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HYDRAULIC PRESSURE CONTROL UNIT

Abstract

The present invention obtains a hydraulic pressure control unit capable of accurately evaluating viscosity of a hydraulic fluid.
The hydraulic pressure control unit according to the present invention includes a controller including an evaluation section that evaluates the viscosity of the hydraulic fluid. The evaluation section evaluates the viscosity on the basis of a reduced amount of a current value of a current flowing through a wire (**314**) at a time when the current value is temporarily reduced in a process in which the current value is increased toward a target current value at beginning of application of the current to the wire (**314**) of an electromagnetic valve (**31**).

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Background/Summary

BACKGROUND

[0001] The present disclosure relates to a hydraulic pressure control unit capable of accurately evaluating viscosity of a hydraulic fluid.

[0002] Conventionally, as a behavior control system for controlling behavior of a vehicle such as a motorcycle, there is a system using a hydraulic pressure control unit that controls a hydraulic pressure generated in a hydraulic fluid. In the hydraulic pressure control unit, the hydraulic pressure that is generated in the hydraulic fluid is controlled by operating an electromagnetic valve that is provided to a channel for the hydraulic fluid.

[0003] Here, when viscosity of the hydraulic fluid is increased, movement of an armature that is a movable portion in the electromagnetic valve tends to be restricted. Thus, in the case where the viscosity of the hydraulic fluid is excessively high, there is a possibility that a function of the electromagnetic valve to open/close the channel is not exerted appropriately. In order to handle such a problem, a technique of evaluating the viscosity of the hydraulic fluid has been proposed to comprehend an actuation state of the electromagnetic valve (for example, see JP2019215009A).

[0004] By the way, the viscosity of the hydraulic fluid is changed as the hydraulic fluid is deteriorated. For example, the viscosity of the hydraulic fluid is increased as the hydraulic fluid is deteriorated and water content of the hydraulic fluid is increased. However, in the related art of the hydraulic pressure control unit, the change in the viscosity associated with the deterioration of the hydraulic fluid is not taken into account in the evaluation of the viscosity of the hydraulic fluid, and the viscosity of the hydraulic fluid is not evaluated accurate enough.

SUMMARY

[0005] The present invention has been made with the above-described problem as the background and therefore obtains a hydraulic pressure control unit capable of accurately evaluating viscosity of a hydraulic fluid.

[0006] A hydraulic pressure control unit according to the present invention is a hydraulic pressure control unit used for a behavior control system of a vehicle, and includes: a hydraulic pressure control mechanism that includes a base body and components including an electromagnetic valve assembled to the base body for controlling a hydraulic pressure generated in a hydraulic fluid for the behavior control system; and a controller that includes a control section controlling operation of the components. The electromagnetic valve includes a wire and an armature that moves in association with application of a current to the wire, and is a valve that is closed or a valve that is opened in an energized state where the current is applied to the wire. The controller includes an evaluation section that evaluates viscosity of the hydraulic fluid. The evaluation section evaluates the viscosity on the basis of a reduced amount of a current value of the current flowing through the wire at a time when the current value is temporarily reduced in a process in which the current value is increased toward a target current value at beginning of the application of the current to the wire.

[0007] In the hydraulic pressure control unit according to the present invention, the controller includes the evaluation section that evaluates the viscosity of the hydraulic fluid. The evaluation section evaluates the viscosity on the basis of the reduced amount of the current value of the current flowing through the wire at the time when the current value is temporarily reduced in the process in which the current value is increased toward the target current value at the beginning of the application of the current to the wire of the electromagnetic valve. In this way, it is possible to evaluate the viscosity of the hydraulic fluid by taking a change in the viscosity associated with the deterioration of the hydraulic fluid into account. Therefore, it is possible to accurately evaluate the viscosity of the hydraulic fluid.

Description

BRIEF DESCRIPTION OF DRAWINGS

[0008] FIG. **1** is a schematic view illustrating an outline configuration of a vehicle according to an embodiment of the present invention.

[0009] FIG. **2** is a schematic view illustrating an outline configuration of a brake system according to the embodiment of the present invention.

[0010] FIG. **3** is a schematic cross-sectional view illustrating an example of an electromagnetic valve in a hydraulic pressure control unit according to the embodiment of the present invention.

[0011] FIG. **4** is a schematic view illustrating an example of a current sensor in the hydraulic pressure control unit according to the embodiment of the present invention.

[0012] FIG. **5** is a block diagram illustrating an example of a functional configuration of a controller according to the embodiment of the present invention.

[0013] FIG. **6** is a schematic graph illustrating an example of transition of a current value of a current flowing through a wire at beginning of application of the current to the wire of the electromagnetic valve in the hydraulic pressure control unit according to the embodiment of the present invention.

[0014] FIG. **7** is a flowchart illustrating an example of a processing procedure related to evaluation of viscosity of a hydraulic fluid that is executed by the controller according to the embodiment of the present invention.

DETAILED DESCRIPTION

[0015] A description will hereinafter be made on a hydraulic pressure control unit according to the present invention with reference to the drawings.

[0016] A description will hereinafter be made on the hydraulic pressure control unit that is used for a brake system of a two-wheeled motorcycle (see a vehicle **100** in FIG. **1**). However, the hydraulic pressure control unit according to the present invention may be used for a behavior control system other than the brake system (for example, a system that controls a damping force of a suspension, or the like). In addition, the hydraulic pressure control unit according to the present invention may be used for the behavior control system of a vehicle other than the two-wheeled motorcycle (for example, another straddle-type vehicle, such as an all-terrain vehicle, a three-wheeled motorcycle, or a bicycle, a four-wheeled automobile, or the like). Here, the straddle-type vehicle means a vehicle that a rider straddles, and includes a scooter and the like.

[0017] A description will hereinafter be made on a case where one front-wheel brake mechanism and one rear-wheel brake mechanism are provided (see a front-wheel brake mechanism **12** and a rear-wheel brake mechanism **14** in FIG. **2**). However, at least one of the front-wheel brake mechanism and the rear-wheel brake mechanism may be plural. Alternatively, one of the front-wheel brake mechanism and the rear-wheel brake mechanism may not be provided.

[0018] A configuration, operation, and the like, which will be described below, constitute merely one example, and the hydraulic pressure control unit according to the present invention is not limited to a case with such a configuration, such operation, and the like.

[0019] The same or similar description will appropriately be simplified or will not be made below. In the drawings, the same or similar members or portions will not be denoted by a reference sign or will be denoted by the same reference sign. A detailed structure will appropriately be illustrated in a simplified manner or will not be illustrated.

