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(54) CONTROL SYSTEM FOR HYDROSTATIC PUMP

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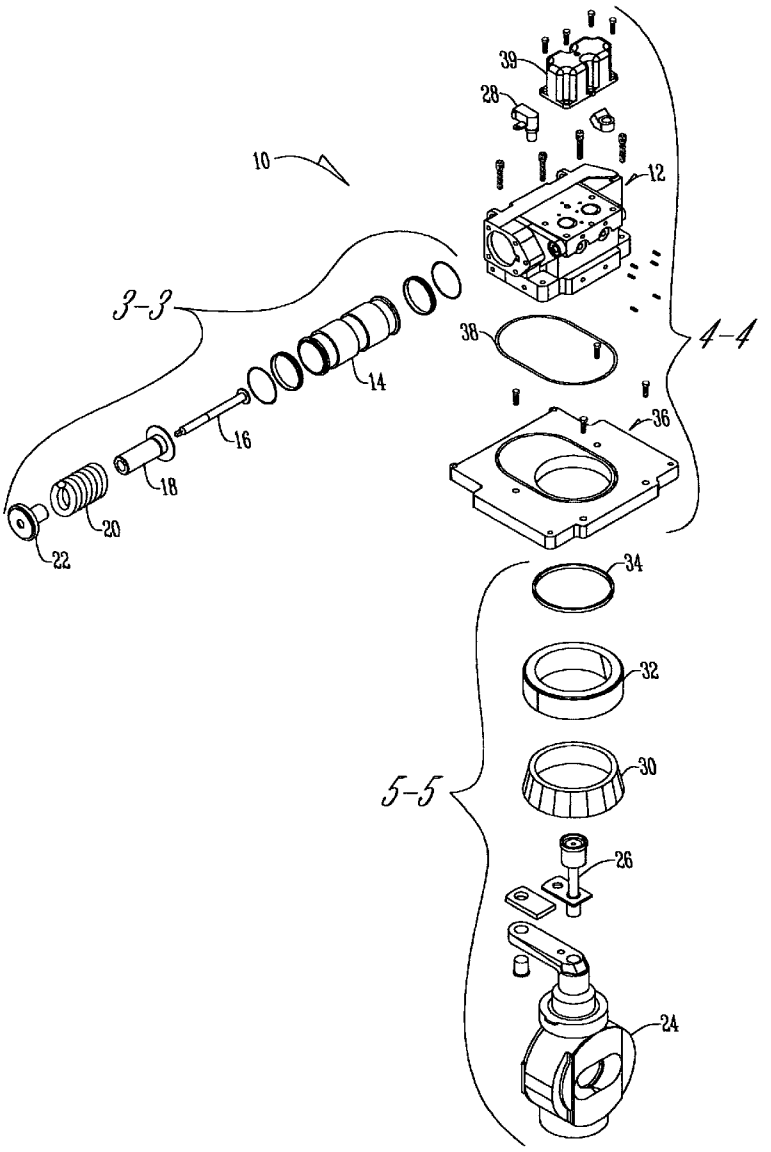
(57) ABSTRACT

A control system that can be used on a hydrostatic pump has a feedback sensor to detect the angle of a swashplate. From the information gathered by the feedback sensor about the swashplate and another set command, this information is sent to a microprocessor. The microprocessor then uses an algorithm to create an output signal and also sends out a superimposed dither signal. This dithered output signal is then received by a pressure control that causes a dither servo pressure in a servo system. Because of the dither pressure the servo system adjusts the position of the swashplate.



