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(54) **VARIABLE DISPLACEMENT METERING PUMP SYSTEM WITH MULTIVARIATE FEEDBACK**

DOSIERPUMPENSYSTEM MIT VARIABLER VERDRÄNGUNG MIT MULTIVARIATER RÜCKKOPPLUNG

SYSTÈME DE POMPE DE DOSAGE À DÉPLACEMENT VARIABLE DOTÉ D'UNE RÉTROACTION MULTIVARIÉE

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EP 4 092 268 B1

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Description

BACKGROUND

[0001] The present disclosure relates to a pump system, and in particular to a metering pump system.

[0002] Metering pump systems supply fuel to an engine of a vehicle. For example, metering pump systems can supply fuel to a jet turbine engine of an aircraft or to an engine of an automobile. An improved metering pump system is disclosed hereafter. A metering pump is known from US2010/0251814. This pump does not measure fuel temperature and actuator displacement by a linear variable displacement transducer.

SUMMARY

[0003] The invention is defined by the appended claims. In one example, a metering pump system includes a variable displacement pump having an inlet and an outlet, a flow sensing valve fluidically connected to the outlet of the variable displacement pump, and an actuator mechanically coupled to a displacement mechanism of the variable displacement pump. The metering pump system also includes an electronic engine controller in communication with the flow sensing valve. An electrohydraulic servo valve is electrically connected to the electronic engine controller and is hydraulically connected to the actuator. The electrohydraulic servo valve is configured to hydraulically drive the actuator to move the displacement mechanism to change displacement of the variable displacement pump.

[0004] In another example, a metering pump system includes a variable displacement pump, an actuator mechanically coupled to the variable displacement pump, and a drive unit connected to the actuator. The metering pump system also includes an electronic engine controller electronically connected to the drive unit, a linear variable displacement transducer on the actuator and configured to measure a position of the actuator. The linear variable displacement transducer is in communication with the electronic engine controller. The metering pump system also includes a flow sensing valve fluidically connected to an outlet of the variable displacement pump. The flow sensing valve includes a resistance temperature detector configured to measure a temperature of fuel flow in the flow sensing valve. The resistance temperature detector is electrically connected to the electronic engine controller. The flow sensing valve also includes a further linear variable displacement transducer configured to measure a linear displacement of the flow sensing valve. The linear variable displacement transducer is electrically connected to the electronic engine controller.

[0005] In another example, a method of pumping in a system includes pumping fuel through the system with a variable displacement pump, wherein the variable displacement pump comprises a displacement mechanism

mechanically connected to an actuator. The fuel is directed through a flow sensing valve connected to an outlet of the variable displacement pump. A temperature of the fuel flowing through the flow sensing valve is sensed via a resistance differential transducer. A linear displacement of the flow sensing valve is sensed via a linear variable differential transducer. The method also includes communicating the temperature of the fuel flowing through the flow sensing valve and the linear displacement of the flow sensing valve to an electronic engine controller. An electrical current is delivered to a servo valve by the electronic engine controller. The servo valve moves the actuator to actuate the displacement mechanism of the variable displacement pump and alter displacement of the variable displacement pump.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] FIG. 1 is a schematic diagram of a metering pump system.

[0007] While the above-identified figures set forth one or more embodiments of the present disclosure, other embodiments are also contemplated, as noted in the discussion. In all cases, this disclosure presents embodiments by way of representation and not limitation. It should be understood that numerous other modifications and embodiments can be devised by those skilled in the art. The figures may not be drawn to scale, and applications and embodiments of the present disclosure may include features and components not specifically shown in the drawings.

DETAILED DESCRIPTION

[0008] In the present disclosure, a metering pump system includes a variable displacement pump, a flow sensing valve, an actuator, an electronic engine controller, and a servo valve. The flow sensing valve includes a resistance temperature detector and a linear variable differential transducer configured to measure the temperature of fuel flow through the flow sensing valve and a linear displacement of the flow sensing valve. The actuator is connected to a displacement mechanism of the variable differential pump. The actuator includes another linear variable differential transducer configured to sense or measure the linear displacement of the actuator. The electronic engine controller can calculate a flow rate of fuel exiting the variable displacement pump using the sensed temperature of fuel flow through the flow sensing valve and sensed linear displacement of the flow sensing valve. The electronic engine controller can also calculate a predicted flow rate of fuel leaving the variable displacement pump using the linear displacement of the actuator. The electronic engine controller can compare the calculated flow rate through the flow sensing valve and the predicted flow out of the variable displacement pump to determine the wear of the variable displacement pump. Further the metering pump system can use the actuator

to adjust the displacement mechanism of the variable displacement pump based on the flow rate through the flow sensing valve to optimize the performance of the system. The metering pump system will be discussed with reference to FIG. 1.

[0009] FIG. 1 is a schematic diagram of metering pump system 10. Metering pump system 10 includes variable displacement pump 12, flow sensing valve 20, actuator 30, electronic engine controller 50, and drive unit 58 with servo valve 60. Variable displacement pump 12 includes inlet 14, outlet 16, and displacement mechanism 18. Flow sensing valve 20 includes resistance temperature detector 22 and linear variable differential transducer 24. Actuator 30 is a piston assembly including housing 32, piston cylinder 34, fluid chamber 36, spring chamber 38, piston rod 40, and linear variable differential transducer 42.

