovering energy from a swing system of an off-highway machine having a primary pump 102 to supply a fluid from a fluid reservoir 106 to a swing motor 110 through a swing control arrangement 104, the hydraulic hybrid arrangement 100 comprising:

an accumulator 114 to store a high pressure fluid from the swing motor 110; and

a hydraulic control system 124 to control the supply of fluid from the accumulator 114 to a hybrid hydraulic motor 120,

the hybrid hydraulic motor 120 being configured to drive a hybrid hydraulic pump 126, wherein the high pressure fluid from the swing motor 110 stored in the accumulator 114, is supplied to the hybrid hydraulic motor 120 which converts the hydraulic energy into mechanical energy and transfers it to the hybrid hydraulic pump 126, the hybrid hydraulic pump 126 supply oil to the swing motor 110 through the swing control arrangement 104 independent of the primary pump such that the demand for power required to rotate the off-highway machine components is reduced.

2. The hybrid hydraulic arrangement 100 as claimed in claim 1, wherein the hydraulic hybrid arrangement 100 further comprises a regenerative hybrid valve 112 to allow the high pressure fluid to flow from drownstream of the swing motor 110 to the accumulator 114.

3. The hybrid hydraulic arrangement 100 as claimed in claim 1, wherein the hydraulic hybrid arrangement 100 further comprises a pressure transducer 130 to measure pressure in the accumulator 114 and send a feedback to the hydraulic control system 124.

4. The hybrid hydraulic arrangement 100 as claimed in claim 3, wherein the hydraulic control system 100 starts or stops the fluid flow from the accumulator 114 to the hybrid hydraulic motor 120 based on the feedback received from the pressure transducer 130 and a main controller 108.

5. The hybrid hydraulic arrangement 100 as claimed in claim 1, wherein the hydraulic hybrid arrangement 100 further comprises a hybrid solenoid valve 122 to allow fluid flow from the accumulator 114 to the hybrid hydraulic motor 120.

6. The hybrid hydraulic arrangement 100 as claimed in claim 1, wherein the hydraulic hybrid arrangement 100 further comprises a first check valve 116 to prevent the backflow of fluid from the accumulator 114 and a second check valve 128 to prevent cavitation of hybrid hydraulic motor 120.

7. The hybrid hydraulic arrangement 100 as claimed in claim 1, wherein the swing control arrangement 104 is operated by the main controller 108.

8. The hybrid hydraulic arrangement 100 as claimed in claim 7, wherein the main controller 108 is a joystick.

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FIELD OF INVENTION

The invention generally relates to hydraulic machines and in particular to a hydraulic hybrid swing drive.

BACKGROUND

An excavator is an example of construction machines that uses multiple hydraulic actuators to accomplish a variety of tasks. These actuators are fluidly connected to a pump that provides pressurized fluid to chambers within the actuators. This pressurized fluid force acting on the actuator surface causes movement of actuators and connected work tool. Once the hydraulic energy is utilized, pressurized fluid is drained from the chambers to return to a low-pressure reservoir. Usually the fluid being drained is at a higher pressure than the pressure in the reservoir and hence this remaining energy is wasted once it enters the reservoir. This wasted energy reduces the efficiency of the entire hydraulic system over a course of machine duty cycle. A prime example of energy loss in an excavator is its swing drive where the fluid emptying to the low-pressure reservoir is throttled over a valve during the retardation portion of its motion to effect braking of swing motion. Another example is a boom system where energy is wasted during lowering of arm components.

Typically, the energy loss is due to swift and short rotation cycle of 45 to 180 °, where the rotation is stopped with high breaking force resulting in conversion of kinetic energy into heat energy. Such loss of energy not only results in efficiency loss but also affect components due to heat dissipation.

The present invention is directed to overcoming one or more of the problems as set forth above.

SUMMARY OF THE INVENTION

According to an embodiment of the invention, a hydraulic hybrid arrangement for recovering energy from a swing system of an off-highway machine is disclosed. The arrangement may include a primary pump to supply a fluid from a fluid reservoir to a swing motor and a swing control arrangement to control the flow of fluid from the primary pump to the swing motor. The hydraulic hybrid arrangement may further comprise of an accumulator to store a high pressure fluid from the swing motor, a hydraulic control system and a hybrid hydraulic motor such that the hybrid hydraulic motor may be configured to drive a coupled hybrid hydraulic pump. The high pressure fluid from the swing motor stored in the accumulator may be supplied to the hybrid hydraulic motor which may convert the hydraulic energy into mechanical energy and transfer it to the hybrid hydraulic pump so that the demand for power required to rotate the off-highway machine components is reduced.