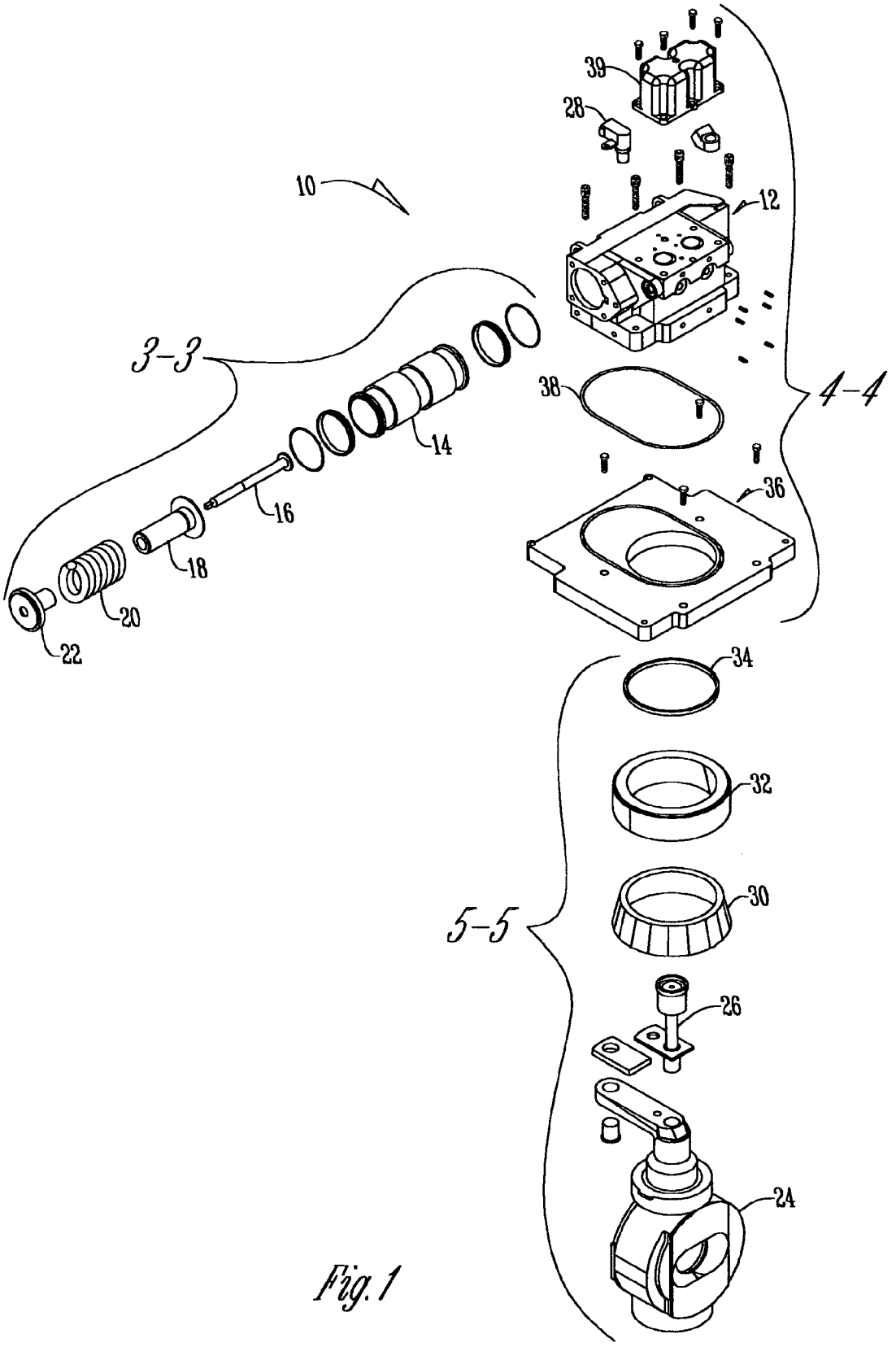


Fig. 1

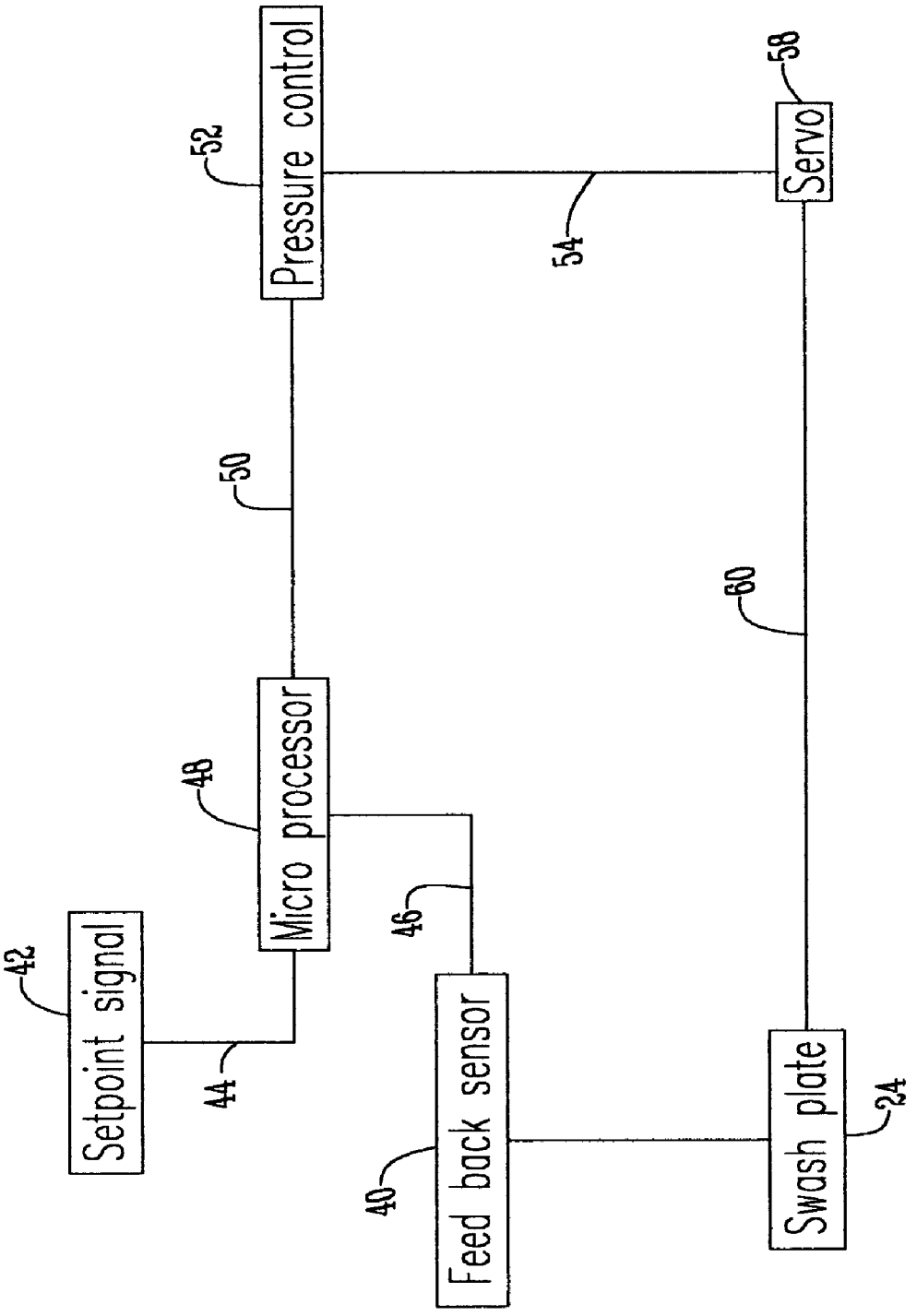

Pressure control
52
Servo
58
54
50
60
Micro processor
48
Setpoint signal
42
44
46
Feed back sensor
40
Swash plate
24

