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HYDRAULIC APPARATUS FOR AGRICULTURAL VEHICLE

Abstract

There present disclosure relates to a hydraulic apparatus for an agricultural work vehicle, the hydraulic apparatus including: a hydraulic passage, and an oil tank configured to store hydraulic oil supplied to the hydraulic passage; a hydraulic pump configured to supply the hydraulic oil to the hydraulic passage; an oil supply conduit disposed on the hydraulic passage, and configured to connect the oil tank and the hydraulic pump to each other; an oil return conduit disposed on the hydraulic passage, connected to the oil tank at one end thereof, and configured to guide the hydraulic oil to the oil tank; and an air drain conduit formed such that one end thereof is connected to the oil supply conduit and the other end thereof is connected to the oil return conduit, and configured to guide air, contained in hydraulic oil flowing through the oil supply conduit, to the oil return conduit.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION [0001] This application is a National Stage of International Application No. PCT/KR2022/007564 filed on May 27, 2022, which claims priority to and the benefit of Korean Patent Application No. 10-2021-0069839, filed on May 31, 2021, the disclosures of which are incorporated herein by reference in its entirety.

FIELD

[0002] The present disclosure relates to a hydraulic apparatus for an agricultural work vehicle, and more particularly to a hydraulic apparatus for an agricultural work vehicle that is equipped with a steering unit and a hydraulic pump for supplying hydraulic pressure to a work machine.

BACKGROUND

[0003] Agricultural work vehicles are used to grow crops required for human life by using land. For example, combines, tractors, etc. correspond to agricultural work vehicles. Combines are used to cut and thresh crops such as rice, barley, wheat, soybeans, etc. Tractors perform the work required to grow crops by using traction force.

[0004] These agricultural work vehicles include a transmission device to adjust torque, speed, etc. during a work process as needed.

[0005] Generally, the power generated from the engine of an agricultural work vehicle is mainly transmitted to a steering unit and a work machine.

[0006] The steering unit is a device related to the driving of the agricultural work vehicle. The agricultural work vehicle may receive power from the engine and be driven. Pressed hydraulic oil is introduced into the steering unit by a steering unit pump. When hydraulic oil is introduced into the steering unit, the steering unit may be operated using the hydraulic pressure of the hydraulic oil.

[0007] The work machine is a device related to the work of the agricultural work vehicle. The agricultural work vehicle may receive power from the engine and be driven. Pressed hydraulic oil is introduced into the work machine by a work machine pump. When hydraulic oil is introduced into the work machine, the work machine may be operated using the hydraulic pressure of the hydraulic oil.

[0008] A hydraulic passage is formed from an oil tank to the work machine or steering unit. Hydraulic oil flows inside the hydraulic passage, flows into the cylinder of the work machine or steering unit, and transmits power.

[0009] In this case, the hydraulic oil flowing inside the hydraulic passage may contain some air. For example, when hydraulic oil is supplied to the oil tank, air may be drawn in, and the drawn air may be dissolved in or mixed with the hydraulic oil. While the hydraulic oil is flowing, fine air may penetrate the hydraulic oil from the outside and be contained in the hydraulic oil for various reasons.

[0010] As described above, when the hydraulic oil contains air, various problems arise. The hydraulic oil has the characteristic of low compressibility. As air is contained in the hydraulic oil, compressibility increases, thereby causing a problem in that power cannot be completely transmitted to the work machine or steering unit. Additionally, there is a problem in that noise and vibration occur as the hydraulic oil containing air flows.

[0011] In order to solve the above problems, various efforts are being made to remove the air contained in the hydraulic oil flowing inside the hydraulic passage.

SUMMARY

[0012] An object of the present disclosure is to provide a hydraulic apparatus for an agricultural work vehicle that removes the air contained in hydraulic oil flowing inside a hydraulic passage in the hydraulic apparatus for an agricultural work vehicle, thereby improving the power transmission performance of the hydraulic apparatus and preventing noise or vibration from occurring.

[0013] The objects of the present disclosure are not limited to the object mentioned above, and other objects not mentioned will be clearly understood by those skilled in the art from the following description.