[0010] Flow sensing valve 20 is fluidically connected to outlet 16 of variable displacement pump 12. Resistance temperature detector 22 is in contact with an interior of flow sensing valve 20 and is configured to measure a temperature of fuel flow through flow sensing valve 20. Linear variable differential transducer is also in contact with an interior of flow sensing valve 20 and is configured to measure a linear displacement of flow sensing valve 20. In one example, flow sensing valve 20 can be the valve disclosed in U.S. Patent Pub. 2010/0251814. In another example, flow sensing valve 20 can be any other valve used to determine the flow rate of a fluid within a system.

[0011] Actuator 30 is mechanically coupled to displacement mechanism 18 of variable displacement pump 12. Piston cylinder 34, fluid chamber 36, and spring chamber 38 are contained inside housing 32 of actuator 30. Fluid chamber 36 is on a first side of piston cylinder 34. Spring chamber 38 is opposite fluid chamber 36 relative to piston cylinder 34. Piston rod 40 is attached to piston cylinder 34 and extends outside of housing 32. Piston rod 40 is operably connected to displacement mechanism 18 of variable displacement pump 12. Linear variable differential transducer 42 of actuator 30 is configured to measure a linear displacement of actuator 30. Linear variable differential transducer 42 of actuator 30 can measure a linear displacement of actuator 30 by measuring a linear displacement of piston cylinder 34 and/or piston rod 40.

[0012] Electronic engine controller 50 is in communication with flow sensing valve 20. More specifically, electronic engine controller 50 is in communication with resistance temperature detector 22 and linear variable differential transducer 24 of flow sensing valve 20. Electronic engine controller 50 is also in communication with linear variable differential transducer 42 of actuator 30. Thus, resistance temperature detector 22 and linear variable differential transducer 24 of flow sensing valve 20, linear variable differential transducer 42 of actuator 30, and electronic engine controller 50 form a continuous positive feedback loop.

[0013] Drive unit 58 includes servo valve 60. Servo valve 60 is electrically connected to electronic engine controller 50 and hydraulically connected to actuator 30. Servo valve 60 is configured to hydraulically drive actuator 30 to move displacement mechanism 18 to change displacement of variable displacement pump 12. Servo valve 60 can be an electrohydraulic servo valve that drives actuator 30 by directing fuel from outlet 16 of variable displacement pump 12 to fluid chamber 36 of actuator 30. In other examples, servo valve 60 can direct fuel or fluid from inlet 14 of variable displacement pump 12, or any other suitable source, to fluid chamber 36 of actuator 30. In one example, displacement mechanism 18 can be a swashplate. In another example, displacement mechanism 18 can be any other mechanism that alters the displacement of variable displacement pumps. In another example, servo valve 60 can be an electro-pneumatic, electromechanical, or any other kind of servo valve.

[0014] In operation, variable displacement pump 12 generates fuel flow in metering pump system 10 and pulls fuel through inlet 14. The fuel flow is pushed out outlet 16 of variable displacement pump 12 and through flow sensing valve 20. Resistance temperature detector 22 senses a temperature of the fuel flowing through flow sensing valve 20. Linear variable differential transducer 24 senses a linear displacement of sensing valve 20. Resistance temperature detector 22 and linear variable differential transducer 24 communicate the sensed temperature of the fuel flowing through flow sensing valve 20 and the sensed linear displacement of sensing valve 20 to electronic engine controller 50.

[0015] Electronic engine controller 50 determines an actual flow rate of fuel through flow sensing valve 20 using the sensed temperature of the fuel flowing through flow sensing valve 20 and sensed linear displacement of flow sensing valve 20. After receiving the sensed temperature of the fuel flowing through flow sensing valve 20 and the sensed linear displacement of flow sensing valve 20, electronic engine controller 50 calculates the actual flow rate of the fuel flowing through flow sensing valve 20. In response to the calculated flow rate of fuel flowing through flow sensing valve 20, electronic engine controller delivers an electrical current to servo valve 60. In response to the electrical current received by servo valve 60, servo valve 60 sends hydraulic fluid to actuator 30 or releases hydraulic fluid from actuator 30 to adjust the output of variable displacement pump 12. When servo valve 60 sends the hydraulic fluid (i.e., fuel) to actuator 30, the hydraulic fluid fills fluid chamber 36, which moves piston cylinder 34 and piston rod 40. As discussed above, piston rod 40 is operably connected to displacement mechanism (i.e., swashplate) 18 of variable displacement pump 12. The movement of piston rod 40 actuates displacement mechanism 18 of variable displacement pump 12. When piston rod 40 actuates displacement mechanism 18 the displacement of variable displacement pump 12 changes. Therefore, the displacement

of variable displacement pump 12 is changed in response to the temperature of the fuel flowing through flow sensing valve 20 and the linear displacement of flow sensing valve 20.