Fig. 2

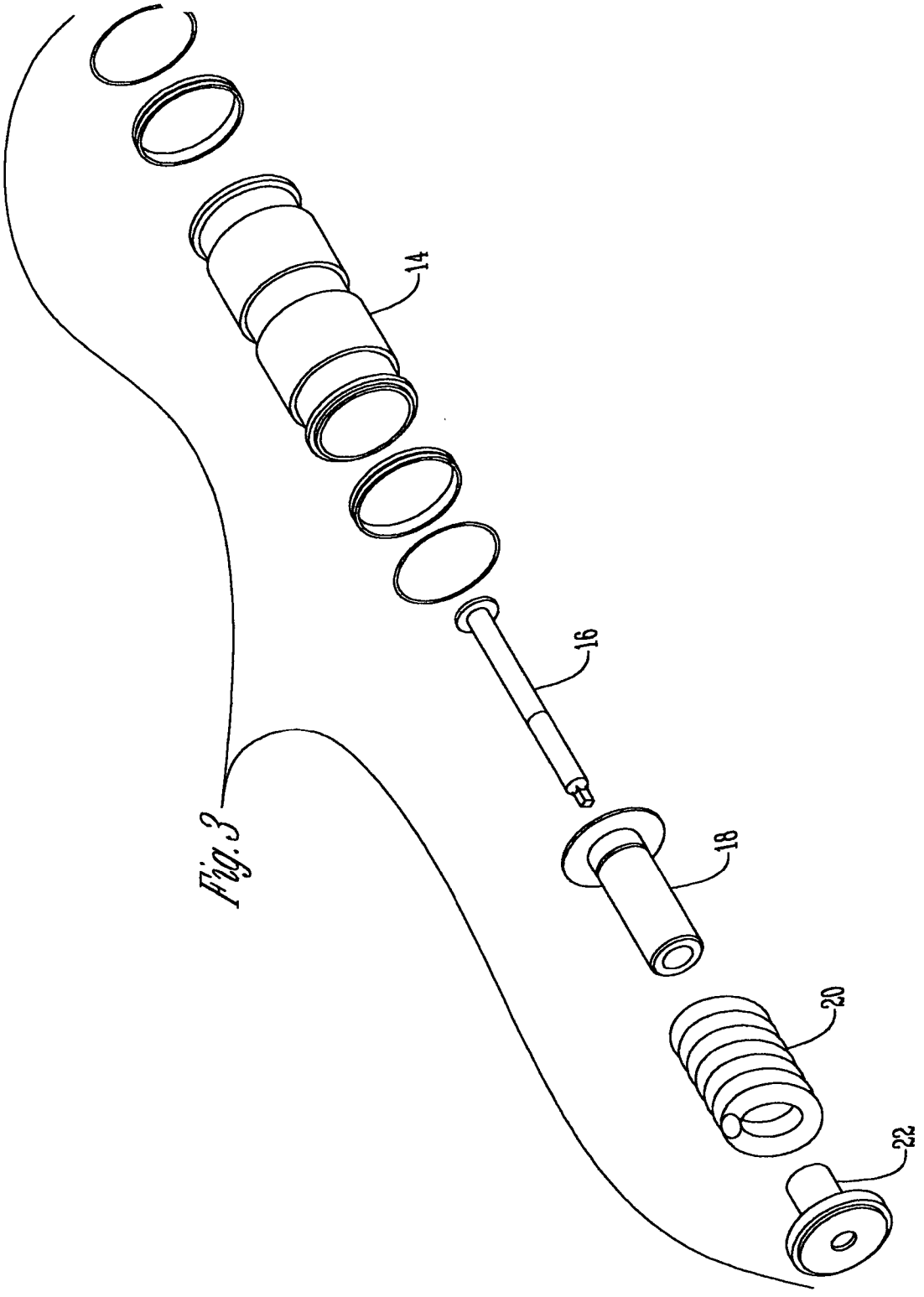


Fig. 3

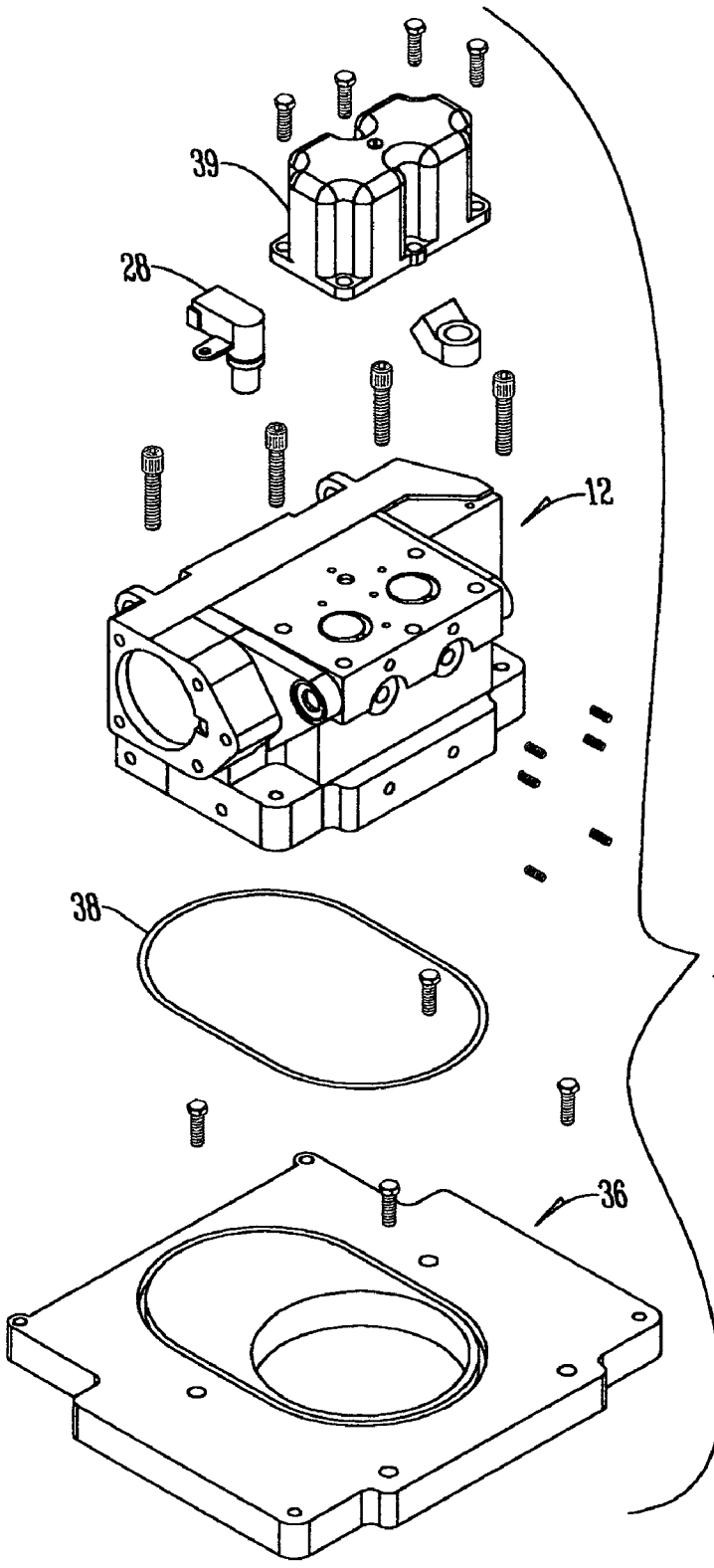


Fig. 4

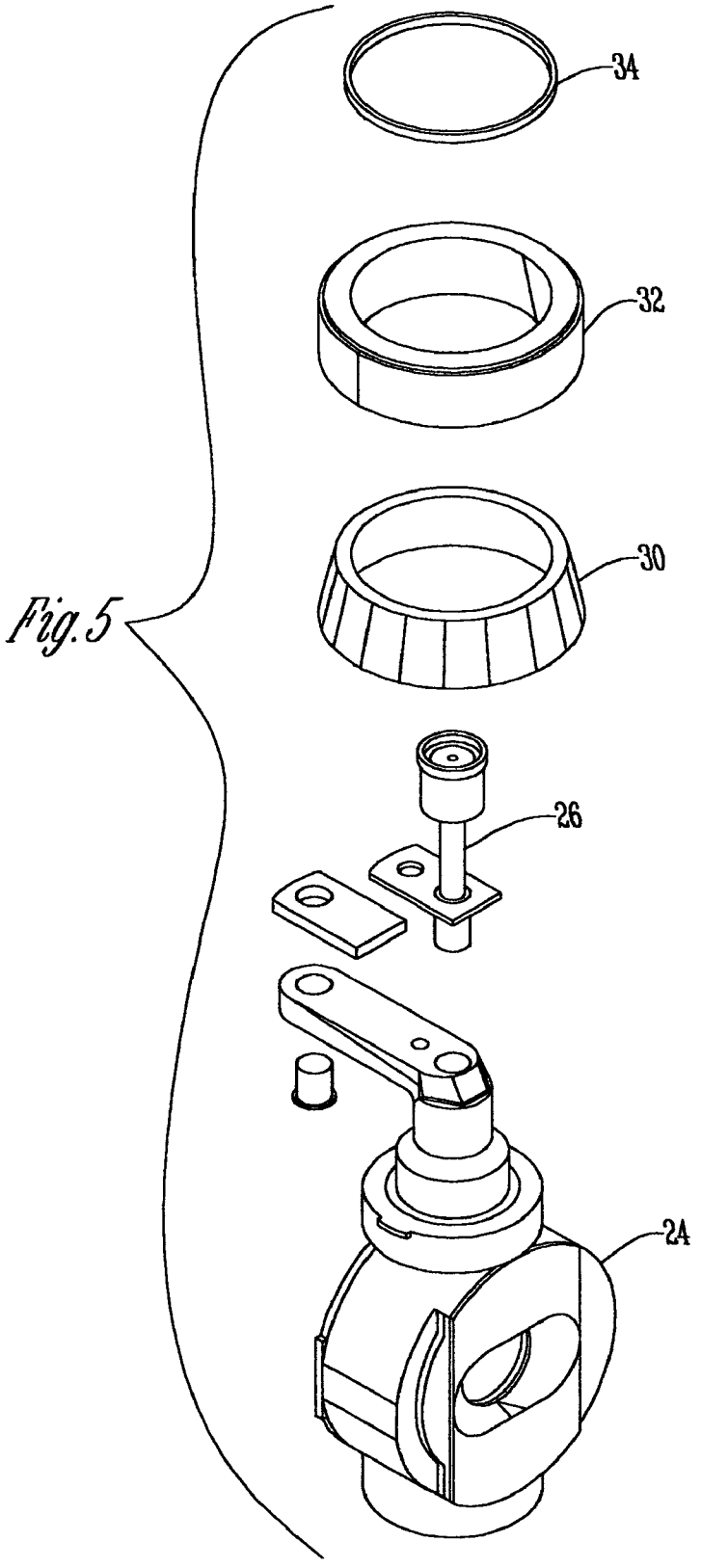


Fig. 5

CONTROL SYSTEM FOR HYDROSTATIC PUMP

BACKGROUND OF THE INVENTION

[0001] This invention relates to a control system for a hydrostatic unit. More specifically, and without limitation, this invention relates to a control system that utilizes a dither signal incorporated with its normal input signal in order to adjust the angle of a swashplate.

[0002] In the art of hydraulics, oil is pumped by mechanical hydraulic pumps for the purpose of causing a hydraulic motor to revolve, a hydraulic cylinder extend, or for other useful purposes. A common aspect of many tractors, earth-moving machines, and the like is a hydrostatic transmission. In its most basic form a hydrostatic transmission consists of a hydrostatic pump which is normally driven by an internal combustion engine, and provides a source of pressurized oil flow which causes one or more hydrostatic motors to rotate. The rotation of these one or more hydrostatic motors will cause the machine to travel forward or reverse as commanded by the drive of the machine.