Vehicle Configuration

[0020] A description will be made on a configuration of the vehicle **100** according to an

embodiment of the present invention with reference to FIG. **1** to FIG. **5**.
[0021] FIG. **1** is a schematic view illustrating an outline configuration of the vehicle **100**. FIG. **2** is a schematic view illustrating an outline configuration of a brake system **10**.
[0022] The vehicle **100** is a two-wheeled motorcycle that corresponds to an example of the vehicle according to the present invention. As illustrated in FIG. **1**, the vehicle **100** includes: a trunk **1**; a handlebar **2** that is held by the trunk **1** in a freely turnable manner; a front wheel **3** that is held by the trunk **1** in the freely turnable manner with the handlebar **2**; a rear wheel **4** that is held by the trunk **1** in a freely rotatable manner; a hydraulic pressure control unit **5**; and a notification device **6**. The hydraulic pressure control unit **5** is used for the brake system **10** of the vehicle **100**. The notification device **6** notifies the rider. The notification device **6** has a sound output function and a display function. The sound output function is a function to output sound and is implemented by a speaker, for example. The display function is a function to show information visually, and is implemented by a liquid-crystal display, a lamp, or the like, for example. The vehicle **100** includes a drive source such as an engine or a motor, and travels by using power that is output from the drive source.
[0023] As illustrated in FIG. **1** and FIG. **2**, the brake system **10** includes: a first brake operation section **11**; the front-wheel brake mechanism **12** that brakes the front wheel **3** in an interlocking manner with at least the first brake operation section **11**; a second brake operation section **13**; and the rear-wheel brake mechanism **14** that brakes the rear wheel **4** in an interlocking manner with at least the second brake operation section **13**. The brake system **10** also includes the hydraulic pressure control unit **5**, and the front-wheel brake mechanism **12** and the rear-wheel brake mechanism **14** are partially included in the hydraulic pressure control unit **5**. The hydraulic pressure control unit **5** is a unit that has a function of controlling a braking force to be applied to the front wheel **3** by the front-wheel brake mechanism **12** and a braking force to be applied to the rear wheel **4** by the rear-wheel brake mechanism **14**.
[0024] The first brake operation section **11** is provided to the handlebar **2** and is operated by the rider's hand. The first brake operation section **11** is a brake lever, for example. The second brake operation section **13** is provided to a lower portion of the trunk **1** and is operated by the rider's foot. The second brake operation section **13** is a brake pedal, for example. However, like a brake operation section of the scooter or the like, each of the first brake operation section **11** and the second brake operation section **13** may be the brake lever that is operated by the rider's hand.
[0025] Each of the front-wheel brake mechanism **12** and the rear-wheel brake mechanism **14** includes: a master cylinder **21** in which a piston (not illustrated) is installed; a reservoir **22** that is attached to the master cylinder **21**; a brake caliper **23** that is held by the trunk **1** and has a brake pad (not illustrated); a wheel cylinder **24** that is provided to the brake caliper **23**; a primary channel **25** through which a brake fluid in the master cylinder **21** flows into the wheel cylinder **24**; a secondary channel **26** through which the brake fluid in the wheel cylinder **24** is released; and a supply channel **27** through which the brake fluid in the master cylinder **21** is supplied to the secondary channel **26**.
[0026] Each of the front-wheel brake mechanism **12** and the rear-wheel brake mechanism **14** is provided with an electromagnetic valve **31** for controlling a hydraulic pressure generated in the brake fluid as a hydraulic fluid. In an example illustrated in FIG. **2**, the electromagnetic valves **31** are an inlet valve (EV) **31***a*, an outlet valve (AV) **31***b*, a first valve (USV) **31***c*, and a second valve (HSV) **31***d*.
[0027] The inlet valve **31***a* is provided to the primary channel **25**. The secondary channel **26** bypasses a portion of the primary channel **25** between the wheel cylinder **24** side and the master cylinder **21** side of the inlet valve **31***a*. The secondary channel **26** is sequentially provided with the outlet valve **31***b*, an accumulator **32**, and a pump **33** from an upstream side. The first valve **31***c* is provided between an end on the master cylinder **21** side of the primary channel **25** and a portion of the primary channel **25** to which a downstream end of the secondary channel **26** is connected. The supply channel **27** communicates between the master cylinder **21** and a portion on a suction side of

the pump **33** in the secondary channel **26**. The second valve **31***d* is provided to the supply channel **27**.
[0028] The inlet valve **31***a* is the electromagnetic valve **31** that is opened in an unenergized state and is closed in an energized state, for example. The outlet valve **31***b* is the electromagnetic valve **31** that is closed in the unenergized state and opened in the energized state, for example. The first valve **31***c* is the electromagnetic valve **31** that is opened in the unenergized state and is closed in the energized state, for example. The second valve **31***d* is the electromagnetic valve **31** that is closed in the unenergized state and is opened in the energized state, for example.
[0029] The hydraulic pressure control unit **5** includes: a hydraulic pressure control mechanism **51** that includes a part of the front-wheel brake mechanism **12** and a part of the rear-wheel brake mechanism **14** described above; and a controller (ECU) **52** that controls operation of the hydraulic pressure control mechanism **51**.
[0030] The hydraulic pressure control mechanism **51** includes: a base body **51***a;* and components that are assembled to the base body **51***a* and include the electromagnetic valves **31** for controlling the hydraulic pressure generated in the brake fluid as the hydraulic fluid in the brake system **10**. The component means an element such as a part that is assembled to the base body **51***a*.
[0031] The base body **51***a* has a substantially rectangular-parallelepiped shape and is formed of a metal material, for example. In the base body **51***a* of the hydraulic pressure control mechanism **51**, the primary channels **25**, the secondary channels **26**, and the supply channels **27** are formed, and the electromagnetic valves **31** (more specifically, the inlet valves **31***a*, the outlet valves **31***b*, the first valves **31***c*, and the second valves **31***d*), the accumulators **32**, and the pumps **33** are assembled as the components. As will be described below, operation of each of these components is controlled by the controller **52** of the hydraulic pressure control unit **5**. The base body **51***a* may be formed of one member or may be formed of plural members. In the case where the base body **51***a* is formed of the plural members, the components may separately be provided in the plural members.
[0032] A description will hereinafter be made on a detailed configuration of the electromagnetic valve **31** that is provided to the hydraulic pressure control unit **5** with reference to FIG. **3**. FIG. **3** is a schematic cross-sectional view illustrating an example of the electromagnetic valve **31** in the hydraulic pressure control unit **5**. Hereinafter, a description will primarily be made on a case where the electromagnetic valve **31** in FIG. **3** is the valve that is closed in the energized state (more specifically, the inlet valve **31***a* and the first valve **31***c*). Then, a description on a case where the electromagnetic valve **31** is the valve that is opened in the energized state (more specifically, the outlet valve **31***b* and the second valve **31***d*) will be supplemented.
[0033] As illustrated in FIG. **3**, the electromagnetic valve **31** includes a case **311**, an armature **312**, a tappet **313**, a wire **314**, a core **315**, a spring **316**, a first channel **317**, and a second channel **318**, for example.
[0034] The armature **312** corresponds to a movable portion that can reciprocate relative to the case **311** in the case **311**. The armature **312** has a substantially cylindrical shape, for example. The armature **312** is arranged in an internal space that is formed on the inside of the case **311**, and can reciprocate along an axial direction of the armature **312**. The tappet **313** is fixed to the armature **312** and can move integrally with the armature **312**. For example, the tappet **313** is a solid rod member that has a circular cross-sectional shape, and is fitted and fixed to an inner circumferential portion of the armature **312**.
[0035] The wire **314** is fixed to the case **311**, and generates a magnetic field when being applied with a current. For example, the wire **314** is provided in a manner to surround the internal space of the case **311** along a circumferential direction of the armature **312**. The core **315** is an iron core that is magnetized by the magnetic field generated by the wire **314**, and has a substantially cylindrical shape, for example. In the internal space of the case **311**, the core **315** is coaxially arranged with the armature **312**, and the tappet **313** is inserted through an inner circumferential portion of the core **315**. When the core **315** is magnetized, a magnetic force in a direction to approach the core **315**

acts on the armature **312**. In this way, the armature **312** moves in association with application of the current to the wire **314**.