[0016] Electronic engine controller 50 determines a predicted flow rate of fuel out of variable displacement pump 12 using the linear displacement of actuator 30. Linear variable differential transducer 42 of actuator 30 senses a linear displacement of actuator 30 and communicates the linear displacement of actuator 30 to electronic engine controller 50. Metering pump system 10 can be pre-calibrated such that electronic engine controller 50 can convert a position measurement of actuator 30 to a position measurement of displacement mechanism 18. Electronic engine 50 can be pre-programed to convert the position measurement of displacement mechanism 18 to a predicted flow rate of variable displacement pump 12. Electronic engine controller 50 can compare the actual flow rate of the fuel flow through flow sensing valve 20 with the predicted flow rate of the fuel out of variable displacement pump 12 to analyze the performance of variable displacement pump 12.

[0017] For example, if there is a variance between the actual flow rate of the fuel flow through flow sensing valve 20 with the predicted flow rate of the fuel out of variable displacement pump 12, variable displacement pump 12 can be worn. Additionally, in response to the variance between the actual flow rate of fuel flow through flow sensing valve 20 with the predicted flow rate of the fuel out of variable displacement pump 12, electronic engine controller 50 can increase the current sent to servo valve 60. Servo valve 60 can then increase the hydraulic fluid sent to actuator 30, which will further actuate displacement mechanism 18, which will increase the pumping rate of variable displacement pump 12 to compensate for the difference between the predicted flow rate and the actual flow rate.

[0018] Metering pump system 10 includes one or more processors and computer-readable memory can contain software that is executable to produce an actual flow rate of fuel through flow sensing valve 20 using the sensed temperature of the fuel flowing through flow sensing valve 20 and sensed linear displacement of flow sensing valve 20. Further, the one or more processors and computer-readable memory can include software that is executable to convert the position measurement of displacement mechanism 18 to a predicted flow rate of variable displacement pump 12. Lastly, the one or more processors and computer-readable memory can contain software that compares the actual flow rate of the fuel flow through flow sensing valve 20 with the predicted flow rate of the fuel out of variable displacement pump 12 to analyze the performance of variable displacement pump 12.

Discussion of Possible Embodiments

[0019] The following are non-exclusive descriptions of

possible embodiments of the present invention.

[0020] A metering pump system includes a variable displacement pump having an inlet and an outlet, a flow sensing valve fluidically connected to the outlet of the variable displacement pump, and an actuator mechanically coupled to a displacement mechanism of the variable displacement pump. The metering pump system also includes an electronic engine controller in communication with the flow sensing valve. An electrohydraulic servo valve is electrically connected to the electronic engine controller and is hydraulically connected to the actuator. The electrohydraulic servo valve is configured to hydraulically drive the actuator to move the displacement mechanism to change displacement of the variable displacement pump.

[0021] The metering pump of the preceding paragraph can optionally include, additionally and/or alternatively, any one or more of the following features, configurations and/or additional components:

wherein the flow sensing valve comprises a resistance temperature detector configured to measure a temperature of flow through the flow sensing valve; and a linear variable differential transducer configured to measure a linear displacement of the flow sensing valve;

wherein the actuator is a piston assembly comprising: a housing; a piston cylinder inside the housing; a fluid chamber contained within the housing on a first side of the piston cylinder; a spring chamber inside the housing and opposite the fluid chamber relative to the piston cylinder; and a piston rod attached to the piston cylinder;

wherein the piston rod is operably connected to the displacement mechanism of the variable displacement pump;

wherein the displacement mechanism is a swash-plate;

wherein the actuator comprises a second linear variable differential transducer configured to measure a linear displacement of the actuator;

wherein the flow sensing valve, the electronic engine controller, and the linear variable differential transducer form a continuous positive feedback loop; and/or

wherein the actuator is a hydraulic actuator that uses fuel for a hydraulic fluid.

[0022] A metering pump system includes a variable displacement pump, an actuator mechanically coupled to the variable displacement pump, and a drive unit connected to the actuator. The metering pump system also includes an electronic engine controller electronically connected to the drive unit, a linear variable displacement transducer on the actuator and configured to measure a position of the actuator. The linear variable displacement transducer is in communication with the electronic engine controller. The metering pump system also

includes a flow sensing valve fluidically connected to an outlet of the variable displacement pump. The flow sensing valve includes a resistance temperature detector configured to measure a temperature of fuel flow in the flow sensing valve. The resistance temperature detector is electrically connected to the electronic engine controller. The flow sensing valve also includes a second linear variable displacement transducer configured to measure a linear displacement of the flow sensing valve. The linear variable displacement transducer is electrically connected to the electronic engine controller.

[0023] The metering pump of the preceding paragraph can optionally include, additionally and/or alternatively, any one or more of the following features, configurations and/or additional components:

wherein the drive unit comprises an electrohydraulic servo valve;

wherein the actuator is a piston assembly hydraulically connected to the electrohydraulic servo valve; wherein the variable displacement pump comprises a displacement mechanism mechanically connected to the piston assembly;

wherein the displacement mechanism is a swash-plate; and/or

wherein the flow sensing valve, the electronic engine controller, and the linear variable differential transducer form a continuous positive feedback loop.