[0003] The swashplate is a mechanism in a hydrostatic transmission that controls the fluid flow that a hydraulic pump may deliver. Usually the angle of the swashplate is determined by a hydraulic cylinder or servo system based on information that a control system or microprocessor receives. A typical microprocessor uses an algorithm to determine an output signal that will adjust the swashplate to a position. The pump and servo system usually do not match the resolution and accuracy of the input signal to the hydrostatic unit. This can cause the incorrect positioning of the swashplate.

[0004] Thus, it is a primary object of the present invention to provide a control system for a hydrostatic pump that improves upon the state of the art.

[0005] Another object of the present invention is to use a dither signal to improve the resolution and accuracy of fluid flow (e.g. swash angle position) of the pump and/or motor in a hydrostatic control system.

[0006] Yet another object of the present invention is to provide a hydrostatic control system that is able to adjust a swashplate angle based on system parameters using a dithered signal.

[0007] These and other objects, features, or advantages of the present invention will become apparent from the specification and claims.

BRIEF SUMMARY OF THE INVENTION

[0008] The present invention is a control system that controls the angle of a swashplate. The control system can be a microprocessor that receives information from a feedback sensor and setpoint sensor. The microprocessor determines not only the angle of the swashplate but also a set point command. From the information received from the sensor(s), the microprocessor uses an algorithm to process the information and send out an output command signal. The microprocessor can simultaneously send out a superimposed dither signal that produces a resulting signal that drives a pressure control. The pressure control in turn causes a servo system to alter the angle of the swashplate.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] **FIG. 1** is an exploded view of the hydrostatic pump of this system;

[0010] **FIG. 2** is a block representation of the control system of the present invention;

[0011] **FIG. 3** is an enlarged scale portion **3-3** of **FIG. 1**;

[0012] **FIG. 4**. is an enlarged scale portion **4-4** of **FIG. 1**; and

[0013] **FIG. 5** is an enlarged scale portion **5-5** of **FIG. 1**.

DETAILED DESCRIPTION OF THE INVENTION

[0014] The control system of the present invention can be connected to the hydrostatic pump seen in **FIG. 1**. The hydrostatic pump **10** has a central housing **12** of a standard servo hydrostatic pump. A servo piston **14** is disposed through the central housing **12**. The servo piston **14** incorporates a servo screw **16**, spring guide **18**, servo spring **20**, and spring seat **22**.

[0015] The hydrostatic pump **10** also has a swashplate **24**. Swashplate **24** is connected to a shaft feedback assembly **26** that works with the angle sensor assembly **28** to determine the angle of the swashplate **24**. The swashplate **24** connects to the central housing **12** by use of a cone bearing **30** that is connected to cup bearing **32** which is then connected to a first O-ring **34**. The first O-ring **34** rests against the bottom of plate adapter **36**. A second O-ring **38** meshes between the plate adapter **36** and the bottom of the central housing **12**. On the top of the housing is a bi-directional pressure control PCP assembly **39** having two coils. As one can appreciate from **FIG. 1** this is a standard servo hydrostatic pump.

[0016] **FIG. 2** shows in block form a typical closed loop control system can used to drive hydrostatic pump **10**. The control system includes feedback sensor **40** and an operational parameter setpoint sensor **42**. The setpoint sensor **42** sends a setpoint signal **44** and the feedback sensor **40** detects the angle of the swashplate **24** and sends a feedback signal **46**. Both the setpoint signal **44** and the feedback signal **46** are received by a device having the capability to produce a dithered electrical control signal. This device in a preferred embodiment is a microprocessor **48** as pictured; however, in alternative embodiments the device may be an electric joystick, an electric foot pedal control, or any other device that can produce a dithered output signal. The microprocessor **48** then sends out a control signal **50** comprised of an average signal and a dither signal. A pressure control **52** then receives the control signal **50** and creates a pressure signal **54** or **56** that is sent to a servo system **58**. The servo system **58** then produces a force **60** that alters the position of swashplate **24**. It should be appreciated that the feedback sensor **40** is optional as the system can improve performance in a closed loop as well as open loop mode.