[0036] The spring **316** urges the armature **312** in a direction away from the core **315**. For example, in the internal space of the case **311**, the spring **316** is provided in a manner to be held between an inner circumferential portion of the case **311** and an end surface on the core **315** side of the armature **312**.

[0037] The first channel **317** and the second channel **318** are formed in the case **311** and each form a part of the primary channel **25**, the secondary channel **26**, or the supply channel **27** provided with the electromagnetic valve **31**. In addition, in the case **311**, the first channel **317** and the second channel **318** are mutually connected via a space in which a tip of the tappet **313** is accommodated.

[0038] In the electromagnetic valve **31** (more specifically, the inlet valve **31***a* and the first valve **31***c*) that is closed in the energized state, in a state where the current is not applied to the wire **314** (that is, the unenergized state), as indicated by solid lines in FIG. **3**, the armature **312** is held at a separated position from the core **315** by an urging force of the spring **316**. In this way, the first channel **317** and the second channel **318** are brought into a mutually communicating state (that is, a state where the electromagnetic valve **31** is opened).

[0039] Meanwhile, in a state where the current is applied to the wire **314** (that is, in the energized state), the armature **312** is attracted with the tappet **313** to the core **315** side by the magnetic force that is generated between the armature **312** and the magnetized core **315**, and is thereby held at a position indicated by two-dot chain lines in FIG. **3**. In this way, an opening at an end of the second channel **318** is closed by the tip of the tappet **313**. As a result, the first channel **317** and the second channel **318** are brought into a mutually blocked state (that is, a state where the electromagnetic valve **31** is closed).

[0040] In the electromagnetic valve **31** that is opened in the energized state (more specifically, each of the outlet valve **31***b* and the second valve **31***d*), in the unenergized state, as indicated by the two-dot chain lines in FIG. **3**, the opening at the end of the second channel **318** is closed by the tip of the tappet **313**, and the first channel **317** and the second channel **318** are brought into the mutually blocked state (that is, the state where the electromagnetic valve **31** is closed). Then, in the energized state, the magnetic force in a direction away from the opening at the end of the second channel **318** acts on the armature **312**, and, as indicated by the solid lines in FIG. **3**, the first channel **317** and the second channel **318** are brought into the mutually communicating state (that is, the state where the electromagnetic valve **31** is opened).

[0041] As illustrated in FIG. **2**, the hydraulic pressure control unit **5** is provided with a current sensor **41** that detects a current value of the current flowing through the wire **314** of the electromagnetic valve **31**. Here, the current sensor **41** may detect another physical quantity that can substantially be converted to the current value of the current flowing through the wire **314** of the electromagnetic valve **31**. The current sensor **41** is provided for each of the electromagnetic valves **31**. More specifically, the current sensors **41** are: a current sensor **41***a* that is provided for the inlet valve **31***a*; a current sensor **41***b* that is provided for the outlet valve **31***b*, a current sensor **41***c* that is provided for the first valve **31***c;* and a current sensor **41***d* that is provided for the second valve **31***d.* A detection result of each of the current sensors **41** is output to the controller **52** and used for processing executed by the controller **52**.

[0042] A detailed description will hereinafter be made on the current sensor **41** that is provided to the hydraulic pressure control unit **5** with reference to FIG. **4**. FIG. **4** is a schematic view illustrating an example of the current sensor **41** in the hydraulic pressure control unit **5**.

[0043] As illustrated in FIG. **4**, the current sensor **41** includes a shunt resistor **411** and an operational amplifier **412**, for example.

[0044] The shunt resistor **411** is connected in series with the wire **314** of the electromagnetic valve **31** that is connected to a power supply **7** such as a secondary battery. Electric power is supplied from the power supply **7** to the wire **314** of the electromagnetic valve **31**. The operational amplifier

412 is connected in parallel with the shunt resistor **411**, and amplifies and outputs a voltage difference between both ends of the shunt resistor **411**. The current sensor **41** detects the current value of the current flowing through the wire **314** of the electromagnetic valve **31** on the basis of a resistance value of the shunt resistor **411** and an output value of the operational amplifier **412**.

[0045] As illustrated in FIG. **2**, the hydraulic pressure control unit **5** is provided with temperature sensors **42**, **43**, each of which detects a temperature of the brake fluid. Each of the temperature sensors **42**, **43** may detect another physical quantity that can substantially be converted to the temperature of the brake fluid. The temperature sensor **42** is provided to the front-wheel brake mechanism **12** and detects the temperature of the brake fluid in the front-wheel brake mechanism **12**. The temperature sensor **43** is provided to the rear-wheel brake mechanism **14** and detects the temperature of the brake fluid in the rear-wheel brake mechanism **14**. Each of the temperature sensors **42**, **43** is provided in a master cylinder pressure sensor, for example.

[0046] The controller **52** of the hydraulic pressure control unit **5** controls the operation of the above-described components that are assembled to the base body **51***a* of the hydraulic pressure control mechanism **51**. For example, the controller **52** is partially or entirely constructed of a microcomputer, a microprocessor unit, or the like. In addition, the controller **52** may partially or entirely be constructed of one whose firmware and the like can be updated, or may partially or entirely be a program module or the like that is executed by a command from a CPU or the like, for example. The controller **52** may be provided as one unit or may be divided into plural units, for example. In addition, the controller **52** may be attached to the base body **51***a* or may be attached to a member other than the base body **51***a*.

[0047] FIG. **5** is a block diagram illustrating an example of a functional configuration of the controller **52** in the hydraulic pressure control unit **5**. As illustrated in FIG. **5**, the controller **52** includes an acquisition section **52***a*, a control section **52***b*, and an evaluation section **52***c*, for example.

[0048] The acquisition section **52***a* acquires information from each of the sensors provided to the hydraulic pressure control unit **5** and outputs the acquired information to the control section **52***b* and the evaluation section **52***c*. For example, the acquisition section **52***a* acquires information from each of the current sensors **41** and the temperature sensors **42**, **43**.