[0024] A method of pumping in a system includes pumping fuel through the system with a variable displacement pump, wherein the variable displacement pump comprises a displacement mechanism mechanically connected to an actuator. The fuel is directed through a flow sensing valve connected to an outlet of the variable displacement pump. A temperature of the fuel flowing through the flow sensing valve is sensed via a resistance differential transducer. A linear displacement of the flow sensing valve is sensed via a linear variable differential transducer. The method also includes communicating the temperature of the fuel flowing through the flow sensing valve and the linear displacement of the flow sensing valve to an electronic engine controller. An electrical current is delivered to a servo valve by the electronic engine controller. The servo valve moves the actuator to actuate the displacement mechanism of the variable displacement pump and alter displacement of the variable displacement pump.

[0025] The method of the preceding paragraph can optionally include, additionally and/or alternatively, any one or more of the following features, configurations and/or additional components:

sensing a linear displacement of the actuator with a second linear variable differential transducer; and communicating the linear displacement of the actuator to the electronic engine controller; determining an actual flow rate of fuel through the

flow sensing valve with the electronic engine controller using the temperature of the fuel through the flow sensing valve and linear displacement of the flow sensing valve; determining a predicted flow rate of the fuel out of the variable displacement pump with the electronic engine controller using the linear displacement of the actuator; and comparing the actual flow rate of the fuel through the flow sensing valve with the predicted flow rate of the fuel out of the variable displacement pump to analyze performance of the variable displacement pump; wherein the displacement mechanism is a swash-plate; wherein the servo valve is an electrohydraulic servo valve; and/or wherein the actuator is a hydraulic actuator that uses fuel for a hydraulic fluid.

[0026] While the invention has been described with reference to an exemplary embodiment(s), it will be understood by those skilled in the art that various changes may be made without departing from the scope of the invention. For example, while the present disclosure shows actuator 30 as a piston assembly, actuator 30 can be any actuator that uses electricity, pneumatics, hydraulics, and/or any other combination of energy. Actuator 30 can be a linear screw drive and drive unit 58 for actuator 30 can be an electric motor. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment(s) disclosed, but that the invention will include all embodiments falling within the scope of the appended claims.

Claims

1. A metering pump system (10) comprising:

a variable displacement pump (12) comprising an inlet (14) and an outlet (16);
a flow sensing valve (20) fluidically connected to the outlet of the variable displacement pump, the flow sensing valve comprising:

a resistance temperature detector (22) configured to measure a temperature of flow through the flow sensing valve; and
a first linear variable differential transducer configured to measure a linear displacement of the flow sensing valve;

an actuator (30) mechanically coupled to a displacement mechanism (18) of the variable displacement pump, the actuator comprising a second linear variable differential transducer con-

- figured to measure a linear displacement of the actuator;
 an electronic engine controller (50) in communication with the flow sensing valve, wherein the electronic engine controller is configured to determine an actual flow rate of fuel through the flow sensing valve using the temperature of the fuel through the flow sensing valve and the linear displacement of the flow sensing valve and to determine a predicted flow rate of the fuel out of the variable displacement pump using the linear displacement of the actuator; and
 an electrohydraulic servo valve (60) electrically connected to the electronic engine controller and hydraulically connected to the actuator, wherein the electrohydraulic servo valve is configured to hydraulically drive the actuator to move the displacement mechanism to change displacement of the variable displacement pump.
2. The metering pump system of claim 1, wherein the actuator (30) is a piston assembly comprising:
- a housing (32);
 - a piston cylinder (34) inside the housing
 - a fluid chamber (36) contained within the housing on a first side of the piston cylinder;
 - a spring chamber (38) inside the housing and opposite the fluid chamber relative the piston cylinder; and
 - a piston rod (40) attached to the piston cylinder.
3. The metering pump system of claim 2, wherein the piston rod (40) is operably connected to the displacement mechanism (18) of the variable displacement pump.
4. The metering pump system of claim 3, wherein the displacement mechanism (18) is a swashplate.
5. The metering pump of claim 1, wherein the flow sensing valve (20), the electronic engine controller (50), and the linear variable differential transducer form a continuous positive feedback loop.
6. The metering pump system of claim 1, wherein the actuator (30) is a hydraulic actuator that uses fuel for a hydraulic fluid.
7. The metering pump system of claim 1, wherein the actuator (30) is mechanically coupled to the variable displacement pump, the metering pump system further comprising:
- a drive unit (58) connected to the actuator;
 - wherein the electronic engine controller (50) is electronically connected to the drive unit;
- wherein the second linear variable differential transducer (24) on the actuator is configured to measure a position of the actuator, wherein the linear variable differential transducer is in communication with the electronic engine controller; and
 wherein the resistance temperature detector is electrically connected to the electronic engine controller; and
 wherein the linear variable differential transducer is electrically connected to the electronic engine controller.
8. The metering pump system of claim 7, wherein the drive unit (58) comprises an electrohydraulic servo valve (60), and preferably wherein the actuator (30) is a piston assembly hydraulically connected to the electrohydraulic servo valve, and preferably wherein the variable displacement pump (12) comprises a displacement mechanism (18) mechanically connected to the piston assembly, and preferably wherein the displacement mechanism (18) is a swashplate, and more preferably wherein the flow sensing valve (20), the electronic engine controller (50), and the second linear variable differential transducer (24) form a continuous positive feedback loop.
9. A method of pumping in a system comprising:
- pumping fuel through the system with a variable displacement pump, wherein the variable displacement pump comprises a displacement mechanism mechanically connected to an actuator;
 - directing the fuel through a flow sensing valve connected to an outlet of the variable displacement pump;
 - sensing a temperature of the fuel flowing through the flow sensing valve via a resistance differential transducer;
 - sensing a linear displacement of the flow sensing valve via a first linear variable differential transducer;
 - communicating the temperature of the fuel flowing through the flow sensing valve and the linear displacement of the flow sensing valve to an electronic engine controller;
 - delivering an electrical current to a servo valve by the electronic engine controller; and
 - moving the actuator with the servo valve to actuate the displacement mechanism of the variable displacement pump and alter displacement of the variable displacement pump;
 - sensing a linear displacement of the actuator with a second linear variable differential transducer;
 - communicating the linear displacement of the actuator to the electronic engine controller;