[0017] In the microprocessor **48** an error signal is generated which is processed through a typical closed loop algorithm. These algorithms include, but are not limited to, PID, PID plus feed forward, and KIDT1. From the output of the algorithm(s) the microprocessor **48** creates an output signal that is superimposed with a dither signal generating the resulting signal **50** that is received by pressure control **52**. It should be appreciated that the pressure control **52** can

be of any type, including but not limited to a flapper nozzle style pilot valve with two boost spools, a flapper nozzle style pilot valve with one boost spool, a flow control (a device that converts an electrical signal into an hydraulic signal to position the swashplate), or a plurality of pressure controls.

[0018] The pressure control **52** responds to the output signal and the dither to generate a dithering servo pressure. Based on this dithering servo pressure the max slew rate of the swashplate **24** is determined. The pump swashplate **24** position is therefore determined by the typical force balance of the servo springs, servo pressure, pressure moments, speed moments, and other system factors.

[0019] It should be appreciated that the dither signal created by the microprocessor **48** can be independent or dependent of the swash angle value related by feedback sensor **40**. Furthermore, the feedback sensor **40** and the closed loop algorithm used by the microprocessor can be any standard feedback sensor or algorithm. In the current embodiment the microprocessor **48** generates the dither signal; however, the dither signal could also be generated internally in the pressure control **52** or externally in another device.

[0020] It will be appreciated by those skilled in the art that other various modifications could be made to the device without the parting from the spirit in scope of this invention. All such modifications and changes fall within the scope of the claims and are intended to be covered thereby.

What is claimed is:

1. A control system for a hydrostatic unit having a swashplate comprising:

an electronic means for producing a dithered output signal;

a pressure control adapted to receive the dithered output signal and position the swashplate.

2. The control system for a hydrostatic unit of claim 1 wherein the electronic means is a microprocessor.

3. The control system of claim 2 wherein the microprocessor receives information from a set point command signal.

4. The control system of claim 2 wherein the microprocessor receives information from a feedback sensor.

5. The control system of claim 1 wherein the pressure control is a flapper nozzle style pilot valve with two boost spools.

6. The control system of claim 1 further comprising:

a servo system operably connected to the pressure control and swashplate.

7. A method of controlling the angle of a swashplate of a hydrostatic unit having a swashplate comprising steps of:

generating an electric signal based on a set point signal;

receiving the electric signal in a microprocessor;

interpolating the information from the electric signal using an algorithm contained in the microprocessor;

sending an output signal from the microprocessor to a pressure control;

dithering the output signal; and

generating a dithered pressure from the pressure control that displaces the swashplate.

8. The method of claim 7 wherein the set point signal is generated by measuring an operational parameter.

9. The method of claim 8 wherein the operational parameter is the angle of the swashplate.

10. The method of claim 7 wherein the algorithm is a PID type algorithm.

11. The method of claim 7 wherein the algorithm is a PID+feed forward algorithm.

12. The method of claim 7 wherein the algorithm is a KIDT1 algorithm.

13. The method of claim 7 wherein the pressure control is a flapper nozzle style pilot valve with two boost spools.

14. The method of claim 7 wherein the pressure control is a flapper nozzle style pilot valve with one boost spool.

15. The method of claim 7 wherein the pressure control is a flow control.

16. The method of claim 7 wherein the pressure control is comprised of two pressure controls.

17. The method of claim 7 wherein the output signal is dithered by the pressure control.

18. The method of claim 7 wherein the output signal is dithered by the microprocessor.

19. A control system for a hydrostatic pump having a swashplate comprising:

a feedback sensor adapted to sense the angle of the swashplate;

a microprocessor adapted to receive information from the feedback sensor and produce a dithered output signal;

a pressure control adapted to receive the dithered output signal and position the swashplate.

20. The control system of claim 19 wherein the microprocessor is also adapted to receive information from a set point command signal.

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