[0014] In order to accomplish the above object, according to an embodiment of the present disclosure, there is provided a hydraulic apparatus for an agricultural work vehicle, the hydraulic apparatus including: a hydraulic passage, and an oil tank configured to store hydraulic oil supplied to the hydraulic passage. A hydraulic pump supplies the hydraulic oil to the hydraulic passage by pressing it. An oil supply conduit is disposed on the hydraulic passage, and connects the oil tank and the hydraulic pump to each other. An oil return conduit is disposed on the hydraulic passage, is connected to the oil tank at one end thereof, and guides the hydraulic oil, circulated through the oil supply conduit, to the oil tank. An air drain conduit is formed such that one end thereof is connected to the oil supply conduit and the other end thereof is connected to the oil return conduit, and guides air, contained in hydraulic oil flowing through the oil supply conduit, to the oil return conduit.

[0015] The air drain conduit may be connected to the upper portion of the oil supply conduit based on the direction of gravity.

[0016] In this case, according to one embodiment of the present disclosure, the hydraulic passage may include a work machine flow path passing through a work machine supply conduit, and the air drain conduit may include a first air drain conduit connected to the oil return conduit of the work machine flow path.

[0017] In this case, according to another embodiment of the present disclosure, the hydraulic passage may include a steering unit flow path passing through a steering unit supply conduit, and the air drain conduit may include a second air drain conduit connected to the oil return conduit of the steering unit flow path.

[0018] In this case, according to still another embodiment of the present disclosure, the hydraulic passage may include a work machine flow path passing through a work machine supply conduit and a steering unit flow path passing through a steering unit supply conduit, and the air drain conduit may include a first air drain conduit connected to the oil return conduit of the work machine flow path and a second air drain conduit connected to the oil return conduit of the steering unit flow path.

[0019] In this case, the oil supply conduit may include: a common supply conduit connected to the oil tank at one end thereof; a work machine supply conduit formed such that one end thereof is connected to the other end of the common supply conduit and the other end thereof is connected to a work machine pump; and a steering unit supply conduit formed such that one end thereof is connected to the other end of the common supply conduit and the other end thereof is connected to a steering unit pump; and the air drain conduit is formed such that the first air drain conduit and the second air drain conduit are both connected to the common supply conduit and are connected at locations spaced apart from each other.

[0020] The hydraulic apparatus may further include an ejector disposed in a connection portion between the air drain conduit and the oil return conduit and configured to discharge air, flowing through the air drain conduit, into hydraulic oil flowing through the oil return conduit.

[0021] Specific details of other embodiments are included in the detailed description and the drawings.

[0022] According to the hydraulic apparatus for an agricultural work vehicle of the present disclosure, one or more of the following effects are achieved.

[0023] First, one end of the air drain conduit is connected to the oil supply conduit and the other end thereof is connected to the oil return conduit. The air in the hydraulic oil flowing through the oil supply conduit is returned to the oil tank through the air drain conduit, and only the hydraulic oil excluding air flows into the work machine or steering unit, so that there are effects in that power can be completely transmitted and noise and vibration can be prevented from occurring.

[0024] Second, the ejector generates negative pressure according to Bernoulli's principle and draws in air from the hydraulic oil flowing in the oil supply conduit. There is also an effect that air can be drawn in from the hydraulic oil even without a separate pump.

[0025] The effects of the present disclosure are not limited to the effects mentioned above, and other effects not mentioned will be clearly understood by those skilled in the art from the description of the claims.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] FIG. 1 is a schematic diagram showing the structure of an agricultural work vehicle according to the present disclosure;

[0027] FIG. 2 is a schematic diagram showing the structure of a hydraulic circuit inside an agricultural work vehicle according to a first embodiment of the present disclosure;

[0028] FIG. 3 is a schematic diagram showing the structure of a hydraulic circuit inside an agricultural work vehicle according to a second embodiment of the present disclosure;

[0029] FIG. 4 is a schematic diagram showing the structure of a hydraulic circuit inside an agricultural work vehicle according to a third embodiment of the present disclosure;

[0030] FIG. 5 is a schematic diagram showing the structure of a hydraulic circuit inside an agricultural work vehicle according to a fourth embodiment of the present disclosure;

[0031] FIG. 6 is an enlarged view showing a connection portion between an air drain conduit and an oil supply conduit; and

[0032] FIG. 7 is an enlarged view showing a portion of an oil return conduit in which an ejector is installed.

DETAILED DESCRIPTION

[0033] The advantages and features of the present disclosure and methods for achieving them will become clear by referring to the embodiments described in detail below together with the accompanying drawings. However, the present disclosure is not limited to the drawings. embodiments disclosed below, but may be implemented in various different forms. These embodiments are merely provided to ensure that the disclosure of the present disclosure is complete and to fully inform those skilled in the art of the scope of the disclosure. The disclosure is defined only by the scope of the claims. Throughout the specification, like reference numerals denote like components.