determining, with the electronic engine controller, an actual flow rate of fuel through the flow sensing valve using the temperature of the fuel through the flow sensing valve and the linear displacement of the flow sensing valve; and
 5 determining, with the electronic engine controller, a predicted flow rate of the fuel out of the variable displacement pump using the linear displacement of the actuator.

10. The method of claim 9, further comprising:

comparing the actual flow rate of the fuel through the flow sensing valve with the predicted flow rate of the fuel out of the variable displacement pump to analyze performance of the variable displacement pump.

11. The method of claim 9 or 10, wherein the displacement mechanism is a swashplate.

12. The method of any of claims 9-11, wherein the servo valve is an electrohydraulic servo valve.

13. The method of any of claims 9-12, wherein the actuator is a hydraulic actuator that uses fuel for a hydraulic fluid.

Patentansprüche

1. Dosierpumpensystem (10), umfassend:

eine Pumpe (12) mit variabler Verdrängung, die einen Einlass (14) und einen Auslass (16) umfasst;

ein Durchflusserfassungsventil (20), das mit dem Auslass der Pumpe mit variabler Verdrängung fluidverbunden ist, wobei das Durchflusserfassungsventil Folgendes umfasst:

einen Widerstandstemperaturdetektor (22), der dazu konfiguriert ist, eine Temperatur des Durchflusses durch das Durchflusserfassungsventil zu messen; und

einen ersten linearen variablen Differenzialwandler, der dazu konfiguriert ist, eine lineare Verdrängung des Durchflusserfassungsventils zu messen;

einen Aktuator (30), der mechanisch mit einem Verdrängungsmechanismus (18) der Pumpe mit variabler Verdrängung gekoppelt ist, wobei der Aktuator einen zweiten linearen variablen Differenzialwandler umfasst, der dazu konfiguriert ist, eine lineare Verdrängung des Aktuators zu messen;

eine elektronische Motorsteuerung (50), die mit dem Durchflusserfassungsventil in Ver-

bindung steht, wobei die elektronische Motorsteuerung dazu konfiguriert ist, eine tatsächliche Durchflussrate von Kraftstoff durch das Durchflusserfassungsventil unter Verwendung der Temperatur des Kraftstoffs durch das Durchflusserfassungsventil und der linearen Verdrängung des Durchflusserfassungsventils zu bestimmen und eine prognostizierte Durchflussrate des Kraftstoffs aus der Pumpe mit variabler Verdrängung unter Verwendung der linearen Verdrängung des Aktuators zu bestimmen; und
 ein elektrohydraulisches Servoventil (60), das elektrisch mit der elektronischen Motorsteuerung verbunden ist und hydraulisch mit dem Aktuator verbunden ist, wobei das elektrohydraulische Servoventil dazu konfiguriert ist, den Aktuator hydraulisch anzutreiben, um den Verdrängungsmechanismus zu bewegen, um die Verdrängung der Pumpe mit variabler Verdrängung zu ändern.

2. Dosierpumpensystem nach Anspruch 1, wobei der Aktuator (30) eine Kolbenbaugruppe ist, die Folgendes umfasst:

ein Gehäuse (32);

einen Kolbenzylinder (34) im Inneren des Gehäuses eine Fluidkammer (36), die innerhalb des Gehäuses auf einer ersten Seite des Kolbenzylinders enthalten ist;

eine Federkammer (38) im Inneren des Gehäuses und gegenüber der Fluidkammer relativ zu dem Kolbenzylinder; und

eine Kolbenstange (40), die an dem Kolbenzylinder befestigt ist.

3. Dosierpumpensystem nach Anspruch 2, wobei die Kolbenstange (40) mit dem Verdrängungsmechanismus (18) der Pumpe mit variabler Verdrängung wirkverbunden ist.

4. Dosierpumpensystem nach Anspruch 3, wobei der Verdrängungsmechanismus (18) eine Taumelscheibe ist.

5. Dosierpumpe nach Anspruch 1, wobei das Durchflusserfassungsventil (20), die elektronische Motorsteuerung (50) und der lineare variable Differenzialwandler eine kontinuierliche positive Rückkopplungsschleife bilden.