[0049] The control section **52***b* controls the operation of each of the above-described components that are assembled to the base body **51***a* of the hydraulic pressure control mechanism **51**. In this way, the control section **52***b* can control the braking force to be applied to the front wheel **3** by the front-wheel brake mechanism **12** and the braking force to be applied to the rear wheel **4** by the rear-wheel brake mechanism **14**. As will be described below, the control section **52***b* can also control operation of the notification device **6**.

[0050] The control section **52***b* controls the operation of each of the above components according to a travel state of the vehicle **100**, for example. In a normal time (that is, when anti-lock brake control, automated brake control, or the like, which will be described below, is not executed), the control section **52***b* opens the inlet valve **31***a* and closes the outlet valve **31***b*. When the first brake operation section **11** is operated in such a state, in the front-wheel brake mechanism **12**, the piston (not illustrated) in the master cylinder **21** is pressed to increase the hydraulic pressure of the brake fluid in the wheel cylinder **24**, the brake pad (not illustrated) of the brake caliper **23** is then pressed against a rotor **3***a* of the front wheel **3**, and the braking force is thereby generated on the front wheel **3**. Meanwhile, when the second brake operation section **13** is operated, in the rear-wheel brake mechanism **14**, the piston (not illustrated) in the master cylinder **21** is pressed to increase the hydraulic pressure of the brake fluid in the wheel cylinder **24**, the brake pad (not illustrated) of the brake caliper **23** is then pressed against a rotor **4***a* of the rear wheel **4**, and the braking force is thereby generated on the rear wheel **4**.

[0051] The anti-lock brake control is control that is executed when the wheel (more specifically, the front wheel **3** or the rear wheel **4**) is locked or possibly locked and that reduces the braking force to be applied to the wheel without relying on a brake operation by the rider, for example. For example, when the anti-lock brake control is executed, the control section **52***b* closes the inlet valve **31***a*, opens the outlet valve **31***b*, opens the first valve **31***c*, and closes the second valve **31***d*. When the pump **33** is driven by the control section **52***b* in such a state, the hydraulic pressure of the brake fluid in the wheel cylinder **24** is reduced, and the braking force that is applied to the wheel is thereby reduced.

[0052] The automated brake control is control that is executed when it is necessary to stabilize a posture of the vehicle **100** during turning or the like of the vehicle **100** and that causes generation of the braking force to be applied to the wheel (more specifically, the front wheel **3** or the rear wheel **4**) without relying on the brake operation by the rider, for example. For example, when the automated brake control is executed, the control section **52***b* opens the inlet valve **31***a*, closes the outlet valve **31***b*, closes the first valve **31***c*, and opens the second valve **31***d*. When the pump **33** is driven by the control section **52***b* in such a state, the hydraulic pressure of the brake fluid in the wheel cylinder **24** is increased, and the braking force that brakes the wheel is thereby generated.

[0053] The evaluation section **52***c* evaluates viscosity of the brake fluid as the hydraulic fluid in the brake system **10**. In the evaluation of the viscosity of the brake fluid, the evaluation section **52***c* may specifically specify an estimation value of the viscosity of the brake fluid or may roughly specify a degree of the viscosity of the brake fluid.

[0054] Here, the viscosity of the hydraulic fluid such as the brake fluid is changed as the hydraulic fluid is deteriorated. For example, there is a case where the brake fluid absorbs moisture in atmospheric air in the course of use thereof. In addition, for example, water may directly enter into the brake fluid during replacement of the brake fluid, or the like. As a result of an increase in water content of the brake fluid due to any of these factors, the brake fluid is deteriorated. When the brake fluid is deteriorated and the water content of the brake fluid is increased, the viscosity of the brake fluid is increased. When the viscosity of the brake fluid is increased, movement of the armature **312** of the electromagnetic valve **31** tends to be restricted.

[0055] In the example illustrated in FIG. **3**, when the current is applied to the wire **314**, as indicated by the two-dot chain lines in FIG. **3**, the armature **312** moves to a position at which the electromagnetic valve **31** is brought into the closed state. That is, a stroke amount Δx (see FIG. **3**) of the armature **312** is large enough to cause the electromagnetic valve **31** to function appropriately. The stroke amount Δx of the armature **312** is a distance from a movement start position to a movement end position of the armature **312** (that is, an movement amount of the armature **312**) when the current is applied to the wire **314** of the electromagnetic valve **31**. As described above, since the tappet **313** can move integrally with the armature **312**, the stroke amount Δx of the armature **312** matches a stroke amount of the tappet **313**. In the case where the viscosity of the brake fluid is increased, the stroke amount Δx of the armature **312** is reduced, which possibly hinders the brake fluid from being blocked or distributed by the electromagnetic valve **31** as expected. Here, in the case where the viscosity of the brake fluid is increased, a moving speed of the armature **312** is also reduced. This can also be a factor that inhibits the brake fluid from being blocked or distributed by the electromagnetic valve **31** as expected. To handle such problems, in order to comprehend an actuation state of the electromagnetic valve **31** (that is, whether the electromagnetic valve **31** is in an appropriate functioning state), it is necessary to evaluate the viscosity of the brake fluid.

[0056] In this embodiment, the viscosity of the brake fluid is accurately evaluated by devising processing related to the evaluation of the viscosity of the brake fluid that is executed by the controller **52**. A detailed description on such processing related to the evaluation of the viscosity of the brake fluid will be made below.

Operation of Hydraulic Pressure Control Unit

[0057] A description will herein be made on operation of the hydraulic pressure control unit **5** according to the embodiment of the present invention with reference to FIG. **6** and FIG. **7**.

[0058] In this embodiment, the evaluation section **52***c* evaluates the viscosity of the brake fluid on the basis of behavior of the current value of the current flowing through the wire **314** at beginning of the application of the current to the wire **314** of the electromagnetic valve **31**. A description will hereinafter be made on the behavior of the current value of the current flowing through the wire **314** at the beginning of the application of the current to the wire **314** with reference to FIG. **6**.

[0059] FIG. **6** is a schematic graph illustrating an example of transition of the current value of the current flowing through the wire **314** at the beginning of the application of the current to the wire **314** of the electromagnetic valve **31** in the hydraulic pressure control unit **5**. In FIG. **6**, a horizontal axis represents time t[s], and a vertical axis represents a current value i[A] of the current flowing through the wire **314**.

[0060] When the current starts being applied to the wire **314** of the electromagnetic valve **31**, the current value i of the current flowing through the wire **314** starts being increased toward a target current value isw. Then, after reaching the target current value isw, the current value i is maintained at the target current value isw. In the present specification, the beginning of the application of the current to the wire **314** of the electromagnetic valve **31** means a period from time at which the current value i starts being increased in association with the application of the current to the wire **314** to time at which the current value i reaches the target current value isw.

[0061] In an example indicated by a solid line in FIG. **6**, at a time point t**1**, the current starts being applied to the wire **314**, and the current value i of the current flowing through the wire **314** starts being increased. Thereafter, at a time point t**4**, the current value i reaches a target current value isw**1**. Then, at the time point t**4** onward, the current value i is maintained at the target current value isw**1**. The target current value isw in the example indicated by the solid line in FIG. **6** is the target current value isw**1**. However, the control section **52***b* can vary the target current value isw.