[0034] The present disclosure will be described below with reference to the drawings illustrating hydraulic apparatuses for an agricultural work vehicle according to embodiments of the present disclosure.

[0035] FIG. 2 is a diagram showing the structure of a hydraulic circuit inside an agricultural work vehicle 1 according to the present disclosure. According to FIG. 2, a work machine pump 821 and a steering unit pump 831 are mechanically connected to an engine 4, are rotated along with the rotation of the engine 4, and are operated simultaneously.

[0036] In general, the power required to drive the steering unit 832 during driving is smaller than the power required to drive the work machine 7. Accordingly, the capacity of the work machine pump 821 is designed to be larger than that of the steering unit pump 831.

[0037] The hydraulic oil stored in an oil tank circulates through a work machine flow path (path A) passing through the work machine **7** or through a steering unit flow path (path B) passing through the steering unit **832**. When the hydraulic oil contains air, noise or vibration may occur as the hydraulic oil flows inside a hydraulic passage. Alternatively, the air has higher compressibility than the hydraulic oil. Accordingly, when the hydraulic oil containing air flows into a cylinder, the volume is changed by the pressure, so that a problem arises in that high reliability cannot be achieved.

[0038] Accordingly, the hydraulic apparatus for an agricultural work vehicle according to the present disclosure includes an air drain conduit **851**. One end of the air drain conduit **851** is connected to an oil supply conduit **841**, and the other end thereof is connected to an oil return conduit **842**. With this arrangement, the air drain conduit **851** separates air from the hydraulic oil flowing inside the oil supply conduit **841** and allows the separated air to flow. The separated air passes through the oil return conduit **842** and is returned to the oil tank **810**. Accordingly, only the hydraulic oil from which the air has been removed flows inside the hydraulic passage, so that noise or vibration does not occur, with the result that high reliability can be achieved.

[0039] Additionally, the hydraulic apparatus for an agricultural work vehicle according to the present disclosure includes an ejector **852**. The ejector **852** may generate negative pressure according to Bernoulli's principle, and may separate and draw in air from the hydraulic oil using the negative pressure. Accordingly, air may be easily separated from the hydraulic oil even without a separate pump for pumping air.

[0040] The hydraulic apparatus for an agricultural work vehicle according to the present disclosure will be described in detail below.

[0041] An agricultural vehicle according to the present disclosure may be the agricultural work vehicle **1** such as a tractor, a combine, or the like.

[0042] Referring to FIG. **1**, the agricultural work vehicle **1** includes drive wheels **2** and **3**. The drive wheels **2** and **3** are components that move the agricultural work vehicle **1**.

[0043] The drive wheels **2** and **3** may be divided into front wheels **2** and rear wheels **3**.

[0044] The front wheels **2** are disposed in front of the center of gravity of the agricultural work vehicle **1**. The front wheels **2** support the front half of the agricultural work vehicle **1**.

[0045] The front wheels **2** may be mechanically connected to the steering unit **832**. Accordingly, when the steering unit **832** is operated, the front wheels **2** may be rotated, and the agricultural work vehicle **1** may be turned and moved.

[0046] The front wheels **2** may be mechanically connected to the engine **4**. Accordingly, the front wheels **2** may receive the driving force of the engine **4** and move the work vehicle selectively forward and rearward.

[0047] The rear wheels **3** are disposed behind the center of gravity of the agricultural work vehicle **1**. The rear wheels **3** support the rear half of the agricultural work vehicle **1**.

[0048] The rear wheels **3** are mechanically connected to the engine **4**. Accordingly, the rear wheels **3** may receive the driving force of the engine **4** and move the work vehicle selectively forward and rearward.

[0049] The rear wheels **3** may be mechanically connected to the steering unit **832**. Accordingly, when the steering unit **832** is operated, the rear wheels **3** may be rotated together with or separately from the front wheels **2**.

[0050] The diameter of the front wheels **2** may be formed to be smaller than that of the rear wheels **3**.

[0051] Referring to FIG. **1**, an agricultural work vehicle **1** includes the engine **4**. The engine **4** provides driving force to the agricultural work vehicle **1**.

[0052] The engine **4** is mechanically connected to the drive wheels **2** and **3**, so that the agricultural work vehicle **1** can be driven when the engine **4** is operated.

[0053] The engine **4** is mechanically connected to the work machine **7**, and thus, can drive the

work machine **7** so that the work machine **7** performs various tasks.

[0054] The engine **4** may be connected to a main pump and operate the main pump, and the hydraulic oil may be supplied to the work machine flow path (path A) connected to the work machine **7**.