6. Dosierpumpensystem nach Anspruch 1, wobei der Aktuator (30) ein hydraulischer Aktuator ist, der Kraftstoff als Hydraulikfluid verwendet.

7. Dosierpumpensystem nach Anspruch 1, wobei der Aktuator (30) mechanisch mit der Pumpe mit variabler Verdrängung gekoppelt ist, wobei das Dosierpumpensystem ferner Folgendes umfasst:

eine Antriebseinheit (58), die mit dem Aktuator verbunden ist;
wobei die elektronische Motorsteuerung (50) elektronisch mit der Antriebseinheit verbunden ist;
wobei der zweite lineare variable Differenzialwandler (24) an dem Aktuator dazu konfiguriert ist, eine Position des Aktuators zu messen, wobei der lineare variable Differenzialwandler mit der elektronischen Motorsteuerung in Verbindung steht; und
wobei der Widerstandstemperaturdetektor elektrisch mit der elektronischen Motorsteuerung verbunden ist; und
wobei der lineare variable Differenzialwandler elektrisch mit der elektronischen Motorsteuerung verbunden ist.

8. Dosierpumpensystem nach Anspruch 7, wobei die Antriebseinheit (58) ein elektrohydraulisches Servoventil (60) umfasst, und wobei der Aktuator (30) bevorzugt eine Kolbenbaugruppe ist, die hydraulisch mit dem elektrohydraulischen Servoventil verbunden ist, und wobei die Pumpe (12) mit variabler Verdrängung bevorzugt einen Verdrängungsmechanismus (18) umfasst, der mechanisch mit der Kolbenbaugruppe verbunden ist, und wobei der Verdrängungsmechanismus (18) bevorzugt eine Taumelscheibe ist, und wobei das Durchflusserfassungsventil (20), die elektronische Motorsteuerung (50) und der zweite lineare variable Differenzialwandler (24) bevorzugt eine kontinuierliche positive Rückkopplungsschleife bilden.

9. Verfahren zum Pumpen in einem System, umfassend:

Pumpen von Kraftstoff durch das System mit einer Pumpe mit variabler Verdrängung, wobei die Pumpe mit variabler Verdrängung einen Verdrängungsmechanismus umfasst, der mechanisch mit einem Aktuator verbunden ist;
Leiten des Kraftstoffs durch ein Durchflusserfassungsventil, das mit einem Auslass der Pumpe mit variabler Verdrängung verbunden ist;
Erfassen einer Temperatur des durch das Durchflusserfassungsventil fließenden Kraftstoffs über einen Widerstandsdifferenzialwandler;
Erfassen einer linearen Verdrängung des Durchflusserfassungsventils über einen ersten linearen variablen Differenzialwandler;
Übermitteln der Temperatur des durch das

Durchflusserfassungsventil fließenden Kraftstoffs und der linearen Verdrängung des Durchflusserfassungsventils an eine elektronische Motorsteuerung;

Abgeben eines elektrischen Stroms an ein Servoventil durch die elektronische Motorsteuerung; und

Bewegen des Aktuators mit dem Servoventil, um den Verdrängungsmechanismus der Pumpe mit variabler Verdrängung zu betätigen und die Verdrängung der Pumpe mit variabler Verdrängung zu verändern;

Erfassen einer linearen Verdrängung des Aktuators mit einem zweiten linearen variablen Differenzialwandler;

Übermitteln der linearen Verdrängung des Aktuators an die elektronische Motorsteuerung;

Bestimmen einer tatsächlichen Durchflussrate von Kraftstoff durch das Durchflusserfassungsventil mit der elektronischen Motorsteuerung unter Verwendung der Temperatur des Kraftstoffs durch das Durchflusserfassungsventil und der linearen Verdrängung des Durchflusserfassungsventils; und

Bestimmen einer prognostizierten Durchflussrate des Kraftstoffs aus der Pumpe mit variabler Verdrängung mit der elektronischen Motorsteuerung unter Verwendung der linearen Verdrängung des Aktuators.

10. Verfahren nach Anspruch 9, ferner umfassend:
Vergleichen der tatsächlichen Durchflussrate des Kraftstoffs durch das Durchflusserfassungsventil mit der prognostizierten Durchflussrate des Kraftstoffs aus der Pumpe mit variabler Verdrängung, um die Leistung der Pumpe mit variabler Verdrängung zu analysieren.

11. Verfahren nach Anspruch 9 oder 10, wobei der Verdrängungsmechanismus eine Taumelscheibe ist.

12. Verfahren nach einem der Ansprüche 9-11, wobei das Servoventil ein elektrohydraulisches Servoventil ist.

13. Verfahren nach einem der Ansprüche 9-12, wobei der Aktuator ein hydraulischer Aktuator ist, der Kraftstoff als Hydraulikfluid verwendet.