[0062] Here, when the current starts being applied to the wire **314**, the core **315** is magnetized, and the magnetic force in the direction to approach the core **315** acts on the armature **312**. Consequently, the armature **312** is attracted to and moves toward the core **315** side with the tappet **313**. At this time, in the magnetic field generated by the wire **314**, the armature **312** moves relative to the magnetic field. As a result, a counter-electromotive force is generated to the wire **314** in a manner to weaken magnetic flux generated by the wire **314**. Thus, in a process in which the current value i of the current flowing through the wire **314** is increased toward the target current value isw, the current value i exhibits behavior of being temporarily reduced. For example, in the example indicated by the solid line in FIG. **6**, at a time point t**2**, the current value i starts being reduced. Thereafter, at a time point t**3**, the reduction of the current value i is stopped, and the current value i starts being increased again toward the target current value isw.

[0063] In this embodiment, the evaluation section **52***c* evaluates the viscosity of the brake fluid on the basis of a reduced amount Δi of the current value i at the time when the current value i of the current flowing through the wire **314** is temporarily reduced in the process in which the current value i is increased toward the target current value isw at the beginning of the application of the current to the wire **314** of the electromagnetic valve **31**. For example, the reduced amount Δi in the example indicated by the solid line in FIG. **6** is a reduced amount Δi**1** that corresponds to a difference between the current value i at the time point t**2** and the current value i at the time point t**3**. When a phenomenon that the counter-electromotive force is generated to the wire **314** in association with the movement of the armature **312** is focused, it is understood that, as the viscosity of the brake fluid is increased, the stroke amount Δx of the armature **312** is reduced, and the reduced amount Δi of the current value i is reduced. Here, as the viscosity of the brake fluid is increased, the moving speed of the armature **312** is reduced.

[0064] This can also be a factor that reduces the reduced amount Δi of the current value i. Accordingly, the evaluation section **52***c* evaluates that the viscosity of the brake fluid is high as the reduced amount Δi is reduced, for example. Just as described, by focusing on the phenomenon that the counter-electromotive force is generated to the wire **314** in association with the movement of the armature **312**, it is possible to evaluate the viscosity of the brake fluid while taking the change in the viscosity associated with the deterioration of the hydraulic fluid into account. Therefore, it is possible to accurately evaluate the viscosity of the brake fluid.

[0065] Here, the evaluation section **52***c* determines that the current value i is temporarily reduced in the case where the current value i at a time point after a lapse of a reference period from the reduction start time point of the current value i (for example, the time point t**2** in the example indicated by the solid line in FIG. **6**) is lower by a reference value or more than the current value i at the reduction start time point (that is, in the case where a difference between the current value i at the time point after the lapse of the reference period from the reduction start time point of the current value i and the current value i at the reduction start time point is equal to or larger than the reference value). Each of the reference period and the reference value described above is set to a value with which it is possible to distinguish whether the current value i is temporarily reduced due to the generation of the counter-electromotive force to the wire **314** or a detection value of the current sensor **41** is only momentarily and slightly reduced by a noise component. That is, in the case where the difference between the current value i at the time point after the lapse of the reference period from the reduction start time point of the current value i and the current value i at the reduction start time point is smaller than the reference value, the evaluation section **52***c* determines that the detection value of the current sensor **41** is only momentarily and slightly reduced by the noise component, and thus does not evaluate the viscosity of the brake fluid.

[0066] Here, compared to the example indicated by the solid line, an example indicated by a broken line in FIG. **6** is an example at the different brake fluid temperature. In addition, compared to the example indicated by the solid line, an example indicated by a one-dot chain line in FIG. **6** is an example with the different target current value isw. These examples will be described below.

[0067] FIG. **7** is a flowchart illustrating an example of a processing procedure related to the evaluation of the viscosity of the brake fluid that is executed by the controller **52** in the hydraulic pressure control unit **5**. For example, the control flow illustrated in FIG. **7** is repeatedly initiated at a time interval, which is set in advance, after being terminated. Step S**101** and step S**108** in FIG. **7** respectively correspond to initiation and termination of the control flow.

[0068] In the control flow illustrated in FIG. **7**, as described above, the evaluation section **52***c* evaluates the viscosity of the brake fluid on the basis of the behavior of the current value i of the current flowing through the wire **314** of the electromagnetic valve **31**. Here, in the case where the evaluation section **52***c* evaluates the viscosity of the brake fluid in the front-wheel brake mechanism **12**, the evaluation section **52***c* evaluates the viscosity of the brake fluid on the basis of the behavior of the current value i of the current flowing through the wire **314** of the electromagnetic valve **31** in the front-wheel brake mechanism **12**. Meanwhile, in the case where the evaluation section **52***c* evaluates the viscosity of the brake fluid in the rear-wheel brake mechanism **14**, the evaluation section **52***c* evaluates the viscosity of the brake fluid on the basis of the behavior of the current value i of the current flowing through the wire **314** of the electromagnetic valve **31** in the rear-wheel brake mechanism **14**. The processing related to the evaluation of the viscosity of the brake fluid, which will be described below, may be executed on the basis of the behavior of the current value i of the valve that is closed in the energized state (more specifically, the inlet valve **31***a* and the first valve **31***c*), or may be executed on the basis of the behavior of the current value i of the valve that is opened in the energized state (more specifically, the outlet valve **31***b* and the second valve **31***d*).

[0069] When the control flow illustrated in FIG. **7** is initiated, in step S**102**, the evaluation section **52***c* determines whether the current starts being applied to the wire **314** of the electromagnetic valve **31**. If it is determined that the current starts being applied to the wire **314** (step S**102**/YES), the processing proceeds to step S**103**. On the other hand, if it is determined that the current does not start being applied to the wire **314** (step S**102**/NO), the control flow illustrated in FIG. **7** is terminated.