[0055] The engine **4** may be connected to the steering pump and operate the steering pump, and the hydraulic oil may be supplied to the steering unit flow path (path B) connected to the steering unit **832**.

[0056] The engine **4** may be placed in the front half of the agricultural work vehicle **1**. The front half refers to the portion of the agricultural work vehicle **1** in front of the midpoint between the front and rear ends of the agricultural work vehicle **1**. Alternatively, the front half may refer to the portion of the agricultural work vehicle **1** in front of the center of gravity of the agricultural work vehicle **1**.

[0057] The engine **4** may be placed over the front ones **2** of the drive wheels **2** and **3**.

[0058] Referring to FIG. **1**, the agricultural work vehicle **1** includes a work machine drive unit **6**. The work machine drive unit **6** is a component that drives the work machine **7** using the power of the engine **4** and the pressure of the hydraulic oil.

[0059] The work machine drive unit **6** may move the work machine **7**, for example, by raising and lowering the work machine **7**.

[0060] The hydraulic oil circulates through the work machine drive unit **6**, and the work machine drive unit **6** is operated by hydraulic pressure.

[0061] Referring to FIG. **1**, the agricultural work vehicle **1** includes the work machine **7**. The work machine **7** refers to a tool for agricultural work. The work machine **7** may be a backhoe for digging up the soil, or a plow or rotary for clearing the soil. In addition to the above-described mechanisms, the work machine **7** may include all mechanisms within the range in which those skilled in the art can easily adopt them.

[0062] Referring to FIG. **2**, a hydraulic circuit circulating through the agricultural work vehicle **1** will be described.

[0063] The oil tank **810** is a component that stores hydraulic oil.

[0064] The hydraulic oil stored in the oil tank **810** may circulate through the work machine flow path (path A). The hydraulic oil circulating through the work machine flow path (path A) circulates from the oil tank **810** through the work machine pump **821**, a loader valve **822**, and the work machine **7** and is returned back to the oil tank **810**. Alternatively, when the loader valve **822** is turned on, the hydraulic oil circulates only through the work machine pump **821** and the loader valve **822** and is then returned to the oil tank **810**. The hydraulic oil circulating through the work machine flow path (path A) flows through a work machine inlet conduit **845**.

[0065] Hydraulic pumps are components that press and pump hydraulic oil. The hydraulic pumps are operated by the engine **4**. The hydraulic pumps are mechanically connected to the power of the engine **4** and are driven by receiving power from the engine **4**.

[0066] The fluid pressed by the hydraulic pumps is used for the lubrication and operation of vehicle parts of the agricultural work vehicle **1**.

[0067] Such hydraulic pumps may be divided into fixed delivery type-hydraulic pumps in which the volume of hydraulic oil discharged is constant and variable delivery type-hydraulic pumps in which the volume of hydraulic oil discharged can be changed. The hydraulic pumps according to the present disclosure may be of a fixed delivery type or a variable delivery type.

[0068] The hydraulic pumps included in the agricultural work vehicle **1** according to the present disclosure may be divided into the work machine pump **821** and the steering unit pump **831**.

[0069] The work machine pump **821** is a component that presses and circulates the hydraulic oil inside the work machine flow path (path

[0070] A). The work machine pump **821** is disposed downstream of the oil tank **810**. The work machine pump **821** is connected to the oil tank **810** and supplies the hydraulic oil to the work

machine **7**.

[0071] The hydraulic oil flowing through the work machine inlet conduit **845** may be supplied to the work machine drive unit **6** for driving the work machine **7**, as shown in FIG. **1**. Although the hydraulic oil flowing through the work machine inlet conduit **845** may be described as being supplied to the work machine **7** in the following description, the hydraulic oil is not limited to the above description but may be described as being supplied to the work machine drive unit **6**.

[0072] The work machine inlet conduit **845** is a component through which the hydraulic oil circulating in the work machine flow path (path A) flows. The work machine inlet conduit **845** connects the work machine pump **821** and the work machine **7**. One end of the work machine inlet conduit **845** is connected to the work machine pump **821**. The other end of the work machine inlet conduit **845** is connected to the work machine **7**.

[0073] Furthermore, the work machine inlet conduit **845** may pass through the loader valve **822**. The loader valve **822** is a component that may selectively supply hydraulic pressure to a loader provided at the front of the agricultural work vehicle **1**. The loader valve **822** may be disposed downstream of the work machine pump **821**, and more specifically, may be disposed between the work machine pump **821** and the work machine **7**. Additionally, a drain conduit **843** connecting the loader valve **822** and the oil return conduit **842** may be connected to the loader valve **822**.