BRIEF DESCRIPTION OF DRAWINGS

Other objects, features, and advantages of the invention will be apparent from the following description when read with reference to the accompanying drawing:

Figure 1 illustrates a hydraulic circuit diagram of an exemplary hydraulic hybrid arrangement according to an embodiment of the invention.

DETAILED DESCRIPTION OF DRAWINGS

This disclosure relates to a hydraulic system and method for recovering the energy generated during stopping of a swing motor, converting the energy into hydraulic potential energy, and reusing the hydraulic potential energy to improve the machine productivity and fuel efficiency of the overall system. The hydraulic system includes an accumulator for collecting kinetic energy caused by the motion of the swing motor. The accumulator stores exit oil from the swing motor that is pressurized by the inertia torque applied on the moving motor via movement of one or other part of the machine, such as an excavator.

The energy stored in the accumulator may be reused by a hybrid hydraulic motor coupled to a hybrid hydraulic pump to accelerate the swing motor independent of a primary pump connected to the swing motor. The swing motor may be connected to the primary pump in parallel with the hybrid pump. The disclosed arrangement may help in recovery of hydraulic power independent of variation in load pressure of swing system. Since the accumulator, pressure will be most of time lower than the load pressure the disclosed arrangement will help in converting power from a medium pressure reservoir (accumulator) to a high-pressure system as required.

Figure 1 illustrates a hydraulic circuit diagram of an exemplary hydraulic hybrid arrangement 100 for recovering energy from swing system of an off-highway machine according to an embodiment of the invention. The hydraulic hybrid arrangement 100 for swing system may include a primary pump 102. According to an embodiment, the primary pump 102 may be a variable displacement load sensing pump. The primary pump 102 is configured to supply fluid to a swing motor 110 from a fluid reservoir 106 through a swing control arrangement 104. A main controller 108 such as, but not limited to a joystick may control the functioning of the swing control arrangement 104. The joystick may be an arrangement to control the functions

of the swing control arrangement 104. On receiving a start signal from the main controller 108, the swing control valve 104 may open the fluid supply from the primary pump 102 to the swing motor 110. The swing motor 110 in turn rotate the required component of the off-highway machine. On receiving a stop signal from the main controller 108, the swing control valve 104 may close the fluid supply from the primary pump 102 to the swing motor 110. However the swing motor 110 may keep on rotating due to inertia of the off-highway machine components. The swing motor 110 may act as pump and pressure builds up on the downstream side of the swing motor 110. The high-pressure build up on downstream side of the swing motor 110 may enable opening of one or more regenerative hybrid valve 112. The regenerative hybrid valve 112 may divert high-pressure fluid to an accumulator 114 that may store the high pressure energy in the form of hydraulic energy.

According to an embodiment, the accumulator 114 may be pre-charged with an inert gas, such as but not limited to nitrogen, and may store fluid such as oil at high pressure. According to another embodiment, the accumulator 114 may be a rubber bladder type or a piston type accumulator. According to yet another embodiment, the accumulator 114 may act as a dampener for the swing motor 110 to reduce the jerk of off-highway machine components while stopping. The arrangement 100 may optionally have one or more first check valves 116 to check the back flow of oil from accumulator 114 to the swing motor 110. According to yet another embodiment, the accumulator 114 may have an accumulator relief valve 118 to limit control the maximum fluid pressure in the accumulator 114.

The accumulator 114 may supply stored fluid to a hybrid hydraulic motor 120 through a hybrid solenoid valve 122. The supply of fluid from the accumulator 114 to the hybrid hydraulic motor 120 may be initiated and controlled by a hydraulic control system 124. The hybrid hydraulic

motor 120 may be connected mechanically to a hybrid hydraulic pump 126. The hybrid hydraulic motor 120 may convert hydraulic energy of the fluid received from the accumulator 114 to mechanical energy, which can be used to run the hybrid hydraulic pump 126. The hybrid hydraulic pump 126 may be connected to the swing control arrangement 104. According to an embodiment, a second check valve 128 may be provided in the supply line of the hybrid hydraulic motor 120. The check valve 128 may prevent cavitation of hybrid motor 120 in case if there is scarcity of fluid supply from accumulator.

According to another embodiment, the arrangement 100 may have a pressure transducer 130 in communication with the accumulator 114 for measuring the pressure of the fluid in the accumulator 114. The pressure transducer 130 may be further configured to provide a feedback to the hybrid control system 124. The hybrid control system 124 may also get feedback from the main controller 108 and may feed status to the main controller 108. Based on the feedback the hybrid control system 124 may operate the hybrid solenoid valve 122 and selectively supply fluid from accumulator114 to the hybrid hydraulic motor 120.