[0070] For example, the evaluation section **52***c* determines whether the current starts being applied to the wire **314** on the basis of the detection value of the current sensor **41**. As described above, when the current starts being applied to the wire **314**, the current value i of the current flowing through the wire **314** starts being increased toward the target current value isw. Accordingly, the evaluation section **52***c* can determine whether the current starts being applied to the wire **314** on the basis of the behavior of the current value i of the current flowing through the wire **314** (for example, whether the current value i is increased to exceed a specified value).
[0071] If it is determined YES in step S**102**, in step S**103**, the evaluation section **52***c* determines whether the current value i of the current flowing through the wire **314** of the electromagnetic valve **31** stops being increased. If it is determined that the current value i of the current flowing through the wire **314** stops being increased (step S**103**/YES), the processing proceeds to step S**104**. On the other hand, if it is determined that the current value i of the current flowing through the wire **314** does not stop being increased (step S**103**/NO), the determination processing in step S**103** is repeated.
[0072] For example, the evaluation section **52***c* determines whether the current value i of the current flowing through the wire **314** stops being increased on the basis of the detection value of the current sensor **41**. As described above, after being increased to the target current value isw, the current value i of the current flowing through the wire **314** is maintained at the target current value isw. Accordingly, the evaluation section **52***c* can determine whether the current value i of the current flowing through the wire **314** stops being increased on the basis of the behavior of the current value i of the current flowing through the wire **314** (for example, whether a fluctuation width of the current value i becomes equal to or smaller than a specified value).
[0073] If it is determined YES in step S**103**, in step S**104**, the evaluation section **52***c* evaluates the viscosity of the brake fluid. More specifically, as described above, the evaluation section **52***c* evaluates the viscosity of the brake fluid on the basis of the reduced amount Δi of the current value i at the time when the current value i of the current flowing through the wire **314** is temporarily reduced in the process in which the current value i is increased toward the target current value isw at the beginning of the application of the current to the wire **314** of the electromagnetic valve **31**. For example, after step S**102** and until it is determined YES in step S**103**, the acquisition section **52***a* keeps acquiring the current value i at each of the time points, and the evaluation section **52***c* can identify the reduced amount Δi on the basis of history of the acquired current value i.
[0074] Here, from a perspective of improving evaluation accuracy of the viscosity of the brake fluid, the evaluation section **52***c* preferably evaluates the viscosity of the brake fluid on the basis of another parameter in addition to the reduced amount Δi of the current value i.
[0075] For example, the evaluation section **52***c* evaluates the viscosity of the brake fluid on the basis of the temperature of the brake fluid in addition to the reduced amount Δi of the current value i. In the evaluation of the viscosity of the brake fluid in the front-wheel brake mechanism **12**, the evaluation section **52***c* evaluates the viscosity of the brake fluid on the basis of the temperature of the brake fluid that is acquired from the temperature sensor **42**, for example. Meanwhile, in the evaluation of the viscosity of the brake fluid in the rear-wheel brake mechanism **14**, the evaluation section **52***c* evaluates the viscosity of the brake fluid on the basis of the temperature of the brake fluid that is acquired from the temperature sensor **43**, for example.
[0076] Here, such a relationship is established that the viscosity of the brake fluid is increased as the temperature of the brake fluid is reduced. Compared to the example indicated by the solid line, in the example indicated by the broken line in FIG. **6**, the temperature of the brake fluid is low, and the viscosity of the brake fluid is high. Thus, compared to the example indicated by the solid line, in the example indicated by the broken line in FIG. **6**, the reduced amount Δi of the current value I is small. More specifically, the reduced amount Δi in the example indicated by the broken line in FIG. **6** is a reduced amount Δi**2** that is smaller than the reduced amount Δi**1**.
[0077] As described above, there is a tendency that the reduced amount Δi of the current value i is

reduced as the temperature of the brake fluid is reduced. Just as described, the reduced amount Δi of the current value i varies with a change in the temperature of the brake fluid. Thus, when evaluating the viscosity of the brake fluid by taking the temperature of the brake fluid into account in addition to the reduced amount Δi, the evaluation section **52***c* can improve the evaluation accuracy of the viscosity of the brake fluid.

[0078] For example, the evaluation section **52***c* evaluates the viscosity of the brake fluid on the basis of the target current value isw in addition to the reduced amount Δi of the current value i.

[0079] Here, compared to the example indicated by the solid line, in the example indicated by the one-dot chain line in FIG. **6**, the target current value isw is small. More specifically, the target current value isw in the example indicated by the one-dot chain line in FIG. **6** is the target current value isw**2** that is lower than the target current value isw**1**. Accordingly, compared to the example indicated by the solid line, in the example indicated by the one-dot chain line in FIG. **6**, the reduced amount Δi of the current value i is large. More specifically, the reduced amount Δi in the example indicated by the one-dot chain line in FIG. **6** is a reduced amount Δi**3** that is larger than the reduced amount Δi**1**.

[0080] As described above, there is a tendency that the reduced amount Δi of the current value i is increased as the target current value isw is reduced. Just as described, the reduced amount Δi of the current value i varies with the change in the target current value isw. Thus, when evaluating the viscosity of the brake fluid by taking the target current value isw into account in addition to the reduced amount Δi, the evaluation section **52***c* can improve the evaluation accuracy of the viscosity of the brake fluid.

[0081] The above description has sequentially been made on the example in which, in addition to the reduced amount Δi of the current value i, the temperature of the brake fluid is used to evaluate the viscosity of the brake fluid and the example in which, in addition to the reduced amount Δi of the current value i, the target current value isw is used to evaluate the viscosity of the brake fluid. Here, from a perspective of further effectively improving the evaluation accuracy of the viscosity of the brake fluid, the evaluation section **52***c* preferably evaluates the viscosity of the brake fluid on the basis of both of the temperature of the brake fluid and the target current value isw in addition to the reduced amount Δi of the current value i. Here, in the case where the estimation value of the viscosity is specifically identified in the evaluation of the viscosity of the brake fluid, a relationship between the estimation value of the viscosity and each of the parameters (for example, the reduced amount Δi, the temperature of the brake fluid, and the target current value isw) may be defined, and a mathematical formula, a map, or the like that is used to identify the estimation value of the viscosity may be determined on the basis of a theoretical formula or may be determined on the basis of an experimental result.

[0082] Next, in step S**105**, the control section **52***b* determines whether the viscosity of the brake fluid is higher than reference viscosity. If it is determined that the viscosity of the brake fluid is higher than the reference viscosity (step S**105**/YES), the processing proceeds to step S**106**, and the control section **52***b* increases the target current value isw to be higher than the current value. Accordingly, in the process of repeating the control flow illustrated in FIG. **7**, the target current value isw is gradually increased until the viscosity of the brake fluid becomes equal to or lower than the reference viscosity (that is, until it is determined NO in step S**105**). On the other hand, if it is determined that the viscosity of the brake fluid is equal to or lower than the reference viscosity (step S**105**/NO), the processing proceeds to step S**107**.

[0083] The reference viscosity in step S**105** is a value that is set to a value with which it is possible to determine whether the viscosity is increased due to the deterioration of the brake fluid, and is set to be increased as the temperature is reduced. That is, if it is determined that the viscosity of the brake fluid is equal to or lower than the reference viscosity (that is, if it is determined NO in step S**105**), it can be determined that the brake fluid is not deteriorated or that a degree of the deterioration is minute and thus the electromagnetic valve **31** is in the appropriate functioning state.