[0074] When the loader valve **822** is turned off, the hydraulic oil discharged from the work machine pump **821** passes through the loader valve **822** and flows into the work machine **7** along the work machine inlet conduit **845**. When the loader valve **822** is turned on, the hydraulic oil discharged from the work machine pump **821** is supplied to the loader through the loader valve **822**, drives the loader, and is returned to the oil tank **810** via the drain conduit **843**.

[0075] Meanwhile, the hydraulic oil stored in the oil tank **810** may circulate through the steering unit flow path (path B). The hydraulic oil circulating through the steering unit flow path (path B) circulates from the oil tank **810** through the steering unit pump **831** and the steering unit **832** and is returned back to the oil tank **810**. The hydraulic oil circulating through the steering unit flow path (path B) flows through the steering unit inlet conduit **846**.

[0076] The steering unit pump **831** is a component that presses and circulates the hydraulic oil inside the steering unit flow path (path B). The steering unit pump **831** is disposed downstream of the oil tank **810**.

[0077] The steering unit **832** is a component that drives the drive wheels **2** and **3**. For example, when the steering unit **832** is operated, the drive wheels **2** and **3** may be rotated, and the agricultural work vehicle **1** may be turned and driven.

[0078] Referring to FIG. **2**, the hydraulic apparatus for an agricultural work vehicle according to the present disclosure includes the air drain conduit **851**. The air drain conduit **851** is a component that separates the air contained in the hydraulic oil from the hydraulic oil and bypasses it. In more detail, although the hydraulic oil together with the air are bypassed inside the air drain conduit **851**, air is described as flowing inside the air drain conduit **851** for the sake of convenience.

[0079] One end of the air drain conduit **851** is connected to the oil supply conduit **841**, and the other end thereof is connected to the oil return conduit **842**. The air drain conduit **851** guides the air, contained in the hydraulic oil flowing through the oil supply conduit **841**, to the oil return conduit **842**.

[0080] With this arrangement, the air contained in the hydraulic oil flowing through the oil supply conduit **841** is separated and flows into the oil return conduit **842** through the air drain conduit **851**. Accordingly, the hydraulic oil excluding air flows downstream of the air drain conduit **851** in the oil supply conduit **841**, and flows into the work machine **7** or the steering unit **832**. Accordingly, noise or vibration does not occur, so that high reliability can be achieved.

[0081] Referring to FIGS. **2** to **6**, the oil supply conduit **841** may be divided into a common supply conduit **8411**, a work machine supply conduit **8412**, and a steering unit supply conduit **8413**.

[0082] One end of the common supply conduit **8411** is connected to the oil tank **810**. More

specifically, the front end of the common supply conduit is connected to the outlet end of the oil tank **810**, and hydraulic oil flows in from the oil tank **810**.

[0083] One end of the work machine supply conduit **8412** is connected to the other end of the common supply conduit **8411**, and the other end thereof is connected to the work machine pump **821**. The work machine supply conduit **8412** branches off from the common supply conduit **8411**, and some of the hydraulic oil flowing through the common supply conduit **8411** flows in.

[0084] One end of the steering unit supply conduit **8413** is connected to the other end of the common supply conduit **8411**, and the other end thereof is connected to the steering unit pump **831**. The steering unit supply conduit **8413** branches off from the common supply conduit **8411**, and some of the hydraulic oil flowing through the common supply conduit **8411** flows in.

[0085] The hydraulic oil flowing through the common supply conduit **8411** is divided and separately flows into the work machine supply conduit **8412** and the steering unit supply conduit **8413**. Alternatively, the hydraulic oil may selectively flow into the work machine supply conduit **8412** or the steering unit supply conduit **8413**.

[0086] A hydraulic apparatus for an agricultural work vehicle according to a first embodiment will be described below with reference to FIG. 2.

[0087] Referring to FIG. 2, the air drain conduit **851** is connected to the common supply conduit **8411**. With this arrangement, the air drain conduit **851** may separate and bypass the air contained in the hydraulic oil flowing inside the common supply conduit **8411**. Accordingly, the air contained in the hydraulic oil flowing through the work machine passage (path A) and the steering unit flow path (path B) may be removed simultaneously by installing only the one air drain conduit **851**.