According to yet another embodiment, the hybrid motor 120 may be also connected to the primary pump 102 to directly drive and thereby reduce demand of power from engine.

The present invention is applicable to any type of rotating bodies or machines where kinetic energy is lost while de-accelerating/stopping and the hydraulic circuit diagram shown here is only for illustration purpose.

In the drawings and specification there has been set forth preferred embodiments of the invention, and although specific terms are employed, these are used in a generic and descriptive

sense only and not for purposes of limitation. Changes in the form and the proportion of parts, as well as in the substitution of equivalents, are contemplated as circumstances may suggest or render expedient without departing from the spirit or scope of the invention.

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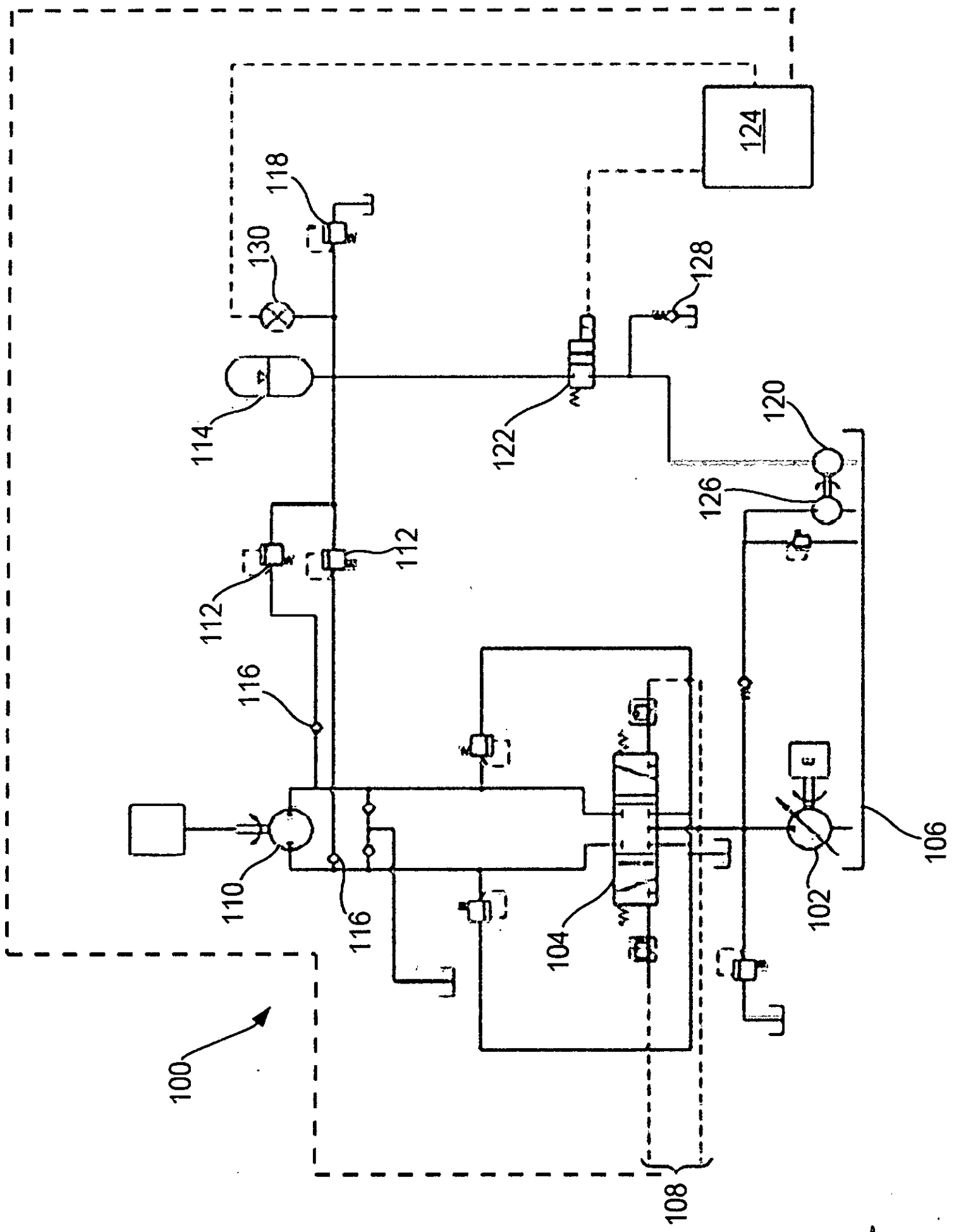

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