Revendications

1. Système de pompe de dosage (10) comprenant :
- une pompe à cylindrée variable (12) comprenant une entrée (14) et une sortie (16) ;
 - une soupape de détection de débit (20) reliée fluidiquement à la sortie de la pompe à cylindrée

variable, la soupape de détection de débit comprenant :

un détecteur de température à résistance (22) configuré pour mesurer une température d'écoulement à travers la soupape de détection d'écoulement ; et

un premier transducteur différentiel variable linéaire configuré pour mesurer un déplacement linéaire de la soupape de détection de débit ;

un actionneur (30) couplé mécaniquement à un mécanisme de déplacement (18) de la pompe à cylindrée variable, l'actionneur comprenant un second transducteur différentiel variable linéaire configuré pour mesurer un déplacement linéaire de l'actionneur ;

un dispositif de commande de moteur électronique (50) en communication avec la soupape de détection de débit, le dispositif de commande de moteur électronique étant configuré pour déterminer un débit réel de carburant à travers la soupape de détection de débit en utilisant la température du carburant à travers la soupape de détection de débit et le déplacement linéaire de la soupape de détection de débit et pour déterminer un débit prédit du carburant sortant de la pompe à déplacement variable en utilisant le déplacement linéaire de l'actionneur ; et une servovanne électrohydraulique (60) connectée électriquement au dispositif de commande de moteur électronique et connectée hydrauliquement à l'actionneur, dans lequel la servovanne électrohydraulique est configurée pour entraîner hydrauliquement l'actionneur afin de déplacer le mécanisme de déplacement pour modifier le déplacement de la pompe à cylindrée variable.

2. Système de pompe de dosage selon la revendication 1, dans lequel l'actionneur (30) est un ensemble piston comprenant :

un boîtier (32) ;

un cylindre à piston (34) à l'intérieur du boîtier une chambre à fluide (36) contenue dans le boîtier sur un premier côté du cylindre de piston ; une chambre à ressort (38) à l'intérieur du boîtier et opposée à la chambre à fluide par rapport au cylindre à piston ; et

une tige de piston (40) fixée au cylindre de piston.

3. Système de pompe de dosage selon la revendication 2, dans lequel la tige de piston (40) est reliée de

manière fonctionnelle au mécanisme de déplacement (18) de la pompe à déplacement variable.

4. Système de pompe de dosage selon la revendication 3, dans lequel le mécanisme de déplacement (18) est un plateau oscillant.

5. pompe de dosage selon la revendication 1, dans laquelle la soupape de détection de débit (20), le dispositif de commande de moteur électronique (50) et le transducteur différentiel variable linéaire forment une boucle de rétroaction positive continue.

6. Système de pompe de dosage selon la revendication 1, dans lequel l'actionneur (30) est un actionneur hydraulique qui utilise du carburant pour un fluide hydraulique.

7. Système de pompe de dosage selon la revendication 1, dans lequel l'actionneur (30) est couplé mécaniquement à la pompe à cylindrée variable, le système de pompe de dosage comprenant également :

une unité d'entraînement (58) reliée à l'actionneur ;

dans lequel le dispositif de commande de moteur électronique (50) est connecté électriquement à l'unité d'entraînement ;

dans lequel le second transducteur différentiel variable linéaire (24) sur l'actionneur est configuré pour mesurer une position de l'actionneur, dans lequel le transducteur différentiel variable linéaire est en communication avec le dispositif de commande électronique du moteur ; et

dans lequel le détecteur de température à résistance est connecté électriquement au dispositif de commande électronique du moteur ; et dans lequel le transducteur différentiel variable linéaire est connecté électriquement au dispositif de commande électronique du moteur.

8. Système de pompe de dosage selon la revendication 7, dans lequel l'unité d'entraînement (58) comprend une servovanne électrohydraulique (60), et de préférence dans lequel l'actionneur (30) est un ensemble piston relié hydrauliquement à la servovanne électrohydraulique, et de préférence dans lequel la pompe à déplacement variable (12) comprend un mécanisme de déplacement (18) relié mécaniquement à l'ensemble piston, et de préférence dans lequel le mécanisme de déplacement (18) est un plateau oscillant, et de préférence dans lequel la soupape de détection de débit (20), le dispositif de commande de moteur électronique (50) et le second transducteur différentiel variable linéaire (24) forment une boucle de rétroaction positive continue.

9. Procédé de pompage dans un système comprenant :

pompage du carburant à travers le système avec une pompe à cylindrée variable, la pompe à cylindrée variable comprenant un mécanisme de déplacement relié mécaniquement à un actionneur ;
 acheminement du carburant à travers une soupape de détection de débit reliée à une sortie de la pompe à cylindrée variable ;
 détection la température du carburant circulant à travers la soupape de détection de débit via un transducteur différentiel à résistance ;
 détection un déplacement linéaire de la soupape de détection de débit via un premier transducteur différentiel variable linéaire ;
 communication la température du carburant circulant à travers la soupape de détection de débit et le déplacement linéaire de la soupape de détection de débit à un dispositif de commande de moteur électronique ;
 acheminement d'un courant électrique à une servovanne par le dispositif de commande électronique du moteur ; et
 déplacement l'actionneur avec la servovanne pour actionner le mécanisme de déplacement de la pompe à cylindrée variable et modifier le déplacement de la pompe à cylindrée variable ;
 détection d'un déplacement linéaire de l'actionneur avec un second transducteur différentiel variable linéaire ;
 communication du déplacement linéaire de l'actionneur au dispositif de commande électronique du moteur ;
 détermination, avec le dispositif de commande électronique du moteur, d'un débit réel de carburant à travers la soupape de détection de débit en utilisant la température du carburant à travers la soupape de détection de débit et le déplacement linéaire de la soupape de détection de débit ; et
 détermination, avec le dispositif de commande électronique du moteur, d'un débit prévu du carburant sortant de la pompe à cylindrée variable en utilisant le déplacement linéaire de l'actionneur.