[0088] Referring to FIG. 2, the air drain conduit **851** is connected to the oil return conduit **842a** of the work machine flow path. In more detail, one end of the air drain conduit **851** is connected to the common supply conduit **8411**, and the other end thereof is connected to the oil return conduit **842a** of the work machine flow path. With this arrangement, the air contained in the hydraulic oil flowing inside the common supply conduit **8411** is separated from the hydraulic oil and flows through the air drain conduit **851**, and flows through the oil return conduit **842a** of the work machine flow path and is returned to the oil tank **810**.

[0089] The capacity of the work machine pump **821** is larger than that of the steering unit pump **831**, and the flow rate inside the work machine flow path (path A) is larger than that inside the steering unit flow path (path B). The flow rate and pressure of the hydraulic oil flowing inside the work path (path A) are sufficiently high, so that the width of the pressure drop increases as the hydraulic oil passes through the ejector **852**. Accordingly, the negative pressure is generated more strongly, thereby allowing air to be more easily drawn in at the inlet end of the air drain conduit **851**.

[0090] A hydraulic apparatus for an agricultural work vehicle according to a second embodiment of the present disclosure will be described below with reference to FIG. 3. The description of the hydraulic system apparatus of the agricultural work vehicle according to the above-described first embodiment may be adopted as long as it does not conflict with the hydraulic apparatus for an agricultural work vehicle according to the second embodiment. The hydraulic apparatus for an agricultural work vehicle according to the second embodiment will be described below with a focus on the differences from the first embodiment.

[0091] Referring to FIG. 3, the hydraulic apparatus for an agricultural work vehicle according to the present disclosure includes an air drain conduit **851**.

[0092] The air drain conduit **851** is connected to the oil return conduit **842b** of a steering unit flow path. In more detail, one end of the air drain conduit **851** is connected to a common supply conduit **8411**, and the other end thereof is connected to the oil return conduit **842b** of the steering unit flow path. With this arrangement, the air contained in the hydraulic oil flowing inside the common supply conduit **8411** is separated from the hydraulic oil flow path and flows through the air drain conduit **851**, and flows through the oil return conduit **842b** of the steering unit flow path and is

returned to an oil tank **810**.

[0093] When the oil supply conduit **841** and oil return conduit **842** of the hydraulic passage of the hydraulic apparatus for an agricultural work vehicle are connected to each other, there may be a possibility that the hydraulic oil inside the oil return conduit **842** flows back into the oil supply conduit **841** due to the pressure difference.

[0094] In this case, the pressure inside a work machine flow path (path A) is formed to be higher than that of the steering unit flow path (path B). Accordingly, there may be a relatively high possibility that the hydraulic oil will flow back from the oil return conduit **842a** of the work machine flow path to the common supply conduit **8411** through the air drain conduit **851**.

[0095] Therefore, in the second embodiment, the other end of the air drain conduit **851** is connected to the oil return conduit **842b** of the steering unit flow path, thereby preventing a back flow in the air drain conduit **851**.

[0096] A hydraulic apparatus for an agricultural work vehicle according to a third embodiment of the present disclosure will be described below with reference to FIG. 4. The descriptions of the hydraulic apparatus for an agricultural work vehicle according to the above-described first or second embodiment may be adopted as long as they do not conflict with the hydraulic apparatus for an agricultural work vehicle according to the third embodiment. The hydraulic apparatus for an agricultural work vehicle according to the third embodiment will be described below with a focus on the differences from the first and second embodiments.

[0097] Referring to FIG. 4, an air drain conduit **851** includes a first air drain conduit **851a** and a second air drain conduit **851b**. The first air drain conduit **851a** is connected to the oil return conduit **842a** of a work machine flow path, and the second air drain conduit **851b** is connected to the oil return conduit **842b** of a steering unit flow path.

[0098] In more detail, one end of the first air drain conduit **851a** is connected to a work machine supply conduit **8412**, and the other end thereof is connected to the oil return conduit **842a** of the work machine flow path. Furthermore, one end of the second air drain conduit **851b** is connected to a steering unit supply conduit **8413**, and the other end thereof is connected to the oil return conduit **842b** of the steering unit flow path. With this arrangement, the air contained in the hydraulic oil flowing through the work machine flow path (path A) passes through the first air drain conduit **851a** and flows into the oil return conduit **842a** of the work machine flow path, and flows into the steering unit flow path (path A). The air contained in the hydraulic oil flowing through the steering unit flow path (path B) passes through the second air drain conduit **851b** and flows into the oil return conduit **842b** of the steering unit flow path.