[0084] On the other hand, if it is determined that the viscosity of the brake fluid is higher than the reference viscosity (that is, if it is determined YES in step S**105**), it is possible to determine that the viscosity is increased due to the deterioration of the brake fluid and the electromagnetic valve **31** is in a state of not appropriately functioning. More specifically, there is a case where, when the viscosity is increased due to the deterioration of the brake fluid, the stroke amount Δx becomes insufficient and the brake fluid is no longer blocked or distributed as expected. In such a case, the control section **52***b* increases the target current value isw to be higher than the current value. In this way, it is possible to eliminate a shortage of the stroke amount Δx and cause the electromagnetic valve **31** to function appropriately. As described above, from a perspective of avoiding the shortage of the stroke amount Δx, the control section **52***b* preferably controls the target current value isw on the basis of an evaluation result of the viscosity of the brake fluid.
[0085] If it is determined NO in step S**105**, or following step S**106**, in step S**107**, the control section **52***b* controls the notification operation on the basis of the evaluation result of the brake fluid, and then the control flow illustrated in FIG. **7** is terminated.
[0086] The notification operation is operation to notify the rider of various types of information. For example, the notification operation is performed by the notification device **6** and may be operation to show the information or operation to output the sound. Here, in the case where the notification operation continues for a set time, the control flow illustrated in FIG. **7** may be terminated. Alternatively, in the case where the rider performs an input operation to stop the notification operation, the control flow illustrated in FIG. **7** may be terminated.
[0087] In step S**107**, for example, if it is determined that the viscosity of the brake fluid is higher than the reference viscosity (that is, if it is determined YES in step S**105**), the control section **52***b* causes the notification device **6** to perform the notification operation so as to notify that the viscosity is increased due to the deterioration of the brake fluid. In this way, the rider can be urged to replace the brake fluid. On the other hand, if it is determined that the viscosity of the brake fluid is equal to or lower than the reference viscosity (that is, if it is determined NO in step S**105**), the control section **52***b* stops the notification operation by the notification device **6**. However, if it is determined NO in step S**105**, the control section **52***b* may cause the notification device **6** to perform the notification operation to notify that the brake fluid is not deteriorated or that the degree of the deterioration is minute.
[0088] The notification operation may be performed by a device other than the notification device **6**. For example, the notification operation may be performed by a display device (for example, a transmissive display arranged over the rider's line of sight) that is provided to a helmet worn on the rider's head. Alternatively, for example, the notification operation may be performed by a sound output device that is provided to the helmet worn on the rider's head. Further alternatively, for example, the notification operation may be operation to generate vibration by a vibration generator that is provided to the vehicle **100** or is attached to the rider. For example, the notification operation may be operation to instantaneously decelerate the vehicle **100**. The above instantaneous deceleration may occur by reducing output of the drive source, may occur by generating the braking force by the hydraulic pressure control unit **5**, or may occur by changing a gear ratio of a transmission mechanism of the vehicle **100**.
[0089] The above description has been made on the example of the processing procedure related to the evaluation of the viscosity of the brake fluid with reference to FIG. **7**. However, the processing procedure related to the evaluation of the viscosity of the brake fluid is not limited to the example of the flowchart in FIG. **7**. For example, an additional step may be added to the flowchart in FIG. **7**. For example, some of the steps (for example, step S**105**, step S**106**, and the like) in the flowchart in FIG. **7** may be omitted. For example, an order of some of the steps in the flowchart of FIG. **7** may be changed (for example, step S**107** may be executed prior to step S**105**).
[0090] Although a case where the reduced amount Δi of the current value i is excessively small is not described above, in such a case, the evaluation section **52***c* may execute processing other than

the processing that has been described above. For example, in the case where the reduced amount Δi of the current value i is smaller than the reference amount, the evaluation section **52***c* may evaluate the viscosity of the brake fluid after the temperature of the brake fluid is increased. The reference amount is set to a value that is small enough to be able to determine that the armature **312** has not moved at the beginning of the application of the current to the wire **314**. That is, in the case where the reduced amount Δi of the current value i is smaller than the reference amount, it is possible to determine that the armature **312** has not moved at the beginning of the application of the current to the wire **314**.

[0091] In the case where the reduced amount Δi of the current value i is smaller than the reference amount, the reduced amount Δi is excessively small. Thus, it is difficult to evaluate the viscosity of the brake fluid on the basis of the reduced amount Δi. In addition, such a possibility is also considered that the armature **312** does not move due to a factor other than the increase in the viscosity of the brake fluid. Thus, in such a case, the evaluation section **52***c* evaluates the viscosity of the brake fluid after the temperature of the brake fluid is increased and the viscosity of the brake fluid is thereby reduced. In this way, in the case where the factor that hinders the movement of the armature **312** is the increase in the viscosity of the brake fluid, the viscosity of the brake fluid can be evaluated by using the reduced amount Δi in a state where the reduced amount Δi becomes equal to or larger than the reference amount in association with the reduction in the viscosity of the brake fluid. Meanwhile, in the case where the factor that hinders the movement of the armature **312** is a factor other than the increase in the viscosity of the brake fluid, the reduced amount Δi is maintained in the state of being smaller than the reference amount. Thus, the above factor can be comprehended.

Effects of Hydraulic Pressure Control Unit

[0092] A description will be made on effects of the hydraulic pressure control unit **5** according to the embodiment of the present invention.

[0093] In the hydraulic pressure control unit **5**, the evaluation section **52***c* evaluates the viscosity of the brake fluid as the hydraulic fluid on the basis of the reduced amount Δi of the current value i at the time when the current value i of the current flowing through the wire **314** is temporarily reduced in the process in which the current value i is increased toward the target current value isw at the beginning of the application of the current to the wire **314** of the electromagnetic valve **31**. In this way, by focusing on the phenomenon that the counter-electromotive force is generated to the wire **314** in association with the movement of the armature **312**, it is possible to evaluate the viscosity of the brake fluid while taking the change in the viscosity associated with the deterioration of the hydraulic fluid into account. Therefore, it is possible to accurately evaluate the viscosity of the brake fluid.

[0094] Preferably, in the hydraulic pressure control unit **5**, the evaluation section **52***c* evaluates the viscosity of the brake fluid on the basis of the temperature of the brake fluid in addition to the reduced amount Δi of the current value i. In this way, it is possible to further appropriately evaluate the viscosity of the brake fluid by focusing on the relationship between the temperature of the brake fluid and the reduced amount Δi. Therefore, it is possible to improve the evaluation accuracy of the viscosity of the brake fluid.

[0095] Preferably, in the hydraulic pressure control unit **5**, the evaluation section **52***c* evaluates the viscosity of the brake fluid on the basis of the target current value isw in addition to the reduced amount Δi of the current value i. In this way, it is possible to appropriately evaluate the viscosity of the brake fluid by focusing on the relationship between the target current value isw and the reduced amount Δi. Therefore, it is possible to improve the evaluation accuracy of the viscosity of the brake fluid.

[0096] Preferably, in the hydraulic pressure control unit **5**, the control section **52***b* controls the notification operation on the basis of the evaluation result of the viscosity of the brake fluid. In this way, it is possible to notify the rider of the information on the evaluation result of the viscosity of the brake fluid. Thus, the rider can understand whether the electromagnetic valve **31** is in the appropriate functioning state. Therefore, safety is improved. In addition, by notifying the rider of the deterioration of the brake fluid, the rider can be urged to replace the brake fluid.