10. Procédé selon la revendication 9, comprenant également :

comparaison le débit réel du carburant à travers la soupape de détection de débit avec le débit prévu du carburant sortant de la pompe à cylindrée variable pour analyser les performances de la pompe à cylindrée variable.

11. Procédé selon la revendication 9 ou 10, dans lequel le mécanisme de déplacement est un plateau oscillant.**12. Procédé selon l'une quelconque des revendications 9-11, dans lequel la servovanne est une servovanne électrohydraulique.****13. Procédé selon l'une quelconque des revendications 9-12, dans lequel l'actionneur est un actionneur hydraulique qui utilise du carburant pour un fluide hydraulique.**

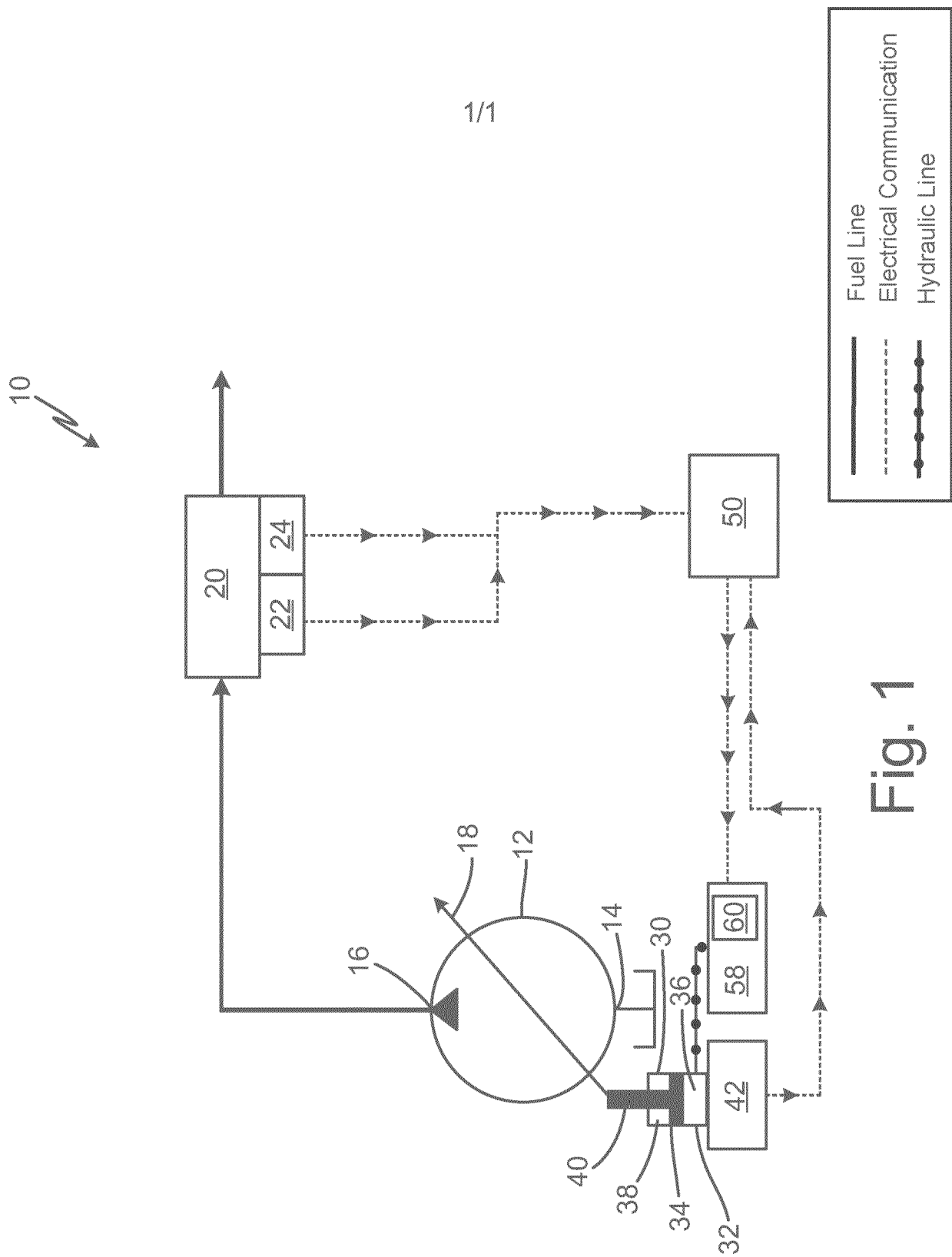


Fig. 1

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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