[0099] In the third embodiment, the air contained in the hydraulic oil flowing through the work machine flow path (path A) and the air contained in the hydraulic oil flowing through the steering unit flow path (path B) are removed through the respective air drain conduits **851**. With this arrangement, the shapes of conduits and the structure of an ejector **852** are designed differently, and thus the dimensions that can most appropriately draw in air may be determined based on the features of the hydraulic oil flowing in the work machine flow path (path A) and the features of the hydraulic oil flowing in the steering unit flow path (path B).

[0100] Referring to FIG. 4, a first air drain conduit **851a** and a second air drain conduit **851b** are simultaneously disposed in a hydraulic passage. Alternatively, only the first air drain conduit **851a** may be disposed in the hydraulic passage without the second air drain conduit **851b**. Alternatively, only the second air drain conduit **851b** may be disposed in the hydraulic passage without the first air drain conduit **851a**.

[0101] A hydraulic apparatus for an agricultural work vehicle according to a fourth embodiment of the present disclosure will be described below with reference to FIG. 5. The descriptions of the hydraulic apparatuses of the agricultural work vehicles according to the above-described first to third embodiments may be adopted as long as they do not conflict with the hydraulic apparatus for an agricultural work vehicle according to the fourth embodiment. The hydraulic apparatus for an

agricultural work vehicle according to the fourth embodiment will be described below with a focus on the differences from the first to third embodiments.

[0102] Referring to FIG. 5, one end of the first air drain conduit **851a** is connected to a common supply conduit **8411** (at **853a**), and the other end thereof is connected to the oil return conduit **842a** of a work machine flow path. Furthermore, one end of the second air drain conduit **851b** is connected to the common supply conduit **8411** (at **853b**), and the other end thereof is connected to the oil return conduit **842b** of a steering unit flow path. With this arrangement, the air contained in the hydraulic oil flowing through the common supply conduit **8411** may be introduced into the first air drain conduit **851a** or the second air drain conduit **851b** in two steps.

[0103] In more detail, the first air drain conduit **851a** may be connected to the common supply conduit **8411** upstream of the second air drain conduit **851a**. In other words, a connection portion **853a** between the first air drain conduit **851a** and the common supply conduit **8411** is disposed upstream of a connection portion **853b** between the second air drain conduit **851b** and the common supply conduit **8411**. With this arrangement, some of the air contained in the hydraulic oil flowing through the common supply conduit **8411** flows into the first air drain conduit **851a**, and the remaining air thereof flows into the second air drain conduit **851b**.

[0104] Unlike in FIG. 5, the first air drain conduit **851a** may be connected to the common supply conduit **8411** downstream of the second air drain conduit **851a**.

[0105] According to the fourth embodiment, the air contained in the hydraulic oil is drained first and second, i.e., twice. The air in the hydraulic oil may be removed more effectively.

[0106] Referring to FIG. 6, an air drain conduit **851** according to the present disclosure is connected to the upper portion of an oil supply conduit **841** based on the direction of gravity.

[0107] The air drain conduit **851** may be connected to the top of the oil supply conduit **841** and extend upward. With this arrangement, the air contained in the hydraulic oil flowing through the oil supply conduit **841** may be collected on the ceiling of the oil supply conduit **841** by buoyancy and flow into the air drain conduit **851** connected to the top.

[0108] Referring to FIG. 7, a hydraulic apparatus for an agricultural work vehicle according to the present disclosure includes an ejector **852**. The ejector **852** is a component that draws in air by generating negative pressure. The ejector **852** is disposed in a connection portion **853** between an air drain conduit **851** and an oil return conduit **842**.

[0109] The ejector **852** may be disposed in the oil return conduit **842a** of the work machine flow path as shown in FIG. 2, may be disposed in the oil return conduit **842b** of the steering unit flow path as shown in FIG. 3, and may be disposed on both sides as shown in FIGS. 4 and 5.

[0110] Referring to FIG. 7, the ejector **852** is formed to be long along the direction of movement of the hydraulic oil flowing inside the oil return conduit **842**. The air drain conduit **851** is connected to the ejector **852** in a direction crossing the longitudinal direction of the ejector **852**. With this arrangement, the hydraulic oil flows along the longitudinal direction of the ejector **852**, and air flowing inside the air drain conduit **851** flows in from its side and is discharged into the oil tank **810** together with the hydraulic oil inside the ejector **852**.

[0111] The air drain conduit **851** is connected to the ejector **852** in the radial direction of the ejector **852**. In a connection portion between the air drain conduit and the ejector **852**, the extension direction of the air drain conduit **851** and the longitudinal direction of the ejector **852** may be perpendicular to each other.