[0097] Preferably, in the hydraulic pressure control unit **5**, the control section **52***b* controls the target current value isw on the basis of the evaluation result of the viscosity of the brake fluid. In this way, in the case where the viscosity is increased due to the deterioration of the brake fluid and the electromagnetic valve **31** does not function appropriately, it is possible to avoid the shortage of the stroke amount Δx and cause the electromagnetic valve **31** to function appropriately.

[0098] Preferably, in the hydraulic pressure control unit **5**, the control section **52***b* increases the target current value isw in the case where the viscosity of the brake fluid is higher than the reference viscosity. In this way, in the case where the viscosity is increased due to the deterioration of the brake fluid and the electromagnetic valve **31** does not function appropriately, it is possible to avoid the shortage of the stroke amount Δx and cause the electromagnetic valve **31** to function appropriately.

[0099] Preferably, in the hydraulic pressure control unit **5**, in the case where the reduced amount Δi of the current value i is smaller than the reference amount, the evaluation section **52***c* evaluates the viscosity of the brake fluid after the temperature of the brake fluid is increased. In this way, in the case where the factor that hinders the movement of the armature **312** is the increase in the viscosity of the brake fluid, the viscosity of the brake fluid can be evaluated by using the reduced amount Δi in the state where the reduced amount Δi becomes equal to or larger than the reference amount in association with the reduction in the viscosity of the brake fluid. Meanwhile, in the case where the factor that hinders the movement of the armature **312** is the factor other than the increase in the viscosity of the brake fluid, the reduced amount Δi is maintained in the state of being smaller than the reference amount. Thus, the above factor can be comprehended.

[0100] Preferably, in the hydraulic pressure control unit **5**, the evaluation section **52***c* determines that the current value i is temporarily reduced in the case where the current value i at the time point after the lapse of the reference period from the reduction start time point of the current value i is lower by the reference value or more than the current value i at the reduction start time point. In this way, it is possible to distinguish whether the current value i is temporarily reduced due to the generation of the counter-electromotive force to the wire **314** or the detection value of the current sensor **41** is only instantaneously and slightly reduced by the noise component. Thus, it is possible to appropriately evaluate the viscosity of the brake fluid by focusing on the phenomenon that the counter-electromotive force is generated to the wire **314** in association with the movement of the armature **312**.

[0101] The present invention is not limited to the embodiment that has been described. For example, only a part of the embodiment may be implemented.

Reference Signs List

[0102] **1**: Trunk [0103] **2**: Handlebar [0104] **3**: Front wheel [0105] **3***a*: Rotor [0106] **4**: Rear wheel [0107] **4***a*: Rotor [0108] **5**: Hydraulic pressure control unit [0109] **6**: Notification device [0110] **7**: Power supply [0111] **10**: Brake system [0112] **11**: First brake operation section [0113] **12**: Front-wheel brake mechanism [0114] **13**: Second brake operation section [0115] **14**: Rear-wheel brake mechanism [0116] **21**: Master cylinder [0117] **22**: Reservoir [0118] **23**: Brake caliper [0119] **24**: Wheel cylinder [0120] **25**: Primary channel [0121] **26**: Secondary channel [0122] **27**: Supply channel [0123] **31**: Electromagnetic valve [0124] **31***a*: Inlet valve [0125] **31***b*: Outlet valve [0126] **31***c*: First valve [0127] **31***d*: Second valve [0128] **32**: Accumulator [0129] **33**: Pump [0130] **41**: Current sensor [0131] **41***a*: Current sensor [0132] **41***b*: Current sensor [0133] **41***c*: Current sensor [0134] **41***d*: Current sensor [0135] **42**: Temperature sensor [0136] **43**: Temperature sensor [0137] **51**: Hydraulic pressure control mechanism [0138] **51***a*: Base body [0139] **52**: Controller [0140] **52***a*: Acquisition section [0141] **52***b*: Control section [0142] **52***c*: Evaluation section [0143] **100**: Vehicle [0144] **311**: Case [0145] **312**: Armature [0146] **313**: Tappet [0147] **314**: Wire [0148] **315**:

Core [0149] **316**: Spring [0150] **317**: First channel [0151] **318**: Second channel [0152] **411**: Shunt resistor [0153] **412**: Operational amplifier [0154] i: Current value [0155] isw: Target current value [0156] isw**1**: Target current value [0157] isw**2**: Target current value [0158] Δi: Reduced amount [0159] Δi**1**: Reduced amount [0160] Δi**2**: Reduced amount [0161] Δi**3**: Reduced amount [0162] Δx: Stroke amount

Claims

1. A hydraulic pressure control unit (**5**) used for a behavior control system (**10**) of a vehicle (**100**), the hydraulic pressure control unit comprising: a hydraulic pressure control mechanism (**51**) that includes: a base body (**51***a*); and components that include an electromagnetic valve (**31**) assembled to the base body (**51***a*) for controlling a hydraulic pressure generated in a hydraulic fluid for the behavior control system (**10**); and a controller (**52**) that includes a control section (**52***b*) controlling operation of the components; wherein the electromagnetic valve (**31**) includes a wire (**314**) and an armature (**312**) that moves in association with application of a current to the wire (**314**), and is a valve that is closed or a valve that is opened in an energized state where the current is applied to the wire (**314**), the controller (**52**) includes an evaluation section (**52***c*) that evaluates viscosity of the hydraulic fluid, and the evaluation section (**52***c*) evaluates the viscosity on the basis of a reduced amount (Δi) of a current value (i) of the current flowing through the wire (**314**) at a time when the current value (i) is temporarily reduced in a process in which the current value (i) is increased toward a target current value (isw) at beginning of the application of the current to the wire (**314**).
2. The hydraulic pressure control unit according to claim 1, wherein the evaluation section (**52***c*) evaluates the viscosity based on a temperature of the hydraulic fluid in addition to the reduced amount (Δi).
3. The hydraulic pressure control unit according to claim 1, wherein the evaluation section (**52***c*) evaluates the viscosity on the basis of the target current value (isw) in addition to the reduced amount (Δi).
4. The hydraulic pressure control unit according to claim 1, wherein the control section (**52***b*) controls notification operation on the basis of an evaluation result of the viscosity.
5. The hydraulic pressure control unit according to claim 1, wherein the control section (**52***b*) controls the target current value (isw) on the basis of an evaluation result of the viscosity.
6. The hydraulic pressure control unit according to claim 5, wherein the control section (**52***b*) increases the target current value (isw) in the case where the viscosity is higher than reference viscosity.
7. The hydraulic pressure control unit according to claim 1, wherein in the case where the reduced amount (Δi) is smaller than a reference amount, the evaluation section (**52***c*) evaluates the viscosity after a temperature of the hydraulic fluid is increased.
8. The hydraulic pressure control unit according to claim 1, wherein the evaluation section (**52***c*) determines that the current value (i) is temporarily reduced in the case where the current value (i) at a time point after a lapse of a reference period from a reduction start time point of the current value (i) is lower by a reference value or more than the current value (i) at the reduction start time point.
9. The hydraulic pressure control unit according to claim 1, wherein the vehicle (**100**) is a motorcycle.