[0112] Referring to FIG. 7, based on the portion where the air drain conduit **851** and the ejector **852** are connected to each other, the diameter of the ejector **852** increases toward both ends. With this arrangement, according to the continuity theorem, in the connection portion between the air drain conduit **851** and the ejector **852**, the speed of the hydraulic oil gradually increases as it moves from the front end of the ejector **852** to the connection portion, and gradually decreases as it moves from the connection portion to the rear end of the ejector **852**. Accordingly, according to Bernoulli's theorem, the flow speed in the connection portion between the air drain conduit **851** and the ejector

852 becomes the highest. As a result, when negative pressure is generated in the connection portion between the air drain conduit **851** and the ejector **852**, the air flowing in the oil supply conduit **841** flows into the ejector **852** through the air drain conduit **851**.

[0113] According to the present disclosure, the air contained in the hydraulic oil flowing through the oil supply conduit **841** flows into the oil return conduit **842** through the air drain conduit **851** and is returned into the oil tank **810**. Accordingly, only the hydraulic oil from which the air has been removed flows in a subsequent hydraulic passage. There are provided effects in that the high reliability of operation may be achieved and noise or vibration does not occur.

[0114] While the preferred embodiments of the present disclosure have been illustrated and described above, the present disclosure is not limited to the specific embodiments described above. It will be apparent that various modifications may be made by those having ordinary skill in the art to which the present disclosure pertains without departing from the gist of the disclosure claimed in the patent claims. These modified implementations should not be understood separately from the technical spirit or perspective of the present disclosure.

Claims

1. A hydraulic apparatus for an agricultural work vehicle, the hydraulic apparatus comprising: a hydraulic passage, and an oil tank configured to store hydraulic oil supplied to the hydraulic passage; a hydraulic pump configured to supply the hydraulic oil to the hydraulic passage by pressing it; an oil supply conduit disposed on the hydraulic passage, and configured to connect the oil tank and the hydraulic pump to each other; an oil return conduit disposed on the hydraulic passage, connected to the oil tank at one end thereof, and configured to guide the hydraulic oil, circulated through the oil supply conduit, to the oil tank; and an air drain conduit formed such that one end thereof is connected to the oil supply conduit and a remaining end thereof is connected to the oil return conduit, and configured to guide air, contained in hydraulic oil flowing through the oil supply conduit, to the oil return conduit.
2. The hydraulic apparatus of claim 1, wherein the air drain conduit is connected to an upper portion of the oil supply conduit based on a direction of gravity.
3. The hydraulic apparatus of claim 1, wherein: the hydraulic passage includes a work machine flow path passing through a work machine supply conduit; and the air drain conduit includes a first air drain conduit connected to an oil return conduit of the work machine flow path.
4. The hydraulic apparatus of claim 1, wherein: the hydraulic passage includes a steering unit flow path passing through a steering unit supply conduit; and the air drain conduit includes a second air drain conduit connected to an oil return conduit of the steering unit flow path.
5. The hydraulic apparatus of claim 1, wherein: the hydraulic passage includes a work machine flow path passing through a work machine supply conduit and a steering unit flow path passing through a steering unit supply conduit; and the air drain conduit includes a first air drain conduit connected to an oil return conduit of the work machine flow path and a second air drain conduit connected to an oil return conduit of the steering unit flow path.
6. The hydraulic apparatus of claim 5, wherein: the oil supply conduit includes: a common supply conduit connected to the oil tank at one end thereof; a work machine supply conduit formed such that one end thereof is connected to a remaining end of the common supply conduit and a remaining end thereof is connected to a work machine pump; and a steering unit supply conduit formed such that one end thereof is connected to a remaining end of the common supply conduit and a remaining end thereof is connected to a steering unit pump; and the air drain conduit is formed such that the first air drain conduit and the second air drain conduit are both connected to the common supply conduit and are connected at locations spaced apart from each other.
7. The hydraulic apparatus of claim 1, further comprising an ejector disposed in a connection portion between the air drain conduit and the oil return conduit and configured to discharge air,

flowing through the air drain conduit, into hydraulic oil flowing through the oil return conduit.

8. The hydraulic apparatus of claim 7, wherein: the ejector is formed to be long along a direction of movement of hydraulic oil flowing inside the oil return conduit; and the air drain conduit is connected to the ejector in a direction crossing a longitudinal

9. The hydraulic apparatus of claim 8, wherein a diameter of the ejector increases toward both ends thereof based on a portion where the air drain conduit and the ejector are connected to each other.
